The anatomy of dialogue in out-of-hospital cardiac arrest resuscitation

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Abstract

Research on medical teams constantly recognise the crucial value of communication. Studies on various medical teams, such as surgery and trauma, provide evidence for how communication either affects or is affected by a range of outcomes and variables. Nevertheless, much of this work has focused on in-hospital communication. Less is known about the patterns of communication amongst medical practitioners in high-stakes emergency care outside of the hospital. This thesis presents an investigation of dialogue during pre-hospital resuscitations when paramedics are responding to out-of-hospital cardiac arrest (OHCA).

A bespoke dialogue annotation system, called the Dialogue Annotation for Resuscitation coding scheme (DARe), is developed for this purpose. DARe is used to annotate four simulated and 40 real-life OHCA resuscitation attempts by paramedics who are based in Edinburgh, Scotland. We examine (1) the distributions of communicative functions and subject matters (threads); (2) specific statements used by team members to align themselves; (3) the prevalence and forms of mitigated directives; (4) the verbal manners of planning; (5) the occurrence of closed-loop communication and other structures of verbal communication loops; and (6) the prevalence of socioemotionally-related utterances. For the real-life resuscitation dialogues, the study additionally investigates (7) the correlations between the distributions of the dialogue patterns with the assessed performance of resuscitation team leaders and with the time taken to successfully deploy a mechanical chest compression device (AutoPulse).

Analysis for the simulation dialogues was performed from the start of simulation until the end or near the end of the procedure, whilst analysis for the real-life dialogues concentrated on the first five minutes. Despite this difference in timing, the results showed that simulated and real-life OHCA dialogues comprised similarly high frequencies of statements, directives, acceptances, and acknowledgments. Both simulated and real-life dialogues also contained sociolinguistic influences from the linguistic context that these were derived from, i.e. Scottish English.

In considering the threads across both settings, the largest proportion of threads revolved around planning and execution of tasks, followed by threads on patient history and related instrument/equipment. Dialogues during real-life OHCA resuscitations differed from the simulated resuscitations in the additional presence of two communicative techniques, namely *Alerters* (used to attract hearer's attention) and *Affective performatives* (used to convey affective or socioemotional statements). Additionally, real-life resuscitation dialogues contained a larger proportion of threads pertaining to patient positioning due to the use of the AutoPulse.

Resuscitation team members often used a statement structure called *State-awareness* to align themselves with one another in terms of their current state or task. Directives were frequently mitigated, with strategies ranging from simple use of softeners (e.g. *please*) to less straightforward directive structures (e.g. suggestion). Plans were verbalised in temporal clusters, i.e. distinguishable in terms of the immediacy of the task to be performed. Few verbal affective behaviours (e.g. humour, gratitude, compliments) were observed. Team members also used very few exchanges that resembled the standard, three-level closed-loop

communication structure typically required from professionals in other high-stakes dialogue environments.

Correlation analyses revealed that the frequencies of both the communicative functions and threads were associated with the performance scores of resuscitation team leaders. Teams led by higher rated leaders (the ideal score group) showed higher proportions of *Alerters, Affective performatives, State-awareness,* and *Plan of action* in their dialogues compared to teams led by lower rated leaders (the low score group). There were also variations in the concentrations of chest compressions, patient history, and rhythm threads in the two groups, indicating that both discussed the same threads but at different junctures of the procedure. Meanwhile, the time taken to deploy the AutoPulse was positively correlated with the communicative function *Acknowledge* and the threads *Patient history* and *Movement other than patient,* and negatively correlated with the communicative function *Open-option* and the threads *Ventilation* and *Airway access.*

Based on these results, several potential measures for optimising OHCA resuscitation are proposed: the use of sewn-on name badges for paramedics; shorter time dedicated for the extraction of patient history; verbal reports of vital points throughout the procedure; the use of non or less mitigated directives; and standardisation of resuscitation phrases. Each suggestion is also discussed in terms of anticipated challenges and possible solutions.

The results presented in this thesis provide grounds for further research on the features of pre-hospital resuscitation dialogues. DARe has been demonstrated to be useful in discriminating linguistic patterns, suggesting that dialogue annotation analysis can be utilised to further investigate this area and ultimately contribute to resuscitation performance.

Lay summary

Communication is an important element in the medical domain. Studies on medical team communication show that communication patterns can affect the outcome of a medical procedure. However, previous studies mostly revolve around teams that work in a hospital (e.g. surgery teams), and less often on medical teams that work out of the hospital or pre-hospital (e.g. paramedic teams). In addition, medical team communication studies rarely examine the linguistic characteristics of the team dialogues. Hence, very little is known about pre-hospital team communication and whether any of its patterns is associated with outcomes. This study attempts to fill these gaps by investigating paramedic communication during out-of-hospital cardiac arrest (OHCA) resuscitations.

To achieve this aim, we developed a dialogue analysis tool called the Dialogue Annotation for Resuscitation (DARe) coding scheme. DARe is used to categorise the paramedic dialogue into various communicative functions, such as questions, instructions, statements, etc., and contents (called threads), such as patient history, medication, heart rhythm, etc. This allows us to distinguish the linguistic characteristics of the dialogue. Using this coding scheme, we analysed four simulated and 40 real-life resuscitation attempts by paramedics who are based in Edinburgh, Scotland.

Results revealed that, overall, paramedic communication during OHCA resuscitations contained high frequencies of plan-related statements and instructions, but few social elements such as compliments and gratitude. We found team leader performance scores to be associated with both the communicative function and thread frequencies. Teams managed by leaders with higher rated performance scores used higher proportions of statements that help align team members with one another; plans that coordinate team members' tasks and movements; social elements; and names or terms used to alert hearers.

Our results also revealed that there were differences between the resuscitation dialogues in the simulated setting and real-life setting. There were fewer occurrences of verbal affective behaviours or positive politeness in the simulation dialogues. We also discovered that in simulation dialogues, paramedics did not discuss threads pertaining to movement and space as frequently as in the real-life dialogues. However, both sets of dialogues contained sociolinguistic influences from the Scottish English context in the forms of words and sentence structures.

In addition, teams with higher rated leaders discussed their patients' heart rhythms and gathered their patients' medical history earlier. Results also showed that the time taken to set up the mechanical chest compression device (AutoPulse) was associated with several communicative function and thread distributions. Our findings indicate the possibility of using these kinds of dialogue features to help improve the resuscitation procedure. Moreover, we observed that closed-loop communication, a commonly-suggested communication strategy for teams in high-risk settings, was not widely used in OHCA resuscitation team communication, suggesting further needs to understand pre-hospital resuscitation dialogue in order to develop more feasible, context-specific strategies.

Based on the findings, we offer several potential measures that could be useful in optimising OHCA resuscitation communication. These are: for paramedics to have sewn-on name badges, which will allow others to address them by name especially before giving instructions; dedicating a shorter time for the extraction of patient history to allow focus on other resuscitation tasks; giving verbal reports of vital points throughout the resuscitation procedure; using succinct directives rather than mitigated ones; and standardising resuscitation phrases, starting with phrases used during defibrillation. Each suggestion is also discussed in terms of its anticipated challenges and possible solutions.

Through the work presented here, we have demonstrated the utility of the DARe coding scheme in discriminating linguistic characteristics in resuscitation dialogue and how the data could be explored to understand the way resuscitation dialogue unfolds. This thesis thus offers the first step towards expanding our knowledge of an underexplored research area through the use of dialogue annotation. We are confident that the results presented in this thesis would help contribute to the optimisation of the resuscitation procedure.

Declaration

I declare that this thesis is of my own composition, and the work presented here is entirely my own, unless stated otherwise by reference or acknowledgment. It has not been submitted, in whole or in part, in any previous application for a degree or professional qualification.

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"The science behind what it takes to improve survival is not difficult to understand. However, delivering a consistently effective response to OHCA is not straightforward."

Maureen Watt, MSP Minister for Public Health, in OHCA: A Strategy for Scotland, 2015, p. 1

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Introduction

1.1 Restarting a heart

Out-of-hospital cardiac arrest (OHCA) is one of the most prominent medical emergencies worldwide. OHCA accounted for approximately half a million deaths per year in Europe and North America alone (Eisenberg et al., 2016). Due to its nature, a cardiac arrest is classed as a Category A (immediately life-threatening) incident (British Heart Foundation, 2014). When cardiac arrest occurs, the heart stops pumping blood normally, causing a loss of blood circulation to vital organs. Consciousness is typically lost in seconds. Without any chest compressions, a patient's chance of survival decreases 10% for every minute that passes, with biological (as opposed to clinical, or brain) death after roughly 10 minutes (Eisenberg et al., 2016).

On average, OHCA survival rates have been fairly low. An international, multisite study that tracked OHCA survival outcomes from 27 European countries revealed that overall survival rate was at 10.3% (Gräsner et al., 2016). In the United Kingdom, where annually, around 30,000 cardiac arrests occurred outside of the hospital setting, survival rates were found to vary between 2-12% (Perkins & Brace-McDonnell, 2015). London Ambulance Service reported to have resuscitated 4,389 OHCA patients between the year 2017 to 2018, with a survival-to-hospital discharge (i.e. when a patient survives cardiac arrest and is discharged from a hospital) rate at 9.4% (London Ambulance Service, 2018), whilst Scottish Ambulance Service resuscitated 3,484 patients within the same period, with a survival-to-discharge rate reported at 8.3% (Clegg, McGivern, Bywater, & Short, 2018).

The determinants of survival, however, are not based upon a single variable, but on three sets of factors – patient, event, and system (Eisenberg et al., 2016). Patient factors (e.g. co-morbidity, age) and event factors (e.g. witnessed or unwitnessed arrest, heart rhythm) are influential to the outcomes (Sasson, Rogers, Dahl, & Kellerman, 2010) but are unalterable. System factors on the other hand, which include the configuration and quality of the procedure, are very much dependent on both the individual level, i.e. the person(s) attempting resuscitation (the quality of chest compressions, efficiency of teamwork, etc.), and the organisation level, i.e. the coordination of the overall resuscitation routine (the effectiveness of ambulance triage, the ability to deliver care quickly, etc.). System factors therefore can be adjusted and continuously improved until these reach the gold standards that would optimise OHCA resuscitation and bring about desired outcomes.

Figure 1 illustrates an approximate flow of OHCA survival. The numbers are approximations from Scotland's OHCA data (*Out-of-Hospital Cardiac Arrest: A Strategy for Scotland*, 2015).

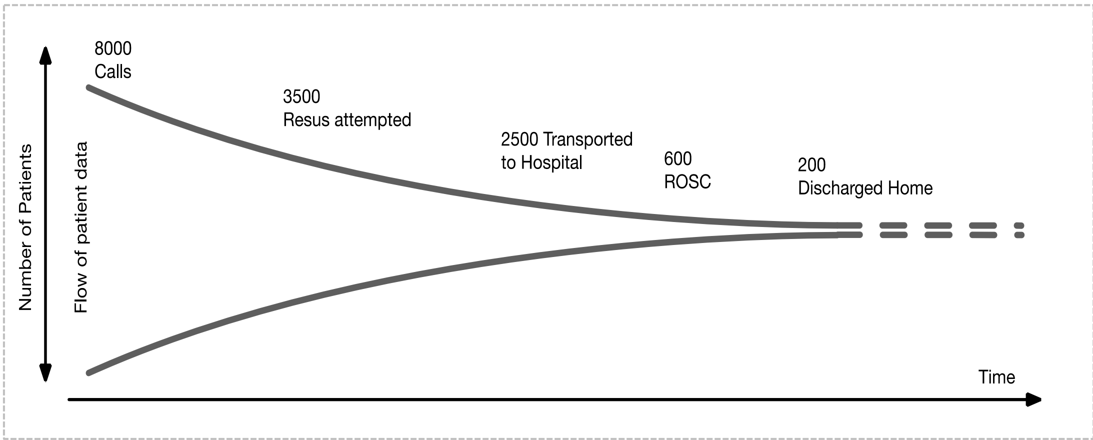


Figure 1. The OHCA survival funnel showing approximate numbers of survival against time.
Resus: Resuscitation; ROSC: Return of spontaneous circulation

Even though generally the survival rates of OHCA are low, some regions reported better survival outcomes. For instance, the survival rates from St. John Emergency Ambulance

Service New Zealand for the period between 2016 to 2017 were slightly higher at 12% for all resuscitation attempts (Dicker, Howie, & Tunnage, 2017). Even higher survival rates (22% for all resuscitation attempts) were reported in Seattle and King County, United States of America (*Out-of-Hospital Cardiac Arrest: A Strategy for Scotland*, 2015). In contrast to these, Scotland's rate of OHCA survival is strikingly lower. As part of a plan to improve desirable outcomes of pre-hospital cardiac arrest, Scotland launched a five-year plan called *Out-of-Hospital Cardiac Arrest: A Strategy for Scotland,* which commenced in March 2015. The main aims of the plan are to increase OHCA survival rates by 10% across Scotland within five years and make Scotland an international leader in OHCA management by 2020. Part of the strategies mentioned in the plan is the recognition and integration of non-technical skills, like leadership and communication, into resuscitation team training.

Variables contributing to desirable OHCA outcomes

Regions with higher-than-average number of OHCA survival rates have been found to share several elements when dealing with OHCA (*Out-of-Hospital Cardiac Arrest: A Strategy for Scotland*, 2015). Seven such elements are identified and listed in the report, as follows:

1. The existence of a cardiac arrest registry
2. The mapping and dispatching of community first responders and defibrillators
3. Concerted efforts to increase bystander CPR[1]
4. Utilisation of multiple emergency service trained co-responders
5. Rapid deployment of advanced paramedics
6. Dedicated receiving units for post-cardiac arrest
7. The use of performance feedback

From the list, point number 5, regarding advanced paramedics, and number 7, regarding performance feedback, are of interest to the current study. In the Edinburgh region, a specialist, second-tier paramedic response to OHCA is provided by a unit called the Resuscitation Rapid Response Unit or 3RU (see the Resuscitation Research Group website, http://www.rrg-edinburgh.com/projects/3ru/, for more information). 3RU paramedics are continuously trained for pre-hospital resuscitation. Training includes a twice-monthly

[1] Cardiopulmonary resuscitation: A medical technique used in a cardiac arrest. The term "CPR" includes all procedures involved in the technique (Resuscitation Council UK)

resuscitation and non-technical skills practice sessions (Lyon, Crawford, Crookston, Short, & Clegg, 2015). 3RU paramedics are also familiar with performance feedback, although to our knowledge, this has not included analysis of specific dialogue acts that might help optimise the resuscitation procedure.

One element that is not explicitly mentioned in the list but has been consistently established to affect clinical outcome is *communication*. Reports and studies on how medical communication can result in adverse events are widespread in the literature. Poor communication, for instance, has been shown to be an actual or potential contributor to adverse outcomes (e.g. Britten, Stevenson, Barry, Barber, & Bradley, 2000; Lingard et al., 2004; Greenberg et al., 2007; Sutcliffe, Lewton, & Rosenthal, 2004). The Joint Commission (2015) listed communication as one of the top three root causes of adverse medical events in the United States in three consecutive years (2013 to 2015). Similarly, the CRICO Annual Benchmarking Report (2015) on malpractice risks showed that communication failures contributed to 30% of cases filed between 2009-2013.

1.2 Medical communication: Previous research and open questions

Previous communication research in the medical setting has principally revolved around observable behaviours in medical teams. Communication between team members is typically assessed using scoring tools that subsume verbal behaviours under various behavioural categories like teamwork, decision-making, and leadership. Studies have revealed associations between the use of particular dialogue patterns and outcomes. For instance, when the wordings in the instructions for CPR were changed, the performance of chest compressions also changed (Mirza et al., 2008). More recently, a study discovered that different linguistic strategies used by call handlers to persuade callers to do CPR yielded different caller compliance (Riou et al., 2018). In the resuscitation setting, it was found that leadership strategies that resulted in quicker task performance were correlated with the specific dialogues that the leaders used (Hunziker et al., 2010). These kinds of findings suggest that it would be worthwhile to investigate medical team communication on a micro level; that is, by paying attention to specific words and linguistic strategies used by the team members.

However, rarely has communication in medical teams, in terms of dialogue structures and linguistic strategies, been studied on its own. The few studies that analysed team dialogues (e.g. Calder et al., 2017; Xiao, Seagull, Mackenzie, Ziegert, & Klein, 2003) applied limited or unspecified dialogue annotation schemes which were often not based on any linguistic frameworks; thus, results are not immediately comparable. For instance, what counts as a *request* in one study may entail all types of directive-related acts (e.g. commands, instructions, recommendations, etc.), but in another study, the same term may be used to only capture a specific linguistic form. Consequently, very little is known about the linguistic conventions and strategies used by medical teams, especially during real-life medical procedures. To our knowledge, there has been no published study that examines medical team dialogues in a time-constrained, pre-hospital resuscitation setting using a linguistically-based dialogue annotation scheme.

Having said that, it does not mean that there are no dialogue studies at all in the medical field. Fine-grained dialogue studies using principled linguistic approaches have been limited to inter-medical communication research, i.e. dialogues between a medical expert and a non-expert. Inter-medical communication research has been overwhelmingly dyadic in nature, which means that the communication takes place between two people (one speaker and one hearer), typically a physician and a patient. When compared with the findings from the few dialogue studies on medical team communication, it is apparent that the communication patterns differ in these two types of settings. Team communication is far more complex than dyadic communication as the former involves more interlocutors. Additionally, dialogue exchanges between people who share the same knowledge base (i.e. two medical experts) might show a different pattern compared to dialogue exchanges between people who do not share the same knowledge base (i.e. a medical expert and a lay person). Finally, a physician-patient consultation and a time-constrained, high-risk medical procedure are two dissimilar environments.

Seeing how communication can impact medical outcomes, it is imperative to study the structures of dialogue exchanges as they occur. Instead of analysing communication in medical teams as part of observable behaviours, this present study proposes that the dialogues in this kind of environment be analysed using a dialogue annotation system that is constructed based on a linguistic theory. This would allow a more thorough investigation of how naturally occurring language is related to, or reflects, the structure of the procedure it occurs in.

1.3 What the present study addresses

The present study is exploratory in nature. It investigates dialogue patterns and five different areas related to paramedic communication during OHCA resuscitations. We demonstrate the usefulness of using a dialogue annotation scheme that is based on a linguistics model, i.e. Speech Act Theory, to analyse these features. The results inform us about communication patterns during OHCA resuscitations, allow correlational analysis with outcomes and related variables, illuminate areas that could contribute to the optimisation of OHCA resuscitation, and help establish the grounds for further dialogue research concerning pre-hospital resuscitation.

The present study investigates four simulated resuscitations and 40 real-life resuscitations. All the data from this study originate from paramedic teams based in Edinburgh, Scotland. The four simulations form the preliminary study and act as a point of comparison for the real-life findings. For the real-life resuscitation attempts, the study focuses on the first five minutes after the team leaders' arrival on scene, for reasons that are discussed in Chapter 5. All dialogues are annotated using a dialogue annotation scheme which has been developed specifically for this project, introduced in Chapter 3.

1.4 Outline of the thesis

Chapter 1 introduces the study. Here, we introduce out-of-hospital cardiac arrest and resuscitation in general, including survival rates and the current agenda in Scotland (Save A Life for Scotland). We discuss communication as a crucial aspect of medicine and the gap in the current knowledge when it comes to medical team communication. The discussion in this chapter feeds into the literature review in Chapter 2.

Chapter 2 starts with a literature review on medical communication and how this area can be categorised into two major research domains: inter-medical communication research (medical expert – non-expert) and intra-medical communication research (medical expert –

medical expert). Each research domain is discussed in terms of previous findings and common motivations. We focus on the research approach that is usually applied in these domains, showing that dialogue annotation is often applied to analyse dialogues in the inter-medical domain, but seldom applied to analyse dialogues in the intra-medical domain. This is followed by discussion of non-technical skills (NTS) and the use of NTS rating tools to assess medical team communication. We follow with reviews of previous studies that applied dialogue annotation and studies that used NTS rating tools. The chapter continues with discussion of communication strategies that have been recommended for effective team communication, focusing on relevant strategies for resuscitation, specifically, the recommendation to use standard phrases or words and the use of closed-loop communication (CLC). This chapter also highlights how prior work has left open questions on these strategies that the present research will seek to address in subsequent chapters.

Chapter 3 describes the development of the dialogue annotation scheme applied in the current study, i.e. **D**ialogue **A**nnotation for **Re**suscitation (DARe). In this chapter, we consider 12 different dialogue annotation schemes that have been developed for various studies and may be relevant in some ways to our present purposes. We start with a review of six generic (i.e. non-medical) dialogue annotation systems – Dialogue Act Markup in Several Layers (DAMSL); Human Communication Research Centre (HCRC); Dialogue Act Markup Language (DiAML); TRAINS; Augmented Multiparty Interaction (AMI); and Cross-cultural Speech Act Realisation Project (CCSARP). Each is examined based on its theoretical framework, categories of codes or functions, and the context it is used in. This is followed by a review of six dialogue annotation schemes that have been specifically developed for medical settings: Verbal Response Mode (VRM); Communicative and Competence System (CACS); Roter Interaction Analysis System (RIAS); Medical Interaction Process System (MIPS); Generalised Medical Interaction Analysis System (GMIAS); and Dialogue acts in clinical research data query mediation (DREAM). These are also discussed based on their theoretical frameworks, coding categories, and the medical contexts they were developed for. Following this, we describe the development of DARe. We explain how the coding categories in the two sections of DARe (i.e. the communicative function and the subject matter under discussion, or thread, sections) are either selected from previous dialogue annotation schemes or developed from existing procedure guidelines. This is followed by results from the test annotations, which are implemented on resuscitation dialogues from four simulated scenarios. Based on the results, we detail issues and adjustments made to the annotation scheme. The latest coding system is given at the end of the chapter.

Chapter 4 describes the findings and discussion from the four simulation dialogues annotated using DARe. This preliminary study attempts to explore six questions concerning 1) the distributions of communicative functions and threads; 2) verbalisation of situation awareness; 3) the structure of verbal orders or directives; 4) verbalisation of plans; 5) the use of standard CLC as a strategy; and 6) verbal affective behaviours in resuscitation dialogues. Each question is discussed in its own section, with the first question separated into two. The first section presents findings from communicative function coding and the second section presents findings from thread coding. The results and discussions in Chapter 4 provide a platform for the analysis and discussions of real-life resuscitation dialogues in the following chapter.

In Chapter 5, we report results from applying the DARe coding system to the first five minutes of 40 real-life OHCA resuscitation dialogues. Following the structure in Chapter 4, we explored the six aforementioned areas related to paramedic communication during OHCA resuscitation with one addition: we also test possible correlations between the communicative functions and threads with the time that the teams needed to deploy a mechanical chest compression device (AutoPulse) and the team leaders' technical and non-technical performance scores. Findings and discussions of these are presented under eight separate sections. The first seven sections mirror those for simulated resuscitations in Chapter 4 and the eighth section deals with the additional research areas, i.e. the correlational analyses.

In the final chapter, Chapter 6, we conclude the current work, discuss its implications, propose potentially beneficial actions based on our findings, and consider future directions for research in this area.

2

Literature review

Introduction

Studies looking into the structure of communicative practices often utilise dialogue annotations to capture the kinds of dialogues and frequencies of particular dialogue moves that occur in the studied context. This approach has provided some insights into common practices in communication but is rarely applied for studying communicative practices in high-stakes environments like medical procedures. Dialogue analysis can be a useful tool in understanding how communication occurs in such environments and how dialogues may contribute to the outcomes. In addition, analysis of real-life dialogues can shed light on team communication, extending beyond analysis of dialogues procured from simulated scenarios. As it is widely accepted in the literature that communication affects medical outcomes, it follows that examining dialogue acts or speech acts – the building blocks of communication – may yield answers about which types of verbal behaviour or pattern are related to outcomes. This knowledge can be used to inform professional practices.

The present research investigates paramedic verbal communication during out-of-hospital cardiac arrest (OHCA) resuscitation. It attempts to uncover the kinds and frequencies of dialogue acts, or speech acts, and semantic content used by the resuscitation team members and utilise these to explore themes related to resuscitation dialogue. We also sought to examine whether particular linguistic patterns and/or content patterns are linked to outcomes like the team leader's performance scores and time taken to deploy the mechanical chest compression device.

This chapter provides a background against which the present research is situated. There are two parts to the chapter. Part One opens with discussion on medical communication and its impact on medical outcomes to outline the importance of communication to medical practices. This is followed by discussion of *inter-medical communication research*, one of the two research areas of medical communication identified in this study. Part One considers the use of and findings from dialogue annotation schemes in this research area. The discussion shows that studies in this area are almost always focused on dyadic interactions. It further considers the evidence regarding the usefulness of dialogue annotation as an approach.

The next section of Part One focuses on the second area of medical communication studies, called *intra-medical communication research*. This section starts with reviews of prior studies in this area before continuing to describe and discuss the approaches used to study communication between medical experts. Emphasis is given to the discussion of non-technical skills (NTS) rating tools as one of these approaches. The discussion here shows the absence of a dialogue annotation scheme in medical team interaction studies and the possible ways that it could contribute to the pool of information on medical team communication.

Part Two reviews more specific studies on resuscitation and paramedics. It starts with a brief introduction on resuscitation and prior studies on resuscitation, then moves to studies that involved paramedics. The discussion attempts to highlight the paucity of research concerning communication during actual pre-hospital resuscitation attempts – a procedure that falls under the paramedic jurisdiction.

PART ONE

2.1 Medical (mis)communication and adverse outcomes

The importance of communication in the medical field is widely accepted. Numerous studies and reports maintain that ineffective communication leads to adverse effects, with various outcomes ranging from mild confusion to legal actions to fatality. A summary of several such outcomes is given in Table 1:

Studies by	Reported/Discovered adverse effect	Communicative domain if known
Britten et al., 2000; Mira et al., 2013	Confusion with dosage or type of medicine	Physician – patient
Berry, Knapp, & Raynor, 2006; Peter, Sol Hart, Tusler, & Fraenkel, 2014	Lower likelihood of medication adherence/willingness to take medication	Physician – patient
Cooke, Wilson, Cox, & Roalfe, 2000	Inaccurate treatment or overtreatment	Physician – patient
CRICO, 2015 (Annual Benchmarking Report)	Medical malpractice cases – roughly 30% out of 23,658 reported cases	Various
Chassin & Becher, 2002; Lingard et al., 2004	Wrong-site surgery/wrong patient, procedural error, team tension, delay	Surgery/Operating Theatre
Knaus, Draper, Wagner, & Zimmerman, 1986	Higher mortality rates in ICU patients	Various, but inter-team-related
The Joint Commission, 2015 (Sentinel Event Data)	Death and/or permanent loss or function	Various, self-reports from hospitals

Table 1. Adverse effects due to miscommunication in various medical domains

Research on medical communication generally falls into one of two categories: that looking at communication between medical professionals and lay people, e.g. between general practitioners and their patients, and that focusing on communication between members in the health profession, e.g. between surgery team members. As shown in Table 1, adverse outcomes can emerge from either category (i.e. poor or ineffective communication between medical experts and non-experts and/or between members in medical teams). In the present research, the former is termed *inter-medical communication* research and the latter *intra-medical communication* research. Inter-medical communication research is discussed in the next section, and intra-medical communication research is discussed in Section 2.2.

2.2 Inter-medical communication research

Research on communication between medical experts and lay people typically involves physicians and their patients, as shown in Table 1 by Britten et al. (2000), Mira et al. (2013), Berry et al. (2006), Peter et al., (2014), and Cooke et al. (2000). These studies report various adverse outcomes that were linked to poor communication between the physicians and their patients. The question of what factors drive poor communication has also been studied across a number of medical contexts. Findings show several contributing factors, such as inaccurate presumptions of medical knowledge (Bromme, Jucks, & Wagner, 2005; Koch-

Weser, DeJong, & Rudd, 2009), different interpretations and/or understanding of medical terms by lay people and medical professionals (Peckham, 1994; Herz et al., 1996; Cooke et al., 2000; Barker, Reid, & Minns Lowe, 2014), language barriers (Roberts, Moss, Wass, Sarangi, & Jones, 2005), and the use of medical jargon by doctors (Castro, Wilson, Wang, & Schillinger, 2007; Morgan, 2013). Each factor is briefly discussed.

Inaccurate presumptions of medical knowledge

Speakers in a conversation sometimes adopt the same term to repeatedly refer to the same object or concept. This phenomenon, known as *lexical entrainment* (Brennan & Clark, 1996), has also been observed in physician-patient communication, and can result in inaccurate presumptions of medical knowledge. In a study by Bromme et al. (2005), medical experts were asked to respond to queries from fictitious lay people. Some queries included Medical Technical Language (MTL), for example, *blood glucose concentration,* and some included the more generic Medical Everyday Language (MEL) counterpart, i.e. *blood sugar level.* Bromme et al. (2005) found medical experts in the study responded to MEL-term queries with more MEL terms and vice versa and gave more medical explanation to queries using MEL compared to queries using MTL. The researchers posited that this action indicated that experts attributed more knowledge to patients who used MTL.

A similar result was established by Koch-Weser et al. (2009). Their study on physician-patient clinical encounters revealed that doctors were more likely to repeat patient-initiated words as the doctors presumed that patients who used medical terms possessed the medical knowledge associated with the terms (Koch-Weser et al., 2009). Nonetheless, patients who use medical terms might do so with limited or different understanding, an issue that is elaborated in the next section. In clinical encounters such as these studies, the lack of query or response from patients plus the lack of explanation from doctors might further impede understanding or reinforce the wrong one. As a result, patients may receive inaccurate medical advice or treatment.

Different interpretations and/or understanding of medical terms

Research shows that lay people and healthcare professionals sometimes possess different interpretations of commonly used medical terms. Take the terms *fracture*, *constipation*, and *unconscious* as examples. Studies by Peckham (1994), Herz et al. (1996), and Cooke et al.

(2000) revealed that for each respective term, lay interpretations were at odds with medical interpretations. Lay people interpreted *fracture* as better than *break* (both carry the same meaning medically); consistently over-diagnosed *constipation;* and incorrectly described an unconscious person. These kind of differences in interpretation and understanding could result in misdiagnoses.

More recently, Barker et al. (2014) examined lay interpretations and understanding of arthritis-related terms. The researchers selected 10 arthritis-related terms from medical textbooks, journals, and local copies of patient correspondence (*arthritis, osteoarthritis, rheumatism, wear and tear, cartilage, inflammation, rehabilitation, self-management, degenerative changes, and effusion*). Out of the 10 terms, only two (*arthritis* and *rehabilitation*) were rated as "Highly Familiar" by participants. Despite the familiarity level, participants' definitions of the term *arthritis* varied considerably, and *rehabilitation* was viewed as puzzling in terms of its relevance to arthritis. It is clear that the level of understanding regarding medical terms differs between lay people and medical experts, even when the lay people, as in the study, were patients with the condition in question.

Language barriers

Communication between medical experts and the lay community can also be complicated by different first languages and proficiency levels. In a study examining the interactions between physicians with English as a first language and patients with various first languages, the researchers observed that approximately 73% of consultations involving patients with limited English proficiency contained misunderstandings (Roberts et al., 2005). Roberts et al. (2005) listed four main categories of patient talk which were found to lead to misunderstandings, namely pronunciation and word stress, intonation and speech delivery, grammar and vocabulary, and style of self-presentation. Of the four, the style of self-presentation, which is the way patients present themselves to the physicians, was found to cause a higher number of unresolved misunderstandings. One reason for this is the different ways of structuring information by native speakers and non-native speakers during medical consultations. For instance, speakers of local or standard English typically start with the main points or concerns alongside a brief context; in contrast, speakers of other varieties of English were described as organising their self-presentation so that context is given first and the main concern given later. This causes mismatches in communicative expectations, thus exacerbating miscommunication.

The use of jargon by medical experts

The use of medical jargon could present an issue when communicating with someone from outside the field. Consequently, medical manuals or handbooks such as the Oxford Handbook of Clinical Medicine (Longmore, Wilkinson, Davidson, & Mali, 2010) advise that medical experts use the Flesch-Kincaid readability formula to ensure lay comprehensibility. Nevertheless, it is not easy to apply the advice during spoken interactions, as found by Castro et al. (2007). Their study revealed that 81% of physician-patient encounters included unclarified medical jargon. The researchers further assessed patients' comprehension of jargon after their consultations and found that patients' self-rated comprehension was higher than their actual comprehension, which "never reached an adequate threshold" (p. 92). Another study on physician-patient consultations also revealed that communication mismatches can occur as a result of technical and authoritative language use, i.e. physicians may simply assume that patients share similar background knowledge or experience with them (Morgan, 2013). Morgan (2013) cautioned that both the patient and the physician might not be aware of this even though these mismatches could lead to adverse outcomes.

Inter-medical communication research has been conducted using various approaches. The use of dialogue annotation, where interactions between physicians and patients were transcribed, segmented into units, and then labelled categorically, is also common, especially in studies that attempt to examine the types of dialogue acts and the ways speakers utilise these to achieve their goals. The following section discusses this approach.

2.2.1 Dialogue annotation as an approach in inter-medical communication research

Dialogue annotation schemes, sometimes also called coding schemes, coding systems, or dialogue annotation systems, are a useful tool for fine-grained communication analysis. They allow for the categorisation and frequency counts of communicative functions and semantic content (see Chapter 3 for further definitions of the terms) based on a defined unit (e.g. a single thought, a single speech act, a full turn, etc.), which can then be quantified for statistical purposes.

Dialogue annotation can be applied to achieve different research outcomes. It has been used to investigate how people interact in task-oriented dialogues, such as the Human Communication Research Centre (HCRC) map task (Carletta et al., 1996), to distinguish pragmalinguistic (the various linguistic strategies to convey an illocution) and sociopragmatic (social perceptions of appropriateness) structures of speech acts in different languages and cultures (Blum-Kulka & Olshtain, 1984), and to develop computer programmes that can interact with human users, such as TRAINS for transportation planning (Allen, Miller, Ringger, & Sikorski, 1996) and DECODA for call-centre monitoring (Bechet et al., 2012).

In general, dialogue annotation is often applied within non-risky or minimal risk contexts. Its application in high-risk situations has been less widespread, even though dialogue annotations can be very useful in analysing communication in the high-risk context. High-risk, time-constrained settings could challenge the conventional rules of dialogue exchanges even if there are pre-scripted dialogue rules as in the military or aviation (see for instance the Civil Aviation Authority's Radiotelephony Manual, 2015). Even when scripted dialogues are available, the script does not encompass everything. Speakers are still required to interact using their own linguistic resources, which would eventually result in different pragmalinguistic choices. Dialogue annotation would be able to capture these variations. Previous studies revealed that well-performing aviation crews display similar proportions of speech acts such as expressions of intent, acknowledgments, and commands in their communication (Kanki, 2010; Krifka, Martens, & Schwarz, 2003). Similar results were found when fighter jet teams' performance was analysed (Svensson & Andersson, 2006). The study concluded that specific speech acts, for instance, assertions that contained information about current position or activity, promoted the teams' situation awareness (i.e. attentiveness towards the immediate and imminent context), which contributed to favourable outcomes.

In a recent study, findings revealed associations between specific linguistic strategies used by dispatchers and bystanders' willingness to perform cardiopulmonary resuscitation or CPR (Riou et al., 2018). Even though the intended meaning of the dispatchers was the same, i.e.

getting the caller to perform bystander CPR, the linguistic strategies used to convey this intention varied. The study investigated words and phrases used by dispatchers by coding utterances based on three commonly used modalities during the calls: futurity (CPR was expressed as an impending action), obligation (CPR expressed as a necessary action), and willingness (CPR expressed as an action that depends on the caller's willingness or desire). Riou et al. (2018) found that the choice of verbal strategies in this setting had significant impact on callers' willingness to perform CPR. When the dispatchers used futurity (e.g. "We're going to do CPR") or obligation (e.g. "You need to do CPR"), more callers agreed to perform the action compared to when the dispatchers used willingness (e.g. "Are you willing to try CPR?"). The findings of this study provide a clear example of how pragmalinguistic choices can affect intended outcomes. To the best of our knowledge, there has been no dialogue annotation study that examines non-pre-scripted dialogues of speakers who have been strictly trained to follow a set of procedures in a high-risk, time-constrained setting like resuscitation.

In the medical setting, previous dialogue annotation studies have primarily focused on understanding the interaction between the speaker and the hearer (typically physicians and patients) in order to distinguish communicative patterns that may contribute to specific outcomes. Table 2 lists six existing dialogue annotation schemes specifically developed for this type of research. A more detailed discussion of both medical and non-medical dialogue annotation schemes is presented in Chapter 3. The discussion in this chapter concentrates on the motivations for the development of various medical annotation schemes, the previous studies that were conducted using the dialogue annotation schemes in Table 2, and the comparison of results from these studies.

Dialogue annotation scheme	Theoretical framework	Initial context/ domain	Focus
RIAS Roter Interaction Analysis System (Roter & Larson, 2001)	Modified Bales Interactional Analysis System	General medical consultation	Inter-medical communication, mostly dyadic, spoken
VRM Verbal Response Mode (Stiles & Putnam, 1992)	Verbal Exchange Theory	General, psychotherapy	Inter-medical communication, dyadic, spoken
CACS Communicative and Competence System (McNeilis, 1995)	Context-based model of language competence	General medical consultation	Inter-medical communication, dyadic, spoken

MIPS Medical Interaction Process System (Ford, Hall, Ratcliffe, & Fallowfield, 2000)	Resource Exchange Analysis	Oncology	Inter-medical communication, dyadic, spoken
GMIAS Generalised Medical Interaction Analysis System (Laws et al., 2009)	Speech Act Theory	Adherence to HIV treatment	Inter-medical communication, dyadic, spoken
DREAM Dialogue acts in clinical Research dAta query Mediation (Hoxha et al., 2017)	Speech Act Theory	General query about medicine	Inter-medical communication, dyadic, written

Table 2. Six dialogue annotation schemes developed for various medical settings

There are different reasons why different dialogue annotation schemes were developed, but the two main rationales are first, the choice of theoretical frameworks/principles that are appropriate for the research objectives, and second, the context of research. Table 2 illustrates that at least five theoretical frameworks contributed to the six dialogue annotation schemes. Since different theories may emphasise or enhance different communication elements, coding categories resulting from these theories likely differ in terms of their foci and aims. The categorisation in Stiles' (1978) Verbal Response Mode (VRM), for instance, is based on the verbal communication of experience framework, which was later named the Verbal Exchange Theory (Stiles & Putnam, 1992). This theory focuses on determining a component known as the *experience dimension* (knowledge, belief, ideas, feelings, etc.) of the speaker and the hearer. The Communicative and Competence System (CACS) focuses on competency as the mark of effective communication, hence, McNeilis (1995) applied Cegala and Waldron's (1992) communicative competence theory as the framework for her annotation scheme. The Medical Interaction Process System (MIPS) meanwhile perceives interpersonal behaviours as an exchange of resources and focuses more on the sequence/reciprocity between the speaker and the hearer. Therefore, Ford et al. (2000) applied Longabaugh's Resource Exchange Analysis as their framework. The Roter Interactional Analysis System (RIAS) is derived from a few theories, including Bales' Interaction Process Analysis, in order to identify social exchanges during physician-patient consultations (Roter & Larson, 2001: Roter & Larson, 2002). Finally, Speech Act Theory (Searle, 1976) was adopted by Laws et al. (2009) and Hoxha et al. (2017) to develop their respective dialogue annotation schemes because the researchers perceived locutionary, illocutionary, and perlocutionary acts as equally crucial in understanding communication.

The second reason for developing specific annotation schemes is to ensure that coding categories correspond with the context of the study at hand. The different contexts mean that each annotation scheme differs in terms of its communicative function coding and/or its semantic content coding, although in most cases, the more salient difference would be found in the content codes. The Generalised Medical Interaction System (GMIAS), for instance, contained coding categories for the specific purpose of capturing dialogues pertaining to antiretroviral adherence in patients and disease counts, i.e. HIV-related lab test results (Laws et al., 2009). MIPS, like CACS, was developed from a PhD thesis, but unlike CACS, MIPS was primarily designed to teach communication skills to doctors who interact with patients suffering from a specific illness, i.e. cancer. Following this, one of MIPS' content categories concerns cancer treatment (Ford et al., 2000, p. 559). Meanwhile, CACS and RIAS were quite generic at their onset, thus these two dialogue annotation schemes were differentiated by their communicative function coding categories rather than their semantic content categories. CACS' coding categories reflect its focus of examining alignment moves with the presence of codes that capture topic changes, continuers, and extensions (McNeilis, 2001, p. 9), whilst RIAS' categories are more general with its main focus on the instrumental and affective dimensions of medical visits (Hall & Roter, 2012). Finally, DREAM was developed to investigate written medical queries rather than spoken interaction; consequently, their coding categories reflected functions like scheduling personal meetings (Hoxha et al., 2017, p. 96).

Regardless of the differences in frameworks and contexts, dialogue annotation has been shown to successfully discern quantifiable, fine-grained language forms and functions in dialogues in medical settings. Additionally, frequency analyses from the annotation categories have been used to evaluate different constructs. The findings from studies that applied any of the six medical dialogue annotation schemes are discussed below.

Medical dialogue annotation studies

Dialogue annotation studies consistently generate two types of findings: descriptions of dialogue patterns and correlations of particular dialogue patterns with specific constructs. The description of dialogue patterns typically illustrates the frequency of dialogue categories present in various medical communication contexts (Cené et al., 2017; Hoxha et al., 2016;

McNeilis, 2002; Roter & Larson, 2001; Shaw, Adams, Bonnett, Larson, & Roter, 2004; Stiles & Putnam, 1992; Stiles, Shapiro, & Firth-Cozens, 1988; Wissow, Wilson, & Roter, 1994; Wissow et al., 1998; Vail et al., 2011). These frequency findings have also been examined to determine correlations with features like patient satisfaction (Ishikawa, Son, Eto, Kitamura, & Kiuchi, 2017; Laws et al., 2009), patient race and ethnicity (Laws et al., 2014), physicians' level of expertise (Ford & Hall, 2004), perception of physician competence in the delivery of bad news (Gillotti, Thomson, & McNeilis, 2002), and physicians' supportive dialogues (Gemmiti et al., 2017).

A major finding from dialogue annotation studies concerns descriptions of how medical communication takes place between physicians and their patients. This could be on selected patterns, i.e. particular dialogue acts or functions (e.g. McNeilis, 2001), or more comprehensive ones, i.e. the overall communicative patterns (e.g. Stiles & Putnam, 1992). One selective communicative function that has been examined is the use of the continuer, for instance, backchannels, in medical dialogues. A previous study found that physician-patient interactions displayed the following chain: information being provided, and then a continuer given, leading to more information being provided (McNeilis, 2001). This finding suggests that in medical consultations, a continuer is a verbal signal for patients to go on talking, and that it has been utilised by physicians to elicit more information from their patients. In terms of more comprehensive findings, physician-patient interaction pattern has been found to be consistent across the board with regard to category types and frequencies, perceived importance of categories or constructs, and who controls the interaction. This is discussed further in the following section: *Common findings from studies using dialogue annotation schemes*. Dialogue annotation results have also been shown to be able to discriminate different types of treatment and medical approach, indicating that models of communicative functions are context related. A clear example is in the distinctive types of verbal exchanges found in two types of therapy treatment – exploratory therapy and prescriptive therapy – with the prescriptive type showing more queries and the exploratory type showing more interpretive intent (Stiles et al., 1988).

Whilst previous studies on medical communication mostly focused on dyadic interaction between a medical professional and a patient, a few studies did investigate more than two dialogue participants. In terms of whether all speakers communicated equally in such interactions, it was shown that when the scenario involved child patients, physicians directed their talks to parents or guardians and seldom acknowledged the children (Wissow et al., 1994; Wissow et al., 1998), but when it concerned adult patients, physicians communicated with all parties, although patients still contributed less verbal activity (Cené et al., 2017). However, in a scenario involving more than one medical professional, such as a resident, an attending physician, and a patient during a medical consultation, the patient tended to speak more than the attending physician, but less than the resident (Roter & Larson, 2001). For the question of what types of communicative acts were most frequent, physicians were shown to use a high rate of biomedical information-giving (Cené et al., 2017; Roter & Larson, 2001). Similar findings were established in communication between veterinarians with their clients (the humans) and their patients (the pets), except that there were fewer questions where animals were involved (Shaw et al., 2004).

A regularly examined correlation using dialogue annotation results involved patient satisfaction level. Several factors were found to contribute to the patient's level of satisfaction after a medical consultation. The type of information and the time when this information was given were important, as patients had higher satisfaction if information given by the doctors was requested and when doctors provided rationales for their medical decisions (Ishikawa et al., 2017). Patient satisfaction was also positively correlated with the quantity of psychosocial talk, which were utterances that addressed daily living issues, social relations, and patient emotions (Laws et al., 2009).

Laws et al. (2014) applied GMIAS to find out whether doctors use different dialogue structures for anti-retroviral adherence when talking to patients of different ethnicities. Results showed differences in the types of speech act pattern, the frequency of dialogue subject matter, and the frequency of directives addressed to different ethnicities. In a similar manner, differences in the frequency of use of certain dialogue acts have been associated with physicians' level of expertise. Expert oncologists were shown to use significantly more empathetic statements and pose more reflective questions to their patients compared to less expert oncologists (Ford & Hall, 2004). In bad news delivery, it has been found that doctors are viewed as more skilful and reassuring when they use fewer open questions and solicit fewer answers from the patients (Gillotti et al., 2002).

Additionally, dialogue annotation has been used to provide evidence of the biological impact of specific dialogues on hearers. In a study on parents' level of stress during paediatric consultations, Gemmiti et al. (2017) found that both verbal and non-verbal affective communication behaviours reduced parents' cortisol response levels (a high cortisol level indicates high level of stress). The study applied the RIAS socio-emotional cluster to measure verbalisations that included reassurance and empathy. The findings showed that these kinds of affective verbalisations act as a buffer for parents' stress, as shown by the level of cortisol responses, consequently providing biological evidence that the types of dialogue act used by a speaker in a dialogue can indeed affect certain physical outcomes.

Common findings from medical dialogue annotation studies

Does the existence of a variety of dialogue annotation schemes give rise to different findings? Looking at the findings discussed in the previous section, what emerged are a few striking similarities that govern the structure of a typical medical communication, in terms of the existence of category types, the frequency of categories, and who controls the communication.

First, even though the category names or codes may differ, all dialogue annotation schemes contain similar communicative function categories, the two most prominent being interrogatives (also known as questions, queries, question-asking, or information-request) and statements (also known as assertions, information-giving, beliefs, or worldview). These two major categories are after all not unique to medical dialogues; thus, the existence of interrogatives and statements can be expected in any type of dialogue. In fact, the various communicative functions in different medical dialogue annotation schemes can be subsumed under five distinct categories, namely information-giving, question-asking, social conversation, positive talk, and negative talk (Hall & Roter, 2011). Whilst it is possible that these similarities stem from a shared language that is used to develop the coding schemes, i.e. English, RIAS has also been applied to dialogue studies in non-native English contexts, including Asia, Africa, and Latin America (Roter & Larson, 2002). It is therefore possible that a dialogue annotation scheme, utilised in different medical linguistic contexts, can produce similar results in terms of the communicative functions distribution.

Prior research results are also consistent in terms of the content or subject matter that is exchanged between the speakers. The most common type of content exchange is in the form of biomedical information (e.g. medical history, symptoms), which is predictable, seeing as the settings are mostly physician-patient consultations.

The various findings also agree on low frequencies of certain categories. A notable similarity is the low prevalence of instruction-giving or directives (also known as orientations or advisement) during face-to-face physician-patient consultations. For instance, directives only made up approximately 4% of physician talk in McNeilis' (2001) and 7% in Lipkin and Roter's (1997) studies. Another category that has been consistently mentioned as lacking is empathetic or emotionally supportive statements (Laws et al., 2009), even in a setting when physicians were relaying bad news to patients (Vail et al., 2011). Statements of empathy are typically emphasised in studies examining patient-centred or client-centred communication and have always been pinpointed as crucial – but insufficiently applied – in physician-patient dialogues (Stiles, 1978; Ford & Hall, 2004).

Finally, in terms of communication control, most, if not all, previous studies reported that physicians dominated the conversations (McNeilis, 2001; Stiles & Putnam, 1992), whilst patients characteristically asked few questions.

Summary of inter-medical communication research discussion

Based on the discussion, previous studies in the inter-medical communication area can be summed up in terms of their contextual nature and research approach. Studies in this area shared two characteristics: one, they concentrated on interactions between member(s) of the health profession and non-member(s) or lay people, and two, they were almost always dyadic in nature. Therefore, the context of communication has been restricted to expert – non-expert interaction with mostly obvious speaker and hearer roles.

A common approach in this area has been dialogue analysis. Previous research using dialogue analysis showed that there are various theoretical backgrounds and contexts that are applied in the development of various dialogue annotation schemes. Despite this, the studies are consistent in both the major types of coding categories and their findings of coding category frequencies. Whether there are similar patterns in expert – expert team interaction remains to be seen, although hypothetically, medical procedures like surgery and resuscitation may produce different types and frequencies of dialogue acts due to the more complex environment involving team tasks and team talk. More importantly, dialogue annotation findings have been shown to correlate with other types of construct, like the level of patient satisfaction and patients' perceptions of physicians' expertise, thereby offering evidence that the types of dialogue acts could affect outcomes. The use of dialogue annotation schemes to investigate dialogue structures and their impacts is therefore promising for this research context.

2.3 Intra-medical communication research

In contrast to inter-medical communication research that focuses on medical expert – lay person interaction, intra-medical communication research examines communication amongst medical experts. Studies under this paradigm usually focus on more than two dialogue participants or on a group, for instance, a surgery team. This multi-party communication is generally more complex than dyadic communication due to interplays of attributes like power dynamics between team members, shared goals, division of roles and responsibilities, team mental model (i.e. shared understanding of relevant knowledge), and team situation awareness (i.e. team members' attentiveness towards the current and future environment). Nonetheless, findings in both domains have been similar in showing that poor communication is linked to adverse outcomes, whilst good communication correlates with preferred outcomes (Knaus et al., 1986). Knaus et al. (1986) looked at 5,030 patients from intensive care units in 13 hospitals to assess the relationship between communication and mortality. They found that hospitals with good performance, i.e. fewer mortality rates, followed similar non-technical practices, maintained comfortable relationships, and had good communication standards. On the other hand, hospitals that were ranked low on the performance, i.e. higher mortality rates, often showed difficult or incomplete communication. The researchers maintained that the differences in outcome amongst the 13 hospitals were not the result of one particular specialism or diagnostic but of good management, comfortable relationships, and effective communication.

What factors bring about difficult or incomplete communication between members of the same medical team? Previous studies have pinpointed a few factors as driving miscommunication. These include non-standardised interpretations of medical jargon (Yu, Nation, & Dooley, 2005), poorly presented written documentation (Braaf, Manias, & Riley, 2011; Jefferies, Johnson, & Nicholls, 2011; Fatahi, Krupic, & Hellstrom, 2015), non-conducive working environment (Knaus et al., 1986; Sutcliffe et al., 2004), and quite regularly, inter-specialism issues, i.e. clashes of principles between different medical specialists (Hewett, Watson, Gallois, Ward, & Leggett, 2009; Awad et al., 2005; Sutcliffe et al., 2004; Mills, Neily, & Dunn, 2008; Makary et al., 2006).

Non-standardised interpretations of medical jargon

One factor that leads to miscommunication is when the parties in a dialogue interpret things differently. This has been documented in communication between experts and lay people, as discussed previously in Section 2.1.2. A similar issue also exists amongst organisations involved in medication safety, including the British Medical Association, Australian Council for Safety and Quality in Healthcare, American Society for Healthcare Risk Management, Health Canada, and the UK Department of Health. An investigation into the definition of terms used by these organisations revealed that some terms, like *adverse event, near miss*, and *error* were defined differently, sometimes by the same organisation (Aronson & Ferner, 2005; Yu et al., 2005). These various definitions led to different interpretations of the same medical scenario. For example, what was construed as a *side effect* using one definition was not perceived as a *side effect* when another definition was in use (Yu et al., 2005).

Poorly written medical documentation

Studies have also found that the quality of written communication contributes to poor communication in the intra-medical domain. As medical professionals need to collaborate across disciplines, clear documentation is crucial to ensure that the correct messages are received. However, issues that hinder effective communication have been found in the documentation of surgical patients (Braaf et al., 2011). These included omission of information, illegible content, outdated data, and different interpretations of terms and phrases. A more focused investigation on particular sub-specialties revealed that referral cases from clinicians to radiologists were often unclearly written, containing non-standard abbreviations and non-specific requests whilst giving insufficient information (Fatahi et al., 2015). In a similar vein, nursing documentation has been found to contain four main aspects that made understanding difficult, namely non-standard abbreviations, non-quantifiable expressions (e.g. using the term “moderate assistance”), linked fragments (separate ideas that were not logically linked to each other but linked with punctuation like a hyphen) and the absence of a clear subject and/or predicate (Jefferies et al., 2011).

Non-conducive working environment

Another factor contributing to poor communication between members of the medical domain is a working environment that fails to promote healthy interaction amongst the staff (e.g. Knaus et al., 1986; Sutcliffe et al., 2004). This concerns workplace policies and work culture. For instance, the highest-ranked hospital for positive outcomes in Knaus et al.’s (1986) study actively promoted communication amongst its staff in the form of a comprehensive nursing education system, amongst other interventions. The worst-performing hospital, in contrast, had no policy for routine discussions between its staff. Similarly, hospital personnel had reported that unclear division of tasks regarding treatments or patient management also contributed to poor communication and decisions (Sutcliffe et al., 2004).

Inter-specialism issues

Although unclear division of tasks is a result of inadequate work management, this factor may also be largely caused by existing inter-specialism issues. A number of studies have established that different sub-specialisms in medicine, for example surgery, nursing, and anaesthesiology, faced disagreements and culture clashes when working together in teams. There are two possible reasons for inter-specialism issues. The first is the perception of hierarchy or power status by the staff (e.g. Sutcliffe et al., 2004; Hewett et al., 2009; Makary et al., 2006). Communication between sub-specialisms has been found to be fragmented based on expertise and a sense of rivalry. Each sub-specialism viewed others as outsiders. Consequently, there were communication conflicts that resulted in the delay of much-needed treatments.

The second reason is the different training and sub-specialism practices that are observed by each group (e.g. Hewett et al., 2009; Makary et al., 2006). Previous studies found that in general, surgeons were more disposed to thinking that all members on a surgery team were on the same page during surgeries, whilst nurses and anaesthesiologists were less likely to agree with this notion (Awad et al., 2005; Makary et al., 2006; Mills et al., 2008). These different views of what constitute effective teamwork and communication might have resulted from distinct ideas of what teamwork means to each sub-specialism. Nurses might place higher importance on team members showing respect for each other's input, whilst surgeons might perceive that good teamwork means that team members could anticipate needs and follow directions. Interestingly, although members of the same sub-specialism (e.g. nursing) had been consistent in their ratings of each other (high) and others (low), surgeons consistently rated other sub-specialisms highly for teamwork and communication.

2.3.1 Dialogue annotation as an approach in intra-medical communication research

Studies on intra-medical communication (expert – expert; multi-party or team) in general differ from studies on inter-medical communication (expert – lay person; dyadic) in terms of the approach used to gather and analyse data. Medical team communication has been investigated through interviews, focus group discussions, observations, and questionnaires, but very rarely has been analysed via dialogue annotation, with the exception of a few studies using RIAS that have been discussed in the previous section (i.e. Cené et al., 2017; Roter & Larson, 2001; Shaw et al., 2004; Wissow et al., 1994; Wissow et al., 1998). Even the five RIAS studies were mixed interactions, e.g. between a physician, a consultant, and a patient, rather than interactions that occurred wholly between medical team members.

The small number of studies that did incorporate dialogue annotation to examine medical team communication used annotation schemes with limited or unspecified categories of dialogue functions (Calder et al., 2017; Parush et al., 2011; Xiao et al., 2003), or focused on discourse types rather than communicative function types (Gundrosen, Thomassen, Wisborg, & Aadahl, 2018). Calder et al. (2017) listed a number of communicative functions found in their study, which included statements, directives, questions, acknowledgments, instructions, requests, answers, replies, and readbacks, but did not clarify the parameters of each communicative behaviour. The communicative function categories in Parush et al. (2011) were more defined, although the number of categories was limited to six (request, announcement, question, reply, confirmation, and readback). In Xiao et al. (2003), only two categories of communicative function were used to code dialogues – instructions and questions. Annotation of discourse types, meanwhile, does not define categories purely by linguistic function but by a combination of function and context. For instance, Gundrosen et al. (2018, p. 2) examined three categories of discourse types: online commentary, defined as "Description or evaluation of real-time observations", metacommentary, defined as "[An] implicit message framing the activity type, orienting to next action or a plan", and offline commentary, defined as "Clarification and explanation, building evidence". That said, the findings from these studies help shed some light on how verbal communication patterns influence the body of research on medical team communication. To date, we are not aware of any dialogue annotation study conducted on medical teams operating in a time-constrained, algorithm-driven setting like pre-hospital resuscitation.

The constructs in team communication, such as team mental model, situation awareness, decision-making, and task collaboration have been investigated on their own (see for example, Halvorsen and Sarangi (2015) on team decision-making and Tschan (1995) on task-related communication cycles), but in the medical setting, these are considered as parts or elements of the non-technical skills (NTS). This perspective has been used to assess various medical team communication, including the resuscitation team, and has gained traction over the years. The next section elaborates on NTS and NTS-related studies.

2.3.2 Non-technical skills (NTS): History and use

Medical team communication research generally adapts behavioural rather than linguistic theories and concentrates on error avoidance and management. That said, small errors during medical procedures, for instance surgeries, may not affect the procedure or harm the patient, thus these errors are often ignored (Mishra, Catchpole, Dale, & McCulloch, 2008). Nonetheless, theories such as the Swiss Cheese Model and the DuPont Hazard Pyramid view a catastrophic event as the ultimate consequence of a number of failures or errors that are considered insignificant on their own (Reason, 2000; Zimmer et al., 2010). A communication slip, therefore, may be a small hole that lets more disastrous errors slip through. This is a crucial issue for high stakes environments like nuclear engineering, medicine, and aviation, and has spurred the move towards developing the non-technical aspects of team performance.

The history of NTS started four decades ago in 1979, when the National Aeronautics and Space Administration (NASA) conducted a study to discover causes of aviation accidents (Helmreich, Merritt, & Wilhelm, 1999). The results identified human errors such as lack of leadership and poor communication as culprits. To reduce human error, the researchers suggested that these non-technical skills need to be improved via training. Consequently, the aviation industry introduced the Cockpit Resource Management program. This is now officially known as the Crew Resource Management (CRM) program. Since its conception, there have been several generations of CRM, with each generation revised to integrate changes and improve training outcomes. CRM emphasises behavioural strategies that can be used to avoid, catch, and mitigate human errors, although the program is designed to minimise, not fully eliminate, human errors (Helmreich et al., 1999). Overall, CRM programs have been fairly well-received (Kanki, 2010).

Due to its success in bringing desired changes in aviation crews' attitude, CRM has been adopted in other high-risk domains, including medicine. The focus of CRM has always been on behaviours that are considered crucial in team collaboration and interaction. These behaviours were later adapted to suit the medical context and are collectively known as NTS. There are various dimensions that can be found in NTS rating tools, but the following seven generic dimensions are often shared (Flin, O'Connor, & Crichton, 2008):

i. Leadership: The skills to manage, lead, motivate, and direct a team; also, the skills to set standards of the team
ii. Situational/situation awareness (SA): The skills of gathering information from the immediate context, interpreting the information, and planning or anticipating the future. This can be kept up by ongoing dialogue that ensures team members are on the same page
iii. Teamwork: Distinguished from *taskwork* (what the team does). Teamwork or teamworking is how the team coordinates its actions towards a common goal
iv. Decision-making: The skills to select a course of action/reach a judgement
v. Managing stress: The ability to manage the work strain efficiently
vi. Coping with fatigue: Fatigue has been established as a big factor in causing errors.

vii. Communication: Sometimes subsumed under the rest because everything includes communication (both verbal and non-verbal), but essentially, this concerns the skills to exchange information between parties

The identification of NTS for a particular domain comes from various task analyses (e.g. observations of behaviours, analysis of procedures/incidents). The results are then used to establish which workplace behaviours are associated with desired outcomes and which are associated with unwanted outcomes, gradually building taxonomies for training and measurement.

As part of medical team training and outcome measurement, researchers have developed a number of NTS rating tools which are used to measure good (recommended) and poor (not recommended) behaviours as assessed against required standards. Table 3 lists a sample of five such tools. A more extensive list containing a description of 14 NTS tools can be found in Chalwin and Flabouris (2013).

Name	Developers/ Authors	Setting/ Assessment type	Dimensions
ANTS (Anaesthetists' Non-technical Skills)	Flin, Patey, Glavin, & Maran (2010)	Anaesthesiology/ Individual	Task management; Team Working; Situational Awareness; Decision-making.
NOTSS (Non-Technical Skills for Surgeons)	Yule, Flin, Paterson-Brown, Maran, & Rowley (2006)	Surgery/ Individual	Situation Awareness; Decision Making; Communication and Teamwork; Leadership
TEAM (Team Emergency Assessment Measure)	Cooper et al. (2010a)	Emergency medicine/Team	Leadership; Teamwork; Task Management
NOTECHS (Oxford Non-Technical Skills)	Mishra, Catchpole, & McCulloch (2009)	Surgery/Team	Leadership; Teamwork and Cooperation; Problem-solving and Decision-making; Situation Awareness
OSCAR (Observational Skill-based Clinical Assessment tool for Resuscitation)	Walker et al. (2011)	Resuscitation/ Individual and team	Communication; Cooperation; Coordination; Monitoring/Situation Awareness; Leadership; Decision-making

Table 3. Five NTS scoring tools used in various medical settings

As can be seen in Table 3, the NTS rating tools share common dimensions regardless of their medical domain and assessment focus (i.e. individual or team). Whilst communication is not always assessed on its own, it is clearly a component that is present in all the dimensions. This is elaborated in the next section.

Studies on medical team NTS and communication

With the growing number of NTS rating tools came a proliferation of studies investigating medical team effectiveness. Studies related to NTS have been carried out using different approaches, including interviews (Andersen, Jensen, Lippert, & Østergaard, 2010a) and observations (Yule et al., 2008); looking at different sub-specialisms (Arora et al., 2011; Kang, Massey, & Gillespie, 2015); and in both simulated (Arora et al., 2011) and actual environments (Kang et al., 2015; Williams, Lasky, Dannemiller, Andrei, & Thomas, 2010). Several systematic reviews have also been performed to analyse various medical teams' NTS performance (Cooper, Endacott, & Cant, 2010; Hull et al., 2012; Reader, Flin, Lauche, & Cuthbertson, 2006). Whilst it is common to come across the term *communication* in these NTS studies, in general, communication is not perceived as a separate element. Rather, it is subsumed under the various dimensions or components. For example, in Reader et al.'s (2006) review, all types of communication-related elements were classed under *teamwork,* along with other factors like lack of supervision, inadequate assistance, and illegible order. Similarly, verbalisations of information, inquiries, and intention-sharing were considered as different types of *teamwork behaviours* in Williams et al.'s (2010) study. In Cooper et al.'s (2010b) review, communication was subsumed under *leadership*.

Nonetheless, prior studies also made it apparent that communication itself did affect outcomes. Eight out of 10 studies that examined factors associated with adverse events in Intensive Care Units listed some form of communication failure as a factor (Reader et al., 2006). These were stated as "poor communication", "deficiencies in communication", "communication", "inadequate communication", "communication problem", and "communication insufficiency/misunderstanding" (pp. 554-555). However, what constituted *communication* – i.e. function, frequency, at which juncture of procedure, etc. – might differ, as closer scrutiny of the eight studies showed very little elaboration regarding communication. This means that there was very little in-depth linguistic analysis concerning the nature of the dialogues in medical team interactions and how particular dialogue patterns relate to technical skills, the decision to award specific scores, or the types of NTS dimensions, amongst others. The next section discusses this gap further.

The gaps between findings from NTS studies

The use of scoring tools to assess NTS performance has helped reveal what teams do (or do not do) as these assessment tools allow the analysis of behavioural markers. One consistent result from previous studies is the positive correlation of team leaders and/or team members' NTS performance with technical skills (Flin et al., 2008; Reader et al., 2006; Riem, Boet, Bould, Tavares, & Naik, 2012; Von Wyl, Zuercher, Amsler, Walter, & Ummenhofer, 2009). Teams or team members who are rated highly for their technical skills are also very likely to be rated highly for their NTS. Likewise, deficits in NTS performance have been revealed to adversely affect technical performance, leading to errors in the procedure. One study using a simulated cardiac arrest scenario revealed that even medical experts with sufficient knowledge in cardiac arrest treatment failed the treatment assessment when there was no adequate leadership and explicit task distribution (Marsch et al., 2004). In contrast, high-performance leadership has been shown to be positively associated with CPR quality (Yeung, Ong, Davies, Gao, & Perkins, 2012).

More significant to the present work, however, is the lack of information regarding finer-grained linguistic data, especially in the area of cardiac arrest resuscitation. Since communication is not typically viewed as a separate element but embedded in all NTS dimensions (Flin, Glavin, Maran, & Patey, 2003), findings from NTS rating tools do not typically measure the properties of the dialogues in team communication. Neither could the findings determine whether specific dialogue acts affect outcomes. In other words, NTS rating tools are useful in specifying *what* communicative functions are required from (and displayed by) the teams, but not *how* these should be explicitly realised. This is understandable because NTS emphasises observable behaviours rather than verbal actions. For instance, the following statement is taken from the Adapted Leadership Behaviour Description Questionnaire (Adapted LBDQ), used to measure resuscitation team communication: "The leader assigned group members to particular tasks" (Cooper et al., 2010b, p. 13). A response scale of 4 (Always) to 0 (Never) is used to score this criterion, but with no clear indication of whether the same scores should be given to Leader X who assigns tasks using a direct command ("You do the compression") and Leader W who assigns tasks using a request ("Can you do the compression?"). This invites questions about the semantic and pragmatic aspects of *assigning tasks*: Are direct commands and requests scored similarly, as long as they fulfil the same function or convey the same intention? Should they be? If not, which form is considered to yield the more effective communicative function, according to the raters? The same question may be asked regarding the learning objectives found in training programmes like CARDIOTEAM, for example, “Communicates using clear and relevant information” and “Safe verbal procedure” (Andersen, Jensen, Lippert, Østergaard, & Klausen, 2010b, p. 707). The absence of explicit linguistic forms could be an indication that medical practitioners (and the raters) in general possess a sense of what is ideal, possibly through training and experience. It would be beneficial to articulate these intuitions and produce well-defined guidance that can be used to inform training and policies.

A randomised controlled trial by Hunziker et al. (2010) also addressed this issue. The researchers were interested in the impact and sustenance of brief leadership training and technical training for CPR. The leadership group was given explicit instructions to use certain forms of dialogue acts. For instance, the participants were instructed to “Tell their colleagues what they should do!” with an example using direct command and commitment (“I make the ventilation and you are in charge of chest compression!”) (p. 1085). Emphasis was also given on only using clear and short utterances. The technical group, in contrast, focused on correct CPR positioning. Findings revealed that the leadership group was quicker to administer meaningful manoeuvres like ventilations and chest compressions (Hunziker et al., 2010). Although the main objective of their study was to compare the two types of training (technical versus leadership), a corollary to the main findings was the fact that specific dialogue acts were able to significantly influence outcomes. Hunziker et al.’s (2010) findings therefore provided empirical evidence of how employing specific linguistic strategies when issuing instructions can be effective in team communication, albeit in a simulated context.

The use of explicit phrases is one of the many communication strategies recommended for medical team communication. The following section elaborates on two communication strategies that have been suggested for more effective communication in resuscitation teams.

2.3.3 Communication strategies for medical teams

Various strategies have been developed and suggested to enhance communication and minimise errors resulting from miscommunication. As discussed, using short and explicit phrases is one of the recommendations. Two other strategies that have been recommended for resuscitation communication are employing standardised terms or phrases that are specifically developed for resuscitation and using standard closed-loop communication (CLC) exchanges.

Adopting and adapting standardised terms

It is common for different individuals to verbalise different pragmalinguistic strategies to accomplish a speech act. For instance, requests can be worded directly (e.g. "Hand me the scissors") or in a mitigated manner (e.g. "If I can have the scissors now that would be great"). This variability has been observed to occur during resuscitation, thereby increasing the chances of error (Yamada & Halamek, 2014; Yamada & Halamek, 2015). Following this, the researchers suggested streamlining communication during neonatal resuscitation using adapted air traffic control phrases. Given are a few examples of their recommended phrases (for the full list, see Yamada & Halamek, 2015, p. 186):

Air traffic control term	Adapted definition for neonatal resuscitation	Example of use
Abort	Abort a procedure/intervention	"Abort intubation"
Acknowledge	To request a read back if not given spontaneously	"Give a 30 ml normal saline bolus" (No response) "Acknowledge normal saline bolus"
I say again	I repeat for clarity or emphasis	"I say again: Blood transfusion 30 ml immediately"
Read back	Repeat all, or the specified part, of my message back to me exactly as received	"Read back adrenaline dose"
Resume	Resume the intervention	"Resume intubation attempt"
Unable	Indicates inability to comply with specific instruction, request, or order	"Umbilical venous catheter unable"

Table 4. Examples from Yamada and Halamek's (2015) adapted standardised phrases

Whilst Yamada and Halamek's (2015) recommendations have not yet been applied in any intervention studies, there have been a few intervention studies on the use of specific phrases or key phrases and their impact on outcomes. The change of phrase used in CPR instructions, from "Push hard, at least 5 cm" or "Push down firmly 2 inches" to "Push as hard as you can" has been found to improve motivation and CPR performance (Mirza et al., 2008; Rasmussen et al., 2017; Rodriguez et al., 2014). There were also fewer hand placement errors for CPR when the instruction was changed from the recommended "Kneel beside the chest. Place the heel of your hand in the centre of the chest with the other on top" to the more specific "Lay the patient's arm which is closest to you, straight out from the body. Kneel down by the patient and place one knee on each side of the arm. Find the midpoint between the nipples and place your hands on top of each other" (Birkenes et al., 2013, p. 2). Even though all of these intervention studies were performed in simulated environments, the results indicate that standardised phrases could be very useful in resuscitation, especially when giving instructions.

Since directing or requesting someone to do something is commonly viewed as an act with high imposition, i.e. an act with an unwanted or unwelcome force, speakers tend to mitigate their directives or requests (see Kasper, 1991). In physician-patient dialogues, different structures of directive have been shown to generate different responses (West, 1990). Outright commands (e.g. "Do X") were observed to produce less compliance responses compared to mitigated ones (e.g. "Let's do X"), indicating that in this specific setting, mitigated directives work better than direct commands. In contrast, for medical teams, direct or non-mitigated language has been recommended when giving directives, although researchers were careful to point out that communication during a crisis should remain polite (Brindley & Reynolds, 2011). The use of standardised phrases therefore may alleviate speakers' need of mitigating directives.

There is currently limited data on how ambiguous or mitigated language is used in medical team communication directives. Rudeness has been shown to be detrimental to the performance of both individuals and teams during medical procedures (Riskin et al., 2015; Riskin et al., 2017), but both studies investigated rudeness in the form of outsiders' comments. Furthermore, the force of an outright rude comment (e.g. from Riskin et al., 2017, p. 4: "I knew we should have gone to a better hospital where they don't practice Third World medicine!") is dissimilar to the force of an unmitigated directive (e.g. "You do X now"). That said, it is reasonable to assume that medical team members would want to lessen the unwelcome force of directives with mitigating devices to maintain social conventions. To date, there is no available data on how medical professionals reconcile the conflicting pressures to be both direct/succinct and sensitive/polite in time-constrained, high-pressure environments like pre-hospital resuscitation.

Closed-loop communication (CLC)

One of the most frequently recommended approaches, CLC is borrowed from the domains of military and aviation. CLC is composed of three components – the verbal message, or call-out, the acknowledgement of message, or checkback, and the confirmation of correct message, which closes the loop. A classic example would be as follows:

Sender:	John, could you get 20 ml saline solution?	Call-out
Receiver:	Okay Mark, I'll get 20 ml saline solution.	Checkback
Sender:	Thanks.	Closing the loop

As a strategy, the standard CLC has been frequently recommended in medical communication, for instance, in training brochures from health-related companies like ZOLL (Chase, n.d.) and online manuals and guideline like the one from the Victorian State Trauma System. Numerous studies also recommend CLC as a strategy that contributes to the effectiveness of team communication (Fernandez Castelao, Russo, Riethmüller, & Boos, 2013). CLC is also one of the top recommendations given by Advanced Life Saving instructors when interviewed about NTS performance and barriers (Andersen et al., 2010a).

It is interesting to note, though, that recommendations and implementations do not seem to go hand-in-hand for this method. Whilst there have been significant numbers of recommendations for using CLC, there is scant research on whether it is implemented in medical teams, or whether the use significantly affects outcomes. Suggestions to implement CLC appeared to be based on the success in military and aviation sectors and are not specifically medically related. Very few studies specifically investigate the practice of standard CLC in the medical domain, with the exception of El-Shafy et al. (2018), who conducted a study on the impact of CLC use during in-hospital paediatric trauma resuscitation. El-Shafy et al. (2018) found that CLC has a positive significant effect on time-to-task-completion in paediatric trauma resuscitation, but the researchers did not give explicit examples of how CLC exchanges were verbalised during the procedure. Open questions remain about how medical practitioners implement CLC in practice.

Despite its widely accepted status as an effective strategy, not all researchers agreed that CLC should be imposed on medical communication. For instance, Jacobsson, Härgestam, Hultin, and Brulin (2012) pointed out that communication in a medical team has a different nature than communication in a military team, for which closed-loop communication was originally developed. From their examination of emergency trauma team communication in a simulated setting, Jacobsson et al. (2012) determined that trauma team leaders communicate using various communication methods or repertoires. These repertoires were constantly modified based on the roles that the leaders were projecting (e.g. teachers, negotiators, etc.) and the urgency of the situation. Trauma team leaders were therefore not completely autocratic and were not expected to be such, unlike in the military setting.

So far, there has been very little documentation on the application (or non-application) of these strategies during real-life medical procedures. Researchers have cited factors like strict ethics requirements and the Hawthorne effect (i.e. people changing their behaviours because they are aware of being observed) as barriers to collecting authentic data for research (Cooper et al., 2010b; Hunziker et al., 2011). Consequently, the strategies discussed above are usually mentioned in the recommendation section or as part of the researchers' suggested framework for effective communication.

Summary of intra-medical communication research discussion

Intra-medical communication research focuses on team communication. Similar to findings in inter-medical communication research, communication failures amongst medical experts have also led to adverse outcomes. Due to the multi-party nature of a team, the factors underlying communication failures are more complex.

Previous studies on medical team communication have seldom adopted the dialogue annotation approach. Communication is usually perceived as part of the non-technical skills (NTS) compendium. Thus, team communication has been examined using the results from various NTS assessment or rating tools. Consequently, communication is not always investigated per se, but subsumed under other elements like leadership and teamwork. Furthermore, as the nature of NTS rating tools is to concentrate on visible rather than verbal behaviours of team members, very little is known regarding the precise nature of team dialogues during medical procedures.

Research into medical team communication has also included recommendations to use specific communication strategies. Discussion of two of such strategies – standardised phrases and the standard closed-loop communication – reveals limited studies on actual use in real-life medical team dialogues.

2.4 Summary of Part One

To sum up, medical communication is an area that has been widely investigated in previous research. This research domain can be grouped into two clusters: inter-medical, which looks at interaction between medical experts and lay people, and intra-medical, which looks at interaction between medical experts and medical experts. Each cluster has been investigated using various approaches, but the main approach for inter-medical communication studies is using dialogue annotation schemes, whilst the usual approach for intra-medical communication studies is using NTS scoring tools. Dialogue annotation studies consistently reveal that the interaction between medical experts and lay people generally consists of similar linguistic patterns, regardless of the contexts. It is not known whether the same patterns would emerge in medical team interactions as the focus of NTS rating tool studies are not on fine-grained dialogue behaviours. Nonetheless, previous results from NTS rating tools did establish that communication, under the guise of NTS dimensions like leadership, situational awareness, and teamwork, is associated with outcomes such as the speed of medical interventions and the accuracy of techniques. Whilst findings from visible behaviours are unquestionably crucial for measuring medical team performance, we argue that when it comes to tracking a team's communication patterns, dialogues, as the building blocks of team communication, hold the advantage and would allow deeper understanding of how linguistic variables may have affected team performance.

PART TWO

Resuscitation is a high-stakes medical context whose multi-stage complexity makes the language use potentially crucial for coordinating care. In OHCA resuscitation, which is the focus of the present research, factors like the location of arrest and the presence of bystanders add to the complexity. OHCA resuscitation is also in the domain of pre-hospital care, therefore falling under the jurisdiction of first responders such as emergency medical technicians and paramedics. These variables set OHCA resuscitation apart from in-hospital resuscitation.

This section focuses on studies related to resuscitation, a few of which have been mentioned in the earlier section. It discusses resuscitation studies in simulated and authentic settings, focusing on studies that investigated team communication and non-technical skills (NTS) elements, under which communication is normally subsumed. It attempts to highlight the gaps in these research areas and illustrate where the present study can contribute.

2.5 The art of resuscitation

Resuscitation, or cardiopulmonary resuscitation (CPR), is essentially a procedure of restoring a person to life, with the ultimate aim of achieving an early return of spontaneous circulation (ROSC) that leads to neurologically intact survival. This procedure is performed on a person who suffers from a cardiac arrest, a situation where the heart has stopped pumping blood around the body. One of the most likely causes for a cardiac arrest is ventricular fibrillation or VF. During VF, the electrical signal that controls the heartbeat becomes disordered, making the heart quiver or fibrillate rather than pump normally.

What resuscitation always entails is the act of chest compression – an emergency procedure of exerting and maintaining external chest compressions to manually pump the heart. This allows oxygenated blood to keep flowing throughout the body, especially to the brain, in order to keep the patient alive. The international guidelines for quality CPR stipulate a compression rate of 100 to 120 compressions per minute with a depth between 38 to 52 mm (Wik et al., 2005). Without CPR, the chances of survival for a patient suffering from a VF cardiac arrest have been found to decrease 10% every minute, following the initial loss of normal heartbeat (*Out-of-hospital Cardiac Arrest: A Strategy for Scotland,* 2015).

Whilst uninterrupted, high-quality chest compressions form the core of resuscitation, the procedure also involves ventilation (also known as rescue breaths or the kiss of life), defibrillation (administration of high energy electric shock for shockable cardiac arrest rhythms), intubation (insertion of a flexible plastic tube into the trachea to maintain an open airway) and administration of medication (e.g. amiodarone, adenosine, or adrenaline). The term CPR has been acknowledged to encompass all these procedures (Resuscitation Council UK, 2015).

Because CPR is a procedure consisting of stages, it follows that some tasks are to be performed earlier and some later. However, the different steps and stages of CPR are not always linear, but feed into one another. The level of importance and the level of complexity of each task differ as well. Consequently, tasks need to be coordinated accordingly and performed as quickly as possible. The use of a Hierarchical Task Analysis or HTA has been proposed to capture these complex relationships between various tasks and behavioural requirements (Tschan et al., 2011). An HTA is a hierarchical structure that specifies tasks (called *goals*) that need to be achieved, the criteria used to assess each goal (e.g. time, frequency, etc.), the order of performance, and coordination or behaviour required from the team to achieve the goal (e.g. informing other team members). A basic example, adapted from Tschan et al. (2011) and showing only two types of goals, is given in Table 5. For the complete HTA, see Tschan et al. (2011, p. 100).

Main goal	**Diagnose the cardiac arrest**
Criteria to assess goal attainment	Use no more than 10 seconds
Specification (i.e. order)	Do first (before other goals)
Coordination requirements	Ensure that all team members are aware of diagnosis
Sub-goal	**Defibrillate***
Criteria to assess goal attainment	As quickly as possible
Specification (i.e. order)	>200 joules
Coordination requirements	“Clear” command before shock

Table 5. A basic example of HTA for two types of goals

*this goal is only applicable on the assumption that the rhythm is shockable (e.g. ventricular tachycardia, ventricular fibrillation)

As shown, the coordination requirements necessitate (presumably) verbal sharing of diagnosis and commands. This clearly falls under the domain of communication. The focus of studies, and of the HTA itself, are seldom on the verbal behaviour per se. Studies are yet to describe the verbalisations of plans and information that feed into a team's shared awareness during resuscitation or determine whether directives like "Clear" commands are established in real-life scenarios. These are areas where dialogue annotation would be useful as an approach.

2.6 Studies on resuscitation

Research on resuscitation has been widely conducted. The journal *Resuscitation* is specially dedicated to publishing studies concerning all aspects of the procedure. In general, previous studies have been conducted on a wide array of resuscitation-related domains, including adult and/or child resuscitation (El-Shafy et al., 2018; Williams et al., 2010), in-hospital and/or out-of-hospital or pre-hospital resuscitation (Cooper & Wakelam, 1999; Cobbe, Redmond, Watson, Hollingworth, & Carrington, 1991; Norri-Sederholm, Paakkonen, Kurola, & Saranto, 2015), simulated and/or real-life scenarios (Haffner et al., 2017; Hunt, Walker, Shaffner, Miller, & Provonost, 2008; Wik et al., 2005), and the non-technical skills related to the procedure (Cooper & Wakelam, 1999; Cooper et al., 2010a; Bergs, Rutten, Tadros, Krijnen,& Schipper, 2005).

In general, however, previous studies on resuscitation mainly covered two scenarios; one, a simulated setting, and two, in-hospital environment. Non-technical performance is usually investigated in one of the two scenarios or in both, with consistent results that pointed at the need to improve team communication. Of special interest to the present research are studies that investigated communication/verbal behaviours during the resuscitation procedure, in any of these three settings: simulated, actual, or out-of-hospital/pre-hospital. The following sections discuss these further.

Communicating resuscitation: Simulation stories

Simulation, that is, a setting that approximates a real-life scenario, has been increasingly used for both research and training purposes. One clear advantage of simulation is the ability to control variables, unlike in real-life settings. This allows research teams to isolate and manipulate variables that they attempt to study. The use of simulated scenarios also allows trainers to stop in the midst of the exercise to highlight or explain details. Additionally, simulations have been utilised to compare the effect of NTS training with generic training, i.e. training that does not encompass NTS elements. A recent intervention study showed that NTS-incorporated training improved resuscitation team leaders' recognition and correction of incorrect chest compressions during simulated resuscitation attempts (Haffner et al., 2017). The intervention group received a 10-minute, computerised training that included four objectives – anticipate and plan, keep everybody involved, communicate effectively, and crosscheck – whilst the control group received an ethics training comprising four principles of medical ethics. At the post-measurement stage, the researchers noted that the NTS group corrected 35% of the incorrect chest compressions, a rise from 9% in the pre-measurement stage. The ethics group displayed no changes in correction behaviour. It was not indicated which of the four objectives were displayed more during the simulations, although it was mentioned that the leaders' communication had improved as well (Haffner et al., 2017, p.7).

Of the commonly assessed NTS dimensions (see Part One, Section 2.3.2), leadership makes the most frequent appearance in resuscitation studies. Critical reviews of NTS-related papers (Chalwin & Flabouris, 2013; Hunziker et al., 2011; Shields & Flin, 2013) showed that leadership competence is repeatedly highlighted. Verbal behaviour is often considered part of this competence, but rarely investigated on its own. Examples of verbal behaviours are clearly illustrated in the Principles of Effective Leadership which advises resuscitation team leaders to "make orienting remarks", "ask questions", "assign tasks", and "make short and clear statements", amongst others (Hunziker et al., 2011, p. 2385). Little is known regarding whether the dialogue patterns of resuscitation teams actually reflect these suggestions. However, in an in-hospital simulation study of resuscitation in the paediatric ward, findings showed that communication error that caused delay in treatment or affected decision-making was a factor that occurred in all 34 observed simulations, more frequent even than leadership errors (33%) (Hunt et al., 2008). That said, the communication errors identified in this study did appear to originate from the lack of leadership skills. The majority of leaders in the study were observed to have difficulties in giving effective directives and did not share necessary information with their team members. The following scenario exemplifies the failure of sharing information. Insertions in square brackets are our own: "[A] doctor managing the airway recognises that the patient has become apnoeic [stops breathing] and begins BVM [bag valve mask] ventilation but does not inform the team, so they are unaware of the change in status…" (Hunt et al., 2008, p. e38). No example was given to illustrate difficulties in giving effective orders.

Simulations have been perceived as a good indicator of non-simulated scenarios (Hunziker, Tschan, Semmer, Howell, & Marsch, 2010b; Hunziker et al., 2011), although real-life data is needed to compare the fidelity of the communication that takes place during the procedure. As pointed out by McKay, Walker, Brett, Vincent, and Sevdalis (2012), it is tricky to predict how features like NTS performance would play out in an actual scenario. Nonetheless, there is scant data on authentic resuscitation stages, possibly due to the logistical, medical, and/or ethical constraints involved (Hunziker et al., 2011). The following section examines findings from actual resuscitation studies.

Communicating resuscitation: Real-life reports

Studies investigating real-life resuscitations are usually conducted in the hospital setting. The context varies, from emergency trauma resuscitation to the more specific neonatal resuscitation. Studies that concentrate on real-life resuscitation team dialogue patterns are few, but the following work lends some insights into this domain, even though team communication is not the main focus in most of these studies except for Calder et al. (2017), Bergs et al. (2005), and El-Shafy et al. (2018).

Cooper and Wakelam (1999) investigated how leadership affects team performance and found that leaders who initiated team structures, i.e. defining, initiating, and organising tasks, had more dynamic teams which in turn were more likely to perform correctly and in a timely manner. The study examined 20 videotaped cases of cardiopulmonary arrest resuscitation attempted by teams made up of Senior House Officer, Medical House Officer, Intensive Care Senior House Officer, nurse, and sometimes ward nursing and medical staff. The findings established that desired outcomes can depend on how leadership is verbalised. A leader of a resuscitation team should explicitly delegate tasks – an action that includes knowing what should be done, how it should be done, *and how this should be said* – a finding that was echoed by Marsch et al. (2004) and Hunziker et al. (2010), discussed previously in Part One, Section 2.3.1. Directives are therefore considered as crucial to ensure effective planning and team organisation, although the researchers cautioned leaders to avoid autocracy. Hence, how exactly should directives be verbalised? Cooper and Wakelam (1999) suggested that leaders need to take charge and give clear directives but be flexible at the same time. Perhaps some leaders were trying to fulfil these conditions when they were observed to be unusually vague in assigning tasks to their team members. For instance, the researchers noted that when leaders in their study requested that a task be performed, most tended to do so in general terms (i.e. open requests) rather than addressing an individual, causing confusion that led to more than one person performing the task. A study focusing on communication using a linguistically based dialogue analysis would be useful to obtain more information regarding the forms of directives used during resuscitation attempts, and consequently create a path to identifying the forms of directives that work best for the team.

Another study examined the relationship between teamwork behaviours and errors in an actual neonatal resuscitation setting (Williams et al., 2010). The researchers observed 12 live resuscitation attempts and assessed eight categories of teamwork behaviours, of which six clearly focused on verbalisation: information-sharing (verbalised information to other team members); inquiry (questions related to procedure); assertion (verbalisation of opinion about the resuscitation process); intentions shared (intention verbalised before deviating from routine procedure); teaching/advising (exchange of information, advice); evaluation of plans (explicit and detailed discussion about patient status). Findings showed that information-sharing, inquiry, and assertion were the most frequent behaviours. In contrast to Hunt et al. (2008), who found that failure to share intentions was detrimental to team effectiveness, Williams et al. (2010) did not find any correlation between the sharing of intentions with errors, possibly due to the very infrequent occurrence of intentions shared in the study ($n = 2$). Assertions, however, were observed to be more frequent before errors, leading the researchers to speculate that this verbal behaviour might have distracted other team members. It should be noted here that the definition of *assertion* in this study was given as statements or questions containing the speaker's opinion *during critical times*, hence the category is limited to a certain juncture or period in the resuscitation procedure. In addition, the examples given, "Let's intubate" and "We need to do chest compressions" might have been coded into different categories in different dialogue annotation schemes, thus giving rise to different results and conclusions.

The dimension of situational awareness has been investigated quite frequently in medical teams, for instance, in the surgery environment (Gillespie, Gwinner, Fairweather, & Chaboyer, 2013; Hazlehurst, McMullan, & Gorman, 2007; Parush et al., 2011), but less so in resuscitation. A recent study that investigated resuscitation teams' situation awareness compared shared mental models and communication patterns of in-hospital resuscitation teams during simulations and real-life episodes (Calder et al., 2017). The verbal communication part of the study is perhaps the closest to what our present study is attempting to achieve, in that it sought to identify dialogue patterns based on communicative functions or verbal behaviours (e.g. statements, directives, questions) and semantic content (e.g. time, medications, vital signs). Nonetheless, we interpret the results from Calder et al.'s (2017) verbal behaviour frequencies with some caution because, as mentioned previously in Section 2.3.1, the parameters of some functions are not clear. For instance, we do not know whether the "directive" category encompasses all types of speech act that attempt to get the hearer to do something, as per Searle's (1975) illocutionary act definition, or whether it refers to only a specific group of verbal behaviours at a certain time juncture, like Williams et al.'s (2010) definition of *assertions*. This uncertainty affects the interpretation of the communicative function findings.

Findings from 30 simulated observations and 12 real-life cases revealed that resuscitation team members displayed a shared mental model and were capable of conveying large amounts of information to one another consistently. These included utterances of situational awareness. A higher prevalence of statements was observed during simulations (27.2%) compared to real-life observations (18.9%). However, it is unclear why simulations yielded 23.6% directives and 1.4% instructions out of the total communicative behaviours, whilst real-life resuscitations appeared to contain no directives or instructions at all. In contrast, real-life attempts were reported to contain 18.3% requests, but no requests were reported in simulation results. This distinction suggests that "request", "directive", and "instruction" are distinct verbal behaviours in Calder et al.'s (2017) categorisation, highlighting the ambiguity of speech act categories that are defined based on verbs alone, as cautioned by Searle (1976). Consequently, comparison with results found using a different annotation taxonomy would need to take this into account.

One study that focused on investigating communication during real-life, in-hospital resuscitation events was conducted by Bergs et al. (2005). Even though it focused on communication, the aim was not so much on the forms and frequencies of communicative functions than on specific semantic content, i.e. information transfer during the five Advanced Trauma Life Support (ATLS) steps (airway, breathing, circulation, disability, exposure/environment). Communication was examined according to five sub-categories: Intervention; Question to assessing physician, without response; Question to assessing physician, with response; Initiated by assessing physician but not understandable; and Initiated by assessing physician and understandable. Only communication directed to and coming from the assessing physician was observed. The results indicated that successful communication mostly occurred during the breathing assessment, which is the second step in the ATLS guidelines. Overall, the study reported sub-optimal knowledge transfer between the assessing physician and other team members. This study is one of the limited numbers that attempt to explore communication during resuscitation. The findings provide a tentative insight into the communication structure during resuscitation, but not the precise nature of the linguistic behaviours involved. Communication in the study only involved questions/statements and compliance/non-compliance with protocol. Moreover, the focus was on one speaker (the assessing physician, who was not the team leader), therefore little is known concerning other team members other than they experienced both successful and unsuccessful attempts at communicating with the assessing physician.

More recently, El-Shafy et al. (2018) investigated the communication strategy of trauma teams during real-life paediatric resuscitation, concentrating on the use of closed-loop communication or CLC. As reported earlier in Section 2.3.2, the researchers found that CLC is associated with quicker completion of tasks. The findings showed that from 387 verbal orders from the trauma team leaders, 101 or 26.1% were closed-loop, that is, responded to verbally using the standard three-part exchange (i.e. a call-out, a checkback, and a closure). The use of CLC was found to result in significant improvements in the completion of three types of tasks – medication orders, intravenous line placement, and obtaining patients' blood test results from laboratories. This finding thus provides promising evidence supporting the use of CLC during resuscitation, although the question remains open of whether the strategy is practised in real-life OHCA resuscitation scenarios. One certainty would be the absence of verbal orders pertaining to laboratory blood test results, as this task is only applicable in the hospital context.

Out-of-hospital resuscitation: The domain of first responders

From a technical point of view, out-of-hospital resuscitation has seen its share of studies, most likely because OHCA remains a leading cause of death in developed countries despite continued progress in CPR over the years (Boyd & Perina, 2012; Porzer, Mrazkova, Homza, & Janout, 2017). Research has been conducted on skills-related factors such as which resuscitation step is to be performed first and which is to be delayed (Winship, Williams, & Boyle, 2012), criteria for terminating resuscitation (Bonnin, Pepe, Kimball, & Clark, 1993), factors affecting prognosis and patient outcomes (Porzer et al., 2017), and adherence to CPR guidelines (Wik et al., 2005), amongst others. Moreover, because out-of-hospital resuscitation often entails bystander involvement, previous studies have also investigated public attitudes and willingness to do CPR (Dobbie et al., 2018; Hasselqvist-Ax et al., 2015).

Studies that concentrated on communication or NTS performance in pre-hospital resuscitation teams, on the other hand, are far less extensive. In a systematic review on studies concerning resuscitation team coordination and association with performance (Fernandez Castelao et al., 2013), not one out of the 63 articles published over a period of 30 years was on out-of-hospital resuscitation. Could this be due to the criteria set by the researchers? Perhaps. The researchers selected studies with empirical evidence on the association of team coordination with team performance or outcomes. This may have excluded some studies on out-of-hospital resuscitation, although the absence of studies that matched the review's criteria over a period of three decades is notable.

The scarcity of studies on out-of-hospital resuscitation could be associated with a similarly scant number of studies on paramedic NTS. Where medical experts are involved, out-of-hospital resuscitation is the domain of first responders such as emergency medical technicians and paramedics rather than teams of physicians and nurses (which resemble the teams that were the focus of study in Cooper and Wakelam, 1999, for example). A systematic review focusing on papers containing empirical data related to paramedic NTS, over an unrestricted period of years, listed only seven papers (Shields & Flin, 2013). None of the papers examined paramedic communication patterns during non-simulated, out-of-hospital resuscitation procedure.

There are several reasons why paramedics merit a specific area of study. Paramedics face different working constraints compared with other medical sub-specialisms, e.g. surgeons, general practitioners, or nurses. Chief among this is the environment in which they tend to their patients. Unlike hospital settings, paramedics do not have a pre-determined work area; they go wherever their patients are. At the same time, much like in-hospital medical personnel, paramedics may also be expected to lead multi-disciplinary teams that could consist of different members every time (Shields & Flin, 2013). Contrary to in-hospital norms, however, paramedics normally need to deal with bystanders. Adding to these is the time pressure of transferring the patient as quickly as possible to a hospital for more comprehensive treatment (Campeau, 2008). Because of these differences, it could be less effective to replicate conventions that are followed by in-hospital medical personnel in the out-of-hospital contexts that paramedics are required to manage. For instance, the strategies for eliciting patient history from bystanders are crucial to paramedics (Henderson, 2013), and these may differ from the strategies for getting patient history from a family member in the hospital. Clinical handovers in a pre-hospital environment (between road-based ambulance paramedics and specialist pre-hospital teams) have also been shown to use practices that are different from the usually recommended hospital handovers (Fitzpatrick et al., 2018).

The research concerning paramedic NTS is limited enough that as recently as six years ago, no explicit skill sets existed that could be used to develop paramedic NTS training programmes (Shields & Flin, 2013). To date, we do not know whether such a framework has been formally established. Line-by-line analysis of paramedic dialogues during resuscitation can contribute towards understanding the interaction that takes place during the procedure and providing a stronger framework that can be applied to shape paramedic training.

2.7 Summary of Part Two

The existing literature revealed that previous studies on resuscitation have concentrated on simulated contexts and in-hospital settings. Additionally, findings from studies related to the NTS applied during resuscitation consistently indicated the importance of communication, but the specific properties of the dialogue and how it is structured have yet to be detailed in the literature.

Even though simulations are considered as effective scenarios and very similar to actual cases (Hunziker et al., 2010b), an open question remains of whether real-life scenario differs, especially as some findings related to communication patterns seemed to suggest so. Studies that assess real-life communication behaviour of medical teams would be beneficial to aid our understanding of how teams communicate when actual patients are at stake. The findings in turn can be used to inform training on what to say or not to say, amongst other things.

The out-of-hospital setting is also vastly different from the in-hospital setting, not only in terms of the immediate environment, but also in the kinds and numbers of medical experts involved, the available equipment and medications, the presence of non-medical bystanders, and the pressure to extricate the patient as soon as possible. Thus, it is highly possible that the dialogue structures during out-of-hospital resuscitation may differ from the dialogue structures during in-hospital resuscitation. Lack of research on paramedic NTS means very limited literature on out-of-hospital resuscitation team communication patterns, which is needed in order to optimise resuscitation communication. The present study thus attempts to fill this gap.

3

The development of the Dialogue Analysis for Resuscitation (DARe) coding scheme

Introduction

Dialogue annotation is a useful approach for in-depth communication analysis. It has been utilised as an approach to study medical communication, but is limited to inter-medical communication research, especially physician-patient interaction. In this chapter, we detail the development of a bespoke dialogue annotation scheme that can be applied as an analysis tool for resuscitation team communication.

To develop our coding scheme, we review selected dialogue annotation schemes used in both medical and non-medical domains. We found that the dialogue annotation schemes are built upon various frameworks and for different contexts. As we are interested in investigating linguistic features in team resuscitation dialogues, we selected an existing coding scheme that is developed using speech act theory, i.e. the Dialogue Act Markup for Several Layers (DAMSL), as a model for our coding scheme.

The finalised annotation scheme, named **D**ialogue **A**nalysis for **Re**suscitation or **DARe**, is an amalgamation of three existing dialogue annotation schemes, iterative analysis of the present data, and suggestions from pre-hospital resuscitation experts. It consists of two main components, the first to capture linguistic (speech act) functions or *communicative functions* and the second for semantic content or subject matter, called *threads*. The communicative function component contains 22 main categories and 14 sub-categories, whilst the thread component contains 21 categories. Here, we describe and justify the selection of categories for the coding scheme. A complete version of DARe is presented at the end of the chapter. DARe is constructed chiefly for analysing the discourse in the present study rather than to challenge the validity (or superiority) of other dialogue annotation schemes. To our knowledge, DARe is the first dialogue annotation scheme that has been developed specifically to capture resuscitation content.

DARe is used to annotate four simulated resuscitation dialogues in our exploratory study. This enables us to fine-tune the scheme in terms of utterance segmentation and identify the types of existing communicative functions and threads needed to capture resuscitation dialogue contents. This chapter only focuses on the development of the scheme. The results of the exploratory study are presented and discussed in Chapter 4.

3.1 Analysing human dialogue

A common approach for studying human communication is to examine communicative function(s), or the *dialogue act*, present in each utterance in a conversation. This is defined as the minimal communicative action that is performed or is intended to be performed in a specific utterance. A dialogue act involves two principal participants – the agent who sends out a communicative behaviour and whose communicative behaviour is being interpreted, known as the speaker or the sender; and the agent who receives the communicative behaviour and whose information state is being influenced, known as the hearer, the receiver, the recipient, or the addressee. There may be other participants involved in the dialogue act, but these are typically viewed as side-participants (Clark, 1996).

A dialogue act consists of two distinct but inter-related components. The first is *communicative function*, which concerns the specific ways a participant performs a dialogue. The second is *semantic content*, which refers to what the dialogue is about, e.g. specific events, actions, etc. (Bunt, Alexandersson, & Carletta, 2010). These components have also been termed *verbal behaviour* and *content* respectively (Parush, Kramer, Foster-Hunt, McMullan, & Momtahan, 2014). In dialogue research, these are normally identified or extracted using a *dialogue annotation scheme*, also known as a dialogue annotation system, coding system, or coding scheme. Dialogue annotation schemes make use of dialogue annotation to code or tag segments of dialogue with information about the performed dialogue acts. Even though dialogue acts comprise both communicative functions and semantic content, most dialogue annotation schemes are focused on the former rather than the latter (Bunt et al., 2010).

Over the years, a wide array of dialogue annotation schemes has been developed. A few were designed as suggested shared annotation platforms for dialogue researchers, such as Dialogue Act Markup in Several Layers (DAMSL) (Core & Allen, 1997), Dialogue Act Markup Language (DiAML) (Bunt et al., 2010), and the Human Communication Research Centre (HCRC) dialogue coding project (Carletta et al., 1996), whilst others are unique to specific studies and/or contexts, like the TRAINS project (Allen et al., 1996), AMI (see http://www.amiproject.org), and the Cross-cultural Speech Act Realisation Project (CCSARP) (Blum-Kulka et al., 1984). In the next section, each of these annotation schemes is briefly described in terms of its aims, contexts, theoretical frameworks, and coding categories. Characteristics that are of interest and may contribute to the development of the annotation scheme for the present study are also noted.

3.2 Six dialogue annotation schemes: DAMSL, HCRC, DiAML, TRAINS, AMI, CCSARP

The first three dialogue annotation schemes to be discussed are those that have been developed as generic platforms for researchers. In this, they shared a similar aim, but they were based on different theoretical frameworks, had different coding categories, and were applied in different contexts.

DAMSL: Dialog Act Markup in Several Layers

The first of these is DAMSL, or Dialog Act Markup in Several Layers. DAMSL provides a basic skeleton of communicative actions that are used to analyse dialogues. The structure was developed by the Multiparty Discourse Group in Discourse Research Initiative meetings (Core & Allen, 1997). The developers aimed to have a common-enough class of communicative actions on the higher levels to enable researchers to share data across projects. This means that the superordinate categories (i.e. the higher levels) can be standardised across different contexts and studies, although the smaller categories may differ accordingly. For instance, Core (1998) suggested that a dialogue act category from DAMSL on general acknowledgment could be the superordinate category for narrower acknowledgment categories in other dialogue annotation schemes, such as Acknowledge Apology in TRAINS and Feedback in VERBMOBIL.

DAMSL classifies dialogue acts based on whether they are initiative (forward-looking) or responsive (backward-looking). There are three distinct categories or layers, called the Forward Communicative Functions (FCF), Backward Communicative Functions (BCF), and Utterance Features. FCF affect the future portion of the dialogue, BCF are responses or reactions to FCF, and Utterance Features distinguish the content and structure of the dialogue. The FCF layer is based on Searle's (1976) taxonomy of communicative actions or illocutionary acts, i.e. the social act (or acts) that an utterance attempts to convey. Searle (1976) proposed five basic categories of illocutionary acts – representatives, directives, commissives, expressives, and declarations. Three of these are applied directly in DAMSL's FCF categories: representatives (verbal actions that introduce information into the common ground), directives (verbal actions that attempt to create obligations on the listener), and commissives (verbal actions that create obligations on the speaker). DAMSL tags and brief descriptions of each are given as follows.

Forward Communicative Functions (called *antecedents*)

- Statement (claims about the world)
    - Assert (speaker tries to change hearer's beliefs)
    - Reassert (the claim has already been made)
    - Other-Statement (statements that do not belong to either)

- Influencing-addressee-future-action (influence on hearer)
    - Info-Request (questions, requests for information)
    - Directives
        - Action-Directive (creates obligation for hearer to perform action unless hearer indicates otherwise)
        - Open-Option (suggests course of action but places no obligations for hearer to follow)

- Committing-speaker-future-action (influence on speaker)
    - Commit (commits speaker to performing intended future action)
    - Offer (commits speaker to perform intended future action contingent on hearer's agreement)

- Other-forward-functions (other types of initiative utterances, like greetings, explicit performatives, exclamations, etc.)

Backward Communicative Functions (verbal responses to antecedents)

- Agreement (hearer's view of the proposal/claim)
    - Accept (agree fully)
    - Accept-Part (tag for the accepted part of proposal)

    - Maybe (no definite answer or response)
    - Reject-Part (tag for the rejected part of proposal)
    - Reject (disagree fully)
    - Hold (leaves decision open pending further discussion)

- Understanding (actions taken to signal that speakers understand each other)
    - Signal-Non-Understanding (problem in understanding previous utterance)
    - Signal-Understanding
        - Acknowledge (hearer's understanding of proposal/claim without necessarily agreeing or rejecting)
        - Repeat-Rephrase (repeating or rephrasing to signal understanding)
        - Completion (finishing or adding to antecedent)

- Correct-Misspeaking (offer correction)

- Answer (response to antecedent of *Info-request*)
- Information-Relation (how contents in responses relate to their antecedents. Suggested but not elaborated in DAMSL)

Utterance Features (captures features of the content and forms of utterance)

- Information Level
    - Task
    - Task Management
    - Communication Management
    - Other

- Communicative Status
    - Abandoned
    - Uninterpretable

- Syntactic Features
    - Conventional Form
    - Exclamatory Form

In real-life dialogues, an utterance may perform more than one act; hence restricting the type of speech act to one (usually the 'main' one) per utterance may not always be an ideal option. DAMSL acknowledges this by allowing more than one tag to be given to one utterance. Therefore, an utterance that performs more than one action simultaneously can be captured more accurately. Example (1) illustrates one such utterance by Speaker 2. In the dialogue, Speaker 2 both answers the question and gives a promise.

(1)

Speaker 1:	Who is coming to the party?	*Info-request*
Speaker 2:	I'll be there.	*Answer; Commit*

DAMSL coding categories have been tested for inter-annotator reliability using the task-based corpus from TRAINS (Core, 1998) and the non-task-based corpus from SWITCHBOARD

(Jurafsky et al., 1998; Stolcke et al., 2000). The results from the TRAINS corpus revealed kappa scores around 0.6 for most of the coding categories and lower for the categories of *Committing-speaker-future-action* and *Agreement*. Core (1998) suggested that listening to the audio and interpreting the utterance based on dialogue contexts could raise the reliability scores. When inter-annotator reliability was assessed for major dialogue types alone (e.g. *Statements and Opinions, Questions, Answers and Agreements*), higher kappa scores (0.8) were obtained (Stolcke et al., 2000).

HCRC: Human Communication Research Centre dialogue coding scheme

Another dialogue annotation scheme for generic use is called the Human Communication Research Centre (HCRC) dialogue coding scheme, developed by Carletta et al. (1996) at the University of Edinburgh. HCRC aims to develop move categories that are task-independent and thus sufficiently generic to be used with other types of conversation or dialogue. The categories are mapped at a higher level, using game and transaction structures.

The HCRC dialogue annotation scheme is based on conversational game theory. In conversational game theory, conversations are perceived as a kind of game, where participants interact in an attempt to reach a common goal. Conversational game theory is made up of three levels. The first (and the highest level) is called a *transaction*. Transactions are made up of dialogues that perform a major step in the conversation. What constitutes a 'major' step in any conversation depends on the task or goal of the conversation, thus, a transaction differs in different conversations. The goal used in HCRC's initial research is to get participants to duplicate a map route that is only visible to their partners. Therefore, a typical transaction according to Carletta et al. (1997) would be sub-dialogues for one route segment of the map.

The second level is called conversational games, sometimes shortened to *games*. This level has also been called dialogue games, interactions, and exchanges. Conversational games contain sets of utterances that are performed until the goal is either achieved or abandoned. Conversational games distinguish between *initiations* (utterances that set up the discourse path that is to be followed) and *responses* (utterances that fulfil the expected discourse), and have different discourse purposes, for instance asking for or providing information.

The third level is called conversational moves, or simply *moves*. These are the different types of initiations and responses that are categorised accordingly. The HCRC coding scheme has the following codes for moves:

Initiating moves (sets up an expectation of responses)	
Instruct Move	A move that elicits specific action(s)
Explain Move	A move that states information which has not been elicited by the partner
Check Move	A move that confirms information that the checker has reasons to believe in, but is unsure of
Align Move	A move that checks attention, agreement, or readiness of partner
Query-YN Move	A query requiring a Yes or No response. Different from a Check or Align
Query-W Move	A query that is not covered by other categories
Response moves (completes current game)	
Acknowledge Move	A verbal response that minimally shows that the speaker has heard the move; also, to show acceptance and understanding
Reply-Y Move	Any reply to a Yes or No surface form query
Reply-W Move	Any reply to any type of query which does not simply mean Yes or No
Clarify Move	A reply to a query that includes extra information other than what is being asked

Table 6. The HCRC coding categories (Carletta et al., 1996)

HCRC also includes another type of move, which is called the Ready Move. This a move that occurs at the beginning of a new game initiation and includes short utterances like "Right" and "Okay". A decision tree is used to identify the categories of move (see Carletta et al., 1997, p. 15).

The corpus for this project came from a previous project called the HCRC Map Task by Anderson et al. (1991). The dialogues were collected at the Human Communication Research Centre (HCRC) at the University of Edinburgh. Inter-annotator reliability showed that move coding was reproducible but the game coding less so. As the inter-annotation sample size was small, no statistical results were produced.

DiAML: Dialogue Act Markup Language

The third dialogue annotation scheme created as a suggested shared annotation platform is the DiAML, or Dialogue Act Markup Language. DiAML is proposed by Bunt et al. (2010) as a generic dialogue annotation system with categories that are aligned with the ISO standards for the Semantic Annotation Framework. It has a three-part definition: one, an abstract syntax defining classes of annotation structures, two, a formal semantics of the said structure, and three, a concrete syntax for reference representation format in XML (Bunt et al., 2010; Bunt, Kipp, & Petukhova, 2012). The categories shown below for General-purpose functions and Dimension-specific functions come from the first two parts of the definition:

- General-purpose functions. General purpose functions concern how semantic content is used to update an information state. For instance, information-seeking functions update the state of information through questions.
    - 4 information-seeking functions (e.g. questions)
    - 6 information-providing functions (e.g. answers)
    - 4 commissive functions (e.g. commitments)
    - 5 directive functions (e.g. instructions)

- Dimension-specific functions. Dimensions are categories of semantic functions, which are essentially properties describing what the dialogue is about, for instance the object or event referred to in the dialogue.
    - 2 auto-feedback functions (the processing of utterances by the speaker)
    - 3 allo-feedback functions (the processing of utterances by the addressee)
    - 2 time-management functions (the speaker's need for time to manage or continue the dialogues)
    - 6 turn management functions (the allocation of speaker role or turn)
    - 3 discourse structuring functions (the structuring of the dialogue)
    - 2 own communication management functions (the management of difficulties in speaker's own utterances)
    - 2 partner communication management functions (the management of difficulties in addressee's utterances)
    - 10 social obligation management functions (the management of social obligations)

Bunt et al. (2010) pointed out that most dialogue annotation schemes ignore the subtleties of communication functions. For instance, the response to an offer may be tagged as accept or reject, with no additional information or any in-between responses, such as uncertainty or emotional responses. To capture this, DiAML also proposed tags for qualifier attributes and values so that it can discriminate responses through more specific details, for instance whether a response is conditional or unconditional, or has certain emotions embedded in it. This attempt to capture indirectness and subtleties is similar to CCSARP, a project that will be discussed later in Section 3.1.6. According to Bunt et al. (2012), DiAML differed from DAMSL and HCRC in the sense that DiAML allowed the annotation of both communicative functions and dimensions (i.e. what the dialogue is about, using the categories listed above), whilst DAMSL and HCRC only recognised communicative functions. This is only partially true, as DAMSL does allow the annotation of dimensions in its Utterance Features, albeit with fewer categories.

The following three projects – TRAINS, AMI, and CCSARP – are more specific to their contexts. All three developed their own annotation schemes. Each project focused on different aspects of dialogue, with TRAINS focusing on goals and plans, AMI on organisation and functions, and CCSARP on specific speech acts and indirectness.

TRAINS

TRAINS is developed by Allen et al. (1996) as a toy system used for a computer to interact with users. The system attempts to develop a natural language interface between users and a system to organise goods transportation between warehouses and factories. It is not intended to be used in real life. The system is developed based on a corpus of simulated planning interactions by human participants. In the TRAINS study, participants relied on a map that showed the whereabouts of factories, warehouses, and vehicles, and were required to plan for their goals based on this knowledge. This corpus was used to formulate a set of planning behaviours, consequently yielding the following categories of speech acts:

Code	Description
T-INFORM	Speaker aims for shared belief in asserted proposition
T-YNQ	Speakers asks a yes/no question that prompts an obligation for response
T-CHECK	Speaker verifies information that is already suspected to be true
T-SUGGEST	Speaker proposes a new item as part of the plan
T-REQUEST	Speaker aims to get hearer to respond. Any suggestion with an obligation to respond also falls under this category
T-ACCEPT	Speaker agrees to a prior proposal
T-REJECT	Speaker rejects a prior proposal
T-SUPP-INF	Speaker provides additional information that supports accompanying speech act

Table 7. The TRAINS coding categories (Allen et al., 1996)

TRAINS shows that a system based on a general language processing, plan-based approach can work in a specific situation. One limitation of TRAINS is the simplification of interaction, which renders it less useful for complex, real-life communication, although it worked sufficiently well for very basic planning with straightforward dialogues (Schiffrin, 2005).

AMI: Augmented Multiparty Interaction

Augmented Multiparty Interaction or AMI aims to produce a generic format for capturing and sharing meeting data. The AMI coding categories are developed to annotate meeting dialogue corpus that is utilised in the development of a meeting browser organiser or software meeting assistant (http://www.amiproject.org). In contrast to the goal and plan-based interactions of TRAINS, AMI focuses on collecting, categorising, and organising the functions of dialogue during meetings. Segmentation of dialogues are performed intuitively, based on expressed speaker intention or speech act. Each segment contains only one intention or speech act. AMI has six classes of dialogue acts, as follows:

Class of dialogue acts	Categories
Special class: Things that are not dialogue acts at all, but present to account for something in the transcription that does not really convey speaker intention	Backchannel Stall Fragment
Information-exchange: Express or elicit information from others	Inform Elicit-inform
Action that an individual or group is about to take	Suggest Offer Elicit-Offer-Or-Suggestion
Commenting on previous discussion	Assess Comment-About-Understanding Elicit-Assessment Elicit-Comment-About-Understanding
Smooth social functioning of the group. Concerns interpersonal relationships, has social overtones	Be-positive Be-negative
Bucket type, or other	Other types that do not fit in given categories, like self-addressed speech

Table 8. The AMI classes of dialogue acts and categories in each (http://www.amiproject.org)

One aspect that belongs to AMI and is not found in DAMSL or DiAML is that AMI analyses group interactions, and therefore it has a section on speakers addressing a specific person and/or the whole group. AMI highlights that when the speaker addresses a specific individual, whether through verbal or non-verbal behaviour, only that individual is considered as the addressee rather than the whole group. Of interest to the present study is the reflexive act category, a special category that is given to dialogue acts about how participants as a group approach a given task. Reflexive acts are essentially verbal plans of how the group is going to carry out the task. The reflexive category is marked over the other dialogue act categories; in other words, any category can be annotated with a reflexive tag as an additional label. Given is an example of a reflexive dialogue act taken from the AMI Manual (2005, p.31):

I'm first going to do an opening |then we get used to one another |and we speak about this tool we're going to design |and try to make a project plan |some discussion |and then we talk about the next meeting. |

This may be a useful interaction criterion for resuscitation teams as well because this type of verbal planning could be essential to a team's performance.

CCSARP: Cross-cultural Speech Act Realisation Project

The third project, the Cross-cultural Speech Act Realisation Project (CCSARP) (Blum-Kulka et al., 1984), is admittedly not a dialogue annotation study per se, but is included here to show how coding can be applied in a more thorough manner, that is, to examine the formulation of specific speech acts. Rather than tag ongoing dialogues between a speaker and a hearer, CCSARP only focuses on the exchange of two types of speech acts – apology and request. The project attempted to discover the nuances of indirectness associated with apologies and requests. It standardised the coding categories for both speech acts and applied the same coding schemes for various languages and contexts. The following categories of request shown in Table 9 (from Blum-Kulka, 1987, p. 133) illustrates a scale of indirectness that is based on the relative length of inferential demands that a category places on the hearer. The categories range from the most transparent or direct (Mood derivable) to the most opaque (Mild hints).

Descriptive category	Examples
Mood derivable	Clean up the kitchen Move your car
Performative	I'm asking you to move your car
Hedged performative	I would like to ask you to move your car
Obligation statement	You'll have to move your car
Want statement	I would like you to clean the kitchen I want you to move your car
Suggestory formulae	How about cleaning up? Why don't you come and clean up the mess you made last night?
Query preparatory	Could you clean up the mess in the kitchen? Would you mind moving your car?
Strong hints	You've left the kitchen in a right mess
Mild hints	We don't want any crowding

Table 9. CCSARP scale of request indirectness (Blum-Kulka, 1987)

The distinction of request categories based on indirectness is of interest to the present study. It can be useful to understand the composition of a request in order to understand how requests (and other types of directive perhaps) differ, and how contexts (i.e. in what situation, to whom it is directed) can influence the choice of directness. A similar coding scheme to examine apologies is described in Blum-Kulka, House, and Kasper (1989):

1. Alerters (e.g. *Hi/Hello/Mr. X/Darling*, etc.)
2. Illocutionary force indicating device (IFID) (e.g. *Sorry/I apologise for…*)
3. Intensifiers
    i. Intensifying adverbials (e.g. *very/terribly/really*)
    ii. Emotional expressions/exclamations (e.g. *Oh no/Oh Lord*)
    iii. Expressions marked for register (e.g. *I do apologise…*)
    iv. Double intensifier or repetition of intensifying adverbial (e.g. *I'm really dreadfully sorry*)
    v. Use of please (e.g. *Please forgive me*)
    vi. Concern for the hearer (e.g. *I hope I didn't upset you*)
4. Taking on responsibility
    i. Explicit self-blame (e.g. *My mistake*)
    ii. Lack of intent (e.g. *I didn't mean to…*)
    iii. Justify hearer (e.g. *You're right to be angry*)
    iv. Expression of embarrassment (e.g. *I feel awful about it*)
    v. Admission of facts but not of responsibility (e.g. *I haven't read it/I missed the bus*)
    vi. Refusal to acknowledge guilt (e.g. *It wasn't my fault/It's your fault*)
5. Explanation or account (e.g. *My tutor kept me late*)
6. Offer of repair (e.g. *I'll pay for the damage*)
7. Promise of forbearance (e.g. *This won't happen again*)
8. Distracting from offence (downgrading)
    i. Query precondition (e.g. *Are you sure we're supposed to meet at 10?*)
    ii. Act innocently/Pretend not to notice the offence (e.g. *Am I late?*)
    iii. Future/task-oriented remark (e.g. *Let's get to work, then!*)
    iv. Humour (e.g. *If you think that's a mistake, you ought to see our fried chicken!*)
    v. Appeaser (e.g. *I'll buy you a cup of coffee*)
    vi. Lexical and phrasal downgraders (e.g. the choice of using *can/could, will/would* etc.)

The coding categories for apology are derived from Brown and Levinson's (1987) politeness theory. Other than finding out frequencies of structure used in apologies, similar to requests, the coding categories for apology also attempt to identify the level of directness when someone apologises.

Clearly CCSARP deviates from the usual dialogue annotation studies as its emphasis is on tagging the elements that make up the structures of selected speech acts (i.e. request and apology) rather than on the whole dialogue or conversation. In other words, CCSARP annotation schemes are used to investigate a finer-grained aspect of dialogue: that is, the makeup, or ingredients, of one or two speech acts. The corpus in this project is also different in that dialogues were obtained from tasks such as Discourse Completion Tasks, where participants were given a specific, usually controlled, context, and were asked to respond to it verbally. As such, the coding schemes from CCSARP would not be suitable for the current study. However, the approach of categorising and tagging a particular speech act composition could be useful if specific speech act types happen to be of interest in the current study.

3.3 Summary of review

Dialogue annotation has been applied to various projects, including in building and managing dialogue corpora, interpreting dialogue participants' communicative behaviour, and designing human-computer dialogue interfaces. For instance, communicative behaviours in different languages and cultures were documented using the annotation scheme developed for CCSARP (Blum-Kulka et al., 1984), and human-system dialogue interfaces were made possible with annotation schemes like TRAINS (Allen et al., 1996). When used to identify dialogue functions, the dialogue annotation schemes often contain similar coding categories that discriminate dialogue acts pertaining to information exchange (e.g. information-providing function in DiAML, inform in TRAINS, information-exchange in AMI) and information seeking (e.g. Info-request in DAMSL, Query-YN in HCRC). Only CCSARP does not contain these categories because it concentrates on the speech acts of request and apology. All six dialogue annotation schemes are developed in English-speaking contexts, using English as the original language, although DAMSL and CCSARP have been utilised to code dialogues in other languages, such as German, Chinese, and Persian (Buckley & Wolska, 2008; Ghanbaran, Rahimi, & Rasekh, 2014; Song & Liu, 2002).

To our knowledge, none of these coding schemes have been applied in studies of dialogues in time-critical and high-risk environments like cardiac arrest resuscitation. However, some characteristics, such as clear distinctions of forward moves and response moves (DAMSL, HCRC), allowing more than one tag for one utterance (DAMSL), and capturing team planning (AMI), can be incorporated to analyse resuscitation dialogues. The attempt to capture the finer distinctions of subtlety or indirectness (DiAML, CCSARP) could be useful when examining instructions during the resuscitation procedure. Finally, dialogue annotation has been shown to work in very specific contexts for which TRAINS was developed.

3.4 Six medical dialogue annotation schemes: VRM, CACS, RIAS, MIPS, GMIAS, DREAM

Medical dialogues have also been investigated using dialogue annotation schemes, although this line of study has predominantly focused on physician-patient communication rather than on medical team communication. This and other findings have been discussed in Chapter 2. Here, we describe the structure, theoretical framework, and context of six existing medical dialogue annotation schemes. The possible issues arising in applying each to analyse the present study's data are also considered.

VRM: Verbal Response Mode

One of the earliest medical dialogue annotation systems is the Verbal Response Mode (VRM), developed by Stiles (1978). The coding system is developed based on Bales' 12-category system of interaction (Stiles, 1978), and has been applied to the psychotherapy domain. Bales' system focuses on experience and frames of experience between two interlocutors. It views each person as a centre of experience, and the communication between them as the interaction between two centres of experience.

The VRM taxonomy is made up of the source of experience (the person whose experience is the topic or source), the frame of experience (the person whose viewpoint is used), and the focus (whether on the speaker or on the other person). This is supplemented with eight basic categories or modes, as shown in the following table:

Modes in VRM	Description
(D) Disclosure	Speaker's experience, speaker's frame of reference, focus on speaker
(Q) Question	Other's experience, speaker's frame of reference, focus on speaker
€ Edification	Speaker's experience, other's frame of reference, focus on speaker
(K) Acknowledgement	Other's experience, other's frame of reference, focus on speaker
(A) Advisement	Speaker's experience, speaker's frame of reference, focus on other
(I) Interpretation	Other's experience, speaker's frame of reference, focus on other
(C) Confirmation	Speaker's experience, other's frame of reference, focus on other
(R) Reflection	Other's experience, other's frame of reference, focus on other

Table 10. The eight modes of VRM (Stiles, 1978)

Utterances in VRM are additionally classified under one of three types of human behaviour – Attentiveness, Acquiescence, and Presumptuousness. Each of the eight modes is associated with what Stiles (1978) called *grammatical form*, which denotes typical linguistic features that are used to convey a person's intent. The categories of these grammatical forms were decided based on the author and his colleagues' combined judgement. As an example, an utterance starting with "Why" and ending with a rising tone is normally treated as a question.

VRM codes each utterance twice – once for grammatical form and once for the speaker's intent. This method works well because a grammatical form may take the structure of a question ("Would you carry this for me?") but carry the intent of a request (or an *Advisement* if based on VRM modes), i.e. "Carry this for me". By tagging the utterances twice, both the explicit and implicit information are picked up. In contrast with the rest of the medical dialogue annotation schemes discussed in this chapter, VRM has no coding categories for semantic content.

VRM requires the speakers to be viewed as centres of experience. Whilst this works well in a dyadic setting (especially a psychotherapy setting, in which the scheme has been applied), VRM may not be as useful in team communication, during which it is not always clear to whom a statement is addressed or who is focused on, as the codes require these aspects to be clearly distinguished.

CACS: Communicative and Competence System

A more general coding scheme is McNeilis' (2001) Communicative and Competence System (CACS). CACS is a dialogue annotation system which is based on Cegala and Waldron's (1992) context-bound communication model and was first developed as part of a PhD thesis by McNeilis in 1995. The Cegala and Waldron competence framework emphasises communicative practices, specifically interlocutors' coordination for achieving goals and the appropriate ways this is accomplished, in their description of competence. Following this, McNeilis (1995) designed CACS as a means to analyse utterances in medical dialogues and how these utterances connect with one another.

CACS was applied in the physician-patient consultation context. It is designed to be generic, which means that the coding scheme should be applicable to any physician-patient interaction in any context. The system focuses on three main criteria – the content of the message, alignment, and function. The CACS coding unit is an utterance, which is defined as a word or words containing a thought or partial thought.

There were originally nine content categories (six medical, e.g. history, symptom, treatment; three non-medical, e.g. small talk, behavioural), two levels of management codes (acknowledgement tokens and interruptions), seven primary uptake codes (codes that deal with how an utterance is responsive to a prior utterance), and 10 function codes – three codes for information exchanges (information-seeking, information-giving, and information-verifying), two codes for how emotions are expressed, three types or levels of directives, which McNeilis (2001) interestingly described as *controlling style*, two codes for rationalisation or justification purposes – as well as nine miscellaneous categories. In total, including the sub-codes, CACS possesses 49 different codes. Some selected coding categories (McNeilis, 1995) are given in Table 11 below:

Coding categories		Description
Content	History	Utterances that describe/report previous instances of medical problems/conditions (e.g. past injuries, treatments, hospital stays)
	Prognosis	Descriptions, explanations, etc. which address the long-term aspect of current medical problems
Management	Acknowledgment token	Utterances that begin with explicit recognition of the partner's previous turn
Primary uptake	Continuer	Brief, normally one-word utterances that serve as backchannels
	Topic change	Utterances that introduce a topic that is substantively different from the prior topic
Function	Bracketing	Utterances to inform that a particular topic will be discussed later in the visit
	Closed question	Utterances designed to solicit specific information
	Directive	Orders/commands, etc. to do something
	Expansion	Continuations of a topic or theme
	Explanation	Utterances to inform/instruct the other (i.e. the hearer) for example on a test or procedure
	Formulation	Utterances that sum up what the speaker or the other has said
	Polite directive	Orders or commands that are phrased in a polite form
	Qualified directive	Orders/commands that are phrased in question form
	Solicited answer	Utterances that serve as direct answers to immediately preceding questions

Table 11. Examples of CACS coding categories (McNeilis, 1995)

The CACS alignment category (e.g. continuer) has proven to be useful in discovering how dialogue is motivated, but the overall communicative function category is heavily geared towards capturing dyadic interaction during a medical consultation, which is generally not a time-constrained environment. This makes CACS categories less suitable to code dialogues that occur during pre-hospital resuscitation. In addition, grouping directives as "polite" under one category might cause complications – a *Qualified directive* (phrased in a question form) and a direct command could also be viewed as polite. A more suitable categorisation is to base the categories on indirectness, similar to the request categories in CCSARP (discussed in previous section).

RIAS: Roter Interaction Analysis System

The Roter Interaction Analysis System, known as RIAS, is probably the most widely applied dialogue annotation scheme for medical interaction (Roter & Larson, 2002), with most studies concentrating on the dyadic physician-patient consultation. As of 1 January 2018, RIAS maintained a site detailing research conducted using RIAS (www.riasworks.com), but the website has since been deactivated.

RIAS is based on a modified version of Bales Interaction Process Analysis. RIAS was part of a health intervention programme that aimed to increase patient involvement during consultations. As such, the RIAS coding scheme focuses on physician-patient interaction in a generic medical domain, i.e. not specific to medical sub-specialisms.

RIAS categories are developed through meta-analysis of published studies involving videos and/or audio recording. From these, the developers select four functions that typically occur in clinical appointments: gathering data, educating and counselling, building a relationship, and activating and partnering. Some of the communication behaviours associated with each function (Cavaco & Roter, 2010, p. 143) are shown in Table 12.

Functional grouping	Communication behaviour	Examples
Gathering data	Open-ended question	
	- Medical condition	What can you tell me about the pain?
	- Therapeutic regimen	How are the meds working?
	- Lifestyle and self-care	What are you doing to keep yourself healthy?
	- Psychosocial topics	What's happening with his father?
Educating and counselling	Biomedical information	
	- Medical condition	Your blood sugar is still high – not any lower than last time
	- Therapeutic regimen	You will have to watch your diet more carefully, especially the carbohydrates
	- Lifestyle and self-care	Getting plenty of exercise is always a good idea
	- Psychosocial topics	It's important to get out and do something with other people every day

Building a relationship	Positive talk - Agreements - Approvals/compliments Emotional talks - Concerns - Empathy	 Yes, I agree that is the way to go You look fantastic, you are doing great I'm worried about that I can see how angry that makes you
Activating and partnering	Partnering and activation - Asking for patient opinion - Asking for understanding - Cues of interest Orientation (directions, instructions)	 What do you think would help? Do you follow me? Right, go on… I'd like to do a physical now. Get up on the table. Now we'll check your back

Table 12. Selected examples of communicative behaviours that are coded in RIAS (Roter & Larson, 2002)

RIAS examines both the utterance forms (statements that are primarily informative, interrogative, persuasive, etc.) and the content areas (medical condition and patient history, therapeutic regimen, lifestyle behaviours, etc.). In addition, coders also rate the speakers' affective dimensions (e.g. interest, dominance, anger, anxiety, friendliness) on a 6-point scale. The coding system has 41 coding categories.

RIAS annotation is applied directly to the audio using special direct entry software. This practice means that whilst no transcription of the dialogues is required, the annotator needs access to the software, which is only available from the developers. To ensure efficiency and reliability, a three-day intensive training workshop followed by 50-to-60-hours of coding practice with the RIAS software is required (Cavaco & Roter, 2010).

The development of RIAS is fully based on the interaction that takes place during a medical interview or consultation between a physician and a patient. As such, RIAS concentrates on communication categories and functions that solely concern this specific domain. Whilst RIAS has shown to be widely applicable in this context, the categories are less suitable to capture communication during a medical procedure, during which the focus is on the stages of procedure rather than giving biomedical information or patient counselling. The functional grouping of the interaction itself might be different for medical teams. Finally, the transcription-less annotation method requires paid training and access to the software for reliable use of the annotation scheme.

MIPS: Medical Interaction Process System

The Medical Interaction Process System (MIPS) is developed based on the principles of Longabaugh's Resource Exchange Analysis, which views interpersonal behaviours (including dialogue) as an exchange of resources between the interlocutors. The coding unit is called the *interact.* MIPS describes an interact as a sequence of interaction on one topic or resource. When a new topic or resource is introduced, this marks a new interact. MIPS categories are developed using a combination of existing RIAS categories and new categories that are derived from previous data on simulated physician-patient dialogue in oncology (Ford et al., 2000).

MIPS coding categories contain 15 content codes that concern the resources (e.g. *Med*: All medical details; *Tests*: Past and future tests; *Drugs*: Prescribed treatments and drugs; *S.Effs*: Side effects of main treatments) and 30 modes that are used to capture the communicative functions of the interacts, of which a selected number (from Ford et al., 2000, p. 560) are shown in Table 13. In addition, there are seven non-verbal categories used to analyse shoulder position, posture, frequency of hand gesture, body leaning position, and eye contact for both physicians and patients, and reading and writing activity and touching of patient for physicians.

MIPS Modes (categories for coding communicative functions)	
Modes that require content categories	*Modes that do not require content categories*
Open question Leading question Multiple question Checks information Checks understanding Summarises Gives information (neutral/positive/negative) Gives reassurance Orientation Directs/Advises Requests/Preference	Agreements Facilitates speech Registers information Empathy/psych support Asks for repetition Interrupts Expresses irritation Expresses gratitude Expresses apology

Table 13. Selected examples of communicative behaviours that are coded in MIPS (Ford et al., 2000)

The domain of MIPS is similar to CACS and RIAS as it concentrates on physician-patient interactions during consultations, with the exception that MIPS is designed for the oncology context. This is clearly reflected in some of the description of MIPS content codes. For instance, the *Tmt* (Treatment) code is described as "Main cancer treatment – including all chemotherapy and drug treatments which aim to cure/control patient's cancer…" (Ford et al., 2000, p. 559). That said, the codes could be applied in other specialisms by changing the type of treatment (e.g. from *cancer* treatment to *orthopaedic* treatment).

MIPS is an evidently reliable coding system, but one that has been developed with dyadic interaction in mind. The two modes of exchange that makes up its coding unit – one from the physician and one from the patient – calls for clearly marked interaction, i.e. identified turns between one speaker and one hearer, something that may be difficult in team communication, where one speaker might address more than one hearer and receive responses from both. In addition, some communicative function codes in MIPS are specific for physicians, for instance, *Leading question, Multiple question*, and *Facilitates speech*, whilst *Requests/preference* is specific to patients. This seems to highlight the expert – non-expert split in the interaction, which is reasonable in evaluating physician-patient communication. It is not clear whether communication between medical experts needs differentiated codes such as these.

GMIAS: Generalised Medical Interaction Analysis System

The Generalised Medical Interaction Analysis System, or GMIAS, is designed by Laws et al. (2009) to analyse physician-patient interaction. The dialogue annotation scheme was developed in connection with a randomised controlled trial of adherence to anti-retroviral (ARV) HIV treatments. Similar to MIPS, GMIAS attempts to fulfil the need for a coding scheme that can account for utterances in a specific medical specialism.

GMIAS is, perhaps, the only medical dialogue annotation scheme, to be developed based on a linguistic framework, namely Speech Act Theory. The unit of speech demarcation is one completed speech act. GMIAS categories contain very explicit context-related codes such as *Anti-retrovirals (ARVs), Disease counts: HIV-related lab tests only,* and *Non-ARV pharmaceutical treatments.* GMIAS is also designed with physician-patient interaction in mind, and therefore includes codes like *Directive aspiration/aim* that captures verbalisations of doctors' orders and *Qualifying utterances* that deals with utterances that gloss bad news or outcome. Despite this, Laws et al. (2009) maintained that GMIAS is generalisable to other fields of study.

GMIAS uses topic codes that are inspired by RIAS concepts; in fact, according to the authors, all top-level codes in GMIAS correspond to RIAS concepts, although the sub-categories differ. In contrast to RIAS, GMIAS coding is done from transcripts. Software called the Interview Analyser (IA) can be used for the annotation process. The GMIAS coding system uses integers to represent the top levels and decimals to represent the sub-categories. There are eight top-level categories in GMIAS, shown in Table 14.

Coding category	Description
1.0 Asks Question or Interrogatives (11 sub-categories)	The speaker requests that an interlocutor provide information
2.0 Give Information (33 sub-categories)	Makes a statement purportedly of fact, including facts about the speaker's state of mind/body or about intersubjective reality
3.0 Conversation Management (7 sub-categories)	An utterance that serves to manage either turn-taking or the topic of the conversation
4.0 Empathy/Reassurance (2 sub-categories)	A statement expressing empathic response to the interlocutor's emotions, concerns, or feelings
5.0 Urge Action or Directives (8 sub-categories)	A statement that serves to control or influence the behaviour of the interlocutor
6.0 Indicate/Confirm Action or Commissives (6 sub-categories)	An utterance in which the speaker makes a promise or resolves to take action
7.0 Humour, Joke, or Levity	Brief humorous narrative and comment
8.0 Social Ritual	Social expression, e.g. "hello", "goodbye", "thank you"

Table 14. The eight top level categories coded in GMIAS (Laws et al., 2009)

For each segmented utterance, two GMIAS codes are applied – one to capture the speech act (linguistic or interaction-related) and the other to capture the topic (domain-related). Only one of each is allowed.

GMIAS presents a valuable basis for the development of the present dialogue annotation system as it was the only medical dialogue annotation system that was built on linguistic grounds. This supports the present study's aim of investigating the use of linguistic features in resuscitation dialogues. The major drawback is the fact that GMIAS was developed for physician-patient interaction in a unique medical domain, i.e. consultation regarding ARV adherence. The dialogues taking place in a medical consultation naturally differ from the dialogues during a medical procedure. A test annotation using one of the transcripts from the present study revealed that many linguistic sub-codes were less practical for the current dialogue analysis (the topic codes were understandably not compatible). For instance, the following categories under the *Internal States* or *Expressives* (sub-categories from 2.0 Give

Information) could be useful in a physician-patient dialogue, but did not seem to occur in resuscitation team dialogues:

2.3 *Values, Belief, Assumptions* (Permanent or long standing ideological or moral orientation to the world, including culturally-determined attitudes and understanding, religious faith, ethical principles)

2.4 *Preferences, Tastes, Opinions* (Personal preferences, likes and dislikes, as they apply to specific objects such as foods, habits, music, specific people or categories of people, the desirability of a certain course of action for another person, including the interlocutor, when not presented as a directive)

That said, some sub-categories appeared to be appropriate for the present study. These include 2.121 *Explain/outline determined future course of action*, 5.1 *Recommend/Suggest*, 5.2 *Request*, and 6.2 *Commit to action*.

DREAM: Dialogue acts in clinical research data query medication

One of the more recently developed dialogue annotation schemes is DREAM, or Dialogue acts in clinical research data query mediation, developed by Hoxha et al. (2016). Unlike its predecessors, DREAM concentrates on the written word. It aims to characterise e-mail discourse during the biomedical query mediation process, that is, communication between a clinical researcher (any researcher that sends an e-mail query regarding medical research) and a query analyst (the person authorised and responsible for responding and providing the information requested).

DREAM is included in this review due to its approach of using an existing, non-medical dialogue annotation system to analyse a relatively medical domain. DREAM retains the major structure of DAMSL but adds several sub-categories to fit the coding scheme to its context. The coding categories in DREAM are definitely developed for written communication (therefore less suitable for face-to-face dialogue), but the use of an existing non-medical dialogue annotation scheme for its basis shows that this approach may also work for the present study. Further, this allows data comparison and sharing since the same coding categories are applied.

3.5 Summary of review

This review of the six medical dialogue annotation schemes reveals that they share some similarities. All six annotation schemes focus on verbal communication during face-to-face interactions, with the exception of MIPS, which contains coding categories for non-verbal gestures, and DREAM, which examines written communication.

Regardless of the theoretical frameworks, all six possess two coding domains; one for communicative functions and another for topic/subject matter. Some communicative function categories of all six schemes are similar or sufficiently similar to be grouped under the same key categories. Table 15 compares three of these – questions or interrogatives, assertions or statements that provide information, and instructions or directives. Of the six medical dialogue annotation schemes, only RIAS has been applied in non-English-speaking contexts, albeit with similar results (Roter et al., 2002).

Dialogue annotation scheme	Categories shared		
	Questions/ interrogatives	*Information-giving statements/assertions*	*Directives/instructions*
	Examples		
VRM	Question (Stiles, 1978, pp. 695-696)	Disclosure; Edification (p. 695)	Advisement (p. 696)
CACS	Closed Question; Moderately Closed Question; Open Question; Embedded Question (McNeilis, 1992, p. 177)	Assertion; Justification, Explanation (pp. 178-179)	Polite Directive; Directive; Qualified Directive (p. 179)
RIAS	Question asking: Open-ended-questions; Closed-ended-questions (Lipkin & Roter, 1997, p. 350)	Biomedical information (p. 350)	Orientation: Directions/Instructions (p. 351)
MIPS	Asks questions: Open, Closed, Leading, Multiple, Focused open (Ford et al., 2000, p. 560)	Gives information: Neutral; Positive; Negative (p. 560)	Directs/Advises (p. 560)
GMIAS	Asks Question/Interrogatives: Open question; Closed question; Leading question; Clarification (Laws et al., 2009, p. 17)	Give Information: Factual information; Behaviour; Conclusion or Deduction; Explain/outline determine future course of action, etc. (pp. 18-23)	Urge Action/Directives: Recommendation/Suggestion; Request; Directive aspiration or aim; Direct/Mandate; Convince; Give permission; Refuse permission; Approve; Disapprove (pp. 24-25)

DREAM	Info-request: Yes-no-question; Wh-question (Hoxha et al., 2016, p. 96)	Representatives: Statement-opinion; Statement-not-opinion (p. 96)	Directives: Info-request; Action-directive; Open-option (p. 93)

Table 15. Comparison of three major communicative functions that are shared in six medical dialogue annotation schemes

A potentially useful communicative function category for the present research is the Commissives, or utterances that bind the speaker to an action. This function is only found in three of the six dialogue annotation schemes (GMIAS, CACS, DREAM), although in CACS, it is only treated as a direct response or compliance to a directive. The Commissive function may be more frequently (and perhaps crucially) applied in medical team dialogues during a procedure rather than during a physician-patient consultation, hence its absence in the previous coding schemes.

The largest difference resides in the content/subject matter coding categories. Each annotation scheme has been tailored to fit its own context; therefore, the content coding categories always reflect these contexts. Our dialogue annotation scheme would need to develop its own subject matter codes as there are no existing content coding categories that have been applied in resuscitation dialogue.

3.6 Deciding the basis for the Dialogue Analysis for Resuscitation (DARe) system

In deciding the basis for developing the present dialogue annotation system, several factors were considered – the background theory or framework applied by the annotation scheme; the flexibility of the original scheme (whether categories are easily deleted or added); and ease of use and access to the full coding categories.

As the present aim is not only to identify the frequencies of language function and content but also to explore the deeper workings of the functions in relations to the context and the forms that they are expressed in, it is appealing to apply Speech Act Theory (SAT) as a framework. SAT would allow analysis along pragmatic lines, for instance identifying the strength of an illocutionary point, such as the level of indirectness in giving instructions, and whether this corresponds to trained communicative behaviours or resuscitation outcomes.

It is also essential to have a flexible annotation scheme. To our knowledge, there has been no previous study that performed dialogue annotation analysis on resuscitation team dialogue. Hence, a basic coding scheme that covers the major dialogue functions is required, but not one that has been fleshed out too much that it includes too many sub-categories that may not be usable in team communication, or one that has been developed with context-specific categories. Where possible, it is also beneficial to have coding categories that correspond to existing annotation schemes. This will allow comparability of research findings and minimise confusion that may arise from the use of terms that defined differently in different studies.

No less important is the access to full coding categories and their ease of use. Some previous dialogue annotation scheme developers did not publish their full coding manual, leaving them only accessible via formal training. Due to data confidentiality, the annotation scheme for the current study needs to be applied manually by a person or persons and not through any automatic annotation tool. This is because the real-life resuscitation videos in the present study are only accessible via their own platform, i.e. not transferable to any external software or location. Hence, it is more convenient (and in the long run, more accurate as the transcripts are reviewed by medical experts) to code the data based on transcripts rather than directly from videos.

DAMSL thus appears to provide a suitable place to start. Inspired by DREAM, the coding categories will be enriched with relevant sub-categories from GMIAS. DAMSL has the following to offer: ease of use and mastery, ease of expansion, and the ability to tag an utterance with more than one type of code. This last function of allowing utterances to be coded into more than one category does not seem to be applied in any of the other medical coding schemes (except for DREAM, but DREAM is based on DAMSL). Meanwhile, GMIAS contains several coding categories that can be integrated into the DAMSL main structure. The fact that both dialogue annotation schemes share the same theoretical background (i.e. SAT) means that the categories can be easily transferred over.

For the purposes of this research, two dimensions of DAMSL – the Forward Communicative Function (FCF) and the Backward Communicative Function (BCF) – are utilised. The Utterance Features, which are designed to capture whether the utterance is about task or communication management, is left out at present. One reason for this is the low reliability for capturing functions on the Utterance Features dimension (Core & Allen, 1997). Even though some categories under FCF (e.g. *Reassert*, *Commit*) and BCF (*Accept*, *Acknowledge*) also showed low inter-annotator reliability, removing the need to identify whether an utterance concerns the management of task or communication may alleviate some of this uncertainty. The example below, taken from Core and Allen (1997), illustrates the added uncertainty when the Utterance Features dimension is tagged.

Utterance	Communicative function	Utterance Features
s: so we'll take the train through Corning	FCF (*Assert*)	*Assert* = Task Level
u: okay	BCF (*Accept*) OR BCF (*Acknowledge*)	If *Accept* = Task Level If *Acknowledge* = Communication Management Level
s: and on to Elmira	FCF (*Assert*)	*Assert* = Task Level

To establish the exact intention of the speaker "u", one would have to read the speaker's mind, which is the issue at the heart of all dialogue annotation criticism. Simply reading the transcription does not give a full picture of what the speaker meant by "okay" – was it an agreement, accepting the prior suggestion, or a backchannel, acknowledging the prior utterance? Could it be both? *Can* it be both? There is no concrete way to confirm this. Clearly, as a response, it belonged under BCF, and it was highly likely meant as a verbal response to the same topic or subject matter, but these are perhaps the only solid conclusions that can be inferred from the utterance. Speculating about its Utterance Feature only adds more uncertainty.

3.7 Basic layout for DARe: Capturing the communicative functions

The initial categories for DARe (largely taken from DAMSL) are as shown:

Forward Communicative Functions (9 coding categories)

Function	Description
Statement	
Assert	Utterances that make explicit claims about the world, which also includes answers to questions. As a rule, the content of statements can be evaluated as being true or false. This function includes weak statements (like hypothesising).
Reassert	Statements that have already been made prior to the present utterance. DAMSL does not specify the distance between the first mention and the second mention. The coder tags *Reassert* when the utterance is made within the same dialogue act.
Influencing-addressee-future-action	
Action-directive	Utterances that directly influence the hearer's future non-communicative actions. This function creates an obligation that the hearer does the action unless the hearer indicates otherwise (unable to comply or refuse to).
Open-option	Utterances that directly influence the hearer's future non-communicative actions but put no obligations on the hearer. This function can be ignored (not responded to) without appearing rude, unlike in *Action-directive*, since no obligations beyond normal conversational constraints are placed on the hearer.
Committing-speaker-future-action	
Commit	Utterances that potentially commit the speaker (in varying degrees of strength) to some future course of action, without requiring hearer's agreement.
Offer	Utterances that indicates speakers' willingness to commit to an action upon the acceptance of the hearer.
Info-request	Utterances that often require binary dimension responses. Utterances that introduce an obligation to provide information, by any means of communication, should be marked as Info-request.
Conventional-open-close	Phrases conventionally used to start interaction/summon addressee/dialogue closing/dismiss addressee. DAMSL originally distinguished openings and closings, but for the present study, they are grouped as one.
Explicit-performatives or Performatives	Speaker performing an action by virtue of making the utterance.

Backward Communicative Functions (11 coding categories)

Function	Description
Agreement: Utterances that indicate the hearer's view of the speaker's proposal (e.g. claim about the world, request, offer, etc.), particularly at the task level.	
• Accept • Accept-part • Maybe • Reject-part • Reject • Hold	• Accept the proposal wholly. • Accepts a part of the proposal. • Non-committal to the proposal. • Disagrees with part of the proposal. • Disagrees with the proposal. • When the speaker states their attitude towards the proposal, for example asking how to comply with the speaker's proposal or questioning its desirability.
Understanding: Utterances that are said to signify that the speaker/hearer are understanding each other as the conversation proceeds. There are many levels of Understanding, ranging from merely	

hearing the words to fully identifying the speaker's intention, but these are grouped together to mean that if the hearer is said to have understood the speaker, then the hearer knows what the speaker meant by the utterance.	
Signal-non-understanding	Utterances explicitly indicating a problem in understanding the previous utterance.
Signal-understanding • Acknowledge • Repeat-rephrase • Completion	 • Short utterances that signal that the previous utterance is understood, without necessarily signalling acceptance. Backchannels are one form of Acknowledge. • Utterances that repeat or paraphrase what was just said to signal that the speaker has been understood. • Finishing/adding to the utterance that the speaker is in the process of constructing.
Answer	A binary dimension where utterances can be marked as complying with an Info-request action. Can be an imperative act as well.

Miscellaneous (1 coding category)

Incomplete	Abandoned utterances
Indecipherable	Poor audio quality/Unintelligible/Coder does not know

DAMSL is quite specific in its Backward Communicative Function categories. Its Forward Communicative Functions, on the other hand, are generally quite broad. Using the coding categories from previous dialogue annotation schemes as a guide, the granularity of three main FCF categories, namely *Assert*, *Action-Directive*, and *Info-Request,* is increased here. The following Tables 16, 17, and 18 show the sub-categories, their descriptions, and where they originate from:

Function	Description
Conclude/Deduce (Under *Representatives* in GMIAS, bulleted as 2.12 in the coding manual)	An assertion of fact presented as the result of a process of logic or consideration.
Forward-course (Under *Representatives* in GMIAS, bulleted as 2.121 under the heading *Explain/Outline determined future course of action* in the coding manual)	When speaker describes or outlines the next course of action, or the future course of action for the team. This is procedure-related as the speaker verbalises the resuscitation script. Sometimes this is tagged together with a directive.

Table 16. Sub-categories for *Assert* borrowed from GMIAS (two categories)

The selection of these two categories is based on the assumptions that, in medical procedures, there would be conclusions or deductions based on the state of the patient, and that paramedics would also communicate about the future course of action that they are going to perform.

Function	Description
Direct/Instruct (Under *Directives* in GMIAS, bulleted as 5.4, originally *Direct/Mandate*)	Utterances that directly command/order the hearer to do an action.
Request (Under *Directives* in GMIAS, bulleted as 5.2 in the coding manual) Covers the range of *Query Preparatory, Want Statement, Obligation Statement, Hedged Performative* in CCSARP	A direct utterance requesting the hearer to do something. Note that this function is usually associated with conventionalised structures/idiomatised pragmalinguistic structures.
Recommend/Suggest (Under *Directives* in GMIAS, bulleted as 5.1 in the coding manual) Similar to *Suggestory Formulae* in CCSARP	Utterances couched to suggest that it is the speaker's advice or proposal, not necessarily an order. Prompts are also included in this sub-category.
Allow (Under *Directives* in GMIAS, bulleted as 5.6 in the coding manual, originally *Give permission*)	Used by the speaker to give permission. It implies that the speaker has control over the hearer's behaviour.

Table 17. Sub-categories for *Action-directive* borrowed from GMIAS and CCSARP (four categories)

The four sub-categories move very roughly from direct to less direct, although they are not as finely distinguished as the degrees in CCSARP. In the event of salient variations that are not covered by the current categories, the CCSARP distinctions will be referred to. The *Direct/Instruct* sub-category is considered as the most transparent, given with explicit syntactic force. The *Request* and the *Recommend* sub-categories are recognised from the wording conventions. *Recommend* is very similar to CCSARP's *Suggestory Formulae* whilst *Request* covers the range of *Query Preparatory, Want Statement, Obligation Statement*, and *Hedged Performative*. Finally, hints are not included in the present annotation scheme but will be added if hints frequently occur in the data.

Function	Description
Open-question (Under *Interrogatives* in GMIAS, bulleted as 1.11)	A broad question with possible unlimited response categories.
Closed-question (Under *Interrogatives* in GMIAS, bulleted as 1.12)	A question that requires a brief, specific answer, especially of the "Yes/No" variety. Also used when speaker needs a specific answer.
Leading-question (Under *Interrogatives* in GMIAS, bulleted as 1.121)	A question that includes a proposed answer. May or may not be asking for reiteration or assurance of accuracy of a previously discussed/suspected fact. Phrasing is key.

Table 18. Sub-categories for *Info-request* borrowed from GMIAS (three categories)

3.8 Basic layout for DARe: Capturing the semantic content

DAMSL captures content using its Information Level dimension, in which the system identifies whether an utterance deals with specific tasks, the process of solving the tasks, or communication management. Since the aim for the present annotation scheme is also to capture explicit resuscitation-related content, more granular and context-specific categories are required. Each of the six medical dialogue annotation schemes discussed earlier operates with two coding domains – one communicative function domain that is linguistic/language-related and another semantic function domain that is topic/subject-related. RIAS provided a good example of classifying utterances into four topic or subject categories for the semantic function domain, but the classifications are predisposed towards clinical consultations rather than clinical procedures. Further scrutiny of GMIAS revealed the existence of "threads", described by Laws et al. (2013) as specific subject matter that arises during dialogues, regardless of topic. The use of threads as an analytic tool captures the intention that is conveyed by specific subject matters throughout a dialogue. In particular, threads are useful in demonstrating where and when subject matter arises as the dialogue progresses (Laws et al., 2013, see p. 196 for an example of a thread graph).

To develop a suitable thread coding scheme for the current study, we searched for existing coding categories for contents applicable to the domain of resuscitation. However, thus far, no coding categories for resuscitation exists. Therefore, we first relied on the Adult Advanced Life Support (ALS) algorithm provided by the Resuscitation Council UK (2015), shown in Figure 2.

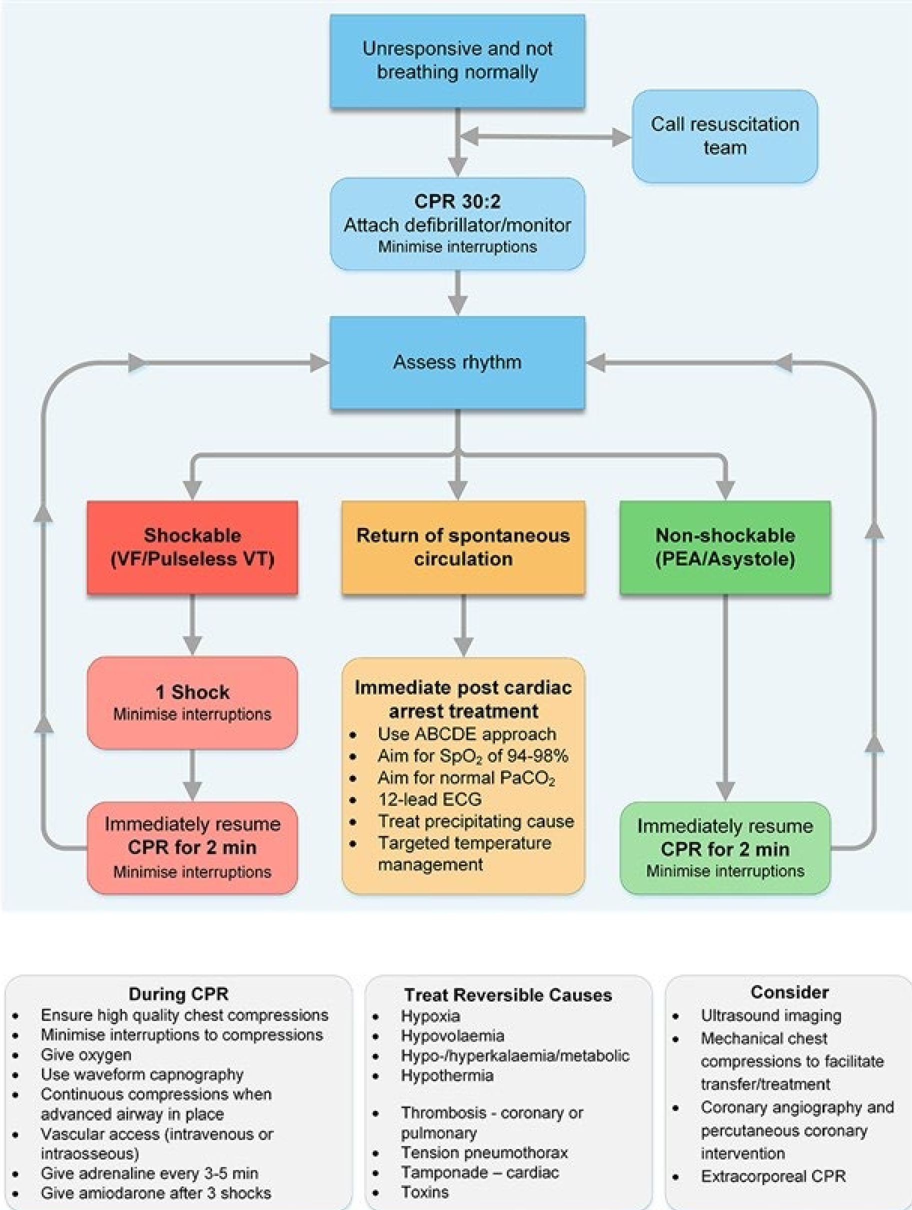


Figure 2. The Adult Advanced Life Support (ALS) algorithm for resuscitation

It is reasonable to expect that threads likely to be discussed during resuscitation would be the ones related to the steps or stages pictured in the algorithm. The following six threads are thus posited:

Thread	Description
Compression	Utterances relating to chest compression
Rhythm	Utterances relating to rhythm (shockable and non-shockable)
Instrument/Equipment	Utterances regarding waveform capnography, IV, IO line
Medication/Treatment	Utterances regarding adrenaline, amiodarone, 12-lead ECG, oxygen, CO_2
Reversible causes	Utterances relating to the 4Hs and 4Ts[2]
Time	Utterances indicating time, e.g. minutes between shocks

Table 14. Six proposed threads for DARe

Because resuscitation is a team task that would be highly likely to involve the verbalisations of planning, we took a leaf out of AMI's reflexive act category, discussed in Section 3.2. In DARe, this is called *Plan of action*, described as utterances regarding the plan(s) of the team to complete the task at hand. It ranges from a general orientation, such as "We will do X and then Y" to a specific plan at a specific time, such as "Stop compression now".

With the basic DARe prepared, test annotations could now be performed. For this purpose, we made the working assumption that simulated scenarios performed by expert paramedics would provide a close representation of out-of-hospital resuscitation. Details of the simulations are given in the next section.

3.9 Annotating simulation transcripts

For the initial test annotations, we selected four simulation videos of out-of-hospital cardiac arrest (OHCA) resuscitation attempts, referenced here as SIM1, SIM2, SIM3, and SIM4. All four simulations are high-fidelity simulations, i.e. simulations that are designed to replicate real-life scenarios, and therefore to provide satisfactory likeness to actual resuscitations.

Video details

The four simulation videos are part of an ongoing training and development exercise for the Resuscitation Rapid Response (3RU) paramedics, a specialist group of second-tier responders based in Edinburgh, Scotland. The 3RU is a group of paramedics who have been trained

[2] Reversible causes that can be treated. 4Hs refer to hypoxia, hypovolaemia, hype/hyperkalaemia, and hypothermia. 4Ts refer to thrombosis, tension pneumothorax, tamponade, and toxins (see Figure 2, Section 3.8)

specifically to handle OHCA resuscitation and normally serve as leaders in pre-hospital resuscitations (refer to Section 1.1).

The four simulations were performed under controlled settings. Each simulation started with a bystander who was doing chest compressions on a cardiac arrest patient (a life-size mannequin). Two paramedics, acting as the first two responders on scene, arrived and took over resuscitation from the bystander. A few minutes later, another paramedic, representing the 3RU, arrived on scene to assist with the resuscitation. There were no external disruptions to the simulations, for instance stopping the simulation for instructions or unrelated matters. The audio quality for all videos was satisfactory.

There were a few variations in the four simulations, which support their ecological validity (see Chapter 4 for more detailed descriptions of the videos). These included the level of communication that a team had with the bystander in the scenario (SIM1 had very little verbal interaction whilst SIM3 had the most); and the use of a mechanical chest compression device called AutoPulse (SIM1 and SIM2 teams did not use the device whilst SIM3 and SIM4 teams did). Other than these, the four simulations showed full adherence to the Advanced Life Support procedures required in OHCA resuscitations. Unlike real-life resuscitation footage, simulation videos could be viewed using external video platforms (ethics are clarified in Section 4.2). Hence, the transcription of the videos was done using online transcription software, O-transcribe, developed by Elliot Bentley and available at https://otranscribe.com/.

The following section reports the annotation process, results from the preliminary annotations, and changes made to the dialogue annotation scheme. The full results are reported in Chapter 4.

Segmentation of utterances

The first part of dialogue annotation involves segmentations of the transcribed dialogues. For the purpose of this study, dialogues were segmented based on the speech act to form distinct units of utterance, following both GMIAS and DAMSL. Examples of dialogue segmentations are given in (2), taken from SIM1, and (3) from SIM2:

(2)

Utterance 76, 3RU:	|Size tube do you want size 8?|	One segment
Utterance 77, P1:	|Eight, |please yeah,| yeah I've got one here|	Three segments
Utterance 78, 3RU:	|You've got one there|	One segment

Sometimes, a speaker might produce one long turn, as can be seen in (3). After segmentation, eight different units (separated with (|) and marked with superscripts [1] to [8]) were established.

(3)

Utterance 67-72, P1: We need help,[1]| she, she's Margaret who was, 88,[2]|she was uh,[3]|staff couldn't wake her up for her breakfast this morning[4]|found her not breathing and kinda cold,[5|]and starts CPR.[6]|She was treated for a recent chest infection[7]| And that's a rhythm check[8]|

An utterance may be broken by an interjection, as shown in the following exchange (4) from SIM2:

(4)

Utterance 151, 3RU:	Can I get you to--
Utterance 152, P2:	*(interjects)* Yes mate
Utterance 151, 3RU:	--swap over

In this case, the 3RU's interjected utterance is still considered as one segment, i.e. "Can I get you to" + "swap over" because the emphasis of the segmentation is on the functional notion of the utterance (in the example, requesting a swap). Ideally, this means that each utterance will contain one type of communicative function coding category. However, sometimes a single utterance may contain more than one type of communicative function. We refer to these as ambiguous utterances, which will be discussed further later in this chapter.

Sentence segmentation is not always clear-cut. In the course of data segmentation, two specific issues surfaced.

ISSUE 1: When to split an utterance containing acknowledgement-like words

When should we split utterances containing an acknowledging word like "Okay" or "Yeah" that is followed by another phrase, for instance, "Will do" or "That's great"? On the one hand, utterances like this can comprise two separate units, but on the other, it can be argued that both parts carry the same meaning, and therefore the utterance should not be split in two. For this issue, we base our decision on GMIAS segmentation guide – if a word by itself contains an identifiable speech act, then it should be segmented and coded as such (Laws et al., 2009). In the previous example (2), the utterance by P1 is segmented as follows:

Utterance 77, P1: |Eight, |please yeah,| yeah I've got one here|

Where |Eight| is the first segment (repeating/rephrasing the preceding question); |please yeah,| is the second segment (answering the preceding question with a yes/no + please); and |yeah I've got one here| is the third segment (still responding to the preceding question but asserting possession of said equipment).

A variety of other combinations can also occur, like the following examples:

(5) Sure, no problems
(6) No, that's fine
(7) Okay, thanks
(8) Alright, alright

To standardise the annotation, several guidelines were devised to help coders decide whether the utterances are to be split or not. As a rule, all utterances of this type are split first. Then, the tags for each are determined, for example:

(5)

Sure	ASSERT
no problems	ASSERT

(6)

No	REJECT
that's fine	ASSERT

(7)

Okay	ACCEPT
thanks	PERF

(8)

Alright	ACKNOWLEDGE
alright	ACKNOWLEDGE

The tags illustrate that when split, the segments in (5) and (8) contain the same types of function. The speaker's intent, or illocutionary point, is considered the same for both – in (5) they indicate assertions and in (8) they indicate acknowledgments. These utterances are consequently viewed as one segment instead of two. On the other hand, the segments in (6) and (7) reveal different communicative functions. These utterances are therefore viewed as two different segments or units.

Words like "Yeah", "Right", or "Okay" are tricky to classify. Placed at the final position or after the main communicative function, these kinds of words tend to act as fillers or mitigation devices that form part of the prior communicative function. The following examples (9) from SIM2 and (10) from SIM4 demonstrate this kind of phrasing:

(9)

Utterance 245, 3RU: Watch out for […][3] the cable, *yeah* P1?

(10)

Utterance 32, P1: You just step back just now, *okay*

However, there are two possibilities that allow for segmentation. The first is when there is a clear pause between the filler and the next utterance and the second is when such words function as a kind of delayed answer. This type of identification of units can be supported by appeal to the time latency between the segments. If there is a pause of one second or more between the first segment and the second, then these can be considered as two separate units, regardless of possible functional similarity. Segmentation based on prosodic clues like tone and pauses have been proposed in previous dialogue research (see Traum & Heeman, 1997). Nonetheless, the use of speech pauses can result in a lot of segmentations, which can break up a dialogue into many micro-utterances and therefore result in inconsequential

[3] […] inaudible speech

segments (Traum, 1996). Due to this, pausing as an identifier of units is only applied to support an initial decision, or when the pause is especially salient in signalling the break of two utterances. Considering (10) as a sample dialogue, if there is a salient pause in the speaker's utterance, this pause can be used to support the initial argument that it is made up of two units of utterances, with the first part functioning as a directive and the second as a confirmation of the directive (or perhaps, a query for the hearer's agreement, depending on the intonation).

Utterance 32, P1: You just step back just now, (1.0 second pause) _okay_

Pauses are not used to segment an utterance if an utterance is clearly only complete as a communicative function when the two pause-separated parts are joined. Considering (10) once more as a sample dialogue:

Utterance 32, P1: You just (1.0 second pause) step back just now, _okay_

The same one-second pause now will does not mark a segmentation boundary. Note that for the present study, segmentations based on pause and tone are only used to support initial decisions and not as the primary method.

ISSUE 2: Segmenting (or not segmenting) utterances with conjunctions

When an utterance contains a conjunction between clauses, for example "but", "and", or "because", this generally means that there are separate independent clauses in the utterance. Following this, segmentation is performed (Laws et al., 2009). For the most part, as in (11), this is reasonable. However, for utterances like (12), the potential segmentation is not appropriate. Both examples are taken from SIM1.

(11)
Utterance 113, 3RU: Okay, so he's had three shocks |and he's still in VF[4]

(12)
Utterance 68, P1: Shall we go |and check?

[4] VF: Ventricular fibrillation

"Go" in (12) is essentially an empty verb (also known as a delexical verb) that accompanies "check". The whole utterance functions the same if the words "go and" are removed since the paramedic involved was not talking about going to a different venue. Consequently, utterances with empty verbs, i.e. verbs that have very little or no meaning on their own, are not segmented.

Initial dialogue act annotation

After segmentation was completed, each segment was then tagged with the categories in DARe. Following DAMSL, DARe allows multiple tags for one utterance depending on the number of functions it possesses; therefore, some utterances may show more than one tag in either or both of its function and thread codes. The excerpt below shows the same dialogue in SIM1 (2) earlier, but with communicative function and thread annotations:

Speaker	Utterance	Communicative function code	Thread code
3RU	Size tube do you want size 8?	*Info-request*	*Instrument*
P1	Eight, please yeah.	*Answer*	*Instrument*
P1	Yeah, I've got one here	*Assert*	*Instrument*
3RU	You've got one there.	*Repeat-rephrase*	*Instrument*

Table 19. Sample of dialogue with communicative function and thread annotations

The repetition of thread code lends evidence to Laws et al.'s (2009) view that topic codes (threads in this study) "remain unchanged across many consecutive speech acts", and therefore are of little use in segmentation of speech but useful for the determination of the subject matter under discussion and the frequency of its discussion.

It became clear after iterative listening to the audio and reading of the transcripts that a few issues needed to be resolved. We discuss the three main issues here.

ISSUE 1: Coding categories did not capture some patterns for sub-categories

The initial dialogue annotation exercises revealed that all utterances could be captured by the major communicative function codes (i.e. *Assert, Action-directive, Info-request,* etc.). However, when the utterances were further classified for *Assert*, some utterances remained uncategorised because they did not belong to either the *Forward-course* or *Conclude/Deduce* sub-categories. Table 20 shows five *Assert* utterances from the four simulation dialogues. The first two were labelled with the two available sub-category codes and the next three were unknown/uncategorised. Note that the utterances are randomly selected to illustrate the absence of some *Assert* sub-categories and therefore are not connected to one another.

Speaker	Utterance	Communicative function code	Sub-category
P2	Next shock at four minutes	*Assert*	*Forward-course*
3RU	Okay, he's making signs of life	*Assert*	*Conclude/Deduce*
P2	5 4 3 2 1	*Assert*	?
P1	Computer on	*Assert*	?
3RU	Can see you're tiring a bit	*Assert*	?

Table 20. *Assert* utterances that do not fit into existing sub-categories

A higher number of uncategorised utterances involved the types of thread. The following table shows examples from the four simulation dialogues. The first five utterances are examples of utterances that can be labelled with the present thread codes and the rest of the utterances are examples of utterances with no available thread codes. Similar to Table 20, the utterances in Table 21 are random and discrete examples. Only the major communicative function codes are shown.

Speaker	Utterance	Communicative function code	Thread code
3RU	We got ROSC?	*Info-request*	*Rhythm*
3RU	[...] three minutes	*Action-directive*	*Time*
3RU	Hypokalaemia?	*Info-request*	*Reversible causes*
P2	Okay, you just continue doing CPR	*Action-directive*	*Compression*
3RU	We're gonna stop that machine	*Action-directive*	*Instrument/ Equipment*
3RU	P2, best as you can, just give him adrenaline	*Action-directive*	*Medication/ Treatment*
3RU	Continue ventilations	*Action-directive*	?
P1	Could you tell us what was going on?	*Info-request*	?
3RU	Okay, so airway's fine	*Assert*	?
P1	Step back in a second	*Action-directive*	?
3RU	And you will cut his t-shirt off	*Action-directive*	?
3RU	Stand clear	*Action-directive*	?
P1	This area feels alright	*Assert*	?
P1	Hey 3RU	*Conventional-open-close*	?

Table 21. Examples of utterances with uncategorised thread

To resolve the first issue, some changes were made to the dialogue annotation scheme. The changes are detailed in Section 3.10.

Another striking issue that surfaced during annotation is the ambiguity of utterances, as described in the following discussion.

ISSUE 2: Ambiguous utterances

Natural dialogue utterances are not always mutually exclusive in terms of the type of communicative functions that they possess, a conundrum that was also observed and admitted by Laws et al. (2009) in their work on physician-patient consultation dialogues. A short example is shown in (13):

(13)
Speaker: We will intubate now

The utterance in (13) is both a *Commit* (an utterance that commits the speaker to a task – going to intubate the patient) and an *Open-option* (an utterance that influences the hearer's future action without requiring verbal response – preparing for intubation or other post-intubation tasks). Most dialogue annotation schemes typically chose to focus on one code per utterance by selecting the code with the higher precedence. However, to force one type of communicative function on one utterance when it might have been deliberately constructed to convey two different functions disregards the reality of linguistic pragmatics. This practice gives a false impression of tidiness that is not always present in natural dialogues. By verbalising (13), the speaker is both committing him/herself to the task and simultaneously alerting team members to the impending task.

That said, it should be noted that categories in the same major function (e.g. *Commit* and *Offer* which are both under *Committing-speaker-future-action*) are mutually exclusive from each other. In other words, if an utterance is a *Commit,* it cannot be tagged as an *Offer.* In the simulation data, we found that a confounding scenario is present with utterances like (14) from SIM2:

(14)
Utterance 101, P1: You wanna do swap over?

Is this a suggestion from the speaker (*Action-directive*)*,* a question about the desire of swapping (*Info-request*), or an offer to swap (*Offer*)? An *Action-directive* requires the hearer to oblige by performing an action; an *Info-request* requires the hearer to supply information;

and an *Offer* presents the hearer with an option. All three are under the same major function of *Influencing-addressee-future-action*. As such, (14) has to be one of these.

There were not many instances of ambiguity in the two simulation videos, but the issue was noted at this stage because ambiguity may occur more in real-life dialogues. It is admittedly difficult, and perhaps impossible, to accurately determine the illocutionary act intended by a speaker at all times, so ambiguous utterances are given special attention.

One way to establish the type of function is by identifying the response to the said utterance in the dialogue context, as suggested by Core (1998). If an utterance is responded to with information-providing responses, then it is tagged as *Info-request*, and if is responded to with an acceptance or rejection, it is tagged as *Action-directive.* Some might be responded to with physical actions – these could sometimes be determined from the following utterances that contain indications of actions – and are also tagged as *Action-directive*. In (14) earlier, the full exchange was:

(14)

Utterance 101, P1:	You wanna do swap over?
Utterance 102, P3:	Yeah,
Utterance 103, P3:	I'll do a swap.

In this dialogue, P3 has been performing manual chest compressions since the paramedics took over from the bystander. In the context of manual chest compression, a change of person who performs the compressions is expected to ensure continuous high-quality compressions: however, the period or time between changes can vary. When P1 verbalised utterance 101, P3 has been doing chest compressions for roughly three minutes, which is a relatively short period of time. Therefore, we decided that P1's utterance is more likely to be a question rather than a directive or an offer, i.e. a way to check if P3 plans to continue the task or to stop and get someone to take over for him (i.e. swap). Following this, P1's utterance has been tagged as an *Info-request*.

ISSUE 3: Indecipherable thread clusters

Thread annotations follow a structure that looks like a cluster of content under discussion. This means that the same thread is usually tagged consecutively, as illustrated in the following example from SIM3 for the thread *Patient history* (note that the utterances are only tagged with threads and not communicative functions):

(15)

Utterance 9, P1:	What's happened to him?	*Patient history*
Utterance 10, Bystander:	He's, he's just collapsed	*Patient history*
Utterance 11, P1:	He just collapsed	*Patient history*
Utterance 12, Bystander:	He's been really, really sick	*Patient history*
Utterance 13, Bystander:	then he just collapsed	*Patient history*

Using this method, we can observe clusters of thread in any given dialogue, thus illustrating what the team members talk about most frequently and when these threads arise in the conversation. One downside, however, is that if the beginning of a cluster is not clear to the annotator, utterances in the same cluster would then be tagged as *Indecipherable*. Thus, using (15) for an example, if the subject matter of Utterance 9 is not known, the four utterances following the initial utterance would have been indecipherable as well (unless if the speaker changes the thread under discussion and this new thread is detected).

Nonetheless, the annotation of thread naturally requires consecutive tagging to allow an overall understanding of the verbalised contents. To minimise clusters of indecipherable threads, opinions were sought from resuscitation experts to clarify possible subject matter.

3.10 Adjustments to DARe

Following the initial coding results, several new categories were devised. These were determined based on their functions in the data, existing literature on communicative functions during medical teamwork communication, and discussion with resuscitation experts.

Adjustments to the communicative function categories

In the communicative function section, only the *Assert* function needs to be adjusted. In addition to the two existing sub-categories of *Forward-course* and *Conclude/Deduce*, five distinct sub-categories can be identified. These are *State-awareness, Information-giving, Hypothesise, Commiserate,* and *Notify*.

State-awareness is a type of assertion that is used to signal an ongoing task or scenario. Typical examples include verbalised chest compression counts during manual chest compressions and verbalised counts for ventilations.

Information-giving is an assertion that usually follows an *Info-request*. Utterances with this function are underlined in (16):

(16)

Utterance 2, P1:	Could you tell us what's going on?
Utterance 3, Bystander:	Um, this is my husband
Utterance 5, Bystander:	and he's had, (…) he's just had some pain

Hypothesise is a weaker version of *Conclude/Deduce*. This tag is introduced because some assertions in the resuscitation dialogues are assumptions which do not fulfil the criteria for conclusion or deduction. Even though both *Conclude/Deduce* and *Hypothesise* are assertions that result from a speaker's process of logic and deliberation, the former are statements of fact whilst the latter are statements of belief. Consider the following examples from SIM3. A *Conclude/Deduce* type of assertion is given in (17) and *Hypothesise* in (18):

(17)
Utterance 305, 3RU: Okay, he's making signs of life

(18)
Utterance 214, 3RU: Um, they should be on their way

The assertion in (17) was the result of observed vital signs (i.e. patient's heart rhythm) whilst the assertion in (18) was a guess regarding an expected ambulance arrival.

The next sub-category, *Commiserate,* is used for utterances that contain elements of empathy or sympathy. This is similar to a GMIAS category called Empathy/Reassurance.

The final addition, *Notify* can be confusing to tag – it might be mistaken as *Info-giving* or *State-awareness* – but compared to *Info-giving*, which is a statement containing previously requested facts/information, *Notify* is an assertion that focuses on the announcement of a fact or belief, and may also function as counsel or advice to bystanders. Similar to *State-awareness*, it is usually verbalised without prior instigation (such as question or request) from another speaker or specific hearer, but unlike *State-awareness*, which revolves around explicit resuscitation tasks, *Notify* is less specific. The following example, for instance, is taken from SIM4:

(19)
Utterance 114, 3RU: This goes here

The utterance in (19) was verbalised when the 3RU was organising/managing patient movement to enable AutoPulse deployment. The utterance referred to a piece of equipment and its location and was not specifically directed to any team member. It was also not a response to any *Info-request* or *Action-directive* but seemed intended as a generic notification. In addition, the utterance was not meant as a verbal landmark of a current task or state.

Notify is also tagged for the following utterance, also from SIM4:

(20)
Utterance 205, Bystander: There's nobody coming

The second utterance was directed towards the resuscitation team members in the simulation. In this example, the bystander had left the scene to wait for the arrival of another ambulance but returned a few minutes later with this announcement. Even though this utterance has intended hearers, similar to (19), the fact or information was not requested; instead, the utterance serves mainly as an announcement or notice.

Figure 3 illustrates the new breakdown. The original sub-categories are in yellow boxes and the new sub-categories are in red boxes. Full descriptions and examples of each are given at the end of this chapter.

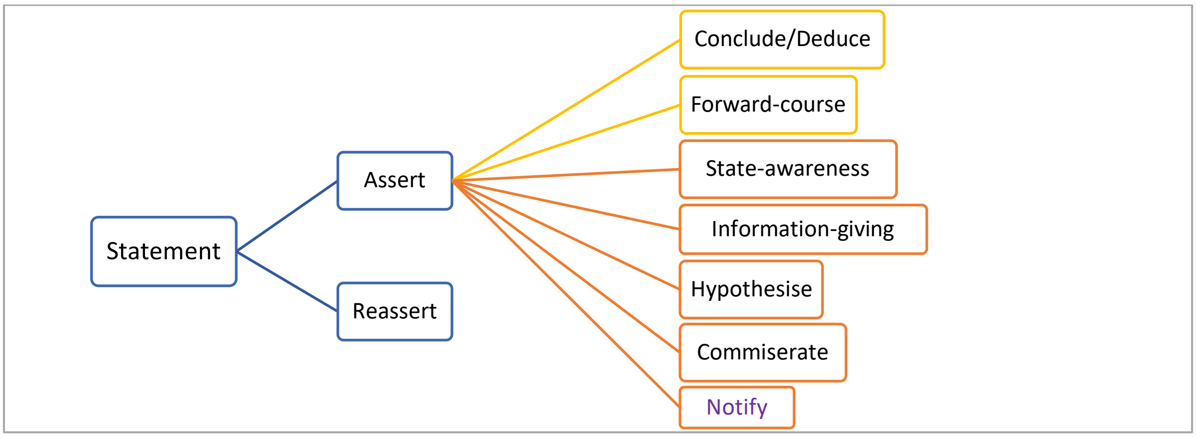


Figure 3. The sub-categories of *Assert* after review

Adjustments to the thread categories

The thread coding categories have more additions compared to the communicative function coding categories. It turned out that developing a thread coding category based on the ALS algorithm alone (Figure 2, Section 3.8) failed to capture the complexities and varieties of threads talked about during simulated resuscitation. This development echoes Fernandez Castelao et al. (2013) in that the algorithm provides an overall plan for the team members to follow, but they are required to fill in the gaps by themselves. We discovered that the filling of this gap included social content like greetings and self-introductions, which is naturally not listed in the algorithm, but still forms part of the content in a resuscitation dialogue. We also realised that some thread categories differed between simulations that did not use the mechanical chest compression device, AutoPulse (SIM1 and SIM2) and those that did (SIM3 and SIM4). To illustrate this, we label the changes made after annotations of SIM1 and SIM2 and after the annotations of SIM3 and SIM4 in Table 22.

Thread category	Description
Original categories derived from ALS algorithm	
Compression	Utterances relating to chest compression
Rhythm	Utterances relating to the type of rhythm, rhythm check
Instrument or equipment	Utterances regarding waveform capnography, IV, IO line
Medication or treatment	Utterances regarding adrenaline, amiodarone, 12-lead ECG, oxygen, CO_2
Reversible causes	Utterances relating to the 4Hs and 4Ts
Time	Utterances indicating time, like the minutes between adrenaline-giving or shocks
New categories derived from SIM1 and SIM2 annotations (no AutoPulse use)	
Patient history	Utterances about the patient’s medical background, events leading to the cardiac arrest
Airway access	Utterances concerning airway access Initially, this was tagged as *Intubation*, but after discussion with resuscitation experts, it was changed to *Airway access* because intubation is only one of the four possible methods of accessing the patient’s airway
Shock	Utterances specifically concerning defibrillation or administering shock Initially, shock-related utterances were tagged under *Rhythm*, but after annotations, we found that rhythm- and shock-related utterances were two distinct subject matters
Ventilation	Utterances concerning ventilations or ‘rescue breaths’, which include the counts
State (of patient)	Utterances regarding the patient’s current condition or state
Resolution	Utterances about how the resuscitation attempt concludes
Plan of action	Utterances regarding the next course of action
Immediate vicinity	Utterances concerning the immediate area where the resuscitation is taking place
Non-immediate vicinity	Utterances concerning areas other than the immediate area where the resuscitation is taking place, e.g. outside of the room/flat
Social agenda setting	Greetings, self-introduction, goodbyes
Indecipherable	Threads that are not sufficiently identifiable
New categories derived from SIM3 and SIM4 annotations (with AutoPulse use)	
Clothing	Utterances about patient’s clothing, usually related to the removal of clothing items to attach equipment or device
Movement of patient	Utterances concerning moving the patient during resuscitation, e.g. moving the patient to a larger/safer immediate area or moving the patient to attach a device (not the extrication process, i.e. the action of transporting/conveying the patient to the ambulance/hospital)
Movement other than patient	Utterances concerning the movement of the team members or bystanders during resuscitation

Table 22. Original and newly added thread categories in DARe

Using the initial coding results from SIM1 and SIM2 as a guide, the thread component in DARe was restructured. In addition to the original six threads, 12 new categories were developed. Nonetheless, when the revised categories were applied in SIM3 and SIM4, some contents were not captured within the categories. The examples in (21) were found in SIM4 and the ones in (22) were found in both SIM3 and SIM4:

(21)

Utterance 91, 3RU:	And you will cut his t-shirt off
Utterance 109, P1:	You have the t-shirt off?
Utterance 115, 3RU:	It'll be okay with his t-shirt like that

(22)

Utterance 97, P1:	Can I get you to just, uh, just to sit there alright?
Utterance 21, P1:	Step back in a second
Utterance 105, 3RU:	Just carry him carry him slightly forward towards you guys
Utterance 106, 3RU:	You two sit him up, please

These led to the development of three new thread categories, *Clothing, Movement of patient*, and *Movement other than patient*, as shown in Table 17. From the three, movement-related threads appeared related to the use of AutoPulse whilst clothes-related utterances may be related to the need to remove clothing obstacles to attach defibrillator pads. Although only the dialogue from SIM4 contained clothes-related threads, following discussions with resuscitation experts, this subject matter was recognised as a category because it can be helpful for the annotation of larger sets of data.

Following the adjustments, DARe now has a total of 22 main coding categories, 14 sub-categories in its communicative function section, and 21 coding categories in its thread section. As an annotation scheme, DARe is sufficiently comprehensive to capture much of the complexities of resuscitation dialogues. We note that DARe categories for both sections are developed based on an English-speaking context, specifically Scottish English, as the dialogue data are retrieved from Scottish paramedics in Edinburgh, Scotland.

The full DARe coding scheme, an abridged DARe flow chart, and a short example of a fully-coded transcript are given to conclude this chapter.

Dialogue Analysis for Resuscitation (DARe) coding scheme

COMMUNICATIVE FUNCTION CODING

Forward Communicative Functions (9 functions)		
Function	Description	Example
Statement Utterances that make explicit claims about the world. There are two categories:		
Assert ASSERT	**Utterances with explicit claims**, e.g. facts, beliefs, hypotheses, judgements, conclusions, explanations, etc. *A way to check* Consider whether utterance could be followed by "That's not true", because ASSERT's key distinction is that the speaker is saying something to affect the hearer's belief.	"Pads on, rhythm check" "Chap's exposed" "…seen by nurse this morning" "25, 26, 27, 28, 29, 30"
Reassert REASSERT	**Statements which have already been said before**, normally by the same speaker, in the same dialogue act. Typically used to emphasise statement. NOTE: Repeated AD, IR, etc. are not REASSERT	UTT2: "Pull" ACTION DIRECTIVE UTT3: "That's it" ASSERT UTT4: "There we go" ASSERT UTT5: "That's it" **REASSERT** (of UTT 3)
Influencing-addressee-future-action Utterances used by the speaker to influence hearer's future (verbal or non-verbal) actions. There are three categories:		
Action-directive AD	Utterances that **directly influence the hearer's future non-communicative actions.** This function creates an obligation that the hearer does the action unless the hearer indicates otherwise (unable to comply or refuse to). Comes in several variants (request, suggestion, instruction, command, hint, etc.). *How to check?* Consider if hearer could respond with "I can't do that". This, however, is a very rough test, and should be used in conjunction with the description above.	"Could you get a list of her medications…?" "Secure it for me please" "Continue ventilations" "And bring the AutoPulse in"

Open-option OO	Utterances that **directly influence the hearer's future non-communicative actions but put no obligations** on the hearer to respond. This function can be ignored (not verbally responded to) without appearing rude, unlike AD, since no obligations beyond normal conversational constraints are placed on the hearer.	"On you go" "Give me a second" "When you're ready"
Info-request IR	Utterances that introduce an obligation to provide information, by any means of communication, should be marked as IR.	"What's happened?" "Any pulse?"
Committing-speaker-future-action Utterances used by the speaker to commit self to an action; can be likened to a verbal promise. There are two categories:		
Commit COMMIT	The defining property for this function is that they potentially **commit the speaker (in varying degrees of strength) to some future course of action**, without requiring the hearer's agreement.	"I'll insert this" "I'll be, I'll swap up next"
Offer 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" "I can bring it to where you are M"
Other-forward-function Other types of utterances present in the dialogue not captured by previous categories under FCF.		
Conventional-open-close CONV-OPEN-CLOSE	Phrases conventionally used to start interaction/summon addressee/conclude interaction/dismiss addressee.	"Hello there" "…and M from ambulance service"
Explicit-performatives PERF	Speaker performing an action by virtue of making the utterance. Focuses on thanking, apologies, etc.	"…thanks pal" "Sorry mate"

Backward Communicative Functions (11 functions)		
Function	Description	Example
Agreement Utterances that indicate hearer's view of speaker's proposal (e.g. claim about the world, request, offer, etc.), particularly at the task level. There are six possible categories:		
Accept ACCEPT	Accepts the proposal wholly.	UTT 1: "Let me know and I'll pre-charge" **UTT 2: "Okay"**
Accept-part ACCEPT-PART	Accepts a part of the proposal.	UTT1: "We should put him on the autopulse now" **UTT2: "Yeah, but bring him up first"**
Maybe MAYBE	Non-committal to the proposal.	UTT1: "Do you want the book and its review?" **UTT 2: "I'll think about it"**
Reject-part REJECT-PART	Disagrees with part of the proposal. Almost similar to ACCEPT-PART, but in REJECT-PART, the rejection comes first or is the major part of the utterance.	UTT1: "Could you call the wife and son?" **UTT2: "I don't know the son"**
Reject REJECT	Disagrees with the proposal.	UTT1: "You want a cricoid?" **UTT2: "No no only the tube for now"**
Hold HOLD	When the speaker states their attitude towards the proposal, for example asking how to comply with the speaker's proposal or questioning its desirability.	UTT1: "Can you call the GP…" **UTT2: "Oh. You want me to call him just now?"**
Understanding Utterances signifying that the speaker/hearer are or are not understanding each other as the conversation proceeds. There are three categories of signalling understanding, and one category to signal non-understanding.		
Signal-understanding: Acknowledge ACKN	Short utterances that signal that the previous utterance is understood, **without necessarily signalling acceptance**. Backchannels are a typical example. Some ACKN are fillers used to start utterances. Tag these as ACKN-FILLER or FILLER. Some ACKN are used to acknowledge actions that have been done. Tag these as ACKN-ACTION.	UTT1: "She's been unwell…" **UTT2: "Uhuh" ACKN** UTT3: "…and GP's been in to see her" UTT1: "Take her hands each" **UTT2: "Okay" ACKN-ACTION** UTT3: "Move her towards me" **UTT1: "Right" ACKN-FILLER/FILLER** UTT2: "I think what we do is we put her on AutoPulse first"

	NOTE: Not all ACKN are segmented as ACKN-FILLER or ACKN-ACTION; the decision was made based on the time elapsed between the word/phrase and the rest of the utterance.	
Signal-understanding: Repeat-rephrase REP-REPHR	Utterances that repeat or paraphrase what was just said to signal that **the speaker has been understood.**	UTT1: "And then you set (name) up for a tube" **UTT2: "Set up tube, okay"**
Signal-understanding: Completion COMPLETION	**Finishing/adding to** the utterance that the speaker is in the process of constructing.	UTT1: "Looks like VF, yeah" UTT2: "We'll need, uh…" **UTT3: (interjects) "a shock"**
Signal-non-understanding SIGNAL-NON-UND	Utterances explicitly indicating **a problem in understanding** the previous utterance. *A way to check* The response can be roughly paraphrased as "What did you say/mean?"	"Hmm?" "What's that?"
Answer ANSWER	A binary dimension where utterances can be marked as complying with an IR action. Can be an imperative act as well, or an assertion.	UTT1: "You got it mate?" UTT2: **"Yep"**

Others (2 functions)		
Incomplete INCOMPLETE	Abandoned utterances.	"Alright, sorry so we sh-"
Indecipherable IND	Poor audio quality/Unintelligible/Coder does not know. (…) indicates inaudible dialogue	"It's not gonna (…) (…)"

Sub-categories of *Assert* (7 sub-categories)		
Function	Description	Example
Conclude/Deduce CONC	An assertion of fact presented as the result of a process of logic or deduction.	"Okay it appears asystolic now" "No breathing"
Forward-course FC	When speaker describes or outlines the next course of action, or the future course of action for the team. This is typically procedure-related as the speaker verbalises the OHCA script. Sometimes this is tagged together with a directive. *A way to check* The utterances provide logical answer to "What do we do next?"	"So we're gonna stay here just now we're gonna do some paperwork…" "20 seconds til next rhythm check" "So plan is…"
State-awareness SA	Utterances that keep everyone on the same page. These are usually not responses to questions but pop out every now and then to alert others. These could also be the current state of a procedure. *A way to check* Imagine that you had your back to the scene; would the utterance inform you about the current task-level? If yes, then it is highly likely a *State-awareness*.	"That's fluid attached" "Okay it's 3, 2, 1"
Information-giving IG	Utterances that provide information relating to the procedure, especially patient history. This can also be a response to a query.	"Got a size 8 tube for you there mate" "So this gentleman collapsed at work"
Hypothesise HYP	An assertion based on an educated guess; a less concrete form of *Conclude/Deduce*. Sometimes found when paramedics discuss reversible causes of event.	"Hypoxia…hypervolaemia were potential…" "I suspect it's an MI…"
Commiserate COMMIS	Utterances that show empathy or sympathy. This is typically directed towards bystanders but could also be used to commiserate with fellow team members. This is similar to GMIAS' 4.0 *Empathy/Reassurance* code.	"Obviously you had a great shock this morning…"
Notify NOT	Utterances that provide information but can also function as counsel/advice/reminder. Generally, *Notify* is not a response to request for information (unlike *Information-giving*), which makes it similar to *State-awareness,* but *Notify* utterances are less task-specific.	"We'll get to you in a moment" "In a minute, there's another colleague coming"

Sub-categories of *Action-directive* (4 sub-categories)		
Function	Description	Example
Direct/Instruct DIRECT	Utterances that directly command/order the hearer to do an action.	"Stand clear, shock" "Secure it for me please"
Recommend/Suggest REC	Utterances couched so as to suggest that it is the speaker's advice, not necessarily an order.	"And let's start thinking about execution" "Okay when you're ready we can pause for a bit"
Request REQ	Direct utterances requiring the hearer to perform an action. Note that this function is usually associated with conventionalised structures/idiomatised pragmalinguistic structures.	"Can we set the BP a cycle for every two-and-a-half minutes?" "If you can keep going at the moment"
Allow ALLOW	Used by the speaker to give permission. It implies that the speaker has control over the hearer's behaviour.	"…and I'll let you get the cannula and stuff" "On you go"

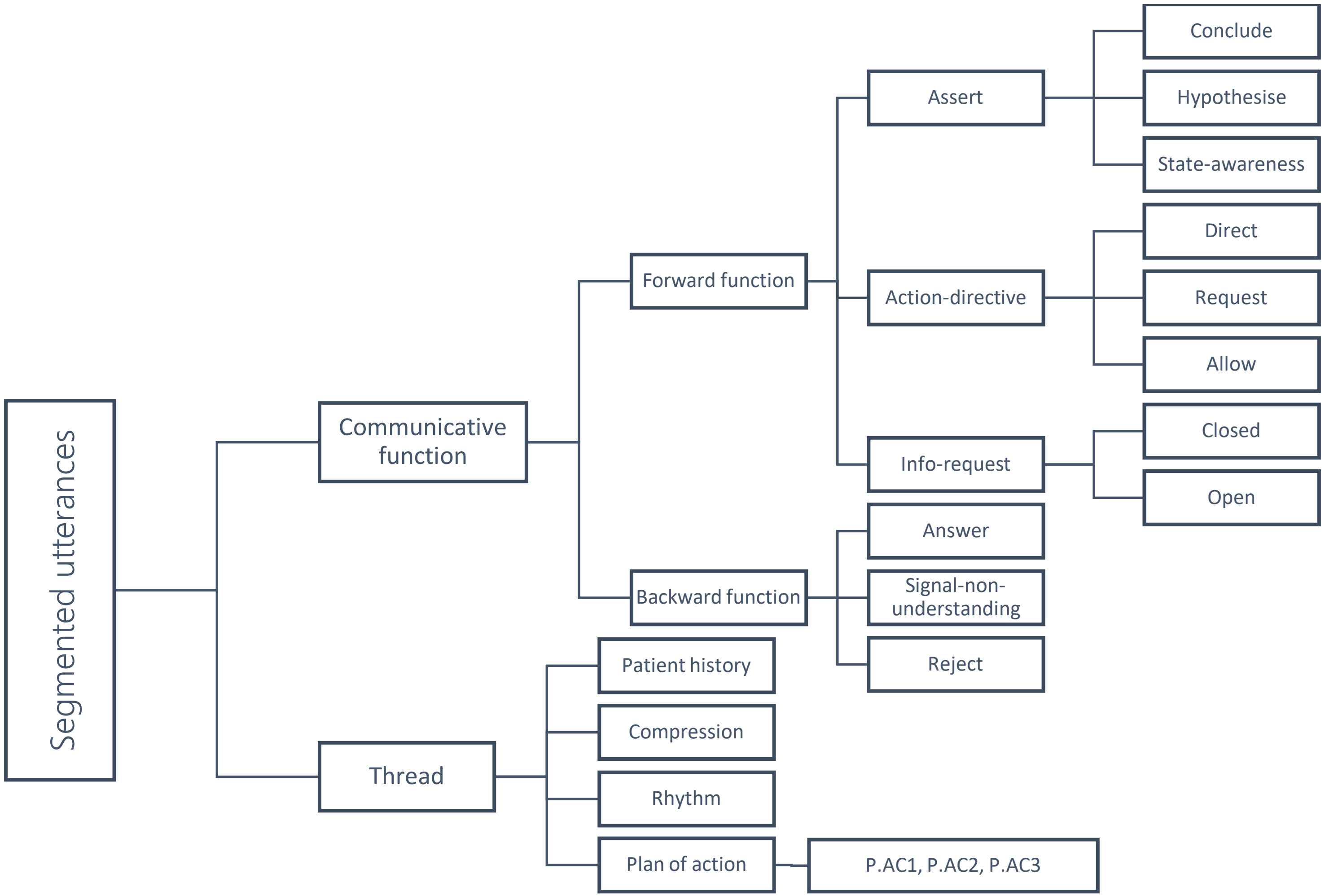
Sub-categories of *Info-request* (3 sub-categories)		
Function	Description	Example
Open-question OQ	A broad question with possible unlimited response categories. *How to check?* Cannot be answered with a "Yes" or "No", or with a limited list of choices.	"What do we got here?"
Closed-question CQ	A question that can be responded to with "Yes" or "No". Also used when speaker needs a specific answer, but one that is not mentioned/proposed in the question.	"You want the pack on?"
Leading-question LQ	A question that includes or suggests an answer. May or may not be asking for reiteration or assurance of accuracy of a previously discussed/suspected fact.	"Size tube do you want size 8?"

THREAD CODING

Subject-matter/Threads (21 codes)		
Thread	Description	Example
Patient history PH	Utterances relating to medical history of the patient, including events leading to the arrest. Can also come from a bystander.	"So, you found her this morning?" "…and she's, umm, takes medication for her diabetes" "…witnessed arrest by husband"
Procedure-related - Compression (COMPR) - Clothing (CLOTH) - Airway access (AIR) - Rhythm/Circulation (RHY) - Medication (MED) - Instrument/Equipment (INST) - Ventilation (VENT) - Time (TIME) - Shock (SHOCK) - State (STATE) - Reversible causes (RC) - Resolution (RES)	Utterances relating to common procedures and steps in resuscitation. COMPR: Chest compression-related; CLOTH: Utterances concerning patient's clothing, usually about removing clothing items to enable defibrillation; AIR: The procedures and act of getting airway access (NPA, OPA, iGEL, or ETT); RHY: Rhythm and pulse oriented (VF, PEA, asystolic, no pulse, etc.); MED: Any medication (e.g. amiodarone, adrenaline), fluids, etc. given to the patient and procedures thereof, including IO/IV access (but not airway); INST: Any mention of instrument or equipment required/used; VENT: The breaths given after certain cycles (typically two) of compressions, 30:2 cycles; TIME: Explicit mention of time, typically in seconds or minutes; SHOCK: Explicit mention of defibrillation (shock) STATE: Utterances regarding the patient's current state other than rhythm; RC: Utterances dealing with reversible causes of event (4Hs and 4Ts). Usually instigated by team leader; RES: Some cases have clear verbalised resolution, e.g. resuscitation attempt is ceased due to death	COMPR: "25 26 27 28 29 30" "Continue CPR" CLOTH: "It'll be okay with his t-shirt like that" AIR: "Okay, I'm gettin a good view" RHY: "…still VF", "PEA" MED: "Another adrenaline," "…need IO access?" INST: "Tube's inflated", "If you've got a cannula then get a 20ml syringe ready" VENT: "One, two", "Continue ventilations" TIME: "Okay 30 seconds", "Two minutes to rhythm check" SHOCK: "Ready for next shock", "Stand clear" STATE: "…his heart's not working as it should…" RC: "…hypoxia we've dealt with…" RES: "…that her being asystolic now for us to stop resuscitation attempt"
Space and movement - Movement involving patient (MOVPT)	Utterances regarding movement and/or space MOVPT: of patient, MOV: of materials, team members or other people in the area, IMM: in the immediate vicinity, i.e. scene of procedure	MOVPT: "Sit him up a little" MOV: "Can you take the knee?", "Come up to this side"

- Movement other than patient (MOV) - Immediate vicinity (IMM) - Non-immediate vicinity (NONIMM)	NON-IMM: outside of the immediate area where the patient is, e.g. the car, ambulance, corridor, lift, etc. NOTE: IMM and NONIMM only tagged when utterances explicitly mention these.	IMM: "It's a bit tight for space" "Bag's behind you" NONIMM: "Could you run to my car…"
Plan of action PAC	Utterances relating to the (next) steps that the team needs to take regarding the case at hand.	"Keep going" "Just disconnect the defib a wee second" "So, once we've got a 12 lead, and we'll let him settle just for a minute or two…"
Social agenda setting AG	Social utterances like greetings, self-introductions, asking for another's name.	"What's your name again?" "Hi guys"
Miscellaneous threads OTHER	Tag given to subject matters other than mentioned, mostly concerning dialogues with bystanders or about bystanders; sometimes can be unrelated to procedure.	"Are you wanting to come too" "His wife is standing outside with some bystanders there"
Indecipherable IND	Given when the utterance is not sufficiently clear to indicate its subject matter (incomplete utterances, indecipherable utterances, or coder doesn't know).	"And watch if (…) got (…) on the left" "Eh, if somebody-"

DARe flowchart showing selected communicative functions and threads



Example of a fully-coded transcript (from SIM1)

Speaker	Utterance	Timestamp	Comm. Function	Thread
P2	Okay, it's 3, 2, 1		ASSERT	COMPRESSION
TL	The first shock was about 30 seconds		ASSERT	SHOCK, TIME
TL	So, we'll do another shock in another two-and-a-half minutes, uh		ACTION-DIRECTIVE	SHOCK, TIME, PLAN
P2	25, 26, 27, 28, 29, 30		ASSERT	COMPRESSION
P2	Is there a pack there?		INFO-REQUEST	INSTRUMENT
P1	Okay […]		INDECIPHERABLE	INDECIPHERABLE
P1	It's not gonna […]		ASSERT	INDECIPHERABLE
P2	You want the pack on?		INFO-REQUEST	INSTRUMENT
P2	Alright 26, 27, 28, 29, 30		ASSERT	COMPRESSION
P2	It's coming up on two minutes	02:28	ASSERT	TIME
TL	You've got to shock him at 30 seconds, alright		ACTION-DIRECTIVE	SHOCK, TIME, PLAN
P2	Yeah		ACCEPT	SHOCK, TIME, PLAN
TL	So, we've got, we've got a two-and-a-half minute before we do a rhythm check		ASSERT	TIME, RHYTHM, PLAN
P2	Two-and-a-half, done		REPEAT-REPHRASE	TIME
P2	25, 26, 27, 28, 29, 30	03:15	ASSERT	COMPRESSION
TL	I'll get the cannulaides		COMMIT	INSTRUMENT, PLAN
P1	Let me know and I'll pre-charge it		OFFER	INSTRUMENT, PLAN
TL	Okay		ACCEPT	INSTRUMENT, PLAN
TL	Can we get to…		INCOMPLETE INFO-REQUEST	INDECIPHERABLE
TL	That's two-and-a-half minute		ASSERT	TIME
TL	Have a rhythm check		ACTION-DIRECTIVE	RHYTHM, PLAN
P2	27, 28, 29, 30		ASSERT	COMPRESSION
TL	Okay, pause		ACTION-DIRECTIVE	COMPRESSION, PLAN
TL	Rhythm check		ACTION-DIRECTIVE	RHYTHM
TL	Still VF		ASSERT	RHYTHM
TL	Charge, please		ACTION-DIRECTIVE	INSTRUMENT
P1	Charging it		ASSERT	INSTRUMENT
P2	Stand clear		ACTION-DIRECTIVE	SHOCK, IMMEDIATE SPACE
P2	Shock		ASSERT	SHOCK
P1	Shall we go and check […]		OFFER	INDECIPHERABLE
P1	No		REJECT	INDECIPHERABLE
P1	I've done it		ASSERT	INDECIPHERABLE
TL	Okay, that's one adrenaline going off to the second shock		ASSERT	MEDICATION, SHOCK

4

Preliminary study on language use in simulated resuscitation

Introduction

In the context of medical communication, open questions remain regarding team members' verbal interaction, particularly in high-stakes medical settings. The current work attempts to identify the communication patterns in paramedic dialogue during out-of-hospital cardiac arrest (OHCA) resuscitation, using dialogue annotation as an approach. The study presented in this chapter analyses a set of simulated resuscitations. Through annotation of the interactions, we first establish the frequency of different dialogue acts as well as the semantic contents of the utterances. Then, we explore the following resuscitation-related verbal avenues: situation awareness in the form of verbal alignment by team members; politeness in the form of mitigation devices that are used with directives; the verbalisation of planning and organisation of tasks; the use of trained communication strategies such as closed-loop communication; and verbal affective behaviours during simulated resuscitation attempts.

The dialogues are annotated using the **D**ialogue **A**nnotation for **Re**suscitation (DARe) coding system (proposed in Chapter 3). The results are discussed in terms of the dialogues' linguistic purposes and semantic content (called *communicative functions* and *threads* respectively). Results showed that the OHCA team dialogues generally contained more frequent directives compared to previous findings from dialogue annotation studies in inter-medical settings. Thread distribution appeared to vary in the four dialogues, although in general, teams talked about plans, patient history, and instrument/equipment the most. Team members align themselves during the procedure by verbally asserting their current stage or task, for instance by verbalising compression or ventilation counts. Directives were not always direct; in fact, team members frequently applied mitigation devices that signal *absolute politeness* (i.e. the use of structures and/or additional terms that are associated with minimising impoliteness, for example, suggesting rather than commanding or adding *please.* Absolute politeness is different from *relative politeness*, which is contingent on the linguistic community's norms). There were frequent utterances concerning planning which could be discriminated temporally, but rare instances of standard closed-loop communication exchanges. Finally, few verbal affective behaviours were found in the simulation dialogues.

Part of the work described here was published as Marzuki, E., Cummins, C., Rohde, H., Branigan, H., & Clegg, G. (2017), Resuscitation procedures as multi-party dialogue. In V. Petukhova and Y. Tians (Eds.), Saardial – *Proceedings of the 21st Works hop on the Semantics and Pragmatics of Dialogue,* 67-76. The paper is included as Appendix A.

4.1 Background and predictions

Dialogue annotation as an analytic approach is more commonly used to study dyadic communication in inter-medical research settings, particularly in physician-patient consultations. In the intra-medical research setting concerning medical team communication, team members' verbal exchanges are typically investigated as part of a team's non-technical skills (NTS) performance, which concentrates on a set of observable behaviours. Verbal communication thus is subsumed under NTS performance and is rarely investigated on its own, especially with a linguistically-based, line-by-line analysis. Consequently, we know little concerning the patterns and distributions of dialogue acts during medical team communication and how these contribute to, or are affected by, the structure or performance of the team.

This knowledge gap is even wider when it comes to resuscitation team dialogue. As verbal behaviours may be influenced by the type of procedure that is being performed (i.e. dialogues during a surgery may differ from dialogues during a resuscitation attempt), it is essential to understand how team members interact during the procedure, including what linguistic choices are made, and what is focused on and when. This information can contribute to what little we know on paramedic communication training, in the effort to achieve optimal team performance during resuscitation. Our focus for the current preliminary study is on paramedic resuscitation teams that are led by Resuscitation Rapid Response (3RU) paramedics based in Edinburgh, Scotland (refer to Section 1.1 for more details on the unit). As a second-tier expert response to OHCA, 3RU paramedics have more experience with OHCA resuscitation scenarios. Analysing the communication patterns in teams led by 3RU paramedics can help clarify dialogues features that may be helpful for more effective resuscitation.

Whilst fine-grained linguistic analysis has been used in investigating communication during other high-risk settings, including aviation (e.g. Svensson & Andersson, 2006; Krifka et al., 2003), to our knowledge, it has not been attempted in the OHCA resuscitation setting. The present study attempts to contribute to this area by exploring the following research questions:

1. What are the prevalence and distribution of communicative functions and subject matter (threads) in paramedic team dialogues during OHCA resuscitation?
2. How is situation awareness, in terms of aligning team members' current state, verbalised during resuscitation?
3. Is there a trade-off between directness and absolute politeness when team members issue instructions to one another?
4. How are plans shared and verbalised during the procedure?
5. What types of trained communicative strategies are applied during resuscitation?
6. How is affective behaviour verbalised in resuscitation dialogues?

As mentioned, the bulk of prior dialogue annotation studies is on physician-patient dialogues, which generally revolve around the communicative functions of giving and asking for information that contains biomedical content. One salient difference between findings from physician-patient dialogues and team communication is the frequency of directives, i.e. verbal behaviours such as request, command, or instruct. Even though directives have been typically observed and coded as a distinct category in inter-medical communication research, the findings are often limited due to the low prevalence of directives in physician-patient dialogues. The few previous studies on team communication, on the other hand, yielded higher frequencies of directives (Calder et al., 2017; Parush et al., 2014). Parush et al. (2014) noted that directives were more frequent in surgery communication compared to handoff communication due to the procedural structure of a surgery. Like surgery, resuscitation also involves explicit stages. This suggests the possibility of frequent directives in resuscitation dialogues as well.

Analysis of threads, meanwhile, can reveal when specific subject matter is verbally introduced in the dialogues, which then can corroborate the sequence of events that occur during resuscitation. If paramedics follow the Advanced Life Support (ALS) algorithm that they are trained in, we would expect to see similar sequences of threads in different resuscitation events, barring outlier scenarios (for instance, death on arrival).

The effectiveness of team communication is also often linked to the team members' non-technical skills (NTS). One of the elements of NTS is known as *situation awareness*, a wide dimension that spans both non-verbal and verbal constructs. The present study is interested in the verbal construct; that is, how team members align themselves during the procedure using verbal utterances. Previous studies on situation awareness showed that team members shared their mental models through various communicative functions, including statements or assertions. It can be hypothesised that these communicative functions would also be useful for resuscitation team members in aligning themselves (and one another) during the procedure. Verbalisation or sharing of plans is also an important part of team situation awareness; therefore, high frequencies of plan-related utterances is anticipated in the OHCA dialogues.

Being in a highly time-constrained environment, the paramedics observed in this study would have to reconcile conflicting pressures to be both succinct/direct and sensitive/polite when issuing directives. We might expect the directives in OHCA resuscitation dialogues to contain more direct instructions or orders than mitigated ones. This may be reinforced by communication training that the paramedics have gone through. Of interest to the present study is the use of classic closed-loop communication (CLC) strategy which contains three distinct parts. As this communicative strategy is widely believed to contribute to effective medical team communication, a question is whether paramedics in the teams do indeed apply the strategy.

Finally, the study examines how affective behaviours are rendered during the simulated resuscitation attempts. This dimension has been investigated in previous dialogue annotation research concerning dyadic medical dialogues. Results showed that verbal affective behaviours in medical dyadic interactions can constitute 10% to 20% of physician dialogues (Cené et al., 2017; Roter & Larson, 2001), although very little is known concerning verbal affective behaviours between medical team members during medical procedures. How much of the dialogues would be given to building social relationships through humour or empathy? Or would medical teams that face time constraint, for instance pre-hospital resuscitation teams, abandon this feature? One presumption is that verbal affective behaviours exist, but in lower frequencies than that which are usually observed in physician-patient dialogues.

4.2 Methods

Data for the current preliminary study is acquired from simulation videos of OHCA resuscitation attempts. The dialogues are analysed using the Dialogue Annotation for Resuscitation (DARe) coding scheme, described in Chapter 3. The results reported in this chapter come from the reapplication of the edited DARe coding scheme on the four simulated resuscitation attempts, described in the following section.

Video data

For the preliminary investigation presented in this chapter, four videos of simulated resuscitation scenarios were selected. The simulations were conducted as part of paramedic training and development at the Royal Infirmary of Edinburgh. All footage was stored securely, reviewed (both for ongoing training and the current study), and subsequently deleted according to a pre-set deletion policy. The simulations were selected due to the involvement of the Resuscitation Rapid Response (3RU) paramedics.

The simulations, called SIM1, SIM2, SIM3, and SIM4, were filmed in a training room at the Royal Infirmary of Edinburgh. Each scenario was constructed to represent the pre-hospital resuscitation setting to a degree, i.e. cardiac arrest occurs outside of the hospital, the patient is attended to by first responders, bystander(s) are present. All four simulations used a life-sized mannequin to represent the patient. Each simulation contained one bystander, who communicated with the resuscitation team to a certain degree. The first two, SIM1 and SIM2, differed from SIM3 and SIM4 in two respects. SIM1 and SIM2 were performed without the use of a mechanical chest compression device (AutoPulse), and the paramedics involved in these two simulations were fully attired in their uniforms. In contrast, SIM3 and SIM4 were performed with AutoPulse and the paramedics in these simulations were not in uniforms. The details of each video are given in the following table:

Video	Duration of video transcription (minutes)	No. of speakers (including bystander)	Use of AutoPulse	Total utterances
SIM1	10:31	4	No	184
SIM2	12:03	4	No	289
SIM3	11:12	4	Yes	311
SIM4*	07:49	4	Yes	204

Table 23. Details of the four simulation videos

**All simulations were transcribed until the video stopped, except for SIM4, which was transcribed until the moment that the team was discussing transport to hospital. This was due to accessibility and audibility issues.*

SIM1's scenario involved a cardiac arrest patient with ventricular fibrillation, a type of shockable rhythm that responds well to defibrillation. The scenario contained two Scottish Ambulance Service (SAS) paramedics and one 3RU paramedic who came in approximately two minutes into the simulation. When the SAS paramedics 'arrived' at the scene, the patient was already being given chest compression by a 'bystander' (acted by a medical researcher). The bystander contributed to the dialogue but left very early in the simulation. SIM1 ended after the patient regained the return of spontaneous circulation, often shortened to ROSC.

SIM2's scenario presented a cardiac arrest patient with a Pulseless Electrical Activity (PEA) rhythm, also known as a flatline, which is not shockable (i.e. defibrillation does not help restart the rhythm). The 'patient' was an elderly woman who already suffered from underlying illnesses. The scenario contained two SAS paramedics and one 3RU paramedic who came in at the three-minute mark. Similar to SIM1, when the SAS paramedics 'arrived', the patient was already being given chest compression. Unlike SIM1, the bystander in this scenario was more verbally active. The bystander provided the patient's medical and personal background and stayed until the end of the procedure. The simulation ended after the patient's 'general practitioner' confirmed over the phone that resuscitation attempts could be ceased due to the patient's conditions.

SIM3 has a specific scenario that included a hysterical spouse as a bystander. The 'patient' had shockable rhythm and was already receiving chest compression from the spouse when the two SAS paramedics 'arrived'. The 3RU paramedic came into the scene approximately two minutes thirty seconds into the simulation with an AutoPulse. Like SIM2, the bystander in this simulation was verbally active, resulting in a higher frequency of dialogue exchanges with the paramedic team. The bystander also stayed until the end of the procedure. SIM3 ended when the 3RU detected a pulse (i.e. patient achieved ROSC).

SIM4 also consisted of a spouse as a bystander, although in this scenario, the spouse was not hysterical and therefore was less verbally active compared to SIM3. The scenario consisted of two SAS paramedics and one 3RU paramedic who came in around two minutes forty seconds into the simulation. The 'patient' showed shockable rhythm and was already receiving chest compression from the spouse when the paramedics 'arrived' on scene. SIM4 resuscitation team also deployed the AutoPulse, which was brought by the 3RU paramedic. SIM4 simulation was transcribed into its eighth minute, when the patient was stabilised, and the team was arranging for transport to the hospital. SIM4's bystander stayed at the scene until the final minute of transcription.

As bystander dialogue exchanges formed part of the overall team dialogues, we included bystander utterances when transcribing the videos. Bystander utterances were also included in the overall frequency counts, although findings that excluded bystander utterances are discussed in the in-depth analysis for three of the most common communicative functions found in the dialogues, namely *Assert*, *Action-directive*, and *Info-request*.

Ethics approval process

The project is covered under existing ethics approval for ongoing research on the 3RU paramedics' training. As advised by the South East Scotland Research Ethics Service in a letter dated 2 February 2017 (Appendix B), no further National Health Service (NHS) review was required.

The project has also been reviewed by the linguistics ethics team from the School of Philosophy, Psychology, and Language Sciences, University of Edinburgh, under the running title “Language in action: A study of what makes effective communication in pre-hospital resuscitation teams”. Approval was given on 22 March 2017.

Transcription and annotation

The dialogues were transcribed using O-transcribe, a free online transcription programme (https://otranscribe.com/). Following segmentation, the utterances were then annotated using the DARe coding scheme. Each utterance was annotated twice, once for communicative functions and once for subject matter types (threads).

DARe distinguishes nine categories of Forward Communicative Functions (FCF): *Assert, Reassert, Open-option, Action-directive, Info-request, Commit, Offer, Conventional-open-close, Performatives,* and 11 categories of Backward Communicative Functions (BCF): *Accept, Accept-part, Maybe, Reject-part, Reject, Hold, Signal-non-understanding, Acknowledge, Repeat-rephrase, Completion, Answer*. To code abandoned and inaudible utterances, DARe uses the categories of *Incomplete* and *Indecipherable.* Three of the functions from FCF (*Assert, Action-directive, Info-request)* are further sub-categorised following previous dialogue annotation schemes and iterative analysis of available data. *Assert* has seven sub-categories; *Action-directive* has four; *Info-request* has three. Following the previous practice of DAMSL, the dialogue annotation scheme that is used as a basis for DARe, an utterance that performs more than one function can be annotated with more than one type of communicative function. The following is an example of this:

(23)

Utterance 114, 3RU:	And after that we’ll swap over	*Action-directive* *Commit*

where *Action-directive* = verbal act that influences hearer’s future action and *Commit* = verbal act that binds speaker to intended future action.

DARe has 21 thread categories which were derived from the amalgamation of the Advanced Life Support (ALS) algorithm, iterative analysis of available data, and discussion with a resuscitation expert. These are *Patient history, Compression, Clothing, Airway access,* *Rhythm, Medication or treatment, Instrument or equipment, Ventilation, Timing, Shock, State, Movement of patient, Movement other than patient, Immediate vicinity, Non-immediate vicinity, Reversible causes, Plan of action, Resolution, Social agenda setting, Other,* and *Indecipherable.* Similarly, a single utterance may be about more than one kind of subject matter, therefore it can be annotated as belonging to more than one thread. For instance, the utterance in (24) can be tagged for three different threads – *Time*, *Rhythm*, and *Plan of action*:

(24)

Utterance 132, P2:	20 seconds until next rhythm check	*Time* *Rhythm* *Plan of action*

where *Time* = the explicit mention of 20 seconds; *Rhythm* = the mention of rhythm check; and *Plan of action* = the description or planning of what happens next.

For more detailed descriptions of the annotation process, refer to Section 3.9.

Reliability

To test reliability, one complete transcription (25% of the whole data) was annotated by another applied linguist who was given instructions on using DARe's communicative function. The same transcription excerpt was annotated by a general practitioner using DARe's thread function. Following the recommendation by McHugh (2012), reliability was calculated based on both percentage rate agreement and Cohen's kappa.

The inter-annotator reliability for communicative function coding reached a percentage rate agreement of 70.2% and a Cohen's kappa of .63, which suggested moderately substantial agreement (McHugh, 2012). Cases of disagreements were reviewed. These resulted from several reasons, including the second annotator's lack of familiarity with the context of the transcript, the inability to access the audio files (which aided in the original annotations of the transcript), and insufficient or unclear understanding of the function descriptions. Insufficient or unclear understanding was exemplified by the total absence of *Accept* tag in the transcript; the second annotator labelled almost all responses with *Acknowledge* instead. This calls to mind the observation by Core and Allen (1997), i.e. annotators typically found in difficult to distinguish whether a response is an agreement (that can be labelled along the continuum of accept to reject) or simply an acknowledgement.

The thread annotation showed lower inter-annotator percentage rate agreement at 50%. When cases of disagreements were reviewed, it was revealed that these mostly arose from the second annotator's decision to treat responses (the Backward Communicative Function) as independent utterances of their own instead of as parts of thread clusters. This is illustrated in the following examples (name has been changed).

(25)

SIM1 Transcript	Original thread coding	Second annotator thread coding
Utterance 8-9		
P2: So, did you see Tony collapse did you?	*Patient history*	*Patient history*
Bystander: Yeah	*Patient history**	*Indecipherable**
Utterance 13-14		
P1: We'll charge that	*Instrument*	*Instrument*
P2: Aye	*Instrument**	*Indecipherable**
Utterance 129-130		
P2: And then after that someone takes over here	*Compression*	*Compression*
P1: Yep	*Compression**	*Indecipherable**

These caused the high discrepancy in the percentage rate agreement. When these specific cases were discussed and rectified, the percentage of agreement increased to 74.8%, with a Cohen's kappa of .69. The remaining disagreements were caused by different interpretations of the utterances, for instance, the second annotator did not view immediate performance of tasks as belonging to the *Plan of action* thread.

The overall reliability for both the communicative function and thread coding were good, considering that the context was not familiar, and the second annotators received minimal, online training. Higher inter-annotator reliability is therefore possible with more extensive training and clearer instructions regarding the use of the coding scheme.

4.3 Communicative function findings

This section presents the results regarding the types and distributions of communicative functions found in the four OHCA resuscitation dialogues. Communicative functions determine the kinds of dialogue acts performed by each utterance, for instance whether an utterance states a fact, asks for information, or directs an act (examples of Forward Communicative Functions), or acknowledges a previous utterance (one example of Backward Communicative Functions).

Distribution of communicative functions: Types, frequencies, and percentages

Together, the four simulations comprise 988 utterances[5]. As DARe allows more than one tag for a single utterance, the total of communicative function and thread types need not match the total number of utterances. For the communicative function analysis, SIM1 has a total of 210 tags but 184 utterances; SIM2 has 324 tags and 289 utterances; SIM3 has 330 tags and 311 utterances; and SIM4 has 210 tags and 204 utterances. Table 24 shows the proportion of utterances in each simulation that were coded with one of the two main communicative functions, i.e., FCF or BCF, and the incomplete utterances (utterances that were abandoned by the speakers) or indecipherable utterances (utterances that were inaudible), which are excluded from the analysis.

Utterance category	SIM1		SIM2		SIM3		SIM4	
	Freq.	%	*Freq.*	%	*Freq.*	%	*Freq.*	%
Forward Communicative Function	131	71.2	205	70.9	199	64.0	138	67.6
Backward Communicative Function	37	20.1	62	21.5	90	28.9	47	23.1
Incomplete/indecipherable	16	8.7	22	7.6	22	7.1	19	9.3
Total	184	100	289	100	311	100	204	100

Table 24. Proportion of FCF, BCF, and incomplete/indecipherable utterances in the four simulations

The following Table 25 displays the frequencies and percentages of the categories of Forward Communicative Functions (FCF). Note that for Tables 25 and 26, the number of utterances differs from the total number of tagged functions. For example, for SIM1, the total number of instances for FCF-category tags is 157; these tags appeared across 131

[5] An utterance refers to the smallest segment that is made up of a specific speech act. Even though we attribute to the idea that an utterance may convey more than one type of communicative function (e.g. there may be two types of speech act for one utterance *X*), the total number of utterances is based on the initial segmentation (refer to Section 3.9), whilst the total number of *tags* reflect the number of speech acts.

utterances, some of which were coded for more than one function. The displayed percentages in these tables show the proportion of utterances coded with a particular tag (e.g. for SIM1, 57 *Asserts* out of 184 total utterances = 31.0%; 157 FCF-category tags out of 210 total tags = 74.8%). Refer to Table 24 for the overall proportions of FCF-tagged and BCF-tagged utterances out of the total utterances in each simulation.

Main communicative function	Sub-function/ Sub-category	SIM1 (n = 184)		SIM2 (n = 289)		SIM3 (n = 311)		SIM4 (n = 204)	
		Freq.	%	*Freq.*	%	*Freq.*	%	*Freq.*	%
Statement	Assert	57	31.0	114	39.4	100	32.2	67	32.8
	Reassert	9	4.9	8	2.8	7	2.3	3	1.5
Influencing-addressee-future-action	Open-option	1	0.5	2	0.7	8	2.6	4	2.0
	Action-directive	42	22.8	37	12.8	48	15.4	32	15.7
	Info-request	15	8.2	23	8.0	36	11.6	22	10.8
Commit-speaker-future-action	Commit	18	9.8	28	9.7	6	1.9	6	2.9
	Offer	7	3.8	15	5.2	1	0.3	0	0.0
Other-forward-functions	Conventional-open-close	4	2.2	5	1.7	8	2.6	7	3.4
	Performatives/Affective-performatives*								
	• Apology	1	0.5	2	0.7	0	0.0	2	1.0
	• Thanking	2	1.1	2	0.7	1	0.3	1	0.5
	• Swearing	0	0.0	1	0.3	0	0.0	0	0.0
	• Complimenting	1	0.5	3	1.0	2	0.6	0	0.0
	• Exclamation	0	0.0	0	0.0	1	0.3	0	0.0
FCF category counts and percentages out of total number of tags		157	74.8	240	74.1	218	66.1	144	68.6

Table 25. The distributions of *Forward Communicative Function* categories in the four simulations

**In the course of the analysis,* Performatives *in the transcripts were found to be made up of socioemotionally-related utterances that possibly contribute to the team relationship. To reflect this more accurately, the* Performatives *tag is renamed as* Affective-performatives*. The findings regarding this function are elaborated in Section 4.9.*

The three most frequently present main communicative functions across the four resuscitation attempts were *Statement, Influencing-addressee-future-action,* and *Commit-speaker-future-action.* A large part of FCF was made up of *Statement*-type utterances, specifically *Assert*. The high relative proportions of *Assert* and *Info-request* utterances were similar to prior medical dialogue research on physician-patient interaction, whilst the high relative proportion of *Action-directive* utterances mirrored previous studies on team dialogues by Calder et al. (2017) and Parush et al. (2014). These results for medical team dialogues run counter to dyadic physician-patient dialogues in that there are higher usage of directives in team interaction.

Of note is the frequency of *Commit* utterances in two of the simulations. This dialogue act was found to be more frequent in SIM1 and SIM2 but rarer in SIM3 and SIM4. Given in (26) are four examples of *Commit* utterances taken from the four simulations:

(26)
SIM1
Utterance 3, 3RU: *(the next course of action)* We'll get him on to CO_2 [6].

SIM2
Utterance 209, 3RU: *(telling bystander to call physician)* I'll have a wee[7] chat with him.

SIM3
Utterance 51, P2: *(taking over manual chest compressions)* I'll take over.

SIM4
Utterance 78, 3RU: *(AutoPulse preparation)* I'm just, I'm just gonna prepare it roughly while you sit and medicate him.

It is not clear whether the frequency difference is an effect of any variable. It could be a result of personal preference (e.g. the team in SIM1 used more *Commit* utterances than the others), or an influence from bystander dialogues (e.g. several *Commit* utterances in SIM2, n = 7, were promises or commitments made to the bystander, much like Utterance 209 in the given example). Previous medical team communication research including Hunziker et al. (2010), has highlighted the importance (and positive effect of) Commissives during resuscitation, therefore, it is possible that this dialogue act is associated with effective team performance or effective team leadership, although the current data is too limited to support this supposition. Utterances that commit a speaker to a task have been included in dialogue annotation schemes for inter-medical interaction (e.g. in Laws et al., 2009), but

[6] CO_2: Referring to the capnography device that monitors carbon dioxide, amongst other uses

[7] Scottish English term meaning "little" or "small". The use of this term does not alter the communicative function in this utterance (i.e. *Commit*), but it suggests a sociolinguistic variation typically associated with speakers of Scottish English (McKenzie, 2015)

there has been very little published data on how frequently Commissives were verbalised during medical procedures, or on the forms that these utterances take.

The Backward Communicative Functions (BCF) distributions are given in Table 26.

Main communicative function	Sub-function	SIM1 (n = 184)		SIM2 (n = 289)		SIM3 (n = 311)		SIM4 (n = 204)	
		Freq.	*%*	*Freq.*	*%*	*Freq.*	*%*	*Freq.*	*%*
Agreement	Accept	15	8.2	18	6.2	18	5.8	12	5.9
	Accept-part	0	0.0	0	0.0	0	0.0	0	0.0
	Maybe	0	0.0	0	0.0	0	0.0	0	0.0
	Reject-part	0	0.0	0	0.0	0	0.0	0	0.0
	Reject	0	0.0	0	0.0	6	1.9	2	1.0
	Hold	0	0.0	2	0.7	3	1.0	0	0.0
Understanding	Signal-non-understanding	0	0.0	0	0.0	3	1.0	1	0.5
	Signal-	9	4.9	22	7.6	28	9.0	12	5.9
	understanding:	2	1.1	2	0.7	7	2.3	6	2.9
	Acknowledge	0	0.0	0	0.0	0	0.0	0	0.0
	Repeat-rephrase								
	Completion								
Answer	Binary + (probable) utterance	11	6.0	18	6.2	25	8.0	14	6.9
BCF category counts and percentages out of total number of tags		37	17.6	62	19.1	90	27.3	47	22.4

Table 26. The distributions of Backward Communicative Function categories in the four simulations

The Backward Communicative Function categories, which signal verbal responses from hearers, showed very little variation – in fact, to show agreement or disagreement, only three categories were used in all four simulations, *Accept, Hold,* and *Reject*. Examples of each are given as follows (only the communicative function tags are given):

(27)
SIM4

Utterance 91, 3RU:	And you will cut his t-shirt off	*Action-directive*
Utterance 92, P2:	**Okay**	***Accept***

(28)
SIM3

Utterance 299, 3RU:	Can you get me a chair?	*Action-directive*
Utterance 300, B:	**Why do you need a chair?**	***Hold***

(29)
SIM3

Utterance 112, P2:	If you could just get [...] details for me	*Action-directive*
Utterance 113, B:	**No, no**	***Reject***

The six counts of *Reject* in SIM3 all came from the bystander (B), who refused a number of suggestions from the paramedic team, as shown in (6). Only the two *Reject* utterances in SIM4 came from team members. Understanding was shown verbally using mostly *Acknowledge* utterances and a few *Repeat-rephrase* utterances. There were very few verbal utterances signalling non-understanding in SIM3 and SIM4 and none in SIM1 and SIM2. This may be due to the teams' shared knowledge of a known, agreed-upon protocol. *Answer* utterances were more frequent, ranging from 6.0% to 8.0% of the dialogue. The analysis in Chapter 5 allows us to test whether the same pattern repeats in real-life resuscitation attempts.

Figure 4 illustrates the existing communicative functions in the four OHCA simulations from the most frequently used to the least frequently used.

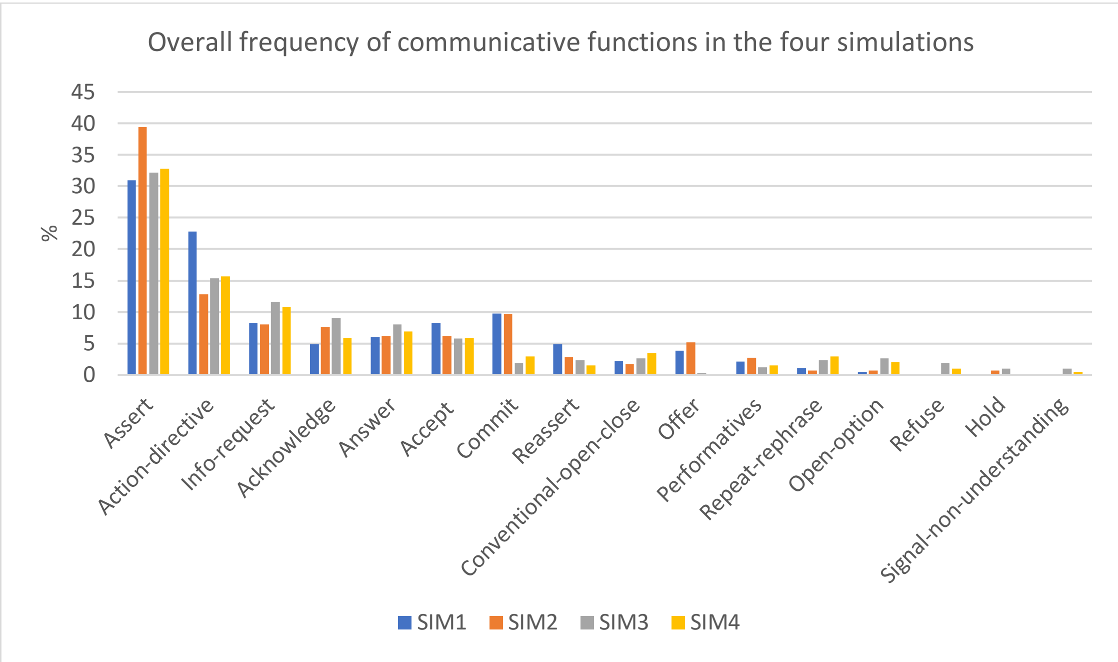


Figure 4. Frequency of communicative functions (%) in SIM1, SIM2, SIM3, and SIM4

The overall pattern of usage for all four scenarios is similar, although the *Commit* and *Offer* functions were noticeably higher in SIM1 and SIM2 dialogues.

The communicative functions of *Assert, Action-directive,* and *Info-request* were analysed further. Prior research concerning medical dialogues typically discusses all three functions (see summary in Section 3.5), thus marking these as possibly crucial communicative elements in medical dialogues. In the next sections, we examine all three communicative functions in more detail. We further discuss the possibility of how certain variables during resuscitation, such as using a mechanical chest compression device and bystander participation, affect the frequency of their use.

Breaking down *Assert*

Assert is one of the main categories generally found in dialogue annotation studies. It is the primary means of exchanging information between interlocutors. In the current data, *Assert* accounted for 31.0% of communicative functions in SIM1, 39.4% in SIM2, 32.2% in SIM3, and 32.8% in SIM4, making it the most frequent type of dialogue act in all four teams' interaction. This is consistent with findings from previous dialogue annotation studies in both medical and non-medical contexts.

Nonetheless, these frequencies were based on all *Assert* utterances during the scenario, i.e. utterances by team members as well as bystanders. Prior research either did not need to differentiate those because there were only two interlocutors (e.g. McNeilis, 2001), or because the study purposely included bystanders or family members (e.g. Cené et al., 2017). In the present study, bystanders (people who act as a family member, colleague, etc.) are not officially part of the resuscitation team, although in some scenarios, they communicated quite frequently with the team members. When *Assert* utterances from and/or directed to bystanders were excluded, the following results were obtained:

Video	Total *Assert*	*Assert* directed to and from resuscitation team members only		*Assert* directed to and from bystanders only	
		Freq.	*% out of the total dialogue*	*Freq.*	*% out of the total dialogue*
SIM1 (n = 184)	57	55	29.9	2	1.1
SIM2 (n = 289)	114	92	31.8	22	7.6
SIM3 (n = 311)	100	44	32.1	56	18.0
SIM4 (n = 204)	68	55	27.0	13	6.4

Table 27. *Assert* total counts, team-only counts, and bystander-inclusive counts

The biggest difference can be seen for SIM3, where *Assert* frequencies to and from team members only represented less than half of the total. SIM3, as described earlier, was designed as a scenario with a hysterical bystander. Many *Assert* utterances in this simulation originated from the bystander (38 times out of the 100 *Assert* counts; the remaining 28 were directed to the bystander). In contrast, SIM1, designed with the most minimal bystander interference, only had two *Assert* utterances from the bystander (out of 57 *Assert* counts). Despite the reduction of frequencies, overall, *Assert* was still one of the most frequently used communicative functions during resuscitation. The fact that the frequencies were high in both team-only and bystander-inclusive analyses suggested that this communicative function is commonly applied in resuscitation dialogues.

The types, or sub-categories, on the other hand, may show different applications of this communicative function. *Assert* utterances are split into seven sub-categories in the present research. From the seven, *Conclude/Deduce* and *Forward-course* originated from a previous dialogue annotation scheme, the Generalised Medical Interaction Analysis System or GMIAS (Laws et al., 2009), while the rest were established from iterative analysis of the four dialogues. A small number of *Assert* utterances, whilst identifiable as assertions, were not completed or had poor audibility (1 or 1.8% from SIM1; 1 or 0.9% from SIM2; 14 or 14.0% from SIM3; 8 or 11.8% from SIM4 total *Assert* counts). These are tagged as *Indecipherable* and are not included in the sub-category analysis in Table 28.

Sub-category	To/from team members only				Examples	To/from bystanders			
	SIM1	SIM2	SIM3	SIM4		SIM1	SIM2	SIM3	SIM4
Conclude/ Deduce	8	10	4	7	“Okay, it appears asystolic now”	0	0	5	1
Forward-course	6	6	3	4	“20 seconds until next rhythm check”	0	2	0	1
State-awareness	28	58	12	13	“That’s fluid attached”	0	0	0	0
Information-giving	4	13	7	14	“So, this gentleman collapsed at work”	2	15	23	6
Hypothesise	4	1	7	3	“I suspect it’s an MI”	0	0	5	0
Commiserate	0	0	0	0	“Obviously you had a great shock…”	0	2	5	3
Notify	4	3	1	6	“In a minute, there’s another colleague coming”	0	3	14	1

Table 28. Raw counts of sub-categories used in team-only and bystander-inclusive *Assert* utterances

Sub-category analysis revealed that the types of *Assert* may differ based on whether it was a team-only interaction or a team-bystander interaction. The clearest example for team-only *Assert* is the *State-awareness*. *State-awareness* forms part of the situation awareness construct, a crucial element in a team’s non-technical skills, and is investigated further in Section 4.5. The restriction of this sub-category to team members only reflects its use to describe ongoing tasks or stages of the procedure, which is of importance to the resuscitation team. The frequency was affected by the resuscitation process. More frequent *State-awareness* utterances were observed in SIM1 and SIM2 as a result of verbalised manual chest compression counts, as no mechanical chest compression machine or AutoPulse was deployed, unlike in SIM3 and SIM4. There were also more *Conclude/Deduce* and *Forward-course* between team members, again, possibly because the *Assert* utterances were related to the task or procedure. *Commiserate*, on the other hand, seemed to only be used when the dialogue included bystanders.

Bystander interaction appeared to be significant in determining the sub-categories of *Assert* and their frequencies. Note that SIM1 has no *Commiserate* sub-category as the bystander in this simulation left early on and did not return to the scene. There was also a noticeably high frequency of *Notify* in SIM3 compared to the other three simulations, almost all of which originated from the bystander. Finally, both team-only and team-bystander interaction used *Information-giving* frequently, but there were perceptibly higher frequencies of this category in SIM2 and SIM3, the two simulation settings with the verbally active bystander.

Breaking down *Action-directive*

The next most frequent communicative function from the four simulations is *Action-directive*. Directives appeared to be a distinctive trait of medical team communication rather than dyadic medical communication, as shown by previous studies (e.g. Calder et al., 2017; Xiao et al., 2003). In the current findings, the most frequent use of *Action-directive* was found in SIM1, where it accounted for 22.8% of the total dialogue, followed by 15.7% in SIM4, 15.4% in SIM3, and 12.8% in SIM2. These frequencies, however, included *Action-directive* utterances to and from bystanders. When these were identified and separated, the following results in Table 29 were obtained.

Video	Total *Action-directive*	*Action-directive* directed to and from resuscitation team members only		*Action-directive* directed to and from bystanders only	
		Freq.	*% out of the total dialogue*	*Freq.*	*% out of the total dialogue*
SIM1 (n = 184)	42	40	21.7	2	1.1
SIM2 (n = 289)	37	27	9.3	10	3.5
SIM3 (n = 311)	48	32	10.3	16	5.1
SIM4 (n = 204)	32	23	11.3	9	4.4

Table 29. *Action-directive* total counts, team-only counts, and bystander-inclusive counts

There was no difference in the order of frequency of the four simulations after the exclusion of bystander-related *Action-directive*. SIM1 still had the highest count of *Action-directives* and was the only scenario that used the communicative function more than 20% of the time. No specific pattern of usage seemed to emerge regarding the use or non-use of the AutoPulse, although simulation scenarios with the least bystander verbal interaction (SIM and SIM4) showed somewhat more frequent use of *Action-directives* between team members. This is especially true in the case of SIM1.

Action-directive was further analysed using four sub-categories, following the ones introduced by Laws et al. (2009) for GMIAS. In addition, *Action-directive* utterances were also examined for addressee specificity (whether an *Action-directive* was addressed to a specific person or given in general) and structural formulation (whether the utterance is in the form of a conventional question, e.g. *Can you come over here?* or a statement, e.g. *Come over here please*). Some *Action-directive* utterances in SIM3 and SIM4 (8 or 16.7%; 3 or 9.4% of total *Action-directive* counts respectively) were not completed or not sufficiently audible for the recognition of specificity and form. These were tagged as *Indecipherable* and omitted from Table 30, which shows the frequencies and percentages of each sub-category in the four simulations for both team-only and team-bystander interactions.

Sub-category	To/from team members only				Examples	To/from bystanders			
	SIM1	SIM2	SIM3	SIM4		SIM1	SIM2	SIM3	SIM4
Direct/ Instruct	25	17	19	18	"Secure it for me, please"	0	4	5	7
Request	2	5	2	1	"Can we set the BP a cycle for every two-and-a-half minutes?"	2	5	8	1
Recommend/ Suggest	12	3	2	1	"Let's look at the 4Hs and 4Ts"	0	1	2	1
Allow	1	2	1	3	"…and I'll let you get the cannula[8] and stuff"	0	0	1	0

Table 30. Raw counts of sub-categories used in team-only and bystander-inclusive *Action-directive* utterances

Data from the study showed that a large proportion of *Action-directive* utterances in team-only dialogues were made up of *Direct/Instruct*, suggesting that when team members issued instructions, they tended to be straightforward and explicit. There was a noticeably high frequency of *Recommend/Suggest* in SIM1, which may be an indication of communicative preference. All four resuscitation teams used *Request* when giving *Action-directive* to bystanders.

In terms of addressee specificity and structural formulation of *Action-directive* utterances, the results showed that in the four simulations, addressee was not often named. There were only six name-specific directives in the dialogues, i.e. three occurrences in SIM1, one in SIM2, two in SIM3, and none in SIM4. There were no verbal indications that the absence of addressee name affected comprehension in any of the four scenarios. This can be explained by a few possible reasons.

First, most directives were verbalised with visual cues or as an extension of what a team member had already been doing prior to the instruction. For instance, the *Action-directive* utterances "Continue ventilations" in SIM1 and "Okay you just continue doing CPR" from SIM3 imply that a specific team member is already handling the ventilation and the chest compression. Second, the simulated resuscitations contained a limited number of people

[8] A small tube that can be inserted into the vein

(one 3RU as the team leader, two paramedics from ambulance service, one bystander each). This small number of people could mean that there was no need for specific naming, even when directing a team member to perform a new task. As an example, if a team member is in the midst of doing intubation, a new directive of “Okay, continuous compressions” could not logically be applied to him or her because a person cannot perform chest compressions and airway intubation simultaneously. A final possible reason is that all team members in both teams were highly familiar with one another. In this case, they would know from experience which tasks were to be done by whom, hence the directives only served as reminders, as suggested in personal communication with paramedics involved in these teams. Whether this pattern holds in real-life resuscitation teams will be discussed in Chapter 5.

In terms of structure, results showed that *Action-directive* utterances were mostly formulated as statements rather than questions (37 out of 42 times in SIM1; 33 out of 37 times in SIM2; 31 out of 40 times in SIM3; 29 out of 29 times in SIM4). An interesting phrasing found in the dialogues gives rise to the possibility of ambiguity in giving directives. The results showed two instances of the structure “Do you want to X”, as shown in (30) from SIM1 and (31) from SIM2:

(30)

Utterance 158, P2:	After this <u>do you want to</u> monitor so we’d need to get a […]
Utterance 169, 3RU:	So, <u>do you want to</u> go and arrange, uh, get a scoop

(31)

Utterance 234, 3RU:	<u>Do you want to</u> swap few minutes from now?

When isolated from its context, this particular structure strikes one as possibly ambiguous – the intent could either be a *Recommend/Suggest* (an utterance couched to suggest it is the speaker’s advice or proposal for the hearer to do the said task), an *Info-Request* (an utterance that requires the hearer to provide information, in this case, whether the hearer wants to or does not want to do the said task), or an *Offer* (an utterance that indicates speaker’s willingness to do something if the hearer agrees). Nonetheless, based on the dialogue context, the team members involved appeared to treat this kind of utterance as a mitigated directive. In Chapter 5, we will examine if this type of phrasing is as commonly used during real-life resuscitation attempts.

Breaking down *Info-request*

Info-request is the third most frequent communicative function in the four simulations. It has also been consistently established as a frequent function in previous dialogue annotation studies. Of the four simulations, SIM3 showed the most frequent use of *Info-request* (11.6%), followed by SIM4 (10.8%), SIM1 (8.2%), and SIM2 (8.0%). Fewer *Info-request* utterances were found in SIM1 and SIM2 dialogues in general compared to SIM3 and SIM4. This is interesting given that SIM3 and SIM4 were simulation settings with AutoPulse use, whilst SIM1 and SIM2 were without AutoPulse. Could the use of the machine affect the number of requests for information? To find out if this is the case, we examined the semantic content (the thread), contained in each *Info-request* utterance from all four simulations. The results showed that it was not the presence of the mechanical chest compression device that caused high frequencies of *Info-request*. From the two instances of *Info-request* in SIM3 and one instance in SIM4 concerning equipment, none seemed related to the AutoPulse directly.

However, when speakers and intended hearers were identified, it became clear that many *Info-request* utterances were either directed to or given by the bystander in the scenario. Out of SIM3's 36 *Info-request*, eight originated with the bystander, and a further 11 were directed towards the bystander. One *Info-request* was even directed to the patient himself, when a paramedic detected a pulse and believed that the patient had regained consciousness. This meant that only 16 *Info-requests* (5.1% of the whole resuscitation dialogue) were directed to team members from other team members in SIM3. Similarly, out of SIM4's 22 *Info-requests*, five came from the bystander and another four were directed to the bystander, leaving 13 *Info-requests* that occurred between team members. When questions to and from the bystander in SIM1 are removed, the total count dropped to 13 from the original 15. In SIM2, the total frequency of *Info-request* utterances decreased to 12 from the original 23 when *Info-request* utterances to and from the bystander are removed.

Table 31 compares *Info-request* utterances between team members and between team members and bystanders.

Video	Total *Info-request*	*Info-request* directed to and from resuscitation team members only		*Info-request* directed to and from bystanders only	
		Freq.	*% out of the total dialogue*	*Freq.*	*% out of the total dialogue*
SIM1 (n = 184)	15	13	7.1	2	1.1
SIM2 (n = 289)	23	12	4.2	11	3.8
SIM3 (n = 311)	36	17*	5.5	19	6.1
SIM4 (n = 204)	22	13	6.4	9	4.4

Table 31. Info-request total counts, team-only counts, and bystander-inclusive counts

*including one *Info-request* directed to the patient

The overall low prevalence of *Info-request*, especially when bystander-related *Info-request* utterances are excluded, indicated that this was not one of the main communicative function categories used by resuscitation team members during OHCA simulations. This finding is dissimilar to previous dialogue studies in the inter-medical domain, in which *Info-request* has been constantly observed as one of the major communicative functions (e.g. 26.2% in Laws et al., 2013; 22.2% in McNeilis, 2001; 17.8-23.9% in Roter & Larson, 2001). Intriguingly, the low percentages of *Info-request* amongst team members in this exploratory study also diverged from findings by Calder et al. (2017), who found that questions made up nearly 20% of resuscitation dialogues (17.1% in simulated scenarios and 17.7% in the live scenarios). It may be possible that this difference is a result of different criteria to tag the utterance – in the present study, *Info-request* is reserved for utterances that specifically ask for information. If the utterance is framed as a question but the illocutionary force is a request, e.g. “Can you swap over?” this is considered as an *Action-directive*.

To find out the type of *Info-request* most frequently used by the OHCA resuscitation team members, the communicative function is analysed based on the three sub-categories in the DARe coding scheme. The frequencies of each sub-category in *Info-request* utterances made to/from team members only and to/from bystanders only were compared to find out if there are any trends. A small number of *Info-request* utterances were sufficiently audible to be identified as *Info-request* but were not distinguishable enough for sub-category analysis. These (1 or 6.7% from SIM1; 1 or 4.3% from SIM2; 4 or 11.1% from SIM3; 4 or 18.2% from SIM4 total *Info-request* counts) were excluded from the frequencies presented in Table 32.

Sub-category	To/from team members only				Examples	To/from bystanders			
	SIM1	SIM2	SIM3	SIM4		SIM1	SIM2	SIM3	SIM4
Open-question	2	1	1	1	"What's happened to him?"	0	1	5	3
Closed-question	8	9	9	9	"You want the pack on?"	0	3	5	1
Leading-question	2	2	5	3	"Size tube do you want size 8?"	2	6	7	1

Table 32. Info-request sub-categories: Comparison of sub-categories between team-only and bystander-team

Overall, the closed-question format was the most frequent across all four simulations when requesting information (44 counts in total), followed by leading-question (27 counts in total). Open questions were only asked 14 times. There are clear differences between the types of *Info-request* used to/from team members and the types used to/from bystanders. Team members appeared to prefer closed questions, suggesting that the act of requesting information between team members during resuscitation favoured brief, specific answers. This resembled previous findings that showed the preference for closed questions in medical dialogues (e.g. McNeilis, 1995). When information was requested by or from bystanders, the leading question format took precedence (16 counts). A higher frequency of open questions was found in the to/from bystander *Info-request* counts.

One notable reason for requesting information was to find out about the well-being of other team members when performing a task or their attitude towards a verbalised plan. The following examples (32), (33), and (34) are taken from SIM1, SIM2, and SIM3 respectively. In all examples taken from the transcripts, names have been changed:

(32)
Utterance: You're okay doing chest tube?
Utterance: Are you okay doing compressions?

(33)
Utterance: Is everybody happy with that?
Utterance: You happy enough with that at the moment?

(34)
Utterance: Are you okay carrying on?
Utterance: P3, you're happy with the airway?

This may reflect verbal signals of efficient leadership. The questions indicated that the team leaders were situationally aware of the tasks that were being performed by the team and the possibility of team members feeling overwhelmed. At the same time, it provided a means for the team to voice suggestions or any concerns that they might have.

Summary of communicative function findings

Communicative function analyses revealed that resuscitation dialogues contained similar distributions of statements (i.e. *Assert*) when compared with other medical dialogue annotation studies, including physician-patient interaction. However, resuscitation dialogues differed in terms of the frequencies of *Action-directive* and *Info-request* utterances. There was a higher prevalence of *Action-directive* utterances (e.g. instructions, commands, requests), a trait that is only observed in procedure-related medical communication such as surgery, yet lower prevalence of *Info-request* utterances compared to any previous dialogue research findings. Verbal responses in the dialogues mainly centred around three categories, namely *Acknowledge, Answer,* and *Accept.* Very few rejections and statements that signal non-understanding were found.

When the communicative functions *Assert*, *Action-directive*, and *Info-request* were analysed based on their sub-categories, we found the following results. First, the most frequently used sub-category of *Assert* was *State-awareness*, which is used to signal the present condition or progress of a task. Second, most *Action-directive* utterances were verbalised in the form of direct instructions rather than as requests or suggestions. Finally, questions during resuscitation tended to be asked in the *Closed-question* form.

4.4 Thread coding findings

The semantic content, or thread, of each utterance indicates what an utterance is about, and therefore identifies the topic under discussion. A speaker might ask two similar questions (with the same structure and manner) but each question might concern a different subject matter. Annotating and categorising threads allows us to examine what subject matters arise throughout the dialogues, how frequently they are mentioned, the sequence in which they are mentioned, and whether the same patterns prevail in all four simulations.

Threads were coded based on the categories in DARe (see the end of Chapter 3 for the full coding scheme). Like the communicative function coding, a single utterance can be tagged with more than one thread if it contains more than one kind of subject matter. Following this, the total thread tag counts were higher than the total utterance counts for all simulations (total thread counts are 218 for SIM1; 327 for SIM2; 379 for SIM3; 254 for SIM4). The total utterance counts are given in Table 33.

Utterance category	SIM1		SIM2		SIM3		SIM4	
	Freq.	*%*	*Freq.*	*%*	*Freq.*	*%*	*Freq.*	*%*
Tagged with (a) thread code(s)	166	90.2	254	87.9	270	86.8	168	82.4
Incomplete/indecipherable	18	9.8	35	12.1	41	13.2	36	17.6
Total	184	100	289	100	311	100	204	100

Table 33. Proportion of utterances that were tagged with a thread (or threads) and incomplete/indecipherable utterances in the four simulations

Distribution of threads: Types, frequencies, and percentages

There are two possible ways for the thread categories to be utilised in order to understand the communication pattern of the resuscitation teams. The first is to compare the thread frequencies between the four simulations to find out whether all four teams used a similar number of utterances to interact about the same subject matter. Second, we can analyse the order of thread introduction into the dialogues and compare it with the resuscitation steps in the ALS guideline. Table 34 shows the counts and percentages of thread distributions in SIM1, SIM2, SIM3, and SIM4, excluding the incomplete and undecipherable utterances (refer to Table 33). The count of incomplete and undecipherable utterances was higher than those in the communicative function analyses because content coding requires clearer contextual clues to be coded. An utterance that can be recognised functionally as a question, for instance, allows it to be tagged as an *Info-request* in the communicative function coding, but if it is not sufficiently clear as to what the question is about, then the thread coding will remain undecipherable. Following this, if the question is responded to verbally, the response will also be tagged undecipherable (see discussion under ISSUE 3, Section 3.9).

Thread	SIM1 (n = 184)		SIM2 (n = 289)		SIM3 (n = 311)		SIM4 (n = 204)	
	Freq.	*%*	*Freq.*	*%*	*Freq.*	*%*	*Freq.*	*%*
Patient history (PH)	9	4.9	76	26.3	61	19.6	36	17.6
Task-related								
Compression (COMPR)	30	16.3	52	18.0	11	3.5	18	8.8
Clothing (CLOTH)	0	0.0	0	0.0	0	0.0	11	5.4
Airway (AIR)	3	1.6	4	1.4	11	3.5	6	2.9
Rhythm (RHY)	34	18.5	24	8.3	11	3.5	6	2.9
Medication or treatment (MED)	5	2.7	11	3.8	3	1.0	13	6.4
Instrument or equipment (INST)	43	23.4	31	10.7	23	7.4	18	8.8
Ventilation (VENT)	3	1.6	21	7.3	0	0.0	0	0.0
Timing (TIME)	12	6.5	4	1.4	9	2.9	1	0.5
Shock (SHOCK)	11	6.0	0	0.0	30	9.6	5	2.5
State (STATE)	1	0.5	0	0.0	2	0.6	6	2.9
Reversible causes (RC)	5	2.7	3	1.0	24	7.7	0	0.0
Resolution (RES)	3	1.6	7	2.4	1	0.3	0	0.0
Space and movement								
Movement of patient (MOVPT)	0	0.0	0	0.0	5	1.6	6	2.9
Movement other than patient (MOV)	0	0.0	0	0.0	13	4.2	6	2.9
Immediate vicinity (IMM)	0	0.0	1	0.3	5	1.6	7	3.4
Non-immediate vicinity (NONIMM)	0	0.0	0	0.0	5	1.6	0	0.0
Plan of action (PAC)	30	16.3	32	11.1	62	19.9	56	27.5
Social agenda setting (AG)	8	4.3	9	3.1	9	2.9	7	3.4
Other (OTHER)	3	1.6	17	5.9	53	17.0	16	7.8

Table 34. The frequencies and percentages of different types of thread in the four simulations

Very generally, the simulation team dialogues appeared to contain similarly frequent threads. Clear differences, however, can be seen when each thread is individually inspected. Figure 5 illustrates the threads in the four OHCA simulations from the most frequently used to the least frequently used (based on the percentages of each thread from the four simulations).

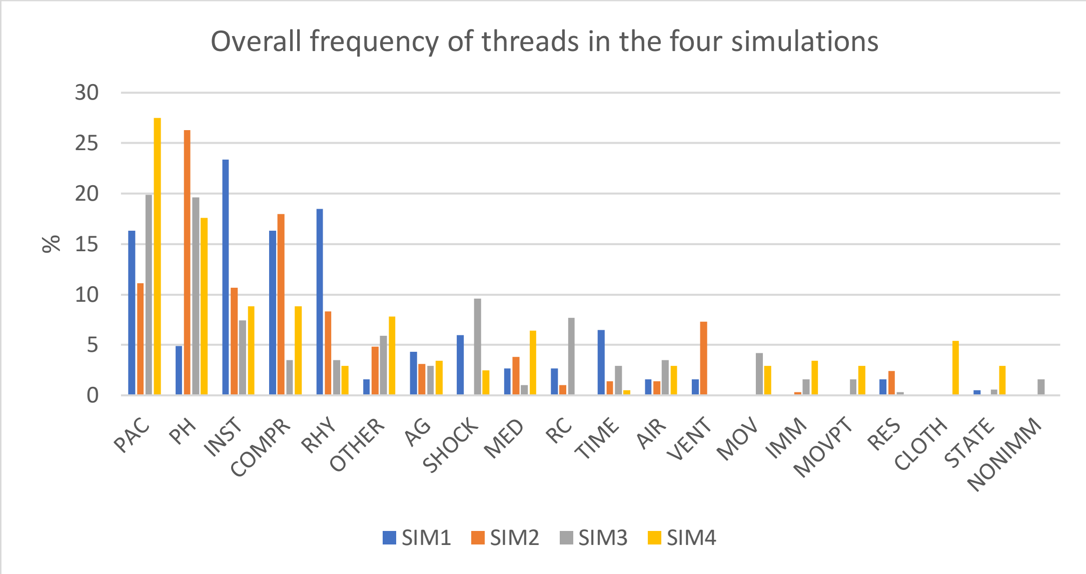


Figure 5. Frequency of threads in the four simulations, from the most frequent to the least frequent

PAC: Plan of action; PH: Patient history; INST: Instrument/equipment; COMPR: Chest compression; RHY: Rhythm, OTHER: Other type of thread including well-being queries; AG: Social agenda setting; SHOCK: Shock; MED: Medication; RC: Reversible causes; TIME: Time; AIR: Airway access; VENT: Ventilation; MOV: Movement other than patient; IMM: Immediate vicinity; MOVPT: Movement of patient; RES: Resolution; STATE: Current state of patient; NONIMM: Non-immediate vicinity

A closer look into these suggested that some of these differences may offer a glimpse into the story of each resuscitation attempt, such as whether the scenario includes verbally active bystander(s), the type of rhythm (shockable or non-shockable), possible outcomes, and whether the team deploys the AutoPulse. A higher frequency of utterances revolving around patient history could indicate that there is someone on scene who is familiar with the patient's medical background, as illustrated by the *Patient history* thread in all simulations except SIM1. A high frequency of *Other* thread – utterances that are mostly about/from bystanders – suggests that the bystander is actively involved in the dialogue (far more so than providing patient history) as shown in SIM3. SIM2 had no thread for *Shock* because the simulated resuscitation scenario depicted a non-shockable rhythm., whilst the other three simulations involved shockable rhythms. A high frequency of *Rhythm* thread for SIM1 can be partly attributed to the pre-planned outcome of the scenario (i.e. ROSC), which made up nine out of the 34 utterances tagged as *Rhythm* in this particular simulation. Finally, movement-related threads (*Movement of patient* and *Movement other than patient*) were only observed in SIM3 and SIM4 as AutoPulse use required that the patient be moved in order for the equipment to be strapped on.

In addition to the four possible scenarios, non-verbalisation of threads also contributed to low thread frequencies. It should be noted that verbal counts for ventilation and/or chest compression are not compulsory in resuscitation. The variations in the *Ventilation* thread distributions (i.e. very frequent in SIM2, less in SIM1, none in SIM3 and SIM4) were due to non-verbalisation of ventilation counts. Unlike in SIM2, during which ventilation counts were clearly audible, the other three teams did not count out loud (or if they did, the counts were not sufficiently audible to be captured). This does not mean that the teams did not ventilate; all teams were observed to have followed the 30:2[9] cycle. Similarly, *Compression* thread counts were lower in SIM3 and SIM4 because the cycles were automated using the AutoPulse, hence eliminating the need for manual counts. By itself, the lack of frequency counts for any task is therefore not an indicator of whether or not a task is performed.

The findings showed that different resuscitation scenarios (i.e. bystander present or not present, rhythm is shockable or non-shockable, AutoPulse is deployed or not deployed) and the outcomes (i.e. ROSC, ceasing resuscitation attempt) could influence the use and frequencies of specific thread types. In addition, non-verbalisation of compression and ventilation counts due to either personal choice or lack of need also affects thread patterns. A surface level comparison of thread frequencies can demonstrate these differences but would not be useful for predicting whether tasks are performed accordingly. This makes it difficult to correlate surface-level frequencies with outcomes, as, for instance, a high overall frequency of *Rhythm* thread does not automatically mean a team is more competent when assessing the patient's rhythm, and the absence of the *Ventilation* thread does not mean a team has forgotten to ventilate the patient. The frequencies alone do not show us one important part – *when* the utterance is verbalised. To examine this, we mapped each thread against the order of utterance in which it was mentioned.

Order of verbal introduction of each thread

Resuscitation teams are trained to follow a standard algorithm such as the Advanced Life Support (ALS) guideline to optimise favourable outcomes. Can the progress of this algorithm be captured from the team members' verbalisation of threads? If thread verbalisation can illustrate this, the order of their verbal introductions may reveal a similar pattern for all four simulations. One way to analyse this is by plotting the order of thread introduction in the

[9] One cycle consisting of 30 chest compressions followed by two ventilations

four dialogues. The following figures illustrate the time of introduction of each thread into the dialogue in terms of utterance sequence, the cluster of exchanges regarding the thread (showing where in the dialogue team members talk most frequently about a specific thread), and where each thread disappears and reappears in the conversation. The threads ranged from 14 types to 18 types. In contrast to prior expectation, there were no clear similarities in the thread patterns of the four simulations.

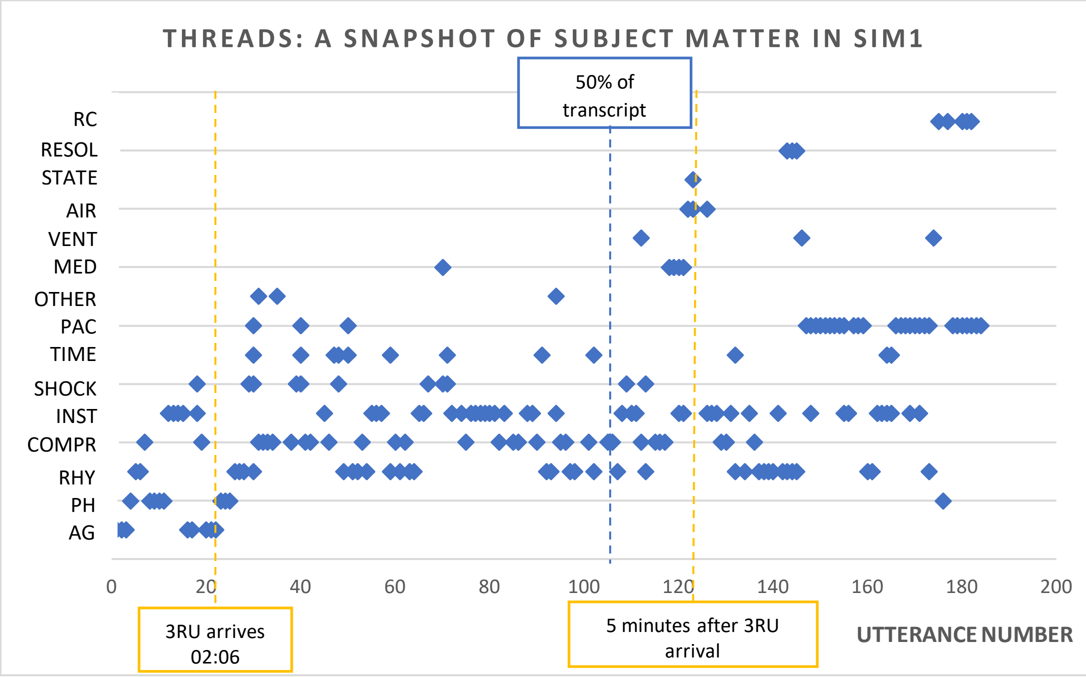


Figure 6. Distribution of threads in SIM1 as the dialogue progresses (utterance number 4 corresponds to the 4th utterance in the dialogue)

AG: Social agenda setting; AIR: Airway access; COMPR: Chest compression; IMM: Immediate vicinity; INST: Instrument/equipment; MED: Medication; MOV: Movement other than patient; MOVPT: Movement of patient; NONIMM: Non-immediate vicinity; OTHER: Other types of thread including well-being queries; PAC: Plan of action; PH: Patient history; RC: Reversible causes; RES: Resolution; RHY: Rhythm; SHOCK: Shock; STATE: Current state of patient; TIME: Time; VENT: Ventilation

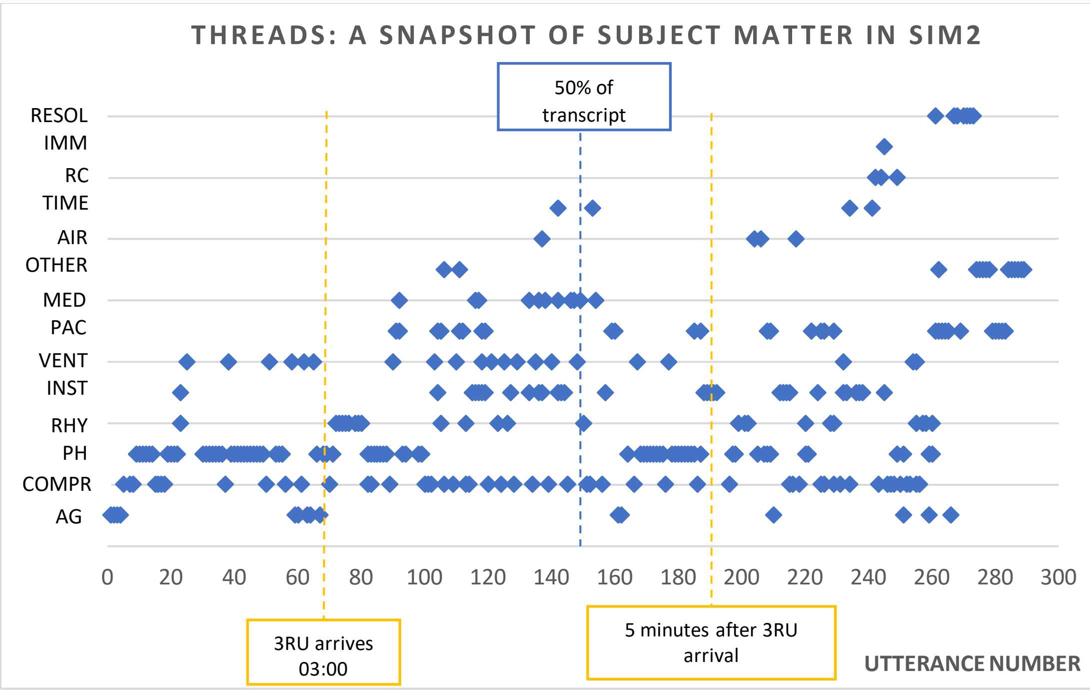


Figure 7. Distribution of threads in SIM2 as the dialogue progresses (utterance position 4 corresponds to the 4th utterance in the dialogue)

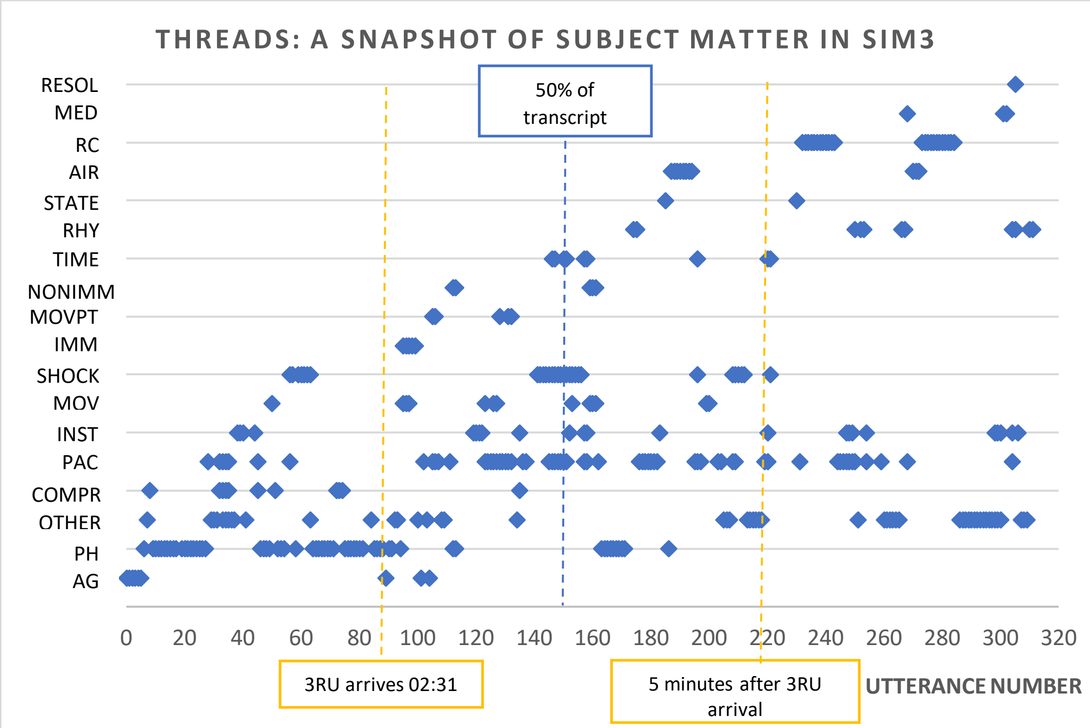


Figure 8. Distribution of threads in SIM3 as the dialogue progresses (utterance number 4 corresponds to the 4th utterance in the dialogue)

AG: Social agenda setting; AIR: Airway access; COMPR: Chest compression; IMM: Immediate vicinity; INST: Instrument/equipment; MED: Medication; MOV: Movement other than patient; MOVPT: Movement of patient; NONIMM: Non-immediate vicinity; OTHER: Other types of thread including well-being queries; PAC: Plan of action; PH: Patient history; RC: Reversible causes; RES: Resolution; RHY: Rhythm; SHOCK: Shock; STATE: Current state of patient; TIME: Time; VENT: Ventilation

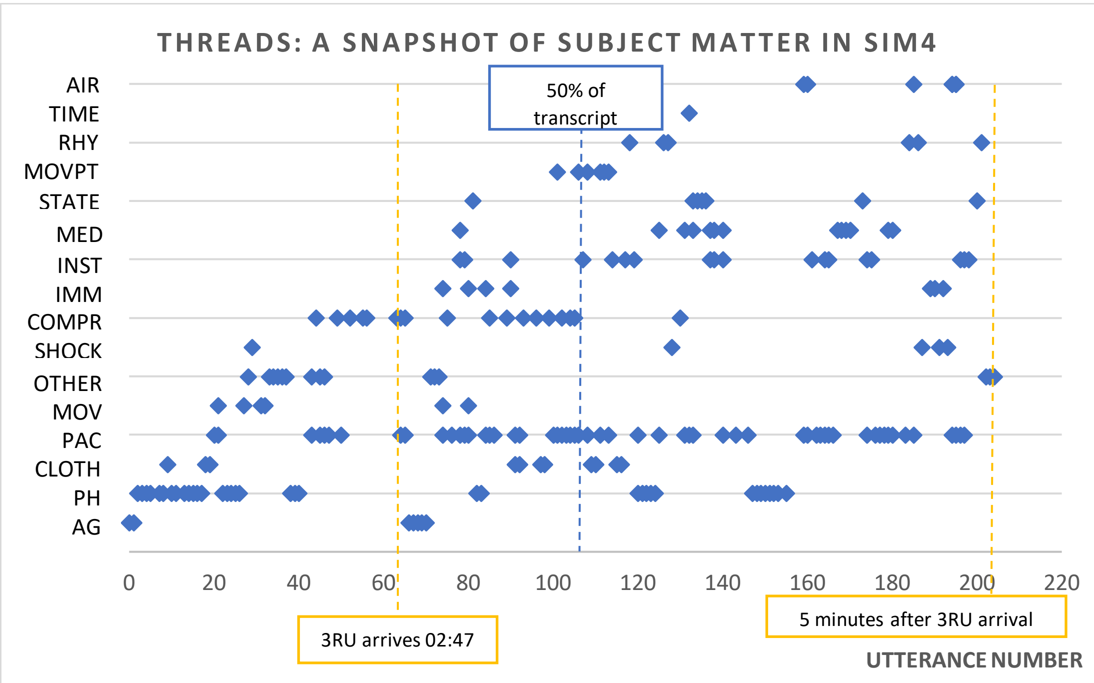


Figure 9. Distribution of threads in SIM4 as the dialogue progresses (utterance position 4 corresponds to the 4th utterance in the dialogue)

Despite the absence of distinctively similar patterns, the four simulation dialogues did show a few similar trends. Generally, most threads were verbally introduced in the first half of the transcript. Six threads were consistently introduced early, namely *Social agenda setting, Patient history, Compression, Instrument, Plan of action*, and *Other*. Of these, *Social agenda setting* and *Patient history* were almost always the first two threads to be verbalised upon arrival, indicating that after the initial greetings and introductions, the dialogues immediately turned to patient information and medical history. The following is one example from when the 3RU paramedic arrived on scene in SIM1. Note that only the threads of the utterances are tagged and not the communicative functions.

(35)

Utterance 21, 3RU:	Hi guys	*Social agenda setting*
Utterance 22: 3RU:	I'm Ian[10], 3RU paramedic	*Social agenda setting*
Utterance 23, P2:	Hiya	*Social agenda setting*
Utterance 24, 3RU:	What do we got here?	*Patient history*
Utterance 25, P1:	So, this gentleman collapsed at work	*Patient history*

Meanwhile, *Resolution* and *Reversible causes* consistently appeared later, i.e. in the second half of the transcript. Whilst this is expected for the *Resolution* thread, it also suggests that the reversible causes of cardiac arrest were only discussed later in the dialogues after other subject matters were dealt with. This explains why no *Reversible causes* thread was found in SIM4 – the dialogue might have not advanced to the part that concerned this specific subject matter. In SIM1, the first verbal introduction of the *Reversible causes* thread was found in Utterance 175; in SIM2, in Utterance 242, and in SIM3, in Utterance 232. These clusters of *Reversible causes* threads are shown in (36), (37), and (38) respectively.

(36)

Utterance 175, 3RU:	[…] looks like he's probably been thromboembolic
Utterance 176, 3RU:	He's had a […] chest pains
Utterance 177, 3RU:	I suspect it's an MI[11]

[10] All actual names in this thesis have been substituted with pseudonyms or terms such as P1, P2, P3, etc.

[11] Myocardial infarction

(37)
Utterance 242, 3RU: So, we'll run the possible causes
Utterance 244, 3RU: Hypoxia were connecting,
Utterance 245, 3RU: hypovolaemia possibly connecting

(38)
Utterance 232, 3RU: Let's look at the 4Hs and 4Ts
Utterance 233, P2: Yep
Utterance 234, 3RU: Okay, hypoxia […]
Utterance 236, 3RU: Hypovolaemia?

In the four dialogues, approximately half of the threads (between six to eight) were introduced prior to the 3RU paramedics' arrival. Three threads, however, only consistently appeared after 3RU arrival in all four simulations, namely *Time*, *Medication*, and *Airway access*, indicating the possibility that these subject matters fall under the 3RU paramedics' expertise. Where applicable, the *Movement of patient* and *Immediate vicinity* threads also appeared after the 3RU paramedics were on scene. This could be attributed to the organisation of team members, i.e. who stands where to perform which task, and the alignment of patient into position for the AutoPulse.

Other than these, the verbal introduction of the rest of the threads varied across the dialogues in ways that appear to lack obvious systematicity. The *Ventilation* thread, for instance, was introduced late in SIM1 but earlier in SIM2. The *Rhythm* thread showed up in the third and fourth place in SIM1 and SIM2 respectively, yet, was only introduced in the second half of SIM3 and SIM4 dialogues. The clusters of dialogue exchanges on specific threads also appeared unsystematic, varying with each simulation. The clusters indicated that at a specific juncture, the dialogue exchanges heavily revolved around a specific subject matter. SIM1 showed dense clusters of the *Plan of action* thread; SIM2, the *Patient history* thread. SIM3 showed several dense clusters, including *Shock*, *Other*, and *Reversible causes*, whilst SIM4 showed thick clusters of *Patient history* and *Plan of action* threads.

It appears that both the order of introduction and the clusters were highly sensitive to the variables present in the specific resuscitation scenario (e.g. hysterical bystander → dense clusters of *Other* thread; patient's clothes obstructing compression → *Cloth* thread introduced earlier, awkward space → *Movement of patient* or *Movement other than patient* thread introduced earlier, etc.), which would mean that examining threads in the individual orders of which they were introduced and the clusters they produced might result in various, non-identical patterns unique to their resuscitation settings. In short, if 100 resuscitation attempts were mapped this way, there may well be 100 different distribution patterns of threads. These variabilities would indicate that each resuscitation scene is different but would not tell us much in terms of a generic, shared pattern. In practice, thus, we can surmise that threads can be verbalised in diverse ways.

Comparing the order of thread introduction with the steps in the ALS algorithm

It was predicted earlier that the introduction of threads would be approximately similar to the steps in the ALS algorithm (refer to Figure 2, Section 3.8). Should each step be verbalised, the following threads would be obtained in approximately the following order. To make it easier to follow the steps and expected threads, these are numbered (1), (2), and (3). Note that whilst the steps follow an order of priority, they are not strictly linear.

Step	Summary of ALS algorithm	Expected verbalised thread
1	Perform and maintain chest compressions (30 compressions, two breaths or ventilations).	*Compression*, *Ventilation*
2	Rhythm assessment. If shockable rhythm, administer shock; otherwise, continue 30:2 CPR. If there is a pulse, i.e. return of spontaneous circulation, administer post cardiac arrest treatment.	*Rhythm*, *Shock* (if applicable)
3	During CPR: Use waveform capnography, place airway, administer adrenaline/amiodarone, treat reversible causes.	*Instrument*, *Airway*, *Medication*, *Reversible causes*

Table 35. ALS steps (adapted from Resuscitation Council UK, 2015) and expected threads during resuscitation

Figures 6 – 9 demonstrate that the thread introduction for each simulation did not follow the predicted configuration given in Table 33. Having said this, it should be noted that CPR is a continuous procedure and that tasks like checking the rhythm can be successfully performed without following a rigid sequence. Nonetheless, verbalisation of these tasks would highly likely show a kind of progression. For instance, given that continuous, high-quality chest compression is vital to desired outcome, one might expect to find the *Compression* thread early in the dialogues before threads about *Shock* or *Rhythm*, and

Reversible causes thread later in the dialogues after the rest of the subject matter has been managed.

To compare the verbal order of thread introduction with the ALS steps, further analysis was performed on ALS-associated threads (i.e. the eight threads given in Table 35) and these threads' order of introduction relative to other types of thread in the dialogues. The results showed eight ALS-related threads in SIM1, seven in SIM2 (no *Shock* thread), seven in SIM3 (no *Ventilation* thread), and six in SIM4 (no *Ventilation* and *Reversible causes* threads). The order of thread verbal introduction in general did not strictly adhere to the ALS steps. Table 36 illustrates these results, with ALS-associated threads numbered and in bold.

Verbal order of introduction	SIM1 (8 ALS-related threads)	SIM2 (7 ALS-related threads)	SIM3 (7 ALS-related threads)	SIM4 (6 ALS-related threads)
First introduced Last introduced	Social agenda setting Patient history **(2) Rhythm** **(1) Compression** **(3) Instrument** **(2) Shock** Time Plan of action Other **(3) Medication** **(1) Ventilation** **(3) Airway** State Resolution **(3) Reversible causes**	Social agenda setting **(1) Compression** Patient history **(2) Rhythm** **(3) Instrument** **(1) Ventilation** Plan of action **(3) Medication** Other **(3) Airway** Time **(3) Reversible causes** Immediate vicinity Resolution	Social agenda setting Patient history Other **(1) Compression** Plan of action **(3) Instrument** Movement other than patient **(2) Shock** Immediate vicinity Movement of patient Non-immediate vicinity Time **(2) Rhythm** State **(3) Airway** **(3) Reversible causes** **(3) Medication** Resolution	Social agenda setting Patient history Clothing Plan of action Movement other than patient Other **(2) Shock** **(1) Compression** Immediate vicinity **(3) Instrument** **(3) Medication** State Movement of patient **(2) Rhythm** Time **(3) Airway**

Table 36. The order of verbal introduction of threads in the four simulations

Note: (1), (2), and (3) refer to the ALS algorithm steps in Table 33

Only one transcript (SIM1) contained all the ALS algorithm-associated threads. Clearly, not all eight threads were verbalised in the dialogues. This could mean that a specific thread is not required during the procedure (e.g. *Shock,* which was not applicable for SIM2) or is usually mentioned later as the dialogue progresses (e.g. *Reversible causes*). The reason for the absence of the *Ventilation* thread in both SIM3 and SIM4 is a bit more uncertain, although this could simply be because the team members did not find ventilation counts necessary to be said out loud. Another possibility is that some verbalisations might have been inaudible.

The order of verbalisation varied from simulation to simulation although *Compression* was almost always verbalised in the beginning and *Reversible causes* later in the procedure. One explanation is that the verbalisation of tasks in resuscitation does not align with the task progression. SIM4 video showed that chest compression was administered from the very beginning by the SAS paramedics (within the first couple of minutes into the resuscitation attempt and definitely before the 3RU paramedic arrival), but only went on the verbal record after seven other threads were managed. It should also be noted that the ordinal nature of the threads means that there may only be one second of time difference between one thread verbalisation to another, as can be seen in the clusters of thread in Figures 6 – 9; hence, the order in Table 36 illustrates progression rather than efficiency or competence level.

Summary of thread findings

To identify thread patterns, the study analysed the overall distribution of threads and compared the order of verbalisation of selected threads against the ALS guideline steps. Findings revealed that thread distributions were affected by the specific resuscitation scenario. For instance, the threads concerning space and movement were highly frequent in scenarios with AutoPulse use compared to scenarios without the device. All four simulation dialogues, however, contained threads relating to airway management, chest compression, rhythm, medication or treatment, instrument or equipment, explicit timing, patient history, greetings and introductions, and plans.

When the verbal order of introduction was examined, it was revealed that overall, thread verbalisation did not strictly reflect the priority order in the ALS guideline. Having said that, the *Compression* thread was almost always the first to be mentioned and the *Reversible causes* thread the last.

4.5 Exploring five areas of the OHCA resuscitation dialogue

The data from the communicative function component and thread component are subsequently used to investigate five distinct areas relevant to paramedic communication during OHCA resuscitation. The first area looks at how team members keep each other situationally aware of the ongoing tasks and progress during resuscitation. The second area explores absolute politeness in paramedic directives and how this is exercised in a high-stakes, time-pressured environment. The third area examines how paramedics verbalise their plans and strategies. This is followed by an analysis of the occurrence of trained communication strategies during resuscitation, focusing on closed-loop communication. Finally, we investigate how affective behaviours are reflected verbally in the resuscitation dialogues. The following sections present the findings.

4.5.1 Verbal alignment as part of situation awareness

Situation awareness is a skill that is used by teams to maintain an overall awareness of the environment whilst taking account of all relevant elements. Verbal statements that alert team members to current happenings form part of situation awareness and provide a means for teams to align themselves during procedures. DARe captures team alignment using *State-awareness*, a sub-category of *Assert* that was generated via iterative analysis of the data and is part of the situation awareness dimension. Utterances tagged with *State-awareness* are meant to act as verbal landmarks, alerting team members to the current task progress or patient condition. In this way, *State-awareness* utterances are akin to unprompted self-reports.

In SIM1 and SIM2, *State-awareness* made up approximately half of the *Assert* utterances (49.1% and 50.8% for SIM1 and SIM2 respectively). In contrast, SIM3 and SIM4 showed fewer (12.0% for SIM3 and 19.1% for SIM4 respectively). The most prevalent of *State-awareness* reports are the verbal counts for chest compressions. Usually, the paramedic doing compressions would start counting out loud from 25, continuing to 30, where “30” signalled the end of the current compression cycle and cued ventilations (in SIM2) or rhythm check (in SIM1) to be performed. Ventilation counts (two counts for each session) also appeared to be useful because the second count served as a cue for the paramedic who was doing chest compression to start another round. Given is an example of such dialogue from SIM2:

(39)
Utterance 37, P3: 25, 26, 27, 28, 29, 30.
Utterance 38, P2: *(ventilates)* One, two.
Utterance 50, P3: *(restarts compression, verbalises count when reaching 25)*

When AutoPulse is employed, chest compressions are mechanically taken care of, hence there is no need to verbally count manual compressions. This explains the lower frequencies of *State-awareness* in SIM3 and SIM4. *State-awareness* in these two simulations took place during other tasks like administration of shocks, for instance:

(40)
SIM3
Utterance 143, P2: *(defibrillates)* One shock straight in.

SIM4
Utterance 193, 3RU: *(after observing second defibrillation)* That's the second shock in.

Aside from compressions and defibrillations, there were also self-reports from team members that described their present state of action, as given in the following examples:

(41)
SIM1
Utterance 123, P1: *(during intubation, referring to thorax)* It's a bit dry.
Utterance 131, P3: *(declaring possession of equipment)* I've got the tube.

SIM2
Utterance 138, P2: *(after attaching fluid)* That's fluid attached.
Utterance 147, P2: *(preparing adrenaline)* 1 mg adrenaline July 2017.
Utterance 148, P2: *(administers)* That's adrenaline on.

All of these self-reports were verbally unprompted. Very few were verbally acknowledged, except in instances when a team leader reminded the team to do a rhythm check after the compression cycle was completed, as shown in (42).

(42)
SIM1

Utterance 90, P3:	25, 26, 27, 28, 29, 30	*Assert (State-awareness)*
Utterance 91, 3RU:	Okay 30 seconds,	
Utterance 92, 3RU:	another rhythm check guys	

In this exploratory study, *State-awareness* utterances appeared to be mostly centred on chest compression counts. Resuscitation team members (personal communication with paramedics involved) revealed that they found the verbal counts of compressions very helpful as these helped mark where the team was in the whole procedure, and also as a reminder for the next step in the resuscitation process. Nonetheless, when the AutoPulse is deployed, the need to manually count the cycles would be eliminated. We expect that this may motivate the use of more *State-awareness* utterances for other types of thread. Additionally, as kind of utterance possibly contributes to a team's situation awareness, it may be positively associated with non-technical skills performance scores. This will be explored in Chapter 5.

4.5.2 Mitigation strategies in directives

The high frequency of *Action-directive* utterances found in the simulations is one of the main findings that differentiates resuscitation dialogues from physician-patient dialogues. Two explanations can be given for this higher usage: first, a procedure performed by a team generates more directives than a medical consultation. Even though physician-patient consultations would have included directives like "Open your mouth", this specific dialogue act has been found to be limited compared to other categories of communicative functions. Physician-patient consultations focus on obtaining or clarifying biomedical information from patients, which is accomplished through the act of asking questions and encouraging statements of information (McNeilis, 2001). Resuscitation, on the other hand, is a team procedure that focuses on task or goal execution, which is typically performed using directives. Second, the presence of a leader who oversees an overall procedure is likely to add to the usage of *Action-directive.* Resuscitation team leaders are expected to organise the teams in terms of the management and delegation of people and tasks (Cooper & Wakelam, 1999). Consequently, this contributes to the higher prevalence of directives in resuscitation dialogues.

Of interest is the forms taken to express an *Action-directive,* given that resuscitation is a highly time-constrained scenario and the paramedics involved have been trained to be succinct in giving directives. For these reasons, an earlier prediction was that the majority of directives would be direct rather than mitigated. However, from a politeness theory standpoint (Brown & Levinson, 1978), instructing someone to perform an action usually requires a face-saving strategy or mitigation[12]. Politeness markers are often employed for this purpose, but would paramedics in a time-constrained environment do so, especially after being trained to be direct? With this as a platform, the study examined *Action-directive* utterances for the presence of mitigation devices that are conventionally applied to signal absolute politeness. These included terms like *please, can you/could you/would you, we/us*, and various pragmalinguistic strategies such as the ones listed by Blum-Kulka et al. (1987). In their list of nine descriptive categories of request, eight are mitigated, with mild hints described as the most indirect or opaque (shown in Table 9, Section 3.2). The application of these mitigated structures might yield ambiguity as well as taking extra time to be produced.

SIM2, SIM3, and SIM4 included a small number of utterances that were identifiable as *Action-directive* but were incomplete or insufficient for in-depth structure identification. These utterances were excluded from this analysis (3 or 8.1% from SIM2; 8 or 16.7% from SIM3; 3 or 9.4% from SIM4 total *Action-directive* counts respectively). Following this, we found that in all four simulations, more than half of *Action-directive* utterances were mitigated (69.0% in SIM1; 64.7% in SIM2; 73.0% in SIM3; 55.2% in SIM4). The data suggested a slight preference for using mitigated directives when speaking to bystanders rather than to team members.

The types and frequencies of mitigating devices found in the four simulations are given in Table 37. Note that the frequencies do not tally with the overall totals because some *Action-directives* contained more than one type of mitigating device.

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[12] It should be acknowledged that an unmitigated request or command does not necessarily mean that the utterance is less polite, merely that it is unmitigated in the sense of absolute politeness.

Types of mitigating device	No. of utterances with mitigating device			
	SIM1	SIM2	SIM3	SIM4
	Freq. *(%)*	*Freq.* *(%)*	*Freq.* *(%)*	*Freq.* *(%)*
Use of *Let's* (indicates that hearer is not forced into action)	6 (14.3%)	0 (0.0%)	1 (2.5%)	0 (0.0%)
Use of first-person plural pronouns like *we* and *us* (signals that speaker is part of team)	11 (26.2%)	7 (20.6%)	4 (10.0%)	5 (17.2%)
Use of *please, okay, alright, just* (softens a directive)	9 (21.4%)	5 (14.7%)	16 (40.0%)	9 (31.0%)
Use of affective terms like *pal, mate, guys* (indicates affective relations/positive politeness)	2 (4.8%)	1 (2.9%)	2 (5.0%)	0 (0.0%)
Use of idiomatised pragmalinguistic structures (e.g. *Can you X; Would you X; Could you X; If-structures*)	7 (16.7%)	10 (29.4%)	12 (30.0%)	2 (6.9%)
Use of entreaties like *for me* (highlights speaker's need for help/assistance from hearer)	1 (2.4%)	2 (5.9%)	4 (10.0%)	1 (3.4%)

Table 37. Presence of mitigating devices in *Action-directives*. Percentages are out of the total *Action-directives* in each transcript.

Many directives were mitigated with more than one type of mitigating device. The following examples (43) to (46) are taken from SIM1, SIM2, SIM3, and SIM4 respectively:

(43)
An *Action-directive* containing five mitigation devices from SIM1

Okay	**can you just,**	**guys,**	**keep a finger on his pulse just to make sure**	**we**	**don't lose output?**
Use of "okay" as a softener	Use of idiomatised pragmalinguistic structure + "just" as a softener	Use of affective term	Use of "just" as a softener	Use of "we" to signal unity	-

(44)
An *Action-directive* containing two mitigation devices from SIM2

Please,	**If you would**	**phone the GP first**
Use of "please" as a softener	Use of idiomatised pragmalinguistic structure	-

(45)
An *Action-directive* containing two mitigation devices from SIM3

Now **if you**	move your hands off	**for me**
Use of idiomatised pragmalinguistic structure	-	Use of "for me" as entreaty

(46)
An *Action-directive* containing two mitigation devices from SIM4

You	just	step back just[13] now	okay?
-	Use of "just" as a softener	-	Use of "okay" as a softener

Unmitigated *Action-directive* utterances (13 or 31.0% in SIM1; 12 or 35.2% in SIM2; 11 or 28.0% in SIM3; 13 or 44.8% in SIM4) were more frequently used when instructing fellow team members. Team members received unmitigated directives 13 out of 13 times in SIM1, eight out of 12 times in SIM2, 10 out of 11 times in SIM3, and 10 out of 13 times in SIM4. These unmitigated directives concerned resuscitation tasks, for instance moving the patient to an ideal position, checking the patient's rhythm, and defibrillation. Nonetheless, the same tasks were also initiated using mitigated directives, as shown in Table 38.

Context	Unmitigated *Action-directive* utterances	Mitigated *Action-directive* utterances
Checking the pulse	*Have a rhythm check*	*Another rhythm check, guys*
Chest compression	*You need one more round*	*If you can keep going at the moment*
Instrument or equipment	*Pause that AutoPulse*	*Secure it for me, please*
Medication	*Get some, some fluids*	*If you could get a bag of fluids up for me*
Getting bystander to move away from patient	*Keep safe away from him*	*You just step back just now, okay*

Table 38. Comparing unmitigated and mitigated *Action-directive* utterances in similar contexts

Higher frequencies of unmitigated instructions between team members suggested that all four resuscitation teams favoured short and direct *Action-directives* when giving verbal instructions or commands to one another. This is in line with their NTS training of using direct and succinct instructions during the procedure. On the other hand, the consistent use of mitigation devices in directives could have been prompted by the absence of standardised language for resuscitation dialogues (e.g. air traffic controller communication). Paramedics in this exploratory study might have mitigated their directives as part of professional communication, which includes maintaining good rapport with colleagues. It is also possible that the sense of urgency was less acute in simulated scenarios. Different findings may be found in real-life resuscitation attempts.

[13] *Just* in this statement is part of "just now", which means "right now" in Scottish English; therefore, it is not considered a mitigation device.

4.5.3 Verbalisation of plans and tasks

Team coordination is a crucial element for achieving mutual goals. In time-constrained, high pressure medical contexts like OHCA resuscitation, team coordination takes centre stage. Prior research showed that planning is a vital component of successful coordination.

It is not yet known how verbalisation of plans is performed in OHCA resuscitation dialogues. In this exploratory study, we examined planning-related utterances to see if these can illuminate the structure of plans and task priorities in the four resuscitation attempts.

Initially, the communicative function sub-category *Forward-course* was thought to be the main annotation category to capture verbalised plans, but upon further analysis, it was discovered that the thread category *Plan of action* encompassed plans more effectively. This is because *Forward-course* was only applicable when an utterance has been tagged with *Assert.* Hence, any plans verbalised using other communicative functions, for instance, *Action-directive,* would not be included. In contrast, the thread *Plan of action* includes any utterance with planning content, including the ones tagged with *Forward-course*. The examples given below in Table 39 illustrate this point. Following this, verbalisation of plans and tasks was investigated using the *Plan of action* thread.

Examples of plan-related utterances	Communicative function category	Thread category
20 seconds till next rhythm check	*Assert, Forward-course*	*Rhythm, Time, Plan of action*
We'll get him onto CO_2	*Action-directive*	*Medication, Plan of action*
Okay so I'm gonna tube	*Commit*	*Airway, Plan of action*
…get a stretcher ready	*Action-directive*	*Instrument, Plan of action*
…and you just bend the adrenaline before you do that	*Assert, Forward-course*	*Medication, Plan of action*

Table 39. Examples of planning verbalisation captured with the *Forward-course* sub-category and the *Plan of action* thread. Only two out of five utterances would be recognised as plan-related under the *Forward-course* sub-category.

The *Plan of action* thread was one of the most frequent threads during the four resuscitations, comprising 16.3% of SIM1 dialogues, 10.0% of SIM2, 19.9% of SIM3, and 27.5% of SIM4. Utterances tagged with *Plan of action* reflect the planning and organisation of tasks by the resuscitation team members. In contrast with *State-awareness* utterances, *Plan of action* utterances were normally verbally acknowledged. Consequently, sets or clusters of plans can be recognised, as illustrated in the following example (47) from SIM4 between a team member and a bystander (B). In these exchanges, the plan revolves around what the bystander could do to assist the paramedics. Note that the utterance numbers are not consecutive due to other unrelated utterances in between (not included in the example).

(47)

Utterance 43, B:	Can uh, can I do something for him?
Utterance 45, P1:	No,
Utterance 46, P1:	not at the moment if you just stand
Utterance 47, P1:	*(suggests B to fetch list of patient medicines)* You could go on right […] down for us
Utterance 50, B:	Okay

The next example from SIM1 showed exchanges between team members regarding their plan for leaving the scene and going to the hospital.

(48)

Utterance 166, 3RU:	And let's start thinking about execution
Utterance 167, 3RU:	So, once we've got a 12-lead and we'll let him settle just for a minute or two,
Utterance 168, 3RU:	and then we'll get him out
Utterance 169, 3RU:	So, do you want to go and arrange, uh, get a scoop,
Utterance 170, P2:	Yep
Utterance 171, 3RU:	get a stretcher ready
Utterance 172, P2:	Okay

These plan clusters may provide insights into a team's shared mental model, i.e. the organised understanding of relevant knowledge shared by team members, including in the planning of tasks. The patterns of these plan clusters appeared to be motivated by the resuscitation scenario. In SIM1, the patient had a shockable rhythm (ventricular fibrillation), whereas in SIM2, the patient had a non-shockable rhythm (Pulseless Electrical Activity). These were reflected in both the focus and the frequency of the verbalised plans. In SIM1, earlier plan clusters concerned the administrations of shock, rhythm checks, and time. In SIM2, the plans started with a medication/treatment-related thread. SIM2 plan verbalisations also revolved more frequently around chest compression because defibrillation or shock is not applicable in this scenario. The direction of *Plan of action* thread for both simulations revealed which ALS algorithm steps were being followed (refer to Figure

2, Section 3.8), with SIM1 planning following the path indicated for shockable rhythms and SIM2 planning following the path indicated for non-shockable rhythms. With the use of the mechanical compression device, SIM3 and SIM4 had additional plan clusters regarding movement of patient, team members, and the removal of patient's clothing in order to strap the AutoPulse onto the patient. For both simulations, the verbalisations of these plans constantly preceded the AutoPulse deployment.

A closer look at the *Plan of action* utterances showed the possibility of distinguishing the plans temporally. Some plans displayed a higher amount of immediacy, whilst others seemed to be projections of the near future. Consider the following:

(49)
We need to shock now (SIM3)
Continue to ventilate just now (SIM1)
Just carry on with the CPR (SIM4)

(50)
Next shock at four minutes (SIM3)
When it stops again do a quick rhythm check (SIM3)
I'm swapping with you next up (SIM2)

(51)
We'll start thinking about post-op checks guys (SIM1)
So, once we've got a 12-lead, and we'll let him settle for just a minute or two (SIM1)
So, if that's failed, if that's failed, we got an IO (SIM4)

The plans in (49) appeared to be plans that needed to be performed right away or continued as they were. In (50), the plans were less immediate, seemingly for the near future or to be performed after a specific task has been completed. Finally, in (51), the plans sounded less immediate, referring further onward into the future, and more like an overall orientation for the team.

Whether this difference affects any outcome is yet to be studied. It is also possible that there are finer distinctions that shape planning utterances, for instance the complexity and the level of importance of the task that needs to be done.

4.5.4 Identifying communication strategies: Closed-loop communication

Team communication errors have often been associated with adverse outcomes. A communication strategy called closed-loop communication (CLC) has been observed to be consistently present in effective military teams and has, since then, been widely recommended for use in medical teams (Andersen et al., 2010a; Fernandez Castelao et al., 2013). Given its reported effectiveness, we expect to find frequent CLC exchanges in the current resuscitation dialogue teams, especially as the 3RU paramedics have been trained to apply this communication strategy.

A fully-formed standard CLC requires three distinct verbal stages – a call-out, a checkback, and a closing of the loop. Each stage has a salient role. This is where line-by-line dialogue annotation can be useful, as it allows the identification of each utterance's communicative function(s) and thread(s).

To identify the presence of standard CLC exchanges, two attributes need to be fulfilled. The first is the similarity of the type of thread in all three utterances. Given that a CLC exchange concerns the same subject matter, the utterances involved need to be in the same thread cluster, as illustrated in example (52). Note that for examples (52) and (53) only the thread annotations are shown:

(52)

Speaker: *(call-out)*	Do a rhythm check now	*Rhythm; Plan of Action*
Hearer : *(checkback)*	Will do rhythm check now	*Rhythm; Plan of Action*
Speaker: *(closing loop)*	Thanks[14]	*Rhythm; Plan of Action*

Should the hearer respond with a different subject-matter, the thread will be broken, and the exchange is not considered as a CLC exchange, as illustrated in the following:

(53)

Speaker: *(call-out)*	Do a rhythm check now	*Rhythm; Plan of Action*
Hearer : *(-)*	You need to take over compression	*Compression; Plan of Action*
Speaker: *(-)*	Okay	*Compression; Plan of Action*

[14] "Thanks" on its own does not convey any indication of any thread, but this utterance is a response to the previous utterance. Thread annotation perceives responses like "Thanks", "Okay" etc. as part of the same cluster of the utterance it responds to (see Section 3.9 for more details).

In the case of (53), it becomes a renegotiation of plans rather than an instance of CLC.

The second attribute is the type of communicative function that can serve the purpose of a CLC exchange. A call-out is normally an instruction (*Action-directive*) or an assertion (*Assert*), although it could also be a commitment (*Commit*). A checkback is typically described as a repeat or a rephrase of the call-out (*Repeat-rephrase*), and the closing of the loop is an acknowledgment from the original speaker that the hearer has understood the message as conveyed (mostly *Acknowledge,* but also *Accept* or *Performative*). Following these rules, one example of the communicative functions in a standard CLC would be as shown in (32). It should also be noted that, in this example, the hearer could have simply closed with an *Acknowledge* or an *Affective-performative* and still close the loop. Using either or both to close the loop would still count as one instance of completed CLC even though "Okay" and "thanks" are classified as two separate utterances.

For examples (54) to (56), only the communicative tags are shown.

(54)

Speaker: *(call-out)*	Do a rhythm check now	*Action-Directive*
Hearer : *(checkback)*	Will do rhythm check now	*Repeat-rephrase*
Speaker: *(closing loop)*	Okay,	*Acknowledge*
Speaker: *(closing loop)*	thanks	*Performative*

Other possible combinations of communicative functions may also occur, although these may result in weaker derivatives of CLC (i.e. not repeating or rephrasing the original message). These are demonstrated by the following samples of exchanges:

(55)

Speaker: *(call-out)*	Do a rhythm check now	*Action-Directive*
Hearer : *(checkback)*	Okay	*Accept*
Speaker: *(closing loop)*	Thanks	*Performative*

(56)

Speaker: *(call-out)*	Do a rhythm check now	*Action-Directive*
Hearer : *(checkback)*	Okay	*Accept*
Speaker: *(closing loop)*	Okay	*Acknowledge*

Using the two aforementioned attributes as guidelines, the four simulation dialogues were examined for the presence of standard CLC exchanges. Out of the total number of 338 *Assert,* 159 *Action-directive,* and 58 *Commit* utterances from the four simulations, only two exchanges fulfilled the criteria, one (57) from SIM1 and one (58) from SIM3, as follows:

(57)

P1:	Yeah, I've got one here	*Assert*	*Instrument*
3RU:	You've got one there	*Repeat-rephrase*	*Instrument*
P1:	Yeah	*Acknowledge*	*Instrument*

(58)

3RU:	Ready for next shock	*Action-directive*	*Shock*
P2:	Next shock, at four minutes	*Repeat-rephrase, Assert*	*Shock*
3RU:	Okay	*Accept*	*Shock*

Further examination of the data revealed that closed-ended exchanges – where a directive and/or a statement is responded to by the hearer, but with no acknowledgment from the speaker afterwards – were more common. Exchanges (59) and (60) are from SIM1, (61) and (62) from SIM2, (63) and (64) from SIM3, and (65) and (66) from SIM4:

(59)

3RU:	You've got to shock him at 30 second alright	*Action-directive*	*Shock, Plan of action*
P2:	Yeah	*Accept*	*Shock, Plan of action*

(60)

3RU:	Another rhythm check, guys	*Action-directive*	*Rhythm*
P2:	Will do	*Accept*	*Rhythm*

(61)

P2:	That's adrenaline on	*Assert*	*Medication*
P2:	Yeah	*Acknowledge*	*Medication*

(62)

P1:	I'll be I'll swap up next	*Commit*	*Compression, Plan of action*
3RU:	Alright,	*Accept*	*Compression, Plan of action*
3RU:	cheers	*Affective-performatives*	*Compression, Plan of action*

(63)

3RU:	We need to shock now	*Action-directive*	*Shock, Plan of action*
P2:	Yep	*Accept*	*Shock, Plan of action*

(64)

3RU:	Let's look at the 4Hs and 4Ts	*Action-directive*	*Reversible causes, Plan of action*
P2:	Yep	*Accept*	*Reversible causes, Plan of action*

(65)

3RU:	Okay, so, I'm gonna tube him	*Commit*	*Airway, Plan of action*
P2:	Okay	*Accept*	*Airway, Plan of action*

(66)

3RU:	So, if you could set up the intubation equipment	*Action-directive*	*Instrument, Plan of action*
P2:	Okay	*Accept*	*Instrument, Plan of action*

Arguably, simply accepting or acknowledging an utterance without repeating the original message is not a foolproof strategy to ensure accurate receipt of message. However, this does close a dialogue, albeit in a way that does not conform to the classic CLC three-turn standards. As CLC is highly recommended in the medical communication literature and formed part of the non-technical skills training that the paramedics in this study went through, the finding that it occurred rarely raises the question of its usefulness in resuscitation dialogues. The present data, however, merely captures the natural occurrence of the strategy during simulated resuscitation attempts. At this juncture of the study, there is no evidence for the effectiveness or non-effectiveness of the classic CLC – we can merely observe that it was not frequently used in practice. If the four simulations analysed in this exploratory study reflect actual resuscitation dialogues, this may mean that few standard CLC occurrences will be found in real-life settings as well.

4.5.5 Verbal affective behaviours during simulated resuscitation dialogues

Another element that has been continuously explored in inter-medical interactions is verbal affective behaviours, used to build rapport between the speaker and the hearer. In the sociolinguistics domain, these are identified as part of positive politeness – the attempt to address a hearer's positive face[15], i.e. the hearer's wants and interests – by being friendly, using humour, showing agreement with the hearer, etc. (Brown & Levinson, 1987). In the present study, these are viewed as part of verbal affective behaviours, in accordance with previous medical communication research that have investigated similar constructs. The functions of these verbal behaviours, nonetheless, are the same.

In examining verbal affective behaviours, researchers have utilised the Roter Interaction Analysis System (RIAS), lending evidence to the usefulness of dialogue annotation schemes in investigating dialogue data (e.g. Cavaco & Roter, 2010; Cené et al., 2017; Gemmiti et al., 2017; Lipkin & Roter, 1997; Vail et al., 2011). These kinds of studies have shown that the use of affective behaviours such as positive talk (e.g. jokes), negative talk (e.g. criticisms, disapprovals), agreements, social talk (i.e. non-medical chats), and emotional talk (e.g. compliments, reassurance, empathy) can be associated with patient satisfaction and stress levels.

Verbal affective behaviours are rarely, if ever, investigated in medical team communication. It is unknown whether the dialogues between medical team members, specifically paramedic teams, contain verbal affective behaviours, and if this function is associated with any team variable or procedural outcome. The lack of research pertaining to this communicative function means that findings in the present study can only be compared with results from previous physician-patient studies.

[15] Positive face: The theory that posits that an individual needs her/his wishes to be appreciated in social context (in opposite of negative face, i.e. an individual's need for freedom of action and freedom from imposition).

To investigate the verbal affective behaviours in the present OHCA simulated resuscitation dialogues, data is extracted from three communicative functions, namely *Affective performatives*, *Commiserate*, and *Conventional-open-close*, and one thread, namely *Social agenda setting*. *Affective performatives* contain functions such as compliments, apologies, and thanking; *Commiserate* covers utterances that convey empathy; *Conventional-open-close* are ritualistic greetings and leave-taking; and *Social agenda setting* includes utterances such as self-introduction. Due to the absence of negative talk in the present dataset and the emphasised importance of positive verbal affective behaviours in general (Gemmiti et al., 2017), negative talk is excluded in this analysis.

As the *Conventional-open-close* and *Social agenda setting* tags sometimes overlap (the former is used to annotate the utterance function and the latter is used to annotate the subject matter), utterances with these two tags are categorised under either one of the two categories. For instance, the utterance in (67) from SIM3 is tagged with both:

(67)

		Communicative function	Thread
Utterance 1, P1:	Hello	*Conventional-open-close*	*Social agenda setting*

Utterances like (67) were directly placed under the communicative function, leaving utterances such as (68), also from SIM3, to be placed under *Social agenda setting*. This decision was made because the *Social agenda setting* thread covers a slightly wider area compared to the *Conventional-open-close* category.

(68)

		Communicative function	Thread
Utterance 101, P1:	This is Ian here	*Assert*	*Social agenda setting*

Previous studies on physician-patient dialogues showed that verbal affective behaviours can be quite frequent, ranging from a mean of 24 utterances per session (Wissow et al., 1994) to approximately 40 utterances per session (Roter, Hall, Blanch-Hartigan, Larson, & Frankel, 2011). In contrast, the present findings revealed that in simulated OHCA resuscitation dialogues, the frequencies are far lower, as shown in Table 40:

	Overall frequency	Mean	Range	% out of 988 utterances
Affective performatives	19	4.8	3 – 8	1.9
Commiserate	10	2.5	0 – 5	1.0
Conventional-open-close	24	6.0	4 – 8	2.4
Social agenda setting	9	2.3	0 – 4	0.9

Table 40. Frequency, mean, range, and percentage of the four categories related to verbal affective behaviours in the four simulations

Overall, the utterances from the four categories made up 6.2% of the total 988 utterances from the four simulations. The means for all four categories total 15.6, which is lower than previous findings from dyadic inter-medical dialogues. The lower prevalence in the current analysis may be a result of not including agreements as part of the verbal affective behaviours. Should agreements be included in the analysis (n = 62), the overall percentage rises to 12.5%, with an overall mean of 31.1, which is closer to prior findings from inter-medical communication research.

Nonetheless, the current study does not include agreement utterances as part of affective behaviour. This marks a difference between how verbal affective behaviours are categorised in RIAS compared to the dialogue annotation system used in the present study, Dialogue Annotation for Resuscitation (DARe). In DARe, utterances that are tagged as agreement are categorised under Backward Communicative Function and defined along a continuum of acceptance-rejection (of previous utterance) rather than suggesting exclusive support (of previous utterance). In other words, whilst agreement can indeed signal positive politeness in the sense of emotionally supporting a speaker's belief, this is not necessarily the case in our data as agreement can simply mean verbal acceptance of an instruction, as illustrated in previous examples (59), (60), (63), (64), and (66). Following this, utterances tagged as agreements in our data are not considered to be part of socioemotional communication or verbal affective behaviour. Thus, the findings on verbal affective behaviours in the current dialogues of simulated OHCA resuscitation attempts are comparatively quite low.

The current data is too limited to provide satisfactory reasons behind the difference in frequency of usage, although the lower frequency in the present findings could perhaps be attributed to the nature of intra-medical communication, i.e. communication between medical experts, compared to inter-medical communication, i.e. communication between lay people and medical experts. In the latter, especially during patient consultation or when breaking bad news to patients, physicians may be more likely to apply positive verbal affective behaviours such as expressing concern. In contrast, during a time-constrained medical procedure like OHCA resuscitation, with the exception of comforting a bystander, team members may not feel the need to verbalise empathy towards one another. Another possible reason is that a simulated setting does not trigger the same emotional responses as an actual setting, hence resulting in fewer affective utterances. The verbal affective behaviours in real-life OHCA dialogues will be analysed and discussed in Chapter 5.

4.6 Summary of the preliminary study

Using the dialogue annotation scheme, four simulated resuscitation attempts were analysed. The resuscitation transcripts contained 184 utterances for SIM1, 289 utterances for SIM2, 311 utterances from SIM3, and 204 utterances for SIM4. Each utterance was annotated with communicative function and semantic content. From these annotations, the different forms and frequencies of each category were determined.

The main findings were that the types of communicative function differed in one particular aspect – that is, the high frequency of directives that were present in the simulated OHCA resuscitation attempts compared to prior findings from studies on medical communication. Utterances concerning commitment were also more frequent compared to previous findings, although this was only true for SIM1 and SIM2. These findings suggest that the OHCA resuscitation communication pattern is distinctive. Additionally, we observed verbal vestiges of the Scottish English context in the dialogues in the use of terms like *wee*, *just now*, and *aye*, amongst others.

Results from the thread annotations revealed that the order of introduction of threads varied from scenario to scenario. This, as well as variations in the frequency of use and the distribution, are very likely influenced by inherent factors of each resuscitation scene: for instance, the presence of a bystander, the type of rhythm, and the use (or non-use) of mechanical compression device. Despite the differences, in general, we could see that five threads, namely *Plan of action*, *Patient history*, *Instrument*, *Compression*, and *Rhythm,* were actively used by all four teams. The order of thread verbalisation showed similarities in respect of the early appearance of the *Compression* thread and later appearances of the

Resolution and *Reversible causes* threads in the dialogues, possibly reflecting the priorities of the subject matter.

The distribution results from this exploratory study were then utilised to explore five areas associated with OHCA resuscitation communication. The first area examines how paramedics align themselves during the resuscitation procedure. As part of situational awareness, alignment is considered a crucial element for effective teamwork. We discovered that the *State-awareness* sub-category marks utterances that help paramedics be aware of ongoing tasks around them. The second area of research is to investigate the use of mitigation when paramedics issue directives during the procedure. Early findings showed a preference for direct instructions, especially to fellow team members, although mitigation devices were present in directives. The third area investigates the ways plans were verbalised during OHCA resuscitation. Even though the data from the pilot study is limited, analysis of utterances tagged with the *Plan of Action* thread suggested that plans could be identified based on their temporal characteristics and perhaps complexity.

As a fourth research area, the annotations were applied to identify the use of standard closed-loop communication or CLC during OHCA resuscitation. The way categories are distinguished in DARe has been useful in disclosing that there were few instances of CLC during the simulated OHCA resuscitations, and in identifying other verbal communication strategies during the procedure. The fifth and final area explores the use of verbal affective behaviours during simulated resuscitations. The preliminary results indicated that there were fewer instances of verbal affective behaviours in simulated resuscitation dialogues compared to previous findings from physician-patient dialogues.

In summary, the preliminary findings revealed that dialogue annotation is useful in understanding resuscitation dialogues. The application of this approach allows dialogues to be assessed in a more detailed manner, producing results to help understand verbal team communication that takes place in a high-risk, time-constrained medical setting.

5

Findings from real-life resuscitation attempts: The early minutes

Introduction

Not much is known about dialogue patterns during resuscitation and how these may affect outcomes or be influenced by variables like team leaders' performance. For actual pre-hospital resuscitations, the gaps in knowledge are even wider. The current work attempts to address a set of open questions by examining communication patterns in paramedic dialogue during out-of-hospital cardiac arrest (OHCA) resuscitation, using dialogue annotation. The dialogues are annotated using the **D**ialogue **A**nnotation for **Re**suscitation (DARe) coding system (described in Chapter 3). This chapter presents an analysis of 40 real-life OHCA resuscitation attempts, focusing on how communication takes shape in the early minutes of the procedure. Through annotations of the interactions, we establish the frequency of different linguistic functions as well as the semantic contents of utterances. The annotation results allow five explicit themes to be explored, namely verbal alignment in situation awareness; mitigated language use in directives; verbalisation of planning and task organisation; automatic use of trained communication strategies such as standard closed-loop communication (CLC); and verbal affective behaviours. Additionally, we investigate possible correlations with two different variables: the time that a team takes to deploy the mechanical chest compression device (AutoPulse), and the performance (technical skills and non-technical skills scores) of the team leader.

The results are discussed in terms of the distributions of the dialogues' linguistic functions and semantic content (called *communicative functions* and *threads* respectively). Where possible, we compare the results from the real-life dialogue analyses with results from simulation dialogue analyses presented in Chapter 4 and prior work on medical communication. Of note is the finding that the real-life resuscitation dialogues contained a few different communicative functions absent from the simulated resuscitation dialogues. Consequently, two new Forward Communicative Functions were added into DARe. Thread categories, meanwhile, remained the same.

Overall, the communicative functions in real-life resuscitation dialogues showed comparable patterns to other findings on medical team dialogues – high prevalence of assertions and directives and very few rejections – but differed from non-team dialogues in terms of the lower prevalence of questions. Thread distribution remained similar for some, e.g. *Plan of action*, but varied for others, e.g. *Movement involving patient,* indicating that threads are sensitive to variables present during the resuscitation attempt. Chief amongst the findings concerning the five themes are: Team members' verbal alignment can be assessed in the form of their *State-awareness* utterances; three-quarters of directives during resuscitation attempts were mitigated; plans were verbalised slightly differently in teams led by highly-rated leaders and lower-rated leaders; team members employed different strategies to close communication loops during resuscitation rather than standard CLC; and teams led by highly-rated leaders tended to use higher frequencies of verbal affective behaviours. The investigation on possible correlations revealed that the time taken to deploy the AutoPulse was associated with two communicative functions and four threads, and that team leaders' rated performance was associated with the resuscitation teams' dialogue patterns.

5.1 Background and predictions

Analysis of medical communication using line-by-line dialogue annotation has been used in studies on inter-medical communication, most notably on physician-patient interaction, but rarely utilised in intra-medical communication, i.e. amongst team members during medical procedures. When medical team communication is assessed, it is often treated as part of the non-technical skills compendium, or subsumed under various non-technical skills elements, such as leadership, team collaboration, and decision making. By focusing on verbal communication data, one can gain in-depth qualitative insights into how medical procedures unfurl, how tasks are planned, and how content is conveyed, amongst other things.

Communication patterns derived from these would allow deeper understanding of the roles of various linguistic features that aid or hinder team communication.

The present research intends to analyse verbal communication during a high-risk, time-constrained context, namely OHCA resuscitation dialogues. These resuscitation dialogues are of special interest due to the presence of the 3RU paramedics (see Section 4.1 for more details). The present study focuses on studying the patterns of communication by resuscitation teams when these 3RU paramedics are in attendance, with the aim of extracting useful linguistic patterns that can assist in optimising OHCA communication. No study has been conducted so far on the communication patterns of resuscitation teams led by 3RU paramedics.

The results from the simulation videos form a preliminary basis of investigation for the analysis of a larger dataset containing 40 real-life OHCA resuscitation attempts. The results from both the simulation data and the real-life data are compared to determine potential differences between the resuscitation dialogues during a simulated setting and resuscitation dialogues in a real-life setting. Given prior work showing consistent parallels between high-fidelity simulation and real-life settings (Hunziker et al., 2010b), it is possible that both contain similar communicative functions and/or thread patterns.

As with the simulated resuscitation analysis, the analyses for the real-life resuscitation dialogues attempt to answer six questions, as follows:

1. What are the types and distributions of communicative functions and subject matter (threads) in paramedic team dialogues during real-life OHCA resuscitation?
2. How is situation awareness, in terms of aligning team members' current state, verbalised during resuscitation?
3. What are the forms of mitigated language used by team members when giving directives, if there are any?
4. How are plans shared and verbalised during the procedure?
5. What types of trained communicative strategies are applied during real-life resuscitation?

6. How much of the resuscitation dialogues is dedicated to socioemotional/affective behaviours and in what way?

If the findings from the real-life setting reflect the findings from the simulated setting, we would expect to find *Assert*, *Action-directive*, and either *Info-request* or *Commit* (or both) as the most frequent FCF categories, and *Accept*, *Acknowledge*, and *Answer* as the most frequent BCF categories. The largest FCF sub-categories would be *State-awareness*, *Direct/Instruct*, and *Closed-question* for *Assert*, *Action-directive*, and *Info-request* respectively. Thread types and frequencies have been found to vary in the simulation findings, most likely affected by specific resuscitation scenarios, but the five most frequently observed threads, i.e. *Plan of action*, *Patient history*, *Instrument/Equipment*, *Compression*, and *Rhythm*, could still be the most prevalent threads in the real-life setting. However, because all real-life resuscitation attempts in this study (except one) utilised the mechanical chest compression device (AutoPulse)[16], we predicted more frequent movement-related threads. This is motivated by the simulation results, where higher distributions of *Movement involving patient* and *Movement other than patient* threads were observed in the two simulations with AutoPulse use.

Real-life resuscitation scenarios in the present study differ from the simulation setting in respect of greater use of the mechanical chest compression device (AutoPulse), which is expected to reduce the frequency of out-loud compression counts. This in turn would lower the frequency of *State-awareness* utterances, as compression counts belong to this category. We might also find fewer mitigated instructions and more frequent direct instructions than in the simulation dialogues, due to the greater sense of urgency prevailing in in the real-life setting. However, if the simulations are reliable in other respects, we would expect real-life dialogues to replicate their key features: a high prevalence of verbalised plans that can be clustered temporally; few fully-formed closed-loop communication exchanges but more frequent occurrences of closed-ended dialogue exchanges; and low prevalence of verbal affective behaviours compared to inter-medical communication settings.

[16] AutoPulse is carried by 3RU paramedics only

For the real-life resuscitation dialogues, the study also attempts to investigate the communicative function and thread association with two specific variables; one representing the resuscitation progress in terms of the time taken for a team to deploy the AutoPulse, and another representing an individual's performance evaluation (the team leader's technical and non-technical skills). The aim is to answer the following question:

7. Are there any associations between the frequency patterns of communicative functions and threads with either the timing of AutoPulse deployment or the team leader's technical and non-technical skills scores?

AutoPulse deployment requires team collaboration. As soon as a 3RU decides to put a patient on the AutoPulse, a series of tasks are set in motion: first, the 3RU has to verbalise the plan to the team; second, team members need to move into position to move the patient (either to a better space or into a position to strap the device on); third, the team needs to fit the device around the patient; and finally, the 3RU needs to assess whether the device works as intended.

In OHCA resuscitation with a 3RU paramedic in attendance, the 3RU training emphasises deploying the AutoPulse in the first five minutes after arrival, as can be seen in the Perfect 10 guideline (Figure 10, Section 5.2). Since this clearly requires team organisation, it is possible that teams with more efficient organisation would be able to accomplish this task more quickly. Whether this is reflected at all in the teams' verbal directives or plans is not known, although teams with quicker deployment might show distinct planning patterns compared to teams with slower deployment. However, it should be noted that there are other variables that could affect the timing. One team might have to perform resuscitation in a tight space while another does so in on an open field. It would naturally take longer for the team in the tight space to organise movement of both the patient and the team members when trying to deploy the device.

The second variable that we look at, the 3RU's technical and non-technical skills scores, reflects the 3RU's performance during the resuscitation attempt as the team leader. Marsch et al. (2004) determined that successful resuscitation team leaders verbally clarified and explicitly distributed tasks within the first five minutes of the procedure. Similarly, Wik et al.

(2005) found that the overall quality of resuscitation can be predicted from the first five minutes – can the same amount of time capture distinct patterns of communicative function and/or threads? This study predicts that there may be certain functions that are used more frequently, or less frequently, by team leaders, which may correspond to their technical and/or non-technical skills scores, and that these differences may be sufficiently observable in the first five minutes after the 3RU paramedic's arrival on scene. Nevertheless, the 3RU paramedics in this study are all highly-trained individuals, hence their capabilities may be close to ceiling, making it difficult to measure variations.

5.2 Methods

Video data

Each video was captured using a body camera (VB-200 VideoBadge® from Edesix) worn by a paramedic from the Resuscitation Rapid Response Unit (3RU). The body camera recorded both video and audio of the resuscitation procedure. Typically, the 3RU paramedic would turn on the body camera on their way to the scene and turn it off when the patient has been transferred to the hospital. All footage was stored securely, reviewed, and subsequently deleted according to a pre-set deletion policy. The videos are routinely used for audit purposes, to identify priorities for training and system improvement.

The overall duration of the real-life OHCA resuscitation videos was longer than the simulated resuscitation videos (mean duration = 41 minutes 46 seconds). The number of speakers also varied considerably (mode = 5; min = 3; mean = 4.4). In addition, the scenarios differed in terms of the setting (indoor versus outdoor), witnessed versus unwitnessed arrest, and the type of rhythm (shockable versus non-shockable). Most videos started during the journey to the scene (n = 38), but a couple (n = 2) started when the 3RU paramedic reached the scene. Most of the time, the real-life resuscitation started much like the simulation episodes, where the 3RU paramedics arrived after the Scottish Ambulance Service (SAS) paramedics, but in nine out of the 40 scenarios, the 3RU paramedic was first on the scene.

The focus for the real-life videos is therefore on the first five minutes of resuscitation rather than on the whole resuscitation attempt. This decision is supported by several considerations. First, previous research suggests that the first five minutes of resuscitation are crucial in determining the overall quality of the procedure (Hunt et al., 2008; Wik et al., 2005), indicating that the structure during the early minutes is worth concentrating on. Other studies have additionally shown that a short duration of dialogue analysis is sufficiently reliable to analyse the dialogue patterns in a medical scenario (Roter et al., 2011). Second, the first five minutes should be sufficient to assess whether the task of deploying the AutoPulse has been successfully completed. This is based on the Perfect 10 algorithm, a local advanced life support protocol based on the UK Resuscitation guidelines, developed by the Resuscitation Research Group for 3RU training (refer to Figure 10 in Section 5.2). The Perfect 10 algorithm protocolises additional actions and tasks alongside the Advanced Life Support (ALS) practice. Additionally, it should be noted that real-life OHCA resuscitations' start and end points vary considerably. Some cases were recorded from the moment the 3RU left for the scene and some only when the 3RU arrived at the scene. Others continued until the patient handover at the hospital whereas some stopped when the patient was being conveyed in the ambulance.

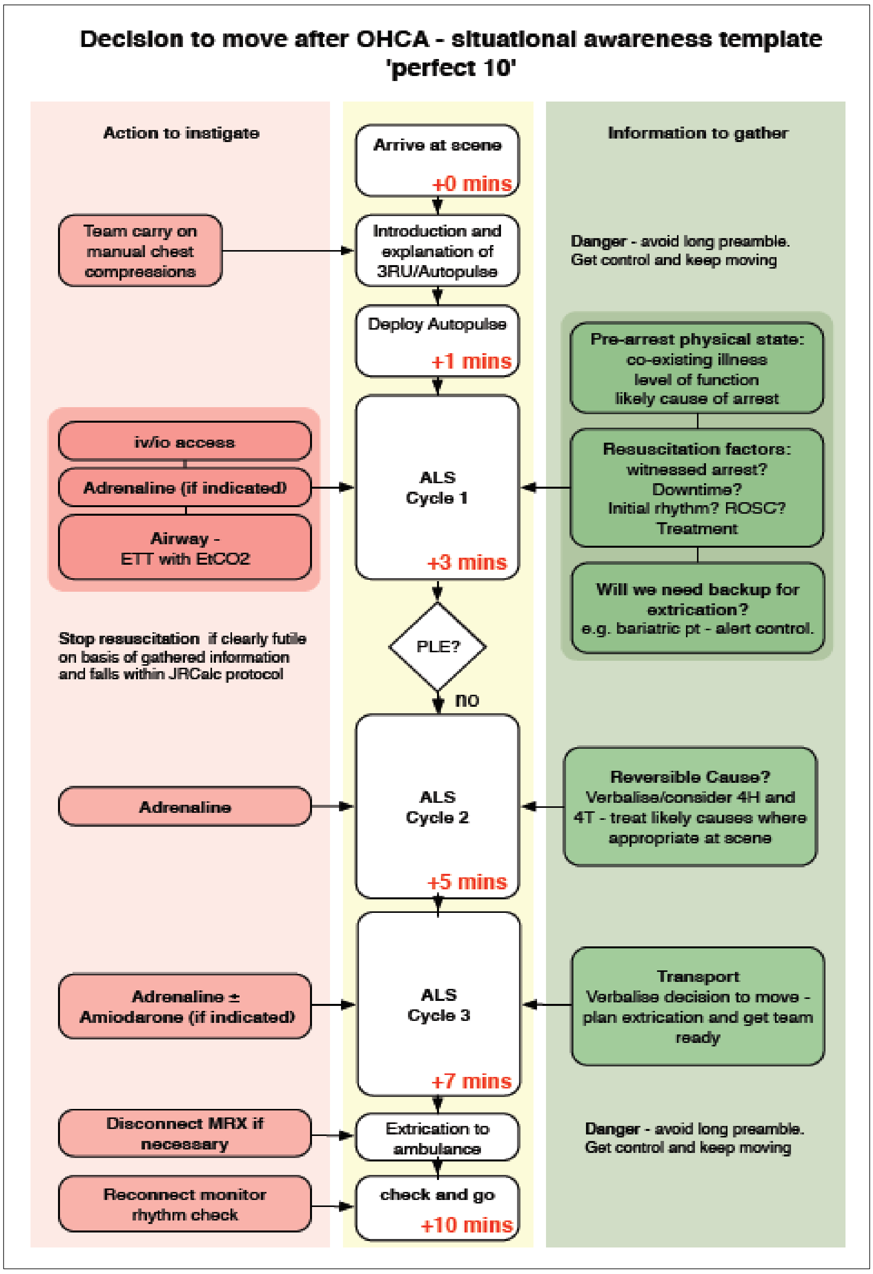

Figure 10. The Perfect 10 guideline used for 3RU training

The five minutes in this study starts from Utterance Zero, defined as the first utterance by the team leader (the 3RU paramedic) to any of the team members, either as a Forward Communicative Function (i.e. starting a dialogue with the team, for example by greeting a team member) or a Backward Communicative Function (i.e. responding to a previous utterance by a team member, for example by verbally acknowledging a greeting). The transcription of the dialogues ideally ends on the fifth minute (05:00). Whenever this falls in the middle of an utterance, the transcription continues until the utterance is fully completed.

Table 41 lists the details of the 40 real-life videos, including each team leader's technical (TS) and non-technical skills (NTS) scores. The scores were obtained from a previous assessment conducted by a team of resuscitation experts from the Royal Infirmary of Edinburgh, including a Resuscitation Officer and an Emergency Medicine Consultant. The scores were allocated based on a rating tool that was designed for scoring paramedic resuscitation performance. The TS scoring sheet is developed to comply with the ALS protocol. The NTS scoring sheet is developed based on the Anaesthesiologists' Non-technical Skills (NTS) framework, which has been validated for evaluating the non-technical skills of anaesthesiologists. To score resuscitation, the same NTS dimensions (described in Chapter 2) were retained, but the exemplars were changed to reflect the domain. The scores range from 0 (lowest, non-existent) to 4 (highest).

Vid. No.	Total video duration	Total length of transcription (minutes)	Total utterances transcribed	No. of audible speakers	3RU first on scene?	TS score	NTS score	Time zero*	AutoPulse start time
158	0:53:53	05:08	168	5	Yes	3	4	15:51	18:21
171	0:41:30	05:00	113	6	No	3	2	02:51	05:39
182	0:39:33	05:06	99	4	No	2	2	07:40	10:34
188	1:05:26	05:00	78	4	Yes	2	3	06:59	11:40
193	0:34:42	05:02	173	5	No	4	4	04:51	08:12
197	0:42:35	05:01	70	3	No	4	4	08:33	10:25
198	0:42:31	05:00	141	5	No	4	3	07:19	10:15
199	0:35:57	05:03	126	5	Yes	3	4	02:24	04:18
200	0:45:55	05:07	176	5	Yes	1	2	02:25	09:40
212	0:28:25	05:01	100	5	No	4	4	00:13	03:48
217	0:27:48	05:04	143	5	No	3	2	01:06	02:47
219	0:32:32	05:10	126	4	Yes	3	3	00:40	02:23
223	0:45:01	05:05	158	5	No	4	4	26:25	30:06
227	0:45:17	05:00	88	4	No	3	3	11:33	13:31
237	0:34:10	05:06	138	4	No	2	3	04:45	06:24
244	1:00:01	05:03	151	5	No	4	4	11:52	25:14
251	0:58:14	05:10	123	4	No	4	3	02:24	04:04
263	0:34:57	05:02	138	5	No	2.5	3	00:00	02:00
271	0:31:15	05:03	114	4	No	2.5	3.5	05:23	11:58
280	0:58:51	05:00	106	4	No	3	3	02:44	06:17
289	0:54:21	05:08	118	4	No	4	3	03:03	04:38
290	0:12:04	05:04	146	4	No	1.5	3	00:02	01:36
293	0:37:52	05:02	204	4	No	4	4	11:06	**NA
294	0:41:28	05:06	170	5	Yes	4	4	06:42	09:17
300	0:20:24	05:04	144	5	No	4	4	03:21	05:36
302	0:55:31	05:01	104	4	No	3	4	04:37	08:05
307	0:29:49	05:00	104	3	No	3	3	03:30	06:14
310	0:28:46	05:05	84	6	Yes	3.5	3	04:49	05:26

317	1:10:52	05:03	178	4	No	3	4	16:12	21:04
336	0:46:37	05:07	120	5	No	3	3.5	04:59	07:27
361	0:35:49	05:04	176	4	No	2.5	4	01:03	08:01
371	0:40:07	05:06	118	4	No	2.5	3.5	00:00	02:02
410	0:32:53	05:07	130	4	No	3	4	03:05	05:46
411	0:40:13	05:09	141	5	No	4	4	02:37	06:24
412	0:57:08	05:03	148	3	No	4	4	01:36	05:34
414	1:00:41	05:01	188	6	Yes	2	3.5	06:56	11:07
417	1:02:02	05:00	175	4	No	4	4	16:16	20:27
418	0:26:02	05:00	98	5	Yes	4	4	05:17	09:33
420	0:33:16	05:07	123	5	No	2.5	3	01:39	06:47
424	0:32:40	05:03	167	5	No	4	4	01:49	05:27

Table 41. Details of the 40 real-life OHCA resuscitation videos

**Time zero is the actual start time of the first utterance, as displayed in the video*

***The resuscitation team in Video 293 did not deploy the AutoPulse. This decision was made on the basis of patient size (see the National Institute of Healthcare and Excellence [NICE] website for published size guidance for AutoPulse) and available space for AutoPulse placement. When the 3RU paramedic arrived, the patient was already on a trolley in the ambulance*

The total number of utterances for each video listed in Table 41 include utterances made by and/or directed to bystanders. These bystander exchanges are included in the frequency distributions as they formed parts of the overall dialogues, but excluded from the in-depth analyses for *Assert*, *Action-directive*, and *Info-request* functions. More than half of the dialogues contain bystander – team member exchanges (n = 25).

Ethics approval

The project is covered under the same ethics approval as the Resuscitation Rapid Response Unit (3RU) study. Because the videos were real-life recordings of OHCA resuscitation cases which involved real patients, they were treated with high confidentiality. We therefore sought advice from the South East Scotland Research Ethics Service on whether the project required further National Health Service (NHS) ethical review. Data transcription of the real-life scenarios started once the board confirmed that the project did not need further NHS ethical review. The letter, dated 2 February 2017, is appended as Appendix B.

The project received approval on 22 March 2017 from the linguistics ethics team, School of Philosophy, Psychology, and Language Sciences, under the running title "Language in action: A study of what makes effective communication in pre-hospital resuscitation teams". Part of the approval stipulated that sufficient support would be given to protect the researcher, especially psychologically, when viewing the videos as sensitive materials may be encountered. It was agreed that the researcher should be able to review the videos in a safe environment to enable needed support. The video viewing was arranged on a secure platform in a secure room at the Royal Infirmary of Edinburgh. Other people who provided support were experts who have medical training and permission to watch the videos.

The dialogue annotation scheme

The annotation of dialogues was performed using the Dialogue Analysis for Resuscitation (DARe) coding scheme. Two new categories were added to DARe after iterative analysis of the real-life resuscitation dialogues, namely *Alerter* and *Other-assert-social* (a sub-category of *Assert*). These two communicative functions will be discussed in Section 5.3. The addition of these new categories raised DARe's main communicative function coding categories to 23 (from 22) and *Assert*'s sub-categories to eight (from seven). The coding categories in DARe's semantic content or thread section remained at 21 (see Appendix C for the resulting DARe coding scheme). Following the previous practice of the Dialogue Act Markup for Several Layers (DAMSL) coding, an utterance that performs more than one function can be annotated with more than one type of communicative function.

Transcription and annotation

Since one of the aims of the study is to examine possible correlations between linguistic actions and performance scores, videos were selected that had been scored for both their technical and non-technical skills performance. This narrowed the dataset to 40 videos. Each video was redacted, i.e. visually darkened and pixelated to avoid recognition, but leaving the audio intact. The videos were only available on the Edesix platform, which was only accessible from a secure computer in a secure room located at the Royal Infirmary of Edinburgh.

All videos were transcribed by the researcher and the transcriptions reviewed by a medical expert familiar with the resuscitation videos. The transcriptions were annotated by the researcher using the DARe coding scheme. Details of the annotation process are given in Section 3.9.

Reliability

It can be difficult to gain very high inter-annotator reliability scores for dialogue annotations, although acceptable levels have been achieved in previous studies. The Coordination and

Communication System (CACS) coding scheme reliability scores, based on Holsti's method, varied based on the tested functions, but overall ranged from .68 to .87 (McNeilis, 2001). The Dialogue Act Markup for Several Layers (DAMSL) coding scheme showed Cohen's kappa 0.6 (Core & Allen, 1997), which indicates mostly reliable inter-annotation. The Roter Interaction Analysis System (RIAS) meanwhile showed inter-annotator correlations (Spearman's r) ranging from .74 to .84 (Wissow et al., 1998). The present study calculates inter-annotator reliability using Cohen's kappa. Percentage rate agreements were also given following the suggestion by McHugh (2012).

Prior to the annotation exercise, the annotators received instructions and samples of DARe coding to familiarise themselves with the coding categories. Inter-annotation for the communicative function component was performed by an applied linguist who is a native speaker of English. Four complete transcriptions, representing 10% of the total real-life data, were chosen randomly to be annotated. Results showed percentage rate agreement of 75% and Cohen's kappa of .68, indicating moderately substantial agreement (McHugh, 2012).

The thread component was annotated by a senior trainer from the Scottish Ambulance Service OHCA clinical directorate. The senior trainer, a native speaker of English, was primarily responsible for the training of paramedics and was therefore very familiar with pre-hospital resuscitation. Four complete transcriptions, representing 10% of the real-life data, were randomly selected for this purpose. The results revealed percentage rate agreement at 80% and Cohen's kappa at .85, indicating highly substantial agreement (McHugh, 2012). Context-familiarity is likely to have played a role in the high agreement, as discussed in Core et al. (1999).

Both communicative function and thread components showed higher inter-annotator reliability for the real-life dialogues compared to the simulation dialogues. The higher reliability scores could be an effect of language familiarity, clearer or more defined coding criteria, or context familiarity (especially in regard to the thread annotation); or a combined effect of these.

Chapter organisation

Section 5.3 and Section 5.4 address the frequency findings for communicative functions and threads respectively. These are followed by Sections 5.5 to 5.6 which discuss the five areas related to OHCA resuscitation dialogues, namely verbal alignment in situation awareness, mitigated language use in directives, verbalisation of planning and task organisation, automatic use of trained communication strategies like closed-loop communication, and verbal socioemotional utterances. These sections correspond to the simulation results presented in Section 4.3 to Section 4.6 in Chapter 4. Following these, Section 5.7 explores possible associations between communicative function and thread patterns with the time taken to deploy the mechanical chest compression device, AutoPulse, and the team leader's performance scores.

5.3 Communicative function coding findings

The communicative function component distinguishes various types of dialogue act, such as statements, questions, or orders (all of which belong under Forward Communicative Functions) and acknowledgments or refusals, which are examples of Backward Communicative Functions. This section presents the findings on the types and distributions of communicative functions in the 40 real-life OHCA resuscitation dialogues. The findings help us discern the dialogue patterns that take place during the resuscitation process. Furthermore, a new category of communicative function, *Alerter*, and a new sub-category of *Assert*, *Other-assert-social*, are discussed.

Distribution of communicative functions: Types and frequencies

As the Dialogue Analysis for Resuscitation (DARe) annotation scheme allows more than one function tag for one utterance, the total number of communicative function tags (n = 5,570) was higher than the total number of utterances (n = 5,365), on account of utterances that were perceived to perform more than one function. Indecipherable utterances (5.8% of total utterances) and incomplete utterances (2.1%) were excluded. Three utterances (two from VID263 and one from VID300) did not fit into any of the function categories and were therefore tagged as “Other”. These utterances were unique as they were either not directed to any (human) hearer or only meant for the speaker. The three utterances are given in Table 42.

Video and utterance number	Utterance tagged as *Other*	Context
VID263 Utterance 105	Right, get in there ya wee bugger	Speaker was intubating the patient and inserting the airway equipment. Utterance was addressed to the equipment.
VID263 Utterance 109	Oopsie-daisy, don't do that again please	Speaker was referring to the AutoPulse, which unexpectedly stopped. Utterance was addressed to the equipment.
VID300 Utterance 25	What is this?	Speaker muttering to self. Utterance was addressed to no one in particular.

Table 42. The three utterances tagged as *"Other"*

The findings for each type of Forward Communicative Function category and Backward Communicative Function category are listed in Table 44 and Table 45 respectively. Note that for both tables, the displayed percentages show the proportion of utterances coded with a particular tag (e.g. 1,274 *Asserts* out of the 5,365 total utterances from the 40 OHCA videos = 23.7%). Refer to Table 43 for the overall proportions of FCF-tagged or BCF-tagged utterances.

Utterance category	40 real-life OHCA resuscitation videos	
	Freq.	%
Forward Communicative Function	3,623	67.5
Backward Communicative Function	1,315	24.5
Incomplete/indecipherable	424	7.9
Other	3	0.1
Total	5,365	100

Table 43. Proportion of FCF, BCF, and incomplete/indecipherable utterances in the first five minutes of the 40 real-life resuscitation videos

	Assert	Reassert	Action-directive	Open-option	Info-request	Commit	Offer	Conventional-open-close	Affective-performatives	Alerter*
Total	1,274	49	1,234	171	549	186	46	90	193	39
% out of 5,365 utterances	23.7%	0.9%	23.0%	3.2%	10.2%	3.5%	0.9%	1.6%	3.4%	0.7%
Mean	32	1	31	4	14	5	1	2	5	1
SD	13.21	1.11	11.86	2.35	4.75	3.03	1.26	2.19	4.52	1.59
Range	9 – 59	0 – 4	9 – 57	0 – 9	3 – 26	0 – 11	0 – 5	0 – 7	0 – 19	0 – 6
Median	31	1	30	4	14	4	1	2	3	0

Table 44. Descriptive statistics for each Forward Communicative Function category from the 40 OHCA videos

*Alerter *is a new Forward Communicative Function category that was developed from iterative analysis of the real-life resuscitation dataset. This function will be elaborated in the following section*

	Accept	Accept-part	Maybe	Reject-part	Reject	Hold	Acknowledge	Repeat-rephrase	Completion	Signal-non-understanding	Answer
Total	484	5	0	1	36	15	380	3	53	22	316
% out of 5,365 utterances	8.7%	0.1%	0%	0%	0.7%	0.3%	7.1%	1.0%	0.1%	0.4%	5.9%
Mean	12	0	0	0	1	0	10	1	0	1	8
SD	5.07	0.39	0	0.16	0.97	0.62	5.32	1.40	0.26	0.77	3.86
Range	4 – 24	0 – 5	0 – 0	0 – 1	0 – 3	0 – 2	2 – 21	0 – 5	0 – 1	0 – 3	1 – 17
Median	12	0	0	0	1	0	8.5	1	0	0	7

Table 45. Descriptive statistics for each Backward Communicative Function category from the 40 OHCA videos

The Forward Communicative Function analysis revealed that *Assert* and *Action-directive* had the highest prevalence overall in the dialogues (23.7% and 23.0% respectively). Combined, these two functions made up almost 50% of all Forward Communicative Function categories used in the resuscitation dialogues. The next most frequently found category is *Info-request*. *Assert*, *Action-directive,* and *Info-request* will be discussed further in upcoming sections on the sub-categories of each of these communicative functions.

The high frequency of assertions (*Assert*) in the real-life OHCA resuscitation dialogues matched findings from previous findings from both inter-medical studies that examined physician-patient interaction (e.g. Laws et al., 2014; Roter & Larson, 2011) and intra-medical studies that examined medical team interaction (e.g. Parush et al., 2014). This indicates that assertions or assertion-related utterances are consistently present during medical dialogues, regardless of the settings. The high frequency of *Assert* in the real-life dialogues is also similar to the frequency of *Assert* found in our preliminary research on simulated OHCA resuscitation dialogues (discussed in Chapter 4).

The high prevalence of *Action-directive* utterances, on the other hand, is not a common finding in casual, non-task-related dialogues like the Switchboard corpus (Stolcke et al., 2000), or in inter-medical communication studies, i.e. in physician-patient dialogues. However, high directive-related counts have been reported in medical team communication (Calder et al., 2017). As a comparison, the *Action-directive* frequency in Stolcke et al. (2000) was found to be 0.4% of the total number of utterances, whilst Calder et al. (2017) reported requests (a type of directive) at 18%. *Action-directive* utterances were also one of the most frequently used communicative functions in simulated OHCA resuscitation dialogues, although in the simulation dialogues, the overall percentage of this function was around 16%, which is lower than the present findings. In real-life resuscitation dialogues, directives were only less frequent from assertions by 40 utterances, indicating that instructions form a large chunk of the dialogues during the early minutes of OHCA resuscitations.

The third most frequent function, *Info-request*, in contrast, was only used approximately half as many times as either *Assert* or *Action-directive*. Similar to *Assert*, a high prevalence of *Info-request* utterances has been consistently reported in previous dialogue annotation studies. Unlike *Action-directive*, which is normally observed to be frequent in medical team communication, *Info-request* typically has high prevalence in both inter-medical (e.g. Laws et al., 2013; McNeilis, 2001) and intra-medical (Calder et al., 2017) communication dialogues. Nevertheless, in both our preliminary findings of simulated OHCA resuscitation and in the present findings of real-life resuscitation dialogues, the overall percentage of *Info-request* utterances remained lower than found in prior research findings. As shown in Table 44, *Info-request* only accounted for 10.3% of the total dialogue, in contrast to 17-18% found in the medical team dialogues investigated by Calder et al. (2017).

The real-life data also returned a high prevalence of *Affective-performatives*, contrary to our previous findings from the preliminary study on simulated OHCA resuscitation. Utterances related to *Affective-performatives* have been investigated in inter-medical setting as part of socioemotional or affective dialogues, especially using Roter Interaction Analysis System (Roter & Larson, 2001), but not in intra-medical settings. This communicative function will be discussed further in Section 5.5.5.

Of interest is the communicative function of *Commit*, which was found to be the fifth most frequent function in real-life resuscitation dialogues. What makes *Commit* worth examining is the existence of previous research (e.g. Hunziker et al., 2010) that reported possible positive effects of Commissives on outcomes. In the real-life dialogues, on average, speakers made commitment-related utterances five times per dialogue/per video. This number is far fewer than the average found from the simulation dialogues in Chapter 4 (mean 15 *Commit* utterances per dialogue in the simulated dataset; five *Commit* utterances per dialogue in the real-life dataset). It is possible that *Commit*-related utterances are not frequently used in the early minutes of real-life OHCA resuscitation, although this remains a conjecture for the moment. Other than our preliminary findings in Chapter 4, the use of Commissives in medical team communication has not been explored.

In summary, the early minutes of real-life OHCA resuscitation team dialogues are similar to other types of dialogues, both in medical and non-medical settings, in terms of the most frequently used Forward Communicative Function (*Assert*). The frequent use of *Info-request* is also a mark of similarity; nonetheless, its prevalence is far lower in the present data compared to findings from previous dialogue studies. The high prevalence of *Action-directives* meanwhile is similar to findings from prior studies on medical teams, hence suggesting that directive-related utterances are characteristic of the medical team communication settings.

The Backward Communicative Function analysis showed *Accept*, *Acknowledge*, and *Answer* categories as the top three most frequent verbal responses. These resemble the preliminary findings from simulated OHCA resuscitation dialogues in Chapter 4. The high prevalence of *Accept* responses suggests that verbally, at least, hearers did not encounter any issues complying with directives, an observation that was also made in Core (1998). Examples of these are shown in examples (69) and (70). The high frequency of *Acknowledge,* meanwhile, comes from backchannels, as illustrated by example (71). In addition, *Acknowledge* is also tagged to utterances that show verbal recognition of an action, as described in (72).

(69)
VID158, Utterance 65-66

3RU:	and we're gonna lift him back and over that area	*Action-directive*
P1:	Okay	*Accept*

(70)
VID182, Utterance 92-93

3RU:	P1 do you want to try to intubate?	*Action-directive*
P1:	Yep	*Accept*

(71)
VID424, Utterance 31-32

P2:	We've got an 84-year-old female	*Assert*
3RU:	Okay	*Acknowledge*

(72)
VID290, Utterance 36-38
Speaker asks for equipment

P1:	Can you throw me the BM kit as well	*Action-directive*
P1:	In the black bag just beside…	*Assert*

Hearer indicates the bag

P1:	That's it	*Acknowledge*

The relatively high frequency of *Answer*, which, as a function, responds to queries (i.e. *Info-request*), indicates that in general, team members provided verbal information when prompted. The ratio of verbal questions to verbal answers is at 1.7: 1 (549 *Info-request*: 315 *Answer*). Examples of *Answer* utterances are given in (73) and (74).

(73)
VID280, Utterance 98-99

3RU:	Is that two shocks he's had?	*Info-request*
P1:	Yep	*Answer*

(74)
VID293, Utterance 161-162

3RU:	Eh, where's your response bags guys?	*Info-request*
P2:	Over there	*Answer*

The findings also revealed that some Backward Communicative Function categories were seldom used. In total, *Hold* was found 15 times. As *Hold* is used to delay judgement or action (see examples 75 and 76), the infrequent use may indicate that the speakers in real-life OHCA dialogues have very few reasons to verbally defer their responses. That said, *Hold*-related utterances appeared to be generally infrequent, including in task-free communication. For instance, dialogue annotations of casual telephone conversations from the Switchboard corpus also yielded 0.3% of *Hold* utterances (Stolcke et al., 2000), the same percentage found in the present study. A slightly higher percentage, 0.5%, was found in our preliminary findings on simulated resuscitation dialogues (discussed in Section 4.3).

(75)
VID182, Utterance 19-20

3RU:	Can you cut down one arm, one sleeve yeah	*Action-directive*
P1:	I'm just going to sort [...]	*Hold*

(76)
VID361, Utterance 159-160

3RU:	What time do we reference?	*Info-request*
P1:	Um, we'd have to look at the log	*Hold*

On the other hand, *Completion* was a little higher (0.4%) in Stolcke et al. (2000), whereas it was only found three times (0.1% of the total dialogue) in the present study. None were found in the preliminary study on simulated resuscitation dialogues. Completing someone's utterance requires inferring what is to be said. A hearer might complete a speaker's utterance in a few contexts. It may be that the speaker appears to struggle to find a term, prompting the hearer to complete the utterance. It may also be that the hearer wants to signal that s/he is also thinking about the same thing. Finally, a hearer may wish to help 'speed up' the conversation. In the present dataset, *Completion* seems to be the result of the second and third possibilities, as shown in the examples. The dashes represent immediate response:

(77)
VID193, Utterance 142-143

3RU:	and you've got--	*Assert*
P3:	--syringe and a bag	*Completion*

(78)
VID237, Utterance 79-80

P2:	Right, but not--	*Assert*
3RU:	--but not in her	*Completion*

(79)
VID418, Utterance 9-10

P1:	Have you got any--	*Info-request*
3RU:	--AutoPulse?	*Completion*

The least frequently used communicative functions, *Accept-part* (80) and *Reject-part* (81), were only tagged six times over the course of the dialogues, whilst *Maybe* was not used at all in the present dataset. Similar results were found previously where the tag *Maybe/Accept-part* was only used in less than 0.1% of the total number of utterances (Stolcke et al., 2000). In written communication analysed using similar dialogue annotation system, *Accept-part, Reject-part,* and *Maybe* were not mentioned in the results, probably due to absence or very rare appearance (Hoxha et al., 2016). Likewise, none of the three communicative functions was found in the simulated resuscitation dialogues analysed in Chapter 4.

(80)
VID412, Utterance 6-8
P1 suggests patient to be laid down

P1:	and we'll get him on the back	*Action-directive*

3RU accepts the suggestion, but indicates that another task will be performed first

3RU:	Yep, yep, yep, we'll do that in a wee bit,	*Accept-part*
3RU:	we'll get this set up first	*Action-directive*

(81)

VID251, Utterance 75-76

P1:	Can I help you at all?	*Offer*
3RU:	Not yet, but…	*Reject-part*

From these results, it appears that dialogues in various settings do share certain patterns when it comes to the use of communicative functions. Regardless of the context, dialogues generally contain a high prevalence of *Assert*-related utterances and a noticeable prevalence of *Info-request* utterances, but very few *Holds*, *Maybes*, and utterances related to partial acceptance or rejection. Finally, *Action-directive* utterances are less common in both casual, non-task-directed communication and physician-patient consultation but have been consistently found in higher frequencies in medical team communication.

The following sections discuss a new category discovered in the real-life resuscitation dialogues, and following this, the findings on the sub-categories of *Assert*, *Action-directive*, and *Info-request* functions.

A new category: *Alerter*

In contrast to the few occurrences of the four existing communicative functions discussed above, we discovered a previously uncategorised function that occurred more frequently in the OHCA dialogues, namely the *Alerter*. This function serves to alert the hearer before the speaker conveys the main utterance. The *Alerter* category in the present study is derived from the *Address term* in the Cross-cultural Speech Act Realisation Pattern annotation scheme for request (Blum-Kulka & Olshtain, 1984). This category is described as a word or words that are usually used at the start of a request as an attention-getting device, for instance, "Excuse me" or the name of the addressee.

Initially, the use of such words was viewed as part of the main utterance, but in the 39 instances of *Alerter* utterances found in the dataset, the name or term is clearly verbalised separately from the main utterance; that is, there is a distinct pause between the name or term and the next utterance. This occurrence was negligible in the simulation dialogues. The existence of a clear pause therefore marks whether a name or term is tagged as an individual function of its own, i.e. an *Alerter,* or considered as part of another communicative function.

In the real-life data, the *Alerters* mostly took the form of a name (33 times out of 39) but were also found in terms like “Guys” or “Pal”. These preceded various functions, including instructions, questions, and statements. Some examples are given below:

(82)
VID188, Utterance 44-45

3RU:	Ian	*Alerter* (name)
3RU:	See those clothes, chuck them all on the bed	*Action-directive*

(83)
VID300, Utterance 127-128

3RU:	So, Jess	*Alerter* (name)
3RU:	What would you say, is that okay?	*Info-request*

(84)
VID223, Utterance 104

3RU:	Right, so guys	*Alerter* (generic)

In two instances, the *Alerters* started from a generic form and changed into specific addressee name, as shown in examples (85) and (86):

(85)
VID223, Utterance 21-22

3RU:	Guys, listen, Ian	*Alerter* (generic → name)
3RU:	I’ve got the AutoPulse	*Assert*

(86)
VID412, Utterance 119-120

3RU:	Somebody, Jess	*Alerter* (generic → name)
3RU:	Could you bring the bag over	*Action-directive*

With the addition of *Alerter*, DARe now has 24 communicative function coding categories. The latest form of the DARe coding scheme is given in Appendix C.

Sub-categories of *Assert*

Assert is consistently established as one of the most frequently used communicative functions in dialogue research. To investigate the various ways assertions were used in resuscitation dialogues, we analyse the 1,274 *Assert* utterances found in the dataset using eight sub-categories – to conclude or sum up a belief or fact (*Conclude*); inform one another of the present state of matters (*State-awareness*); pass or give out information (*Info-giving*); hypothesise or assume (*Hypothesise*); show empathy (*Commiserate*); alert, report, or advise (*Notify*); and plan the next course of action (*Forward-course*). The eighth sub-category, *Other-assert-social*, was added after some *Assert* utterances were discovered to belong to a different sub-category, one which was not part of the original. *Other-assert-social* is discussed further later in the next section.

A small number of *Assert* utterances (47 or 3.7% of total *Assert* count) were either incomplete or only generally identifiable as assertions. These are excluded from the analysis. We included *Assert* utterances to/from bystanders (49 or 3.8% of total *Assert* count) in the analysis as these formed parts of the overall dialogues. From the 53 bystander-related utterances, 34 were *Assert* utterances from bystanders giving information about the patient's medical background and events leading to the cardiac arrest, seven related to providing assistance to the team, five were seeking reassurance, and three were about leaving the scene. Table 46 shows the descriptive statistics of the eight *Assert* sub-categories.

Assert (n = 1,274)	*Conclude*	*State-awareness*	*Info-giving*	*Hypothesise*	*Commiserate*	*Notify*	*Forward-course*	*Other-assert-social*
Total	279	244	324	68	26	190	59	37
% out of 1,274	21.9%	19.2%	25.4%	5.3%	2.0%	14.9%	4.6%	2.9%
Mean	7.0	6.1	8.1	1.7	0.7	4.8	1.5	0.9
SD	3.80	4.19	6.20	1.66	0.94	2.90	1.28	1.08
Range	0 – 15	0 – 18	0 – 26	0 – 6	0 – 3	0 – 11	0 – 4	0 – 5
Median	7	5	8	1	0	4	1	1

Table 46. Descriptive statistics of *Assert* sub-categories in the first five minutes of the 40 resuscitation attempts

Results revealed that *Assert* utterances used to provide information (*Info-giving*) were the most frequent in the dialogues, contradicting our first prediction that *State-awareness* would be the most frequent sub-category, following the simulation results. However, we also hypothesised that with the use of the mechanical chest compression device, *State-*

awareness utterances might become less frequent overall. This second prediction was supported by the findings. That said, *State-awareness* utterances were still in the top three most frequent sub-categories. Their potential use in aligning team members is discussed in Section 5.5.1.

Given the fact that upon arrival, paramedics are trained to find out as much as they can about the patient's medical history and pre-arrival conditions, *Info-giving* utterances pertaining to these subject matters could be identified clearly in all 40 dialogues. Regardless of who the speaker was (a paramedic or a bystander), *Info-giving* utterances concerning patient history were always directed to a paramedic. If a 3RU arrived first, he or she would determine the patient's history and conditions from the bystander(s) (if any possessed such information) and then relay this information to the ambulance paramedics when they arrived. Similarly, if the ambulance paramedics arrived first, they would find out the patient's medical history from the bystander(s) and then relay this information to the 3RU when she or he arrived. This is the reason for the high frequency of *Info-giving* utterances in the dialogues.

Info-giving were typically given as responses to questions (*Info-request*) and were usually in a succession of utterances, as illustrated in examples (87), (88), and (89):

(87)
VID158, Utterance 19-22

3RU:	Um, found capsized	*Info-giving*
3RU:	unknown how long he's been capsized or in the water	*Info-giving*
3RU:	he's been in VF[17]	*Info-giving*

(88)
VID197, Utterance 46-47

P1:	Right, complained of chest pain earlier	*Info-giving*
P1:	thought he had a heart attack	*Info-giving*

[17] VF: Ventricular fibrillation

(89)
VID199, Utterance 25-28

3RU:	Umm, he's previously relatively well	*Info-giving*
3RU:	eh, an elderly gentleman	*Info-giving*
Bystander:	He had a heart attack way back	*Info-giving*
Bystander:	a slight one, a very very slight one	*Info-giving*

The next most frequent *Assert* sub-category was *Conclude*. This sub-category was used for various subject matters, from deducing the space for the resuscitation procedure (90), concluding patient history (91), determining the type of rhythm (92) and the quality of chest compressions (93), and deciding that the patient was in a good position to be fitted with AutoPulse (94).

(90)
Conclusion about space
VID217, utterance 24: there's enough room to put this on
VID244, utterance 5: space-wise no good

(91)
Conclusion about patient history
VID200, utterance 64: So, it was witnessed
VID200, utterance 95: He's obviously got quite a lot ongoing medical

(92)
Conclusion about rhythm
VID219, utterance 1: It's a shockable rhythm
VID244, utterance 57: Okay we've got asystole there

(93)
Conclusion about chest compression quality
VID289, utterance 28: That's good CPR[18]

(94)
Conclusion about patient position
VID290, utterance 34: that's good
VID336, utterance 39: Perfect

[18] CPR: Cardio-pulmonary resuscitation

New *Assert* sub-category: *Other-assert-social*

The *Other-assert-social* sub-category contains *Assert* utterances that were not found in the previously analysed simulated dialogues, marking a possible difference between actual resuscitation interaction and simulated ones. The fact that this sub-category is more frequent than *Commiserate* showed an uncaptured facet of *Assert* in simulated dialogues; that is, there are more frequent usage of statements conveying positive politeness in real-life dialogues. The utterances in this sub-category included humour, encouraging phrases, self-addressed utterances, and expressions of emotions like surprise, as shown in the examples:

(95)
Humour
VID244, utterance 96: Getting all your toys together ey
VID199, utterance 92: Shame on me

(96)
Encouragement
VID200, utterance 91: There we go

(97)
Self-addressed
VID263, utterance 125: I don't like these things
VID271, utterance 79: Can't believe I said that

(98)
Expressing emotions
VID158, utterance 94: What! *(surprised by unexpected movement)*
VID199, utterance 1: Alright! *(expressing gladness when seeing the team)*

Other-assert-social shares an umbrella purpose with the communicative function category *Affective-performatives* in that both play social and partnership-building roles. The difference is that *Affective-performatives* tag is reserved for explicit compliments, gratitude, and apologies, whilst *Other-assert-social* covers humour and other emotion-related statements of facts or beliefs by a speaker, which are first identified as an assertion (i.e. *Assert*). Without this sub-category, utterances that convey social/affective functions like the ones given in examples (27) to (30) might slip through the analysis as these do not belong in the *Affective-*

performatives category, and hence were not tagged as such. Utterances containing these socioemotional functions are discussed further in Section 5.5.5.

The categories of *Action-directive*

Clarity of instructions is crucial in high-risk settings like resuscitation, especially as procedures require a high number of directives. This is reflected in the high frequency of *Action-directive* utterances from the dialogues. In the first five minutes of resuscitation attempts, *Action-directive* utterances totalled 1,234, making up 23% of the total utterances. These included 12 directives given to the bystanders. These were included in the analysis because these directives formed part of the team dialogues during the procedure (i.e. bystanders were helping with chest compressions, thus making them part of the team). All other *Action-directive* utterances, except these 12 instances (1 request in VID197, 1 request, 1 direct, and 1 allow in VID280, 1 direct in VID414, and 7 directs in VID310), were addressed to team members.

To analyse the level of explicitness, the *Action-directives* were analysed in regard to their directness or opaqueness (Blum-Kulka, 1987). A direct *Action-directive* is considered the most explicit (hence, the least opaque), followed by request, suggest, and allow. Direct *Action-directive* utterances only contain the instructions, i.e. the action that the speaker wants the hearer to do. This may be mitigated with softeners like “please” (e.g. *Take this please*), but the utterance is still considered more explicit or direct compared to a request that is given in the form of a question (e.g. *Can you take this?*), a suggestion (e.g. *Let’s take this*), or an allowance (e.g. *You can take this*). A small number of *Action-directive* utterances (8 utterances, 0.7% of total *Action-directive* count) were not sufficiently audible for structure analysis and were thus excluded.

Results showed that the type with the highest frequency is the direct instruction, which occurred 882 times out of 1,234, or 71.5%. The distribution of all sub-categories, along with the forms, is given in Table 47.

Action-directive (n = 1,234)	Sub-categories				Forms of *Action-directive*			
	Direct	*Request*	*Suggest*	*Allow*	Name-specific	Without name	Question	Statement
Total	882	194	118	32	195	1,039	217	1,017
% out of 1,234	71.5%	15.7%	9.6%	2.6%	15.8%	84.2%	17.6%	82.4%
Mean	22	4.9	3.0	0.8	4.9	26	5.4	25.4
SD	9.66	3.26	2.17	0.81	3.84	10.49	3.75	9.90
Range	5 – 53	0 – 12	0 – 9	0 – 3	0 – 16	6 – 50	0 -13	6 – 52
Median	21	4	3	1	4	25	4.5	24

Table 47. Descriptive statistics of *Action-directive* sub-categories in the first five minutes of the 40 resuscitation attempts

The high frequency of direct instructions suggests that the paramedics observed in our study followed the recommendations for communicating during resuscitation, that is, keeping dialogues short and to the point (e.g. Hunziker et al., 2010). One open question is whether there is a trade-off between succinctness and absolute politeness in high-risk setting dialogues. We speculated earlier that pragmalinguistic conventions like "Could you" or "Would you mind" which are typically applied to signal absolute politeness would not be the norm during resuscitation dialogues. Based on the overall results, this appeared to be true. Instructions that were given in the forms of request and suggestion were less frequent (15.7% and 9.6% respectively). This result showed that conventionalised pragmalinguistic structures such as the ones shown in the examples below are indeed less utilised during resuscitation (even though they were not rare). Paramedic names are replaced with P1 or P2.

(99)
Examples of request
VID 212, utterance 99: P2 go and pass me a cannula over would you
VID 302, utterance 103: Can you pass it over, P2?
VID 336, utterance 97: Could you get some pack please
VID 412, utterance 23: Can we grab a bit each?
VID 417, utterance 73: If you can do it from there if you're okay
VID 420, utterance 33: Can you pass me a sharps box?

(100)

Examples of suggestion

VID 193, utterance 50: Okay let's just do a rhythm check once we get plugged in
VID 197, utterance 17: Shall we get him on this first?
VID 199, utterance 73: Probably a size, probably a size 8 tube
VID 200, utterance 106: Shall we do a wee check?
VID 219, utterance 100: You could go up turn round and leave
VID 244, utterance 133: P1, do you want to go and get some history?

Similarly, directives given in the form of a question were less frequent than directives given in the form of a statement, indicating that the paramedics favoured straightforward directives. We do, nonetheless, note two caveats. First, even though direct *Action-directives* are the least opaque of the four sub-types, it does not automatically mean that all 882 counts are free from mitigation devices like "please", which is traditionally used to signal absolute politeness (the use of mitigation devices is discussed in more details in Section 5.5.2). Second, we focused on the structure of the verbal statement, hence paralinguistic signals (smile, wink, a pat on the shoulder, etc.) and the tone of voice were not included in the analysis.

A directive can be given to a specific hearer even without the use of the hearer's name, but in a multi-party setting, using a person's name is a surer means to be acknowledged. We examined directives with specific names in them and found that 36 out of the 40 teams used names when issuing directives. The use of name-specific directives averaged roughly five times per dialogue, although the range varied greatly (from 1 to 16 instances). Overall, the proportion of name-specific directives was higher in the real-life OHCA dialogues compared to the simulation dialogues (name-specific directives made up 4% of directives in the simulation dialogues). This could be due to a higher number of people on scene or a greater need to acquire a team member's attention. Name-specific directives were also used in approximately half of the direct verbal orders (99 out of 195 were *Direct Action-directives*) and most were issued in statement forms (118 out of 195).

The bulk of the directives, however, were issued without specific addressee names. These were usually directed to team members who were either already on the task or prepared to do the required task, thus making the use of names less crucial. The examples below illustrate how an addressee was specified through the task that was being performed, i.e. chest compressions in (101) and airway/medication access in (102).

(101)
VID 307, utterance 37: A bit harder dude
VID 198, utterance 70: Uh slow down your compression just a tad
VID 289, utterance 15: You just keep doing CPR if you can
VID 212, utterance 55: Deeper
VID 158, utterance 28: So if you wanna stop a second

(102)
VID 171, utterance 33: You can leave his airway the now
VID 251, utterance 100: and let you do the airway again is that alright?
VID 371, utterance 19: You can just leave the airway as it is
VID 227, utterance 68: Uh if you can just get a line in the now

Additionally, the use of contextual cues, for instance, verbal markers specifying the selected person, like “you” or “officer” (directed to a police officer present on scene), coupled with either non-verbal cues like touching or pointing or/and the location of the person, reduce the need for names. The following illustrate how addressees were specified through their current whereabouts or location:

(103)
VID 188, utterance 56: You wanna step to the side to get his other arm there?
VID 227, utterance 32: Just stay where you are
VID 200 utterance 25: You come up that way

The results also showed that paramedic teams preferred to use non-question or statement form directives (i.e. *Stay there* rather than *Can you stay there?*). Again, this pointed towards the awareness of avoiding opaqueness, which may be present in mitigated language.

Having said that, in our preliminary study (Chapter 4), we discovered a potentially ambiguous *Action-directive* structure in one of the simulation videos (i.e. “Do you want to X”). This directive structure only occurred twice out of 159 (1.3%) directive counts in the simulation dialogues, but more frequent instances were found in the real-life dialogues (37 out of 1,233 directives or 3.0%). Although it constitutes a small fraction, the higher presence in real-life resuscitation attempts is interesting because such a structure is functionally equivocal – it can be construed as an offer, a request, or a query for information. The use of this particular structure could be argued as being part of mitigated language in giving directives. We discuss this more extensively in Section 5.5.2.

The categories of *Info-request*

It is common for dialogue analysis findings to yield high frequencies of utterances that require information from the hearer, i.e. questions. The same can be seen in our data. As shown in Table 44 earlier, *Info-request* was the third most frequently used communicative function in the real-life OHCA resuscitation dialogue analysis, with a total of 549 utterances (10.2% of the total dialogue). This included several *Info-request* to/from bystanders (n = 8, or 1.5% of total *Info-requests*) as these utterances were part of the team dialogues.

Previous research in medical team communication has linked the frequency of questions to leadership and task urgency. Team leaders were found to ask more frequent questions to more experienced teams and to do so during less urgent tasks (Xiao et al., 2003). However, little is known about the forms that the questions take. Dialogue annotation studies that investigate the forms of questioning more often concentrate on inter-medical communication rather than on intra-medical communication. For instance, asking too many open questions during the delivery of bad news has been found to be negatively associated with patients' perceptions of physicians (Gillotti et al., 2002).

We analysed *Info-request* based on three sub-categories to find out whether the utterances were open-question, closed-question, or leading-question type. We excluded 50 utterances (9.1% of total *Info-request*) from the sub-category analysis. Whilst these 50 utterances could be identified as *Info-request* in general, they were either incomplete or not sufficiently audible for their structure to be positively identified as any of the sub-categories. Table 48 shows the distribution of the three *Info-request* sub-categories.

Info-request (n = 549)	Open-question	Closed-question	Leading-question
Total	97	328	74
% out of 549	17.6%	59.7%	13.5%
Mean	2.4	8.2	1.9
SD	1.72	3.76	1.24
Range	0 – 7	0 – 19	0 – 5
Median	2	8	2

Table 48. Descriptive statistics of *Info-request* sub-categories in the first five minutes of the 40 resuscitation attempts

The findings clearly showed that more than half of *Info-request* utterances were verbalised as closed questions, a query structure that could be responded to satisfactorily with either a yes or a no. This supported our prediction regarding the most frequent type of question used in resuscitation team dialogues. Unlike simulation findings, in the real-life dialogues even the bystander-related *Info-request* leaned more towards closed-questions (n = 4) rather than open-question (n = 2) or leading questions (n = 1). From the point of view of succinctness, the closed question is definitely more beneficial in this dialogue context as it limits the responses of the hearer. Asking a closed question also implies that the speaker knows approximately the information that s/he expects to get.

Similar to findings from the simulation data, *Info-requests* in the real-life OHCA dialogues were also used to check on the well-being of the team members and to confirm that the speaker and the hearer were in agreement, especially during a task and after giving directives. These are characterised by the following examples in (104):

(104)
VID251, Utterance 77: Do you need a rest P2?
VID293, Utterance 170: Are you happy to do that?
VID411, Utterance 7: You okay just cracking on?
VID412, Utterance 122: Happy with that P1?
VID418, Utterance 90: Everybody happy with that?
VID424, Utterance 106: You happy guys?

Whilst structurally, the *Info-request* utterances in (104) are categorised under *Closed-question*, their function is not only to obtain information, but to signal that the speaker is aware of the hearer's state or is prepared to negotiate if the hearer disagrees. In other words, this form of *Info-request* carries a slightly different pragmatic force compared to the examples in (105):

(105)
VID158, Utterance 2: You got a bougie[19] in your motor mate?
VID182, Utterance 35: Right, so, what's his name?
VID197, Utterance 31: You want it up a bit?
VID200, Utterance 155: Can you get in?
VID223, Utterance 137: Can you see that clock?
VID293, Utterance 37: Have we had any shocks in guys?

This variation of communicative function is seldom discussed in dialogue annotation studies, although this type of question is distinguished as expressives (concerning the speaker's inner states or beliefs) rather than representatives (concerning intersubjective reality) in the Generalised Medical Interaction Analysis System, GMIAS (Laws et al., 2009). Future research may be able to discern whether this variation of *Info-request* holds affective power.

Summary

The communicative function findings showed that actual resuscitation dialogues differed from simulated dialogues with the presence of *Alerters* and the sub-category of *Other-assert-social*. These variations suggest that dialogues in real-life settings, in comparison to dialogues in simulated settings, tend to emphasise social connections more, i.e. by using names to alert hearers and verbalising statements to convey matters such as empathy. It is possible that in simulated settings, paramedics are more focused on the tasks that are to be performed, especially if the teams are aware that they are being assessed on their technical capabilities. Consequently, communicative functions that are considered to have more social functions (e.g. showing gratitude) rather than performative functions (e.g. giving instructions) are used far less frequently. The lower frequency of the *State-awareness* category also marked a difference, although this was expected given the use of the mechanical chest compression device. Nonetheless, the use of other sub-categories remained similar, with direct *Action-directive* and *Closed-question* being the most prevalent.

As with the simulation dialogue findings, we also observed the use of the Scottish English dialect (e.g. "Take a *wee* break", "Just keep going *the now* with chest compressions", "Under the *oxsters*[20]") in the real-life resuscitation dialogues, marking the speakers as belonging to the Scottish English sociolinguistic environment.

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[19] Bougie: A device that helps with the intubation of airway
[20] Oxsters: Armpits in Scottish English

The next section discusses the thread findings.

5.4 Thread coding findings

The communicative function of an utterance distinguishes whether the utterance is a question, an offer, or an acceptance, amongst others, but it does not provide information regarding what the question, offer, or acceptance is about. In DARe, this layer is captured using a separate set of coding, called *thread* coding. Annotating these allows the thread pattern to be examined, i.e. the types of thread that appear in the dialogues, how frequently they are mentioned, the sequence of introduction, and whether there is a general pattern in the first five minutes of real-life resuscitation dialogues.

Threads were coded based on the categories in DARe (see the end of Chapter 3 for the full coding scheme). Often, a single utterance contained more than one type of thread and therefore tagged as such. Following this, the total frequency counts for threads (n = 7,787) are higher than the total utterance counts for all videos (n = 5,365). Indecipherable utterances, that is, utterances with unclarified subject matter (12.3% of total utterances) were excluded.

The present study analyses the threads based on their distribution across the dialogues. The occurrences of each type of thread are noted and their frequencies and percentages calculated to get the overall pattern of use. This allows us to uncover what subject matters are most prevalent during the first five minutes of real-life resuscitation dialogues. Similar to the preliminary study, the verbal order of thread introduction is also investigated. However, for the current study, thread introduction is investigated using dialogue and time segments rather than by utterance. The segments illustrate the junctures during which threads are the most prevalent.

Distribution of threads: Types, frequencies, and percentages

Thread annotation yielded findings in terms of the overall frequency distribution and the order of thread introduction into the dialogues. The first part of the finding tells us the frequencies for each type of thread. These revealed the type of contents that were verbalised by the resuscitation teams and their prevalence. The second finding shows which threads are introduced first into the dialogues and whether this order of introduction reflects the resuscitation guidelines that the paramedics were trained with. The following Table 49 shows the thread distribution in the 40 resuscitation dialogues.

	PH	COMPR	CLOTH	AIR	RHY	MED	INST	VENT	TIME	SHOCK	STATE	RC	RES	MOV PT	MOV	IMM	NON IMM	PAC	AG	OTH
Total	490	296	128	202	269	178	1,123	76	190	151	115	14	0	673	271	231	56	2,293	128	243
% out of 5,365 utterances	9.1%	5.5%	2.4%	3.8%	5.0%	3.3%	20.9%	1.4%	3.5%	2.8%	2.1%	0.3%	0.0%	12.5%	5.1%	4.3%	1.0%	42.7%	2.4%	4.5%
Mean	12.3	7.4	3.2	5.1	6.7	4.5	28.1	1.9	4.8	3.8	2.9	0.4	0	16.8	6.8	5.8	1.4	57.4	3.2	6.1
SD	13.13	6.91	3.68	4.97	6.55	5.50	16.12	2.76	4.15	5.57	3.04	1.42	0	12.88	5.13	4.96	2.36	20.33	2.73	3.98
Range	0 -58	0-29	0 -14	0-24	0-26	0-23	2-75	0-12	0-14	0-23	0-13	0-7	0	2-77	0-22	0-27	0-12	23-100	0-11	0-14
Median	8	5	2	4	4.5	2.5	23	1	4	1.5	1.5	0	0	13	6	5	0	53.5	2.5	6

Table 49. Descriptive statistics for each thread category from the 40 OHCA videos

PH: Patient history; COMPR: Chest compression; CLOTH: Patient's clothing; AIR: Airway; RHY: Rhythm; MED: Medication; INST: Instrument/equipment; VENT: Ventilation; TIME: Time; SHOCK: Shock; STATE: Current state of patient; RC: Reversible causes; RES: Resolution; MOVPT: Movement involving patient; MOV: Movement other than patient; IMM: Immediate vicinity; NONIMM: Non-immediate vicinity; PAC: Plan of action; AG: Social agenda setting; OTH: Other threads that do not expressly belong to any of the 19 categories

Overall findings from the thread analysis showed that the most frequent thread concerned plans (*Plan of action*), comprising approximately 42% of verbalised threads in the resuscitation dialogue. The threads *Patient history* and *Instrument* also showed high frequencies. These findings echoed the results from our preliminary study on simulated resuscitation attempts.

As discovered in the simulation results, threads are highly sensitive to the variables in the resuscitation scenario. We discussed, in Section 4.4, how thread frequency varied due to type of rhythm (shockable or non-shockable), the use or non-use of the mechanical chest compression device (AutoPulse), bystander verbal participation, and the resuscitation outcome (Return of Spontaneous Circulation, ceasing resuscitation attempt, etc.). In the present analysis of real-life OHCA resuscitations, only the type of rhythm and the use of AutoPulse are relevant. Real-life bystander verbal participation in the real-life data was minimal compared to bystander verbal participation in the simulations, and resuscitation outcomes, that is, the *Resolution* thread, are not applicable because the first five minutes of resuscitation does not normally include verbal remarks concerning resuscitation outcome.

When the patient's heart rhythm was shockable (e.g. ventricular fibrillation), the threads about defibrillation or shock appeared in the resuscitation dialogue. In contrast, when the patient's heart rhythm was non-shockable (e.g. Pulseless Electrical Activity or PEA), paramedics did not verbalise utterances related to shock, which was the case in 17 resuscitation dialogues out of 40. All 17 cases involved non-shockable rhythm and contained no utterances pertaining to the task of defibrillating the patient, at least in the first five minutes of the procedure after the 3RU paramedic's arrival. The use of AutoPulse appears to be significant as well in influencing the frequency of the thread *Movement involving patient.* This thread is the third most frequent overall in the dialogue. We posit that this is a direct effect of the use of AutoPulse: to strap on the device around a patient's chest, team members need to collaborate to lift the patient up into position, which would most likely result in discussion or instruction regarding the task. Since all OHCA resuscitation teams, except for one, deployed the AutoPulse, this pushed the frequency of *Movement involving patient* thread up to the third most frequent.

The focus here on the early stage of resuscitation also means that some threads may not be verbalised yet. Threads like *Reversible causes* and *Resolution* may only appear at the end of the procedure. As expected, we did not find any *Resolution* thread in any of the dialogues. *Reversible causes,* on the other hand, were mentioned in three different dialogues; in VID271, in VID300, and in VID410. Nonetheless, this is a very small fraction of the whole dialogue (0.2%). Whilst it is expected that no resolution is normally verbalised in the first five minutes of resuscitation, the near absence of the *Reversible causes* thread merits discussion. The Perfect 10 situational awareness guideline for 3RU paramedics shown in Figure 10 (Section 5.2) advocates for this subject matter to be discussed early on in resuscitation, i.e. in the first five minutes. Hence, theoretically (or ideally), the thread findings should have shown far more frequent verbal mentions of this specific thread. Nonetheless, the very limited occurrence of *Reversible causes* thread from our data suggests that, in real-life resuscitation dialogues, other subject matters might take precedence over the verbalisation of reversible causes of cardiac arrest. It should be mentioned, however, that the Advanced Life Support (Resuscitation Council UK, 2015, see Figure 2, Section 3.8) algorithm did not specifically suggest verbalisation of reversible causes during the early minutes of resuscitation. This could be due to the fact that the ALS guideline is meant to be more general (i.e. for use of first responders as a whole) whilst the Perfect 10 guideline is meant to be more specific (i.e. for use of expert paramedics such as the 3RU, who possess the medical knowledge and capabilities to treat cardiac arrest patients further).

Thread trend across resuscitation dialogues

In the preliminary study, the order of thread introduction was investigated by mapping each utterance to its thread to create a snapshot of the whole dialogue (see Section 4.4). This kind of snapshot can be informative when analysing a single, specific dialogue, or a few, but becomes less efficient for analysing a larger number of dialogues. Furthermore, when a thread's verbal order of introduction per utterance is examined individually, the results became too sensitised to each specific resuscitation dialogue's scenario, making it difficult to detect a general pattern.

For the current analysis, the dialogues are divided into 10 segments, or deciles. Each contains approximately 10% of the utterances in the dialogue. Thus, for a transcript containing 150 utterances, the first decile would contain the first 15 utterances, starting from Utterance 0 to Utterance 14; the second decile would contain the second 15 utterances (Utterance 15 to Utterance 29); and so on until the final decile. The number of times that a thread appeared were then calculated for each decile. This approach establishes the overall verbal occurrence of a specific thread in any given 10% segment and creates a frequency trend, thereby documenting whether the thread becomes more prevalent or less prevalent over time.

The following results were obtained for the five most frequent threads – *Plan of action*, *Instrument/Equipment*, *Movement involving patient*, *Patient history*, and *Compression*. The complete results are given in Appendix D.

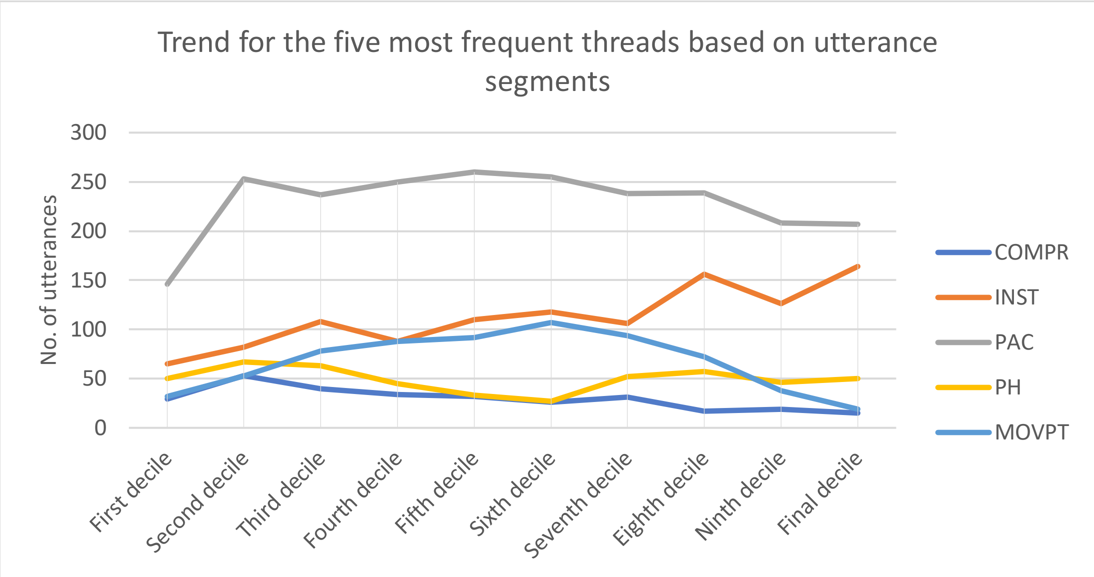

Figure 11. Trend for the top five most frequent threads per decile

COMPR: Chest compression; INST: Instrument/equipment; PAC: Plan of action; PH: Patient history; MOVPT: Movement involving patient

Figure 11 shows fluctuations of thread frequency across the dialogues. Each thread appeared to have its own pattern, although clearly, planning-related threads dominated the dialogues. Team members talked about instruments more frequently as the resuscitation procedure progressed. By contrast, verbal communication about *Movement involving patient* gradually decreased starting from the sixth decile. *Patient history* and *Compression* showed similar patterns initially with peaks in the second decile and reduced frequencies in the middle deciles, although team members started to pick up again on patient history after this whilst compression-related dialogues stayed low. The fall in *Patient history* and *Compression* threads, which coincided with the highest frequency of *Movement involving patient* thread, appeared related – it can be surmised, perhaps, that between the sixth and seventh deciles, teams have successfully deployed the AutoPulse, lowering the overall frequency of communication concerning patient movement (patient is already in position) and chest compression (the AutoPulse takes over chest compressions). This leaves team members free to repursue the subject matter of *Patient history*.

To allow triangulation with actual time, thread frequencies were extracted from one-minute segments (five segments from each dialogue), with the following results. Again, only the top five most frequent threads are illustrated here. The full results are given in Appendix E.

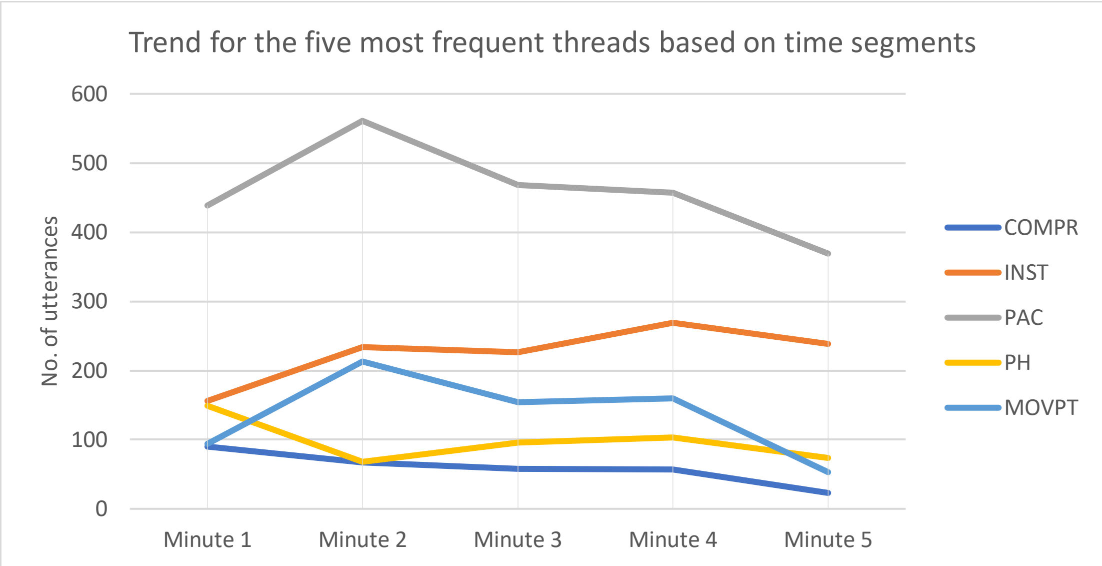

Figure 12. Trend for the top five most frequent threads per one-minute segment

COMPR: Chest compression; INST: Instrument/equipment; PAC: Plan of action; PH: Patient history; MOVPT: Movement involving patient

With the threads segmented based on time, it is revealed that the coinciding patterns of *Patient history*, *Movement involving patient*, and *Compression* threads, shown in Figure 11 in the sixth decile, actually occurred during the second minute of resuscitation, which is quite early on in the procedure. The peak in plan-related threads, shown in the fifth decile, also occurred during the second minute; evidently, plans were being verbalised more frequently during this specific juncture, presumably because this was when the AutoPulse was deployed. Time-based thread segmentation therefore illustrates more clearly the interval during which tasks are being performed.

These distributions of threads allow two observations to be made. One, paramedics verbally juggled multiple threads during resuscitation. The patterns from this could be used to ascertain how specific teams verbally manage specific tasks, and whether these are influenced by variables like the teams' effectiveness. Two, the paramedics' attention to specific subject matters shifted over time as some tasks became prioritised. The most obvious example in Figure 11 and Figure 12 is the thread *Movement involving patient*, which was verbalised infrequently in the beginning, then rose distinctively before declining at the end.

Summary

The results from the thread frequency analyses lend evidence that threads are susceptible to variables during OHCA resuscitation. In other words, dialogue contents are linked to existing factors that may present differently in different resuscitation contexts. Whilst some threads remained frequent, especially *Plan of action,* the prevalence of other threads, such as *Movement involving patient* and *Shock*, could be directly attributed to the use of the AutoPulse (i.e. a patient needs to be moved to attach the AutoPulse pads) and the type of rhythm (i.e. resuscitation for a patient with a shockable rhythm contains more utterances with this thread). The higher frequency of the threads relating to space and movement in the real-life resuscitation dialogues signals a difference between simulated and actual settings. In the simulated resuscitation setting discussed in the previous chapter, there is less need for the paramedics to manoeuvre patients in a small compound, whereas, in the real-life setting, OHCA resuscitation attempts often take place in limited spaces.

The thread trends across the dialogues, extracted through both utterance and time segments, showed different patterns for different threads, revealing the focus of the dialogue at specific junctures during resuscitation. Examination of threads based on the utterance decile and minute segments also appear to be a more effective method to understand the patterns of thread verbalisations across resuscitation dialogues compared to examination of the verbal order of threads per individual utterance discussed in Section 4.4 (Chapter 4).

5.5 Exploring five areas related to OHCA resuscitation dialogue

Following previous research that applied dialogue annotation results to investigate related areas (e.g. patient satisfaction) in medical communication, the present study utilises the data to investigate five distinct areas relevant to paramedic communication during OHCA resuscitation.

The first area looks at how team members use verbal communication to keep each other situationally aware of the ongoing tasks and progress during resuscitation. The second area explores absolute politeness in paramedic directives and how this is exercised in a high-stakes, time-pressured environment. The third area examines how paramedics verbalise their plans and strategies, especially in the light of task complexity and importance. The fourth area looks at the occurrence of trained communication strategies during resuscitation, focusing on closed-loop communication. Finally, we investigate how socioemotional or affective behaviours are reflected verbally in the resuscitation dialogues. The following sections will address each area in turn.

5.5.1 Verbal alignment as part of situation awareness during resuscitation

The term *situation awareness* is often associated with the skills required for successful teamwork. Generally, studies on situation awareness follow the definition provided by Endsley (1995), who also proposes three hierarchies of awareness, namely the capacity to i) gather or perceive current information, ii) comprehend or interpret the information correctly, and iii) anticipate future states. Medical team errors have been associated with the loss of, or inadequate levels of, situation awareness amongst the team members (Schulz et al., 2016). Of the three levels of situation awareness, i.e. perceiving information, interpreting the information, and anticipating future states, failure at the first level was found to be associated with the highest frequency of errors in medical procedures. The same finding has also been reported in other high-risk settings such as aviation and offshore drilling rigs (Flin et al., 2008).

The current study is interested in verbal statements that serve to align team members with one another regarding the current tasks, actions, and/or states. These largely correspond to the first hierarchy of situation awareness, in that they provide information regarding the current task or action that the speaker is performing, or the state the speaker is witnessing. In performing team tasks, it is not enough for only one team member to be aware of the current condition or the progress (or perhaps, delay) of tasks – to optimise team effectiveness, this information needs to be shared (Endsley, 1995). In an observed case where a team member noticed a patient's condition but did not communicate this information to the team, this lack of information hindered the team from making the correct diagnosis earlier, thus slowing the patient's treatment (Schulz et al., 2016). This illustrates the need for the verbal statements that we call *State-awareness*.

In DARe, *State-awareness* is a sub-category of *Assert* that serves as verbal landmarks of a team's progress. One way to describe *State-awareness* utterances is that these are verbalisations of what seems to be obvious tasks, for instance, counting compression counts out loud, or stating that one is performing something ("I'm intubating") or is in possession of something ("I have IV").

The preliminary study on simulated resuscitation dialogues (Chapter 4) showed that, overall, *State-awareness* comprised 32.7% of the total *Assert* utterances from the four teams, making this sub-category one of the most frequent under the *Assert* function. It is possible that team members utilise this type of utterance to align themselves with respect to tasks and progress. Additionally, because of the association between situation awareness and effectiveness, one may anticipate that teams led by leaders with higher performance scores (i.e. rated as more effective) would show higher use of the *State-awareness* function. Finally, the prevalence of *State-awareness* per type of thread is examined to find out which task is associated the most with this function.

The results from the real-life dialogues showed lower frequencies of *State-awareness* utterances compared to the frequencies found in the simulated dialogues. Out of the 1,274 utterances tagged with *Assert*, 244 (19.2%) were identified as *State-awareness*. On average, each resuscitation team dialogue contained around six *State-awareness* utterances (median = 5; SD = 4.19; range = 0 – 18). This finding was lower than the finding from the preliminary study. However, the lower frequency has been expected due to the use of the mechanical chest compression device, AutoPulse, during the real-life resuscitation scenario. In the preliminary study, the high overall percentage was skewed by the high frequency of *State-awareness* utterances in the two resuscitation dialogues without AutoPulse use, mainly because of the verbal counts of manual chest compressions. If these types of counts were excluded, the result (14.9%) was closer to the present findings.

The following are selected samples from the real-life OHCA resuscitation dialogues. *State-awareness* utterances, describing either the current state or current action of the speaker, are in bold.

(106)
VID219, Utterance 8-11

3RU:	Someone get on the chest	
3RU:	Thank you very much	
3RU:	**So, that's the first shock in**	*Current state*
3RU:	**CPR ongoing**	*Current action*

(107)
VID244, Utterance 35-42

3RU:	Maybe you uh, you take over the airway you okay with that?	
P3:	Yeah	
3RU:	Okay	
P2:	**Right, that's the adrenaline going in okay**	*Current action*
3RU:	Okay	

(108)
VID290, Utterance 129-132

P1:	P2, we could do another adrenaline	
P2:	Yep	
P2:	That's good	
P1:	**Fluid's ready**	*Current state*

(109)
VID293, Utterance 96-101

P2:	Just fling the tube up	
P2:	And I'll stick it on there	
3RU:	Okay	
3RU:	That's fine	
P3:	**Pads on**	*Current state*
3RU:	Right	

As illustrated in the examples, the utterances are assertions from the speaker about the current action, task, or state of affairs. Sometimes, these utterances might sound a bit disjointed from the current conversation that is going on because the speaker is asserting something that is not immediately related, like in examples (107) and (109). Similar to the results in the preliminary study, the utterances in the present study were not often verbally responded to.

How *State-awareness* utterances contribute to the resuscitation procedure

State-awareness utterances are different from the other communicative functions as they can be detached from a dialogue sequence. *State-awareness* utterances are not responses to queries or directives, and on their own, they seldom invite verbal responses. In this sense, they are not part of any adjacency pairs. What they do, however, is ensure that an ongoing action, task, or situation is stated out loud for everyone (in the vicinity) to hear. This verbal reporting of current (and ongoing) knowledge is part of situation awareness that aids the team in accomplishing tasks in more effective ways. Here, we describe how this may work for resuscitation dialogues.

First, *State-awareness* utterances contribute to overall safety. This is especially prominent in resuscitation cases that require defibrillation or administration of controlled electric shocks to the patient's heart. Defibrillation-related tasks, like charging the defibrillator and administration of the shocks, are unique to resuscitation dialogues, and indeed not all resuscitation attempts will contain this context as some cardiac arrest rhythms are unsuitable for defibrillation (i.e. asystole and pulseless electrical activity). It is observed that, from 13 resuscitation attempts dealing with shockable rhythms (mostly ventricular fibrillation), eight teams made use of *State-awareness* utterances related to defibrillation. The following are examples of those:

(110)
State-awareness related to charging the defibrillator
VID219, Utterance 3
3RU: I'm charging to 150

VID280, Utterance 39
P1: Charging

VID219, Utterance 98
3RU: So, charging for a shock

VID302, Utterance 33
P2: Alright charging

(111)
State-awareness related to administering shocks
VID219, Utterance 6
3RU: Shocking

VID219, Utterance 77
3RU: Shock's in

VID294, Utterance 154
3RU: Shock

VID310, Utterance 84
3RU: Second shock in

Even though the defibrillation task is always accompanied by directives like "Hands off" or queries like "Are we clear?", the addition of *State-awareness* utterances like the ones above can heighten the overall team attentiveness regarding the ongoing defibrillation.

Another aspect of safety is safety for the patient. *State-awareness* utterances concerning medications, shown in the following examples (112) to (114), can be helpful to remind team members of the current state or condition.

(112)
VID300, Utterance 75-76
P1: He's had two adrenalines so far
P1: And this is his first fluid

(113)
VID310, Utterance 48
3RU: One epi[21] in

(114)
VID336, Utterance 95
P2: She has had two lots of adrenaline

[21] Epi: Short for epinephrine

As various factors can affect a person's situation awareness, especially in high-risk settings, these unprompted verbal reports can be important. Maintaining situation awareness is in part maintaining concentration levels, which depend mostly on working memory (Flin et al., 2008). Moreover, the most current information need to be readily available for team members. The verbalisation of the current situation therefore helps ensure that team members are on the same page.

Second, *State-awareness* utterances allow a smooth and timely transition of tasks. This is most evident for compression-related utterances, when the team members counted the compressions to 30 – the out-loud counts assist the team members in performing ventilations or rescue breaths, which are to be given at the end of a cycle. *State-awareness* utterances related to chest compressions have been discussed in the preliminary study (Section 4.5.1).

In a similar manner, rhythm-related *State-awareness* utterances assist in creating the basis for the next steps. For instance, when a team member said "It's asystolic" after checking the rhythm, this indicated that the team was not going to shock the patient and should focus on maintaining chest compressions instead and deploying the AutoPulse as quickly as possible to allow extrication. This is evident from the dialogue following the utterance, as shown:

(115)
VID307, Utterance 22-26

3RU:	Pause two seconds	*(instruction to pause chest compressions)*
3RU:	Okay	*(after assessing rhythm)*
3RU:	Keep going	*(instruction to continue chest compressions)*
3RU:	**It's asystolic**	*(*State-awareness *utterance; a self-report)*
3RU:	P1, can I get you round to this side dude?	*(organising team members to move patient for AutoPulse deployment)*

In contrast, when a team member said, "We're in VF" (ventricular fibrillation) after checking the rhythm, the following plan would involve defibrillation, as shown in example (116):

(116)
VID212, Utterance 45-50

3RU:	P1, that next set we'll get the rhythm checked	*(instruction for plan)*
P1:	25, 26, 27, 28, 29, 30	*(manual chest compression counts, also functioning as* State-awareness*)*
3RU:	We're in VF	*(*State-awareness *utterance)*
3RU:	Just back on the chest P1	*(instruction to continue chest compressions)*
3RU:	Okay, stand clear	*(instruction to prepare for defibrillation)*
3RU:	Back on	*(shock administered; chest compressions should continue)*

Example (116) also illustrates how the verbal counts of manual chest compressions functioned as a marker for rhythm check. When the count reached 30, this signalled the end of the cycle and therefore allowed the 3RU to assess rhythm. *State-awareness* utterances thus assist in mobilising the team members for the next relevant tasks.

State-awareness frequency in ideal score and low score groups

The level of team situation awareness is affected by the individual members in the team. Thus, as the ones who organise and direct the teams, it is possible that the performance of team leaders could affect the sharing of situation awareness. To investigate this, the frequency of *State-awareness* utterances in teams led by leaders who obtained the highest available technical skills (TS) and non-technical skills (NTS) scores were compared with those from teams led by leaders who obtained the lowest available TS and NTS scores (scores shown in Table 1, Section 5.2). If there are differences in the dialogue patterns, these would be apparent in the comparison of the extreme ends of the team leaders' performance, i.e. the best and the worst.

Following this reasoning, all transcripts with perfect scores are selected to form one group called the *ideal score group* (n = 13). This group has a cumulative score (i.e. total of the TS and NTS scores) of 104. Another set of 13 transcripts with the lowest available cumulative scores (67) was chosen to represent the lower end of the scores. This second group is referred to as the *low score group*. When the ideal score group and the low score group *State-awareness* counts were compared, the following results were found.

	Ideal score group (n = 13)	*Low score group (n = 13)*
Total *State-awareness*	82	65
Mean	6.3	5
Range	0 – 14	1 – 12
Median	5	4
%	20.8%	17.0%
SD	3.88	2.77

Table 50. Comparison of *State-awareness* frequency between ideal and low score groups

The higher frequency of *State-awareness* utterances in the ideal score group could be attributed to the team leaders (3RU paramedics), who might have verbalised this function more frequently. Interestingly, however, closer examination of the speakers showed otherwise. From the 82 *State-awareness* utterances in the ideal group, only 37 were verbalised by the team leader. The rest (45) came from various team members. Meanwhile, from the 65 *State-awareness* utterances in the low score group, 36 came from team leaders and 29 from team members. Whilst not conclusive, there is a slight possibility that better-performing team leaders can motivate their team members into verbalising more frequent *State-awareness* utterances.

Threads associated with *State-awareness*

To find out the type of threads that were most frequently associated with *State-awareness,* the threads tagged to each *State-awareness* utterance were tallied. Out of 19 possible threads, 15 threads were present in *State-awareness* utterances. The four threads that were not associated with *State-awareness* are *Social agenda setting*, *Non-immediate vicinity*, *Patient history*, and *Resolution*.

The distribution of the 15 threads (out of 244 *State-awareness* utterances) are shown in Figure 13:

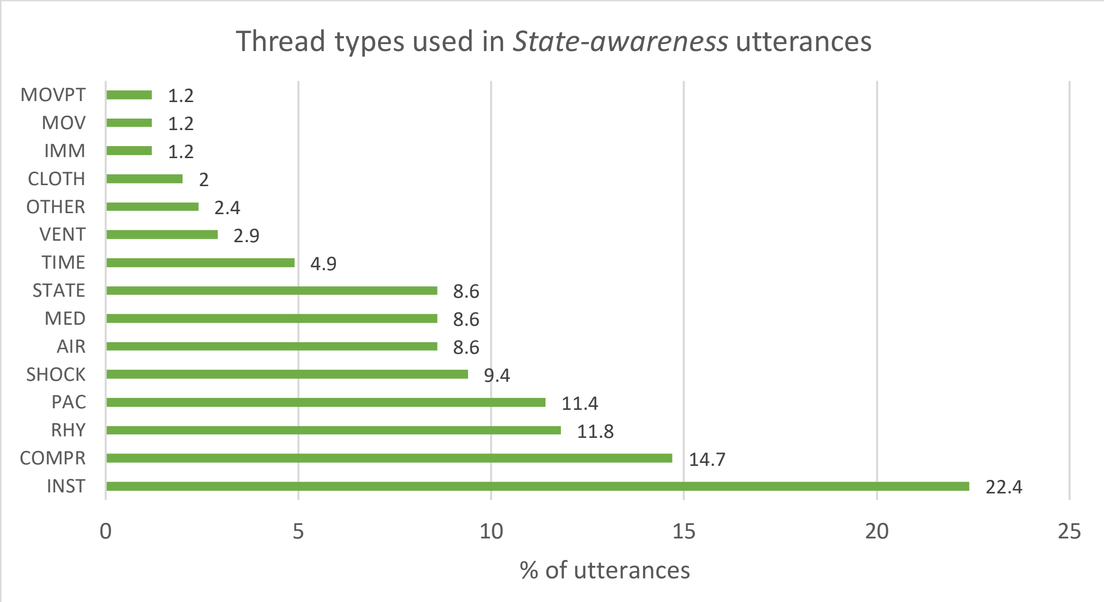

Figure 13. Thread distribution across the *State-awareness* utterances in the resuscitation dialogues

INST: Instrument/equipment; COMPR: Chest compression; RHY: Rhythm; PAC: Plan of action; SHOCK: Shock; AIR: Airway; MED: Medication; STATE: Current state of patient; TIME: Time; VENT: Ventilation; OTHER: Other threads that do not expressly belong to any of the 19 categories; CLOTH: Patient's clothing; IMM: Immediate vicinity; MOV: Movement other than patient; MOVPT: Movement involving patient

In contrast to the findings from the preliminary study on simulated resuscitation dialogues, where the *Compression* thread was the most prevalent, nearly a quarter of *State-awareness* utterances in the real-life resuscitation dialogues revolved around the *Instrument* thread. Examples (117) and (118) illustrate *State-awareness* utterances with the *Instrument* thread.

(117)
VID193, Utterance 165
3RU: I've got a wee grey cannula there

(118)
VID336, Utterance 92
3RU: Your tubes[22] just there

Initially, we assumed that the high count of equipment-related thread resulted from the use of the AutoPulse, but closer examination revealed that the equipment/instrument typically

[22] Tubes: Tracheal tubes used to secure airway

referred to in the *State-awareness* utterances were cannulas, tracheal tubes, laryngeal masks, oral suctioning tool (e.g. the Yankauer suction), and the capnography monitor (an instrument used to measure metabolism, ventilation, and perfusion).

Even though the use of AutoPulse reduced the overall frequency of manual chest compression counts, compression-related *State-awareness* was still quite frequent because the team members still verbalised their manual counts before AutoPulse took over. The remaining threads that were quite frequent appeared to be specifically task-related, concerning rhythm of the patient (asystolic, ventricular fibrillation, pulseless electrical activity), plans for various actions, defibrillation or shock, airway (access and management), medication (adrenaline), the current condition of the patient, and time.

State-awareness utterances may be a small part of situation awareness during resuscitation, but they arguably play important roles in ensuring that team members are aligned during the procedure. As discussed, these utterances provide safety measures and assist in smooth transitions of tasks. Furthermore, even though the differences were small, teams led by leaders who were rated as highly skilled in both technical and non-technical dimensions showed more usage of *State-awareness*. Even though this by itself is not sufficient to provide evidence of team effectiveness, it does imply an association between perceptions of effective teams and the use of situation awareness, which, in this case, takes the form of verbal reports of current landmarks.

5.5.2 Saving life, saving face: Mitigation speech in resuscitation directives

In politeness theory, the act of instructing someone to perform an action is considered a face-threatening act, thereby prompting the speaker to use mitigated speech when doing so. Whilst mitigating directives or giving indirect requests is a normal practice in polite everyday conversation (discussed in Section 4.5.2), in high-risk settings operating within time limits, such as aviation and surgery, mitigated speech has been linked to errors and is strongly discouraged, especially when issuing instructions (Brindley & Reynolds, 2011; Krifka et al., 2003). Mitigated speech is also discouraged in critical care medicine communication, which includes resuscitation (Brindley & Reynolds, 2011).

Findings from the real-life resuscitation dialogues in the present study revealed that requests, suggestions, and allowances made up 27.9% (n = 344) of the whole total of *Action-directives*. These are considered as mitigated speech because their pragmalinguistic structures automatically mitigate the directive. Of the three, suggestions or recommendations strike us as more opaque and potentially ambiguous, particularly when the utterance started with "Do you want to…".

Do you want to? An ambiguous structure of directive

In some instances, paramedics started their directives with "Do you want to…", an ambiguous phrasing that can be inferred as an offer to do (or not do) an action, a request to do said action, or a query for information. In our dialogue annotation system, DARe, an offer is described as an utterance that indicates the speaker's willingness to commit an action upon the acceptance of the hearer (onus on the speaker); a request as an utterance that directly influences the hearer's future non-verbal action (onus on the hearer); and a query, or an information-request, as an utterance that places an obligation on the hearer to provide information (onus on the hearer). One can easily imagine a pragmalinguistic failure like the following:

(119)
Speaker: *(intended as a request)* Do you want to move over here?
Hearer: *(understood as offer)* No, thank you.

This would most likely result in the speaker rephrasing his request (e.g. *I mean, I need you to move over here*), costing a few seconds of delay. In fact, one scenario possibly of this kind did occur in one of the dialogues:

(120)
VID212, Utterance 77-81
3RU: Hey P2, **do you want to, do you want to** watch for a two-minute cycle for us?
3RU: as you're at the head end *(03:55 minutes into the dialogue)*
(no verbal response or indication of action)
3RU: P2
3RU: you're at the head end
3RU: if you watch for the two-minute cycle *(04:03 minutes into the dialogue)*

Given that the earlier utterance was not explicit, the hearer (P2) might have assumed that it was not a directive that should be responded to either verbally or through action, especially because it ended with an assertion ("as you're at the head end"). This prompted 3RU to rephrase the same directive a few seconds later, this time in a less mitigated manner, and with the directive placed after the assertion. The second attempt appeared successful as 3RU did not pursue the thread further. Another possible explanation is that P2 simply did not hear the first directive, although this does not detract from the fact that the phrasing indeed holds ambiguous functions.

The use of this phrasing could also result in delays of actions due to its unclear function. This is clearly illustrated in another example from the transcripts:

(121)
VID193, Utterance 123-130

3RU:	**Do you want to** come up and take the airway, P2? *(08:21 minutes into the dialogue)*	
3RU:	**Do you want to** get some access, P1?	
P2:	Yeah, I can take the tube, cannula	
P2:	whatever you want	
3RU:	You try for some access mate	
3RU:	or **do you want to** take the airway?	*Changes into offer*
P2:	Alright	
P2:	whatever you want	*(08:28 minutes into the dialogue)*

In this slightly longer segment of dialogue, we can see how the directives were mitigated with the "Do you want to…" structure, right from the beginning. These were verbally responded to by one of the hearers in an indefinite term ("whatever you want"). The second set of directives started with a more direct instruction, but because the next utterance turned into an offer, the verbal response was still the same. This whole sequence took approximately seven seconds. In contrast, when the 3RU used a direct instruction right after that, the allocation of task was settled in less than three seconds:

(122)
VID193, Utterance 131-134

3RU:	Airway	*(08:28 into the dialogue)*
3RU:	you go and get the airway	*Direct instruct*
3RU:	You happy with that?	
P2:	Aye, aye	*(08:30 into the dialogue)*

Utterances with this structure necessitated a closer look at the context surrounding the verbalisation to ensure correct annotations. In our data, almost all utterances with this structure were tagged as an *Action-directive* (coded AD) except for three instances where it was clear that the speakers were offering an option to the hearer (coded OFFER) and four instances where the utterances served as queries for information (coded *Info-request* or IR). The list of all "Do you want to X" utterances (n = 42) (also in a few instances transcribed as "Do you wanna X") and the context for each are given in the following Table 51:

Vid.	Speaker	Utterance	Context	Coded
158	3RU	Do you want to come around this side?	Organising paramedic movement	AD
182	3RU	P1, do you want to try and intubate?	Intubating patient	AD
188	3RU	P2, you wanna give me a hand?	Going back to the 3RU vehicle to get some equipment	AD
193	3RU	P2, do you want to get the pads on?	Attaching defibrillator pads	AD
193	3RU	Do you want to come up and take the airway P2?	Intubating patient	AD
193	3RU	Do you want to get some access, P1?	Intubating patient	AD
193	3RU	Or do you want to take the airway?	Intubating patient; 3RU offered an option	OFFER
197	3RU	Do you wanna get to his left arm?	Moving patient	AD
200	3RU	Aye, do you want to come and get on the airway?	Intubating patient	AD
212	3RU	Hey P1, do you want to, do you want to watch for a two-minute cycle for us?	Two minutes of compression before ventilation	AD
212	P1	Do you want to (…) yet?	Sequence of task; P1 asking if P3 wanted to do another task	IR
217	3RU	Do you want to drag him out just now?	Moving patient	AD
219	P1	Do you want to shock before I put this in?	Sequence of task; P1 asking if 3RU wanted to shock first	IR
223	3RU	Do you want to do a wee rhythm check at 14 minutes?	Time of next rhythm check	AD
244	3RU	Do you want to go and give P1 a go on the chest compression?	Swap of person doing chest compression	AD
244	P3	Do you want to grab me an LMA before (…)?	Getting equipment	AD
244	3RU	P1, do you want to go and get some history?	Patient history	AD
244	3RU	Do you want to swap over with P3?	Swap of person doing chest compression	AD
251	3RU	Do you want to leave the bagging just now while, eh…	Stopping ventilations for the time being	AD
251	P3	Do you wanna have a look?	Patient's current rhythm, P3 asking if 3RU wanted to assess rhythm	IR
271	3RU	P1, do you want to move the bed down to us?	Movement of equipment	AD

271	P1	Do you wanna sit him up and drag his clothes off?	Sequence of task; getting patient into position for AutoPulse. P1 was enquiring whether 3RU wanted to do this specific sequence	IR
271	3RU	Do you wanna just sit him up?	Moving patient	AD
290	3RU	Do you want to give a hand dealing with, dealing with the family?	Dealing with bystanders in the scene	AD
290	P1	Do you want to organise some fluids mate?	Medication	AD
290	3RU	Do you wanna grab an end-tidal CO_2 from the…	Getting equipment	AD
294	P1	Do you want to go grab me (…)?	Getting equipment	AD
302	3RU	P1, do you want to try and get some access?	Intubating patient	AD
302	3RU	Right, so then P1, do you want to take airway?	Intubating patient	AD
310	3RU	P1, do you want to set him up with airway please?	Intubating patient	AD
336	3RU	Do you want to get some stuff just ready for P1?	Preparing equipment	AD
371	P1	Do you want to swap places?	Paramedic movement; P1 offering to change position	OFFER
371	P1	Do you want to swap around?	Paramedic movement; P1 offering to change position	OFFER
411	3RU	Do you want to set P2 for a tube?	Assisting a team mate	AD
411	3RU	P2, do you want to try and tube him?	Intubating patient	AD
414	3RU	P4, do you want to go and find the suction?	Getting equipment	AD
417	3RU	If you're struggling with an IV do you want to put an IO[23] in, P2?	Intubating patient	AD
417	3RU	Do you want to try the IO?	Intubating patient	AD
418	3RU	Do you want to do a rhythm check to see what it is?	Checking for rhythm	AD
420	3RU	Do you want to stop for a rhythm check yeah?	Stopping current tasks to check rhythm	AD
420	P2	Do you want to do that side?	Removing patient's clothes; P2 suggesting to team mate to remove clothing on the other side	AD
424	3RU	Do you want to set P2 up for a tube?	Assisting a team mate with intubation	AD

Table 51. List of "Do you want to X" utterances and their contextual clues in the 40 real-life resuscitations

It is possible that this structure triggers more verbal responses as it is in the form of a question. However, the current finding does not lend support to this possibility. From the 42 utterances tabulated, the verbal responses were roughly similar, with 23 utterances responded verbally and 19 not responded to, or at least not verbally.

Where does the structure "Do you want to…" belong on the indirectness scale? Blum-Kulka et al. (1987) described a Want category of request (refer to Table 9 in Section 3.2), but the

[23] IO: Intraosseous (bone) cannulation

category appears to pertain to the wants from the speaker's point of view, not the hearer's. Therefore, the structure in this category would be "I want you to…" rather than "Do you want to…". The question form of the structure places it as part of the Query Preparatory category, and whilst previous studies support this categorisation (e.g. Gao, 1999), we argue that "Do you want to…" is more opaque because it combines a want and a query. Gao (1999) described this structure as a pseudo-question – structured to inquire about the hearer's wish or desire but actually functioning as a request – which makes it hypocritical from the Chinese sociolinguistic perspective and an intriguing choice of pragmalinguistic structure.

A directive that is phrased using this particular structure also does not appear to fulfil the criteria of being verbally succinct and direct, on the basis of it being potentially ambiguous. Why use this at all? It could simply be a common phrasing used in the present context, for a request that does not sound too harsh. 3RU paramedics do not possess higher authority over the other paramedics in the teams even though they have more extensive training in OHCA resuscitation, hence this type of directive may be a way to avoid sounding too autocratic. Furthermore, apart from examples (120) and (121) earlier, there seemed to be no distinctive verbal signs that represent confusion or misunderstanding, for instance, the use of *Signal-non-understanding* or verbal responses that need to be corrected after the phrasing. It is possible that this structure did not pose issues within the teams due to shared linguistic sources. If the resuscitation teams involved non-native English speakers, there may well be some issues with this kind of ambiguity. For instance, Chinese speakers may view this structure in a less positive light.

On dialogue analysis, this finding highlights the importance of context when analysing ambiguous dialogues. In all 35 instances that were identified as directives, the utterance "Do you want to" came with specific context and (presumably) shared awareness, which could be the reasons why the team members had little issues in understanding them as such. Nevertheless, we cannot exclude the possibility that the formal ambiguity of these utterances might lead to delays or misunderstandings. In a time-constrained, high-stakes environment, ambiguity presents risks. There is a reason why direct statements are advocated in aviation and the military. That said, resuscitation communication is dissimilar to communication in these two domains, in that resuscitation does not obligate conventionalised dialogues.

Mitigation strategies in direct commands

The remaining 72.5% of *Action-directive* utterances were verbalised in a less opaque manner (i.e. direct command). This does not mean that the directives were completely unmitigated, although the mitigation strategies were simpler and potentially less likely to affect the force of the directives. The results revealed that, out of the 882 direct *Action-directive* utterances, 318 were mitigated in one way or another. Overall, including directives issued in the forms of request, suggestion/recommendation, and allowances, three quarters of all directives during the resuscitation dialogues (n = 662, 75.0%) were actually issued with mitigating strategies.

Table 52 shows the types and frequencies of mitigation strategies found in direct *Action-directives*. As one mitigated utterance may contain more than one type of mitigation strategy, the total of the types of mitigation (n = 386) is higher than the total of mitigated direct *Action-directive* utterances (n = 317).

	Types of mitigation			
	First person plural pronouns *(we, us)*	Softeners *(okay, if it's alright, please)*	Affective terms *(pal, mate, darling)*	Entreaties *(for me, for us)*
Total	148	173	55	10
Mean	3.7	4.3	1.4	0.3
Range	0 – 12	0 – 19	0 – 7	0 – 2
Median	3	3.5	0	0
% out of 882	16.8%	19.5%	6.2%	1.1%
SD	3.02	4.00	1.97	0.54

Table 52. Types and distribution of mitigation strategies used in direct *Action-directives*

The most frequent type of mitigation strategy was the use of softeners. Most of these came in the form of one-word terms like *okay, right, yeah, please,* or *aye* before or after the main point, for instance:

(123)
VID263, utterance 73: *Right,* we need that oxygen attached
VID182, utterance 66: and carry on with 30 to 2 *alright*
VID263, utterance 108: and get this guy ready to go *yeah*
VID193, utterance 172: *Okay*, just stop
VID212, utterance 89: Grab some suction *please*
VID420, utterance 24: I'm gonna get in where you are *aye*

Other than *please*, which is generally recognised as a politeness marker, other words classed as softeners in (123) are normally viewed as discourse markers. These are included as softeners because they help mitigate the directive by functioning as acknowledgment signals, intimating that the speaker is aware of the force of the ensuing (or preceding) *Action-directive*, i.e. that it is going to obligate the hearer into either performing the action or communicating a refusal.

Other than these, there are also longer forms of softeners. Chief amongst these is a form that includes the term *happy.* Out of the 184 directives with softeners, 13 (7.1%) were *happy*-related. Some examples are listed in (124). Whilst this form did not appear to be especially frequent, the use was quite salient as it more explicitly signalled the speaker's consideration of the hearer's state compared to softeners like *please.*

(124)

VID193, utterance 100:	Everybody *happy* on three
VID289, utterance 105:	You *happy* to intubate with the AutoPulse going?
VID302, utterance 49:	Are you guys *happy* to just sit him forward?
VID411, utterance 21:	and get the story after that if you're *happy*

The use of mitigated language in direct *Action-directive* utterances can be ranked from zero use (completely unmitigated) to mitigated with multiple types of mitigation strategies. The following examples are selected from various dialogues in the dataset to illustrate this continuum within the context of chest compressions.

Unmitigated, direct command	Stop CPR
One type of mitigation strategy (affective term)	You do some CPR, <u>*buddy*</u>
One type of mitigation strategy, used more than once (softener + softener)	<u>*Okay,*</u> back on the chest <u>*please*</u>
Two different types of mitigation strategy (first person plural + softener)	<u>*We*</u>'re gonna continue 30 to 2, <u>*okay*</u>

Higher up the mitigation ladder would be directives that were couched in the structures of request, suggestion/recommendation, weak suggestion/recommendation, and allowance, as follows.

Request	_Can you_ come and do some CPR the now?
Suggest/Recommend	_Do you want to_ go and give P1 a go on the chest compressions?
Weak Suggest/Recommend	_But an OP[24] would be nice though, so…_
Allow	_You can_ do some chest compressions the now

From the findings, it is clear that *Action-directive* utterances were typically mitigated during resuscitation dialogues. There is a continuum of pragmalinguistic strategies associated with directives, from the single incorporation of one mitigation device to a variety of structures that can be quite ambiguous in their communicative functions. The use of mitigation devices to soften what is commonly perceived as a face threatening act is natural; however, mitigated directives in the forms of requests, suggestions, hints, and allowances not only lengthen verbal communication, but admit the possibility of miscommunicated intent, especially if the teams contain speakers with different first languages and cultures. The question of how best to counterbalance the social imperative for politeness with the communicative pressure for optimal efficiency remains open as far as resuscitation is concerned.

5.5.3 Verbalisation of plans and tasks

Planning is widely associated with team effectiveness and efficient communication. In resuscitation, teams that did pre-planning showed better performance during the resuscitation procedures (Marsch et al., 2004). Teams that demonstrated high quality planning behaviours have also been found to utilise more efficient communication during critical phases of their given tasks (Stout, Cannon-Bowers, Salas, & Milanovich, 1999). Similarly, Tschan (1995) found that high-performing teams produced more ideal communication cycles (communication that starts with verbalisations of planning or orientation and ends with evaluation). In contrast, non-articulated plans have been found to cause procedural disruptions during surgery as team members individually projected different expectations of mental models, that is, the cognitive schemas regarding the overall layout plan of a task or procedure (Gillespie et al., 2013).

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[24] OP: Oropharyngeal airway, a device that helps maintain or open airway

The act of planning has also been linked with effective leadership skills. Successful resuscitations have been shown to depend on effective team coordination, which consists of three inter-connecting elements – planning, leadership, and communication (Fernandez Castelao et al., 2013). The verbalisation of a mental model is also deemed to belong under leadership (Thomas et al., 2004; Tschan et al., 2006). Given the links between leadership, planning, and communication, the study of plan-related utterances can potentially provide useful insights into how actual resuscitation teams are coordinated in the early minutes of the procedure.

Very little is known about verbal planning during the early minutes of OHCA resuscitations. The present study investigates the distribution of plan verbalisations in the first five minutes of OHCA dialogues. It also examines how plan-related utterances can be temporally categorised, focusing on the team task of deploying the mechanical chest compression device (AutoPulse). To find out whether leadership performance is associated with either the frequency or type of plan, the verbalisation of plans in resuscitation teams led by highly-rated team leaders and lower-rated team leaders are compared.

Occurrence of *Plan of action* utterances during resuscitation dialogues

To extract plan-related utterances, we used our dialogue annotation scheme, DARe, which contains a thread category called *Plan of action*. The *Plan of action* thread captures utterances that contain the next step that the individual, or the team, needs to perform. As shown in Table 46 earlier, this is the most frequent thread in the resuscitation dialogues, with a total of 2,293 tags, forming 42.7% of the thread type in the dialogues. On average, each dialogue contained approximately 57 *Plan of action* utterances (median = 53; range = 22 – 99; SD = 20.29). This was higher than the preliminary study, where *Plan of action* utterances made up 18.2% of the simulation dialogues (see Section 4.4). This high frequency was also contrary to the low frequency of plan verbalisations found in previous research (e.g. Parush et al., 2014). This may be due to the phase of the resuscitation procedure that is being discussed in the current chapter, i.e. the early minutes, during which there might be a concentration of various tasks that are being planned and coordinated, whereas previous studies, including the preliminary study in Chapter 4, investigated longer procedures, during which most plans might have already been brought into action.

To demonstrate the distribution of *Plan of action* threads across the resuscitation dialogues, each 10% of each of the 40 dialogues (a decile), is examined, following the method described in Section 5.4. Results showed that *Plan of action* was consistently frequent across the deciles, as depicted in the following Figure 14.

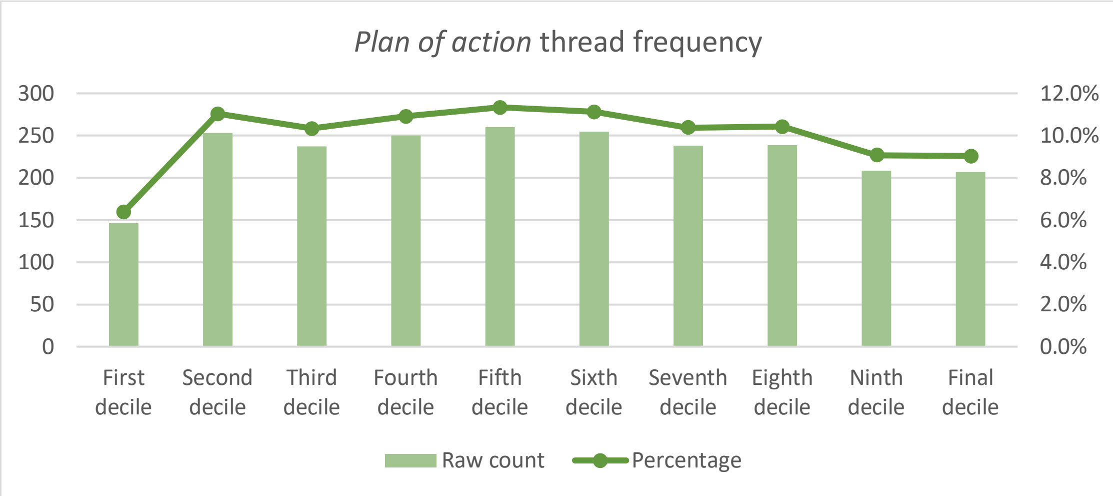

Figure 14. The distribution of *Plan of action* thread per decile for the 40 OHCA dialogues

The 2,293 *Plan of action* utterances were distributed across the 10 deciles with no distinct preference for any segment. An exception is in the first, during which fewer plans were verbalised. This makes sense as team members would need to assess the scene when they first arrived, and then formulate their plans before sharing them. This also explains the high prevalence of plan verbalisations in the second decile of the dialogue. Based on the dataset, the duration of the first decile was generally less than one minute, indicating that the 3RU paramedics in this study literally only took seconds after arriving to formulate and then verbalise their plans.

Temporal classification of *Plan of action* utterances

It was posited in Section 4.5.3 that plan utterances could be classified based on the immediacy of the task or action. By classifying plans this way, the coordination and possible connections of different clusters can be investigated. Using the findings in the preliminary study as a platform and through iterative analysis of the dialogues in the present study, three clusters of *Plan of action* thread were developed, abbreviated here as P.AC1, P.AC2, and P.AC3 respectively. These are described in the following table:

Cluster	Description
P.AC1	Plan for a task that is already underway and needs to be continued or stopped
P.AC2	Plan for a task that needs to be performed right away, immediately following the P.AC utterance
P.AC3	Outline of a plan for a task that will be performed later in the near future but not immediately following the P.AC utterance

Table 53. The three clusters of *Plan of action* thread

P.AC1 is the simplest in the sense that the speaker verbalises a decision to either continue or stop the present task or action. This *Plan of action* thread is usually found for compression-related actions. For example:

(125)
VID244, Utterance 54-56 (P.AC1 cluster)
3RU: Stop chest compressions for a second, P2
3RU: Is that you off the chest?
P2: Yep, yeah

Plans that are to be immediately executed, i.e. right after the verbalised utterance, are tagged as P.AC2. Mostly, this type of thread revolved around the task of moving the patient into position for the mechanical chest compression device, AutoPulse, as follows:

(126)
VID227, Utterance 48-52 (P.AC2 cluster)
3RU: Right, pop him down
P1: Here?
3RU: Up a bit
P1: Right, one two
3RU: That's it

The third class, P.AC3, contains *Plan of action* utterances that are normally more complex because they contained a series of plans that preceded a task. Of the three temporal clusters, P.AC3 perhaps provides the most evidence of future planning for the team and is mostly verbalised in a series of utterances by the same speaker. Therefore, we are especially interested in the prevalence of P.AC3 in the resuscitation dialogues and the tasks that they contain. An example of P.AC3 is as given:

(127)
VID414, Utterance 99-102 (P.AC3 cluster)
3RU: We'll wait until 5.30
3RU: we'll check rhythm
3RU: Check pulse
3RU: And then I'll move him, okay?

Because *Plan of action* is a thread, with the explicit focus of capturing the subject matter under discussion, all related utterances pertaining to the plan are tagged. This often resulted in clusters of dialogue turns, which, when considered separately, would be less obviously part of a thread. For example, if the utterances in example (126) were isolated, the assertion "That's it", on its own, would not reveal any context about the plans.

Out of the 2,293 *Plan of action* utterances in the 40 dialogues, our results showed that a majority belonged to P.AC2 (n = 1,165), followed by P.AC3 (n = 898), and P.AC1 (n = 142). The remaining 88 *Plan of action* utterances that did not fit into any of the three classes comprised questions regarding plans, answers to these questions, self-talk, and abandoned plan-related utterances.

These results revealed that in the first five minutes of OHCA resuscitation, paramedics concentrated on verbalising plans that were immediately executable and not so much on continuing or stopping tasks that were already underway or on general future orientation. This is possibly due to the need to deploy the AutoPulse as early as possible in the procedure. As a result, planning utterances centred around immediately executable tasks of moving the patient, organising movement of team members, and organising or moving equipment. The first example shows a cluster of P.AC2 utterances during a coordinated patient movement, the second shows a cluster of P.AC2 utterances on the organisation of team members, and the third shows equipment-related P.AC2 utterances.

(128)
VID317, Utterance 139-144 (P.AC2 for coordinating patient movement)
3RU: Okay guys, get him down
P2: You want him down like that?
3RU: Just check him first
3RU: Right, bring him down like that
3RU: Just up a little towards me if we can
P1: Uh-huh

(129)
VID193, Utterance 75-81 (P.AC2 for coordinating team members' movement)
3RU: Couple of strong guys, can you come round this side here
P3: Yeah, sure
3RU: You guys, squeeze on over there
3RU: Round the other side of him down by his groin
P2: Yeah, no worries
3RU: Okay, you can squeeze round

(130)
VID217, Utterance 45-46 (P.AC2 related to equipment)
3RU: Pull life band up
3RU: Pop it on

The results for P.AC3 utterances showed that this cluster could appear immediately prior to P.AC2, especially regarding patient movement. When this occurred, it means that the plan is verbalised twice – once before executing the plan and once during the execution of the plan. The shift from P.AC3, i.e. the outline of the plan, to P.AC2, i.e. the execution of the plan, is typically indicated by remarks like "Are you ready" or "When you're ready", such as the one illustrated in example (131):

(131)
VID212, Utterance 57-65 (shift from P.AC2 cluster to P.AC3 cluster)
3RU: So, in a second I'm gonna get youse to take an arm each
3RU: And we'll get the gentleman sitting forward and into the board
3RU: P3, can you just slide down a bit pal
P3: Mh-hm
3RU: **Okay P2 are you ready?** *Prepares for execution of plan; segues into P.AC2*
P2: Yes
3RU: Okay
3RU: On three, one two three
3RU: That's fine

P.AC3 clusters have also been found earlier in the dialogue, separate from the P.AC2 clusters that they corresponded to. In the following example from the same transcript, the P.AC3 cluster to move the patient for AutoPulse was mentioned early in the dialogue (132). The actual execution, i.e. the P.AC2 cluster, occurred later (133).

(132)

VID223, Utterance 41-47 (P.AC3 cluster, first mention of plan)

3RU: What we'll do P1 is we're gonna sit the guy forward
P1: Yes
3RU: And when it's time we slide our board underneath him okay
P1: Aye, aye
P1: Yep
3RU: And then we'll, we'll get him on, uh, machine for chest compression
P1: Right

(133)

VID223, Utterance 105-112 (P.AC2 cluster, execution of plan)

3RU: P1 if you stop CPR
P1: Right
3RU: If you and the police officer come either side
3RU: P3 hold the tube okay?
3RU: One two three
3RU: Into a sitting position
3RU: Pull all that stuff out of the way
3RU: Okay P3, I'll get you to just step to your right…

The P.AC2 cluster continued until utterance 123, when the plan was successfully executed. In both cases, i.e. P.AC3 clusters that appeared immediately before and P.AC3 clusters that appeared earlier before the plan execution, the plans were shared more than once.

To examine whether it is usual or unusual to have repeated plan verbalisations concerning AutoPulse deployment, we examined the dialogues for P.AC3 clusters related to this specific task. The results showed that out of the 40 dialogues, only one did not contain any P.AC3 cluster prior to a P.AC2 cluster that was associated with AutoPulse deployment. On average, for each team, approximately three plan clusters were verbalised prior to the execution of the plans themselves (median = 2; range = 0 – 5; SD = 1.34), indicating that the presence of repeated P.AC3 clusters is a common trend for plans concerning AutoPulse deployment. This suggests that the resuscitation teams were attempting to follow the Perfect 10 guideline shown in Figure 10 (Section 5.2), that is, to start deploying the AutoPulse in the first minute (written as +1 minute in the guideline). As such, plans concerning the deployment of the device were shared early on and repeated until they were successfully performed.

Is this strategy of repeated coordination effective? To date, the effect of this plan coordination on pre-hospital resuscitation teams' performance has never been investigated. The present data does not allow an analysis of this effect; nevertheless, one could compare the verbalisations of plan and the clusters present in teams led by highly-rated leaders and teams led by lower-rated leaders (scores are given in Table 1, Section 5.2). Using the same approach described in Section 5.5.1 to create two groups, the *Plan of action*, the three temporal clusters frequencies, and the presence of P.AC3 AutoPulse-related clusters can be tallied and compared between the two groups. For this analysis, a total of 88 *Plan of action* utterances that were not sufficiently distinct to be categorised into any of the temporal clusters were excluded. Tables 54 and 55 compare the results:

	Ideal score group			
	P.AC1	P.AC2	P.AC3	P.AC3 AutoPulse
Total	57	430	368	42
Mean	4.4	33.1	28.3	3.2
Range	1 – 12	11 – 54	10 – 54	1 – 5
Median	3	34	29	4
% out of 896	6.4%	48.0%	41.1%	4.7%
SD	2.95	13.04	12.15	1.12

Table 54. Ideal score group P.AC utterances

	Low score group			
	P.AC1	P.AC2	P.AC3	P.AC3 AutoPulse
Total	41	345	225	24
Mean	3.2	26.5	17.3	1.8
Range	0 – 7	12 – 39	0 – 30	0 – 4
Median	3	26	18	2
% out of 636	6.4%	54.2%	35.4%	3.8%
SD	1.87	8.14	8.21	1.17

Table 55. Low score group P.AC utterances

The results showed that the two groups differed in both the frequency and focus of plan verbalisations. As depicted in the tables, the ideal score group used more *Plan of action* utterances in general. Percentage-wise, the biggest differences lay in the frequencies of P.AC2 and P.AC3 clusters. The low score group tended to verbalise plans that were more immediate rather than upcoming. Fewer P.AC3 AutoPulse-related clusters were also found in the low score group. Whilst these findings cannot provide evidence regarding the effects of these patterns on the teams' productivity, they do indicate that the evaluation of team leaders' technical skills and non-technical skills are associated with their teams' plan verbalisations.

5.5.4 Closed-loop communication during OHCA resuscitation: Is it necessary?

The use of closed-loop communication or CLC has been repeatedly advocated for communication during medical procedures. Mostly, CLC is recommended in the literature as a communication strategy that contributes to successful team communication, but only a handful of studies investigated its actual occurrence. These showed conflicting results, with some reporting very high closed-loop verbal orders (Taylor, Ferri, Yavorska, Everett, & Parshuram, 2014) and others reporting much lower prevalence (Härgestam, Lindkvist, Brulin, Jacobsson, & Hultin, 2013; El-Shafy et al., 2018). These discrepancies may result from differing definitions of the term *closed-loop communication* (e.g. investigating the full sequence only or any variant of closure) and the setting of the studies (e.g. simulated, real-life, types of medical procedures, equipment used, etc.).

The classic, or as it will be referred to from here on, the *standard form CLC*, that originates from the military requires three distinct stages that are verbalised sequentially – a call-out, a checkback, and an acknowledgement that closes the loop. On the other hand, a simpler or looser form of what is arguably still closed-loop communication only requires the first two verbal stages – a call-out and a checkback. To differentiate this variant of closed-loop communication, this will be referred to as *verbal closed-ended*. A third form of closed-loop communication, one that only uses the first and the third verbal stages – a call-out and an acknowledgement for closure – referred to here as *action closed-ended,* is also identified.

The verbal stages are recognisable from the communicative functions and threads in the DARe coding scheme as described in Section 4.5.4. Using the same approach, the 40 real-life resuscitation dialogues were examined for occurrences of standard form CLC, verbal closed-ended, and action closed-ended communication exchanges, with focus on *Action-directive* utterances to allow more direct comparisons with prior studies. The results are presented in the following Table 56.

	Standard CLC form	*Verbal closed-ended*	*Action closed-ended*	*Open/uncertain*
Total	27	250	386	571
Mean	0.7	6.3	9.5	14.4
Range	0 – 3	0 – 15	2 – 22	2 – 27
Median	0	7	8.5	14
% out of 1,234	2.2%	20.3%	30.8%	46.8%
SD	0.98	3.97	4.83	6.60

Table 56. Comparison of standard CLC form exchanges with other forms of exchanges

Standard form CLC in the early minutes of resuscitation

From the 1,234 *Action-directive* utterances contained in the 40 dialogues, only 27 were standard form CLC, that is, *Action-directives* that were verbally responded to with utterances that fulfil the description of a three-part standard form of a call-out, a checkback, and a closure. The following is an exchange that is similar to the textbook example of a standard form CLC.

(134)

VID290, Utterance 98-100

Speaker	**Utterance**	**Communicative function**	**Thread**	**CLC stage**
3RU:	Alright, so leave him	*Action-directive*	*Movement involving patient*	Call-out
P1:	Leave him	*Repeat-rephrase*	*Movement involving patient*	Checkback
3RU:	Alright	*Acknowledge*	*Movement involving patient*	Close

The standard form CLC exchanges nonetheless mostly varied from the conventional format in terms of the utterances used to signal checkbacks. Often, checkbacks took on the form of one-word acceptances like "Okay" or "Yep" rather than the suggested repetition or rephrasing found in the literature. Checkbacks in the form of one-word acceptances, whilst appearing to serve satisfactorily, are less explicit than repetition or rephrasing of the original directive. This is because one-word generic acknowledgements cannot confirm that the hearer has received the message accurately, merely that she or he has received the message. Nonetheless, this type of checkback formed 16 out of the 27 CLC exchanges. For instance:

(135)
VID158, Utterance 110-112

Speaker	Utterance	Communicative function	Thread	CLC stage
3RU:	Pull the wrap mate	*Action-directive*	*Instrument*	Call-out
P2:	Okay	*Accept*	*Instrument*	Checkback
3RU:	Alright, okay	*Acknowledge*	*Instrument*	Close

(136)
VID417, Utterance 114-116

Speaker	Utterance	Communicative function	Thread	CLC stage
3RU:	Could you stop CPR now?	*Action-directive*	*Compression*	Call-out
P2:	Okay	*Accept*	*Compression*	Checkback
3RU:	Right	*Acknowledge*	*Compression*	Close

(137)
VID317, Utterance 44-46

Speaker	Utterance	Communicative function	Thread	CLC stage
P1:	Shall we do one more wee drag?	*Action-directive*	*Movement involving patient*	Call-out
P2:	Yep	*Accept*	*Movement involving patient*	Checkback
P1:	Alright then	*Performative, Acknowledge*	*Movement involving patient*	Close

(138)
VID294, Utterance 120-122

Speaker	Utterance	Communicative function	Thread	CLC stage
3RU:	Size 4 LMA[25] yeah	*Action-directive*	*Instrument*	Call-out
P2:	Yeah	*Accept*	*Instrument*	Checkback
3RU:	Okay	*Acknowledge*	*Instrument*	Close

The total of 27 exchanges meant that standard form CLC only made up approximately 2% out of the total OHCA real-life dialogues. This result came from the first five minutes of the resuscitation attempts. If one were to analyse the resuscitation dialogues until the end of the videos (the average length of time for the OHCA resuscitation videos in the dataset is 40 minutes), different results may emerge. However, it is possible that the proportion of CLC

[25] LMA: Laryngeal mask airway, a device that keeps airway open

occurrences would remain low as our preliminary findings also showed very few CLC exchanges throughout the entire resuscitation procedures (0.1% out of the total dialogue or one CLC exchange out of 159 *Action-directive* utterances). In contrast, El-Shafy et al. (2018) observed 26.1% closed-loop verbal orders. Since El-Shafy et al. (2018) also applied the standard form CLC description to define the closed-loop exchanges in their study, one can only speculate that the discrepancy might have been due to the nature of in-hospital and out-of-hospital resuscitations. For example, El-Shafy et al. (2018) mentioned the task of obtaining patient blood for laboratory tests, which is typically not performed in a pre-hospital setting. Additionally, the teams in the present dataset utilised the mechanical chest compression device, which was not mentioned, and most probably not used, in the in-hospital paediatric trauma resuscitation analysed by El-Shafy et al. (2018). The addition or deletion of a task and/or equipment would affect the type of directives, which in turn may affect the responses.

The current findings revealed that rather than using the CLC's full three-part exchange format, the paramedics more frequently applied two variant forms that, to some extent, still close the communication loop. The first is in the form of *verbal closed-ended* communication, i.e. *Action-directive* utterances (i.e. call-outs or verbal orders) that are followed by verbal checkbacks but with no verbal closure, and the second is in the form of *action closed-ended* communication, i.e. *Action-directive* utterances that are followed by the required action (non-verbal) and acknowledged verbally immediately after. Figure 15 illustrates the three communication forms.

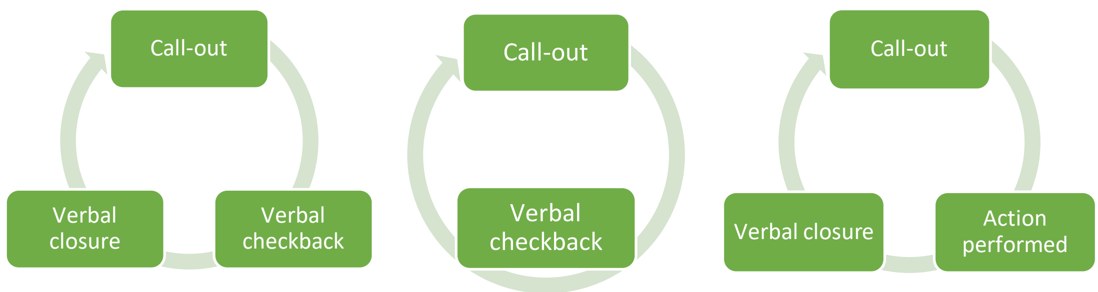

Figure 15. Components in the three variants of closed-loop communication exchanges. Left, standard CLC; middle, verbal closed-ended; right, action closed-ended

The next sections will discuss verbal closed-ended and action closed-ended communication forms found in the resuscitation dialogues.

Verbal closed-ended communication in the early minutes of resuscitation

The verbal closed-ended exchange has been mentioned in previous studies on resuscitation, although it is generally referred to as part of closed-loop communication (Taylor et al., 2014). The description is the same – i.e. utterance specifically acknowledged but no follow through from the first speaker – but the pattern and prevalence are little-known. The present study revealed that verbal closed-ended exchanges occurred in approximately 20% of the *Action-directive* utterances, which was about 10 times higher than the occurrence of the standard form CLC. This finding is similar to the finding from our preliminary study on simulated resuscitation.

The following are verbal closed-ended exchanges from the real-life dialogues. Note that (139) illustrates a double exchange rather than a single exchange:

(139)
VID197, Utterance 23-26

Speaker	Utterance	Communicative function	Thread	CLC stage
3RU:	Do you wanna get to his left arm	*Action-directive*	*Movement involving patient*	Call-out
3RU:	And P2 you get his right arm	*Action-directive*	*Movement involving patient*	Call-out
P2:	Right	*Accept*	*Movement involving patient*	Checkback
P1:	Right	*Accept*	*Movement involving patient*	Checkback

(140)
VID424, Utterance 72-73

Speaker	Utterance	Communicative function	Thread	CLC stage
3RU:	And then we'll LMA her	*Action-directive*	*Plan of action*	Call-out
P2:	Yeah	*Accept*	*Plan of action*	Checkback

As illustrated, what counts as the closed-ended communication's checkbacks are not always in the form of either repeat or rephrase, but rather one-word acknowledgments. These are arguably not ideal, as far as checkbacks go, but the communication loop is still closed. This kind of verbal response differentiates this variant of communication from what the aviation field usually terms as a *readback*, where a directive is repeated, word for word, by the hearer. The example below is taken from the reference guide published by the International Civil Aviation Organisation (n.d., p. 8).

(141)

Control tower:	Big Jet 345, contact Metro Radar 124.6	*Call-out*
Pilot:	Contact Metro Radar 124.6, Big Jet 345	*Readback*

Even though a readback on its own may not have the same safety verbal mechanism imposed by standard form CLC, the repetition of information is arguably better than a generic acknowledgment, as is the usual occurrence in the resuscitation dialogues. This possibly prompted some researchers (e.g. Yamada & Halamek, 2015) to propose the use of proper readback in resuscitation dialogues to repeat back verbal orders.

The dialogues in this study, however, do not contain verbal indications (e.g. admonishment or reprimand) that showed generic checkbacks leading to adverse outcomes. This does not necessarily mean that the dialogues were all error-free following the use of one-word generic checkbacks, merely that to the extent that the current data shows, the team members appeared to comprehend one another. Open questions remain on whether the use of verbal closed-ended communication during OHCA resuscitation is more, or less, effective than using standard form CLC.

Action closed-ended communication in the early minutes of resuscitation

One possible conjecture regarding the lack of use of verbal responses to “close” directives is that verbal responses are not always required for certain contexts. Closer analysis of verbal responses that precede or follow an *Action-directive* in addition to the one(s) directly after the directive can provide more contextual clues. Utterances following the directive can clearly reveal whether the required action or task has been performed even when the hearer did not verbally respond. For example:

(142)
VID223

Speaker	Utterance 121-123	Communicative function	Thread	CLC stage	Context
3RU:	Hold his arm	*Action-directive*	*Movement involving patient*	Call-out	3RU giving a directive
3RU:	Yea, that's it pal	*Acknowledge, Assert*	*Movement involving patient*	-	3RU acknowledges the action
3RU:	Thank you	*Performative*	*Movement involving patient*	Close	3RU thanks the team member for the move

(143)
VID193

Speaker	Utterance 12-14	Communicative function	Thread	CLC stage	Context
3RU:	Can you come and do some CPR the now?	*Action-directive*	*Compression; Plan of action*	Call-out	3RU giving a directive
3RU:	We'll get the AutoPulse on	*Commit*	*Instrument; Plan of action*	-	3RU continues to outline plan
3RU:	Good man	*Performative, Acknowledge*	*Compression; Plan of action*	Close	3RU acknowledges that chest compressions are being performed

It is also possible to infer that an action is performed not only through the acknowledgment of the performed action, but the rejection of the performed action, as shown in example (144). The example also illustrates how the hearer then used a verbal question to ensure accuracy when their initial action closed-ended exchange did not accomplish its aim. Note that the thread code (*Movement*) is a shortened version of *Movement other than patient*.

(144)
VID280

Speaker	Utterance 50-54	Communicative function	Thread	CLC stage	Context
3RU:	P1, you move	*Action-directive*	*Movement*	Call-out	3RU gives a directive
3RU:	You able to go to that side a little bit?	*Action-directive*	*Movement*	-	3RU refines the directive
3RU:	No, the wrong side	*Assert*	*Movement*	Close	3RU rejects the movement, implying that P1 is performing the action as asked, albeit inaccurately

P1:	This way?	*Info-request*	*Movement*	-	P1 verbally requests confirmation
3RU:	Yeah	*Answer*	*Movement*	-	3RU confirms information

Preceding utterances, meanwhile, provide additional contextual clues to the action or task required in a specific *Action-directive*. In the example below, when the 3RU directed P2 to "Press the green", the earlier remark from P2 assists in understanding that the directive is related to the instrument whilst the subsequent utterance implies P2's success in stopping it.

(145)
VID199

Speaker	**Utterance 109-111**	**Communicative function**	**Thread**	**CLC stage**	**Context**
P2:	3RU, it won't stop	*Assert*	*Instrument*	-	Preceding utterance right before directive (AutoPulse is not stopping)
3RU:	Press the green	*Action-directive*	*Instrument*	Call-out	3RU gives a directive
3RU:	There you go	*Assert*	*Instrument*	Close	3RU acknowledges that the action has been done

This third variant of a closed loop – one with the presence of a call-out, no verbal checkback, and a verbal closure – made up approximately 30% of the verbal responses following directives, making it the most frequent form of the three presented in Figure 15. About half of the action closed-ended exchanges occurred during the task of moving the patient into position for the AutoPulse (example 142). Other usual tasks included stopping or starting chest compressions (16.3% of the time, example 143), starting, stopping, handling, or moving equipment (16.3% of the time, example 145), and movement of the team members (7.6% of the time, example 144).

Why is action acknowledgment viewed as a closure? One can argue that when a call-out is accomplished via non-verbal action, and the action is verbally acknowledged, this still closes the loop. In fact, in this case, the verbal order is directly performed *and* performed correctly, as indicated by the approval (i.e. verbal acknowledgments) from the speaker. Otherwise, it is logical to assume that the speaker would verbalise his or her disapproval or repeat/rephrase the directive, as illustrated in example 144 earlier. In a standard form CLC, the checkback is indeed provided and confirmed, but the action is typically not yet accomplished. The verbal acknowledgments in action closed-ended exchanges can therefore signal successful accomplishment of directives, regardless of the fact that the hearer does not verbally provide a checkback to the call-out. One caveat is that the directive needs to contain a task that can be immediately performed and is easily observed by the speaker, such as movements, or stopping and starting equipment. More complex directives, like administration of fluids or actions that involve numbers and quantities of medications, may need a more robust variant verbal exchange.

The higher frequency of the action closed-ended variant compared to the other two variants could indicate that this is a typical exchange in the early stage of resuscitation communication. To our knowledge, this study provides the first data on action closed-ended communication loop in this context.

The total number of occurrences for the three variants of closed-loop communication – the standard form CLC, verbal closed-ended, and action closed-ended – was 657, indicating that 53.2% of the *Action-directive* utterances were closed in one way or another. This implies the possibility that the other half of the directives were verbally open, as far as the data could show. The large chunks of action closed-ended and verbal closed-ended variants revealed a novel strategy that is prevalent in the first five minutes of OHCA resuscitation. Instead of standard form CLC, the paramedics in this study opted to close their communication loops in two other ways.

Are the two variants as theoretically failsafe as the standard form CLC? Possibly not. Standard form CLC allows confirmation of conveyed meaning twice, especially if the second part is a repetition or a rephrase rather than a generic acknowledgment. That said, in OHCA resuscitation, the trade-offs of following this format may be too high. First, standardised phrases that are short and mutually understood in aviation and/or military, for example, “Abort” (definition: terminate pre-planned manoeuvre) and “Over” (definition: my transmission has ended, and I expect a response from you), help automate standard form CLC exchanges, but these are absent from the resuscitation arena. Consequently, resuscitation dialogues are less regimented, making standard form CLC exchanges more complicated. Second, and more importantly, communication during resuscitation is a face-to-face scenario, where the speaker and the hearer can respond to verbal orders with visible actions. This is highly evident in the action closed-ended exchanges. In contrast, an air traffic controller and a pilot rely fully on verbal communication, rendering higher the necessity of accurately conveyed verbal messages. Hence, it may be that the use of standard form CLC for verbal orders in OHCA resuscitation dialogues is not as urgent as the use in aviation and military, and that some particular forms of verbal orders in OHCA resuscitation dialogues can be successfully closed with the two other variants, i.e. verbal closed-ended and action closed-ended exchanges. That said, some specific tasks, such as intravenous line placement in El-Shafy et al.'s (2018) findings, could benefit from using standard form CLC. Further work could elucidate context-effective communication strategies.

5.5.5 *Puck off! I'm not being rude:* Verbal affective behaviours during resuscitation

Utterances related to social functions and affective behaviours have been investigated in previous dialogue research, but this area of study has concentrated on inter-medical interaction. Most of the medical dialogue annotation scheme discussed in Section 3.4 includes categories that relate to affective behaviours. However, because the descriptions of what constitute verbal affective behaviour vary, for the current discussion we concentrate on results from the Roter Interaction Analysis System (RIAS) to allow comparable discussion of results. RIAS has been widely applied in studies that investigate socioemotional or verbal affective behaviours.

Prior findings revealed that verbal affective behaviours in inter-medical communication are quite frequent. Physician and patient utterances relating to affective behaviours, like laughter, compliments, and approvals, were found to average roughly 50 instances per medical session (Roter, Hall, Blanch-Hartigan, Larson, & Frankel, 2011). Paediatricians have been found to use an average of 24 affective utterances, which include compliments or approval, in their dialogues (Wissow et al., 1994). In addition, verbal affective behaviours are encouraged in physician-patient communication due to their reported positive effects. The effect of verbal affective behaviours on alleviating parents' stress levels, for instance, has been documented (Gemmiti et al., 2017).

Previous studies on verbal affective behaviours often presented the results as a cumulation of several categories. However, certain categories, especially explicit expressions of reassurance or empathy, were discovered to be quite infrequent on its own (approximately 6% in Wissow et al., 1994; 4% in Wissow et al., 1998; 5.7% in Roter & Larson, 2001). The frequency of use may have been influenced by context. In a setting where medical experts were required to deliver bad news to patients, expressions of empathy, concern, and reassurance made up 18.2% of the total dialogue (Vail et al., 2011).

These studies revealed a wealth of information about how physicians and patients construct affective behaviours and build partnership, but the same processes have not been investigated in pre-hospital resuscitation team communication. Presently, we can only compare the findings from the real-life OHCA dialogue analysis with the preliminary study on simulated OHCA resuscitation dialogues presented in Section 4.5.5). Results from the preliminary findings showed that verbal affective behaviours during simulated OHCA resuscitation dialogues were less frequent than reported for physician-patient interactions. We previously suggested that this may be a result of three aspects: the different categories selected to represent verbal affective behaviours in this study; the nature of dialogue between expert – expert and expert – non-expert; and the dialogue context. Following the results, each aspect will be discussed.

To examine utterances that constitute positive affective behaviours, we selected categories from DARe that fulfil descriptions similar to the categories that are typically used in previous studies (utterances conveying empathy, reassurance or encouragement, concern, etc.). Utterances that are conventionally used to greet or bid farewell are also included as these also signal positive affective behaviours. These kinds of utterances, as previously discussed in Section 4.5.5, are associated with positive politeness.

In contrast to the preliminary study, where four categories were identified, real-life dialogue analysis revealed six categories – four from the communicative function section and two from the thread section – that can be used to verbalise affective behaviours. In addition to *Affective-performatives*, *Conventional-open-close*, *Commiserate*, and *Social agenda setting*, we recognised the communicative function *Other-assert-social* as a separate sub-category under *Assert* and the thread *Other-wellbeing* as a separate sub-category under *Other*. The description and the frequency of each are given in Table 57.

Component in DARe	Category	Description	Example	Total	Mean per dialogue	%*
Communicative function	*Affective-performatives*	Utterances containing explicit gratitude, apology, compliment, or curses	Thank you Sorry That's fantastic	193	4.8	3.6%
	Other-assert-social (sub-category of *Assert*)	Utterances that belong under *Assert* but identified as a sub-category of statements pertaining to humour, encouragement, or self-talk	Getting all your toys together ey Can't believe I said that	37	0.9	0.7%
	Commiserate (sub-category of *Assert)*	Utterances that show empathy or sympathy	Obviously, you had a great shock this morning	191	4.8	3.6%
	Conventional-open-close	Greetings and farewells	Hello See you	90	2.2	1.7%
Thread	*Other-wellbeing*	Subject matter that belongs under *Other* but specifically concern speaker/hearer well-being	Are you okay? You alright?	41	1.0	0.8%
	Social agenda setting	Subject matter regarding greetings, farewells, introduction of self, etc.	What's your name again? I am …	6**	0.2	0.1%

Table 57. The six categories that make up verbal affective behaviours

**out of 5,365 total number of utterances in the 40 dialogues*

*** The tag* Conventional-open-close *has covered greetings and farewells, therefore, for the* Social agenda setting *thread, only utterances concerning introduction (self and others) are considered for this analysis*

The combination of these six categories illustrates how much of the dialogue is dedicated to positive affective behaviours. Overall, utterances that are identified as part of verbal affective behaviours numbered to 558 in total, averaging 14 such utterances for every dialogue. When examined as a proportion of the total utterances in the 40 dialogues, the six categories made up approximately 10.4% of the OHCA resuscitation dialogues in the first five minutes. This frequency is lower than the frequencies found in previous studies regarding physician-patient communication but is relatively similar to the findings in our preliminary study of simulated resuscitation dialogues.

As noted earlier, the low frequency may be due to three different aspects. First, higher frequencies of verbal affective behaviours in previous findings are very likely due to the incorporation of agreements as part of the affective behaviours, especially in RIAS-related studies. In the present study, agreements (labelled as *Accept* in Dialogue Analysis for Resuscitation or DARe) are not included. The example below is taken from Vail et al. (2011, p. 190), and is used to compare how the same response ("Yeah") is tagged in RIAS and in DARe.

(146)		RIAS coding	DARe coding
Doctor:	I'm afraid it's something we have to check	-	-
Patient:	**Yeah**	*Agree*	*Accept*

Even though *Accept* means agreement of the previous statement's proposal, responding with an *Accept* does not necessarily indicate positive affective behaviour or positive rapport building in our data. Consider the following examples:

(147)
VID188, Utterance 33-34

3RU:	I'm gonna pull him down this way okay	*Commit*
P2:	**Yeah**	*Accept*

(148)
VID193, Utterance 75-76

3RU:	Couple of strong guys, can you come round this side here?	*Action-directive*
P3:	**Yeah, sure**	*Accept*

The responses in the two examples are more indicative of a verbal bond, or perhaps, a verbal contract, stating that the prior action, task, or proposal will be undertaken without opposition. In DARe, responses or utterances that show the kind of agreement that builds rapport would be tagged with one of the six tags in Table 54. This difference in description may be made more pronounced with the dialogue context – previous studies using RIAS were predominantly focused on physician-patient interactions, whilst the current dataset is a medical procedure (discussed below). As such, agreements are not included in our analysis. As agreements typically make up a large proportion of verbal affective behaviours in RIAS-related studies on verbal affective behaviours (Vail et al., 2011), the exclusion of this category is one of the likeliest factors of the low prevalence that we found.

The second aspect, the nature of the dialogues, may have contributed to the agreement-accept category division. The nature of communication between a physician and a patient is different from the nature of communication between members in a medical team. A medical team that is actively performing a medical procedure may concentrate more on task-related utterances (e.g. directives) and less on socioemotional utterances (e.g. reassurance), especially in the absence of bystanders, during which there may be no salient need for empathy or reassurance. This could therefore influence the frequency of verbal affective behaviours in the dialogue.

The third possible reason for the low prevalence of verbal affective behaviours was the dialogue context. A simulated context would likely present a different environment than an actual, real-life resuscitation context, especially if the simulation is conducted with specific objectives, for example, to train a specific set of technical skills. Consequently, lower frequencies of verbal affective behaviours may be observed. Nonetheless, the findings from the real-life dialogues also showed frequencies akin to the simulated setting, i.e. lower compared to previous research findings. This suggests that for resuscitation dialogues, at least, the lower usage of utterances related to affective behaviours may not be related to the simulated or real-life context, but the resuscitation setting itself.

Amongst the different categories that can constitute affective behaviours, the expressions of empathy and/or reassurance have been discussed at length, and as noted, are consistently found to be infrequent in physician-patient dialogues (Wissow et al., 1994; Wissow et al., 1998; Roter & Larson, 2001). To compare these types of utterances with the present data, we examined *Commiserate* and *Other-wellbeing*, which are comparable to prior categories designed to capture expressions of reassurance or empathy. *Commiserate* and *Other-wellbeing* contained 232 utterances combined, making up 4.3% of the total resuscitation dialogue. This finding is similar to previous findings on the frequencies of expressions of empathy and/or reassurance in inter-medical settings, indicating that for this specific portion of verbal affective behaviours, actual team resuscitation dialogues show similar pattern of usage with physician-patient dialogues.

It should be noted, however, that the present results were obtained from the first five minutes of resuscitation. It is possible that higher frequencies would be found by studying different segments of the resuscitation procedure, i.e. from the arrival of the paramedic team until the patient is moved onto an ambulance, from the arrival of the paramedic team until hospital handover, etc.

Team leader scores and the dispersion of verbal affective behaviours

Research into inter-medical communication has established that verbal affective behaviours of physicians are correlated with patients' satisfaction (Hall & Roter, 2012). Whilst it is not viable to assess resuscitation teams based on their patients' satisfaction level, it is possible to compare the prevalence of verbal affective behaviours in the teams based on skills performance scores. As mentioned previously, the team leaders in our dataset have been assessed for their technical and non-technical skills performance by a group of medical experts. This assessment provides a platform to explore possible associations between the scores and the use of verbal affective behaviours; that is, whether teams led by team leaders with higher scores of performance skills differ in their use of verbal affective behaviours compared to teams led by team leaders with lower scores.

To analyse this, the same approach as described in Section 5.5.1 was applied. Five out of the six categories pertaining to verbal affective behaviours were analysed for the two groups. *Social agenda setting* is excluded because there were too few instances in either group (n = 2). The following descriptive results in Table 58 are obtained.

Category	Descriptive statistics	Ideal group (1,899 utterances)	Low score group (1,578 utterances)
Affective-performatives	Total	96	27
	Mean	7.4	2.1
	Range	0 – 17	0 – 4
	Median	7	2
	%	5.1%	1.7%
	SD	5.09	1.50
Other-assert-social	Total	13	8
	Mean	1	0.6
	Range	0 – 3	0 – 2
	Median	1	0
	%	0.7%	0.5%
	SD	0.91	0.87
Commiserate	Total	10	5
	Mean	0.8	0.4
	Range	0 – 3	0 – 2
	Median	1	0
	%	0.5%	0.3%
	SD	0.93	0.65
Conventional-open-close	Total	38	18
	Mean	2.9	1.4
	Range	0 – 17	0 – 4
	Median	7	1
	%	2.0%	1.4%
	SD	2.14	1.50
Other-wellbeing	Total	26	5
	Mean	2	0.4
	Range	0 – 4	0 – 1
	Median	2	0
	%	1.4%	0.3%
	SD	1.22	0.51

Table 58. Comparison of utterances related to verbal affective behaviours in ideal score group and low score group

It is clear from the results that the ideal score group dialogue contained higher frequencies of utterances related to verbal affective behaviours. The difference is most prominent in the *Affective-performatives* category, a category used to label utterances related to maintenance and building of social or emotional rapport, focusing on compliments, apologies, and gratitude. Here, a difference of roughly five utterances was found between the means of the ideal score group and the low score group. Worth noting as well is the *Other-wellbeing* category, where results showed that on average, the ideal score group team members verbally checked on each other twice in every dialogue. These results indicated that skills assessment scores of the resuscitation team leaders could be related to the use of verbal affective behaviours in the teams.

The findings are not conclusive, but the trend is clear – it appeared that groups with ideal scores showed higher frequencies of affective behaviours. It cannot be concluded from the data whether the raters gave higher scores because of the frequency of verbal affective behaviours, or whether the utterances were higher because more effective team leaders (or teams) used them more. In other words, we do not know whether the different scores give rise to the frequency or whether the frequency gives rise to the scores. What is clearly illustrated, however, is a salient difference in the patterns of usage of verbal affective behaviour utterances in the two groups with different skills scores.

5.6 Summary of the five areas related to OHCA resuscitation dialogues

Using the data procured from DARe, we have investigated five distinct areas related to OHCA resuscitation team communication. The findings revealed possibilities that can be utilised in future research, especially with a larger dataset. We discerned a type of verbal statement that signals the current state of the resuscitation procedure, i.e. *State-awareness*, which is part of situation awareness. In giving directives, the results showed that paramedics in the study mitigated their instructions, some of which could be rather indirect, and therefore, ambiguous. Verbalised plans can be classed according to their immediacy, forming temporal clusters that could be useful in determining team effectiveness. The findings also established that standard form closed-loop communication or CLC was not widely used in the early minutes of OHCA resuscitation dialogues. Finally, the findings revealed that even though verbal affective behaviours were infrequently found in the first five minutes of resuscitation dialogues, these were positively associated with the performance of resuscitation team leaders.

The following section discusses possible associations between the communicative function and thread patterns and two selected variables.

5.7 Dialogue patterns and associations with time-to-AutoPulse and team leaders' performance scores

For the present study, two specific variables are investigated. The first represents a team task, that is, the deployment of the mechanical chest compression device (AutoPulse). This can also be considered as an outcome, or one of the milestones, in OHCA resuscitation. The present study attempts to find out whether the time taken by a team to successfully deploy the AutoPulse is associated with the prevalence of specific communicative functions or threads. The second variable is the scores of the team leader's technical and non-technical skills performance (called TS and NTS respectively; described in Section 5.2 earlier). The intent here is to examine whether the rated performance of one person, i.e. the team leader, affects either the communicative function or thread patterns during OHCA resuscitation.

Methods

For the time-to-AutoPulse correlation analysis, Video 293 was excluded as AutoPulse was not used for the patient in this video, leaving 39 videos for the analysis. The time taken to deploy AutoPulse was calculated in seconds. The total time taken for the 39 videos to deploy the device amounted to 8,271 seconds, with a median time of 201 seconds and a mean of 211 seconds. The shortest time taken for AutoPulse deployment was 37 seconds and the longest time was 802 seconds, calculated starting from Utterance Zero. Out of the 39 teams that used the AutoPulse, only five teams did not deploy the device successfully in the first five minutes.

For the performance scores correlation analysis, teams led by leaders who obtained the highest available TS and NTS scores are compared with teams led by leaders who obtained the lowest available TS and NTS scores. The same approach described in Section 5.5.1 is used here.

Communicative functions and time taken to deploy the AutoPulse

The task of deploying the mechanical chest compression device used by the resuscitation teams in this research, the AutoPulse, is a team task as it requires team members to plan and cooperate on behaviours like moving the patient and clearing the immediate vicinity (see Section 5.1 for steps involved in deploying the device). As discussed earlier, AutoPulse needs to be deployed as soon as the 3RU arrives on scene (see Figure 10, Section 5.2).

We first examine whether there is a correlation between the time taken to deploy the device and the frequency of each communication function (percentage), using the Pearson correlation coefficient. For the current findings, only correlations of 0.20 or stronger are reported. Using this threshold, the results showed that all except two categories returned correlations lower than 0.20. The communicative function *Acknowledge* showed a slight association (r = 0.292), whilst the communicative function *Open-option* showed a slightly stronger negative correlation (r = - 0.352). These are illustrated in Figure 16 and Figure 17.

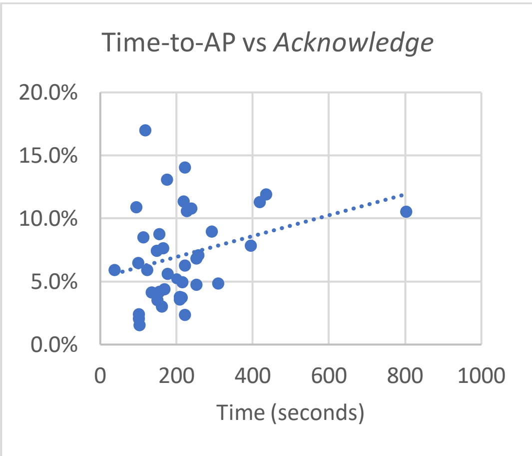

Figure 16. Scatter plot showing positive association between time-to-AutoPulse and the communicative function *Acknowledge*

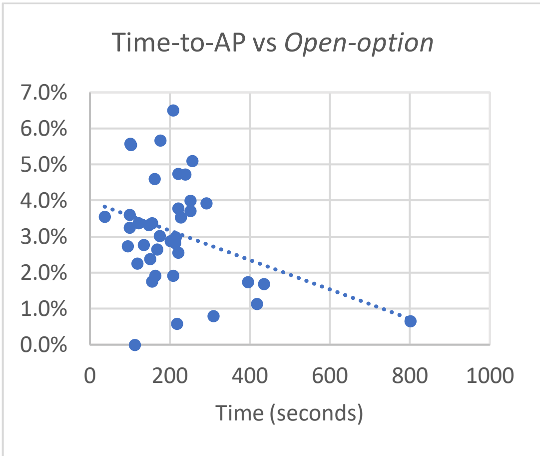

Figure 17. Scatter plot showing negative association between time-to-AutoPulse and the communicative function *Open-option*

When Video 244 (a video that took 802 seconds to deploy the AutoPulse) was removed, *Acknowledge* returned r = 0.264 (Figure 4) and *Open-option* returned r = - 0.239 (Figure 5), which was weaker, but still slightly associated. The following scatter plots showed the associations without the outlier.

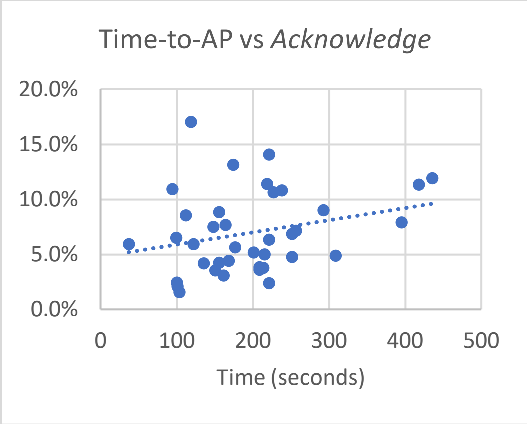

Figure 18. Scatter plot showing slight positive association between time-to-AutoPulse and the communicative function *Acknowledge;* VID244 removed

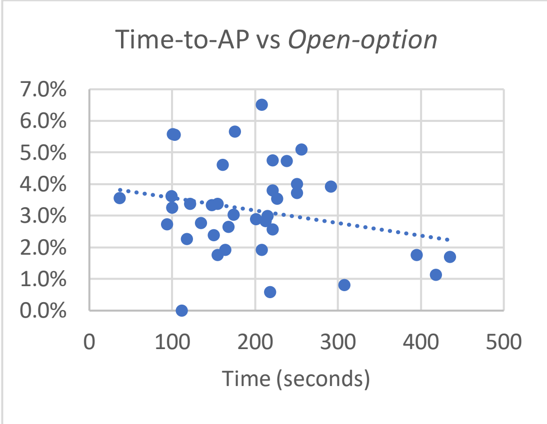

Figure 19. Scatter plot showing slight negative association between time-to-AutoPulse and the communicative function *Open-option*; VID244 removed

The lack of correlation between most communicative function frequencies with time to deploy the AutoPulse suggested that AutoPulse deployment might not be affected by verbal actions. The slight association between *Acknowledge* and the deployment could be due to a higher number of utterances that were responded to with acknowledgments in the course of getting the device ready. These may include utterances concerning the immediate vicinity (i.e. discussions about whether there is sufficient space for AutoPulse) and the patient's history (e.g. past or ongoing medications, etc.). It is highly likely that these thread categories fed into the *Acknowledge* stream, i.e. the longer it took to deploy the AutoPulse, the higher the number of utterances regarding the device or other threads became, and these were responded to with verbal acknowledgments. It should be noted that there is no evidence on the use of acknowledgments leading to longer time to deploy the AutoPulse. The weak negative association between *Open-option* and AutoPulse deployment time is less clear-cut. This could arise because team members switched to the more definite *Action-directive* as the resuscitation proceeded, or simply because *Open-option* was not a preferred communicative function further into the resuscitation process.

It is very likely that other non-verbal-related variables, for instance, the number of people on scene and the size of the area in which resuscitation was taking place were more influential on the time taken to deploy the AutoPulse than the communicative functions used by the team members. This kind of predicament, i.e. constricted space, is clear displayed in several exchanges from one team that took a particularly long time to deploy the AutoPulse

(VID244, 802 seconds). The following six exchanges (149) are all extracted from this team's dialogue. In this scenario, the patient was discovered on the bathroom floor.

(149)
VID244, Utterance 2-6

3RU:	*(3RU just arrived and was surveying the scene)* Space-wise…
3RU:	Hiya, buddy
3RU:	How you doing?
P1:	Very good
P2:	Uh, space-wise no good

Utterance 30-31

3RU:	I don't know if we can get the AutoPulse deployed in this tight space
3RU:	Are you okay just going with that the now?

Utterance 63-65

3RU:	Do you think about if we bring the guy down a bit you'll get a bit of space, P2?
P2:	Err, a bit yeah

Utterance 83-84

3RU:	I just think we're going to really struggle to get the AutoPulse on
3RU:	but we'll get his, get his top cut off just in case

Utterance 110

3RU:	Right, just the space is the problem isn't it

Utterance 141-144

3RU:	I'm just thinking logistically how can we get the chap sat forward
3RU:	and get the AutoPulse on
3RU:	It's gonna be so tight, isn't it?

Communicative functions and team leaders' technical and non-technical skills scores

A chi-square[26] analysis was performed to determine whether there is a significant relationship between team leaders' performance scores and the communicative functions

[26] Chi-square tests are performed under the assumption that the data points are independent. However, this assumption of independence is not upheld for this dataset since we have multiple observations from each speaker and each dialogue. This anti-conservative approach may return false positives. Nonetheless, this method is chosen as a convenient way of establishing apparent discrepancies between the observed counts and those expected under the null hypothesis (i.e. *Affective-performatives* and *Alerter* in the communicative function analysis; *Compression*, *Patient history*, and *Rhythm* in the thread analysis), particularly because we are unaware of an available alternative for modelling data like this with multiple categorical outcomes with repeated measures. Given the large counts in individual cells (in part from the repeated measures), the chi-square test

used in the team dialogues. The test returned a p-value < .001 (df 16, 76.554), indicating that the patterns of communicative function in teams led by leaders with high scores and teams led by leaders with lower scores were different. The data for this are shown in Table 59.

Category	Observed high scores	Observed low scores	Expected high scores	Expected low scores	Contributions to the chi-square statistics	
Accept	182	132	173.23	140.77	0.44	0.55
Acknowledge	155	118	150.61	122.39	0.13	0.16
Action-directive	470	333	443.00	360.00	1.65	2.02
*Alerter**	31	4	19.31	15.69	7.08	8.71
Answer	98	102	110.34	89.66	1.38	1.70
Assert	395	383	429.21	348.79	2.73	3.36
Commit	71	53	68.41	55.59	0.10	0.12
Hold	7	4	6.07	4.93	0.14	0.18
Info-request	181	176	196.95	160.05	1.29	1.59
Offer	23	10	18.21	14.79	1.26	1.55
Open-option	55	52	59.03	47.97	0.28	0.34
*Affective-performatives**	96	27	67.86	55.14	11.67	14.36
Reassert	11	18	16.00	13.00	1.56	1.92
Repeat-rephrase	13	12	13.79	11.21	0.05	0.06
Reject	11	12	12.69	10.31	0.22	0.28
Signal-non-understanding	3	8	6.07	4.93	1.55	1.91
Incomplete	34	48	45.24	36.76	2.79	3.44
	1836	1492	1836	1492	0.44	0.55
Total		3328				

Table 59. Chi-square data for communicative function comparison of the ideal score group and the low score group

The chi-square test data revealed that the communicative functions of *Alerter* and *Affective-performatives* (marked with *) showed the largest discrepancies. Both were observed to be higher than expected in the ideal score group.

Alerter's function is to draw the addressee's attention and is therefore always verbalised as a separate utterance. An *Alerter* can be the addressee's name, a pronoun (e.g. "You"), or a generic term (e.g. "Guys"). This function was discussed and elaborated earlier in Section 5.3.

returns a significant p-value for most comparisons; therefore, we restrict the qualitative analysis to the cases where the chi-square value is largest.

Why would the use of *Alerter* be associated with higher performance scores? A possible reason is that alerters used before giving instructions would optimise the chances that the addressee is paying attention to the speaker as the alerter would have singled out the addressee. Out of the 33 name alerters in the data, 14 were verbally (and clearly) responded to, indicating that the speaker succeeded in catching the addressee's attention, as shown in (150), (151), and (152).

(150)
VID193, Utterance 193-196
3RU: Ian
P1: Yep
3RU: Once we sit him forward could you pull all his clothes off, pal?
P1: Yep

(151)
VID244, Utterance 33-36
3RU: Um, Gary
P3: Yeah
3RU: Ian is going to come and give you a hand with the chest compressions, mate
P3: Okay

(152)
VID411, Utterance 64-66
3RU: Okay, Jess
P2: Yes, boss
3RU: What we'll do is…sit the chap forward

Alerting an addressee to a task minimises the possibility of a 'hanging' instruction, i.e. an instruction that is not clearly directed and has no recipient to take on the responsibility. The use of alerters may therefore be viewed as a sign that a leader is aware of this and is trying to ensure that attention is paid.

Whilst an alerter's function is to draw attention, it can also signal the familiarity level of the speaker with the hearer when names are used. In this case, it is similar to *Affective-performatives*, whose function is to convey socio-emotional content related to building and maintaining emotional or social support, focusing on explicit gratitude, apology, and compliment. *Affective-performatives* belong to the verbal affective behaviour component, discussed in Section 5.5.5. The following are two examples of *Affective-performatives* (an apology and a compliment) and the context they were in.

(153)
VID411, Utterance 80-82

3RU:	Okay, if we can hold his hands up	*Team members were preparing the patient for AutoPulse. Team leader apologised to P2 (pseudonym Ian), possibly because of jostling or because the initial position or placement was not ideal, and the patient needed to be repositioned.*
3RU:	**Sorry, Ian**	
3RU:	it's just, just need to bring him down a little bit, guys	

(154)
VID289, Utterance 28

3RU:	**That's good CPR**	*A team member was doing manual chest compressions. The team leader noticed the high-quality compressions and complimented the team member on it.*

Affective-performatives were highly prevalent in the ideal score group but less so in the low score group. Because *Affective-performatives* utterances are social or emotion-related, the use of this function could provide encouragement to the team. Expressing gratitude explicitly and apologising to the team members indicate that the speaker is aware of socio-emotional conduct even in this time-constrained, high-risk setting, particularly because 3RU paramedics and the ambulance paramedics have similar power status (i.e. they are all on the same scale, except 3RU paramedics have gone into more extensive training regarding OHCA resuscitation). This verbal show of awareness therefore might have influenced the scores.

Our results indicated that team leaders' scores of technical and non-technical skills were associated with the teams' communicative function patterns. Teams led by leaders with higher performance scores were found to use more frequent *Alerter* and *Affective-performatives* utterances. In the next section, we examine whether threads are also affected in the same manner.

Threads and time taken to deploy the AutoPulse

As AutoPulse deployment is a team task, the action may have involved discussions of related subject matter. For instance, the team leader may have to organise the movements of his or her team members, i.e. who stands where or does what in order to move the patient into an ideal position to strap the AutoPulse on (see Section 5.1 for steps involved in deploying the device). What is not known is whether verbalisations of subject matters are associated with the time required to successfully start the AutoPulse. The decision to deploy the AutoPulse is influenced by various factors, including patient size and space limitations (as in Video 293, which was excluded from this analysis).

To look for potential associations between any of the threads and the time taken to successfully deploy the AutoPulse, the Pearson correlation coefficient was repeated for each thread except for *Resolution*, which had no observed frequency. As with communicative functions, the present analysis presents correlations of 0.20 or stronger. Out of the 19 threads, *Compression* and *Patient history* showed positive associations with time-to-AutoPulse (r = 0.364 and r = 0.258 respectively; Figures 20 and 21). *Ventilation* and *State* threads meanwhile returned negative correlations with the time taken to deploy the AutoPulse (r = -0.254 and r = -0.204 respectively; Figures 22 and 23).

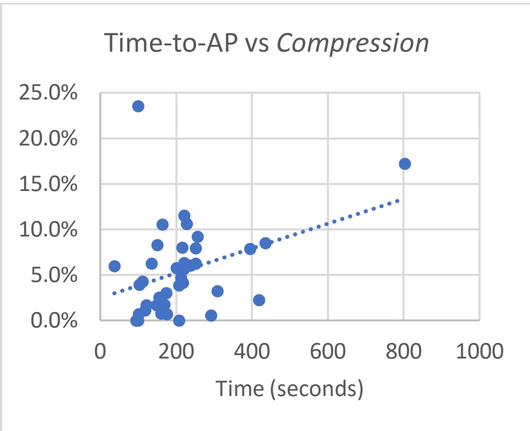

Figure 20. Scatter plot showing positive association between time-to-AutoPulse and the thread *Compression*

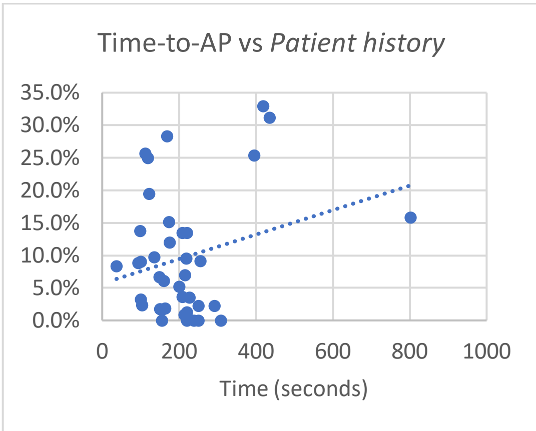

Figure 21. Scatter plot showing positive association between time-to-AutoPulse and the thread *Patient history*

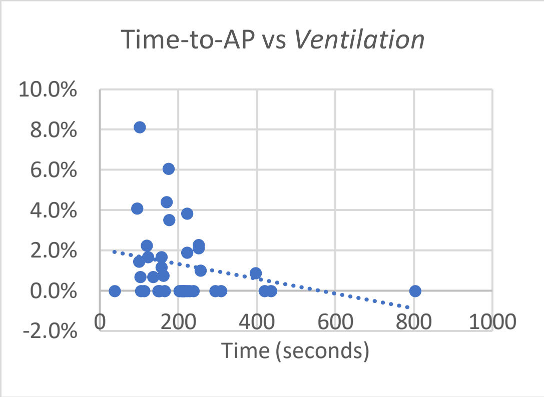

Figure 22. Scatter plot showing negative association between time-to-AutoPulse and the thread *Ventilation*

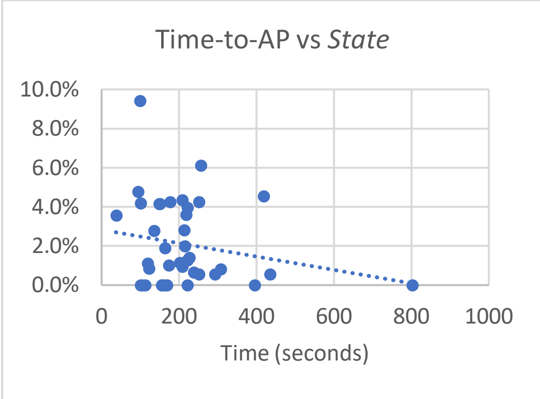

Figure 23. Scatter plot showing negative association between time-to-AutoPulse and the thread *State*

When VID244 (the outlier) was removed, however, only two out of the four threads remained associated with the time-to-AutoPulse deployment, which were *Patient history* (r = 0.267) and *Ventilation* (r = - 0.256). The following show the trends after VID244 was removed.

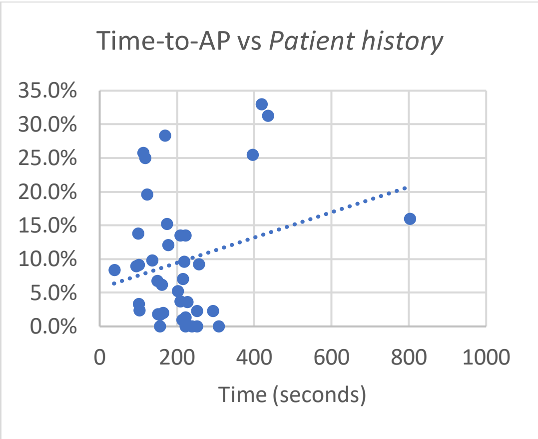

Figure 24. Scatter plot showing positive association between time-to-AutoPulse and the thread *Patient history;* VID244 removed

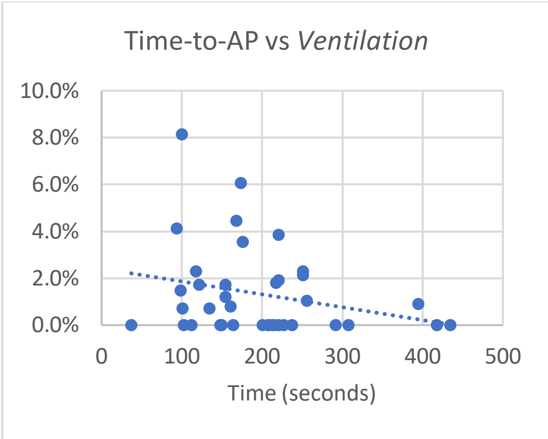

Figure 25. Scatter plot showing negative association between time-to-AutoPulse and the thread *Ventilation;* VID244 removed

The exclusion of VID244 also resulted in two new associations. *Airway access* showed a negative association (r = - 0.318; initially r = - 0.179) with the time taken to deploy the AutoPulse whilst *Movement other than patient* showed a weak positive association (r = 0.229; initially r = 0.01). These are shown in Figures 26 and 27 below. The remaining threads showed no correlations higher than 0.20 with time-to-AutoPulse deployment.

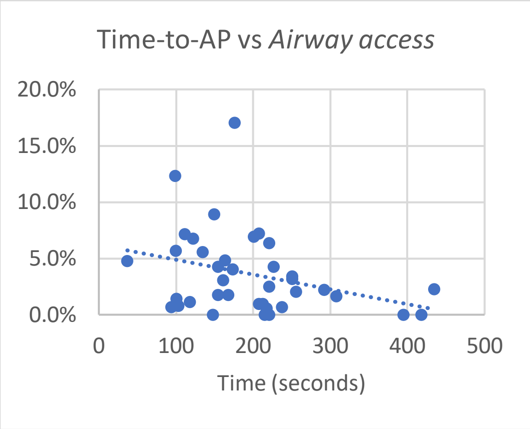

Figure 26. Scatter plot showing negative association between time-to-AutoPulse and the thread *Airway access*; VID244 removed

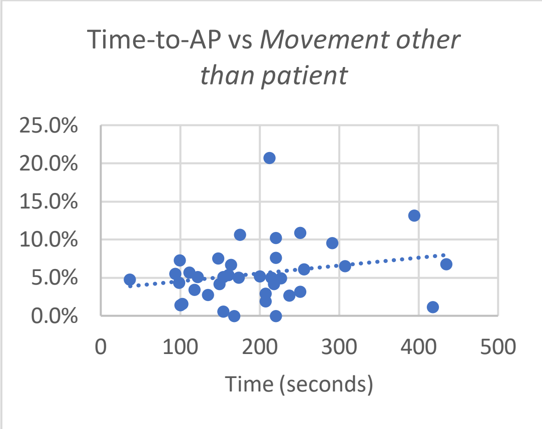

Figure 27. Scatter plot showing slight positive association between time-to-AutoPulse and the thread *Movement other than patient;* VID244 removed

We discuss here the four threads that are still associated with the time taken to deploy the AutoPulse after the elimination of VID244, starting with threads that showed positive correlations (*Patient history* and *Movement other than patient*) and followed by threads that showed negative correlations (*Ventilation* and *Airway access*).

It is possible that team members talked about patient history whilst going through the preparations to deploy the AutoPulse. For example, in the following exchanges, we can see the *Patient history* thread (in bold) interspersed with the task of moving the patient:

(154)
VID200, Utterance 5-13
3RU: P1, can we pull him down a bit?
P1: Aye
P1: **Alright, when did this happen 3RU?**
3RU: Um, uh, I was just here as well
3RU: **This is his bed**
3RU: **The gentleman just found him**
P1: Give me a hand
3RU: **He's been unwell all day**
P1: Give me a hand with his legs

The slight association with more frequent *Movement other than patient* thread could be attributed to the team organisation efforts prior to the device deployment. To move the patient into position, team members often needed to coordinate their own positions. Thus, explicit mentions regarding movements could be slightly more frequent in cases where it took longer to deploy the AutoPulse.

The negative correlations between the threads *Ventilation* and *Airway access* with time taken to deploy the AutoPulse means that the longer the teams took to deploy the device, the fewer threads about ventilations and airway access were verbalised. As ventilations and airway management are related, the finding that both threads yielded the same correlation pattern is understandable. For successful ventilations, an open airway would need to be maintained. These tasks would have been performed early in the procedure, hence, by the time the AutoPulse is deployed, either or both might have been completed, eradicating the need to talk about these two threads.

Closer analysis of the transcripts showed that the *Ventilation* thread usually appeared soon after the AutoPulse was successfully deployed. Examples (155) and (156) demonstrate the dialogue exchanges between a 3RU and a team member regarding ventilation during mechanical chest compressions.

(155)
VID251, Utterance 112-118
AutoPulse start time 04:04, Utterance 112 at 04:22

P2: Will it stop for the ventilation, 3RU?
3RU: Yeah
3RU: it'll give you three beeps
P2: Uh-huh
3RU: And then you vent twice
P2: Quite a quick ventilation, isn't it
3RU: Yeah

(156)
VID289, Utterance 78-79
AutoPulse start time 04:38, Utterance 78 at 05:01

3RU: After the third beep, two vents
P1: Yep

The verbalisation of this thread seemed to cease thereafter. This could be because once a cycle (or two) by the AutoPulse has been completed and team members have had the experience of ventilating the patient guided by the AutoPulse warning beeps, the task went on instinctively henceforth. The results also revealed that the teams that took the longest to deploy the AutoPulse did not verbalise this thread at all, which explains the direction of the correlation for this thread.

Threads and team leaders' technical and non-technical skills scores

To test the independence of the ideal score and the low score groups, another chi-square analysis was performed, but with the exclusion of the *Resolution* and *Reversible causes* threads because these contained zero occurrences. The analysis returned a p-value < .001 (df 16, 135.028), suggesting that the resuscitation dialogue threads were different in resuscitation teams led by team leaders with high scores and in teams led by team leaders with low scores. Table 60 shows the chi-square data.

Category	Observed high scores	Observed low scores	Expected high scores	Expected low scores	Contributions to the chi-square statistics	
Airway access	62	50	63.10	48.90	0.02	0.02
*Compression**	142	55	110.98	86.02	8.67	11.19
Clothing	41	37	43.94	34.06	0.20	0.25
Immediate vicinity	59	73	74.36	57.64	3.17	4.09
Instrument/Equipment	453	299	423.64	328.36	2.03	2.62
Medication	47	60	60.28	46.72	2.93	3.77
Movement other than patient	76	87	91.83	71.17	2.73	3.52
Movement involving patient	215	181	223.09	172.91	0.29	0.38
Non-immediate vicinity	9	21	16.90	13.10	3.69	4.77
Other	113	58	96.33	74.67	2.88	3.72
Plan of action	896	634	861.93	668.07	1.35	1.74
*Patient history**	116	180	166.75	129.25	15.45	19.93
*Rhythm**	118	43	90.70	70.30	8.22	10.60
Shock	42	57	55.77	43.23	3.40	4.39
State	28	42	39.43	30.57	3.32	4.28
Time	69	45	64.22	49.78	0.36	0.46
Ventilation	26	25	28.73	22.27	0.26	0.33
	2512	1947	2512	1947	0.02	0.03
Total		4459				

Table 60. Chi-square data for thread comparison of the ideal score group and the low score group

The results in Table 60 distinguish threads that deviated most strikingly from expectations, namely *Compression*, *Patient history*, and *Rhythm* (marked with *). *Compression* and *Rhythm* threads were clearly far more prevalent in the ideal score group whilst *Patient history* was more prevalent in the low score group.

Closer examination was conducted on these three threads to investigate the patterns of distribution over time. For this purpose, the verbalisation of each thread is analysed based on one-minute segments. The results are illustrated in Figures 28, 29, and 30, as follows. Note that the numbers depicted in the figures are raw counts of the particular thread verbalised during the given minute (e.g. for *Compression*, the ideal score group verbalised this thread 34 times during the first minute and the low score group verbalised this thread 16 times during the same period).

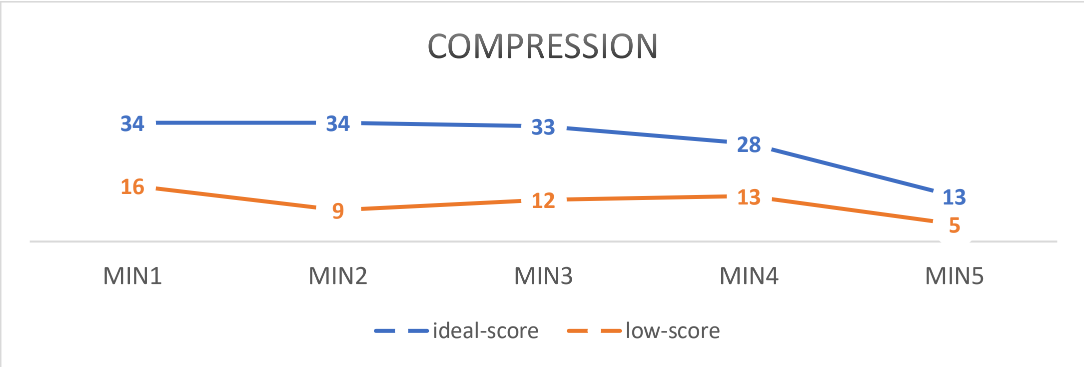

Figure 28. The *Compression* thread per one-minute segments

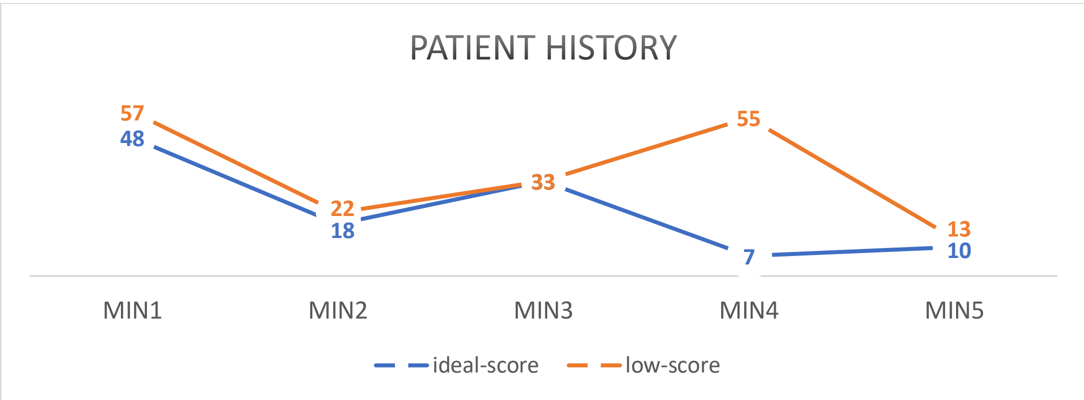

Figure 29. The *Patient history* thread per one-minute segments

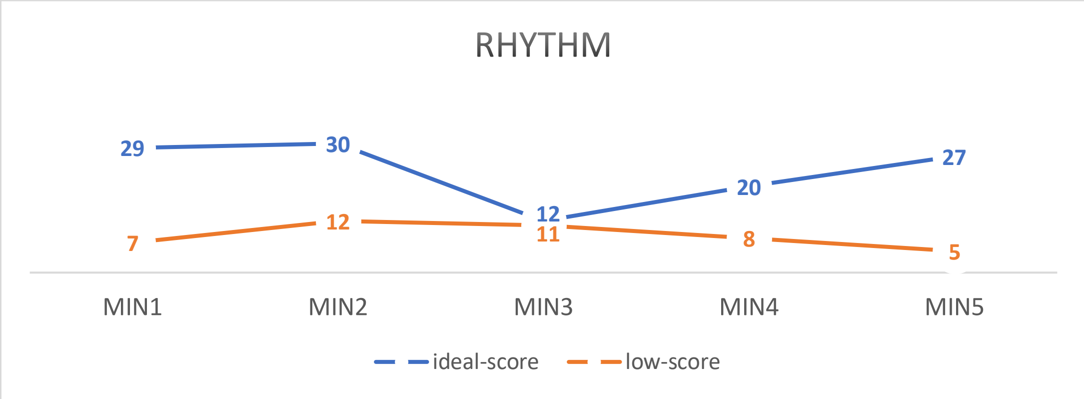

Figure 30. The *Rhythm* thread per one-minute segments

The figures illustrated how the distributions over time varied for the two groups. The *Compression* thread patterns were stable in the first four minutes before declining in the fifth minute. The decline was probably due to the successful deployment of the AutoPulse between the fourth and fifth minutes, thus freeing team members (both from doing and talking about manual chest compressions, e.g. making sure that quality compression was maintained) to focus on other resuscitation tasks. Despite the fact that the ideal score group consistently verbalised this subject matter more than the low score group, it is apparent that the overall patterns were quite similar.

Patient history and *Rhythm*, on the other hand, told different stories. In *Patient history*, the first three minutes displays the same pattern for both groups, both with high prevalence of the thread. Whilst there is no explicit mention of addressing patient history in the Advanced Life Support algorithm (see Figure 2, Section 3.8), the task of gathering patient information is addressed in the Perfect 10 (see Figure 10, Section 5.2). To correctly and quickly treat a patient, it is crucial to gather as much information as possible regarding the patient's medical background or pre-arrest physical state. The importance of understanding patients' medical history has been documented in previous studies as part of the key phases of a medical procedure (e.g. Calder et al., 2017; Gundrosen, Andenæs, Aadahl, & Thomassen, 2016) and was also confirmed by expert paramedics (from personal communication). That said, in the fourth minute, the ideal score group discussion of this subject matter slowed down tremendously. In a striking contrast, the low score group increased the verbalisation of this subject matter. Both groups re-converged in the next minute. What happened in the fourth minute? This could be the juncture during which other resuscitation tasks needed to be accomplished, e.g. getting airway access, administering treatments, and deploying the AutoPulse, amongst other things. The ideal score group ceased communicating about the patient's history to focus on these tasks, but it might be that the low score group was distracted by the task of acquiring patient history. Despite the task's importance, if too much verbal attention is paid to one task, this may affect the quantity (and perhaps, quality) of attention given to other tasks.

The *Rhythm* thread showed different frequencies from the first minute, converged in the middle, and diverged again in the next minute. The patterns possibly revealed the different focus given to patient rhythm management in the two groups. The following segments of transcripts illustrate verbal remarks concerning patient rhythm in an ideal score (Table 61) and a low score dialogue (Table 62).

Timestamp	Transcript	Notes
Transcription starts 11:06 11.55	3RU: Have we had any shocks in guys? P2: No P2: Eh, asystolic since our arrival 3RU: Okay 3RU: How long was it ago?	Initial information shared regarding the last type of rhythm, part of background of arrest
12:53	3RU: Let's just do a wee rhythm check 3RU: and we'll get some pads on P1: Pads are on	First suggestion/reminder to do a rhythm check
13:03	3RU: Let's just see what rhythm we've got there P2 when we get a chance	Second suggestion/reminder to do a rhythm check
13:11	3RU: Stop a wee second 3RU: Right, we've not got a rhythm	First directive to stop compressions and check rhythm, followed by statement about current rhythm
14:19 14:21	3RU: Right, stop a wee second guys 3RU: Let's just see what rhythm we've got 3RU: Just asystole, okay, right	Second directive to stop compressions and check rhythm, followed by statement about current rhythm
15:58	3RU: P2, what I need you to do, is look at that clock, now 11 minutes 3RU: 12 minutes we'll go for a rhythm check okay	Directive for the next rhythm check, part of a plan
16:03 Transcription ends 16:08	3RU: So P2 going to shout out a rhythm check okay?	Reminder about team member's task regarding rhythm check

Table 61. An example of an ideal score group dialogue concerning rhythm management

Timestamp	Transcript	Notes
Transcription starts 01:06 01:21	P2: He's in some kind of agonal thing going on the now P2: CPR […] since he hit the floor 3RU: Yep	Initial information shared regarding current rhythm, part of the background of arrest
03:50	3RU: Every two minutes for rhythm check there P2 yea, if you can eh	First reminder to do rhythm check
04:59 05:01	3RU: So what's the time on the clock? P1: Eh, it's 6.40, 50 P2: It's 6 3RU: So, we'll do a rhythm check 3RU: and then uh go for that tube if you can	Second reminder to do rhythm check
05:18 05:21 Transcription ends 06:06	3RU: Do a rhythm check 3RU: Which is, agonal in nature 3RU: Definitely agonal 3RU: Continue	First directive to check rhythm, followed by statement about current rhythm

Table 62. An example of a low score group dialogue concerning rhythm management

Naturally, the dialogues did not always resemble these two examples completely, but the ideal score group dialogues were more inclined to show the types of exchanges shown in Table 61, that is, containing repeated directives, reminders, and also statements concerning the current rhythm. The low score group dialogues, meanwhile, tended to have fewer of these exchanges.

Summary

We investigated two variables, namely the time taken to deploy the AutoPulse and team leaders' performance scores, to explore possible relationships with either the communicative functions or thread patterns in OHCA resuscitation dialogues. Except for a few weak associations, i.e. *Acknowledgment* and *Open-option* in the communicative function analysis; *Compression*, *Patient history*, *Ventilation*, and *Airway access* in the thread analysis, generally, the time taken to deploy the AutoPulse is not significantly affected by the types of communicative function and thread.

On the other hand, resuscitation teams' dialogue patterns can be associated by their team leaders' technical and non-technical skills performance scores. By focusing on results that appeared to differ most strikingly from expectations through the chi-square values, we can trace the differences to the most influential categories for more in-depth qualitative analysis, which are *Affective-performatives* and *Alerter* in the communicative function analysis, and *Compression*, *Patient history*, and *Rhythm* in the thread analysis.

5.8 Summary of findings from the early minutes of OHCA resuscitation

In this chapter, we investigated 40 real-life OHCA resuscitation dialogues, focusing on the first five minutes of each resuscitation attempt. Our intention is to determine dialogue patterns, in the forms of communicative function and subject matter thread distributions, and explore related areas involving communication during the early minutes of resuscitation. Additionally, we attempt to discover if these distributions are associated with two variables – time taken to deploy the AutoPulse and team leaders' performance scores. As with the preliminary study on simulated resuscitation in Chapter 4, the Dialogue Annotation for Resuscitation (DARe) coding scheme is used to annotate the transcripts. Overall, the data in the present study consist of 5,365 utterances. Each utterance is annotated twice; once for its communicative function, and once for its thread.

The results revealed high frequencies of *Assert* (statements of fact or belief) and *Action-directive* (commands, instructions, requests, etc.) in the Forward Communicative Function. When responding, i.e. in the Backward Communicative Function, paramedics frequently used *Accept* and *Acknowledge* to verbalise acceptance and agreement, in place of other means of showing acquiescence, such as by completing the previous speaker's utterance. There were very low frequencies of rejection. Further examination of *Assert* showed that this function was mainly used to provide information (*Information-giving*), state conclusions (*Conclude/Deduce*), and inform others of the current situation (*State-awareness*), whilst further examination of *Action-directive* showed that the most frequent form was direct instruction (*Direct/Instruct*), followed by request (*Request*). When questions (*Info-request*) were asked, they were mostly in the closed-question form, i.e. could be answered with yes/no.

The results also revealed two new communicative functions that were either not found or not frequent enough to be distinguished as a function of their own in simulation dialogues, namely *Alerter* and *Other-assert-social* (a sub-category under *Assert*). The presence of these functions may mark a communicative difference between the simulated scenario and the actual scenario, although another interpretation could be that the simulation dialogues were too limited to produce these two functions.

Results from thread analysis showed that the dialogues mainly revolved around planning (*Plan of action*). This was followed by threads on instrument (*Instrument/Equipment*) and moving the patient around (*Movement involving patient*). The higher occurrences of thread concerning patient movement in the real-life dialogues indicates that in simulated settings, less attention is paid to the task of moving the patient about, a task that is performed often in actual resuscitation. This is a clear difference between resuscitation in simulated setting and real-life setting. Similar to the simulation findings, thread distributions were found to be permeable to external factors, such as the space, the type of rhythm, and AutoPulse use. The thread trends across segmented sections based on utterance and time demonstrated that threads fluctuate according to the current focus.

The frequency results were further utilised to explore five distinct areas related to resuscitation dialogues. The results from the first area, verbal alignment, showed that paramedics employed the communicative function of *State-awareness* to align themselves to the current situation. Whilst the contribution of *State-awareness* to the resuscitation dialogues may not be measurable in terms of outcomes, i.e. whether the use of this function is correlated with team effectiveness, *State-awareness* was more frequent in teams led by highly-rated leaders (the ideal score group) compared to teams led by lower-rated leaders (the low score group). In the second area, results showed that 75% of all directives were mitigated to some extent. We also observed the use of a suggestion phrasing that can be ambiguous. The third area, verbalisation of plans, revealed that whilst plans were consistently verbalised throughout the dialogues, the clusters of plans varied between the ideal score group and the low score group. In the first five minutes, the ideal score group tended to verbalise AutoPulse-related plans that were clustered as general orientation, whilst the low score group tended to focus on immediate tasks of a non-AutoPulse nature.

The fourth area concerned the occurrence of standard closed-loop communication, or CLC, in verbal directives. The findings showed very few CLC exchanges in the dialogues. In fact, half of all directives did not show any verbal closure. Directives that were verbally closed commonly used either one of two variants of closed-ended communication: the verbal closed-ended and the action closed-ended communication, both of which differ from standard CLC in the forms of their checkbacks. Finally, by exploring utterances related to verbal affective behaviours, we discovered that resuscitation dialogues contained relatively few socioemotional expressions. However, the ideal score group displayed higher frequencies of verbal affective behaviours compared to the low score group.

The present study also investigates possible associations between communicative functions and thread patterns with two variables – the time taken by a team to deploy the AutoPulse, and the team leader's technical and non-technical skills performance scores. The results showed that the time-to-AutoPulse was associated with two communicative functions, *Acknowledge* and *Open-option,* and four threads, *Compression*, *Patient history*, *Ventilation*, and *Airway access*. Team leader's performance appeared to correlate with the frequencies of both communicative functions and threads. As expected, there were certain functions and threads that were used either more frequently or less frequently in teams led by leaders with different performance scores, and these differences are sufficiently observable in the first five minutes after the team leader's arrival on scene. By tracing the source of the largest differences in both components, we determined that the communicative functions *Alerter* and *Affective performatives* and the threads *Compression*, *Patient history*, and *Rhythm* contributed the most to the variations between the ideal score group and the low score group.

Studies that focus on real-life resuscitation communication have been quite limited. Scarcer still are studies on paramedic dialogues during pre-hospital resuscitation. To date, it is not known whether there are other studies that investigate this setting using a dialogue annotation tool that is developed based on a linguistic framework. The novel area of research thus means that the findings in the present study are largely descriptive and exploratory in nature. Nonetheless, the study has established some grounds that would be useful to support further research in this area.

6

Conclusion

In Scotland, only approximately one out of 20 people who suffer from out-of-hospital cardiac arrest (OHCA) is reported to survive to a hospital discharge (*Out-of-Hospital Cardiac Arrest: A Strategy for Scotland*, 2015). This number has increased slightly over the years following a nationwide intervention programme (Clegg et al., 2018), but numerous unexplored avenues remain that can contribute to the optimisation of the resuscitation procedure. The study presented in this thesis offers one of these avenues. It contributes by exploring paramedic communication during OHCA resuscitation attempts to identify current patterns and practices in the dialogues that can help improve resuscitation. The findings, implications, and future research directions are reviewed briefly in this final chapter.

6.1 Present research context

Communication research in the medical setting can be largely divided into two major domains – the first focusing on inter-medical communication, i.e. communication between medical practitioners and lay persons; and the second on intra-medical communication, i.e. communication between medical practitioners. Inter-medical communication research typically investigates physician-patient interaction, for instance, during medical consultations, which are almost always dyadic in nature. Meanwhile, intra-medical communication research examines various medical teams, for instance, surgery teams, which generally contain more than two interlocutors. The research presented in this thesis fits within the larger context of work in the intra-medical communication domain, taking resuscitation teams as its focus.

Previous studies on medical teams largely consider communication as part of the non-technical skills dimension. Consequently, communication is often subsumed under a multitude of observable skills such as leadership, teamwork, decision-making, and situation awareness. Intra-medical communication research also chiefly examines in-hospital rather than out-of-hospital/pre-hospital setting and simulated rather than actual settings. On the other hand, inter-medical communication studies are more frequently conducted in real-life settings. More importantly for the present research aims, studies on physician-patient interactions have focalised the communication acts by using the dialogue annotation approach. Emulating this, the present research applies the same approach to resuscitation team communication using a bespoke annotation system, the Dialogue Annotation for Resuscitation (DARe) coding scheme, which draws on Speech Act Theory for a fine-grained, line-by-line resuscitation dialogue analysis. Dialogue annotation analyses have been used in previous research to show correlations between linguistic structures and outcomes (Hunziker et al., 2010; Riou et al., 2018; Svensson & Andersson, 2006).

The present study sets out to identify communication patterns during OHCA resuscitation. The aim is to conceive an anatomy of pre-hospital resuscitation dialogue that can help improve our current understanding of how communication takes place in this setting, identify possible associations with specific variables, and pinpoint potential areas for further investigation, in order to contribute to the optimisation of resuscitation.

6.2 Review of findings and contribution

In essence, the results reported in the present research show that paramedic communication during OHCA resuscitation comprises a set of patterns regarding its communicative functions and threads. OHCA resuscitation dialogue patterns are similar to other types of dialogues, both medical and non-medical, in terms of the high frequency of statements or assertion-related utterances (e.g. concluding, information-giving, stating current scenario or condition) and similar to other medical team dialogues, like surgery team dialogue, in terms of the high frequency of directives (e.g. instructing, requesting, suggesting). The preference to use acknowledgments, acceptance, and answers for frequent verbal responses are also comparable to prior results. However, the proportion of questions set OHCA resuscitation dialogues apart. Compared to previous findings in dialogue research, the frequency of questions or queries in resuscitation dialogues is relatively low. These communicative function distributions hold true for the dialogues during both simulated and actual resuscitations. There are also evidence of sociolinguistic influences in the dialogues. As the data in the present study are collected from mostly Scottish paramedics based in Edinburgh, Scotland, some terms (e.g. *wee; just now; the now; aye*) and structures (*Do you want to...; Crack on; Are you happy?*) are associated with the UK English generally and Scottish English specifically. As far as the data is concerned, the shared linguistic context of the paramedics in our study means that these variations pose little or no communicative barriers.

Thread analyses show that, in general, OHCA resuscitation dialogues most frequently revolve around four areas of subject matter, namely planning, patient history, instrument or equipment, and chest compression. The remaining 16 threads are more susceptible to variations in the resuscitation context, such as the use (or non-use) of the AutoPulse, type of rhythm (shockable or non-shockable), space, and bystander interaction. In the simulation setting, where only two teams are involved with AutoPulse, there are very few threads related to space and movement. In contrast, the thread concerning patient movement is one of the most frequent threads in the real-life resuscitation dialogues. The order of interaction shows that threads are raised or dropped based on the current focus of the teams. The thread related to greetings, for instance, are only observed at the beginning of the dialogues, whereas threads related to the outcome or resolution, i.e. to stopping the resuscitation attempt or the return of spontaneous circulation, are only found at the end.

Delving deeper into the intricacies of dialogues, the study proceeds to explore five distinct areas related to resuscitation communication: the use of a communicative category called *State-awareness* as part of verbal situation awareness, mitigation strategies in giving directives, verbalisation of plans, the occurrence of closed-loop communication, and the occurrence of verbal affective behaviours. In short, the results show that team members use *State-awareness*, i.e. verbal signals of their current state or action with no verbal prompts, in about 30% of statements or assertions. Directives are mostly mitigated using various forms or strategies, from simple insertions of softeners like *please* into a command to different pragmalinguistic conventions like recommendation and authorisation of action. Meanwhile, plans are continuously verbalised throughout the dialogues, ranging from plans for tasks that are already underway to general or overall orientations. There are very few standard closed-loop communication cycles in the dialogues, although closed-ended communication – that is, the closing of communication loops with verbal acknowledgment or with action – is more frequent. Finally, resuscitation dialogues contain relatively few occurrences of verbal affective behaviours.

Some of these findings differ when teams that are led by highly-rated leaders (the ideal score group) are compared to teams led by lower-rated leaders (the low score group). The ideal score group dialogues show slightly higher frequencies of *State-awareness*, focus twice as much on plans revolving around the deployment of the AutoPulse, and contain more verbal affective behaviour utterances. A summary of paramedic dialogues during OHCA resuscitation can perhaps be given as thus:

OHCA resuscitation dialogues focus on immediately executable plans. Teams mainly communicate using statements or assertions that in a large part function to align the team members with the current task or state. The dialogues also contain a high proportion of directives, which are mostly mitigated to some extent. Responses to statements and directives are typically in the forms of acceptance and acknowledgment, although these are not frequent enough to form full cycles of the standard closed-loop communication strategy. Few utterances are dedicated to socioemotional elements during resuscitation.

Even though the results are not definitive, these patterns help indicate how OHCA resuscitation dialogues are structured. The patterns are similar for both simulated and real-life resuscitation dialogues, even though only the first five minutes of the real-life resuscitation dialogues are analysed here.

There are, nevertheless, two major differences that are found when simulation and real-life dialogues are compared. First, when annotating real-life resuscitation dialogues, two additional communicative functions – *Alerter* and *Other-assert-social* – are observed. These are either not present or rarely found in the simulated dialogues. The frequent occurrences of *Other-assert-social,* which pertains to positive politeness (e.g. using humour, showing gratitude, and giving compliments), raises an interesting question: Do people constantly verbalise affective behaviours more frequently in real-life setting compared to in simulated setting? If yes, could this be due to the awareness that there are observations going on during simulations, normally for assessment purposes? Does this awareness inhibit the use of verbal affective behaviours? More detailed findings in this research area could inform dialogue annotation researchers of how dialogues naturally unfold in controlled environment, such as in a laboratory or during a simulation, versus in real-life. Second, as mentioned earlier, the threads related to space and movement are far more frequent in the real-life dialogues and far less frequent in the simulated dialogues. As threads indicate the semantic content of the utterances, the low frequencies of threads concerning movement and space (i.e. *Movement of patient, Movement other than patient, Immediate vicinity,* and *Non-immediate vicinity*) reveal that this domain is not particularly emphasised in simulations, even though it appears to be one of the central themes in the actual setting. Simulations would be more faithful to the actual context if this particular circumstance is applied, that is, conducting simulations in a limited space rather than in a clear room.

Whilst our findings in the current study are not sufficiently robust to validate the faithfulness of the simulated settings to real life settings, they provide an important foundation for future research in this direction. The differences that we discovered suggest that detailed dialogue analysis is useful in detecting changes in communicative patterns and to identify differences between the dialogue patterns in simulations and real-life settings.

For the real-life dialogues, the study also attempts to discover whether the prevalence of communicative functions and subject matter under discussion are associated with two types of outcomes – one that is individually related (non-technical skills and technical skills ratings of the team leaders) and another that is a team task (the time taken to successfully deploy the mechanical chest compression device, AutoPulse). Results show that both communicative function frequencies and thread frequencies are correlated with the performance scores of the team leaders. Ideal score group dialogues contain more frequent occurrences of the communicative functions *Alerters* and *Affective performatives* and the threads *Compression* and *Plan of action.* In addition, the ideal score group also focused on the *Patient history* and *Rhythm* threads at different junctures of the procedure compared to the low score group. The time taken to successfully deploy the AutoPulse, meanwhile, is associated positively with the frequencies of acknowledgments, as well as threads pertaining to the patient's medical history and movements of team members. It was also negatively associated with the communicative function *Open-option* and the threads *Ventilation* and *Airway access.* Whilst leadership has been correlated with team performance regarding technical skills (Yeung et al., 2012), our findings provide evidence that resuscitation team leaders' observed performance is also associated with the teams' dialogue patterns.

Another contribution from the present study is the coding system DARe. The many extant annotation schemes have produced a considerable pool of literature, but none has been developed to capture the resuscitation procedure, and few draw from Searle's (1976) Speech Act Theory, which has been proven to be a useful framework for coding analysis (Laws et al., 2009). The development of DARe is discussed at length in Chapter 3. The results from the communicative functions analyses share common ground with results from other dialogue annotation studies that are based on the speech act framework, especially studies that utilise the Dialogue Markup in Several Layers (DAMSL) outline, which forms the structure for DARe. The equivalent coding descriptions of communicative action classes under the Forward Communicative Function and Backward Communicative Function ensure that results are comparable regardless of differences in contexts. This eases comparison and reference. In addition, DARe also allows the annotation of the tasks related to the resuscitation procedure, making it a useful tool for analysing how tasks are verbalised.

Potential measures for optimising OHCA resuscitation communication

Based on our results, we propose several actions, challenges, and potential solutions that may be helpful in optimising communication during OHCA resuscitation:

1. Paramedics to wear sewn-on name badges to identify themselves to others. This allows speakers to attract the hearer's attention (especially before giving instructions) without having to personally know the hearer. A hard name badge could pose a risk (e.g. it could snag on equipment, etc.), but a sewn-on cloth name badge will not.
2. Resuscitation teams to restrict the extraction and discussion of patient history to the first three minutes of the procedure. This means that team leaders need to be aware and in control of the current topic(s) of discussion and prepared to get team members to focus on other tasks. A foreseen challenge is that resuscitation teams

may be reluctant to calculate the length of time taken to discuss patient history, especially because the knowledge is considered vital. As a possible solution, we propose that resuscitation team leaders are trained on the optimal ways to extract information from bystanders, both linguistically (i.e. which pragmalinguistic strategies to be used) and behaviourally (i.e. non-verbal conduct). One of the ways is to limit open questions when talking to bystanders.

3. Resuscitation team members to practice verbalising statements that keep one another aligned to the procedure and to acknowledge such statements. One foreseen challenge is to avoid too many overlapping statements, which would lead to lack of attention or misunderstanding. We propose that *State-awareness* statements should focus on critical points of a task, for instance how many times a shock has been administered, or how much adrenaline has been given.
4. Paramedics to train verbalising shorter (i.e. more succinct) directives. A possible barrier to this is the need to show politeness, or to wish to save a hearer's face. We believe that there needs to be an overall acceptance in the resuscitation domain that direct instructions do not equate impoliteness. Paramedics can be made aware that the use of verbal affective behaviours would signal politeness sufficiently well and would not interrupt with administration of directives.

Finally, we would like to add that closed-loop communication may be useful in specific resuscitation tasks, although it is not practical to apply this strategy using its standard, three-part form to all directives. Whilst our own data simply illustrate the infrequent usage of this strategy and thus, cannot be used to determine its effectiveness, we second Yamada and Halamek (2015) on their suggestion to standardise phrases used in the resuscitation context. This is a step towards more reasonable use of CLC as standardised phrases are simpler and easier to repeat. Our dialogue data showed that, at least for defibrillation, paramedics have already employed a set of similar, almost standardised phrases (e.g. “Stand clear”, “Shocking”). Defibrillation can perhaps be used as a point to test the viability of standardising phrases and consequently, using CLC.

6.3 Limitations and future directions

The current research establishes some ground for future work on dialogue analysis during pre-hospital resuscitation. The work presented in this thesis, whilst exploratory in nature, is also the first step into a huge and under-explored research domain. Naturally, this generates open questions that are waiting to be answered. Some of these are considered here.

The study presented here focuses on a small number of simulations and real-life resuscitation attempts. For the real-life resuscitation dialogues, the focus is on the first five minutes of the procedure. Whilst this is intentional for the present purposes, this raises the question of whether longer transcriptions of real-life resuscitation dialogues would yield different dialogue patterns, especially threads. For instance, we already know that certain threads, like *Resolution* and *Reversible causes*, are more likely to emerge near the end of the dialogues rather than in the first five minutes.

As it takes many hours to manually transcribe and annotate dialogues, this opens the question of whether transcription of the videos can be automated and DARe incorporated into an automated tagging system for annotations for richer datasets. Even with the available data, the results from DARe have been shown to be able to discriminate patterns between ideal and low score groups and distinguish associations between distributions of functions with selected variables. With more data, could DARe perhaps be utilised to predict outcomes, such as the time taken to successfully secure a patient's airway, or the time taken to be ready for extrication to ambulance, based on the dialogue patterns that it acquires? After all, prior research has established correlations between specific dialogue structures with outcomes (Hunziker et al., 2010; Mirza et al., 2008; Riou et al., 2018; Rodriguez et al., 2014; Svensson & Andersson, 2006). More dialogue data would enrich this line of study. Attempts to manage, or ease, manual transcriptions have been conducted before. For instance, RIAS (Roter & Larson, 2001) annotates audiotapes directly using direct entry software, hence skipping the transcription stage. Other researchers have attempted to develop automatic annotation tools that can tag different types of speech acts (Georgila, Lemon, Henderson, & Moore, 2009). Machine learning may be the way forward for dialogue annotation studies.

6.4 End word

The aim of the present research is to examine patterns of communication during OHCA resuscitation, and through these, identify potential elements that can either contribute to or hinder optimal resuscitation. This aim, we believe, has been achieved – not that the full story has been told, but enough to fill in some gaps and to proffer a base for future works in the area. To optimise a procedure, one first has to gain some familiarity of the current scenario. This research offers evidence of the current scenario by utilising DARe, the first dialogue annotation scheme tailored for pre-hospital resuscitation, yielding promising results and presenting a vital first step towards expanding our understanding of the nature of pre-hospital resuscitation dialogues.

The present research, in other words, is akin to mapping an island that has never been explored before by examining what the island is made of and determining its various landmarks. We have marked some places where possible treasures (or dangers) could be found. But at this stage, the map is still rudimentary, and further explorations are needed in order for it to be completed.

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Appendices

Appendix A

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.	"Okay it appears asystolic now"
	Situation-awareness Utterances that keep everyone on the same page, usually the current stage.	"That's fluid attached"
	Forward-course Descriptions or outlines regarding the next course of action.	"20 seconds til next rhythm check"
	Commiserate Utterances that show empathy or sympathy.	"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.	"Continue ventilations"
	Recommend/Suggest Utterances couched so as to suggest that it is the speaker's advice, not necessarily an order.	"And let's start thinking about execution"
	Request A direct utterance requesting the hearer to do something, normally in the form of conventionalised structures.	"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.	"What do we got here?"
	Closed-question A question that requires a brief, specific answer, especially of the "Yes/No" variety.	"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

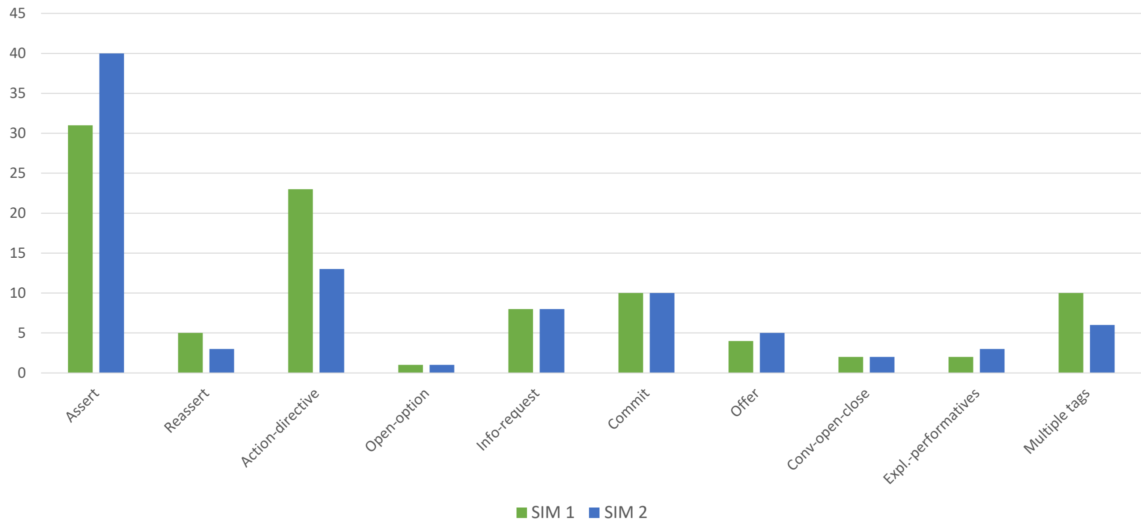

Figure 1: Distribution of utterance types

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

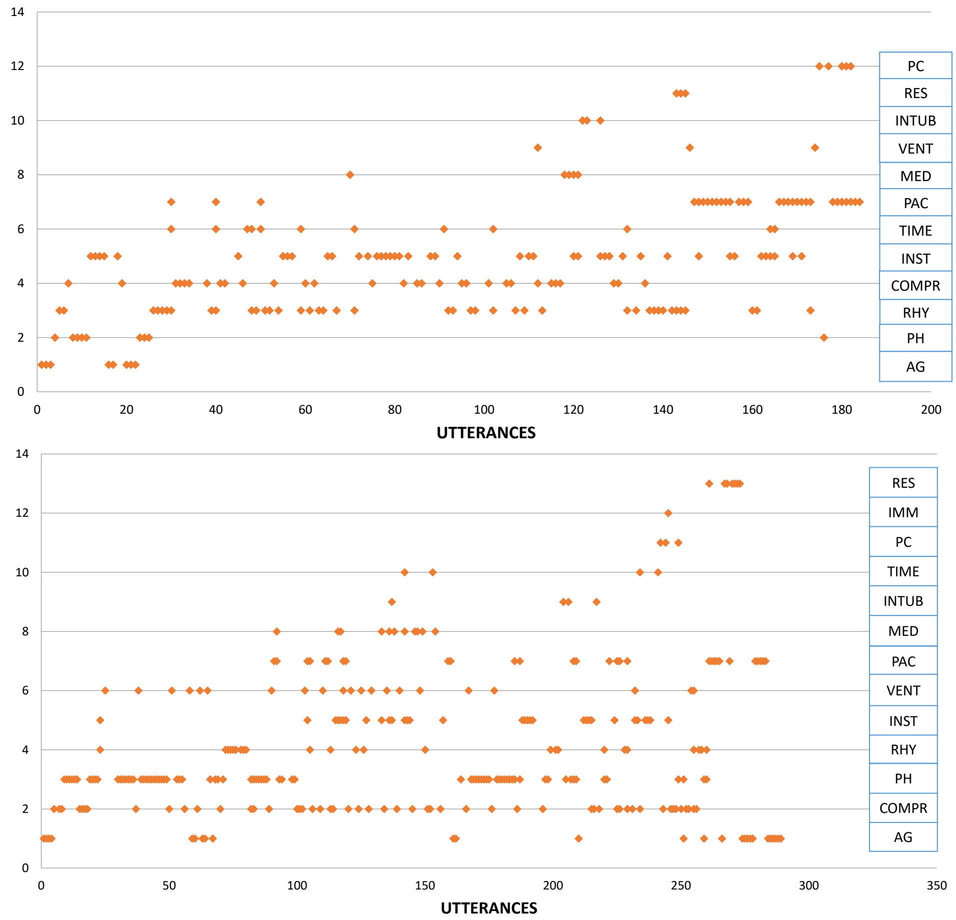

Figure 2: Threads for Simulation 1 (top plot) and Simulation 2 (bottom plot); x-axis is utterance position in the dialoguel; y-axis is thread topic; threads are arranged in order of initiation (bottom to top). Abbreviations are explained in Table 2.

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.

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Appendix B

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Date: 02/02/2017
Your Ref:
Our Ref: NR/161AB6
Enquiries to:
Direct Line: 0131 465 5679
Email:

Dear Dr Clegg,

Project Title: Language in Action - A study of what makes effective communication in prehospital resuscitation teams.

You have sought advice from the South East Scotland Research Ethics Service on the above project. This has been considered by the South East Scotland Research Ethics Service and you are advised that, based on the submitted documentation (email correspondence January 2017 and project proposal above), it does not need NHS ethical review under the terms of the Governance Arrangements for Research Ethics Committees (A Harmonised Edition).

The advice is based on the following:

- *The project is an audit/service evaluation using only data obtained as part of usual care, and notes the requirement for Caldicott Guardian approval for the use or transfer of person-identifiable information within or from an organisation*

If the project is considered to be health-related research you will require a sponsor and ethical approval as outlined in The Research Governance Framework for Health and Community Care. You may wish to contact your employer or professional body to arrange this. You may also require NHS management permission (R&D approval). You should contact the relevant NHS R&D departments to organise this.

For projects that are not research and will be conducted within the NHS you should contact the relevant local clinical governance team who will inform you of the relevant governance procedures required before the project commences.

This letter should not be interpreted as giving a form of ethical approval or any endorsement of the project, but it may be provided to a journal or other body as evidence that NHS ethical approval is not required. However, if you, your sponsor/funder feel that the project requires ethical review by an NHS REC, please write setting out your reasons and we will be pleased to consider further. You should retain a copy of this letter with your project file as evidence that you have sought advice from the South East Scotland Research Ethics Service.

Yours sincerely,
pp

South East Scotland Research Ethics Service

On behalf of Scientific Officer
South East Scotland Research Ethics Service

Differentiating clinical audit, service evaluation, research and usual practice/surveillance work in public health

RESEARCH	SERVICE EVALUATION*	CLINICAL AUDIT	SURVEILLANCE	USUAL PRACTICE (in public health)
The attempt to derive generalizable new knowledge including studies that aim to generate hypotheses as well as studies that aim to test them.	Designed and conducted solely to define or judge current care.	Designed and conducted to produce information to inform delivery of best care.	Designed to manage outbreak and help the public by identifying and understanding risks associated.	Designed to investigate outbreak or incident to help in disease control and prevention.
Quantitative research – designed to test a hypothesis. Qualitative research – identifies/explores themes following established methodology.	Designed to answer: "What standard does this service achieve?"	Designed to answer: "Does this service reach a predetermined standard?"	Designed to answer: "What is the cause of this outbreak?"	Designed to answer: "What is the cause of this outbreak?" and treat.
Addresses clearly defined questions, aims and objectives.	Measures current service without reference to a standard.	Measures against a standard.	Systematic, statistical methods to allow timely public health action.	Systematic, statistical methods may be used.
Quantitative research – may involve evaluating or comparing interventions, particularly new ones. Qualitative research – usually involves studying how interventions and relationships are experienced.	Involves an intervention in use only. The choice of treatment is that of the clinician and patient according to guidance, professional standards and/or patient preference.	Involves an intervention in use only. The choice of treatment is that of the clinician and patient according to guidance, professional standards and/or patient preference.	May involve collecting personal data and samples with the intent to manage the incident.	Any choice of treatment is based on clinical best evidence or professional consensus.
Usually involves collecting data that are additional to those for routine care but may include data collected routinely. May involve treatments, samples or investigations additional to routine care.	Usually involves analysis of existing data but may include administration of interview or questionnaire.	Usually involves analysis of existing data but may include administration of simple interview or questionnaire.	May involve analysis of existing data or administration of interview or questionnaire to those exposed.	May involve administration of interview or questionnaire to those exposed.
Quantitative research – study design may involve allocating patients to intervention groups. Qualitative research – uses a clearly defined sampling framework underpinned by conceptual or theoretical justifications.	No allocation to intervention: the health professional and patient have chosen intervention before service evaluation.	No allocation to intervention: the health professional and patient have chosen intervention before audit.	Does not involve an intervention.	May involve allocation to control group to assess risk and identify source of incident but treatment unaffected.
May involve randomisation.	No randomisation.	No randomisation.	No randomisation.	May involve randomisation but not for treatment.
Normally requires REC review. Refer to www.nres.npsa.nhs.uk/applications/apply/ for more information.	Does not require REC review.	Does not require REC review.	Does not require REC review.	Does not require REC review.

* Service development and quality improvement may fall into this category.

Headquarters
Waverley Gate, 2-4 Waterloo Place
Edinburgh EH1 3EG
Chair: Mr Brian Houston
Chief Executive: Tim Davison
Lothian NHS Board is the common name of Lothian Health Board

Appendix C

DIALOGUE ANALYSIS FOR RESUSCITATION (DARe) CODING SCHEME

COMMUNICATIVE FUNCTION CODING

Forward Communicative Functions (10 functions)

Function	Description	Example
Statement Utterances that make explicit claims about the world. There are two categories:		
Assert ASSERT	**Utterances with explicit claims**, e.g. facts, beliefs, hypotheses, judgements, conclusions, explanations, etc. *A way to check* Consider whether utterance could be followed by "That's not true", because ASSERT's key distinction is that the speaker is saying something to affect the hearer's belief.	"Pads on, rhythm check" "Chap's exposed" "…seen by nurse this morning" "25, 26, 27, 28, 29, 30"
Reassert REASSERT	**Statements which have already been said before**, normally by the same speaker, in the same dialogue act. Typically used to emphasise statement. NOTE: Repeated AD, IR, etc. are not REASSERT	UTT2: "Pull" ACTION DIRECTIVE UTT3: "That's it" ASSERT UTT4: "There we go" ASSERT UTT5: "That's it" **REASSERT** (of UTT 3)
Influencing-addressee-future-action Utterances used by the speaker to influence hearer's future (verbal or non-verbal) actions. There are three categories:		
Action-directive AD	Utterances that **directly influence the hearer's future non-communicative actions.** This function creates an obligation that the hearer does the action unless the hearer indicates otherwise (unable to comply or refuse to). Comes in several variants (request, suggestion, instruction, command, hint, etc.). *How to check?* Consider if hearer could respond with "I can't do that". This, however, is a very rough test, and should be used in conjunction with the description above.	"Could you get a list of her medications…?" "Secure it for me please" "Continue ventilations" "And bring the AutoPulse in"

Open-option OO	Utterances that **directly influence the hearer's future non-communicative actions but put no obligations** on the hearer to respond. This function can be ignored (not verbally responded to) without appearing rude, unlike AD, since no obligations beyond normal conversational constraints are placed on the hearer.	"On you go" "Give me a second" "When you're ready"
Info-request IR	Utterances that introduce an obligation to provide information, by any means of communication, should be marked as IR.	"What's happened?" "Any pulse?"
Committing-speaker-future-action Utterances used by the speaker to commit self to an action; can be likened to a verbal promise. There are two categories:		
Commit COMMIT	The defining property for this function is that they potentially **commit the speaker (in varying degrees of strength) to some future course of action**, without requiring the hearer's agreement.	"I'll insert this" "I'll be, I'll swap up next"
Offer 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" "I can bring it to where you are M"
Other-forward-function Other types of utterances present in the dialogue not captured by previous categories under FCF.		
Conventional-open-close CONV-OPEN-CLOSE	Phrases conventionally used to start interaction/summon addressee/conclude interaction/dismiss addressee.	"Hello there" "…and Ian from ambulance service"
Affective-performatives PERF	Utterances that contain explicit socio-emotional content related to the building and maintaining of social/emotional rapport. This includes apology, compliment, swearing, humour, condolence, empathy.	"…thanks pal" "Sorry mate" "Shit"
Alerter ALERTER	Utterances that are used to alert specific hearer(s). An utterance is considered an alerter if the speaker visibly pauses before the next utterance.	**"Ian"** (salient pause) "could you come here **"Guys"** (salient pause) "come around

Backward Communicative Functions (11 functions)

Function	Description	Example
Agreement Utterances that indicate hearer's view of speaker's proposal (e.g. claim about the world, request, offer, etc.), particularly at the task level. There are six possible categories:		
Accept ACCEPT	Accepts the proposal wholly.	UTT 1: "Let me know and I'll pre-charge" **UTT 2: "Okay"**
Accept-part ACCEPT-PART	Accepts a part of the proposal.	UTT1: "We should put him on the autopulse now" **UTT2: "Yeah, but bring him up first"**
Maybe MAYBE	Non-committal to the proposal.	UTT1: "Do you want the book and its review?" **UTT 2: "I'll think about it"**
Reject-part REJECT-PART	Disagrees with part of the proposal. Almost similar to ACCEPT-PART, but in REJECT-PART, the rejection comes first or is the major part of the utterance.	UTT1: "Could you call the wife and son?" **UTT2: "I don't know the son"**
Reject REJECT	Disagrees with the proposal.	UTT1: "You want a cricoid?" **UTT2: "No no only the tube for now"**
Hold HOLD	When the speaker states their attitude towards the proposal, for example asking how to comply with the speaker's proposal or questioning its desirability.	UTT1: "Can you call the GP..." **UTT2: "Oh. You want me to call him just now?"**
Understanding Utterances signifying that the speaker/hearer are or are not understanding each other as the conversation proceeds. There are three categories of signalling understanding, and one category to signal non-understanding.		
Signal-understanding: Acknowledge ACKN	Short utterances that signal that the previous utterance is understood, **without necessarily signalling acceptance**. Backchannels are a typical example. Some ACKN are fillers used to start utterances. Tag these as ACKN-FILLER or FILLER. Some ACKN are used to acknowledge actions that have been done. Tag these as ACKN-ACTION. NOTE: Not all ACKN are segmented as ACKN-FILLER or ACKN-ACTION; the decision was made based on the time elapsed between the word/phrase and the rest of the utterance.	UTT1: "She's been unwell..." **UTT2: "Uhuh" ACKN** UTT3: "...and GP's been in to see her" UTT1: "Take her hands each" **UTT2: "Okay" ACKN-ACTION** UTT3: "Move her towards me" **UTT1: "Right" ACKN-FILLER/FILLER** UTT2: "I think what we do is we put her on AutoPulse first"

Signal-understanding: Repeat-rephrase REP-REPHR	Utterances that repeat or paraphrase what was just said to signal that **the speaker has been understood.**	UTT1: “And then you set (name) up for a tube” **UTT2: “Set up tube, okay”**
Signal-understanding: Completion COMPLETION	**Finishing/adding to** the utterance that the speaker is in the process of constructing.	UTT1: “Looks like VF, yeah” UTT2: “We’ll need, uh…” **UTT3: (interjects) “a shock”**
Signal-non-understanding SIGNAL-NON-UND	Utterances explicitly indicating **a problem in understanding** the previous utterance. *A way to check* The response can be roughly paraphrased as “What did you say/mean?”	“Hmm?” “What’s that?”
Answer ANSWER	A binary dimension where utterances can be marked as complying with an IR action. Can be an imperative act as well, or an assertion.	UTT1: “You got it mate?” UTT2: **“Yep”**

Others (2 functions)

Incomplete INCOMPLETE	Abandoned utterances.	“Alright sorry so we sh-“
Indecipherable IND	Poor audio quality/Unintelligible/Coder does not know. (…) indicates inaudible dialogue	“It’s not gonna (…) (…)”

Sub-categories of *Assert* (8 sub-categories)

Function	Description	Example
Conclude/Deduce CONC	Assertions of fact presented as the result of a process of logic or deduction.	“Okay it appears asystolic now” “No breathing”
Forward-course FC	When speaker describes or outlines the next course of action, or the future course of action for the team. This is typically procedure-related as the speaker verbalises the OHCA script. Sometimes this is tagged together with a directive. *A way to check* The utterances provide logical answer to “What do we do next?”	“So we’re gonna stay here just now we’re gonna do some paperwork…” “20 seconds til next rhythm check” “So plan is…”
State-awareness SA	Utterances that keep everyone on the same page. These are usually not responses to questions but pop out every now and then to alert others. These could also be the current state of a procedure. *A way to check* Imagine that you had your back to the scene; would the utterance inform you about the current task-level? If yes, then it is highly likely a *State-awareness*.	“That’s fluid attached” “Okay it’s 3, 2, 1”
Information-giving IG	Utterances that provide information relating to the procedure, especially patient history. This can also be a response to a query.	“Got a size 8 tube for you there mate” “So this gentleman collapsed at work”
Hypothesise HYP	Assertions based on an educated guess; a less concrete form of *Conclude/Deduce*. Sometimes found when paramedics discuss reversible causes of event.	“Hypoxia…hypervolaemia were potential…” “I suspect it’s an MI…”
Commiserate COMMIS	Utterances that show empathy or sympathy. This is typically directed towards bystanders but could also be used to commiserate with fellow team members. This is similar to GMIAS’ 4.0 *Empathy/Reassurance* code.	“Obviously you had a great shock this morning…”
Notify NOT	Utterances that provide information but can also function as counsel/advice/reminder. Generally, it is not a response to request for information (unlike *Information-giving*), which makes it similar to *State-awareness,* but *Notify* utterances are less task-specific.	“We’ll get to you in a moment” “In a minute, there’s another colleague coming”
Other-assert-social OAS	Utterances that belong under *Assert* but identified as a sub-category of statements pertaining to humour, encouragement, self-talk, exclamations of emotions (e.g. surprise, gladness).	“Getting all your toys together ey” “Alright!” (expressing gladness when the ambulance team arrives)

Sub-categories of *Action-directive* (4 sub-categories)

Function	Description	Example
Direct/Instruct DIRECT	Utterances that directly command/order the hearer to do an action.	"Stand clear, shock" "Secure it for me please"
Recommend/Suggest REC	Utterances couched so as to suggest that it is the speaker's advice, not necessarily an order.	"And let's start thinking about execution" "Okay when you're ready we can pause for a bit"
Request REQ	Direct utterances requiring the hearer to perform an action. Note that this function is usually associated with conventionalised structures/idiomatised pragmalinguistic structures.	"Can we set the BP a cycle for every two-and-a-half minutes?" "If you can keep going at the moment"
Allow ALLOW	Used by the speaker to give permission. It implies that the speaker has control over the hearer's behaviour.	"…and I'll let you get the cannula and stuff" "On you go"

Sub-categories of *Info-request* (3 sub-categories)

Function	Description	Example
Open-question OQ	A broad question with possible unlimited response categories. *How to check?* Cannot be answered with a "Yes" or "No", or with a limited list of choices.	"What do we got here?"
Closed-question CQ	A question that can be responded to with "Yes" or "No". Also used when speaker needs a specific answer, but one that is not mentioned/proposed in the question.	"You want the pack on?"
Leading-question LQ	A question that includes or suggests an answer. May or may not be asking for reiteration or assurance of accuracy of a previously discussed/suspected fact.	"Size tube do you want size 8?"

THREAD CODING

Thread	Description	Example
Patient history PH	Utterances relating to medical history of the patient, including events leading to the arrest. Can also come from a bystander.	"So you found her this morning?" "…and she's, umm, takes medication for her diabetes" "…witnessed arrest by husband"
Procedure-related - Compression (COMPR) - Clothing (CLOTH) - Airway access (AIR) - Rhythm/Circulation (RHY) - Medication (MED) - Instrument/Equipment (INST) - Ventilation (VENT) - Time (TIME) - Shock (SHOCK) - State (STATE) - Reversible causes (RC) - Resolution (RES)	Utterances relating to common procedures and steps in resuscitation. COMPR: Chest compression-related; CLOTH: Utterances concerning patient's clothing, usually about removing clothing items to enable defibrillation; AIR: The procedures and act of getting airway access (NPA, OPA, iGEL, or ETT); RHY: Rhythm and pulse oriented (VF, PEA, asystolic, no pulse, etc.); MED: Any medication (e.g. amiodarone, adrenaline), fluids, etc. given to the patient and procedures thereof, including IO/IV access (but not airway); INST: Any mention of instrument or equipment required/used; VENT: The breaths given after certain cycles (typically two) of compressions, 30:2 cycles; TIME: Explicit mention of time, typically in seconds or minutes; SHOCK: Explicit mention of defibrillation (shock) STATE: Utterances regarding the patient's current state other than rhythm; RC: Utterances dealing with reversible causes of event (4Hs and 4Ts). Usually instigated by team leader; RES: Some cases have clear verbalised resolution, e.g. resuscitation attempt is ceased due to death	 COMPR: "25 26 27 28 29 30" "Continue CPR" CLOTH: "It'll be okay with his t-shirt like that" AIR: "Okay I'm gettin a good view" RHY: "…still VF", "PEA" MED: "Another adrenaline," "…need IO access?" INST: "Tube's inflated", "If you've got a cannula then get a 20ml syringe ready" VENT: "One, two", "Continue ventilations" TIME: "Okay 30 seconds", "Two minutes to rhythm check" SHOCK: "Ready for next shock", "Stand clear" STATE: "…his heart's not working as it should…" RC: "…hypoxia we've dealt with…" RES: "…that her being asystolic now for us to stop resuscitation attempt"
Space and movement - Movement involving patient (MOVPT) - Movement other than patient (MOV) - Immediate vicinity (IMM) - Non-immediate vicinity (NONIMM)	Utterances regarding movement and/or space MOVPT: of patient, MOV: of materials, team members or other people in the area, IMM: in the immediate vicinity, i.e. scene of procedure NON-IMM: outside of the immediate area where the patient is, e.g. the car, ambulance, corridor, lift, etc.	 MOVPT: "Sit him up a little" MOV: "Can you take the knee?", "Come up to this side" IMM: "It's a bit tight for space" "Bag's behind you" NONIMM: "Could you run to my car…"

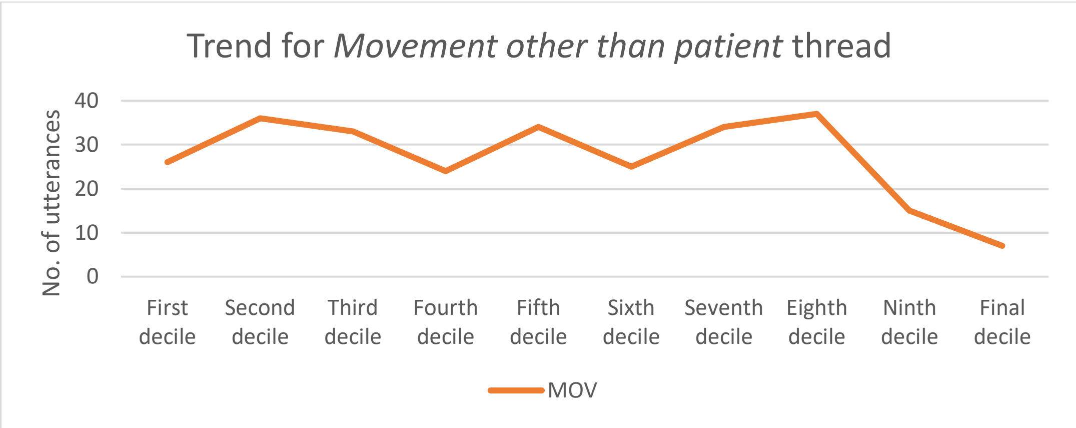
	NOTE: IMM and NONIMM only tagged when utterances explicitly mention these.	
Plan of action PAC	Utterances relating to the (next) steps that the team needs to take regarding the case at hand. NOTE: PAC utterances have a wide span (from immediate plan for ongoing task to general orientation).	"Keep going" "Just disconnect the defib a wee second" "So once we've got a 12 lead, and we'll let him settle just for a minute or two…"
Social agenda setting AG	Social utterances like greetings, self-introductions, asking for another's name.	"What's your name again?" "Hi guys"
Miscellaneous threads OTHER	Tag given to subject matters other than mentioned, mostly concerning dialogues with bystanders or about bystanders; sometimes can be unrelated to procedure. NOTE: Some OTHER utterances can be sub-categorised into Other-wellbeing (OTHER-WB). These are utterances about the well-being or condition of the hearer or the speaker.	"Are you wanting to come too" "His wife is standing outside with some bystanders there" "Are you okay there?" "You okay Ian?" "Happy?"
Indecipherable IND	Given when the utterance is not sufficiently clear to indicate its subject matter (incomplete utterances, indecipherable utterances, or coder doesn't know).	"And watch if (…) got (…) on the left" "Eh, if somebody-"

Appendix D

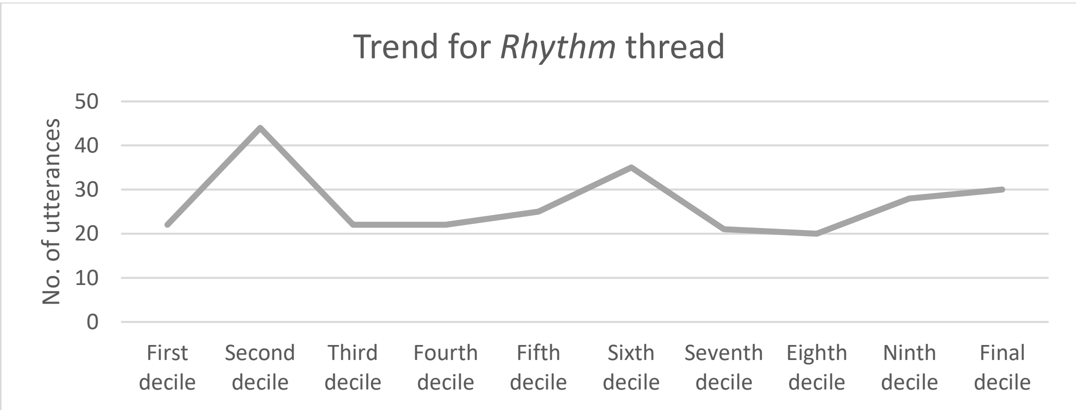
Appendix D (utterance decile)

Line graphs depicting the thread trend in the first five minutes of real-life OHCA resuscitation dialogue, plotted based on frequency of each thread in each decile (first decile is equivalent to the first 10% of the dialogue; second decile is equivalent to the second 10% of the dialogue, and so on).

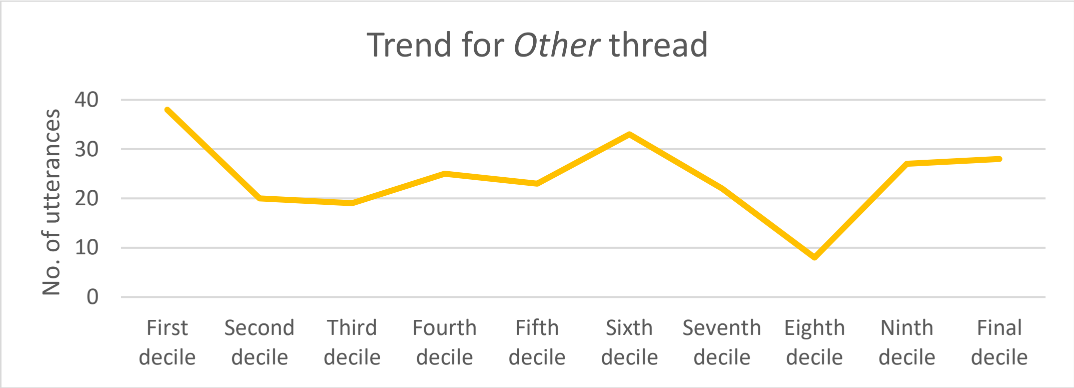
1. *Movement other than patient* (the sixth most frequent thread)



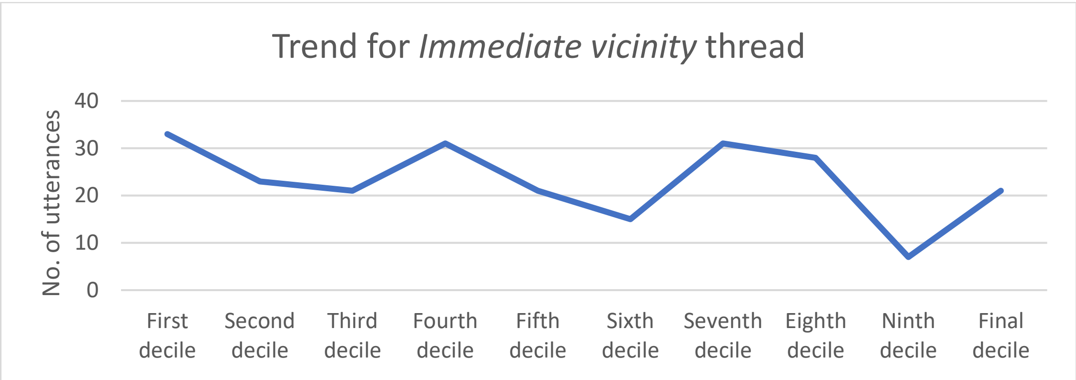
2. *Rhythm* (the seventh most frequent)



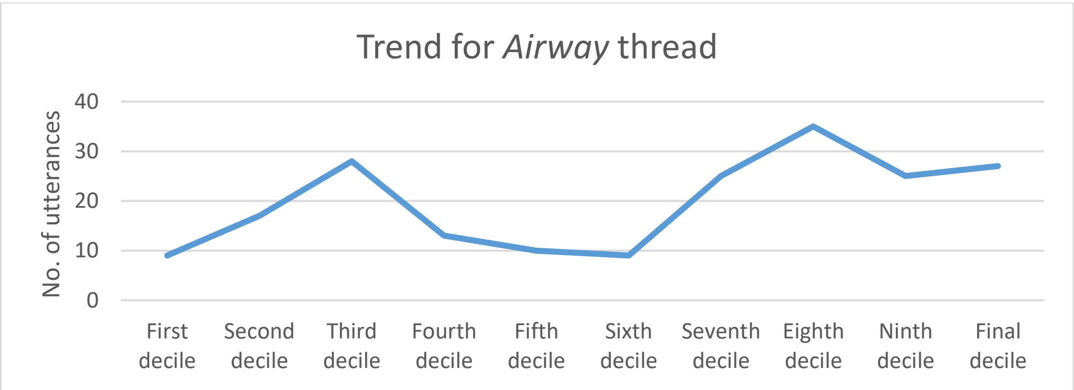
3. *Other or miscellaneous* (the eighth most frequent thread)



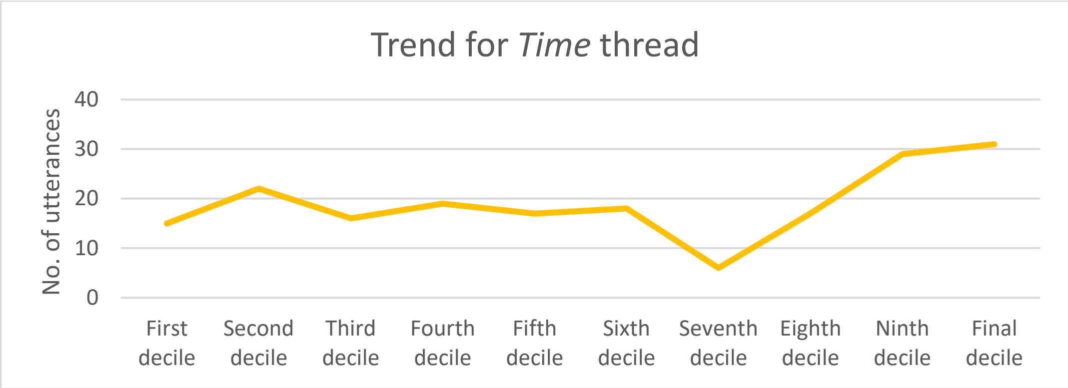
4. *Immediate vicinity* (the ninth most frequent thread)



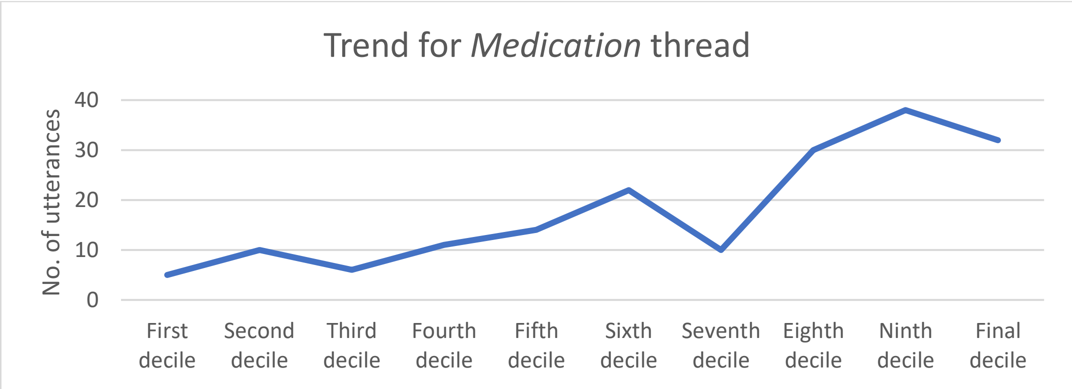
5. *Airway* (the tenth most frequent thread)



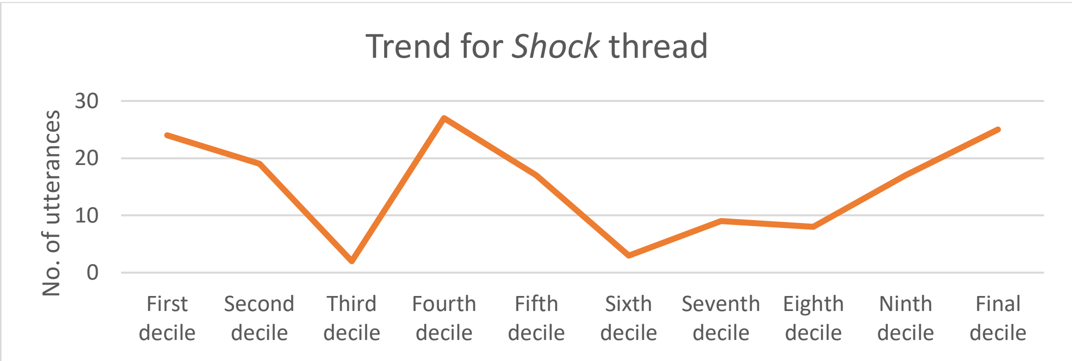
6. *Time* (the 11th most frequent thread)



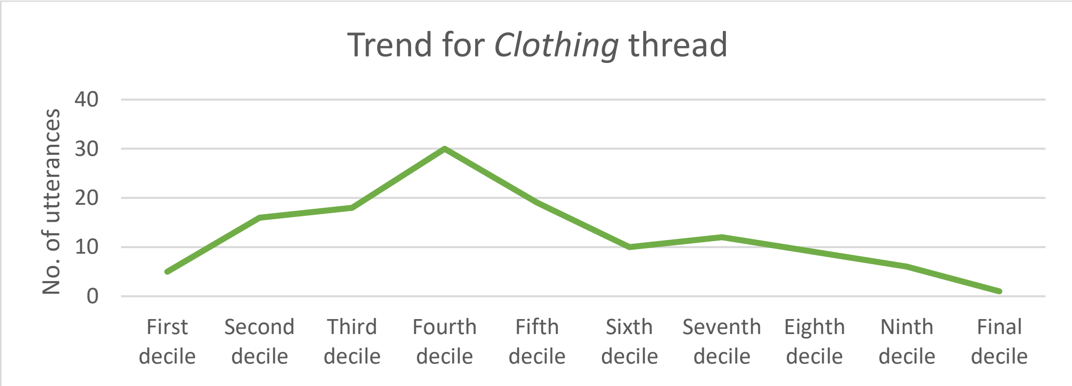
7. *Medication* (the 12th most frequent thread)



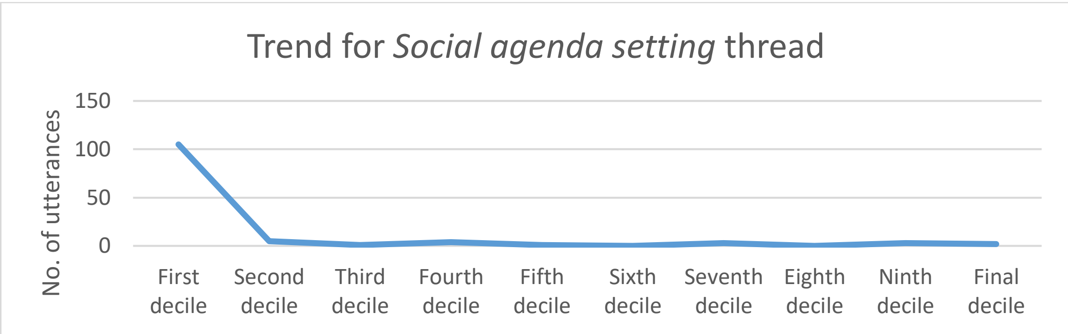
8. *Shock* (the 13th most frequent thread)



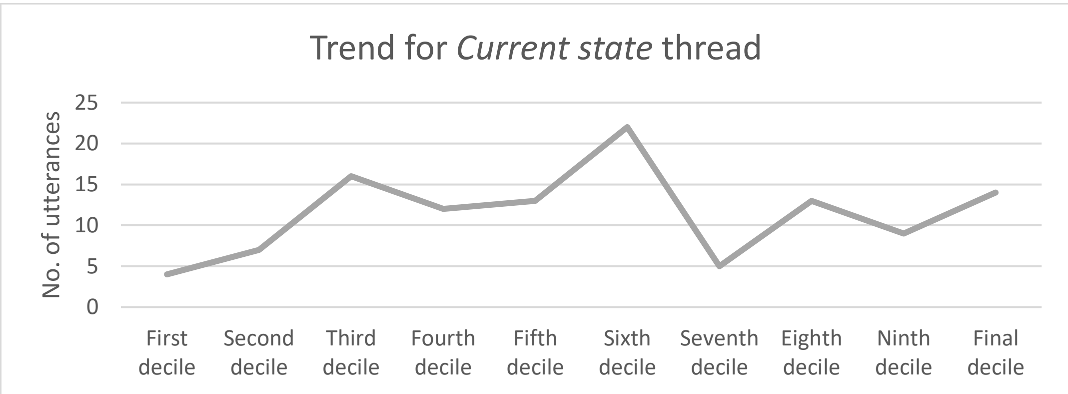
9. *Clothing* (the 14th most frequent thread)



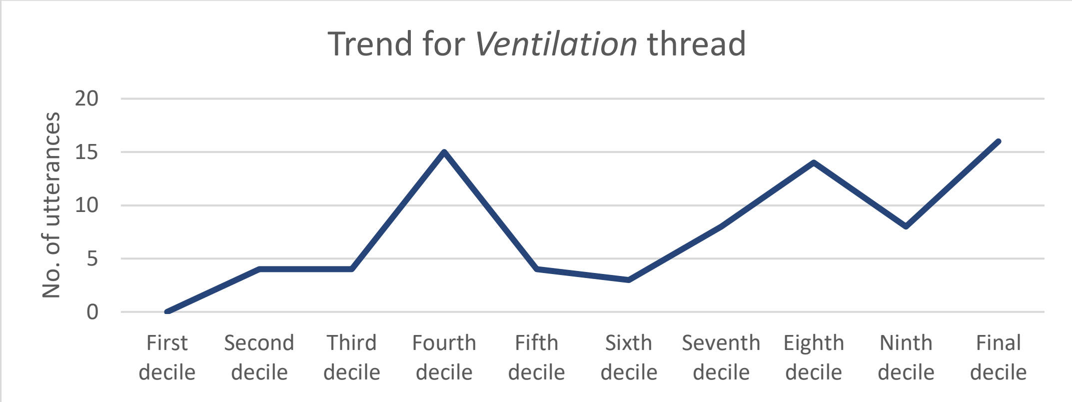
10. *Social agenda setting* (the 15th most frequent)



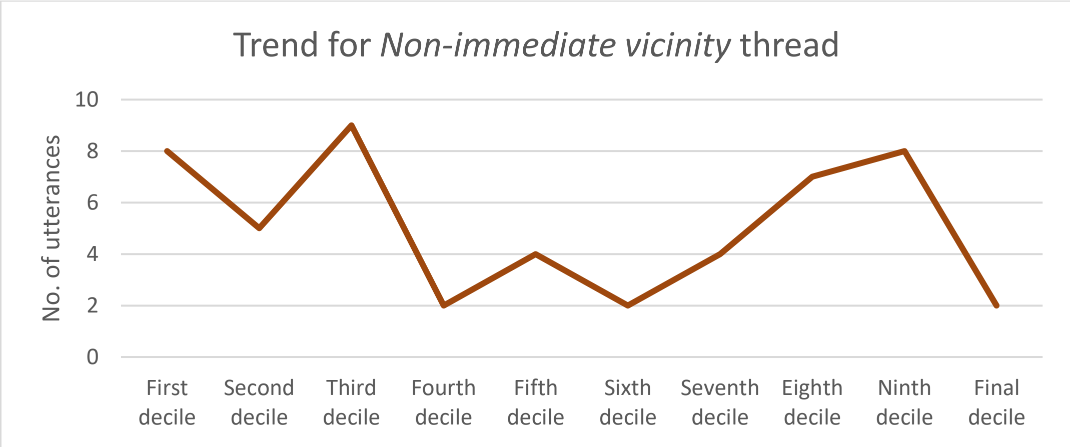
11. *Current state/condition* (the 16th most frequent thread)



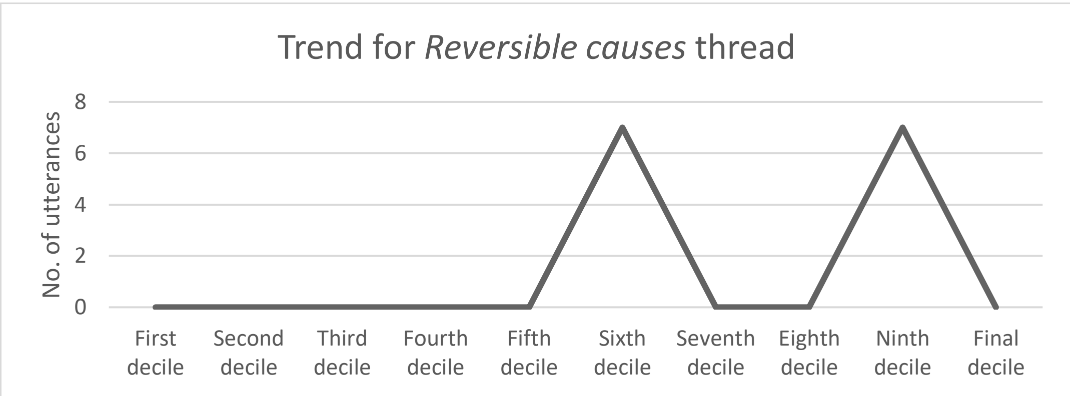
12. *Ventilation* (the 17th most frequent thread)



13. *Non-immediate vicinity* (the 18th most frequent thread)



14. *Reversible causes* (the least frequent thread)

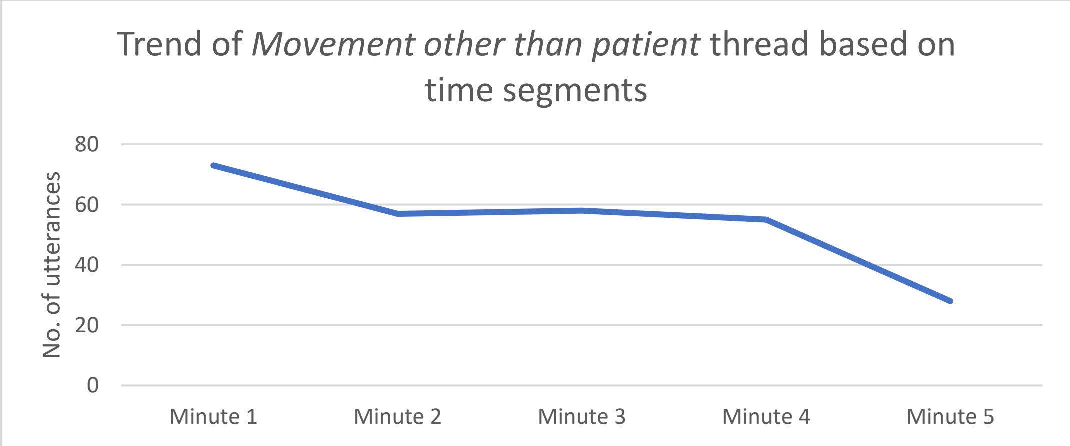


Appendix E

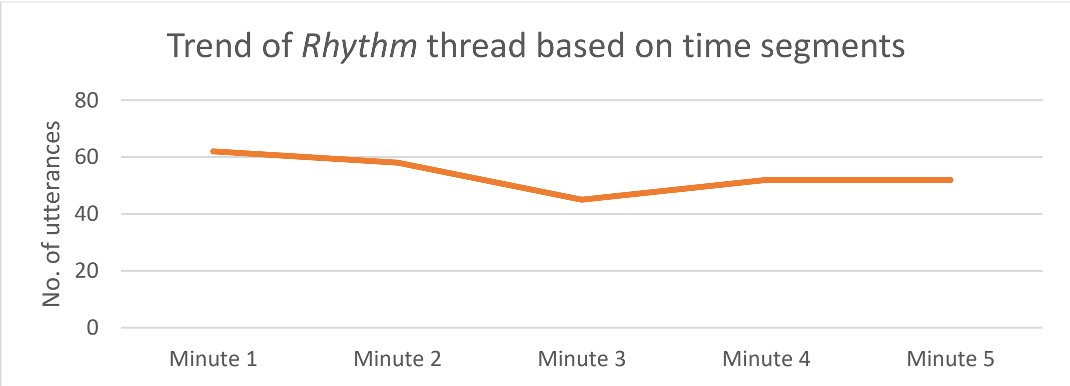
Appendix E (time segment)

Line graphs depicting the thread trend (based on five one-minute time segments) in the first five minutes of real-life OHCA resuscitation dialogue, plotted based on the frequency of each thread in each minute.

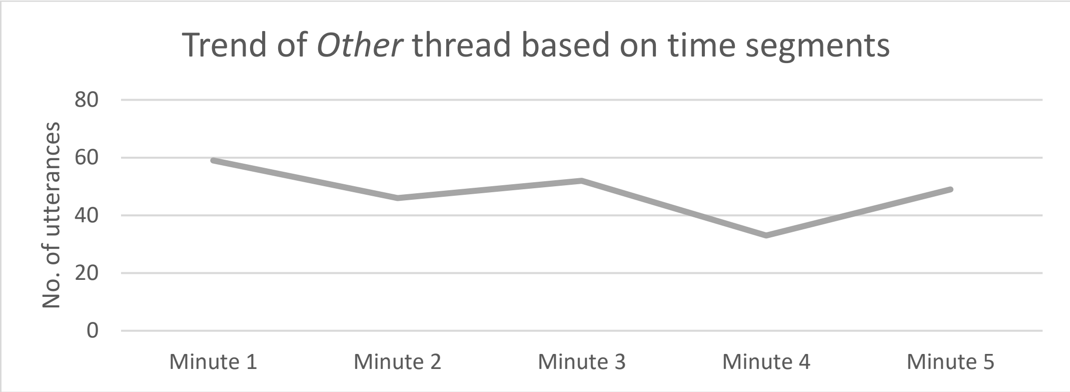
1. *Movement other than patient* (the sixth most frequent thread)



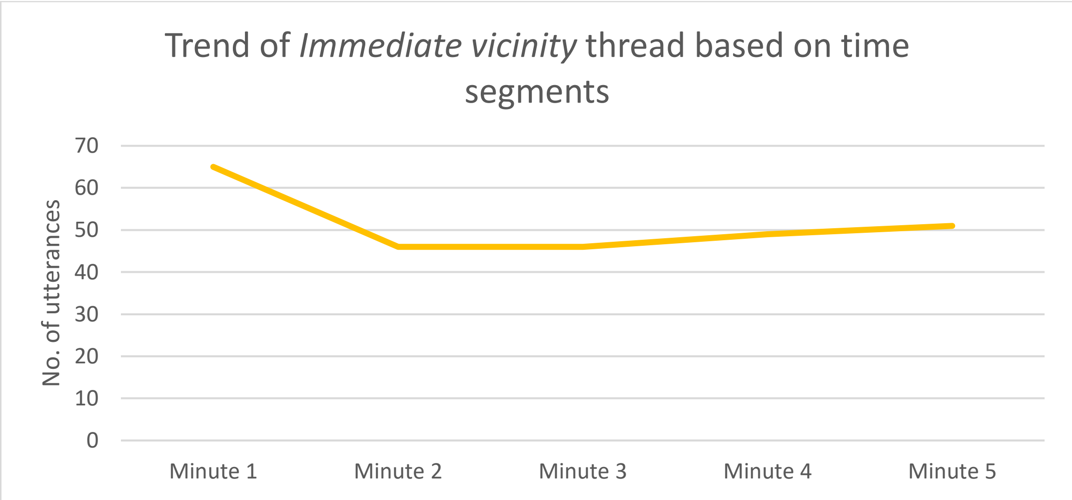
2. *Rhythm* (the seventh most frequent)



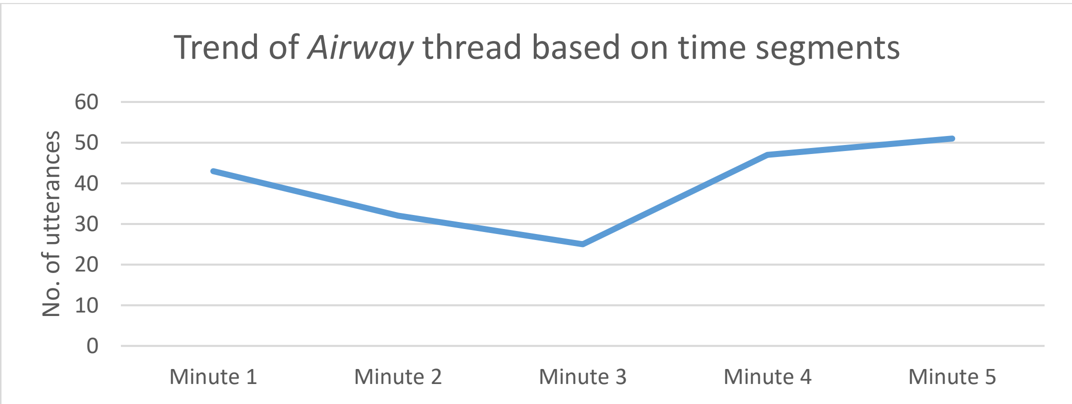
3. *Other* (the eighth most frequent thread)



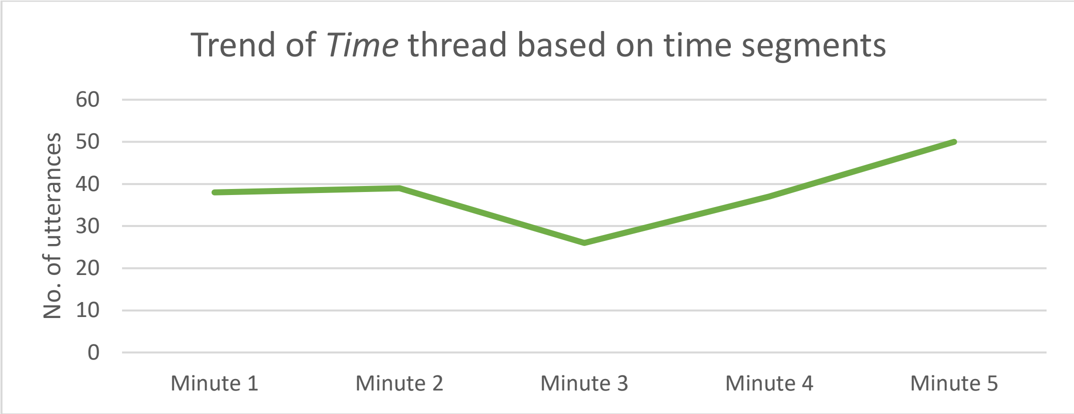
4. *Immediate vicinity* (the ninth most frequent thread)



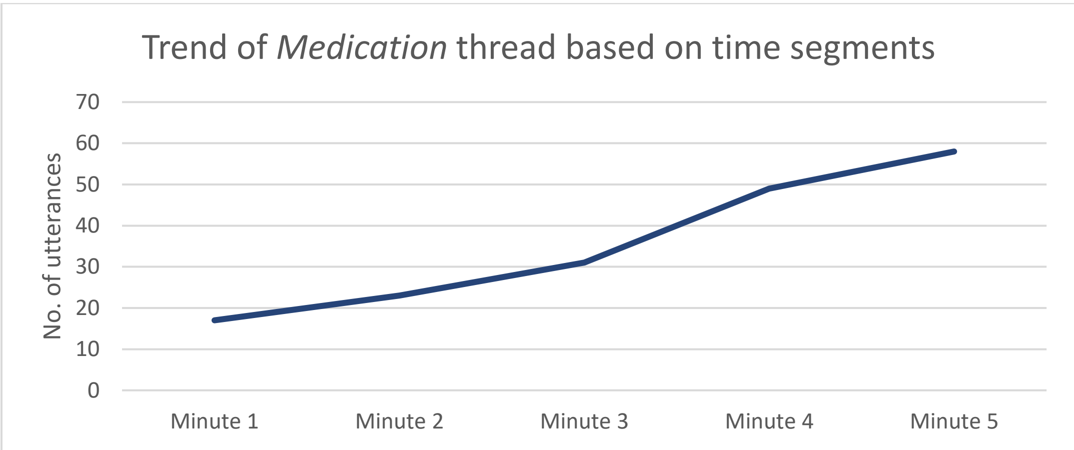
5. *Airway* (the tenth most frequent thread)



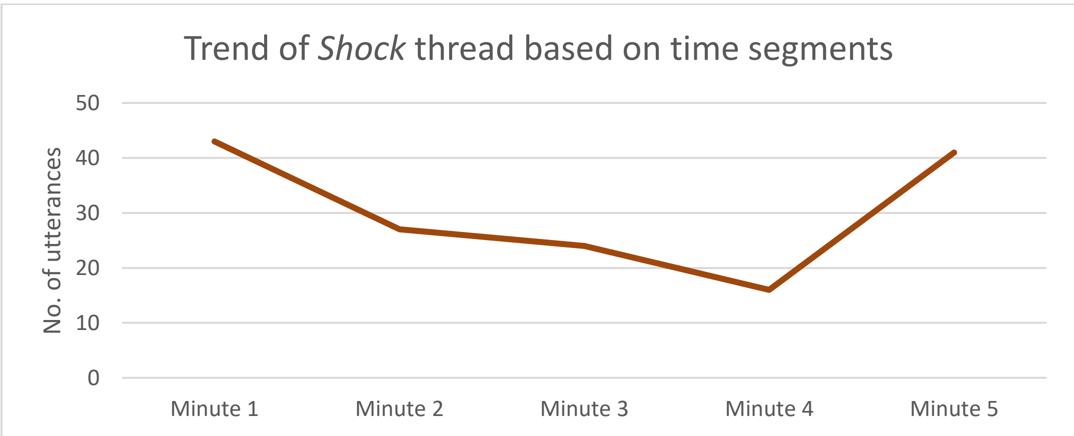
6. *Time* (the 11th most frequent thread)



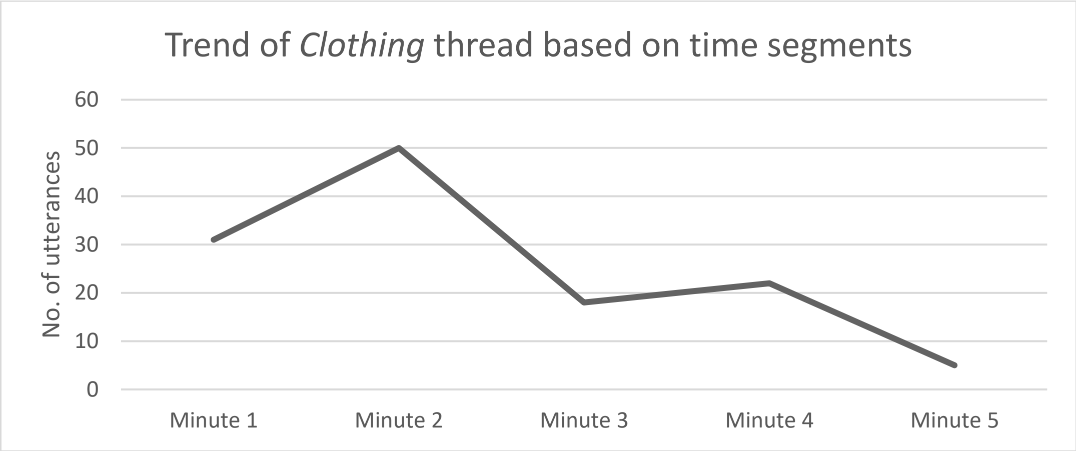
7. *Medication* (the 12th most frequent thread)



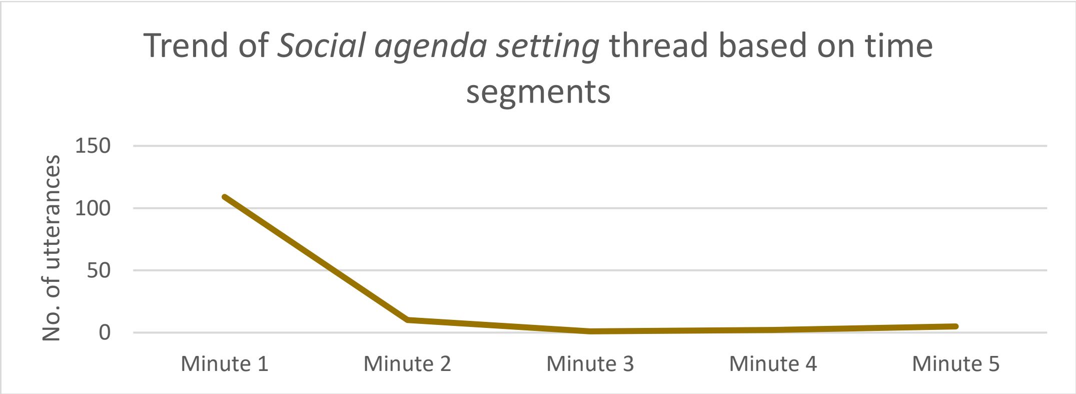
8. *Shock* (the 13th most frequent thread)



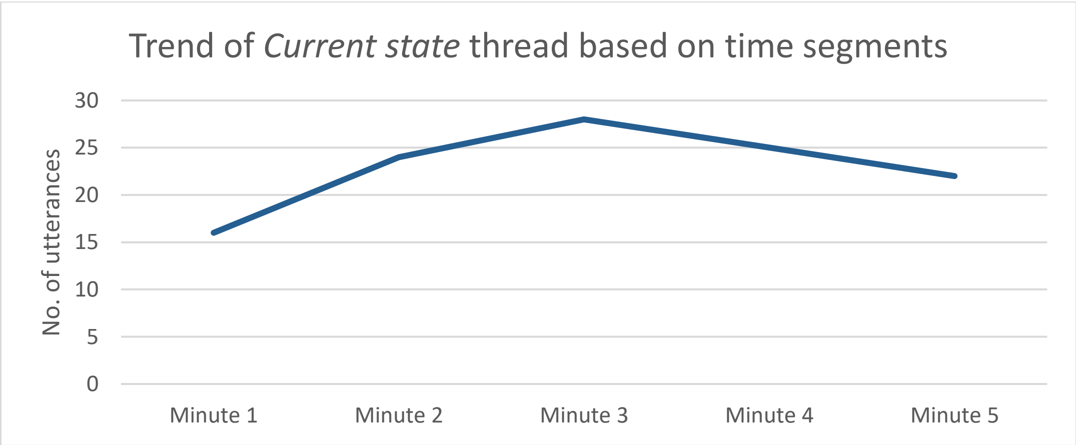
9. *Clothing* (the 14th most frequent thread)



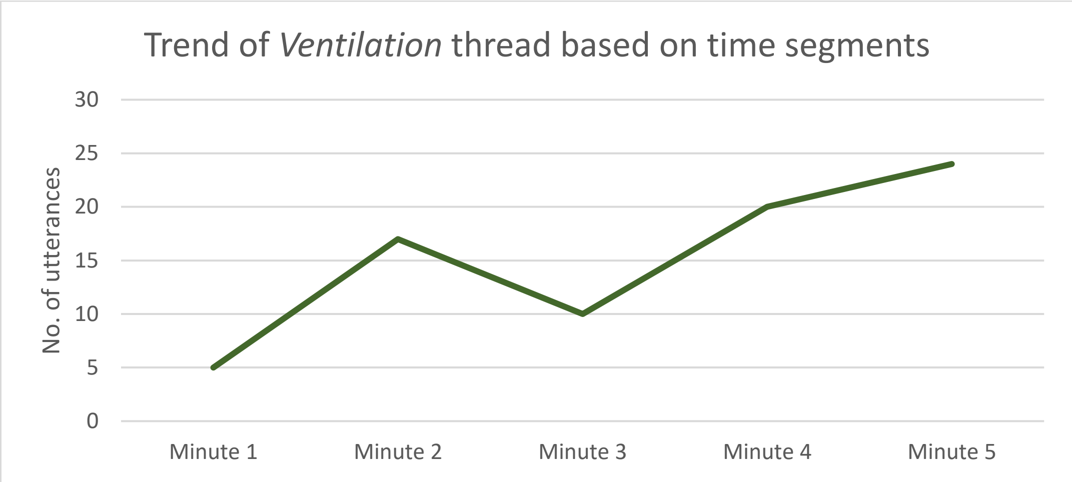
10. *Social agenda setting* (the 15th most frequent)



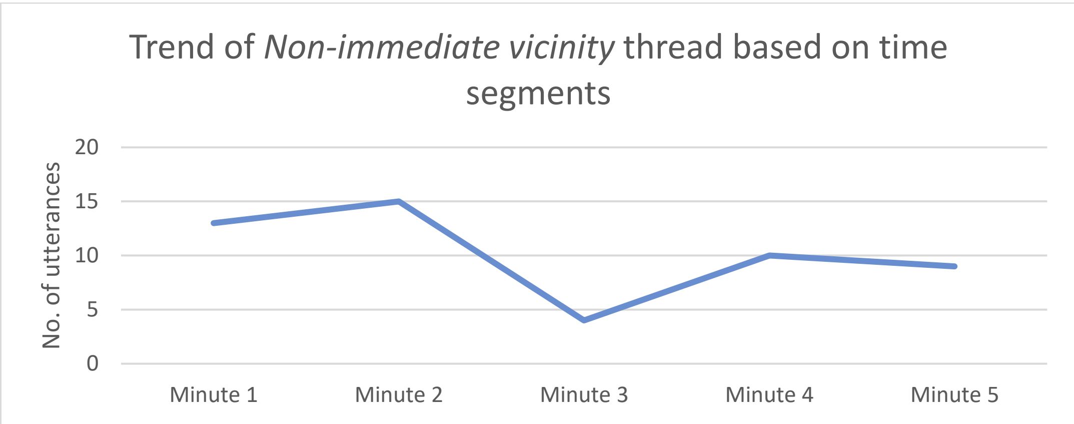
11. *Current state/condition* (the 16th most frequent thread)



12. *Ventilation* (the 17th most frequent thread)



13. *Non-immediate vicinity* (the 18th most frequent thread)



14. *Reversible causes* (the least frequent thread)