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## Talk-work relationship in knowledge-driven emergency team activities

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Thesis for the degree of Philosophiae Doctor

Trondheim, March 2019

Norwegian University of Science and Technology
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# Norsk sammendrag


**Kommunikasjon i handling**

**Forholdet mellom team-språk og teamarbeid i akuttsituasjoner**

Når alarmen går på sykehuset rykker leger og sykepleiere med forskjellig spesialkompetanse ut for å hjelpe pasienter med livstruende tilstander. For å utnytte den samlede kompetansen til et slik akutt-team, er det viktig med god kommunikasjon. Når sekundene teller, er teamkommunikasjon avgjørende for å jobbe sammen på en effektiv og sikker måte. De siste 30 årene har helsetjenesten fulgt anbefalinger fra andre høyrisiko organisasjoner (eks luftfart og forsvaret); «gullstandarder» for strukturert kommunikasjon er adoptert og tilpasset til medisinske team, og simulering er implementert som treningsmetode for å sikre godt samarbeid og god koordinering av oppgaver. Det overordnede målet med denne avhandlingen er å få mer kunnskap om forholdet mellom snakk og arbeid i team som jobber i medisinsk uavklarte akuttsituasjoner. Hensikten er å kunne påvirke kvaliteten på trening for tverrprofesjonelle akutt-team.

Avhandlingen er basert på en kvantitativ (artikkel 1) og to kvalitative studier (artikler 2-4). Datagrunnlaget er videoopptak og observasjon av simulerte og reelle mottak av kritisk syke pasienter, som ikke har vært utsatt for traumer. Første artikkel utforsker gjennomførbarheten av å sette opp en simulert modell i en travel klinisk akuttavdeling (*in-situ*), for å studere «teamarbeid» og «situasjonsforståelse». I de tre siste artiklene ble team-snakk og teamaktiviteter transkribert fra videoopptak av tverrprofesjonelle mottaksteam på sykehus. I artikkel 2 og 3 ble data samlet inn under *in-situ* simulering i en mottaksavdeling, og i artikkel fire studerte vi reelle tverrprofesjonelle mottaksteam i arbeid. Data ble analysert ved bruk av aktivitetsanalyse som er en diskursanalytisk metode.

Aktivitetsanalyse avdekket dynamikken og kompleksiteten i tverrprofesjonelt teamarbeid. Vi fant at språk har en viktig funksjon i «forhandling» om mening, i fordeling av oppgaver og ansvar, og i beslutningsprosesser i tverrprofesjonelle team som jobber i medisinsk uavklarte akuttsituasjoner.  For økt pasientsikkerhet bør forholdet mellom språk og arbeid få større fokus i utdanning. I simuleringstrening for akutt-team bør man være bevisst på hvordan språk påvirker arbeidsprosesser, utover strukturerte «gullstandarder» fra andre høyrisiko organisasjoner.

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**Biveiledere:**
Professor Gøril Thomassen Hammerstad, Institutt for språk og litteratur, Det humanistiske fakultet, NTNU.
Professor Torben Wisborg, Institutt for klinisk medisin, Det helsevitenskapelige fakultet, UiT
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## List of included papers:

1. Gundrosen S. Solligård E. Aadahl P. Team competence among nurses in an intensive care unit: The feasibility of in situ simulation and assessing non-technical skills. Intensive and Critical Care Nursing 2014; 30: 312-17

2. Gundrosen S. Andenæs E. Aadahl P. Thomassen G. Team talk and team activity in simulated medical emergencies: a discourse analytical approach. Scandinavian Journal of Trauma, Resuscitation and Emergency medicine 2016; 24: 135

3. Hammerstad G.T. Andenæs E. Gundrosen S. Sarangi S. Discourse types and (re)distribution of responsibility in simulated emergency team encounters. Communication & Medicine 2016; 13; 51-70

4. Gundrosen S. Thomassen G. Wisborg T. Aadahl P. Team talk and team decision processes: a qualitative discourse analytical approach to 10 real-life medical emergency team encounters. BMJ Open 2018;8:e023749. doi:10.1136/bmjopen-2018-023749

# Summary


**Background**

Communication failures are a common cause of errors threatening patient safety in healthcare. Good communication skills are inextricably connected to good teamwork and are thus a prerequisite in complex medical emergencies when interdisciplinary teams, assembled in an *ad hoc* manner and under time pressure, treat patients with life-threatening illness. "Gold-standard" communication in medical emergencies is mainly derived from standards of crisis team management in other high reliability organizations (HROs), e.g., aviation and defence. As in these organizations, in the last 30 years, simulation has gained an international foothold as *the* training method for teamwork in healthcare. The overall objective of this thesis was to increase knowledge of the talk-work relationship in emergency teamwork to provide suggestions for improving team training.

**Methods**

This thesis is built on one quantitative and two qualitative studies using audio/video recordings and direct observations of teams admitting patients. Data have been collected from nursing team *in situ* simulations in an intensive care unit (ICU), interprofessional emergency team *in situ* simulations in an emergency department (ED), and real-life interprofessional emergency teamwork in an ED. The first study was based on a quantitative educational intervention study exploring the feasibility of using an *in situ* simulation model in the ICU assessing ''Team Working'' and ''Situation Awareness'' using the Anaesthetists' Non-Technical Skills (ANTS) system. In the second and third study, audio/video recordings were transcribed verbatim and activity analysis, a version of qualitative discourse analysis, was applied. The focus was to investigate functions of team-talk by analysing the interconnections between language and actions in communicatively and medically critical phases of teamwork.

**Results**

Paper 1: High clinical activity makes establishing an *in situ* simulation model within a busy ICU challenging but feasible. The intraclass correlation coefficient (ICC) between the two raters indicated moderate agreement in the two main categories of the ANTS system. Statistically, we found no differences. Paper 2-4: The activity analysis uncovered the dynamics and complexity of teamwork. In the knowledge-driven emergency team activities under study, language had an important influence in negotiating meaning, in the (re)distribution of responsibility and in team decision-making processes.

**Conclusion**

To improve communication skills in interprofessional knowledge-driven team activities, there is a need for focusing on the function of language in addition to standardized communication strategies. To improve the quality of team training, educators should include the influence that talking has on work processes. To influence patient safety, educators should be aware of the key role that simulation plays in building shared team mental models of how to speak during emergencies.

## Abbreviations

HRO – High Reliability Organization

ICU – Intensive Care Unit

ED – Emergency Department

WHO – World Health Organization

NTS – Non-Technical Skills

IOM – Institute of Medicine, US.

OR – Operating Room

I-P-O – Input-Process-Output

CRM – Crew Resource Management

SA – Situation Awareness

CLC – Closed-Loop Communication

ANTS – Anaesthetist's Non-Technical Skills

ONC – Online Commentary

MC – Metacommentary

OFC – Offline Commentary

ICC – Intraclass Correlation Coefficient

ABC – Airway, Breathing and Circulation

CPR – Cardio Pulmonary Resuscitation

TR – Team Reflexivity

# 1 Preface

Communication failures are a common cause of errors threatening patient safety in healthcare (1-6). Good communication skills are inextricably connected to good teamwork and are thus a prerequisite in complex medical emergencies when interdisciplinary teams, assembled in an *ad hoc* manner (action-teams) and under time pressure, treat patients with life-threatening illnesses (7-11). “Gold-standard” communication in medical emergencies is mainly derived from standards in other high reliability organizations (HROs), e.g., aviation and defence. As in these organizations, over the last 30 years, simulation has gained an international foothold as *the* training method for emergency teamwork. However, despite the extensive focus on patient safety and team training, communication failure still causes error and adverse events in medicine (1, 6, 12). Largely, communication in medical emergency teams have been studied in what Schmutz and colleagues call algorithm-driven activities (10), where all team members know the working procedure and are able to anticipate roles and actions, e.g., cardio pulmonary resuscitation (CPR) and surgical procedures (13, 14), trauma care (15, 16) and anaesthesia induction (17, 18). In knowledge-driven emergency team activities that imply a degree of uncertainty and high cognitive load (identification of cues, interpretations, integration of existing knowledge and decisions) (10), communicative behaviour has been less explored. To provide training aimed at improving communication skills in interprofessional emergency action teams, understanding the interrelationships between “team-talk” and teamwork is vital.

This PhD started with the researcher’s involvement in simulation and team training for patient safety in medical emergencies. In the first study (paper 1), we explored the feasibility of using an *in situ* model for assessing team competence among nurses in an intensive care unit (ICU) in a Norwegian university hospital. The study identified the possibility of creating a research laboratory within busy clinical areas. Although significant efforts were made to make the simulations realistic, the participants claimed that cooperation and actions were managed differently in a simulation scenario compared with reality. From this experience, we asked ourselves the following questions: How do health professionals speak and interact in teamwork? Furthermore, what is the relationship between team-talk and teamwork? To pursue these questions, we chose to focus on medical team encounters closer to the complexity of real life: interdisciplinary action teams working in knowledge-driven emergency activities. To study the talk-work relationship, we introduced activity analysis, a qualitative discourse analytical perspective on team-talk and team interaction. The second study (papers 2 and 3) involved interdisciplinary emergency teams managing a standardized scenario of admitting a “patient” with both respiratory and circulatory problems during an *in situ* simulation in the hospital emergency department (ED). In the last study (paper 4), we ensured authentic samples of analysis in real-life admissions of patients with critical illness. This PhD has contributed to enhancing the understanding of the interrelationship between team-talk and teamwork in interdisciplinary emergency teams in knowledge-driven activities.

# 2 Background

## 2.1 Patient safety and human error

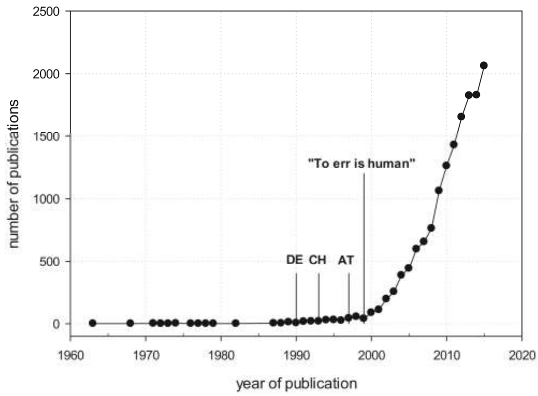
The maxim “Above all, do no harm” motivates education and performance in professional healthcare settings throughout the world (19). This basic rule is at the same time a reminder that medical decisions involve some degree of uncertainty and a risk of error. According to the World Health Organization (WHO), patient safety refers to “the prevention of errors and adverse effects to patients associated with health care” (20). Safety is *the* prime goal in medicine as in other HROs, e.g., the aviation, defence and nuclear industries, and it is considered to be the prime element in quality (21).

Medical treatments leading to harming patients are often referred to as adverse events. It is not possible to prevent all adverse events, e.g., the side effects of essential medication, but all preventable adverse events constitute an unnecessary risk to patients (21-23). The increase in medical insurance premiums in the US in the 1970s led to a focus on the cause of medical errors and how to avoid them (23, 24). The reasons for errors mainly addressed the physician in charge of the treatment, and they were categorized as due to a lack of medical knowledge, lack of practical skills or negligence (23). Inspired by aviation, a growing interest in the connection between human factors and healthcare errors appeared in the early 1990s (25, 26). The discipline of human factors (often referred to as ergonomics) addresses the interface between the work environment, organizational factors and human behaviour, which can affect safety (26). Studies have found that as much as 50 to 80% of errors in critical care are related to human factors (27, 28). James Reason distinguished between two forms of errors: active errors with an immediate effect and latent errors where consequences become evident when triggered by other factors (22). Human error can be explained by either of the following: 1) the originally correct plan is not accomplished as it should, or 2) the chosen plan was not correct for reaching the defined goal (22). Human error is thus inextricably connected to intentional actions. To prevent human errors and adverse events, the “front-line” healthcare professional’s non-technical skills (NTS) is essential (27, 28).  A definition of NTS was developed from a Delphi process in an international panel of expert clinicians, educators and researchers: ‘‘a set of social (communication and team work) and cognitive (analytical and personal behaviour) skills that support high quality, safe, effective and efficient interdisciplinary care within the complex healthcare system’’ (29 p 574). The analysis of 2000 incident reports in The Australian Incident Monitoring Study (1993) found that 83% of the reported errors could be related to insufficient NTS of the personnel (30).

The report from the U.S. Institute of Medicine (IOM), “To err is human: Building a safer health system” (2000), represented a turning point in the process of quality improvement in health services (21). Based on several reports, i.e., Harvard medical practice study I and II published in 1991 (23, 24) the Utah and Colorado study published in 1999 and 2000 (31) and National Health Statistics (1997-1999) (32), the IOM reported an estimate of medical errors to be the 8$^{th}$ largest cause of death in the U.S. (21). The report linked human error to patient safety in a new manner and stimulated to a growing scientific focus on safety in medicine (Figure 1) (33).

**Figure 1**

**A tri-national view on the term "patient safety" from Austria (AT), Germany (DE) and Switzerland (CH)**

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The IOM report outlines how to build safety issues into the process of treating patients and recommends studying how "human performance can result in the creation of safer systems and the reduction of conditions that lead to errors" (21 p. 63.)

Fortunately, most patients do not experience harm from medical treatment. However, to develop knowledge on quality and patient safety, instead of studying how human performance leads to safe practices the focus has been on situations where things go wrong. Ergo, by studying injuries only a small fraction of reality is studied to ensure that patients receive good quality treatment (34, 35). We still need reliable tools to assess quality and safety in healthcare (36, 37). Hollnagel and colleagues (2013) recommend considering safety by combining a focus on avoiding error (Safety I) with understanding why things go right (Safety II), or how health practitioners adapt their behaviour to changes in their working situation to avoid making errors (resilience). These considerations include understanding the main work activities in order to identify where and when preventive efforts are appropriate (34, 38).

## 2.2 Teamwork

Interdisciplinary healthcare teams were first established to increase the efficiency of healthcare outside hospitals. The organization of such teams was inspired by military models for classifying injured soldiers on the battlefield during World War II (39). After World War II, interdisciplinary teams were also established within hospitals to care for patients during surgery, after burn injuries and in rehabilitation. U.S. studies of team-oriented healthcare in the 1960s and 1970s referred to by Baldwin Jr. (2007) showed, among other things, fewer hospitalizations, lower child mortality and lower costs (39).

Supported by team literature, medical care is based on team efforts (40, 41) because teams make fewer mistakes than individuals (21, 42, 43). In team science, team member competencies are defined as *teamwork* (communication, coordination and cooperation) and *taskwork* (technical skills and clinical competence), both of vital importance for team outcomes (43). Manser (2009) reviewed the literature on teamwork and patient safety in dynamic domains (i.e., operating rooms (ORs), ICUs and EDs) and found that teamwork rather than taskwork was the most frequently reported contributing cause of adverse events (44). Manser refers to a general definition of teams: “two or more individuals who work together to achieve specified and shared goals, have task-specific competencies and specialized work roles, use shared resources and communicate to coordinate and adapt to change” (44 p. 143). Within this definition lies an understanding of teams not only as a group of highly qualified individuals. According to Brannick and Prince (1997), teams are groups of professionals who are aware of and act on the understanding that one person’s contribution is crucial for the next person’s effort and who know how to utilize the collective competencies in the team and distribute resources to reach common goals (45).

There are many different team competency frameworks originating from psychological research and describing the components of efficient teamwork (46, 47). Most models are built on McGrath's conceptual framework for systematically studying groups of people: input-process-output (I-P-O) (48). Input factors imply resources, the environment and organizational characteristics; process factors imply the nature and quality of interactions between team members including behaviour cognition and affective phenomena; and output factors imply the results and products appreciated by team member customers or employers (46, 49, 50). Team effectiveness is more a process than an end-state taking both team performance and team interaction into consideration (51, 52). While input and output factors are more definable, process factors appear as a more "non-exact science" (53). Most teamwork models describe process factors as dimensions of behaviour involving coordination, communication and cooperation (46, 52, 54, 55), but there is no consensus on a conceptual teamwork model for clinical team performance (53, 56).

The crew resource management (CRM) model originates from human factors training in commercial aviation in the late 1970s. CRM principles are defined within the I-P-O framework and refined by Helmreich and Foursee (57). In addition to including the person-machine interface and acquisition of timely and appropriate information, CRM involves optimizing interpersonal activities such as leadership and followership, the formation of effective teams and maintaining effectiveness, effective problem-solving and decision-making, and maintaining situation awareness (57). CRM principles have reached conceptual consensus and are integrated in aviation crew training internationally to optimize human performance and reduce human error (58). Systematic safety efforts in aviation (both technical and non-technical) have resulted in a major reduction in fatal accidents with 2017 as the safest year in history (zero fatal accidents in commercial aviation) (59). CRM training meets the criteria for increased team competence within most HROs (41). Gaba and colleagues adapted the CRM principles and training methods (simulation) from aviation and introduced the

Anaesthesia Crisis Resource Management curriculum in 1990, the introduction to human factors training in emergency medicine (60).

In 2005, Salas and colleagues published a review on teamwork models within various domains and presented a conceptual framework, “the Big Five”, with a potential to be a universal model for all kinds of teamwork (Table 1) (52). The Big Five offers a practical teamwork taxonomy, basically a “recipe for good teaming”, with components that influence the outcomes of team actions. In addition, the model focuses on coordination mechanisms, i.e., a structured patterning of cooperatively interactional activities used to reach the team goal (52). The U.S. Agency for Healthcare Research and Quality and the Department of Defence have developed the TeamSTEPPS® (Team Strategies and Tools to Enhance Performance and Patient Safety) framework drawing on the Big Five taxonomy (61, 62)

**Table 1**

**The Big Five and the Coordinating Mechanisms of Teamwork**

| The Big Five | Definition | Behavioural markers |
|---|---|---|
| **Team leadership** | Ability to direct and coordinate the activities of other team members, assess team performance, assign tasks, develop team knowledge, skills, and abilities, motivate team members, plan and organize, and establish a positive atmosphere. | Facilitate team problem solving.<br>Provide performance expectations and acceptable interaction patterns.<br>Synchronize and combine individual team member contributions.<br>Seek and evaluate information that affects team functioning.<br>Clarify team member roles.<br>Engage in preparatory meetings and feedback sessions with the team. |
| **Mutual performance monitoring** | The ability to develop common understandings of the team environment and apply appropriate task strategies to accurately monitor teammate performance. | Identifying mistakes and lapses in other team members' actions.<br>Providing feedback regarding team member actions to facilitate self-correction. |
| **Backup behaviour** | Ability to anticipate other team members' needs through accurate knowledge about their responsibilities. This includes the ability to shift workload among members to achieve balance during high periods of workload or pressure. | Recognition by potential backup providers that there is a workload distribution problem in their team.<br>Shifting of work responsibilities to underutilized team members.<br>Completion of the whole task or parts of tasks by other team members. |
| **Adaptability** | Ability to adjust strategies based on information gathered from the environment through the use of backup behavior and reallocation of intrateam resources. Altering a course of action or team repertoire in response to changing conditions (internal or external). | Identify cues that a change has occurred, assign meaning to that change, and develop a new plan to deal with the changes.<br>Identify opportunities for improvement and innovation for habitual or routine practices.<br>Remain vigilant to changes in the internal and external environment of the team. |
| **Team orientation** | Propensity to take other's behavior into account during group interaction and the belief in the importance of team goal's over individual members' goals. | Taking into account alternative solutions provided by teammates and appraising that input to determine what is most correct.<br>Increased task involvement, information sharing, strategizing, and participatory goal setting. |
| **Coordinating Mechanisms** | **Definition** | **Behavioural markers** |
| **Shared mental models** | An organizing knowledge structure of the relationships among the task the team is engaged in and how the team members will interact | Anticipating and predicting each other's needs.<br>Identify changes in the team, task, or teammates and implicitly adjusting strategies as needed. |
| **Mutual trust** | The shared belief that team members will perform their roles and protect the interests of their teammates. | Information sharing.<br>Willingness to admit mistakes and accept feedback. |
| **Closed-loop communication** | The exchange of information between a sender and a receiver irrespective of the medium. | Following up with team members to ensure message was received.<br>Acknowledging that a message was received.<br>Clarifying with the sender of the message that the message received is the same as the intended message. |

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TeamSTEPPS® is an evidence-based teamwork system designed for healthcare professionals to improve patient safety (62, 63). The framework is presented as a "ready-to-use" overall curriculum and assessment tool, and it has shown successful outcomes within various interdisciplinary team settings (63). TeamSTEPPS® is compounded by five key principles: team structure, communication, leadership, situation monitoring and mutual support (Table 2) (61). In TeamSTEPPS®, communication is considered one of the five key principles and defined as structured information exchange, whereas the Big Five teamwork taxonomy includes communication in the other teamwork components and coordinating mechanisms.

**Table 2**

**TeamSTEPPS® Key Principles** (61)

| |
|---|
| **Team structure**<br>Identification of the components of a multi-team system that must work together effectively to ensure patient safety |
| **Communication**<br>Structured process by which information is clearly and accurately exchanged among team members |
| **Leadership**<br>Ability to maximize the activities of team members by ensuring that team actions are understood, changes in information is shared, and team members have the necessary resources |
| **Situation Monitoring**<br>Processes of actively scanning and assessing situational elements to gain information or understanding or to maintain awareness to support team functioning |
| **Mutual Support**<br>Ability to anticipate and support team members' needs through accurate knowledge about the responsibilities and workload |

Reproduced from http://www.ahrq.gov/teamstepps/instructor/essentials/pocketguideapp.html (61)

Situation awareness (SA) and mental models are two concepts reoccurring in team literature that need attention. According to Endsley (1995), SA points towards the individuals' ability to understand "what is going on" and is defined as "the *perception* of elements of the environment within a volume of time and space, the *comprehension* of their meaning and the *projection* of their status in the near future" (64 p. 36). SA is thus a crucial element in decision-making. In interdisciplinary teamwork, individual team members have their own individual SA reflecting their expertise, role, responsibilities, experience and cognitive skills. Some overlap will exist between team members' SA, what Endsley described as team SA (64). Utilizing mutual resources and working effectively in interdisciplinary teams sharing SA, on issues where this is required, is crucial. The sharing of SA is prerequisite in team decision-making and for team members to anticipate each other's needs, and it occurs mainly through verbal communication (64, 65).

Team SA is affected, among other factors, by shared mental models. The definition of mental models in healthcare studies is often unclear and sometimes mixed with other concepts, e.g., situation awareness, which makes it difficult to apply mental models in practice, education and research (66). In cognitive psychology, mental models reflect cognitive mechanisms allowing "people to predict and explain system behaviour and recognize and remember the relationship between system components and events" (43 p. 225). Mental models provide a source of making expectations, i.e, an underlying framework for individuals to draw inferences, understand phenomena, make predictions, control system execution and decide what to do (43, 52, 66). In teamwork, when individual mental models overlap, the team benefits from having shared mental models promoting mutual understanding and actions and helping to identify common goals and work effectively to attain them (43, 52, 66). Shared mental models are defined by Cannon-Bowers and colleagues (1993) as:

> "knowledge structures held by members of a team that enable them to form accurate explanations and expectations for the task, and, in turn, to coordinate their actions and adapt their behaviour to demands of the task and other team members" (43 p. 228).

According to Endsley and Jones (2001), shared mental models will simplify developing a shared SA within teams (67) and lead to better team performance (18, 52, 68).

Developing shared mental models in a team requires that team members work, communicate and train together over time (52, 67). In emergency medicine, interdisciplinary teams are usually assembled in an *ad hoc* manner, comprising individuals who are on call and in accordance with the patient's medical condition. In team literature such teams are referred to as action and negotiation teams characterized by changing membership, unpredictable circumstances and brief duration of teamwork (44, 51). Action teams usually work under time constraints, forcing quick decisions often with insufficient information and managing parallel tasks at high speed (44, 51, 69, 70). Such teams do not benefit from long-term cooperation, which challenges the ability to rely on shared mental models.

## 2.3 Simulation and team training

To meet the increased complexity in health services (comorbidity, specialization, technological and medical development), the IOM report (2000) recommended using similar methods as in other HROs to promote effective teamwork through training, especially in acute medical contexts (21, 71). Among other factors, the IOM report recommended team training using simulation to increase patient safety. The report refers to Leap defining simulation as:

> "a training and feedback method in which learners practice tasks and processes in lifelike circumstances using models or virtual reality, with feedback from observers, other team members, and video cameras to assist improvement of skills" (21 p. 176).

Simulation include using an actor to play a patient, a computerized mannequin to imitate the behaviour of a patient, a computer program to imitate a case scenario, and an animation to mimic the spread of an infectious disease in a population (21). The introduction of simulations in medical education has resulted in a turning point and new thinking in both safety education and research in medicine. Complexity, the potential for making mistakes and small margins are some of the common features of HROs and emergency medicine (72). Simulation has been used for training and certification of competence in several HROs for many years. In the air force, simulation was introduced during World War I to reduce the loss of valuable material (Bluebox), and, as mentioned earlier, CRM training in commercial aviation also includes simulation training (73).

Medical simulation is a teaching technique using mannequins or phantoms that aims to replicate real-life clinical situations as realistically as possible to develop professional competence in the learners (74, 75). Peter Safar's experimentation with sedated and curarized volunteers to show the effect of the mouth-to-mouth method in the late 1950s was in many ways the start of simulation training in medicine. Training models were developed to train on effective mouth-to-mouth ventilation; when blood flow due to chest compressions was discovered, the production of even more advanced training equipment was activated. Practical skills were a focus at first; however, although the training equipment was simple, this approach became the basis for the alternative teaching of emergency medicine. Simulation training provided an opportunity to train on managing acute situations over and over again, without patient suffering (76, 77). Medical simulation, the way we know it today, was introduced in the U.S. in the late 1980s by David Gaba and Abe DeAnda (1989) (78). Human-sized patient simulators with advanced computer technology introduced a potential for training health professionals and students in the process of teamwork, i.e., leadership, coordination, resource management and decision-making during acute critical events. In 1990, Gaba and colleagues completed the first course using the Anaesthesia Crisis Resource Management curriculum, referred to earlier (60).

Medical simulation is often used in generic terms describing all dimensions of simulation training. In the literature, simulations are often structured into 5 different terms based on David Gaba's 11 dimensions of simulation applications: verbal (role playing), standardized patients (actors), part-task trainers (anatomic models), and patient simulator (software-based and/or virtual reality) (75, 76, 79). The use of simulation in healthcare education is rapidly growing (80). The pedagogic platform builds on David Kolb's theory of the cycle of experiential learning. Experiential learning theory defines learning as "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience" (81 p. 44). The theory is based on a cycle of learning through action and reflection and through experience and abstraction (81). Full-scale simulation using software-based patient simulators is run by skilled facilitators and usually presented to participants through 3 phases. First, the participants are prepared for the learning activity and the learning objectives (briefing), i.e., the provision of written information and literature, familiarization with the simulation environment and lectures. Second, a clinical situation is played out to reflect the participants' professional reality and the learning objectives (scenario). Third, issues, especially teamwork issues, are discussed and reflected on in accordance with the learning objective (debriefing). Audio/video recordings from the scenario are often used as a basis for reflection in debriefing. A safe and controlled environment for enhancing learning is emphasized. In addition to high participant activity, the learning method has its strength in allowing time for reflection, which is seldom possible in real life. Simulations also give students and health professionals the opportunity to go into ways of thinking and practising in their own community of practice (82).

*In situ* simulation involves increasing realism by placing the computerized patient simulator in real clinical areas. The advantage of *in situ* simulation is that the participants can operate in a known environment using familiar technical equipment (74, 83-85). *In situ* simulation is thus the closest to a realistic and controlled research laboratory available to study emergency action teams in action. *In situ* simulation provides the opportunity to “standardize” emergencies and repeat the same scenario several times, thus providing access to an arena for scientific study of team performance during medical emergency teamwork.

Even though medical simulation is theoretically a well-documented learning activity, it is also resource-demanding (personnel and equipment). Several studies have found that team training improves team processes (86-89), but to justify the costs, health services have demanded evidence of improved patient outcomes. Detecting such effects has proven difficult (85), but evidence connecting team training to improved patient outcomes is accumulating (90-94).

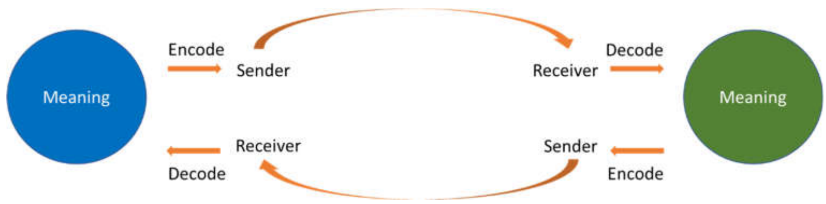
## 2.4 Team communication

Good communication skills are considered as a non-technical social skill prerequisite for effective teamwork (28). Team communication includes written, verbal and body language. In medical emergencies, most team communication is provided using words and body language.

Wilbur Schramm (1971) made an early attempt to adapt a technical communication model to a two-way communication between people (95). The model included the coding of messages by senders through the choice and organization of words, how the message was sent (canal) and the decoding and interpretation by the receiver (Figure 2).

**Figure 2**

**Two-way communication model**




Flin and collegues, 2008 (96)

Being the basis for closed-loop communication (CLC), Scramm's model has been of great importance in teamwork (15, 52, 96, 97). One issue in communication that this model highlights is the importance of understanding in terms of calibrating the meaning of the messages through dialogue. As Rousseau and colleagues (2006) describe:

> "Indeed, when team members interact, they should understand each other, otherwise they will not be able to engage effectively in any of the behavioural processes included in teamwork behaviours. Consequently, the quality of expression helps to reduce the distortion between what is said and what is understood, and it is a necessary condition for most of the teamwork behaviours based on verbal interaction" (46 p. 552).

The focus on effective communication in teamwork was introduced together with attention to the relationship between human factors and error (30), and it thus became important in theoretical teamwork models, team training curriculums and NTS assessment tools (52, 58, 61, 63, 98-100). Effective teamwork is partly a tacit experience—recognized when it is present and missed when it is missing. It is thus challenging to identify good behaviour indicators (46). The individual communicative behaviour of team members would be influenced by the medical condition of the patient, stress, fatigue and the interaction with other team members, potentially leading to delays or inappropriate treatment (47, 52, 101, 102).

In the following, an abbreviated extract of research that addresses interdisciplinary team communication in light of patient safety in emergency medicine is presented. Studies conducted both in simulations and real-life team encounters are included in this extract of research. Most of the studies evaluate the findings in relation to team effectiveness, but only a few examines the relationship between team communication and patient outcome.

### 2.4.1 Standardized communication strategies

A recent study conducted by Rozenfeld and colleagues (2016) assessing pre-intubation team communications in paediatric intensive care simulations revealed that no standardized statements are used when declaring airway emergencies (103). To avoid communication breakdowns, learning from aviation, standardized communication has been recommended in medical emergency teamwork (44, 95, 104, 105). Here, we present three different standardized communication strategies that have gained a foothold in emergency teamwork.

CLC is a general standardized communication strategy based on a two-way communication model and focusing on dialogue securing mutual understanding between the message-sender and the message-receiver. As with several other issues in patient safety, CLC originated from the air force (radio communication) and is based on an understanding of using standardized communication strategies to streamline and enhance safety (3, 40, 97). CLC aims to avoid misunderstandings by ensuring that important observations are communicated in a clear manner (call-outs), that the message is received (check-back) and understood (read-back) (15, 52). CLC is considered to be an important coordinating mechanism facilitating teamwork, and it constitutes an important part of CRM principles and is highlighted as one of three coordination mechanisms in the Big Five taxonomy (52). Studies have found that CLC improves task completion in paediatric trauma resuscitations (16), characterizes more efficient teams in simulated obstetric emergencies and is positively correlated with performance in algorithm-driven activities, e.g., cardiopulmonary resuscitation (10).

To promote communication in the OR, Lingard and colleagues (2005) developed and successfully implemented a preoperative team checklist involving patient information and operative issues in vascular surgery (106). An evaluation of the checklist showed a decline in communication failures within interdisciplinary surgical teams and a positive effect on knowledge and actions in the team (identifying problems, making decisions, bridging knowledge gaps and following actions) (107). The use of standardized preoperative briefings has also resulted in a significant reduction in operating room (OR) delays (108). With the WHO global initiative in surgical safety, the Safe Surgical Checklist was developed and introduced in 2008. The checklist is organized into three different phases related to the surgical procedure (before induction of anaesthesia, before incision of skin and before leaving the operating theatre) aiming to standardize what the surgical team should communicate about and check in each of the three phases (109). The use of the Safe Surgical Checklist has shown an effect on postoperative complications, mortality and surgical site infections (110-112).

Handovers (the delivery of patient information when transferring patient care between individuals/ hospital departments) are considered a potential threat to patient safety (113, 114). To increase safety in handovers, research supports the use of standardized communication strategies to avoid errors (114, 115), while other studies point to significant human interactional issues, e.g., shared sense-making and the opportunity for teaching and learning in handover situations as well as the risk of bypassing them by using communication protocols (113, 116). The beforementioned teamwork system TeamSTEPPS® introduced standardized communication strategies for handoffs ("I PASS THE BATON": Introduction, Patient, Assessment, Situation, Safety Concerns, the Background, Actions, Timing, Ownership, and Next) and for communicating critical information needing immediate attention ("SBAR": Situation, Background, Assessment, Recommendations and requests) (62, 63). In particular, SBAR has reached international acknowledgement and was found to improve interdisciplinary communication and thus potentially increase patient safety (117, 118).

### 2.4.2 Communication skills - a part of non-technical skills assessment tools

To evaluate CRM training, the Anaesthetists' Non-Technical Skills system (ANTS) were developed and validated (Figure 3) (27, 99, 119).

**Figure 3**

**The ANTS system**

| | |
|---|---|
| **Team working**<br>• Coordinating activities with team<br>• Exchanging information<br>• Using authority and assertiveness<br>• Assessing capabilities<br>• Supporting others | **Task management**<br>• Planning and preparing<br>• Prioritizing<br>• Providing and maintaining standards<br>• Identifying and utilizing resources |
| **Situation awareness**<br>• Gathering information<br>• Recognizing and understanding<br>• Anticipating | **Decision making**<br>• Identifying options<br>• Balancing risks and selecting options<br>• Re-evaluating |

Reproduced from Fletcher and collegues (99)

After ANTS, a multitude of NTS assessment tools have been developed for various emergency events, groups of health professionals and for teams (100, 120-122). Most of these tools include communication as part of other assessment categories (100, 119-121), implicitly reflecting that communication skills are inextricably connected to the efficiency of teamwork. While NTS are considered individual skills, they become visible only in human social interactions. Thus, the assessment of individuals often involves the response they receive from the team. In the ANTS system for example, rating SA involves "gathering information", which includes both asking for information and team members providing information, while the assessment of "exchanging information" is categorized as an element of team working (123).

### 2.4.3 Communication and coordination of teamwork

The coordination of team activities is prerequisite for effective teamwork, and studies on team coordination involve studying team communication while representing the "visible" part of team coordination (47, 88).

Leadership is a key factor in coordinating team activities (52, 124). Leading interdisciplinary teams comprising clinical experts in various medical domains is challenging. The leader role and style are not clearly defined, and the hierarchical statuses of the team members are often equal (125, 126). Thus, in emergency team research, leadership communication has been given attention. Härgestam and colleagues (2016) observed 18 trauma teams and found that leaders who gained control and positioned themselves as leaders of the team used nonverbal communication (gaze, vocal nuances and gestures) to underpin their verbal messages (127). The study supports the significance of non-verbal communication in the interpretation of messages and coordination of teamwork, also shown in other studies (128-130). Observing burn resuscitations, Sadideen and colleagues (2015) reported "shared" leadership (131). The most apparent leadership behaviour was to maintain standards by following guidelines and making decisions (131). Edmondson (2003) found that leaders who coached during the implementation of a minimally invasive surgery motivated team members to “speak up” in the OR (132).

Speaking up is closely related to the critical importance of declaring crises and sharing information during medical emergencies. Manser and colleagues (2008 and 2009) found that information transfer, leading to planning and task distribution, predicted high clinical performance scores in anaesthesia teams (133, 185). These findings support Xiao and colleagues (1998), who studied team coordination and breakdowns in trauma teams (70) and found that inadequate information flow (explicit verbalization of problems and lack of task delegation together with conflicting plans and inadequate support) resulted in coordination breakdowns. The authors also found teams to successfully coordinate tasks non-verbally, i.e., by following protocols, monitoring and following the leader, providing unsolicited assistance and anticipating the next action.

Undertaking the concept of adaptive coordination by measuring coordination behaviours in anaesthesia teams, Kolbe and colleagues (2009) suggest a differentiation among “explicit coordination” (usually verbal or written and intentionally used for team coordination), “implicit coordination” (based on shared cognition, anticipating actions and needs related to shared SA) and “heedful interrelating” (team members reconsidering own contribution in relation to the team goal), all exemplified by verbal representations (134).

Building on studies of sense-making during aviation crises (11/9 2001) (135) and in emergency coordination centres (136), Tschan and colleagues (2009) found that teams of experienced physicians in ambiguous diagnostic emergency situations found the correct diagnosis by using explicit reasoning and “talking to the room” (a verbal expression of the speaker's interpretation of situations or events shared with the team without direction, either for informational purposes or as comments on "real-time self-behaviour") (137). Kolbe and colleagues (2010) analysed team communication in anaesthesia teams based on audio/video recordings of anaesthesia inductions. The study concluded that action-related talking to the room appeared to substitute for more direct forms of team coordination such as giving directions, facilitating shared SA and coordinating team actions (17).

### 2.4.4 Communication patterns and characteristics:

Another strain of research in emergency team communication aims to give insight into the patterns and characteristics of naturally occurring language. Lingard and colleagues (2002) explored the communication by OR team members and the implications of tension and their impact on novices during surgery. The authors found that communication patterns reflected strategies of simultaneously receiving goals and minimizing tension. Managing tension between team-members was described as a complex "dance" into which novices are probably socialized (138). Classifying communication failures in the same environment, Lingard and colleagues (2004) found that failures occurred in approximately 30% of all communication exchanges, with 36.4% of them resulting in visible effects. The authors characterized the failures into four categories: "occasion", "content", "purpose" and "audience" (4). Building on the research on preoperative team briefings mentioned earlier (106), Lingard and colleagues (2006) analysed the discourse in 302 OR briefings. Focusing on the theme of ''utility'', a construct defined as the visible usefulness or impact, they described the communicative elements by "informational utility" (with an impact on the team's knowledge or awareness) and "functional utility" (direct communication-work connections), both of which were rated as important for team collaboration (139).

Xiao and colleagues (1998) analysed team communication in case segments of uncertainty in trauma resuscitations and identified two categories of uncertainty; patient-related uncertainty and team-related uncertainty. The latter, the more frequently occurring, involved uncertainties appearing in intrateam communications about resources and schedules, the status and availability of team members, task distribution involving negotiating who should do what, and the intentions of other team members (70). The authors recommend more explicit communication to reduce uncertainties in teamwork (70). Xiao and colleagues (2003) also studied communication patterns (content and frequency) related to team processes in trauma teams, comparing high and low degrees of urgencies and the degree of the teams' shared experience. The authors found that communication of the team leader adapted to the degree of shared experience and urgency. The leader was more involved with experienced members and gave more instructions and less involved with the rest of the team in high versus low urgencies. In teams with shared experience, the leader's communication more often tended to be questions rather than instructions (140).

## 2.5 "Team-talk" and team interaction

This thesis is anchored in an understanding that "reality" and knowledge are created in social interaction (social constructionism), that the world is constructed through human communication (141, 142), and that social action and practices are constituted in discourse (143). Social constructionism (Irwin 2011) is "all about critiquing the taken-for-granted" involving elements of power in constructions people engage in (142 p. 100). On a macro level, this involvement is informed by or linked to wider economic and social processes. On a micro level, it means identifying and observing social processes allowing the individuals involved in it a good deal more influence (142). The macro and micro social processes people engage in are embedded in discourse. Discourse is defined by Sherzer (1987) as:

> “a level or component of language use, related to but distinct from grammar. It can be oral or written and can be approached in textual or sociocultural and social-interactional terms. And it can be brief like a greeting and thus smaller than a single sentence or lengthy like a novel or narration of personal experience and thus larger than a sentence and constructed out of sentences or sentence-like utterances” (144 p. 296).

Moreover, as stated by Roberts and Sarangi (2005):

> “The value of looking at discourse rather than, for example, inner psychological states or more general notions about beliefs, attitudes or behaviour is that language is *a* way, and often *the* way, in which many everyday activities are conducted. Language does not just reflect or express intentions or decisions (the representational role of language); it makes them (the constitutive role of language). In institutional encounters, talk *is* work” (145 p. 632).

This work is inspired by sociolinguistic theory dealing with language as a social phenomenon (146, 147). Some of the theories, which the scientific methods used in three of the papers (papers 2, 3 and 4) are building on, will be mentioned here.

Erving Goffman was a sociologist positioned in social constructionism focusing on the “presentation of self” in the concepts of “frontstage”, i.e., individual appearance and manner in terms of a performance involving an “audience”, as well as “backstage”, where the “suppressed facts” will appear (142, 148). Goffman also described what he called “impression management”, the impression individuals construct of themselves through appearance and manners within a team (142). Another term relevant from Goffman is the concept of “frameworks”, i.e., how individuals interpret what is said and done in situations by implying a background of understanding (framing) when creating meaning for what is going on (149). Goffman’s notion of “footing”, also a relevant term, notes how people align by shifting the way they speak and act during an event, thus changing the frame. Goffman uses a formal military planning session involving acknowledging rank, shifting into a more equivalent decision-making discussion as an example (150).

John J. Gumperz, described as “the founder of interactional linguistics” (147), operated within a research tradition with ethnographic components, i.e., the observation of language in naturally occurring contexts, focusing on understanding language both from structural and functional perspectives. He studied the role of language in social relationships, the reason for misunderstandings and strategies for better communication. His studies were linked to analyses of social interaction and institutional relationships. A key concept is the introduction of contextualization cues (the speakers using pauses, intonation, hesitation and so on) to mediate meaning. The interpretation of such cues relates to historical, cultural and contextual experiences and is connected to an assumed recognition and understanding. This context-bound process between speakers and listeners, named by Gumperz as “conventional inference”, may potentially lead to misunderstanding when the involved parties use and interpret these cues differently (146, 151). Gumperz’s notion of conventional inference is the basis for negotiating meaning and thus creating mutual understanding (149). Language is inextricably bound to thinking and meaning, and meaning is created through the language we use (141, 152, 153).

Goal-oriented talk as a social act involving both the dynamics and constraints of human interaction is constituted in Stephen C. Levinson’s theoretical notion of “activity type” (154). The concept of activity type, building on Wittgenstein’s notion of “language games” involves knowing the ongoing activity to understand the meaning of what is said and done (152, 154, 155). To elaborate on the relationship between act and activity in speech, Levinson uses examples from the team-play of cricket where specific outcries and the use of silence have specific meaning when playing the game (154).

Professional practitioners who are part of institutional meetings with common discursive interest and prototypical characteristics can be categorized as activity types.

Srikant Sarangi has drawn lines from Levinson's socio-pragmatic theory of the role and function of speech in different social activity types and applied it to the interconnections between naturally occurring language and professional practices (155). With this work, Sarangi has proposed activity analysis, a version of qualitative discourse analysis, as a framework for studying speech in professional contexts (155). This analytic method has been used to study communication and interaction in medical practices (143, 156). In activity analysis, the notion of activity type is related to the notion of discourse type (modes of talk), which Sarangi (2000) broadly defines as "specific manifestations of language form in their interactional contexts" (155 p 1). Furthermore:

> "While activity type is a means of characterising settings (e.g., medical consultations, a service encounter, a university seminar), discourse type is a way of characterizing the forms of talk (e.g., medical history taking, promotional talk, interrogation, troubles telling, etc.)" (155 p. 2).

Sarangi argues for an interactional hybridity between discourse types and activity types by indicating that "counselling talk" and "therapy talk" can occur in various activity types and that counselling and therapy sessions can draw on various discourse types. This interactional hybridity underlines how the meaning of speech always depends on the context it appears in (155, 157).

# 3 Aims

Communication is a substantial element in teamwork. Existing team literature on emergency medicine elaborates on only some of the communicative components in use. Teaching communication skills demands an overview of how teams communicate. Although essential, team communication is much more than closed-loop communication and other standardized communication strategies. The aim of increased knowledge on how team members actually talk and interact "on the fly" has led to this thesis exploring the talk-work relationship in medical emergency teams. This was investigated by conducting studies with the following aims:

- Investigate the feasibility of using an *in situ* simulation model to explore the competence of nursing teams in the ICU, assessing ''Team Working'' and ''Situation Awareness'' using the ANTS system.

- Investigate functions of language in interdisciplinary emergency teams with an emphasis on talk-work relationship in communicatively and medically critical phases of teamwork.

- Illuminate the (re)distribution of task responsibilities in interdisciplinary emergency teams through an analysis of the occasioning and functioning of team language.

- Investigate the influence of language in team decision-making processes in real-life interdisciplinary medical emergency teams admitting patients with critical illnesses to the hospital.

# 4 Methods

This thesis is built on one quantitative and two qualitative studies published in four papers. Direct observation and audio/video recordings were made to collect data in all studies. One video camera and one stand-alone microphone were used in the first and second study. In the last study (paper 4) an extra stand-alone microphone was added.

**Paper 1** focused on the feasibility of using an *in situ* simulation model to explore team competence in nursing teams admitting adult patients in the ICU. Some of the data were analysed in Gundrosen's master thesis, a quantitative educational intervention study comparing two different teaching methods (simulation-based and lecture-based) when implementing a local guideline for admitting adult patients in the ICU.

**In papers 2, 3 and 4**, qualitative activity analysis was introduced for the systematic collection, organization, and interpretation of the transcribed material to explore the function of three relevant discourse types in naturally occurring speech in emergency action teams (158). The discourse types in question were "Online Commentary" (ONC), "Metacommentary" (MC) and "Offline Commentary" (OFC). ONC was defined by Heritage and Stivers (1999) as descriptions or evaluations of real-time observations (159), Bateson (1972) described MC as implicit messages framing the activity type orienting towards the next action or a plan (160) and OFC was defined by Sarangi (2010) as clarifications and explanations implying a pedagogic role (161). Examples of these discourse types are summarized in Table 3.

**Table 3**

**Discourse types**

| Discourse type | Definition | Example |
|---|---|---|
| **Online commentary (ONC)** | Description or evaluation of real-time observations | "His oxygen saturation isn't getting any better" |
| **Metacommentary (MC)** | Implicit message framing the activity type, orienting towards the next action or a plan | "I think we should intubate" |
| **Offline commentary (OFC)** | Clarification and explanation, building evidence | "A CT-scan can tell us if there are significant signs of brain anoxia" |

The research team comprised a registered ICU nurse with substantial experience from intensive care and teaching, especially in medical simulation and team training, and three supervisors, two senior consultants (both professors in anaesthesiology), and one professor in applied linguistics. All supervisors had extensive experience in research within their own domains.

## 4.1 Sample, recruitment, and setting

**Paper 1:** Seventy-two of 101 nurses in the ICU in a Norwegian university hospital volunteered and signed an informed consent form prior to participating. Groups of 5-9 nurses at the time were randomized to participate in either a one-hour lecture (Group A) or a one-hour simulation-based teaching lesson (Group B). Data were collected in an *in situ* simulation setting in the ICU. Fifty-four of the 72 volunteering nurses, in teams of 3 individuals at a time, completed the *in situ* simulation. The nursing teams reflected an authentic composition of teams admitting patients in the ICU. All participants had more than two years of clinical experience, and at least one nurse on each team was an authorized intensive care nurse. There was no difference in education or work experience between the nurses in Group A and B. The demographics of the participants are presented in Table 1. No one chose to withdraw from the study.

**Table 4:**

**Demographic data, study 1**

| | A | B | P* |
|---|---|---|---|
| Number of nurses | 27 | 27 | |
| Number of teams | 9 | 9 | |
| Months of clinical experience | 196 (106) | 158 (96) | 0,176 |
| Months of experience in the ICU | 124 (101) | 96 (84) | 0,269 |

A = Lecture-based teaching, B = Simulation-based teaching. Mean (SD)

* Two-sample T-test with two-sided significance level, $p < 0.05$

**Papers 2 and 3:** Eight interdisciplinary emergency action teams in a Norwegian university hospital were recruited while participating in a joint internal *in situ* simulation curriculum that involved three hospital departments (emergency, internal medicine and anaesthesia). Data were collected in an *in situ* simulation setting in the ED. All teams reflected authentic medical emergency action teams at the hospital. The teams comprised 2 physicians from the internal medicine department, 2 nurses from the ED, 1 nurse anaesthetist and 1 anaesthetist (except in one team, when the anaesthetist was occupied elsewhere during the time of simulation). In one of the teams, a medical student also attended. The learning objective was to establish an acute medical response team and new routines for treating patients who were admitted to the hospital with critical illnesses (not exposed to trauma). No one chose to withdraw from the study.

**Paper 4:** Ten live interdisciplinary emergency action teams in a Norwegian university hospital were recruited. Data were collected in real time as patients (not exposed to trauma) were admitted to the hospital ED. The number of health- professionals in each emergency team varied between 11-20 individuals. Some of them were involved in more than one team. Overall, the sample of observed healthcare workers included 144 health-professional roles: 65 physicians from various specialities (cardiology, pulmonary, internal medicine, neurology, ED, radiology, thoracic surgery, anaesthesiology, and prehospital emergency), 46 nurses (ED, anaesthesiology and intensive care), 7 radiographers, 4 medical students and 22 paramedics. All participants provided consent, and no one chose to withdraw from the study.

## 4.2 Data collection

**Paper 1:** Data collection occurred between January and September 2008. We moved a computerized patient simulator (SimMan 2G, Laerdal Medical, Stavanger, Norway) from the hospital simulation centre to the ICU. The test scenario was pre-programmed and reflected the complexity of admitting a patient deteriorating into septic shock. One audio/video recording was excluded because of technical reasons. Two raters from a corresponding simulation institution who were blinded to the teaching methods assessed the 17 available audio/video recordings separately as described in the ANTS System Handbook (123). Both raters had medical and pedagogical education, had work experience in ICUs, were experienced facilitators in medical simulation and were familiar with the ANTS system. The researcher personally brought the 17 audio/video recordings to the raters and provided a one-day training session on using the ANTS system in ICU nursing teams before they assessed the 17 audio/video recordings individually.

**Papers 2 and 3:** Data collection occurred between March and September 2012. The *in situ* simulation (similar to paper 1) was conducted in the hospital ED using a human-sized patient simulator (SimMan 3G, Laerdal Medical). The scenario was pre-programmed and reflected the complexity of admitting a patient with circulatory problems and chest pain without signs of cardiac infarction on the electrocardiogram. Twelve full training sessions were observed. The first 4 sessions were used only for familiarization purposes. All *in situ* simulations were recorded by audio/video for post-scenario debriefing. Of the 8 audio/video recordings, 3 could not be transcribed in full due to technical reasons; thus, only 5 audio/video recordings were available for analysis in paper 2. A professional sound engineer was able to remove some of the background noise in one of the other recordings, providing 6 audio/video recordings for analysis in paper 3.

Picture taken from data collection, study 2

**Paper 4:** Data collection occurred in the ED of a Norwegian university hospital between May 2015 and March 2016. The researcher was included in the emergency team call-out system and came to the ED together with a research assistant when convenient. The researcher brought one mobile video camera and two microphones (one on the camera and one right over the "action zone"). The research assistant provided information and obtained written consent forms from participants while the researcher made the audio/video recordings and took field notes. Of 12 call-outs, two were not included in the study; one because the patient was pronounced dead in the emergency room and one due to emergency team call-off immediately after attendance. Thus, 10 teams admitting patients with critical illnesses (imminent problems with airways, breathing and/ or circulation) were included in the study. The patient ages ranged from 19-88 with a median of 73, and five were women.

### 4.3 Data analysis

**Paper 1:** The main categories ''Team Working'' with its five associated elements and ''Situation Awareness'' with its three associated elements from the ANTS system (Figure 3) were assessed by the two blinded raters. Both categories and elements were scored on a Likert scale from 1 (poor) to 4 (good). ''Not observed'' was given a value of 0. To calculate agreement between the two raters, we used intraclass correlation coefficient (ICC), two-way random, absolute agreement, and single measures. Where agreement reached ICC > 0,6 (moderate agreement), we used a Mann-Whitney U test, two-tailed, with level of significance $p < 0.05$, to compare the two groups of nursing teams. The ICC is a measure of the proportion of observed variance in ratings due to systematic between-target differences compared with the total variance in ratings. The ICC is recommended when calculating interrater reliability (consistency with other raters) and/or interrater agreement (absolute consensus between raters) indexed on a scale from 0 (lack of agreement) to 1 (very strong agreement) (163, 164). The Mann-Whitney U test is a nonparametric test that statistically compares two independent samples (162). It compares the differences between the rank of observations to determine whether the measurements from the two samples are mixed randomly (not different) or if they are clustered at opposite ends, which indicates a difference between them (162). SPSS versions 15 and 16 were used for the statistical analysis.

**Papers 2-4:** Following standardized procedures, we performed qualitative activity analysis according to Sarangi (2000) (155). Paper 2 was considered an introduction to the method of analysing interrelationships between one discourse type (ONC) and team actions. In papers 3 and 4, we extended the analysis by applying interrelationships between three specific discourse types (ONC, MC and OFC) and team actions in identified phases of work, i.e., team expansion in paper 3 and team decision-making processes in paper 4. The analytical approach was conducted stepwise in a five-step process:

1) **Overview of data:** View audio/video recordings repeatedly.
2) **Transcription:** Transcribe the recorded data verbatim.
3) **Structural mapping:** Identify key phases, the overall structure of the organization of tasks and actions within the activity type (165).
4) **Sequential approach**: Address specific professional and interactional issues formed as recognizable communicative phases in the activity type. These phases comprised the sequential organization of team-talk, which is linked to various identifiable functions (155).
5) **Interactional analysis:** Analysis with a focus on the function of specific discourse types in communicative phases relevant to the focus of research.

The researcher and one of the supervisors mapped data into general recursive key activity phases and identified an overarching structure with associated sub-phases across all teams. The structural mapping enabled a minute examination to understand what was occurring at what time and to distinguish typical patterns characterizing the specific activity type (165). Then, we used a sequential approach to identify "critical phases" of both medical and linguistic character in accordance with the aim of study. Guided by the research objective, the interrelationships between specific discourse types and actions were analysed in the identified phases. The researcher, supervisors and co-authors have comprehensive experience from critical care and applied linguistics. To foster reflexivity and avoid preconceptions affecting the results, the researcher and co-authors performed analyses together and discussed the interpretations critically. An analysis was made in the native language of the researchers and supervisors (Norwegian). To illustrate the data and support the findings in international publications, a professional translator translated excerpts to English after the analysis.

## 4.4 Ethical considerations

The studies were conducted in accordance with the Declaration of Helsinki (World medical association 2001). Studies 1 and 2 (papers 1-3) did not involve the collection of sensitive health information and thus were not subject to the approval of a research ethics committee. Data protection issues were reviewed and approved by the Norwegian Social Data Services (ref 17919) (paper 1). The local Data Protection Official for Research at the university hospital approved the second study (papers 2 and 3). Although patients and relatives at the scene were not objects of the study (paper 4), the study was approved by the Regional Committee for Medical Research Ethics (2014/47/REK midt). Participants were provided with written and oral information about the study. They were advised that participation was voluntary and that they could withdraw without needing any explanation. Written consent was obtained from participants before the audio/video recording in paper 1. In the second study (papers 2 and 3), participants were informed about the study, and we requested permission from them to transcribe and analyse the audio/video recordings after the simulation training to avoid influencing the participants' learning outcome. In the last study (paper 4), an extensive effort was made to provide information and ask for consent in advance from health professionals who could potentially be involved in the study. However, because of unpredictability, some of the participants received information and provided consent at the scene. Involvement of critically ill patients unable to take care of themselves requires extraordinary ethical cautiousness. In accordance with ethical approval, all patients and relatives at the scene received written and oral information and gave their informed consent. All patients involved needed immediate medical attention. In addition, some appeared confused or were unconscious, making it impossible to provide information at the scene. Thus, most patients were contacted within the next few days for information and consent. The next of kin gave consent on behalf of four of the patients who were unable to do so because of their medical condition. All transcripts were de-identified. Allowing access to audio/video files only to the research group and keeping the files locked down when not in use assured confidentiality. For control considerations, audio/video files and transcripts will be kept locked down for five years.

# 5 Methodological considerations

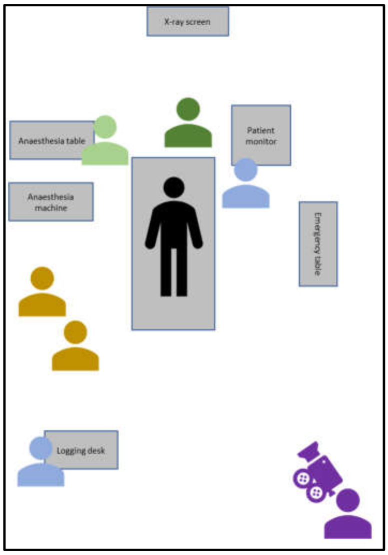
We chose an observational study design that can be involved in both quantitative and qualitative studies. To collect data, we used audio/video recordings and passive direct observation while making field notes. Audio/video recordings provide an opportunity to analyse actions and interrelations in workplace studies in detail. Taking appropriate actions according to the ethical issues described earlier, the advantage lays in being able to collect a massive amount of data from complex environments and the possibility of focusing on details analysing original data juxtaposed with observations and field notes. In addition, audio/video recordings make it easy to cooperate with research fellows by sharing data and analysing data together. On the other hand, the risk of technical problems, how the presence of videorecorders may affect the participants' performance and how the focus on details affects the total overview must be taken into consideration (143, 166, 167). Passive direct observation provides an opportunity to see and listen without interfering, and it is considered a relevant method for studying situated work encounters. Direct observations make it possible to study what people *do*, not what they *think* they did or how they evaluate their achievements (166).

Picture taken from the position of the observer in study 1.

The presence of an observer and a video camera will undoubtedly affect the participants and potentially influence their performance, but to what extent is not known (143). To minimize participant disturbance, we placed the observer and the camera in an acceptable distance from the “action zone” and used stand-alone microphones rather than lapel microphones for sound recording (Figure 4). With only one camera, the camera angle did not always cover all participants or capture all participants’ gazes or gestures and other bodily conduct. Although body language is widely recognized as important in understanding social encounters (128-130), analysing this was not a specific scope in our study, and field notes compensated for this sufficiently by providing additional information to conduct the analysis. Using only one camera (all papers) and one microphone (papers 1, 2 and 3) resulted in variable sound quality. In the second study, only 5 and 6 recordings out of 8 in papers 2 and 3, respectively, were available for analysis. Thus, in the last study (paper 4), we added a second microphone, which increased the sound quality, but still used only one camera.

**Figure 4**

**Sketch of the *in situ* simulation environment in study 2**




## 5.1 Reliability and validity of the study

In general, the relationship between data collection and the research question is the critical issue in all research (166). Reliability, validity, and generalizability are the three indicators usually used for evaluating quality in research (166). Reliability addresses to which extent the results are reproducible and free from systematic errors. Validity is related to the certainty of inferences drawn between the observed variables, i.e., free from design biases (internal validity), to the certainty of inferring that the variables represent some construct (construct validity) and to the extent the results of the study are valid beyond the area of investigation (external validity or generalizability) (166, 168, 169).

As mentioned earlier, paper 1 was based on a quantitative educational intervention study comparing two different teaching methods. Educational intervention research is used to compare “standard” teaching methods with new methods. The aim is to improve cognitive, affective or behavioural outcomes among learners (170). We compared lecture-based (“standard” method) and simulation-based (new method) approaches. Context is important when assessing professional competence; to reach the highest level for assessing clinical performance, assessments should ideally be conducted in real action, i.e., nurses interacting with real patients (171). Although enormous efforts were made to make the simulation realistic, *in situ* simulation is an artificial testing situation and will not provide assessments on the highest level in Miller’s pyramid (“knows”, “knows how”, “shows how” and “does”) for assessing clinical competence (171). Because of the complexity and dynamics in ICU patient care, finding comparable situations in real life is almost impossible. Thus, an *in situ* simulation was chosen to provide a “test laboratory” as close to reality as possible. We observed that some of the nursing teams did not perform according to the expected standards, and during the debriefing some of the participants commented on their own performance as different in the simulation compared with what they would have done in real life. These issues could have been explored elaborately by implementing research interviews that could have given a broader understanding of how the simulation affected performance.

The *in situ* simulation was found to be feasible, providing a standardized realistic model for data collection (paper 1). However, the availability of staff and vacant rooms in a busy clinical area resulted in fewer audio/video recordings for analysis. The number of teams available to participate in our first study was, however, probably too low to give a valid result. Conducting a multicentre study would have provided a larger sample of participants, but this was not possible due to the constraint of the study period.

To minimize selection bias, the groups of nurses were assigned to teaching methods by randomization. Random assignment is the “gold standard” for conducting scientifically credible educational intervention research, meaning that the findings can be directly related to the intervention and not the confounding factors (170). NTS were assessed by two raters, who evaluated the audio/video recordings from the *in situ* simulations. The raters were blinded to the teaching method assigned to the nurses. Blinding refers to concealing the group allocation to the raters; it is commonly used in randomized controlled trials with the aim of avoiding biased assessments (172). In the absence of a validated NTS assessment tool for nursing in the ICU, we chose to use two main categories of the ANTS system validated for assessing anaesthetists (99, 123) that we considered to be recognizable in nursing teams treating critically ill patients. The two main categories “Team Working” and “Situation Awareness” and most associated elements reached a high percentage of observed ratings (> 85%), and both main categories reached a moderate agreement between the two raters (ICC >0,6). Nevertheless, the study did not investigate the validity, reliability and usability of the ANTS systems in ICU nursing teams to a satisfactory extent. To do so, we would have had to involve several more raters in assessing the audio/video recordings. Fletcher and colleagues used 50 trained raters to evaluate the ANTS system (99).

In the first study, the teams comprised only nurses; this is very unusual, although not absolutely unlikely, when admitting patients to the ICU. In this thesis, the first study functioned as an incentive to increase realism by investigating interprofessional emergency teams and to introduce qualitative methods to study talk-work relationships. In the second and third study (papers 2, 3 and 4), we introduced a qualitative activity analysis exploring the function of three modes of talk (ONC, MC and OFC) (Table 2). The following methodological discussion will concern the two qualitative studies included in this thesis (paper 2-4).

According to Malterud (2001) does qualitative research methods involve:

> “the systematic collection, organisation, and interpretation of textual material derived from talk or observation. It is used in the exploration of meanings of social phenomena as experienced by individuals themselves, in their natural context” (173 p. 483).

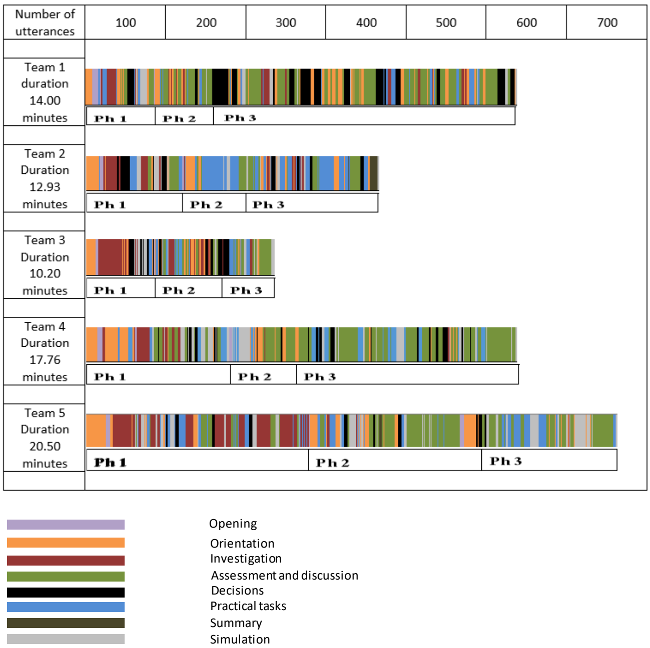
Qualitative research involves a variety of methods for analysis. Morse and colleagues (2002) argue that building strategies for ensuring rigour (investigator responsiveness, methodological coherence, theoretical sampling and sampling adequacy, an active analytic stance, and saturation) into the research process ensures reliability and validity in qualitative research (174).

Experimentally, we performed a structural mapping of the utterances collected from the five interprofessional action-team encounters in study 2 and made an “architectural map” of team-talk (Figure 5, unpublished). The information that could be drawn from this illustration is that, although exposed to the “same patient”, team communication varies, underpinning the significance of human interrelationships in teamwork.

**Figure 5**

**Architectural map of team-talk in 5 simulated emergency team encounters**

Number of utterances, time and 7 categories of speech (Introduction, sharing information, obtaining information, assessment and discussion, decision, support of practical actions and overviews) in the three phases of work: **Phase 1 (Ph1)**, opening phase (greetings, case history, assessments and call for help. **Phase 2 (Ph2)**, core activity (expansion of team, new patient history report, assessment of information, discussions and treatment. **Phase 3 (Ph3)**, closing phase (patient monitoring, ordinations and discussions of follow-ups).




To our knowledge, discourse analysis has not previously been used to study the interconnections between language and team actions in emergency action teams. Thus, to understand more about the function of language in such encounters, we chose a qualitative approach. In our qualitative studies (papers 2, 3, and 4) we provided a systematic three-phased research design in accordance with the standards in discourse analysis: data collection, data transcription and data categorization/analysis (143).

In the following a discussion of reliability and validity through the three terms "reflexivity", "transferability" and "interpretation and analysis", argued by Malterud (2001) to be the standards for evaluating qualitative studies, is presented (173).

### 5.1.1 Reflexivity

Reflexivity involves an "attitude of attending systematically to the context of knowledge construction, especially to the effect of the researcher, at every step of the research process" (173 p. 484). Researcher background and position will guide the choices of what and how to investigate and thus affect the construction of knowledge. The researcher's preconceptions, which probably affect the research process, should thus be continually assessed and shared (173). In this study, the researcher is a registered ICU nurse with substantial experience from intensive care and teaching, especially in team training and medical simulation. The advantage is knowing the field of research from within, e.g. routines, language, and professional roles in interdisciplinary emergency teamwork. The researcher's background motivated and initiated the focus of research, qualified the design of the methods for data collection and may have led to a richer understanding of "what was going on". On the other hand, participants may have reacted to the researcher's presence as a researcher, especially when observing the "home turf" of the ICU. This possible reaction might have affected the participants' performance and the researcher's perspectives in taking some of the observations "for granted".

To strengthen the study design, we followed Malterud's recommendation on involving multiple researchers with backgrounds in applied linguistics and clinical emergency medicine (173). In the study process, the research group supplemented and challenged each other's statements in a critical way to identify relevant focuses of research and increase the understanding of the complexity in the data to ensure valid interpretation. In addition, we focused on verification through systematically checking and confirming by moving back and forth between the literature, data, research question, conceptual work of analysis and interpretations throughout the investigation process to strengthen our results (174). The original data were presented in Norwegian and analysed before translation. The research team verified the translations. Ahead of print, the analysis was presented to the NTNU research group of anaesthesia and emergency medicine and the NTNU research group of applied linguistics. The analysis was also presented in national and international simulation communities, and we received comments that were reflected upon and critically discussed, resulting in a wider perspective. Presenting extracts of the transcripts and interpretations to representative clinical and research communities facilitated recognition from professionals who were acquainted with work in similar clinical situations. Participant comments during the debriefing or interviews could have enriched the data even further.

While the presence of observers is relatively common in emergency care (students, colleagues and relatives), using a video camera is rather unusual, especially in real-life emergency encounters. To reduce the impact of the observers and audio/video equipment, we emphasized providing thorough pre-study information to participants. We did notice some of the participants gazing directly into the camera at the beginning of some of the recordings, but they appeared to soon forget about it when engaging in patient care. This situation also came across from the comments from participants directly after the patient had been transferred from the scene. The participants had been initially nervous about the camera but ignored it almost immediately after the patient's arrival.

### 5.1.2 Transferability

Transferability reflects the internal and external validity of the study—whether it investigates the intended subject and in what contexts the findings can be applied (173). The presentation of sampling, context and study setting are thus vital in qualitative research for the reader to determine for what situations the findings are relevant (173). Appropriate sampling means that the analysis is based on data consisting of participants who represent the research topic (174). In this study, the audio/video recordings consisted of authentic interdisciplinary action teams and naturally occurring language in the *in situ* simulation training (papers 2 and 3) and in real-life encounters (paper 4). The data samples therefore consisted of participants situated in the discourse of interest, providing genuine data on the topic under investigation (175).

The impact of *in situ* simulation regarding data validity is scarcely addressed in emergency teamwork literature. Although simulation has become extremely popular in medical education, only a limited number of studies have identified a coherence between team training and real-life performance (85). Manser and colleagues (2007) studied the activity patterns in anaesthesia teams in real life and in simulations and found behavioural aspects of ecological validity: "the extent to which the environment experienced by the subjects in a scientific investigation has the properties it is supposed or assumed to have by the experimenter" (176 p. 247). Weller and colleagues (2014) also studied anaesthesia teams and found their communication patterns to be similar in routine cases in real life and simulations but different in routine and crisis simulations (177). Both studies build evidence for simulation validity.

Routine anaesthesia cases, however, do not share the complexity of interprofessional emergency action teams engaging in knowledge-driven activities. Researching simulation validity in such dynamic situations is almost impossible because of the variation in team composition and patient heterogeneity. In contrast with aviation simulators, patient simulators can never replicate the complexity of treating live patients to a full extent. We observed that limited cues provided by the patient simulator restricted the focus of ONC to, e.g., the patient's skin colour and temperature; instead, to obtain such information, the participants addressed the simulation facilitator, which possibly disturbed the natural flow of team-talk.

Saturating data is a vital verification strategy in qualitative research (173). Saturation means collecting sufficient samples to verify that the findings are replicated in the data but still not oversized as to prevent the researchers from synthesizing an overview of the data, which is needed to test reflexivity and counter coherences. Thus, in qualitative research, the amount of data should not be exaggerated (173). Although we used small samples, the material in this research was rich, and all authors agreed that the data sampling was adequate to fulfil the recommendations of saturation and reflexivity.

Investigating authentic teams and collecting data from complex real-life encounters increases transferability in our study. As Malterud (2001) argued, by describing the research settings and demographics thoroughly in all papers, readers can ascertain in which situations our findings are valid (173). Reflecting real-life interdisciplinary action teams in our qualitative studies, the participants in simulation training (papers 2 and 3) and in the real-life encounter (paper 4) were chosen not by the researcher but rather by a random selection made by the participants' administrative leaders according to rotation schemes. We thus had no influence on the team composition according to participants' work experience, gender distribution or cultural background. In general, all of these components could affect the power structures and thus team-talk. In addition, all samples were collected from the same Norwegian University hospital. Norwegian culture is characterized by informality and distributed power, including a dislike of control (178). Elaborating on these issues through multicentre studies and participant interviews could have given a wider perspective of analysis and increased the transferability in our studies.

The transferability of our findings is supported by research in other domains. Connections between speech and work have been established by Garbis and Artman (2004), who studied shared SA in Swedish underground control room teams (179). The function of ONC, MC and OFC has been investigated in studies of midwives' communicative expertise in obstetric ultrasound encounters by Sarangi and Gilstad (2014). The authors found that ONC had an explicit function related to what was seen on the ultrasound screen, OFC functioned to describe or explain what is seen on the screen and MC primarily concerned framing phases of activity operating at the level of participant structure and the level of medical procedures and actions (165).

### 5.1.3 Interpretation and analysis

Interpretation is an essential part of qualitative analysis. According to Malterud (2001), the researcher's task is to ".. organise, compare, and validate alternative interpretations. Only when the researcher can identify the systematic procedure that has been followed in this process, can it be shared with others" (173 p. 486). Discourse analysis is concerned with naturally occurring language – how individuals both mediate and construct understanding of reality through speech (175). "The objective of a discourse analysis is to understand what people are doing with their language in a given situation" (175 p. 1376). Discourse analysis is based on revealing sequential features of speech, meaning that interpretation is bound in context to speakers' actions and listeners' responses. To capture the complexity of talk-work relationship in the observed encounters, the audio/video recordings provided a rich amount of data, which were transcribed verbatim, to investigate the functions of team-talk in relation to work activities. Preparing the rich audio/video recordings for analysis by transcribing speech and interactions was a compound and tedious process. To attain consistency in the analytical process, we chose to collect and transcribe all audio/video recordings before the analysis. Transcriptions work as the researchers' "noticing device", allowing access to details in interactions, which are not available in any other way (180). Transcriptions will never cover all activity in complex emergency team interactions. Transcriptions must be fit to purpose. Issues of authenticity must be balanced with issues of intelligibility and representation (143). In many ways, transcription may be viewed as a "translation" made for practical purposes and thus considered a theoretically motivated interpretation (143, 180). In discourse analysis validity is sought using transparent categories (173). To provide transparency and convey what was done in the analysing process, excerpts of the transcripts and a narrative reflecting the analysis were presented to the readers (paper 2-4).

To achieve reliability in the qualitative discourse analysis, efforts should be made to ensure the quality of the transcriptions. In study 2 (papers 2 and 3), a research assistant with no medical background performed the transcribing following established conventions developed for researching authentic interactions. Transcripts were reviewed for accuracy regarding the team-talk, the interactional activities and the medical activities by the researcher and co-authors. Preferably, researchers should transcribe their own data with the purpose of the investigation in mind. Thus, in study 3 (paper 4) the researcher made all transcriptions herself, and the co-authors reviewed the transcripts for accuracy before analysis. The transcripts were depersonalized and performed in a column format to map the interactional trajectories and markings such as pauses and overlapping speech to capture the dynamics and complexity of parallel speech and actions. Comments on the interactions between participants, interactions with the patient and interactions with the facilitator (papers 2 and 3) were extracted from the field notes and audio/video recordings and added to the transcripts (Figure 6). This level of transcript is time-consuming but necessary in order to attempt a rigorous analysis of the interactional dynamics of teamwork (143).

**Figure 6**

**Example of transcription, study 2 (papers 2 and 3)**

| **Utterance** | **Speaker** | **Talk** | **Action** |
|---|---|---|---|
| 104 | Physician 1 | [2][Chest][2]. [3][Short of breath and X X][3] [4][X X. It][4] [5][It's gurgling X.][5] | Physician 1 looks at the patient, puts down the ECG sheet and walks towards the patient's head. |
| 105 | ED nurse 1 | [3][The patient’s name is John.][3] | ED nurse 1 looks at the nurse anaesthetist |
| 106 | Nurse anaesthetist | [4][How old is John?][4] | Nurse anaesthetist looks at ED nurse 1. |
| 107 | ED nurse 1 | [5][John is][5] | ED nurse 1 walks to the desk, where the patient’s record is located. |
| 108 | Anaesthetist | [5][I turned up the oxygen.][5] | Anaesthetist comes to the bed from the left where the oxygen flowmeter is positioned, looking down and reaching for her stethoscope. Physician 1 looks at Anaesthetist. |
| 109 | Physician 2 | [5][OK.][5] | |
| 110 | Physician 1 | And he is hypotensive | Physician 1 looks at Physician 2. |
| 111 | Anaesthetist | [6][But you][6] hear coarse rattling sounds. | Anaesthetist looks at Physician 1. |

**Transcript key**: X = word not audible; [2][words][2] = overlapping speech (the numbers indicate the order of the nearby overlap)

# 6 Results

**Paper 1. Team competence among nurses in an intensive care unit: The feasibility of *in situ* simulation and assessing non-technical skills.**

Eighteen teams consisting of 3 nurses in the ICU participated in this quantitative study. The focus was on the feasibility of using an *in situ* simulation model to explore team competence among nurses in the ICU and to assess nursing teams using two main categories in the ANTS system, i.e., “Team Working” and “Situation Awareness” and their associated elements. The main findings were that establishing a simulation model within a busy ICU was challenging. Due to high clinical activity, we had to extend the test period to include 54 of the nurses (9 + 9 teams) in the study. The ICC between the two raters indicated moderate agreement in the two main categories of the ANTS system (team working: ICC 0.646, situation awareness: ICC 0.686). Statistically, there was no difference between the two groups of nurses (lecture-based teaching/simulation-based teaching). However, across all 18 teams, we did observe that some basic practical nursing tasks were not prioritized; 16% of the teams did not provide more oxygen when the saturation dropped. Only 33% of the teams monitored the respiration rate, and only 44% prioritized antibiotic treatment during the sepsis scenario.

**Paper 2. Team talk and team activity in simulated medical emergencies: a discourse analytical approach.**

Observation and audio/video recordings from 5 interdisciplinary emergency teams admitting critically ill "patients" (not exposed to trauma) in an *in situ* simulation were analysed. The aim was to investigate the functions of team-talk by analysing the interconnections between ONC and actions in communicatively and medically critical phases of teamwork. The main findings were that the activity analysis uncovered the dynamics and complexity of teamwork, overlapping dialogs, parallel speech and parallel ongoing activities. Three key activity phases were identified: Phase 1, the *opening phase* (greeting, a summary of the case history, an assessment related to the case history and a call for extra help); Phase 2, the *core activity* (expansion of the team, a new case/patient history report, an assessment of the information, discussions and treatment); and Phase 3, the *closing phase* (patient monitoring, ordinations and discussions of follow-ups). Phase 2, team expansion, stood out as a critical phase both in clinical and communicative ways. ONC, in this phase of work, functioned to create action, attract attention, construct tasks, and (re)distribute responsibilities as an argument for a decision and as a request for more evidence.

**Paper 3. Discourse types and (re)distribution of responsibility in simulated emergency team encounters.**

The analysis was conducted on the same data as in paper 2. One additional audio/video recording was included after improving the sound quality through digital noise reduction. Thus, six interdisciplinary emergency teams representative of the composition of a typical *ad hoc* team at the hospital, were observed and audio/video recorded during the *in situ* simulation of admitting critically ill "patients" (not exposed to trauma). The aim was to illuminate the (re)distribution of task responsibilities through an analysis of the occasioning and functioning of the following three discourse types: ONC, OFC and MC in the phase of team expansion. The main findings were that OFC particularly foregrounded the participation status, including the educator role, through offering explanations and at times making additional evidence available. ONC routinely triggered a (re)distribution of tasks and responsibilities within the team, seemed to delay intervention, facilitated the consultation of the summary of the patient's history or even resulted in an MC providing a decisional formulation. Both ONC and MC triggered the next action. MC more specifically triggered a variety of actions ranging from the (re)distribution of tasks, arriving at decisions without sufficient evidence and the prefacing of decisions to suggestions regarding the next course of action. The combination of ONC and MC illustrated the slippery boundaries between these two discourse types, with both resulting in future actions without explicit instructions. The constant shift between ONC and MC occurred as the team approximated a decision.

**Paper 4. Team-talk and team decision-processes: a qualitative discourse analytical approach to 10 real-life medical emergency team encounters.**

Ten interdisciplinary medical emergency teams were observed and audio/video recorded while admitting patients with critical illnesses (not exposed to trauma) in real life. The aim was to expand knowledge on the talk-work relationship in complex, heterogeneous, and knowledge-driven emergency situations by investigating how the three discourse types, ONC, MC and OFC, influenced team decision-making processes in real-life interdisciplinary medical emergency teams. Four key activity phases were identified: Phase 1, the *opening activity* (greeting both patient and colleagues, information handover, and patient movement from the stretcher to a hospital bed); Phase 2, the *initial activity* (monitoring the patient and performing primary ABC); Phase 3, the *core activity* (planning and accomplishing diagnostic examinations and treatment); and Phase 4, the *closing activity* (conclusions/tentative diagnosis and patient preparation and movement from the ED for further examination and treatment). The main findings were that both ONC and MC generated progression in the decision-process, triggered action, and (re)distributed tasks and responsibilities. ONC indicated critical situations and created attention. MC was oriented towards both acknowledgements and doubts of expertise. OFC had a pedagogic function: expressing the speaker's expertise, seeking mutual understanding and creating a broader base for decisions. OFC also challenged the grounds for making decisions by demanding further evidence while putting the decision-making process temporarily on hold. Consequently, MC signalled urgency and coordinated team actions when there was limited time to seek further evidence. ONC conflating into MC appeared to "speed up" the decision-process.

# 7 Discussion of main findings

The activity analysis uncovered the dynamics and complexity of teamwork: overlapping dialogues, parallel speech and ongoing parallel activities in interprofessional emergency team encounters. The findings gave insight to the relationship between language, interaction and action in knowledge-driven emergency action team activities "on the fly". The studies illuminated how ONC, MC and OFC functioned in negotiating meaning (expressed expertise and observations through clarifications and explanations, created attention, suggested next steps of action, and acknowledged or doubted other team members contributions), influenced coordination ((re)distributed tasks and responsibilities) and sought mutual understanding by creating a broader base in team decision-making processes. The studies also highlighted the inextricable relationship between meaning and context by uncovering how ONC and MC both result in future actions without explicit instructions. Although challenging, the *in situ* simulation was feasible for studying team competence in highly active clinical areas.

## 7.1 Negotiating shared situation awareness

All healthcare professionals attending interdisciplinary emergency action teams have a common overall goal: providing patients with the best available treatment. In addition, team members have their specific professional roles and sub-goals guiding their situation awareness. SA is an individual cognitive process central to real-time decision-making (65, 181, 182). Team members are interdependent for reaching team-goals, meaning that the sub-goals and required SA overlap to some extent (team SA). Medical decisions in emergencies generally involve more than one person, especially in action teams which are formed to solve complex situations together. Sharing SA pertinent to other team members is vital to utilizing the collective expertise in team decision-making to enhance patient safety (67). In our studies we found communicative patterns of speech functioning to negotiate mutual understanding “on the fly”, e.g., team members expressing expertise and observations through clarifications and explanations (OFC), by creating attention (ONC), by suggesting the next step of action, and by acknowledging or doubting the contributions of other team members (MC) (papers 3 and 4).

SA is included among cognitive NTS to avoid human error. Cognitive skills are difficult to detect and thus challenging to describe and assess (paper 1) (65, 99). Schultz and colleagues studied distributed SA by following the anaesthetists’ gaze (recordings by front head cameras) and found a difference in attention in critical situations versus in ordinary situations (65). In NTS assessment tools, behaviours such as the frequency of scanning the environment, preventive actions, and the communicative performance of team members are used for evaluating SA (65, 99). All utterances provided in action are founded in the speaker’s SA and thus reflect the specific roles and sub-goals of the team members. Xiao and colleagues (1998) found that explicit verbalization of situation assessments and the planning of the next step was an indication of trauma teams reaching a point of decision (70). Our findings of the increased frequency of ONC and MC when teams approximated decisions (paper 3) and of ONC conflating to MC (“I do not get any contact with the patient. I think we have to intubate”) “speeding up” decision-making processes (paper 4) support Xiao. Considering Endsley’s model of SA mentioned on page 24, the combination of these discourse types involves the speaker’s verbalization prerequisite for shared SA in team decision-making processes (64, 67).

A collective understanding of the ongoing situation is a critical factor in constructing and maintaining shared knowledge and common goals in a team (179). Lingard and colleagues (2006) studied the communication process in preoperative team briefings and identified discursive patterns of informative and functional utility (139). Utterances with informational utility had an impact on the attention and knowledge of team members and functioned to obtain a mutual understanding in the team, whereas utterances with functional utility caused actions by the team (139). Our analysis of team-talk in emergency action teams provided, similar to Lingard, insight on how team members verbally negotiate mutual understanding “on the fly” (papers 2, 3 and 4). Our findings also have parallels to SA research in other team-driven domains. Sulistyawati and colleagues (2009) found that high performing teams of military flight pilots comprise individuals with high SA, and they found associations between high SA and team interactions such as information sharing, feedback, support and backup behaviour (183). Garbis and Artman (2004) studied team SA in Swedish underground control rooms and found that the operators both communicated their understanding and questioned or corrected the speaker to reach shared understanding. In unexpected stressful situations, they found that team members would «lose» the team’s SA due to limited communication between the operators. The operators got back «on track» by drawing the attention to one problem by verbal communication (179). In our studies, we found similar functions of ONC, MC and OFC, possibly indicating that these discourse types are communicative tools facilitating teams’ shared SA. The active and dynamic communicative constructions among team members negotiating meaning, sharing understanding and projecting future actions functioned to utilize joint competence by building mutual understanding and broaden the evidence base for team decision-making in critical medical situations (papers 3 and 4).

## 7.2 Team-talk and team coordination

Shared SA is a distributed communicative practice strongly connected to the coordination of information and actions (179, 181). Most studies of team coordination involve team-talk (133, 135, 183-185). We found that both ONC and MC have coordinative functions (leading to (re)distribution of responsibilities and tasks) in knowledge-driven interdisciplinary emergency teamwork (papers 2, 3 and 4).

Protocols, algorithms and checklists are noted in the CRM principles as forceful mechanisms that build mutual understandings, facilitate decisions and make team coordination more effective (57). In algorithm-driven activities, a pre-negotiated common meaning and the mutual understanding of utterances benefit the coordination of work, e.g., “start CPR!”. Schmutz and colleagues (2015) found a connection between CLC and clinical performance in algorithm-driven activities and suggest that CLC is an effective coordination mechanism when team members have an algorithm to work with and know what clinical cues they should be aware of (10). Most emergencies alternate between algorithm-driven and knowledge-driven phases, and successful teams are capable of adapting coordination techniques in accordance with the patient’s changing needs (133). Burke and colleagues (2006) define team adaptation as:

> “a change in team performance, in response to a salient cue or cue stream, that leads to a functional outcome for the entire team. Team adaptation is manifested in the innovation of new or modification of existing structures, capacities, and/or behavioural or cognitive goal-directed actions” (186 p. 1190).

As mentioned on page 35, Kolbe and colleagues (2009) have developed a taxonomy for measuring the process of adaptive coordination in anaesthesia teams (134). The taxonomy involves explicit coordination strategies (verbalized orders, queries for information and/or task assistance, answering questions and providing situation summaries) and implicit coordination strategies (primary based on anticipation and rooted in shared SA and shared mental models, not intentionally used for coordinating team activities but still with that function, e.g., providing information or offering assistance without request). In addition, Kolbe involves the heedful interrelating behaviour described as team members constantly reconsider own contribution in relation to the team goal, allowing themselves to "speak up" when necessary (134). Algorithm-driven activities activate the possibility of using implicit coordination mechanisms (184, 187). However, one drawback to using algorithms as coordination mechanisms is that it may be difficult to change tactics if something unexpected occurs (187).

One could expect that unpredictable situations would lead to explicit coordination mechanisms, but compared with aviation teams, Groete and colleagues (2004) found that anaesthesia teams tended to choose implicit coordination mechanisms in all situations (187). The authors suggested the reason for this to be that members of anaesthesia teams know each other and operate within a shared visual field of activity (187). Conducting ethnographic studies, Hindmarsch and Pilnick (2007) found that anaesthesia teams coordinated work using the environment in addition to body, gaze, and implicit messages (often framed as information to the patient) in anaesthesia inductions (129). Our studies provide an insight to language-based coordination in complex knowledge-driven emergency team activities (papers 2, 3 and 4). In Kolbe's taxonomy of adaptive coordination strategies (134), using ONC would be categorized as an implicit coordination mechanism. MC, on the other hand, would probably be categorized both as explicit and implicit coordination. Even though MC sometimes occurs as an explicit "order", MC requires that the listener know the context and are able to interpret the implicit meaning that is based on anticipation, rooted in shared SA, and shared mental models. As when the anaesthetist says, "we have to intubate", the nurse anaesthetist starts preparing for the procedure by providing the necessary equipment and medication (paper 4). This example indicates that team members have shared mental models, i.e., a shared understanding of the overall goal that they can coordinate work by knowing what is expected of them and predict each other's needs (43, 52). The protocol describing intubation is integrated in anaesthetists' and nurse anaesthetists' daily work. Although the example mentioned here is from a phase that is critical for the patient (not a planned preoperative induction), incorporated routines are activated. These examples have similarities with what the linguistic anthropologist

Gumperz (1982) referred to as “contextualisation cues”: statements signalling contextual presumptions of what will happen next (151). In cognitive psychology, the referred team interactions would be considered as establishing shared SA and a manifestation of shared mental models (43, 52). In contrast, we observed that the nurse anaesthetist student needed explicit orders before being involved in the intubation procedure (paper 4), which indicates that she did not share the mental model guiding the work. In other HROs, the focus has been on using uniformed concepts in communication. In aviation for instance, all pilots are trained in using predefined concepts in English. While there is little conceptual consensus in emergency teamwork, we need to focus on the function of words in team training to increase the ability to coordinate team activities. Pre-negotiated meaning is thus a great advantage in emergency teamwork, and the use of ONC and MC may save time when patients are suffering from life-threatening conditions. In addition to clinical practice, simulation is an acknowledged method for learning how to work in a team. Our findings support the significance of focusing on alternative communicative behaviour in training in addition to standardized communication strategies as CLC, SBAR and Safe Surgical Checklist. To increase patient safety, simulation should be an arena for team members to pre-negotiate the meaning of verbal concepts to develop a shared mental model of how to speak during emergencies.

## 7.3 Communication style in interprofessional emergency teams

The encounters we have studied have the prototypical characteristics of what Levinson (1979) describes as an activity type. This assessment implies, among other things, that the team members participate within familiar and goal-defined frames, and with norms, rules and patterns affecting the interaction among team members (154). According to Linell (1998), this means that utterances and communicative actions cannot be understood fully without reference to what is going on and the context in which the talking occurs (152). This does not mean, however, that all team members always have a mutual understanding of all utterances within the activity type.

Misunderstandings can occur. Sarangi (2000) underpins that the prototypical characteristics of the activity type make them recognizable and separate from other activity types, but they are open to participant improvisation and not rigid (155). Without explicit expressions, language mirrors what the speaker thinks, means, the culture, competence, experience, and relationships between self and others, to mention some. The understanding of what is said is "filtered" in the same way by the interpreter.

Interprofessional emergency teams consist of health professionals with various medical expertise appropriate to meet patient needs in critical and complex medical situations. Even though the team members participate within the same activity type they have different communicative jargon based on their medical expertise. In addition, team members in action teams have maybe never met or worked together before and have had no opportunity to incorporate a mutual communicative behaviour. This may affect the team's ability to utilize their mutual competence. Activity analysis illuminated how team members sought mutual understanding and created a broader base of evidence by negotiating meaning "on the fly". The recommendation for using standardized communication implies an assumption that safe language is built on standardized terminology and procedures (15). Standardized communication strategies however, do not consider the inextricable relationships between language and interaction and, thus, the interdependency among *who* is working, the *language* used and the *context* in which they work. Activity analysis provides a unique opportunity to study the talk-work relationship in emergencies in «slow motion». What is said in the team create meaning through the interpretation by other team members, and the understood meaning are acknowledged or rejected by verbal and/or activity responses (152). For instance when the physicians had different views whether to perform a cerebral CT or not (paper 4), the analysis gave insight in how OFC foregrounded participant status by involving an educator role providing evidence and create a broader base for team decision-making. OFC also offered explanations putting decision-making processes temporarily on hold. In addition, MC functioned to acknowledge or doubt what was said. The communicative style used to negotiate whether to go through with a CT-scan or not, have similarities to what Lingard and colleagues (2002) describe as a complex "dance" to manage tension within the team (138). Including studies of real-life emergency encounters increase the significance of the findings and contribute to the understanding of how speech functions in clinical practice. By implementing the function of speech in team training, participants can achieve a better understanding of how team activities are coordinated by language and how the use of professional jargon may lead to misunderstandings in interdisciplinary action teams.

## 7.4 *In situ* simulation, an arena for learning and investigating team communication skills

Although challenging, we found that conducting the *in situ* simulation for nurses within an ICU was feasible (paper 1). By blending training and a real work environment, *in situ* simulation is assumed to positively influence both the perception of realism and the transfer of learning to clinical practice (74, 83, 84). Simulation is a powerful learning method in medical education used both in individual and team learning (92, 188, 189). Especially in emergency care, pursuing the improvement of patient safety, simulation has become an essential method for learning effective teamwork. Improved communication skills are usually a desired learning outcome in such training (190). However, learning outcomes have mostly been assessed in simulated encounters, and the transfer of knowledge from simulation-based education to improved patient outcomes has been difficult to prove (85, 87).

Studying real-life emergency encounters is necessary to assess the influence of team communication on team performance and patient outcome. Real-life studies of emergency teams, however, are challenging because of low accessibility and a potential risk of disturbing ongoing life-saving activities. Studying team performance in emergency medicine is difficult without simplifications and/or standardizations, and *in situ* simulation has thus become a convenient “substitute” to real-life research. Although outside our scope of investigation, we found elements indicating differences between *in situ* simulations and real-life situations that might have affected team communication. Some of the nursing teams in the ICU did not perform according to expected standards (paper 1); even though we used sophisticated computerized mannequins, the participants claimed during the debriefing that they wold have acted differently if it were a real patient. Speech and interaction reflect the participants’ thinking in action. Among the interdisciplinary teams, we observed metacommunication about the simulation session to occur simultaneously while treating the patient. We also observed that there were no comments on patient behaviour, probably because the patient simulator had limitations in providing behavioural cues. When communicating about these missing cues, the simulation facilitator was involved instead of the team, influencing the natural “flow” of communication (paper 2). On the other hand, we found similar functions of ONC, MC and OFC in the simulated encounters as in the real-life study. Removing some of the complexity from the research arena means diverging from real life without knowing to what extent this affects team performance. Although some attempts have been made to investigate the ecological validity of simulation environments (176, 177), these are concentrated on structured cases of anaesthesia, not complex interprofessional action-team encounters.

To meet the requirements of interprofessional emergency teamwork, Schmutz and colleagues (2018) suggested training in what they call “team reflexivity” (TR), a structured method helping the team continually to adapt to what is occurring. TR involves negotiating shared SA “on the fly” to uncover gaps between the desired and real situation to be able to adapt and achieve an optimal treatment for the patient (191). Training TR includes focusing on the linguistic means to start negotiating meaning within the team. Our studies provide insight to how ONC, MC and OFC influence the negotiation of meaning in critical phases of knowledge-driven interdisciplinary emergency teamwork and may thus be a contribution to TR training. In addition, our studies include attention to how the simulation itself can influence team communication; simulation facilitators and *in situ* simulation researchers should be aware of this effect.

# 8 Conclusion

It is feasible to design an *in situ* simulation model in a complex clinical environment to study team communication in action. Activity analysis is an applicable method for exploring talk-work relationships in interprofessional emergency team encounters. Implementing activity analysis to emergency team-talk illuminates the meaning of language in a new way. The analysis uncovers underlying issues significant to effective communication in interdisciplinary teamwork and leads to a deeper understanding of the function of emergency team-talk. Online commentary, metacommentary and offline commentary have important effects on the negotiation of meaning in knowledge-driven emergencies. ONC creates action, attention, and work as arguments for decisions and as a request for further evidence. MC is oriented towards both acknowledgements and doubts of expertise in the team, triggering a variety of actions by suggesting the next step of action, prefacing decisions and sometimes leading to decisions without sufficient evidence. We found that both ONC and MC coordinated team activities by leading to the (re)distribution of tasks and responsibilities. ONC conflated with MC appeared to "speed up" the decision-process. OFC indicated the participant status through the speaker's expressions of expertise, making additional evidence available to the team and seek mutual understanding. OFC also challenged the grounds for making decisions by demanding evidence while putting the team decision-making process temporarily on hold. Our contribution has been to give insight into the function of speech in emergency teamwork, which would not be visible without a discourse analytical approach.

# 9 Implications for practice

The findings in this thesis, together with prior research, imply that to improve communication skills in interprofessional teamwork, there is a need to focus on the function of language embedded in the activity type in addition to standardized communication strategies.

To improve the quality of team training, especially in knowledge-driven emergencies, educators should involve the findings from this studies to increase team members' awareness of the influence speech has in negotiating meaning, in sharing SA, in creating action, in team decision-making processes and in coordinating teamwork. Although ambiguities are an intrinsic feature of the discourse types examined, a systematic explanation of their occurrence and functions can contribute to successful educational interventions. Beside supervised clinical practice, simulation is the most accessible and realistic arena for healthcare professionals to learn how to communicate in emergency action teams. To influence patient safety, educators should be aware of the key role that simulation plays for team members to build shared team mental models of how to speak during emergencies.

# 10 Implications for research

By introducing activity analysis to emergency team-talk, we have «opened a door» into deeper investigations of the talk-work relationship in action team activities. The method can be developed and be a basis for, or combined with, quantitative analyses to investigate coherences between how team members speak and their non-technical skills. Especially in knowledge-driven activities where negotiating meaning is crucial to utilizing mutual resources in the team, such controlled studies could result in new linguistic tools to identify effective communicative behaviour in teamwork.

Another issue that needs further investigation noted in this thesis is how simulation affects team communication in knowledge-driven emergency team activities. Following McGrath's conceptual framework for the systematic study of teams (48), simulation itself could affect the input factor in team research and be a confounder when assessing team competence. If simulation is to be used to investigate team competence in more dynamic contexts, we need to know to what extent communication in simulations is comparable with real-life communication. Conducting further linguistic analyses, with validity in mind, could elaborate on this topic. In addition, approaching this line of research with studies based on interviews would illuminate how team members experience simulation compared to real life and provide insight on how to compensate when conducting simulation training and research.

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# Paper 1

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ORIGINAL ARTICLE

# Team competence among nurses in an intensive care unit: The feasibility of *in situ* simulation and assessing non-technical skills

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**KEYWORDS**
Critical care;
*In situ* simulation;
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**Summary**
*Objectives:* Nursing competence affects quality of care in intensive care units (ICUs). Team competence is particularly important for preventing errors. This paper focuses on the feasibility of using an *in situ* simulation model to explore team competence in the ICU, and on using parts of the Anaesthetists' Non-Technical Skills (ANTS) taxonomy for assessing Non-Technical Skills (NTS) in nursing teams.
*Methodology/design:* Seventy-two nurses were randomised into two groups and introduced to a new guideline *via* either lecture-based or simulation-based teaching. A preprogrammed patient simulator and a video camera were installed inside the ICU, and a scenario was enacted to simulate the admission of a patient with septic shock. All available facilities in the ICU were used. Two blinded raters evaluated ''Team Working'' and ''Situation Awareness'' *via* video recordings using the ANTS taxonomy.
*Results:* Due to high activity in the ICU, 54 nurses completed the *in situ* simulation. Assessments of the video recordings revealed moderate agreement between the two raters. Observations revealed issues deviating from expected standards of competence.
*Conclusion: In situ* simulation may be feasible for assessing competence in ICUs. The ANTS appears to be a promising foundation for developing a team assessment tool for ICUs.


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**Implications for Clinical Practice**

- The competence of nurses working in intensive care units (ICUs) is important for quality of care.
- *In situ* simulation may be feasible for exploring team competence in the ICU.
- *In situ* simulation may define areas for quality improvement.

## Introduction

The complexity of critical illnesses and the need for advanced monitoring and treatment have been shown to strongly influence the incidence of adverse events in critical care (Bion and Heffner, 2004). The single most important indicator of quality in critical care is the patient survival rate, which is the result of a multilayered process composed of individual factors, team factors and system factors (Pronovost et al., 2004).

The competence of nurses working in intensive care units (ICUs) is an important element in this process. Competence is related to knowledge base, skills, attitudes, values and experience (Epstein and Hundert, 2002; Pronovost et al., 2004). Ääri et al. (2008) suggested dividing competence into clinical and professional aspects. Clinical competence relates directly to patient care and involves the principles of nursing care, clinical guidelines and nursing interventions, whereas professional competence relates to the nursing profession in general and consists of ethical activities, decision making, development work and collaboration. Thus, abilities related to working in a team, cooperating and communicating contribute to defining and classifying competence in intensive care (Rosen et al., 2008; Ääri et al., 2008).

The use of *in situ* simulation has been promoted to make simulations more realistic and available (Kobayashi et al., 2008). The obvious advantage of this approach is that participants can operate in a known environment and use the medical equipment with which they are familiar. For example, the actual time spent treating a patient is more realistic with this approach (Kobayashi et al., 2008; Lighthall and Barr, 2007). Additionally, *in situ* simulation using a computerised manikin provides the opportunity to present the same patient scenario several times in a real ICU, which allows *in situ* simulation to serve as a model for monitoring both individual and team competence in action. This approach can also help define elements that can be assessed in the process of improving quality and patient safety in critical care.

Non-technical skills (NTS) are the ability to make decisions and plans (cognitive skills) and to communicate and work in teams (social skills) (Fletcher et al., 2002; Jeffcott and Mackenzie, 2008). Studies have shown that 50—80% of adverse events in critical care are related to NTS (Fletcher et al., 2002; Reader et al., 2006). Although it is difficult to link team performance directly to patient survival, Pronovost et al. (2004) claim that the manner in which existing therapies are delivered is fundamental to improving quality of care in the ICU.

The implementation of new guidelines is a common practice for optimising care (Rivers et al., 2001). Guidelines describe professional standards that can be used to assess competence and quality of care (Cabana et al., 1999). Individually, nurses require high levels of competence, including good NTS, when new patients arrive in the ICU. Teams must utilise common resources to provide patients with high-quality treatment (Pronovost et al., 2004). However, including NTS standards in professional guidelines is difficult because cognitive, mental and social qualities are involved. The Anaesthetists' Non-Technical Skills (ANTS) behavioural marker system was developed and validated by Fletcher et al. (2003). To the best of our knowledge, there is no validated tool to assess NTS in intensive care teams. However, in a literature review, Reader et al. (2006) found that critical incidents in ICUs can be classified using the same four categories used in ANTS: ''Team working'', ''Situation Awareness'', ''Task Management'' and ''Decision Making'' (Fig. 1). Those authors also described a team performance framework for the ICU that mirrored the ANTS taxonomy (Reader et al., 2009).

Miller's pyramid for assessing clinical competence distinguishes between four different levels of competence (''knows'', ''knows how'', ''shows how'' and ''does'') and is widely used in medical education (Norcini, 2003; Wass et al., 2001). The level ''does'' reflects how practitioners act in real life and is, according to Miller, the most accurate way to assess clinical competence (Norcini, 2003). According to this framework, scant information can be gained from assessing experienced intensive care nurses using the three lower levels of the pyramid. In contrast, one must evaluate how nurses perform when they are actually doing their work in a clinical setting and how they use their competencies in action. Professional practice means being able to use knowledge in action (Schön, 1983), and competence should preferably be assessed while nurses are interacting with real patients in the ICU (Norcini, 2003; Wass et al., 2001).

Furthermore, ICU patients are not a homogeneous group, which makes it challenging or nearly impossible to find similar, applicable situations for comparing the competence of nurses on the job. In addition, the lack of assessment tools makes it even more difficult to use competence as a quality indicator in the ICU.

This paper focuses on the feasibility of using an *in situ* simulation model to explore team competence in the ICU, and to assess ''Team Working'' and ''Situation Awareness'' in nursing teams using the ANTS system. The data originate from a randomised trial comparing learning outcomes in two groups of ICU nurses. The educational results will not be discussed in detail in this paper (see discussion section).

## Methods

The relevant department management approved the use of the ICU at a university hospital in Norway as a data collection site. Data were collected from January to September 2008, and the study was approved by the Norwegian Social

**The ANTS System**

| Categories | Elements |
|---|---|
| Team Working | Coordinating activities with team<br>Exchanging information<br>Using authority and assertiveness<br>Assessing capabilities<br>Supporting others |
| Situation Awareness | Gathering information<br>Recognizing and understanding<br>Anticipating |
| Task Management | Planning and preparing<br>Prioritizing<br>Providing and maintaining standards<br>Identifying and utilizing resources |
| Decision Making | Identifying options<br>Balancing risks and selecting options<br>Re-evaluating |

From Flin R, Glavin R, Maran N. Anaesthetists' Non-Technical Skills (ANTS) System Handbook v1.0. University of Aberdeen 2012.

**Figure 1** ANTS.

Science Data Services. All 101 nurses working in the ICU at the start of the study were informed and asked to participate. Seventy-two of the nurses volunteered and signed an informed consent form prior to participating.

The nursing rotation scheme in the ICU involved one day dedicated to an internal curriculum every 12 weeks. Teaching by different methods was common in the department and the randomised trial was conducted as part of this curriculum. The data were analysed in the first author's master's thesis. The nurses received a one-hour lesson that was either lecture-based (Group A, 38 nurses) or simulation-based (Group B, 34 nurses). The learning goal for both groups was to implement a new standardised guideline: ''Admitting new critically ill adult patients to the ICU'', describing the initial treatment of critically ill patients. In Group A, 5—9 nurses at a time received a traditional theoretical lecture supported by a PowerPoint presentation. In Group B, 2—4 nurses at a time participated in a scenario at the medical simulation centre. The scenario included using the new guideline, and each session was followed by a conventional debriefing according to Steinwachs (1992). Non-technical skills were not included in the new guideline and therefore not a learning goal in either of the teaching methods. All teaching sessions in both groups were conducted by the first author.

A critically ill patient arriving in the ICU at our institution is typically met by a team of three nurses and one physician, if available. The nursing teams are designed to ensure a broad range of competence and experience. The nurse in charge assigns one of the nurses to lead the team, while the other two nurses assist the team leader. Nine different teams from Group A and nine teams from Group B were tested. Each team consisted of three nurses from the same teaching group. The composition of the teams and the roles among the nurses were similar to reality. The nurses were told to act as they normally do when the ICU physician is only available by telephone. Due to the 12-week nursing rotation scheme and the summer holidays, the test was conducted between three and five months after the teaching session.

Simulated case history:

Ann Olsen is a 56-year-old patient who was previously in good health.

Actual: She received an injury to her left hand while gutting fish 1 week prior to presentation. Upon examination, this hand was swollen, red and painful. Her general condition is currently deteriorating; she has a fever and is experiencing breathing difficulties.

Description of "patient" upon arrival:
• Gray wig, hospital shirt, socks and underwear
• Arterial line connected

**Figure 2** Case history.

## *In situ* simulation

The ICU is a semi-open ward with room for 10 critically ill patients and 12 postoperative patients. It admits approximately 700 ICU patients per year. Only five rooms were designed for patients who require shielding. In three of these five rooms, shelves for a video camera were installed. The learning outcomes were assessed through an *in situ* simulation, which required that one of these three rooms was vacant and that there were nurses available to participate. We moved a computerised patient simulator (SimMan 2G, Laerdal Medical, Stavanger, Norway) from the hospital simulation centre and spent approximately 30 minutes setting up and testing the simulation equipment prior to the simulation.

To make the *in situ* simulation as realistic as possible, the scenario reflected the complexity of admitting a patient with septic shock. In particular, this patient simulator had exacerbated problems with respiration and circulation (Fig. 2). The changing physiological parameters were preprogrammed and visible to the participants *via* an ICU monitor. The mannequin had palpable central and peripheral pulses and chest movements according to a programmed respiration rate. Through a wireless sound transmission system, the human patient simulator answered questions from the nurses and complained about breathing problems, feeling ill and cold.

Three ICU physicians were briefed and ready to answer questions by telephone from the nurses involved in the scenario. The nurses were told that the ICU physician was occupied in an emergency situation elsewhere in the hospital but was available by telephone. The department's medical equipment and drugs were used as normal.

Each team was briefed about the manikin and the use of the ICU facilities. Preliminary medical information about the patient was provided 10 minutes before the patient's arrival. The teams then had 10 minutes to prepare. The scenario began with an oral and written handover report and lasted for 25 minutes. The scenario was video-recorded. After the scenario, the participants were debriefed in the same conventional manner (Steinwachs, 1992). Each *in situ* session lasted approximately two hours per team, including the briefing, scenario and debriefing. The installation of the simulation equipment in the ICU, the briefing, running the scenario and the debriefing were conducted by the first author and an assistant. A maximum of three *in situ* simulations were conducted per day.

### Measurement and analysis

One of the 18 videos from the *in situ* simulation was excluded for technical reasons. Two raters from a corresponding simulation institution who were blinded to the teaching methods assessed the remaining 17 videos. The main categories ''Team Working'' (TW) with its five associated elements and ''Situation Awareness'' (SA) with its three associated elements (Fig. 1) were assessed separately as described in the ANTS System Handbook (Flin et al., 2012). TW includes the skills necessary to cooperate with others in a team, while SA describes the observation of relevant information, understanding the meaning of what one observes and the ability to plan according to the expected development (Flin et al., 2012). Both categories and elements were scored on a Likert scale from 1 (poor) to 4 (good). ''Not observed'' was given a value of 0. Both raters had medical and pedagogical education, had work experience from ICUs, were experienced facilitators in medical simulation and were familiar with the ANTS system. They had both participated in a one-day training course on using the ANTS in ICU nursing teams before they assessed the 17 video-recordings individually. Inter-rater reliability was calculated with SPSS for Windows Version 16 using Intraclass Correlation Coefficient (ICC) two-way random, absolute agreement, single measures indexed on a scale from 0 (lack of agreement) to 1 (very strong agreement) (LeBreton and Senter, 2008).

The learning outcome was assessed by observing how the teams followed the guideline's practical recommendations. This included checking routines and producing medical equipment before the patient arrived. The time the teams spent before they performed tasks such as monitoring physiological parameters, starting volume therapy, oxygen treatment and antibiotics was also recorded.

## Results

Fifty-four of the 72 volunteering nurses completed the *in situ* simulation. All of them had more than two years of practical experience, and at least one nurse on each team was an authorised critical care nurse. There was no difference in education or work experience between the nurses in Groups A and B.

Intraclass Correlation Coefficient for the main categories TW and SA were 0.646 and 0.686 respectively, indicating a moderate agreement between the two blinded raters. An ICC value greater than 0.6 was also found for two of the TW elements (exchanging information, ICC = 0.664, and using authority and assertiveness, ICC = 0.705) and one of the SA elements (anticipating, ICC = 0.602). For all the other five elements ICC was less than 0.5 (SA: coordinate activities with team ICC = 0.402, assessing capabilities ICC = >0 (scale not reliable), supporting others ICC = 0.292. TW: gathering information ICC = 0.484 and recognizing and understanding ICC = 0.358) (Table 1).

No statistically significant difference in learning outcomes between the two groups was found during analysis, but we did observe that less than 50% of all the 18 teams remembered to prepare for intubation and fluid transfusion before the patient arrived. Of all the teams that completed the study, 16% did not increase the $FiO_2$ when the saturation dropped. Only 33% of the teams monitored respiration rate and only 44% initiated antibiotic treatment during the scenario.

## Discussion

Using the described *in situ* simulation model we completed 18 scenarios reflecting the admission of a patient with septic shock in an ICU involving 54 of the 72 nurses who volunteered to participate. The observability and inter-rater reliability calculated between the two raters assessing ''Team Working'' and ''Situation Awareness'' with associated elements from these *in situ* simulations support the idea of using the ANTS taxonomy as a basis for developing an NTS assessment tool for ICU teams.

Educational research in a busy workplace is challenging and our randomised trial comparing learning outcomes had several limitations. The guideline ''Admitting new critically ill adult patients to the ICU'' was new to the nurses, but it did not imply a major change in the way the nurses were used to work in admitting new patients. This made it difficult to choose appropriate outcome measures demonstrating differences in learning outcome. A small intervention together with short instructional sessions, different teaching-group sizes and the fact that the first author was providing instructions, collecting data and analyzing them, may have biased the results. In addition, due to the high clinical activity, some of the tests had to be postponed until after the summer holidays. Different intervals between instructions and evaluating learning outcomes (3—5 months) probably affected the results.

The reason why we chose to collect our data during *in situ* simulation in the ICU department and not in the simulation centre was to make the environment as realistic as possible. The nurses were tested in a familiar

**Table 1** Results for observability and inter-rater reliability between two blinded raters assessing Team Working and Situation Awareness with associated elements using the ANTS taxonomy scheme in ICU nursing teams. Seventeen videos from *in situ* simulation were observed.

| Categories<br>Elements | Observability<br>%[a] | ANTS | ICC |
|---|---|---|---|
| ''Team Working'' | 100 | 3 (2–4) | 0.646 |
| Coordinating activities with team | 100 | 3 (2–4) | 0.402 |
| Exchanging information | 100 | 3 (2–4) | 0.664 |
| Using authority and assertiveness | 97 | 3 (0–4) | 0.705 |
| Assessing capabilities | 56 | 3 (0–4) | >0[b] |
| Supporting others | 85 | 3 (0–4) | 0.292 |
| ''Situation Awareness'' | 100 | 3 (2–4) | 0.686 |
| Gathering information | 100 | 3 (2–4) | 0.484 |
| Recognizing and understanding | 100 | 3 (2–4) | 0.358 |
| Anticipating | 97 | 3 (0–4) | 0.602 |

[a] Basic descriptive: % of observed ratings ANTS: median (range). Likert scale: 1 = poor, 2 = marginal, 3 = acceptable, 4 = good, *N* = not observed is labelled 0, ICC: two-way random, absolute agreement, single measures.
[b] Scale not reliable below 0.

environment, where they knew where to find the necessary medical equipment and medicines and knew the routines for calling the physician. According to Miller's pyramid for assessing competence, ICU nurses should ideally be observed when they work with real patients, but it is difficult to identify sufficiently comparable situations in clinical practice. We therefore need a model realistic enough for us to trust that the assessment is valid in clinical practice. To avoid potential sources of bias, standardised situations are essential. This study provided a standard test situation using a computerised patient simulator inside the ICU. Good planning and support from the ICU management was vital to accomplish this. Nonetheless, *in situ* simulation demands considerable resources in terms of available staff and vacant rooms in the ICU. In our study, the high activity in the ICU prevented 18 of the 72 nurses from participating in the *in situ* simulation.

The ANTS system is a tool used to assess non-technical skills in anesthesiology. The four categories in this tool are transferable to other medical areas, but the behavioural markers that describe the categories and associated elements were specifically created for assessing anesthesiologists in an operating room (Reader et al., 2006). Even if errors and adverse events in the ICU can be categorised in the ANTS taxonomy, ANTS has not been validated in an ICU team setting before (Reader et al., 2006). Because of this, only two of the main ANTS categories were selected in this study. ''Team Working'' and ''Situation Awareness'' seemed to be appropriate while they both describe elements recognisable in ICU nursing teams treating a critically ill patient without a physician present.

Behavioural assessment tools require high rater skills. In aviation, Flin and Patey (2011) refer to a recommended minimum of two days' training for raters with prior knowledge of NTS. The raters in our study were familiar with the ANTS and *in situ* simulation; they had work experience from ICUs prior to the assessment. Due to the raters' background and our use of only two of the four main categories in the ANTS system, we settled for one-day training of the raters. Even with this limited rater training, we achieved good observability in both main categories and in their associated elements (≥85% in all except assessing capabilities). We also achieved moderate agreement (ICC > 0.6) (LeBreton and Senter, 2008) between the raters in both main categories. As in Fletcher's evaluation of the ANTS (2003) the inter-rater reliability may have been improved by more rater training. However, our study supports the idea that the ANTS may serve as a basis for developing a tool to assess non-technical skills in intensive care teams. Furthermore, identifying good examples that define and describe good and poor performance will be essential to the future development of this process.

Increasing oxygen when saturation drops, starting antibiotics early, measuring the respiration rate and preparing for fluid infusion while waiting for a patient with septic shock reflect the nursing teams' priorities during the *in situ* simulation. The loyalty of health personnel to clinical practice guidelines has been shown to vary (Hamman et al., 2010), but our findings relate to more than simply whether a professional guideline was used or not. This type of knowledge is basic, and experienced nurses in the ICU are expected to be familiar with these tasks. Some of the teams in our study did not perform according to the expected standards. We cannot be certain whether this performance indicates lack of expertise or is related to realism in the simulation method. If our findings are related to poor competence, the consequences could be a potential threat to patient safety and quality in the ICU. A focus on evidence-based quality measures and the ability to observe different teams performing in the same situation may reveal the quality level in the department and potential areas for improvement (Hamman et al., 2010). Considering the importance of how care and treatment are delivered, *in situ* simulation was shown to be feasible for assessing team competence. However, further research is necessary to explore the correlation between *in situ* simulation and real life.

## Conclusion

Although *in situ* simulation presents limitations in terms of realism and availability, it may be feasible to assess competence in action inside ICUs. Thus, *in situ* simulation has potential for monitoring quality and identifying potential threats to patient safety in the ICU (Hamman et al., 2010). The ANTS appears to be a feasible foundation for developing a non-technical skill assessment tool for intensive care.

## Conflict of interest

The authors have no conflict of interest to declare.

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# Paper 2

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ORIGINAL RESEARCH — Open Access

# Team talk and team activity in simulated medical emergencies: a discourse analytical approach

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## Abstract

**Background:** Communication errors can reduce patient safety, especially in emergency situations that require rapid responses by experts in a number of medical specialties. Talking to each other is crucial for utilizing the collective expertise of the team. Here we explored the functions of "team talk" (talking between team members) with an emphasis on the talk-work relationship in interdisciplinary emergency teams.

**Methods:** Five interdisciplinary medical emergency teams were observed and videotaped during *in situ* simulations at an emergency department at a university hospital in Norway. Team talk and simultaneous actions were transcribed and analysed. We used qualitative discourse analysis to perform structural mapping of the team talk and to analyse the function of online commentaries (real-time observations and assessments of observations based on relevant cues in the clinical situation).

**Results:** Structural mapping revealed recurring and diverse patterns. Team expansion stood out as a critical phase in the teamwork. Online commentaries that occurred during the critical phase served several functions and demonstrated the inextricable interconnections between team talk and actions.

**Discussion:** Discourse analysis allowed us to capture the dynamics and complexity of team talk during a simulated emergency situation. Even though the team talk did not follow a predefined structure, the team members managed to manoeuvre safely within the complex situation. Our results support that online commentaries contributes to shared team situation awareness.

**Conclusions:** Discourse analysis reveals naturally occurring communication strategies that trigger actions relevant for safe practice and thus provides supplemental insights into what comprises "good" team communication in medical emergencies.


**Keywords:** Emergency medicine, Patient safety, Interdisciplinary teams, Communication, Patient simulation, Qualitative research

## Background

Analyses of adverse events in medical emergency situations have emphasized the importance of good communication, and several reports conclude that communication errors can jeopardise patient safety [1–5]. Team communication is particularly important for coordinating responses to medical emergencies [6–8]. These situations are characterized by high complexity due to the rapidly changing state of the patient and the attendance of several experts with different medical specialties. Interdisciplinary medical emergency teams are composed of the individuals that are on call at the time rather than being a predetermined group of individuals [9, 10]. Although all team members have the same goal i.e. to offer the patient the best available treatment, each person assesses and approaches the situation based on their own individual professional expertise [10, 11]. Thus, to optimize treatment and to coordinate team activities, communication amongst team members, termed "team talk", is crucial for

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utilizing the collective expertise during team interactions. Communication skills are highly emphasized both in emergency team training and in the assessment of team performance [11–16]. Recommendations for standardized communication, including closed loop communication, have been obtained mainly from work in the defence and aviation communities. However, the extent to which such communication strategies is implemented in medical practice remains unclear [17–19]. An additional concern is that the functions of medical emergency team talk—that is, the relationship between what is said and what is done—have remained more or less unexplored [10, 20, 21].

Qualitative discourse analysis is an inductive linguistic methodological approach to studying the interconnections between naturally occurring language and professional practices in an attempt to reveal the structural and interactional organization of the speech that takes place in certain situations. This approach pays particular attention to the micro level of interactions and to how decisions and actions can be considered interactional achievements based on negotiations by the team members [22, 23]. In the healthcare context, discourse analysis is used to investigate the structure and interactions between patients and clinicians in general medical practices, in genetic counselling and consultations in the emergency department [24–26]. It is also used to analyse shift handoffs and to identify communication patterns that are linked to collaboration during preoperative team briefings [27, 28]. Transcription is a decisive element in discourse analysis. Transcription offers a way to translate the content and structure of an interaction into a written format that helps the analyst notice details that are not readily apparent through observation, looking and listening. Transcription is thus an important tool for capturing interactional dynamics and for identifying patterns and variety across a corpus of data [29]. "Online commentaries" are utterances that frequently occur during a physical examination in patient-physician consultations. Online commentaries describe or evaluate what the physician is observing at that exact moment, and they both reassure the patient and contribute to the physician's evaluation of the patient's problems [30]. In the context of team communication, online commentaries are the way that team members share information of their real-time observations and assessments of observations based on relevant cues in the clinical situation [31–33]. Online commentaries are thus elements in team coordination and team adaption, which is associated with better team performance and which can impact patient safety [34–36].

Medical simulation has become an important arena for teaching and studying teamwork [37–39]. Simulation provides an opportunity to present the same patient scenario to multiple medical teams. *In situ* simulation allows teams to practice their response in a known environment with familiar medical equipment, making the simulation more realistic to the participants [39, 40]. *In situ* simulation provides a unique opportunity to explore the connections between what is said and what is done (what actions are taken).

To our knowledge, discourse analysis has not been used previously to study the functions of talk in interdisciplinary ad hoc emergency teams. To understand more about the interconnections between team talk and actions, we introduced the use of this analytical approach to 5 authentic teams during *in situ* simulation training in the emergency department at the hospital.

The aim of this study was to investigate functions of team talk with an emphasis on talk-work relationship by analysing the interconnections between online commentaries and actions in a communicatively and medically critical phase of the teamwork. Data was collected during *in situ* simulation training for interdisciplinary medical emergency teams.

## Methods

Data were collected from March to September 2012 during full-scale *in situ* simulations in the emergency department of a university hospital in Norway. The study was registered and approved by the Data Protection Official for Research at the hospital and by the managing authorities at the emergency department where the data collection took place. To capture the interconnections between team talk and actions in interdisciplinary emergency teams, we chose to simplify and standardize the emergency setting as much as possible through *in situ* simulation. The simulation was part of a joint internal curriculum that involved three hospital departments (the emergency, internal medicine and anaesthesia departments). The learning objective was to establish an acute medical response team and new routines for treating patients who were admitted to the hospital with critical illness. All *in situ* simulations were videotaped for post-scenario debriefing. One of the authors (EA) had a background in applied linguistics, so to familiarize this author with the simulation situation, this author observed 12 full training sessions and recorded team activities using field notes. The first 4 sessions were used only for familiarization purposes; however, the participants in the other 8 sessions were informed about the study, and we requested permission from them to transcribe and analyse the videotapes after the simulation training. All participants provided consent, and none chose to withdraw from the study.

The *in situ* simulation was conducted with a man-sized patient simulator (SimMan 3G, Laerdal Medical, Stavanger, Norway). The scenario was pre-programmed (Fig. 1), and the program was run by a simulation facilitator. This facilitator also provided the patient's verbal responses through a wireless sound transmission system. The central and peripheral pulses were palpable, and chest movements were observable. The participants were also able to observe the patient's physical deterioration with standard monitoring equipment that is available in the emergency department. A second simulation facilitator began videotaping and then played the role of a paramedic who was handing the patient over to the team of participants. After the handover, this second facilitator provided each team with the patient's test results and answered questions regarding the simulation throughout the scenario.

Of the 8 videotapes, 3 could not be transcribed in full due to technical reasons thus only 5 videos was available for analysis. The videos involved a total of 30 healthcare workers on 5 different acute medical response teams. The members of each team (Teams 1–5) were representative of the composition of a typical ad hoc team and were composed of individuals that work together at the hospital. The scenario (Fig. 1) began with a report that was handed over to the specialty registrar or physician consultant on call from the internal medical department (Phys1) and to two experienced emergency department nurses (EDnu1 and EDnu2). Next in the simulation, the patient's situation deteriorated, and the physician called for assistance. This request activated the response team, which consisted of one anaesthesiologist (AN), one nurse anaesthetist (nuAN), and another specialty registrar or physician consultant from the internal medical department (Phys2). Notably, a medical student was present on Team 3, and Team 2 had to manage without the anaesthesiologist, who was occupied elsewhere during the time of the simulation. Thus, the scenario represented the realistic hospital admission of a critically ill patient. The training sessions ended shortly after the patient was intubated.

## Analysis

The authors had extensive experience from clinical emergency situations, medical simulation (SG and PA) and applied linguistics (EA and GT). We followed standard procedures to prepare for and to conduct an analysis of the recorded data. First, all 5 videos were viewed repeatedly. Second, the recorded (videotaped) data were transcribed in detail following established conventions that were developed for researching authentic interactions. The transcription was done in a format that was developed to portray the interactional architecture systematically by marking parallel talk (separate but concurrent verbal exchanges), pauses and non-verbal activities. Comments on the interactions between participants, interactions with the patient and interactions with the facilitator were extracted from the field notes and videos and added to the transcripts. Thus, the data included both team talk and the corresponding actions. All authors reviewed the transcripts for accuracy regarding the team talk, the interactional activities and the medical activities. To foster reflexivity and avoiding preconceptions affecting the results, the four authors performed analyses together and discussed the interpretations critically [41].

John Olsen is 71 years old. He has a history of angina pectoris, and he uses nitroglycerine for symptoms that manifest upon exertion. He also regularly takes beta blockers to treat hypertension.

Current status: Dyspnea started last night. He feels ill and has some pain in the epigastric region, but nitroglycerine has had no effect. An electrocardiogram recorded in the ambulance showed no sign of cardiac infarction. His skin felt cold and clammy when he arrived at the emergency department.

Development: He had worsening breathing problems, tachycardia and decreasing blood pressure. The electrocardiogram showed sinus rhythm with right bundle branch block; an echocardiogram showed a dilated right ventricle; and a lung x-ray showed pulmonary oedema.

**Fig. 1** Case history (simulation scenario)

In recognition of the relationship between talk and work, we introduced activity type analysis which is a version of discourse analysis that focuses on the flexible relationship between talk and function in the communicative activity type [42]. The simulation sessions were considered as realizations of a goal-oriented communicative activity type. Consequently, every utterance could be analysed as part of a specific communicative phase that was recognizable by specific actions and interactions [43]. First, the talk was mapped into general recursive structural components—key activity phases—that were identified as an overarching structure that had associated sub-phases across all teams. Second, a sequential approach was used to deal with specific medical and interactional issues that was addressed by the team (such as when to expand the team, how to respond to observations, how to distribute tasks and responsibilities and the timing of the interventions). These issues formed recognizable communicative phases. These phases comprised the sequential organisation of team talk, which is linked to various identifiable functions [44]. Third, we used activity type analysis to identyfy a medically and communicatively critical phase of the teamwork. Recognizing the importance of speaking up about relevant individual real-time observations and assessments in interdisciplinary teamwork, we analysed the function of utterances that can be characterized as online commentaries.

## Results

Here we present excerpts that were selected to illustrate the data and that support our findings. The utterances are numbered according to their sequence in the team talk. All transcripts were anonymized and were translated from Norwegian after the analysis.

### Key activity phases

Multiple careful viewings of the videos revealed three overall key activity phases and associated sub-phases that were present in all of the simulations. Each of the three phases was tied to a clinical process and reflected the state of the simulated patient. Phase 1, the *opening phase*, consisted of a greeting, a summary of the case history, an assessment related to the case history and a call for extra help. Phase 2, the *core activity*, included an expansion of the team, a new case/patient history report, an assessment of the information, discussions and treatment. Phase 3, the *closing phase*, included patient monitoring, ordinations and discussions of follow-ups.

Excerpt A demonstrates the talk-work relationship in one of the teams right after tracheal intubation (core activity).

**Excerpt A**

| Utterance | Speaker | Talk | Action |
|---|---|---|---|
| 472 | Phys2 | Mhm. Could it be a $^{1}$[CNS (central nervous system) problem?]$^{1}$ | Phys2 looks at Phys1. |
| 473 | Phys1 | $^{1}$[And of course]$^{1}$ I'll need blood samples. What? | Phys1 looks and points to EDnu2 standing by the documentation desk. EDnu1 looks at Phys1. Phys1 then looks at Phys2. |
| 474 | Phys2 | Could it be a CNS problem? | Phys2 looks at Phys1. |
| 475 | Phys1 | Well, he was awake $^{2}$[when he arrived and he was in pain]$^{2}$. No, yes. | nuAN is fixating the tube. AN is performing bag-tube ventilation. |
| 476 | Phys2 | $^{2}$[There wasn't any paresis, was there?]$^{2}$ | Phys2 looks at Phys1. |
| 477 | nuAN | Should we insert a $^{3}$[nasogastric tube?]$^{3}$ | nuAn is standing beside AN. |
| 478 | Phys1 | $^{3}$[Yes, but didn't get a chance to perform a]$^{3}$ $^{4}$[full neuro exam.]$^{4}$ | EDnu1 draws blood. |
| 479 | AN | $^{4}$[We may insert a nasogastric tube.]$^{4}$ | AN looks down on the patient's head and nods |
| 480 | Phys2 | No, OK. | nuAN walks out of view to the right. |
| 481 | Phys1 | Eh $^{5}$[X X X.]$^{5}$ | |
| 482 | AN | $^{5}$[The pupils are still X.]$^{5}$ | AN leans over the patient's head. |
| 483 | Phys2 | Could we place a urine catheter if possible? | Phys2 looks down on the patient's head. |
| 484 | AN | This pupil reacts, but the other one is hardly reacting. | AN, Phys1 and Phys2 lean over the patient's head. |
| 485 | Phys1 | No OK. | |
| 486 | AN | But are they equal $^{6}$[or not?]$^{6}$ | Phys1 looks out of the field of view to the left. |
| 487 | Sim | $^{6}$[Yes they]$^{6}$ are supposed to be equal. | EDnu1 looks at EDnu2. |
| 488 | nuAN | $^{6}$[nasogastric tube?]$^{6}$ | nuAN walks toward the rear of the bed and speaks to EDnu2. |

**Transcript key**: X = not audible; $^{2}$[words]$^{2}$ = overlapping speech (the numbers indicate the order of the nearby overlap)

Excerpt A is an example of how overlapping dialogs and parallel talk mirror the complexity of the interactions and the parallel ongoing activities in the interdisciplinary emergency team. In this short sequence of team talk and corresponding actions, the team members, and even the simulation facilitator, were involved in multiple interactions and practical tasks. Sometimes the team members switched their focus from one utterance to the next, and sometimes they switched their focus even within the same utterance (e.g. Excerpt A, u 473). Frequently two or more team members talked simultaneously, and sometimes one team member was communicative and interactionally involved in more than one issue at the same time. One example of this is when AN was deciding whether to place a nasogastric tube and assessing the patient's neurological status while also ventilating the patient.

Some utterances were simulation-related in that they contained information that normally is observable in real-life situations but that was not clear in the simulated scenario due to technical issues connected to the simulation or to the mannequin (i.e., Excerpt A u 486 and u 487).

### Online commentaries

The structural analysis drew our attention to the team expantion in phase 2 (the core activity). As medical experts joined the team, they became engaged in working on the patient, and the situation demanded concurrent attention to several tasks simultaneously. The patient's history and status were repeated as each new team member arrived. In addition, the deteriorating status of the patient had to be managed, and the team had to be (re)organised by distributing tasks and responsibilities. This phase stood out both in clinical and communicative ways that were identifiable in videos and transcriptions; thus, the interval between calling for assistance until the time at which all team members were involved in the activity was considered a medically and communicatively critical phase. Through activity analysis at the micro level, we identified several different functions of online commentaries during this phase of the teamwork. Online commentaries are indicated in italics in the excerpts below.

**Excerpt B** (while Phys1 is reporting the patient's history and status to new team members)

| Utterance | Speaker | Talk | Action |
|---|---|---|---|
| 104 | Phys1 | $^{2}$[Chest]$^{2}$. $^{3}$[Short of breath and X X]$^{3}$ $^{4}$[X X. It]$^{4}$ $^{5}$[It's gurgling X.]$^{5}$ | Phys1 looks at the patient, puts down the ECG sheet and walks toward the patient's head. |
| 105 | EDnu1 | $^{3}$[The patient's name is John.]$^{3}$ | EDnurse1 looks at nuAN. |
| 106 | nuAN | $^{4}$[How old is John?]$^{4}$ | nuAN looks at EDnu1. |
| 107 | EDnu1 | $^{5}$[John is]$^{5}$ | EDnu1 walks to the desk, where the patient's record is located. |
| 108 | AN | $^{5}$[I turned up the oxygen.]$^{5}$ | AN comes to the bed from the left where the oxygen flowmeter is positioned, looking down and reaching for her stethoscope. Phys1 looks at AN. |
| 109 | Phys2 | $^{5}$[OK.]$^{5}$ | |
| 110 | Phys1 | *And he is hypotensive* | Phys1 looks at Phys2. |
| 111 | AN | $^{6}$[But you]$^{6}$ hear coarse rattling sounds. | AN looks at Phys1. |
| 112 | Phys1 | I think I hear coarse rattling sounds $^{6}$[X X X.]$^{6}$ | Phys1 touches the patient's ribcage. |
| 113 | X | mm | |
| 114 | Phys2 | $^{7}$[*He's getting fluid*]$^{7}$ | Phys2 is looking at Phys1. |
| 115 | nuAN | $^{7}$[*He has*]$^{7}$ *falling saturation.* | nuAN looks at the monitor at the right. AN turns and looks at the monitor at the right. |
| 116 | Phys1 | Yes. | |
| 117 | AN | $^{7}$[Yes]$^{7}$ $^{8}$[I turned up]$^{8}$ the oxygen a bit. | |
| 118 | EDnu1 | $^{8}$[Yes.]$^{8}$ | |
| 119 | X | $^{8}$[He had that yes.]$^{8}$ | |
| 120 | EDnu1 | *He has two IV cannulas.* His pressure was a bit low. Blood pressure was 90 over 40. | EDnu1 points to the patient's hand before he points up toward the monitor. EDnu1 then goes to the desk where the patient's journal is located. |
| 121 | X | Mm | |
| 122 | Phys2 | There $^{9}$[is fluid going]$^{9}$ right? | Phys2 looks at Phys1 and points to the patient. |
| 123 | AN | $^{9}$[But eh.]$^{9}$ | |
| 124 | EDnu1 | Eh $^{10}$[*two Ringers are going.*]$^{10}$ | EDnu1 stands by the desk, where the patient's journal is located and looks in the direction of the patient. |
| 125 | Phys1 | $^{10}$[Yes it is going in fact X X]$^{10}$ I think. | Phys1 looks at and touches the IV fluid hanging over the patient's chest. |

**Transcript key**: X = word not audible; $^{2}$[words]$^{2}$ = overlapping speech (the numbers indicate the order of the nearby overlap)

The report by Phys1 on the patient's status in Excerpt B led to AN managing the oxygen. Upon hearing Phys1's comment regarding the patient's hypotension, AN responded to Phys1 by asking about auscultation. Thus, the online commentary "and he is hypotensive" led to a joint construction of tasks and to the distribution of responsibilities between AN and Phys1. The nuAN's online commentary regarding her assessment of the patient's blood oxygen saturation level triggered a report on an action from AN that acknowledged nuAN's observation (u 117). In Excerpt B, Phys2's commentary about ongoing fluids led EDnu1 to assess the available IV access points; this was framed as an online commentary and was followed by a statement on the patient's blood pressure (u 120).

**Excerpt C** (AN not present)

| Utterance | Speaker | Talk | Action |
|---|---|---|---|
| 197 | nuAN | Eh, *his saturation is falling*. I think I have to assist him with his ventilation. | nuAN is looking at the monitor, holding a CPAP-mask to the patient's nose and mouth and then looks around the room. |

Excerpt C illustrates how nuAN's online commentary comes across as an argument for a decision.

**Excerpt D** (while Phys1 is reporting the patient's history and status to new team members)

| Utterance | Speaker | Talk | Action |
|---|---|---|---|
| 91 | AN | ¹[*But his saturation is low*.]¹ | AN looks at the monitor, and AN and nuAN both move toward the patient's head. |
| 92 | Phys1 | Yes he has received 15 l of $O_2$. We should switch to a mask with a ²[reservoir.]² | Phys1 looks in direction of nuAN and AN. |
| 93 | AN | ²[X X]². (1.5) Take this one here instead. Let's see can you connect it? | AN takes a bag-mask ventilator from the wall. AN looks at nuAN. |

**Transcript key**: X = word not audible; (number) = pause, with the number indicating seconds; ²[words]² = overlapping speech (the numbers indicate the order of the nearby overlap)

Phys1is reporting the patient's history to new team members when AN comments on the patient's low oxygen saturation level. AN's online commentary was treated by Phys1 as an indirect instruction to change the oxygen treatment.

**Excerpt E**

| Utterance | Speaker | Talk | Action |
|---|---|---|---|
| 123 | nuAN | *There is no saturation.* | nuAN looks at the monitor on the right. |
| 124 | AN | Let's see. | |
| 125 | EDnu1 | No it fell [off.] | EDnu1 picks up the saturation probe from the floor. |

**Transcript key**: [words] = overlapping speech

nuAN's online commentary in Excerpt E regarding the missing oxygen saturation value elicited a response from EDnu1, who then re-established the monitoring probe used to measure oxygen saturation. This is an example of how an online commentary can be used to get things done without asking directly.

**Excerpt F**

| Utterance | Speaker | Talk | Action |
|---|---|---|---|
| 142 | AN | ¹[Does he have a pulse?]¹ | AN looks at Phys1. Phys1 moves to palpate for a carotid pulse. Phys2 palpates the patient's groin. |
| 143 | Phys1 | Yes. | |
| 144 | AN | Does he have a pulse? (3.0) *Yes, his pulse is 77 X* ²[*yes X 77*.]² | AN looks at the monitor at the right. |
| 145 | Phys1 | ²[*Yes, he has a pulse*.]² | Phys2 palpates for a carotid pulse and looks at the patient's chest. |
| 146 | AN | *Yes, 77. His saturation is going up*. But I still think we have to ³[intubate him.]³ | AN looks at the monitor on the right. |
| 147 | nuAN | ³[Intubate him yes.]³ | nuAN looks at AN. |
| 148 | Phys1 | ³[Intubate him yes.]³ | Phys1 looks at AN. |

**Transcript key**: X = word not audible; (number) = pause, the number indicates seconds; ²[words]² = overlapping speech (the numbers indicate the order of the nearby overlap);

AN had previously proposed intubating the patient. In Excerpt F, AN implicitly asked the team members to assess the patient's blood pressure and pulse before going ahead with the intubation. AN and Phys1 and Phys2 took action. AN and Phys1 provided online commentaries as responses to the request for information by AN.

**Excerpt G** (while Phys1 is reporting the patient's history and status to new team members)

| Utterance | Speaker | Talk | Action |
|---|---|---|---|
| 213 | EDnu2 | [1][*His saturation is falling.*][1] | EDnu2 looks at the monitor on the right. |
| 214 | Phys1 | Yes that, yes. And suspicion of pulmonary oedema. He has crackling sounds in the lungs. Eh. And is slightly clammy peripherally. The blood gas result says metabolic [2][acidosis.][2] | Phys1 looks quickly at the monitor and then at AN. |

**Transcript key**: [2][words][2] = overlapping speech (the numbers indicate the order of the nearby overlap)

The online commentary from EDnu2 regarding the patient's falling oxygen saturation level triggered a complementary report on the patient's status.

## Discussion

In this study, we transcribed verbatim the speech of the members of five interdisciplinary teams during an *in situ* simulation of the hospital admission of a critically ill patient. We then analysed the team talk. Three key activity phases, i.e. the opening phase, the core activity phase and the closing phase, reflected the simulated patients' clinical situations. When we used qualitative discourse analysis to evaluate the complex communications between team members, which at first seemed unstructured, patterns emerged in terms of the embedded structure and the targeted dialogue loops that recurred. These patterns showed the variations in team activities during the scenario. We found that team members could rapidly switch focus, sometimes even during a single utterance. This, together with frequently overlapping dialogues and parallel talk, illustrated the ongoing activity, the dynamics and the complexity of the teamwork. Through activity analysis, we found that the online commentaries served a number of different functions during the critical phase of team expantion.

The transcription of team talk and activity in these five teams provided the opportunity to study team interactions in slow motion. In this study we found evidence of the inextricable interdependency between communication in interprofessional emergency teams and team activity, supporting Roberts (2005) who claims: "In institutional encounters, talk is work" [22].

Structural mapping of team talk revealed recurring patterns on the one hand and diversity among the teams on the other hand. We captured what appeared to be the prototypical character of all teams and also the variety within and among the teams. The team talk did not follow a predefined structure such as that used for standardized cockpit communication; nevertheless, all of the teams appeared to have a common understanding of what to talk about. This mutual understanding can be viewed as a pattern that arose from common goals and methods [44]. The flow of the team talk shows the teamwork dynamics and how the team members had the flexibility and adaptability they needed to accomplish the expected tasks, which is important for high-level team performance [33, 34, 45]. Although the team talk appeared to be unstructured, which could have some risks, the team members managed to manoeuvre safely within this complex situation by communicating with each other. In interprofessional emergency teamwork, team members have special responsibilities regarding their medical expertise. In addition, team interactions depend on team members' individual non-technical skills, such as cognitive and social skills, which are vital for preventing medical errors in teamwork [11, 12]. In ad-hoc teams, cooperation begins the moment that members interact. Teamwork thus involves negotiations both in terms of the clinical process and in terms of cooperation within the team. In this study, we excluded clinical differences between patients by using an *in situ* simulation and standardized scenarios. Differences between the teams could thus be interpreted as diversity in team cooperation.

In medical emergencies, patient safety depends on decisions that are based on team members' awareness and on their ability to take the right actions at the right times. Adaptive team performance depends on each team member's ability to identify and assess relevant cues from the environment, share information and adjust the activity as the situation changes [33–35]. The meanings of words within a community of practice are negotiated, confirmed and completed for current purposes [46]. Even so, misunderstandings do occur in emergencies, and sometimes they result in life-threatening situations. To help prevent errors during a response to medical emergencies, communication patterns such as closed loop communication have been adapted from the defence and aviation sectors. Despite the extensive focus on the relationship between closed loop communication and patient safety in medicine, Härgestam (2013) found that closed loop communication was rarely used during trauma team training, even in high performing teams [17]. In addition, closed loop communication initiated by a team member rather than by the team leader could lead to communication overload [47]. Online commentaries are closely related to utterances that are termed "information-related talking to the room", which refers to interpreting and sharing information that is associated with the further use of information-related talking to the room in high-performing anaesthesia teams [48]. Kolbe (2010) suggests that such utterances can be interpreted as contributing to shared team situation awareness, which facilitates adequate patient safety [48]. Our results support this interpretation. Although closed loop communication is an important communicative tool, we must expand our knowledge about what constitutes "good" communication in interdisciplinary emergency teams by using analytical tools, such as discourse analysis, that can reveal communication strategies within the relevant activity type that trigger actions that are relevant to safe practices.

Patient simulation is increasingly used in team communication training. By identifying the functions of online commentaries, we observed that the cues provided by the patient simulator were restricted; i.e., team members could see, feel and hear a limited number of cues. For instance, in our material, we found no online commentaries on patient behaviour (e.g. shivering), appearance (e.g. oedema) or skin signs (e.g. temperature, colour). Such cues were only available through the simulation facilitator and thus were not framed as online commentaries within the team. When conducting team simulation training and assessing teamwork during simulations, it is important to consider whether simulation itself might affect the talk-work relationship that is vital for team coordination and adaptability.

### Study limitations and strengths

Studying multiple authentic teams that are working with similar "patients" provided an opportunity to demonstrate the usefulness of discourse analysis for analysing communication in interdisciplinary ad hoc emergency teams. One limitation of this study was that the team talk was analysed for just five medical teams. Nevertheless, the amount of data was sufficient to investigate the functions of team talk with an emphasis on the talk-work relationship in simulated scenarios. Although we used sophisticated computerized mannequins, patient simulators have limitations because they have limited observable clinical changes. In addition, team talk might be affected by the knowledge that the situation was a simulation. Similarly, the knowledge that the members were being observed and studied may have affected participant performance during the simulation. Since it is unknown exactly how and to what extent this factor might affect performance [23], to avoid bias permission to transcribe and analyse the video recordings was requested after the simulation training was complete. To blend into the setting as much as possible, the observer was introduced as a communication specialist who was interested in health communications. The participants were informed that the observer had been instructed not to commingle in the simulation training. To avoid distraction, we used just one camera and one stand-alone microphone instead of lapel microphones. The resulting variable sound quality made transcription of some of the speech challenging; however, the field notes compensated sufficiently for these difficulties. Although it is widely recognized that body language is important in communication, analysing body language was not a specific aim of the present study [49, 50]. Nevertheless, connecting team talk to teamwork represents a new methodological approach that is important for researching communication in medical emergencies.

## Conclusion

In this study, we used qualitative discourse analysis to evaluate video-recorded, interdisciplinary emergency ad-hoc teams during a simulated emergency. Through discourse analysis, we were able to capture the dynamics and the complexity of team talk. This analysis revealed the key functions of the team talk and the inextricable interdependency between team talk and teamwork. Through structural mapping, we identified the essential dimensions of team talk that were related to the activity type. On one hand, recurrent patterns indicated prototypical characteristics; on the other hand, there were variations that reflected specific negotiations and diverse situations. Even though the team talk did not follow a predefined structure, the team members managed to manoeuvre safely within the complex situation. The analysis revealed the functions of online commentaries that were essential for team situational awareness and for coordination of teamwork as well as issues that might affect the talk-work relationship in simulation training. In general, discourse analysis reveals naturally occurring communication strategies that trigger actions that are relevant to safe practices; here, this analysis provided important supplemental information that is useful for pursuing good team communication in medical emergencies.

#### Abbreviations

AN: AnaesthesiologistEDnu1: Experienced nurse from the emergency department; EDnu2: Experienced nurse from the emergency departmentnuAN: Nurse anaesthetist; Phys1: First specialty registrar or consultant from the internal medical department at the scene; Phys2: Second specialty registrar or consultant from the internal medical department at the scene; Sim: Simulation facilitator

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### Availability of data and material
The data supporting our findings are included in the manuscript (Excerpts A–G).

### Authors' contributions
SG and PA made substantial contributions to the study conception and design, SG and EA contributed to data acquisition, GT operationalised the research design according to principles in discourse analysis and all four authors were involved in data analysis and interpretation. All four authors helped draft the manuscript, revised it critically for important intellectual content and approved the final version.

### Competing interests
The authors declare that they have no competing interests.

### Consent for publication
Not applicable.

### Ethics approval and consent to participate
Ethics approval for this study came from the Data Protection Official for Research at St. Olavs Hospital, University Hospital in Trondheim, Norway. All participants were informed about the study, and we requested permission to transcribe and analyse the videotapes after the simulation training. All participants provided consent, and none chose to withdraw from the study.

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# Paper 3

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# Discourse types and (re)distribution of responsibility in simulated emergency team encounters

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## Abstract

*Successful teamwork, constitutive of team talk, depends largely on shared responsibility in the coordination of tasks in a goal-oriented way. This paper examines how specific modes of talk or 'discourse types' are utilised by a healthcare team in simulated emergency care. The data corpus comprises six video-recorded simulation training sessions in an emergency department at a large Norwegian hospital. Our analysis focuses on the critical moment when the original healthcare team is joined by other specialists in an* ad hoc *manner, which necessitates the (re)distribution of expert responsibility in the management of the patient's condition. We examine the interactional trajectories and, in particular, the discourse types surrounding the critical moment which marks the incorporation of the new team members. The analysis centres on three discourse types (online commentary, offline commentary and metacommentary) that are utilised in accomplishing the multiple tasks in a collaborative and coordinated fashion. We suggest that team talk overlays and overlaps with distributed medical work in highly charged decision-making contexts such as emergency care. The findings have relevance for how healthcare professionals and students are trained in multidisciplinary team talk and teamwork.*

*Keywords: activity type; discourse types; metacommentary; offline commentary; online commentary; simulated emergency medicine; team talk*

## Introduction

Teamwork is recognised as a key component of healthcare delivery ranging from multidisciplinary team meetings to operating theatres to clinical handovers to emergency medicine. According to Ellingson, drawing on Goffman's concept of frontstage and backstage (Goffman 1959: 112), clinical teamwork mainly happens in 'backstage areas such as break rooms, hallways, clinic computer desk and work tables, photocopy rooms, and offices' (Ellingston 2002: 13), which may explain why it has not become a direct object of communication research or a core component of healthcare education curricula. As DiPalma (2004: 303) observes:

> Much healthcare teamwork is invisible, discretionary, indirect and, in addition, administrative. While many interdisciplinary healthcare teams function well, they often do so only by interacting in complex ways that irregularly blur the boundaries of conventional team concepts.

Healthcare teams themselves are extremely diverse in terms of their composition, mandate and the nature of the tasks involved. Many multidisciplinary teams are long established: members are familiar with one another, and such teams have access to shared communicative practices and mutual understandings of divisions of expertise/labour and distributed collaboration. In contrast, in emergency medicine – in operating rooms or in trauma and resuscitation units – teams are assembled in an *ad hoc* manner, resulting in what may be called ephemeral teamwork. Such teams are entrusted with time-bound specific tasks which can be challenging when (communicative) practices are not necessarily shared; Sundstrom *et al.* (1990) include surgery teams within a category of 'action and negotiation' teams, described as 'highly skilled specialist teams cooperating in brief performance events that require improvisation in unpredictable circumstances' (Sundstrom *et al.* 1990: 121).

A key component of teamwork in real-life and simulated situations is team talk, the visible/audible aspect of the otherwise invisible teamwork. The talk generated in and through a team has been appropriately characterised as 'talking to the room' (Tschan *et al.* 2009: 7) – talk that is addressed to the room rather than to specific other participants. Kolbe *et al.* (2010) extend this observation to suggest that talking to the room facilitates the process of diagnosis and invites other team members to participate in coordinating ongoing tasks. This observation underscores the reality of 'continuous communication and rapid updating of information' in the context of emergency medicine (Vincent and Wears 2002: 410). In functional terms, the team members coordinate their task responsibilities through team talk, which amounts to 'signal' rather than 'noise'.

This paper is concerned with the simulated environment of team talk in the operating theatre. More specifically, the setting is the in-house training sessions in a Norwegian hospital. Our main analytic interest is the types and functions of specific modes of talk – what Sarangi (2000, 2010) refers to as 'discourse types' constitutive of a given activity type – in coordinating medical tasks across the team. We suggest that the team members jointly structure their participation (Goffman 1981) through an interplay of different discourse types, deriving from their expertise and role-responsibilities. Our aim is to illuminate the (re)distribution of task responsibilities through an analysis of the occasioning and functioning of the following three discourse types: online commentaries, offline commentaries and metacommentaries.

We first provide a review of relevant literature, combining studies drawn from both medical and discourse/communication disciplines surrounding a number of sites where teamwork features prominently. We then describe our research site and analytical framework. This is followed by a data analysis, which focuses on three distinct modes of talk and their specific functions in teamwork. In the concluding section we discuss our findings and their relevance for medical education and multidisciplinary team decisions.

## Literature review: Team talk in healthcare settings

One strand of literature on team talk in healthcare settings considers healthcare providers' perceptions of patient safety and leadership style. A literature review by Manser (2009) notes two studies in particular here: that of Lingard *et al.* (2004), which demonstrates that an increase in adverse events can be attributed to poor team performance rather than a lack of clinical skills, and that of Eisenberg *et al.* (2005: 391), which observes that teamwork in emergency care is characterised by a high level of multiplicity and uncertainty coupled with time constraints, which may force teams to make decisions on the basis of insufficient information. Additionally, Xiao *et al.* (1996) note that the workload for each team member is often high, and that technically difficult procedures that can be carried out sequentially in less urgent circumstances are routinely expected to be executed concurrently and at a fast pace. Here talk may play a crucial function in the coordination of contingent tasks.

Another strand of research concerns handover or handoff communication. Iedema *et al.* (2009) characterise handover communication as 'critical communication' as it involves 'successful transfer of responsibility (personal task commitment) and accountability (organisational role obligation) among healthcare practitioners' (Iedema *et al.* 2009: 133). Handover of patient information is viewed as handing over responsibility and is associated with the transfer of care between individuals and/or departments. The allocation of responsibility in handover information is fundamental to the professional activities that follow (Alvarado *et al.* 2006).

In a quantitative study focusing on communication errors and omissions, Brandon *et al.* (2011) report clinically significant discrepancies – relating to both examination and laboratory results – between what is recorded in physician documentation and what is reported verbally during the handoff encounter. Different factors such as handoff time, length of patient stay in the emergency department (ED) and use of support materials contribute to such errors and omissions. The authors go on to recommend the implementation of a standardised handoff protocol. This is echoed by other researchers: An observational study by Ye *et al.* (2007) of handover communication in ED in Australia makes use of a checklist of codes (e.g. present complaints, past medical history, examination and investigation findings, management plans, communications made), and reports that when crucial information – such as details of management, investigations and dispositions – is missing there will be adverse effects on doctors and patients, mainly leading to repetition of assessment and delayed management.

However, although studies such as Brandon *et al.* (2011) and Ye *et al.* (2007) favour standardised protocols, Eggins and Slade (2012) offer a critique of the ISBAR protocol (Introduction, Situation, Background, Assessment, Recommendation) in the Australian shift-change clinical handover context. Drawing on analytical insights from conversation analysis and systemic functional linguistics, they identify a range of communication strategies deployed by healthcare professionals in which both interactive and informational dimensions assume significance.

Apker *et al.* (2010) develop and evaluate the handoff communication assessment (via telephone), involving transfer of patients from ED to inpatient care. They point to the double-edged nature of handoff communication: on the one hand, it is an occasion to remedy faulty assumptions and overlooked diagnoses and treatment, but on the other it allows for the inappropriate transfer of particular information. The authors' qualitative study is based on coded utterances; they focus on content (patient presentation, assessment, professional environment) and language form (e.g. information seeking, information giving, information verifying), and conclude that the predominant activity is information giving by the emergency physician. Wears and Perry (2010) use utterance-level coding of audio-recordings of shift-change handoffs and find more active elicitation of information by receiving doctors (unlike other studies reporting information transfer as the predominant modality – cf. Cohen and Hilligoss 2010).

Team talk constitutes only one component of teamwork; another which has attracted the attention of many communication researchers is that of embodied action. Studies in this area include the routine passing of instruments between nurses and surgeons in the operating theatre, labelled as 'instrumental action' (Svensson *et al.* 2007), and the socio-technical organisation of surgical treatment, which can be linked to sensorial reflexivity (Moreira 2004). At a micro-analytic level, Hindmarsh and Pilnick (2002) have explored the tacit order of teamwork among anaesthetists, drawing upon and extending Goffman's metaphors of frontstage and backstage. The participation status of the co-present members changes continuously, thereby requiring a reconsideration of the boundary between these two areas. Their focus is on how one action engenders cooperation from co-present colleagues and the extent to which the team 'displays an expertise in reading the implications of these activities for their own work' (Hindmarsh and Pilnick 2002: 149). Anaesthetists' talk with patients plays an important function to 'camouflage' collaboration with colleagues. Relevant here are a study by Bezemer *et al.* (2011) on talk and embodied conduct with a focus on body gloss practices and recipient design, and Goodwin's (2007) study of the organisation of the spatial order *vis-à-vis* bodies and tools, also in the context of clinical anaesthetic work.

In a later study, Hindmarsh and Pilnick (2007) explore the nature of embodiment or what they call 'embodied conduct' in preoperative anaesthesia in a UK teaching hospital. Embodied conduct includes verbal, visual and tactile dimensions of action, and the authors' focus is on 'the informal and tacit practices that underpin the production of teamwork' (Hindmarsh and Pilnick 2007: 1396) within the activity of intubation, when the patient is already anaesthetised. They report that the team members anticipate what comes next in order to coordinate their actions successfully, at times with minimal amount of talk. They label this 'intercorporeal knowing' – 'practical knowledge of the dynamic bodies of others in the local ecology' (Hindmarsh and Pilnick 2007: 1396) – and emphasise its importance. The bodily conduct is embedded in the activity and is central to coordination. At the same time 'it also remains somehow "unnoticed" by participants' (Hindmarsh and Pilnick 2007: 1413). However, insertion of verbal instructions, however minimal, can trigger multiactivity. For instance, Mondada (2011) finds that stating the word 'coagulation' leads to concurrent courses of action and talk in the operating room. This multiactivity is systematically organised both sequentially and temporally. In a later work, the same author draws attention to how verbal, gestural and silent embodied instructions are instrumental to coordinating surgery. The accountability embedded in the surgeon's instructions and the assistant's instructed actions sheds light on 'the global vision the team has of the procedure' (Mondada 2014: 158).

In this paper we focus on talk that accompanies and constructs coordinated action. Several studies dealing with the physical examination phase of the medical consultation have drawn attention to the nature of accompanying talk in embodied action, which we take up in the next section.

## Methodology and analytical framework

### *Data and methods*

Our data setting is the in-house training sessions in a Norwegian hospital. The sessions were arranged by the local medical simulation centre and took place in the emergency department at the hospital. Six training sessions on one scenario were videotaped and observed. We opted for video-recording (following usual informed consent procedures and anonymisation of data for reasons of confidentiality), as nonverbal contextualisation cues would assume greater significance in the emergency team-talk setting because of coordination strategies involving talk, members' bodily conduct and various artefacts, as well as the patient's body. The videoed encounters were transcribed verbatim and in a column format that systematically mapped the interactional trajectories, by marking aspects such as pauses and overlapping talk. This level of transcription is time-consuming but necessary in order to attempt a rigorous analysis of the interactional dynamics of teamwork.[1]

### *Scenario*

Phase 1: A simulated patient is brought in to the emergency department (ED) by a paramedic. On arrival the patient is seen by the ED team: one physician (Dr1) and two nurses (Nu1 and Nu2).

Phase 2: After handover from the paramedic, Dr1, as the team leader, assumes responsibility for the medical treatment of the patient. Dr1 examines the patient via interview, palpation and auscultation. Dr1 also requests the nurses to supply blood tests, x-rays and ECG. Due to the patient's exacerbating breathing problems, Dr1 seeks assistance from the medical support team (MST).

Phase 3: The MST arrives, made up of one anaesthetist (DrAn), one nurse anaesthetist (NuAn) and one physician. Many important decisions must be made in complex, ambiguous clinical situations in which all possible options cannot be known.

### *Analytical framework*

Talk as constituting social action is an assumption commonly made in much language/interaction studies. Levinson's (1979) notion of 'activity type' captures the goal-orientation of language as social action and lends itself to activity analysis (Sarangi 2000, 2010); this framework is particularly suited to the goals of the present study, drawing attention to the role of language when coordinating tasks in an emergency team.

In a given activity type such as the emergency team encounter, different participants are likely to use different modes/types of talk or discourse types (Sarangi 2000) to accomplish different actions, sequentially and concurrently. According to Sarangi (2000, 2010), all activity types are constituted in discourse types (e.g. question-answer sequence, reported speech, narrative, repetition, overlap, laughter, gaze etc.), and these, like contextualisation cues (Gumperz 1982), derive their specific meanings from their contexts of use. As noted above, the current study refers to three discourse types with differential meanings/functions, all related to physical examination in primary care: *online commentaries*, *offline commentaries* and *metacommentaries* (for a detailed account of the interrelationship between discourse types activity roles and discourse roles in team talk settings, see Halvorsen and Sarangi 2015).

The notion of *online commentary* (ONC) was proposed by Heritage and Stivers (1999). The authors define ONC as statements given simultaneously or embedded in the physical examination which relate to what the physician is seeing, hearing or feeling. The function of these statements could be to report observations or evaluate what is observed, and they are targeted at the patient even though they are not directly addressed to or responded to by the patient. ONC for us is a discourse type which formulates the evidence that is available to the physician in the course of the medical examination. Examples of online commentaries include 'that's a little bit red back there', 'I don't see any fluid', 'your ears look good'.

*Offline commentary* (OFC) has been identified by Sarangi (2010) as a different discourse type that works in conjunction with ONC. In contrast to ONC, OFC constitutes explanations of various kinds which may serve a pedagogical function while putting on hold ongoing actions and consequently online commentaries. Examples of offline commentaries are: 'children usually have this', 'sometimes, with this kind of bronchitis in babies, because the airways are already tightening because babies are small and it swells up, we run into little problems with breathing'. It is worth noting that online commentaries and offline commentaries can both be mapped onto the different roles healthcare professionals occupy during a consultation. By offering explanations through offline commentaries, the physician foregrounds a participation structure in which s/he foregrounds an educator role. As shown in our analysis, the boundary between online commentaries and offline commentaries is a way of illuminating the dynamics of participation structure and participation status within a given activity type.

Bateson's (1972) suggestion that we interpret and negotiate our understanding of the situation at hand by using verbal and nonverbal framing markers or contextualisation cues (Gumperz 1982) is similar to the concept of *metacommunication* and echoes Goffman's seminal question, 'What is it that is going on here?' (Goffman 1974); i.e., the ongoing frame as well as shifts in frame and footing. In the context of physical examination in ultrasound encounters, Sarangi and Gilstad (2014) find that metacommentaries operate at the level of participation structure and at the level of specific medical procedure and action. As we will see in our data, a team member deploys metacommentaries to suggest what has to be done as next action (cf. Hindmarsh and Pilnick 2007). More specifically, a team member announces the next action as a chronological preference. This could be targeted at the patient as well as the team. Examples of metacommentaries are: 'We should switch to a mask', 'should just take a blood sample', 'then we must turn off that one'. The boundary between online commentaries and metacommentaries can be fuzzy at times as both discourse types can trigger next action – something we will return to in our analysis and discussion sections.

In summary, the three discourse types are routinely accompanied by embodied action. They are not specific to the physical examination phase of the consultation; they also feature during the treatment/intervention phase in and beyond the medical consultation activity. As indicated earlier, our focus is on how an expanded emergency support team utilises the various discourse types to accomplish coordinated action and responsibility in an activity-specific manner.

### *Data analysis: role of discourse types in coordinating tasks*

Given our focus on talk that accompanies and constructs present and future action, we find it useful to begin with the structural mapping of the activity type under consideration. The structural phases are pre-intervention, intervention and post-intervention, each consisting of the following sub-phases:

Phase 1: greeting, summary of past history, assessment of past history, call for extra staff.
Phase 2: expansion of team, handover of information, assessment of information, treatment.
Phase 3: monitoring, ordination, follow-up.[2]

In what follows we analyse extended data extracts from the critical moment when the team expands. We focus on the three discourse types introduced earlier to see how they evolve and lead to coordinated actions *vis-à-vis* participation status of the emergency team members.

Our first extract occurs when the support team enters the emergency room and the anesthetist, DrAn, opens with a question searching for a routine report (turn 85).

In response to DrAn's opening question (turns 86–88), Dr1 offers a summary of past history, highlighting elements of potential cause for shortness of breath. We can interpret Dr2's physical examination of the patient (turn 90) as triggered by this summary. In turn 91, Dr1 announces that the summary has come to an end ('*here is after all*'). This could also be seen

**Extract 1a**

| Turn | Participant | Talk sequence | Action sequence |
|---|---|---|---|
| 85 | DrAn | [hi]. what's happening? | Nu2 goes out of the picture, taking the electrocardiograph with her. |
| 86 | Dr1 | we have earlier XX angina and [then] last night he has had shortness of breath gurgling slight cough epigastric pain. | Dr2 checks the ECG results together with Dr1. DrAn look quickly at the ECG results and then moves to the patients head. NuAn leaves the medication she has brought and then joins DrAn. |
| 87 | Nu1 | [yes]. | |
| 88 | Dr1 | and [the blood gas]. | |
| 89 | Nu1 | [now a few more people have come in Johannes]. | Nu1 positions himself next to Pat while he looks at a monitor. |
| 90 | Pat | [mm]. | DrAn palpates P's neck. |
| 91 | Dr1 | [low pO]. uhm. he got[a little] Furix and a little morphine from the ambulance. and a bit better on the saturation of 80 and. (2,0) here is after all -s- | |
| 92 | NuAn | [yes]. | |
| 93 | Nu2 | should just take a blood sample [then]? | Nu2 enters the picture and looks at Nu1 while she rolls up the sweater sleeve on P's left arm. |
| 94 | Dr1 | [there] is atrial fibrillation. [(laughs)] [(laughs)] [(laughs)]. | |
| 95 | Dr2 | [(laughs)]. | |
| 96 | DrAn | [yes]. | |

| | | | |
|---|---|---|---|
| 97 | Nu1 | [take take] [only one <X batch X> of X] X. | Nu1 points to the right. Nu2 exits the picture to the right. |
| 98 | DrAn | [X… like that.. here]. | |
| 99 | Dr1 | [uhm X X X]. | |
| 100 | Dr2 | Eh… yes… but is there anything new? | Dr2 points at ECG report that Dr1 is holding. |
| 101 | Dr1 | No we do not know any[thing] about that | |
| 102 | Dr2 | [no].<br>no. | |
| 103 | NuAn | what do we have [here]? | NuAn looks at Nu1. |
| 104 | Dr1 | [chest]. [short of breath and X X] [X X. It][it's gurgling X X]. | Dr1 looks at Pat. Dr1 then puts down the ECG report and walks toward Pat's head. |
| 105 | Nu1 | [Johannes]. | |
| 106 | NuAn | [yes. how old is]? | |
| 107 | Nu1 | [Johannes he is]. | Nu1 goes to look at the journal. States the answer out in the room. |

as a potential onset of online commentary. Nu2 requests an online commentary, through a metacommentary on what will happen next, and is checking that her intended next action receives approval (turn 93). This is responded to by Dr1 with an online commentary that resembles a metacommentary within this activity type, referring to the discrepancy between the monitor and the ECG results, which prompts lots of laughter. The online commentary becomes a basis for two types of action that illustrate the distributed responsibility between Nu1 and Nu2 on the one hand and between Dr1 and DrAn on the other (turns 97–99). This (re)distribution of tasks could be seen as a manifestation of how team members project contingent and future actions onto online commentaries. Dr2's question about potential diagnosis (turn 100) is answered by Dr1, as it seems to function as an online commentary (turns 101 and 104). Online commentaries may, however, not have a specific addressee but rather serve as a division of tasks and responsibilities.

At this point, NuAn initiates a sequence which runs parallel to and partly overlaps with Dr1's online commentary (turn 104), but is seemingly unconnected to it (turns 103 and 105–107). Turning to Nu1, and smiling broadly, she mimics the question that DrAn or NuAn usually ask on entering the room, and which then is followed by Dr1's report. Nu1 does not offer a new report, but replies by just providing the patient's name. When NuAn asks the patient's age, Nu1 goes to the log to check. In the meantime, NuAn becomes engaged in work on the patient, and Nu1's reply is a case of 'talking to the room' (Tschan *et al.* 2009), targeted at no one and with no one paying any attention to it (turn 113). We see this sequence as embedded within this activity type, not something that would have taken place in a clinical situation. Possibly, it introduces an element of playfulness. It is interesting to note that NuAn quickly abandons it when she is needed to work on the patient.

Drawing on Goffman's (1981) notion of participation structure and participation status, which displays the emerging relationships amongst participants, we notice the dynamics of responsibility as constituted in the use of different discourse types. It is noticeable that online commentaries can be a long stretch of turns, sometimes constructed jointly, and not necessarily delivered as a monologue. DrAn offers an online commentary in 108 and across this sequence (turns 108–125) the online commentary is a joint construction between DrAn and Dr1 (turns 111–112) and between DrAn and

**Extract 1b**

| Turn | Participant | Talk sequence | Action sequence |
|---|---|---|---|
| 108 | DrAn | [I turned up the oxygen]. | |
| 109 | Dr1 | and he is hypotensive | Dr1 looks at Dr2. |
| 110 | Dr2 | [okay]. | |
| 111 | DrAn | [but you] hear coarse ratteling sounds. | DrAn looks at Dr1. |
| 112 | Dr1 | I think it's gurgling a bit there and<br>[X X X <XX>]. | Dr1 palpates Pat's rib cage. |
| 113 | Nu1 | [he is 40, Johannes is]. | |
| 114 | DrAn | [he's getting fluid]. | |
| 115 | NuAn | [he has..] falling saturation. | NuAn looks at the monitor at the right. DrAn turns and looks at the monitor at the right. |
| 116 | Dr1 | yes. | |
| 117 | DrAn | [yes] [I turned up] the oxygen a bit. | |
| 118 | Nu1 | [yes] | |
| 119 | X | [he had that yes]. | |
| 120 | Nu1 | he has two siv-cannulas. his pressure was a bit low. blood pressure was 90 over 40. | Nu1 points to Pat before he points up toward the monitor. Nu1 then goes to the journal. NuAn goes further into the room and looks for something. |
| 121 | X | mm. | |
| 122 | Dr2 | there [is fluid going in] right? | Dr2 looks at Dr1 and points to Pat. |
| 123 | DrAn | [but eh]. | |
| 124 | Nu1 | eh [two Ringer's are going]. | |
| 125 | Dr1 | [yes in fact we got X X] I think | Dr1 looks at the monitor. |
| 126 | Dr2 | [two Ringer's yes]. | Dr2 looks away towards Nu1, nods. |
| 127 | Nu2 | [takes blood sample] here. | Nu2 looks at Dr1. |
| 128 | Dr1 | yes we'll take blood<br>[tests guess we have to]? | Dr1 puts on the stethoscope. |

NuAn (turns 114–115) while Nu1 is looking at the monitor. Within this extended online commentary we notice an insertion of offline commentary ('*he is 40*', turn 113) when Nu1 gives a delayed response to NuAn's question asked in turn 106.

The (re)distribution of tasks is manifest as three ways: as reports of action (turn 117), triggered by the online commentaries; as reports of observations leading to assessments that are supported by observations at the monitor (turn 120); and as a question requesting further online commentary (turn 122). This question is addressed directly to Dr1 and is answered simultaneously by both Nu1 and Dr1. The question comes across as ambiguous in its design when requesting online commentary and at the same time framing what should happen next. Subsequently, Dr1 initiates what seems to be an offline commentary but which is conflated into a metacommentary '*I think*', while simultaneously looking at the screen (turn 125).

Further, Nu1's answer is framed as an offline commentary providing additional information (turn 124). Nu1 steps out of the present task to offer an explanation by reporting about two doses of Ringer's solution. In giving such explanations, which count as offline commentary, both Nu1 and Dr1 take on an educator role towards the rest of the team, and foreground their participation status concerning task responsibility. Dr1's explanation projects what has to be next action and could be seen as the onset of intervention while attending to the monitor. Dr2 directs her attention to Nu1 and confirms the relevance of the information ('*two Ringer's yes*', turn 126). Nu2 seems to act upon Dr1's initial request for intervention by stating the next move. Dr1 responds by foregrounding the dynamics of task responsibility concerning her and Nu2, thus implying the need for intervention through a rhetorical question ('*guess we have to?*', turn 128). Simultaneously, she puts on the stethoscope and assumes responsibility for further intervention.

Unlike the previous example, we notice in Extract 2a below that online commentary is volunteered by Dr1 ('*we're inserting a cannula*', turn 86) when he offers the routine summary.

**Extract 2a**

| Turn | Participant | Talk sequence | Action sequence |
|---|---|---|---|
| 85 | DrAn | what's happening here? (laughs) | |
| 86 | Dr1 | it's a man born in 41. With known angina has been to coronary angioplasty. no known lung [disease] of any kind. non-smoker. eh chest pain in the night which has increased. eh....more or less about in the centre of the chest sternally. no [radiation] and [shortness of breath. he is crepitating] bilaterally. we are taking an ECG and now we're inserting a cannula. | Nu1 and Nu2 continue connecting the ECG leads. Dr1 indicates on the patient where the chest pain is. |
| 87 | Nu1 | [X]. | |
| 88 | Nu2 | [X]. | |
| 89 | Nu1 | [X <X X> X X it]. | Nu2 are preparing to take a blood sample. |
| 90 | Dr1 | he has received [Furix and] morphine. | |
| 91 | DrAn | [but his saturation is low]. | |
| 92 | Dr1 | yes has received fifteen litres of O2. we should switch to a mask with [reservoir]. | |
| 93 | DrAn | [X X]. (1,5)<br>take this one here instead. let's see...<br>[can you connect it] Kari? | DrAn takes ambu bag. DrAn looks at NuAn. |
| 94 | Dr1 | [and then the blood pressure is poor]. | |
| 95 | NuAn | yes... let's see. | |
| 96 | DrAn | has [any fluid] been hung up? | DrAn looks at Dr1. |
| 97 | Dr1 | [they are recording an ECG now]. | Dr1 points toward Nu1 and Nu2. |
| 98 | DrAn | has any fluid been hung up for him? (1,5) | |
| 99 | Dr1 | yes... | |
| 100 | NuAn | [should have]. | |

| | | | |
|---|---|---|---|
| 101 | DrAn | [yes or on] the anaesthesia machine there perhaps. (2,0) Let's see. is he awake now? | DrAn points to the anaesthesia machine at the left. NuAn walks over there and connects the oxygen to the ambu bag lead. DrAn bends over Pat. |
| 102 | Instr | no it is.. [the frequency] is not right but the rest [is right] [X X.]. | The ECG result is handed to a medical student. |
| 103 | Dr1 | [no]. | |
| 104 | DrAn | [huh]? | DrAn looks at Dr1. |
| 105 | Dr1 | [no he is not] awake. [Johan]? | Dr1 turns toward P. |
| 106 | X | [X X]. | |
| 107 | Pat | (groans). | |
| 108 | DrAn | [hello]. | |
| 109 | Dr1 | [you are] awake yes. | |
| 110 | DrAn | so now you will [get a different mask on]. | DrAn is facing Pat. |
| 111 | Medical student | [XX the frequency does][not agree][but otherwise X X]. | Instructor hands the ECG result to the medical student who gives the ECG results to Dr1. Dr1 then goes to the foot end of Pat's bed and looks at the ECG result together with Dr2 and the medical student. |
| 112 | Pat | [mm]. | |
| 113 | DrAn | [then we must turn off that one] over there y'know. | |
| 114 | Medical student | X X. | |
| 115 | DrAn | I'm just going to hold your jaw a little. | |
| 116 | Pat | (groans) | |
| 117 | DrAn | let's see . are you breathing then? yes you are. (2,0) let's see here now. 82. | |
| 118 | NuAn | X X X X X. (2,0) | |
| 119 | DrAn | I'll just help a bit with this now. | DrAn and NuAn are standing close to P's head. They are looking at the monitor at the right, outside the picture. DrAn squeezes the ambu bag. |

The summary provided by Dr1 resembles an online commentary, and is responded to by Nu1 and Nu2 (turns 87–89) through an action-oriented report. DrAn overlaps with her online commentary that the patient's saturation is low – an observation that would normally call for immediate action from an anesthetist. Dr1 minimally recognises her comment ('*yes*', turn 92), then proceeds with his report on treatment during the previous phase and concludes with a metacommentary framing how to interpret the action ('*we should switch to a mask*', turn 92). When inserted within an online commentary, the metacommentary functions as an offline commentary. We note that metacommentary can also trigger action. DrAn does not openly contradict Dr1 on this, but takes the ventilation bag, saying '*take this one here instead*' (turn 93).

This exchange runs parallel with the exchange between DrAn and Dr1 (turns 94 and 96–98).

DrAn signals through her question that Dr1 holds overall responsibility and her question could be seen as both a request for intervention and a request for a summary (turn 96). Dr1 delivers an online commentary reporting actions '*they*' are taking (turn 97) while pointing at Nu1 and Nu2. Here online commentary functions as a delaying tactic in terms of diagnosis/intervention. DrAn repeats her question ('*has any fluid been hung up for him?*', turn 98). By adding '*for him*' she enhances the urgency of her indirect instruction. This is then followed by a long pause. Instead of delivering a summary of past history Dr1 gives a short confirmation signalling this task is closed (turn 99), while NuAn confirms the action previously mentioned by DrAn (turn 93) through a metacommentary ('*should have*', turn 100).

Throughout the sequence, DrAn gives an online commentary of her own work (turns 101–119). This may be heard as online commentary offered to the team. In turn 101, having directed NuAn where to connect the oxygen, DrAn bends over the patient and asks whether he is awake now. This initiates a series of exchanges where Dr1 holds that the patient is not awake, and then calls the patient's name (turn 105). The patient reacts, resulting in an online commentary from Dr1 that he is awake (turns 107 and 109), which overlaps with DrAn's calling the patient in turn 108. In turn 110, DrAn explains her procedure to the patient through a metacommentary.

Interspersed with this exchange are observations related to the ECG result. The result is handed over to the medical student from the instructor, with an explanation about a discrepancy between the printed results and those on the screen (turn 102). This is a metacommentary on the simulation environment. In turn 111, the student repeats the metacommentary as he gives the results to Dr1, who then goes to join Dr2 and the student at the foot of the bed. Simultaneously the medical student provides an online commentary, followed by offline commentary including assessment of findings. This is addressed to Dr1 and triggers a joint activity where Dr1, Dr2 and the student interpret the ECG, through what seems to be a joint production of an offline commentary (turns 111 and 114). At the same time, DrAn helps the patient breathe by using the ventilation bag, examines the patient's chest, asks if he is awake and looks at the monitor. This multiactivity is accompanied by a short online commentary from DrAn (turn 117). Again she provides an online commentary on her own work. In turns 113, 115 and 119 we observe the occurrence of metacommentaries addressed to the patient, which project what will happen next. These metacommentaries prepare the patient for the medical procedure in a frontstage mode (see parallels to ultrasound encounters, Sarangi and Gilstad 2014). Additionally, the functioning of DrAn's metacommentaries could be seen as what Bezemer *et al.* (2011) refer to as camouflaged collaboration with colleagues, particularly alongside NuAn. Extract 2b continues the exchange.

As can be seen, NuAn's question (turn 120) triggers an online commentary (turn 121) before NuAn offers another online commentary while looking at the monitor (turn 123). Simultaneously, Dr1 offers an offline commentary to Dr2 and the medical student assessing the ECG results (turn 122). NuAn's online commentary (turn 123) triggers a distribution of tasks, whereby NuAn checks the equipment while DrAn monitors the patient's breathing and continues the online commentary (turns 124–128). DrAn's next question, which is accompanied by laughter, seems ambiguous and could be seen as announcing a potential diagnosis as well as an online commentary regarding the training session. This is followed by a pause and another question, which can be regarded as an implicit instruction to check SAT (turn 129). Nu1, Dr1 and Dr2 assume shared responsibility amongst them and provide online commentaries of what can be observed on the screen. Dr1's question (turn 134) about the patient's condition results in an online commentary followed by a metacommentary from DrAn ('*now he's starting to turn blue here too. I think we must intubate him*', turns 135 and 137). This online commentary combined with the metacommentary (turn 135) becomes a trigger for the next action and illustrates how to get tasks done without explicit allocation (turn 136). Subsequently DrAn delivers another metacommentary prefacing intervention (turn 137). DrAn

**Extract 2b**

| Turn | Participant | Talk sequence | Action sequence |
|---|---|---|---|
| 120 | NuAn | do we have any contact with him? | |
| 121 | DrAn | [yes he is slightly awake. are you awake Johan? (1,5) he is not really awake]. | DrAn talks to Pat. |
| 122 | Dr1 | [X X X bundle branch block with X X. X X. (2.0) X X X X]. | Dr1 looks at the ECG results together with Dr2 and the medical student. |
| 123 | NuAn | there is no SATS. | NuAn looks at the monitor at the right. |
| 124 | DrAn | let's see. | |
| 125 | Nu1 | no it fell [off]. | The SATS probe falls to the floor. Nu1 picks it up. |
| 126 | DrAn | [X put that] on. let's see. now he's not breathing either. | |
| 127 | Med Stud | X X X X [X]. | |
| 128 | Nu1 | [there]. | |
| 129 | DrAn | <F is that right he's not breathing? F> (laughs) (2,0). do we have any SATS now? | DrAn says this out in the room, then looks at the monitor at the right. |
| 130 | Nu1 | X [X]. | |
| 131 | Dr1 | [70]. | |
| 132 | Nu1 | [it's at 69]. | Nu1 looks at the monitor at the right. |
| 133 | X | [yes it was X X]. | |
| 134 | Dr1 | is [he]? | |
| 135 | DrAn | [now] he's starting to turn blue here too. | |
| 136 | Dr1 | [<X we have any pulse? X>]. | |
| 137 | DrAn | [I think we must intubate him]. | DrAn looks at NuAn. |
| 138 | NuAn | yes. | |
| 139 | DrAn | what's his blood pressure now then? | DrAn looks at the monitor at the right. |
| 140 | Dr1 | X [X X X. X last.. does he have a pulse]? | |
| 141 | DrAn | [67. I wasn't so good with that mask intubation. like so yes]. there it's possible to ventilate him at least (2.0). | |
| 142 | Dr1 | but now he [has gone into a cardiac arrest]? | |
| 143 | DrAn | [does he have a pulse]? | DrAn looks at Dr1. |
| 144 | Dr1 | yes. | |
| 145 | DrAn | does he have a pulse. (3.0) yes 77 X [yes X 77] | Dr1 goes to palpate for a pulse in Pat. Dr2 palpates Pat's groin. |
| 146 | Dr1 | [yes he has a pulse]. | |
| 147 | DrAn | yes 77. He's SATS is going up. But I still think we have to [intubate him]. | DrAn looks at the monitor at the right. |
| 148 | NuAn | [intubate him yes]. | |
| 149 | Dr1 | [intubate him.. yes]. | |
| 150 | DrAn | [X X X X X]. | |

is perhaps seeking an online commentary prior to intervention (turn 139), while Dr1 responds with a question about potential diagnosis (turn 140). Next, DrAn provides a metacommentary about her own action in a previous training session, '*I wasn't so good with that mask intubation*' (turn 141). This works as a contrast to her assessment of the present situation, which takes the form of an online commentary ('*there it's possible to ventilate him at least*', turn 141). This triggers a division of tasks where DrAn continues seeking online commentary (turn 143) and Dr1 is checking the patient's pulse and looking at the screen (turns 145 and 146) while jointly producing a warrant for decision making (turns 143–146). DrAn offers another online commentary (turn 147), which includes assessment and is transformed into a metacommentary anticipating a consensual decision that is acknowledged by both NuAn and Dr1 (turn 148, 149).

Extract 3 occurs at the end of Dr1's summary of past history, and we notice that she switches to an online commentary about the current situation, '*Now we have taken a blood gas*', before offering a metacommentary, '*we are waiting for the result*' (turn 110).

**Extract 3**

| Turn | Participant | Talk sequence | Action sequence |
|---|---|---|---|
| 110 | Dr1 | But he also has very p- low saturation [percentage. Now we] have taken a blood gas and we are waiting for the result. | Dr1 looks out of the picture towards the left. |
| 111 | X | [yes low]. | |
| 112 | Instr | yes. | Dr1 and Dr2 go to receive the results from the blood gas analysis. |
| 113 | X | ECG [X X]. | |
| 114 | DrAn | [and a bit low] in blood pressure. (1,5) has he received yes | |
| 115 | Dr1 | eh [X X X X X] [X X]. | Dr1 looks at the bloodgas analysis, Dr2 looks at ECG result. |
| 116 | DrAn | [is he getting any medication?] | DrAn looks at Nu1. |
| 117 | Nu1 | [he has received 2.5] mor[phine]. | |
| 118 | Dr1 | [X]. | |
| 119 | Nu1 | yes. | |
| 120 | Dr1 | so. [but eh]. | Dr1 walks towards Pat and says something to NuAn, DrAn and Nu1. |
| 121 | Dr2 | he has known. [has a right bundle branch] [block] [here X]. | Dr2 stands next to Dr1 looking at the ECG results. |
| 122 | DrAn | [hello hello]. | DrAn looks at Pat. |
| 123 | Pat | [hello]. | |
| 124 | DrAn | [hello Johannes]. | |
| 125 | Dr1 | yes. | |
| 126 | Pat | hello. | |
| 127 | DrAn | yes. | |

| | | | |
|---|---|---|---|
| 128 | Dr1 | SAT of [84] and pO2 of X then perhaps we should start[... BiPAP]. | Dr1 looks at the results from the blood gas analysis. Is on her way to put it down but shows it to NuAn and DrAn instead. |
| 129 | Pat | [X]. | |
| 130 | DrAn | [what did you say pO2 of]? | |
| 131 | Dr1 | eh pO2 is at 6.71 [and] then there is a X X X. | |
| 132 | DrAn | [yes]. | |
| 133 | Nu2 | we can. | Nu2 goes to join the others who are standing around Pat. |
| 134 | DrAn | what then? | |
| 135 | Nu2 | [C-PAP]. | |
| 136 | Dr1 | [X X X] X X. I think it's BiPAP actually but look here. | Dr1 puts down the blood gas analysis on Pat's feet. Nu2 then picks this up. |
| 137 | Nu1 | BiPAP [I have X]. | Nu1 looks at Dr1. |
| 138 | DrAn | [X X X]. | |
| 139 | Nu1 | [X X X X]. | |
| 140 | Dr1 | [OK then we'll try C-PAP first] to start with. | Dr1 looks at Nu1. |

The metacommentary ('*we are waiting for the result*', turn 110) triggers collaborative action between Dr1 and Dr2 picking up the result, while Nu2 and DrAn provide online commentaries about ECG and blood pressure (turns 113 and 114). As in Extract 1, we notice the online commentary revisiting the summary of past history when DrAn asks '*has he received yes*' (turn 114) before she reformulates the question and addresses it directly to Nu1 (turn 116). Nu1's ensuing response adds evidence to the summary. Dr1 directs her attention to NuAn, DrAn and Nu1 and produces an offline commentary, while Dr2 offers what seems to be part of the summary followed by an online commentary ('*has right bundle branch block here*', turn 121) addressed to Dr1. DrAn tries to get contact with the patient and this action (turns 122–127) could be seen as being triggered by the preceding online commentary.

Dr1 makes a shift to the present situation when she gives an offline commentary, '*SAT of 84*', and then provides this as a warrant for specific intervention, '*perhaps start BIPAP*' (turn 128). As a response to Dr1's suggestion, DrAn seeks online commentary prior to intervention. This search for more evidence results in another offline commentary where Dr1 refers to some factual details ('*pO2 is at 6.71*') and tries to explain what the observations mean, '*and then there is*' (turn 131). DrAn frames her next question as if she anticipates different opinions about the next move and signals that a decision has to be made ('*what then?*', turn 134). The question seems to contribute to a series of actions concerning the decision. Nu2 offers a different suggestion to Dr1's, namely '*C-PAP*' (turn 135). This is challenged by Dr1, who invites Nu2 to look at the evidence while she assesses the observations, starting with a metacommentary ('*I think it's*'), prefacing a decision before offering an offline commentary (turn 136). Nu1 then offers online commentary concerning BIPAP addressed to Dr1 (turn 137). This results in a metacommentary which resembles a decision formulation, where Dr1 frames it as a temporary decision with possible weaknesses ('*we'll try first to start with*', turn 140). Through this she is signalling the necessity in this activity type of making a decision without sufficient evidence and takes on board her responsibility in this matter. Throughout this extract it seems offline commentaries are provided by Dr1 when online commentaries are asked for, thus contributing to the fact that decisions have to be temporarily put on hold.

In our final extract (Extract 4), Dr1 is performing an ultrasonic test when the support team arrives. The team has previously summarised the past history and we notice Dr1 concluding the summary by providing online commentaries to act upon.

**Extract 4**

| Turn | Participant | Talk sequence | Action sequence |
|---|---|---|---|
| 226 | Dr1 | [he has been low in blood pressure from nitro]. | |
| 227 | Nu2 | [X X X X X X X]. | |
| 228 | Dr2 | X X X X X X. | Dr2 has walked toward the desk where the journal is placed and takes notes. |
| 229 | Dr1 | X X [X X]. | |
| 230 | Nu2 | [mm]. | |
| 231 | DrAn | do we have [do we have a palpable] pulse? | DrAn looks at Nu1. |
| 232 | Dr1 | [but then X X]. | |
| 233 | Dr2 | X X [X X X]. | |
| 234 | Dr1 | [eh we had it] a little while ago. | Dr1 looks at the monitor to the right. |
| 235 | Dr2 | do we have any [X X or]? | |
| 236 | DrAn | [he… is not] breathing. | |
| 237 | Dr1 | no. (2,5) | |
| 238 | Nu2 | angina. | Dr2 looks at the journal Nu2 is holding out. Dr2 points at the sheet. |
| 239 | Dr2 | X.. [X X X X] [X X]. | |
| 240 | Dr1 | [has had sinus tachycardia] [the whole]time. | Dr1 looks at Nu1, DrAn and NuAn. |
| 241 | DrAn | [you] | |
| 242 | Dr1 | the ECG shows a right bundle branch block. | |
| 243 | Dr2 | yes [X X X is not breathing]. | |
| 244 | DrAn | [now I'll assist his ventilation a little I think]. | DrAn looks at the monitor at the right before she looks at Pat. |
| 245 | Dr1 | [okay]. | |
| 246 | Nu2 | [he's not] breathing. | |
| 247 | Nu2 | X [X X]. | |
| 248 | Dr1 | [okay]. | |
| 249 | DrAn | [he is not breathing on his own]. | DrAn starts squeezing the ambu bag. |
| 250 | Dr2 | [X X X] [X X]. | |

| | | | |
|---|---|---|---|
| 251 | Dr1 | [no okay]. | |
| 252 | Dr2 | X X. (2,0) yes like that. | |
| 253 | Dr1 | shall we start the fluids again with pressure bag since the left ventricle looked fine [then] [I] think we can try that. | Dr2 looks at Dr1 and points to the bag. Nu1 opens the iv-line. |
| 254 | Nu1 | [mm]. | |
| 255 | Dr2 | [mm]. | |
| 256 | Dr1 | even though [he has a filled vena cava]. | |
| 257 | DrAn | [and that blood pressure there is] real? | DrAn looks at Dr1. |
| 258 | Dr1 | it [is as] real as we can get it. | |
| 259 | DrAn | [is it]?<br>yes. | NuAn exits to the right |
| 260 | Dr2 | mm… mm. X X. | Dr2 makes a note. |

Dr1's summary of past history (turn 226) mutates into an online commentary signalling potential cause of breathing problems (turn 236). As a result, Nu2 and Dr2 return to the patient's history and consult the medical record (turns 238 and 239). As in both Extracts 1 and 3, the online commentary triggers a revisiting of the summary. Dr1 assumes responsibility to summarise and provides details about past history ('*has had sinus tachycardia the whole time*', turn 240). Subsequently both Dr1 and Dr2 offer online commentaries (turns 241 and 242) concerning the patient's heart function, while DrAn simultaneously provides a metacommentary related to the patient's breathing (turn 244). This comes across as a framing of what is going to be her next action ('*now I'll assist his ventilation a little I think*', turn 244). As someone with expert knowledge about breathing, DrAn is in a position to provide this kind of a commentary. Nu2's online commentary (turn 246), which repeats Dr2's words '*he's not breathing*', functions as selective reinforcement.

DrAn continues with an online commentary ('*he is not breathing himself*', turn 249) which overlaps with an offline commentary by adding 'himself' as explanatory evidence. Her commentary is accompanied by preparations of the equipment. Dr1's online commentary in turn 253 comes across as an instruction that trails off into an offline commentary providing an explanation ('*since the left ventricle looked fine*') before he offers a metacommentary signalling what will happen next ('*I think we can try that*'). Dr1 then steps aside from the present task and provides further evidence (turn 256) for the suggested decision concerning treatment signalled in turn 253. As in previous examples, DrAn is seeking online commentary prior to intervention (turn 257). DrAn's question is designed both as information-seeking and as a metacommentary about blood pressure being difficult to monitor. This triggers a metacommentary where Dr1 frames blood pressure values as uncertain and sensitive to contextual aspects, and in doing so implies that she needs to act upon the available information. NuAn exits to the right and coordinates the ongoing task by giving DrAn space to prepare for intervention. Thus NuAn orients to the dynamics of role-relationships between her and DrAn as well as her responsibility to facilitate the anaesthetist's work.

**Discussion**

The work conditions in emergency care change frequently, and the team is often assembled in an *ad hoc* manner. As Manser (2009) points out, these *ad hoc* teams need to respond in a coordinated way with regard to expected and unexpected events. A closer look at such teamwork, and team talk more particularly, demonstrates that there are elements of 'talking to the room' but also talk which is directly addressed to individual team members, as the question-answer sequences attest in our data. Furthermore, the 'talk' itself can be differentiated, as we have attempted to do, into different discourse types – online commentary, offline commentary and metacommentary – which then allows us to examine their specific functions in accomplishing activity-specific tasks and goals. Generally speaking, online commentary specifically codes or documents observable evidence upon which next actions can be projected. Offline commentary pertains to elaborating certain kinds of evidence as required. Metacommentary more explicitly orients to decision trajectories.

It is worth noting that these discourse types are realised differentially. The occasioning and functioning of online commentary, offline commentary and metacommentary in the context of treatment intervention in emergency teams are more complex than in the context of the physical examination in the primary care setting or in the ultrasound encounter. This complexity is manifest in the configuration of the three discourse types we have focused on in our analysis *vis-à-vis* the team members' participation status and the circumstantial affordances. In particular, online commentaries may be produced by team members depending on their spatial positioning in relation to the patient and the equipment, whereas offline commentary is more likely to index participation status and expertise of individual team members. A metacommentary may be the preferred strategy for the team member who has overall responsibility for the patient's condition.

As we have seen, online commentary routinely triggers a (re)distribution of tasks and responsibilities within the team, even without being targeted at specific addressees. The physician with responsibility as the team leader for the medical treatment (Dr1) produces most of the online commentaries, both volunteered and when elicited. Those volunteered have the characteristics of being 'talk to the room,' whereas elicited online commentaries are less so. Other team members also offer online commentaries as appropriate: for instance, in Extract 3, the anaesthetist (DrAn) provides online commentaries indicative of her ongoing work when engaged in simultaneous tasks. Interestingly, Dr2 and Nu1 provide online commentaries that are particularly addressed to Dr1 rather than being 'talk to the room' (see Extracts 3 and 4). This may be seen as the team members' way of orienting to Dr1 as the leader of the team.

The metacommentaries addressed to the patient indirectly function as projected collaboration across the team. In this respect, a metacommentary can straddle the so-called backstage and frontstage of professional practice. The combination of online commentary (coding of evidence) and metacommentary (suggesting what has to be the next action) illustrates the slippery boundaries between these two discourse types, with both resulting in future actions without explicit instructions (see Extract 2b). Similar to Hindmarsh and Pilnick's (2007) findings, 'prospective embodied conduct' is accomplished through both online commentary and metacommentary. We have also drawn attention to the fact that an online commentary may be jointly constructed over a sequence of turns, as in Extract 1b. Offline commentary particularly foregrounds the participation status, including the educator role, of a team member through offer of explanations (Extract 1b), at times making additional evidence available (Extract 3). In one instance, an offline commentary follows a request for online commentary (Extract 3).

Our analysis shows that both online commentary and metacommentary trigger next action. With the use of both these discourse types, a team member leaves it up to the rest of the team to draw inferences from the information provided. Metacommentary more specifically triggers a variety of actions ranging from (re)distribution of tasks (Extracts 1b and 3) to arriving at decisions without sufficient evidence (Extract 1b), to prefacing of decisions (Extract 3), to suggestions regarding the next course of action (Extract 4). Online commentary, on the other hand, seems to delay intervention (Extract 2a), to distribute responsibility between team members (Extract 1a), to facilitate consulting the summary of the patient's history (Extract 1a, Extract 3, Extract 4) or even to result in a metacommentary providing a decisional formulation

(Extract 3). The constant shift between online commentary and metacommentary occurs as the team approximates a decision about intervention (Extract 2b).

## Conclusion

In interprofessional healthcare delivery, successful management of tasks and responsibilities amounts to coordination of joined-up actions. Our focus in this paper on how joint actions are layered and coordinated in the emergency team's training sessions has revealed the mediating role of talk, or discourse types, in conjunction with other bodily conduct. While teamwork is largely invisible, a close analysis of team talk offers useful insights. Of course, medical teams coordinate their actions not only through talk, but also through monitoring of the patient and their colleagues' work; but talk remains a major tool for accomplishing interprofessional collaborative work. The crucial role of talk becomes evident in critical moments – e.g. in the constitution of teams that are assembled in an *ad hoc* manner or in clinical handover procedures – and these moments have been identified as an area of high risk for adverse events.

In medical education, simulated encounters have constituted a key site for developing and assessing communication skills pertaining to doctor–patient consultation. In recent years simulated encounters are also becoming a means to afford educational training for interprofessional communication in emergency care settings. However, how to teach and assess team-based performance remains a challenge. Although ambiguities are an intrinsic feature of the modes of team talk examined here, a systematic account of their occurrence and functions can contribute towards successful educational intervention.

## Notes

1. The videos have two significant shortcomings. We used only one camera, which does not always cover all participants, and the camera angle often does not let us capture the gaze or gestural and other bodily conduct. The observer's field notes (as can be found in the last column of the transcript) provide additional information. The original data is in Norwegian, which has been translated and verified by the research team.
2. A detailed structural and interactional mapping of the activity type allows us to identify the critical moment when the team expands and how the key discourse types play a significant role in the teamwork (Gundrosen *et al.* 2016).

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# Paper 4

BMJ Open

# Team talk and team decision processes: a qualitative discourse analytical approach to 10 real-life medical emergency team encounters

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## ABSTRACT

**Objectives** Explore the function of three specific modes of talk (discourse types) in decision-making processes.
**Design** Ten real-life admissions of patients with critical illness were audio/video recorded and transcribed. Activity-type analysis (a qualitative discourse analytical method) was applied.
**Setting** Interdisciplinary emergency teams admitting patients with critical illness in a Norwegian university hospital emergency department (ED).
**Participants** All emergency teams consisted of at least two internal medicine physicians, two ED nurses, one anaesthetist and one nurse anaesthetist. The number of healthcare professionals involved in each emergency team varied between 11 and 20, and some individuals were involved with more than one team.
**Results** The three discourse types played significant roles in team decision-making processes when negotiating meaning. Online commentaries (ONC) and metacommentaries (MC) created progression while offline commentaries (OFC) temporarily placed decisions on hold. Both ONC and MC triggered action and distributed tasks, resources and responsibility in the team. OFC sought mutual understanding and created a broader base for decisions.
**Conclusion** A discourse analytical perspective on team talk in medical emergencies illuminates both the dynamics and complexity of teamwork. Here, we draw attention to the way specific modes of talk function in negotiating mutual understanding and distributing tasks and responsibilities in non-algorithm-driven activities. The analysis uncovers a need for an enhanced focus on how language can trigger safe team practice and integrate this knowledge in teamwork training to improve communication skills in ad hoc emergency teams.

## Strengths and limitations of this study

- ► Audio/video recording of emergency teams during real-life admissions of patients with critical illness ensured authentic samples for analysis.
- ► The activity-type analysis provided new insight in how team talk influences teamwork in non-algorithm-driven medical emergencies.
- ► Culture and body language, significant issues in talk–work relationship, were not addressed in this study.

## INTRODUCTION

Communication error is a common cause of adverse events in healthcare.[1–6] There has been a growing scientific focus on cognitive and social skills, 'non-technical skills' (NTS), for health professionals in an effort to improve patient safety.[7–9] NTS are crucial for avoiding errors, especially in emergency teamwork.[10–14] Crew resource management principles (CRM) have been adapted to medical NTS training from aviation in order to improve teamwork in emergency care,[15–17] and communication skills are integrated in CRM-guided team frameworks in several medical specialities.[18–20] Studies show that team training improves team processes[21–24] and evidence connecting team training to improved patient outcomes is accumulating.[25 26] Standardised communication strategies such as closed-loop communication (CLC) are recommended in critical care.[27–29] Recent studies indicate, however, that the use of CLC is limited despite recommendations and extensive training, especially in non-algorithm-driven activities implying high cognitive load (identification of cues, interpretations, integration of existing knowledge and decisions).[13 30–33] Studies of naturally occurring team talk have increased our understanding of the talk–work relationship. Lingard *et al* found communication patterns benefiting safety in interdisciplinary team discussions during presurgical checklist-driven team briefings,[34] and Kolbe *et al* found that high performing anaesthesia teams used monitoring and talking to the room during general anaesthesia induction.[35] Previous reports have also uncovered specific modes of talk constructing and supporting coordination in

Table 1 Discourse types

| Discourse type | Definition | Example |
|---|---|---|
| Online commentary | Description or evaluation of real-time observations[42] | 'His oxygen-saturation isn't getting any better' |
| Metacommentary | Implicit message framing the activity type, orienting to next action or a plan[43] | 'I think we should intubate' |
| Offline commentary | Clarification and explanation, building evidence[44] | 'A CT-scan can tell us if there are significant signs of brain anoxia' |

emergency team activity during standardised scenario in situ simulation training.[36 37]

Interdisciplinary ad hoc teams comprised to meet specific patient needs in critical and complex medical situations attend most in-hospital medical emergencies. Communication is crucial in such teams to converge joint expertise in support of team decisions, defined as 'a team process that involves gathering, processing, integrating and communicating information in support of arriving at a task-relevant decision'.[38–41] Here, we investigate how three discourse types defined as 'online commentary' (ONC), 'metacommentary' (MC) and 'offline commentary' (OFC) influence team decision-making processes in real-life interdisciplinary medical emergency teams while admitting non-trauma patients with critical illness to the hospital. ONC was defined by Heritage and Stivers[42] as descriptions or evaluations of real-time observations,[42] Bateson[43] described MC as implicit messages framing the activity type orienting to next action or a plan,[43] and OFC is defined by Sarangi as clarifications and explanations implying a pedagogical role.[44] Examples of these discourse types are summarised in table 1.

## METHODS

Data were collected in the emergency department (ED) of a Norwegian university hospital from May 2015 to March 2016. Information was provided to all health professionals with potential for involvement in the study, and written informed consent from the participating healthcare professionals was collected at the scene or ahead of time. Although patients were not objects of this study, both patients and relatives gave their informed consent to participate. The next of kin gave consent on behalf of four of the patients who were unable to do so because of their medical condition, in accordance with the ethical approvals. No participants, patients or relatives chose to withdraw from the study.

### Patient and public involvement statement

Patients and the public were not objects of this study and thus not involved in study design or conduct of this research.

### Context

According to hospital procedure, the emergency team is activated when non-trauma patients are admitted to the hospital with imminent problems with airways, breathing and/or circulation. All teams consisted of at least two internal medicine physicians, two ED nurses, one anaesthetist and one nurse anaesthetist.

### Data collection

The first author attended the ED with a mobile video camera and two microphones. A research assistant placed one of the microphones in the emergency room and provided information and written consent forms to participants. Ten teams admitting patients with critical illness were recorded and observed to capture the interconnections between team talk and actions. Patient ages ranged from 19 to 88 with a median of 73, and five were women. The number of healthcare professionals involved in each emergency team varied between 11 and 20 people, and some individuals were involved with more than one team. The 10 videos covered 144 health professional roles, including 65 physicians from various specialities (cardiology, pulmonary, internal medicine, neurology, ED, radiology, thoracic surgery, anaesthesiology, prehospital emergency), 46 nurses (ED, anaesthesiology and intensive care), seven radiographers, four medical students and 22 paramedics.

### Analysis

The four authors have comprehensive experience in critical care and applied linguistics. We followed a standard procedure previously described.[36 37] Briefly, all 10 videotapes were first viewed repeatedly before making detailed depersonalised transcriptions marking parallel talk, pauses and non-verbal activities. All authors reviewed the transcripts, and the first and the second author performed the analyses together. The analytical method is inspired by Levinson's sociopragmatic theory of the role and function of speech in different social activity types.[45] Activity-type analysis is a version of discourse analysis used to perform sequential studies of the interconnections between naturally occurring language and professional practices, revealing the structural and interactional organisation of the speech,[46–48] and builds on a perspective in which language is understood as principal for negotiating meaning.[49 50] First, we mapped the data across all teams into general recursive key activity phases defined as an overarching structure with associated subphases. Then SG and GT individually performed a sequential approach to identify phases of both medical and linguistic relevance to the decision-making processes. Concurrency was shown by both authors in identifying the same phases in the extensive data corpus, and all authors reached a consensus of interpretations through discussions.[51] A professional translator translated the transcripts from Norwegian to English for publication.

## RESULTS

Structural mapping of all 10 videos illuminated four overarching activity phases with associated subphases. Phase 1 is characterised as opening activity: greeting both patient and colleagues, information handover, and patient movement from the stretcher to a hospital bed. Phase 2 is characterised as initial activity: monitoring the patient and performing primary ABC. Phase 3 is core activity: planning and accomplishing diagnostic examinations and treatment. Finally, phase 4 is closing activity: conclusions/tentative diagnosis, and patient preparation and movement from the ED for further examination and treatment.

Analysing the function of ONC, MC and OFC in teamwork show the complexity in talk–work relationship. An abbreviated summary of the findings is presented in table 2. We have selected four excerpts to illustrate the data and support the findings. The excerpts are taken from phase 3 and come from four different teams. Full transcripts can be found in online supplementary appendices 1–4, and utterances specified in the results section are referred to with numbers taken from the relevant appendix. XX: words not audible, (()): author's supplement.

### Excerpt A

This extensive excerpt is divided in two, for presentation of the results (online supplementary appendix 1).

### Part 1: before the anaesthetist's involvement in the CT decision

Situation: Patient is <40 years old. Indication for hospital admission: cardiac arrest. Cardiopulmonary resuscitation (CPR) was performed and return of spontaneous circulation (ROSC) occurred prior to hospital transport. The patient was unconscious and breathing inadequately at ED arrival. Team members are separated in two 'working groups' during this phase of work; ED nurse 1, nurse anaesthetist, ED physician 1 and the anaesthetist are all involved in patient-related practical tasks (ECG, suctioning, establishing an arterial line and sedation), while ED physician 1, physicians 1, 2 and 3 from internal medicine, and ED nurse 2 are standing next to the logging desk. Physician 3 is standing in a small distance from the latter group answering his telephone.

The excerpt begins with physician 3 answering the caller with MC: 'Yes. He is going to have a head CT-scan down here now.' He then addresses the group of physicians at the foot of the bed, 'Is he?' distributing responsibility to physician 2 by sight (276). The response uncovers diversities among the physicians: ED physician 1 agrees (277) while physician 2 disagrees (278). Physician 3's MC trigger action and the physicians start negotiating a mutual understanding. ED physician 1 and physician 2 contribute verbally, while physician 1 and physician 3 both contribute by bodily conduct (288, 294). ED physician 1's question 'Are we 100 % sure that it is the heart?' (284) challenges physician 2's view by seeking more evidence. In his next utterance, 'It isn't hypoxia' (OFC 287), he provides an explanation framing his expertise and putting the decision temporarily on hold, seeking ONC. Physician 2 responds 'Yes, but you have this and this,' while pointing twice at something placed on the logging desk (ONC 288). ED physician 1 responds with an OFC, 'But we would like to have a XX,' using 'we' as a strengthening factor (289) and again challenging the grounds of the decision and seeking more evidence. Physician 2 later distributes tasks and responsibilities to the other team-members framed as MC: 'You can investigate but I XX up to the ICU myself' (294).

### Part 2: after the anaesthetist's involvement in the CT decision

Negotiations of how to understand the available evidence continues with ED physician 1 seeking clarification about the necessity of cerebral CT prior to introducing hypothermia (OFC 298). The three physicians at the foot of the bed and the anaesthetist agree that CT is not necessary (299–301). The anaesthetist suspends his attempt to insert an arterial line and walks over to the other physicians, expressing his expertise with OFC: 'It's more out of- If there's doubts about the diagnosis X.' Physician 2 uses MC to continue to argue for direct transfer to the ICU: 'Sedated. Get him up to the ICU,' seeking to create progress (305). The anaesthetist responds with OFC: 'But there is no rush to get him up to the ICU either,' putting the decision temporarily on hold (310). Physician 2 challenges the decision-making basis by adding evidence for direct transfer to the ICU: 'We're going to get him into hypothermia after all just get him up to the ICU,' then continuing with an MC: 'If you want to get him to CT then-' seeking progress and distributing tasks and responsibility (314). The nurse anaesthetist observes blood in the patient's mouth and tracheal-tube and calls for action in parallel with the CT-discussion: 'It is bleeding in the mouth here.' (ONC 304). The ONC triggers redistribution of team resources when recognised, and the anaesthetist walks up to the nurse anaesthetist and works on the bleeding problem. Physician 3 summarises the grounds for CT-scanning by 'thinking out loud' (OFC 323). This OFC puts the decision temporarily on hold and initiates physician 1 to ask about arterial blood gas (MC 324). The excerpt ends with consecutive MC, starting with physician 2: 'But (micropause) XX make a decision. If we are going to get him to CT then we get him to CT. Not XX.' (343), building up to a mutual understanding.

### Excerpt B

Situation (online supplementary appendix 2): Patient is >80 years old, living at home. Indication for hospital admission: inguinal pain and syncope. The patient was nodding adequately when spoken to (yes/no) and had

**Table 2** Influence of online commentaries (ONC), metacommentaries (MC) and offline commentaries (OFC) in team decision-making processes, abbreviated summary of findings

| Discourse types | Findings | Examples |
|---|---|---|
| ONC | Created attention and indicated critical situations. Triggered action.<br><br>(Re)distributed tasks and responsibility. Created progression in team decision processes. | Nurse anaesthetist: 'It is bleeding in the mouth here.' Leading to: The anaesthetist leaves the CT-discussion and walks up to the nurse anaesthetist to manage the bleeding problem (excerpt A, online supplementary appendix 1, utterance 304 and following). |
| MC | Triggered action.<br><br>(Re)distributed tasks and responsibility. Oriented both towards acknowledgements and doubts of expertise. Created progression in team decision processes. Consecutive MC signalled urgency. | Anaesthetist: 'I haven't fetched the defibrillator.' Leading to: emergency department (ED) nurse 1 announces that she will fetch the defibrillator and the automatic chest compression machine, and the nurse anaesthetist asks for a bag-valve-mask. (Excerpt B, online supplementary appendix 2, utterance 293 and following).<br>Anaesthetist: 'But is it-. Should a pericardiocentesis be done, or is it-?" acknowledging the present team's expertise in decision-making. The lack of response results in her rephrasing the question: 'Has a thoracic surgeon been called? Or a thoracic anaesthetist- to come and assess- (3 s pause) In terms of status.', challenging the present expertise including her own, and distributing the responsibility of seeking necessary expertise to the others. (Excerpt C, online supplementary appendix 3, utterance 395 and following).<br>Anaesthetist: 'Must have suction now!', 'I need it now! (8) Can you watch out for his arm.', 'Suction in the mouth.', 'Suxamethonium and fentanyl' Leading to: ED nurse 1 sets up the suction device and starts suctioning secretions from the patient's mouth, the nurse anaesthetist delegate inserting a stylet in the tube to the nurse anaesthetist student while managing the medication herself. (Excerpt D, online supplementary appendix 4, utterance 228 and following). |
| OFC | Expressed the speaker's expertise. Sought mutual understanding. Created a broader base for decisions. Put the team decision processes temporarily on hold. | ED physician 1 question: 'Are we 100% sure that it is the heart?' seeking more evidence. And in his next utterance, 'It isn't hypoxia' he provides an explanation framing his expertise putting the decision temporarily on hold. (Excerpt A, online supplementary appendix 1, utterance 284 and following). |
| ONC conflating into MC | Seemed to 'speed up' team decision processes. | Anaesthetist: 'No contact. I think we'll intubate.' Leading to: Physician one turns towards the anaesthetist nodding, the nurse anaesthetist asks for confirmation and starts preparing for the intubation, and ED nurse one reports the patient's oxygen saturation. (Excerpt D, online supplementary appendix 1 , utterance 223 and following). |

possible face drooping at ED admission. An oropharyngeal airway is established, and intravenous fluid is ongoing. During this phase of work, the nurse anaesthetist is standing at the head of the bed providing the patient with oxygen, the anaesthetist is palpating the patient's inguinal pulse, physician 1 and ED nurse 1 are standing beside the bed, and ED nurse 2 is standing by the logging desk while physician 2 is outside the room checking CT laboratory availability. Physician 1, an intern at the hospital, activated the emergency team, and physician 2 is a senior physician. The excerpt begins when the patient's medical condition is progressing to a life-threatening phase. Breathing is deteriorating, the inguinal pulse is weak and it is difficult to measure blood pressure. The anaesthetist seeks attention to the patient's deteriorating medical condition with ONC (288): 'we are in the process of ((collapsing)).' This ONC draws attention and triggers action, physician 1 agrees (291) and the nurse anaesthetist encourages the patient to take a deep breath while ED nurse 2 places herself in a 'stand-by' position at the foot of the bed. The anaesthetist triggers action and distributes tasks and responsibility with MC (293): 'I haven't fetched the defibrillator.' ED nurse 1 announces that she will fetch the defibrillator and the automatic chest compression machine (MC 294), and the nurse anaesthetist asks for a bag-valve-mask (MC 295). Both utterances indicate a mutual understanding of the situation and acknowledge the anaesthetist's expertise. While the nurse anaesthetist and ED nurse 2 are about to connect the bag-valve-mask, the anaesthetist seeks attention to her observation of a weak carotid pulse (ONC) and then offers an MC related to the next step of action: 'I'm about to lose the radial, no carotid pulse. I'll just X. Start X.' (298). Physicians 1 and 2 are standing outside the room and the anaesthetist goes to the doorway and calls out the same message twice (300, 302). ONC conflating to a MC triggers action in the team and distributes tasks and responsibility, resulting in the decision expressed by physician 2: 'He's living at home and active and must start CPR (3 s pause) and intubate him.' This results in confirmation from physician 1 and the anaesthetist, and the nurse anaesthetist engages in the intubation while ED nurse 1 connects the defibrillator.

### Excerpt C

Situation (online supplementary appendix 3): Patient is >70 years old. Indication for hospital admission: syncope. The patient was awake and adequate with no pain at arrival. The anaesthetist is performing an ultrasound and preparing to place a central venous line in the patient's neck area. ED nurse 1 is preparing to insert a urine catheter, and the ED physician is standing beside the bed. The nurse anaesthetist is securing the patient's arterial cannula, and physicians 1 and 2 are standing beside ED nurse 2 at the logging desk. The bed is not functioning properly and cannot be tilted head down for the central venous line procedure, and a chest X-ray has just been taken. The excerpt begins with the anaesthetist's ONC: 'Her venous volume is good' seeking attention to her observation of high venous volume on the ultrasound screen (311). This utterance distributes responsibility and triggers action as ED physician leans over to see the anaesthetist's ultrasound screen. ED physician responds by offering an OFC framed as a question negotiating mutual understanding: 'Is it cardiogenic shock?' (312). The anaesthetist replies with an OFC in a pedagogical frame, building evidence: 'If you look at the vein here. Can you see it?' (313). ED physician follows with an ONC: 'Yes, I see. It's enormous,' implying an understanding of a critical situation (314). The anaesthetist agrees and they both put the decision temporarily on hold with further OFC, building evidence for what to do next (316, 317). The radiographer announces that the chest X-ray is ready for examination and the anaesthetist seeks attention from the ED physician while looking at the X-ray screen: 'Come and look at the X-ray here. The mediastinum is widened.' (ONC 326). The ONC triggers action and redistributes tasks and responsibility, manifested by ED physician stopping his preparations for vena cava scanning and moving to the X-ray screen, followed by physicians 1 and 2. After explaining her evaluation of the X-ray (OFC 330 and 332), the anaesthetist directs attention to the patient's decreasing blood pressure and presents an ONC conflating to an MC: 'Now her blood pressure is falling. Do we have some pressor-?' (335) indicating a critical situation. This utterance triggers action and distributes tasks and responsibility to the nurse anaesthetist, who shifts focus from communicating with the radiographer to informing the anaesthetist about available medication (OFC 339). While the anaesthetist and the nurse anaesthetist are handling the patient's low blood pressure, ED physician, physician 1 and physician 2 are deciding about the chest X-ray. Framed as an ONC supported by an OFC, ED physician announces their mutual understanding to the team: 'Chest X-ray shows widened mediastinum. So, we must suspect there's an aortic dissection causing her low blood pressure' (343). This puts the decision temporarily on hold while many parallel activities are following. ED physician interviews the patient before continuing the vena cava examination, and the anaesthetist continues preparing for a central venous line while discussing norepinephrine administration and communicating about the vena cava examination. At the same time, ED nurse 1 proceeds with inserting a urine catheter. Framed as an ONC conflating into an OFC, the ED physician evaluates the ultrasound image: 'The vena cava inferior is hardly moving. So it is obstructive or cardiogenic shock.' (394). This utterance triggers action by the anaesthetist, asking 'But is it-. Should a pericardiocentesis be done, or is it-?' (MC 395), acknowledging the present team's expertise in decision-making. The lack of response results in her rephrasing the question: 'Has a thoracic surgeon been called? Or a thoracic anaesthetist- to come and assess- (3s pause) In terms of status.' (MC 402), challenging the present expertise including her own, and distributes the responsibility of seeking necessary expertise to the others. ED physician interprets the anaesthetist's MC as a decision and confirms.

### Excerpt D

Situation (online supplementary appendix 4): Patient is >70 years old, living at home. Indication for hospital admission: cardiac arrest. CPR and ROSC prior to hospital transport. The patient was unconscious but breathing spontaneously at ED arrival and the airway was secured with a supraglottic airway device. During this phase of work, physician 1 is standing beside ED nurse 2 at the logging desk and two physicians from the thoracic surgical department are called and stand a small distance from the bed. Two radiographers are standing in the back of the room. The anaesthetist is standing near the patient's head and the nurse anaesthetist, nurse anaesthetist student and ED nurse 1 stand close to the anaesthetist. The excerpt begins with the anaesthetist's question to the radiographers: 'X haven't you taken the chest X-ray yet?' (MC 186), distributing responsibility for progress to the radiographers. The anaesthetist's next MC is framed as a question and directed to physician 1, reflecting his understanding of the situation while specifying his opinion of necessary task priority: 'Shall we take it now before we intubate him?' (192). Physician 1 decides: 'Yes, we'll do that. We'll take a chest X-ray.' (MC 193), resulting in the radiographer preparing to take a chest X-ray while the anaesthetist prepares for intubation. The anaesthetist removes the supraglottic airway device and asks about the patient's name when the X-ray is about to be taken. He then distributes the task to ED nurse 1 with an MC: 'Can you find a suction device for me?' (216). ED nurse 1 confirms and goes to fetch the necessary equipment. The anaesthetist tries to get contact with the patient after the X-ray and then addresses physician 1 with an ONC conflating into an MC: 'No contact NAME ((physician1)) I think we'll intubate.' (223). This utterance triggers action and distributes tasks and responsibility, physician 1 turns towards the anaesthetist while nodding, the nurse anaesthetist asks for confirmation and begins to prepare for the intubation, and ED nurse 1 provides an ONC on the patient's low oxygen saturation repeated by ED nurse 2, who is logging the events. The anaesthetist presents consecutive MC: 'Must have suction now!' (228), 'I need it now! (8) Can you watch out for his arm.' (230), 'Suction in the mouth.' (234), 'Suxamethonium and fentanyl.' (237) and "XX turn up-" (243) triggering action, distributing tasks and responsibility and indicating a critical situation.

## DISCUSSION

We observed and videotaped 10 real-life medical emergency teams admitting critically ill patients to the hospital to expand knowledge on the talk–work relationship in emergencies. We used activity type analysis to identify patterns related to the occasioning and functioning of ONC, MC and OFC, and their influence on team decision-making processes.

A discourse analytical perspective on team talk in medical emergencies uncovered the dynamics and complexity of interdisciplinary teamwork, and included simultaneous talk, parallel activities, distribution of tasks and responsibility, and negotiation of meaning. Securing mutual understanding and coordinating activities are both dependent on effective communication skills and are highlighted in emergencies to avoid errors.[23] Sharing mutual understanding is crucial for patient safety and gives team members the ability to predict developments in a situation and support team decisions.[27 41] A structure of adjustments in team decision-making processes is an important coordination mechanism that can facilitate progression towards team goals.[27] This study illuminates the ways in which team members negotiate meaning to use collective expertise, creating common grounds for making good decisions. Every utterance is anchored in an understanding of the situation. Negotiating meaning means to acknowledge and challenge understanding within the team.[50] Our analysis clarified the role of OFC to communicate expertise in which the speaker takes on a pedagogical role to seek mutual understanding within the team of experts and create a common basis for decisions. OFC also challenges the existing grounds for making decisions by demanding more evidence, putting decisions temporarily on hold to build mutual understanding and extend the basis for decisions. This mirrors a dilemma found in safe teamworking in non-algorithm-driven activities, specifically sacrificing time to create common grounds for good decision-making. Future studies should focus on how emergency teams communicate when time is a limiting factor and relate this to patient outcome. This study demonstrates how ONC and MC generate attention and indicate critical situations. Both bring progress to the decision-making processes and distribute responsibilities and tasks. Our analysis show examples of the ways in which team members manoeuvre safely, creating mutual understanding and accelerating the decision-making process by using ONC conflating into MC. MC implies activity-type-specific messages with implicit meaning, already negotiated within the community of practice and thus assumed to be understood within the specific context. 'I think we have to intubate' is a good example of this, as the nurse anaesthetist shows his correct interpretation by immediately providing medication and equipment for oral intubation. MC has similarities to what the anthropologist Gumperz refers to as 'contextualisation cues,' statements signalling contextual presumptions of what will happen next.[52] When discussion time is limited, using MC may appear to be time saving. However, building a mutual communicative practice and negotiating interpretations of implicit meaning may be difficult in interdisciplinary ad hoc emergency teams, and using MC could lead to misunderstandings or time-consuming explanations. There is a need for further investigations of whether team training could improve mutual communicative practice to avoid misunderstandings when time is a limiting factor.

This study illuminates the dynamics, complexity and 'potential risks' connected to naturally occurring team communication in non-algorithm-driven medical activities. The analysis uncovers the ways that modes of talk function to negotiate meaning in team decision-making processes and to distribute tasks and responsibilities within the team. We must increase our scientific focus on the ways that modes of talk trigger safe team practice and integrate this into team training to improve communication skills in ad hoc emergency teams.

## Strengths and limitations

Video recording live hospital admissions in the ED was challenging due to low accessibility, the risk of disturbing ongoing life-saving activities and the implications of observing patients in vulnerable situations. Data collection was planned comprehensively and the study was carefully discussed with ethical authorities. Much research on emergency teamwork has been performed in standardised simulation scenarios. The most advanced simulators enable highly realistic emergency scenarios, but cannot replace all the complexity present in real life. Collecting real-life data is thus a strength, ensuring adequate samples for analysis. Analysing the talk–work relationship in emergency settings also demands cultural insight into the communicative activity type. Norwegian culture is characterised by informality and decentralised power, including a dislike of control.[53] Although both culture and body language are undeniably significant issues most likely influencing the talk–work relationship,[54 55] they were not addressed in this study.

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# Online supplementary, paper 4

# Appendix 1, Excerpt A

**Abbreviations**: Phys1-3: Physicians from internal medicine department, EDphys-1-2: Physicians working in the emergency department, EDnurse1-3: Nurses working in the emergency department, AN: Anaesthetist, NurseAN: Nurse anaesthetist.

**Transcript key**: X: word not audible, XX: words not audible, [words]$^2$: overlapping speech (the numbers indicate the order of the nearby overlap), –: unfinished words or sentences, (.): micropause, (3): seconds pause, @: laughter.

**Situation:** Patient is < 40 years old. Indication for hospital admission: cardiac arrest. Cardiopulmonary resuscitation (CPR) was performed and return of spontaneous circulation (ROSC) occurred prior to hospital transport. The patient was unconscious and breathing inadequately at ED arrival. Team-members are separated in two "working-groups" during this phase of work; ED nurse 1, nurse anaesthetist, ED physician 1, and the anaesthetist are all involved in patient related practical tasks (ECG, suctioning, establishing an arterial line and sedation), while ED physician 1, physicians 1, 2, and 3 from internal medicine, and ED nurse 2 are standing next to the logging-desk. Physician 3 is standing in a small distance from the latter group answering his telephone.

**Part 1, before the anaesthetist's involvement in the CT decision.**

| **Utterance number** | **Speaker** | **Utterance** | **Speakers actions** | **Other actions** |
|---|---|---|---|---|
| 276 | Phys3 | Yes. He is going to have a head CT-scan down here now. Is he? | Stands next to Phys1 and looks at Phys2. Holds phone to ear. | |
| 277 | EDphys1 | Yes. | Standing outside the video frame | Phys3 and EDphys2 looks in direction of EDphys1. Phys2 shakes her head. |
| 278 | Phys2 | Is he? | Shakes head. Turns towards EDphys1. | |
| 279 | EDphys1 | Don't you think so? | | |
| 280 | Phys2 | Why? (1) [Get him up to the ICU. Get him up to the ICU.]$^4$ | Shakes head. Turns towards EDphys1. | Phys1 turns towards EDphys1 and nods. |

| | | | | |
|---|---|---|---|---|
| 281 | Phys3 | [No, he doesn't have any X indication XX][4] | Talks on the telephone, turns and walks away from the bed. | |
| 282 | EDphys1 | Well- | | Phys1's eyes follow the conversation between EDphys1 and Phys2. |
| 283 | Phys2 | Or-? Don't you think XX? | Walks backward towards EDphys1. Stands next to EDphys1. | |
| 284 | EDphys1 | Are we- Are we [100 % sure that][5] it is the heart? | | |
| 285 | NurseAN | [X suction X X.][5] | Works with the patient's endotracheal tube. Moves to the patient-monitor and fetches the suction device | |
| 286 | Phys2 | Jaah 100 (.) [but ][6] | Looks at Phys1. | EDnurse1 looks at display on the ECG device |
| 287 | EDphys1 | [It][6] isn't hypoxia - | Standing outside the video frame | Phys1 and Phys2 are standing together with EDphys1. |

| | | | | |
|---|---|---|---|---|
| 288 | Phys2 | Yes, but you have this and this. I don't know myself, but anyway that XX CT [already.][7] | Standing at the edge of the image. Looks at EDphys1 and ((points)) twice at something lying on the logging desk | Phys1 looks at Phys2 and nods. |
| 289 | EDphys1 | [But we][7] we would [like to have a XX][8] | | NurseAN suctions secretion from the patient's mouth. AN is positioned close to the patients' right wrist - tries to insert an arterial line. |
| 290 | EDnurse1 is commenting on carrying out the ECG-test | | | |
| 291 | Phys2 | Not necessarily a clear suspicion of that. (1) [Not because we have any clear suspicion of what it is then, but-][9] | | |
| 292<br>293 | NurseAN informs AN about the patient's moving his arm and AN to decides to give the patient a sedative | | | |
| 294 | Phys2 | You can [investigate but I XX up to the ICU myself.][11] Do you want to get him to CT-scanning? | Looks at Phys3. | Phys1 looks at Phys2 while she is talking. Then turns toward Phys3. Phys3 nods his head. |
| 295 | NurseAN asks for confirmation on AN's ordination | | | |

| | | | | |
|---|---|---|---|---|
| 296 | Phys3 | No. [I don't want][12] to interfere in that decision at all. | Looks at Phys2. | |
| 297 | AN | [XX.][12] | Looks at NurseAN. | |
| | | | | |
| **Part 2, after the anaesthetist's involvement in the CT-decision.** | | | | |
| 298 | EDphys1 | OK. Is it an indication for inducing X hypothermia [then to][13] to do a CT of the brain? | | |
| 299 | Phys2 | [No.][13] | | |
| 300 | Phys3 | [No.][13] | | |
| 301 | AN | No. | Straightens back, lets go of the patient's left hand, turns and walks towards Phys1, EDphys1, Phys2 and Phys3. | Phys2 outside the video-frame. Phys1, and Phys2 turn towards AN. Phys1is nods. |
| 302 | Phys2 | No (.) no. I - | | |
| 303 | AN | It's more out of- If there's doubt about the diagnosis [X][14] | Moves towards EDphys1 and Phys3. | |
| 304 | NurseAN | [It is bleeding][14] in the mouth here. | Suctions secretion from the patient's mouth. | |
| 305 | Phys2 | Sedated. Get him up to the ICU. | Looks at AN. | Phys1 and Phys3 look alternately at AN and Phys2. |
| 306 | AN | Yes, but X XX. | Looks at Phys2. | |

| | | | | |
|---|---|---|---|---|
| 307 | Phys1 | X[X][15] | Stands facing EDphys1. | Phys3 stands facing EDphys1. |
| 308 | Phys2 | [Yes.][15] True, that is more important. | Looks at AN. | Phys1 nods and turns towards the bed |
| 309 | NurseAN | Blood in the tube. | Suctions secretion from the patient's mouth. | |
| 310 | AN | But there's no rush to get him up to the ICU either. | Looks at Phys2. | EDphys2 looks at NurseAN. EDnurse1 is working with the ECG. The other team members are standing at the foot of the bed |
| 311 | Phys2 | What? | | |
| 312 | AN | There's no rush to get him [up to the ICU either][16] | Looks at Phys2. | Phys3 leans forward towards AN while AN is speaking |
| 313 | EDnurse 1 | [Out of paper.][16] | Looks at ECG-machine. | |
| 314 | Phys2 | [No.][16] It's just- But is he awake X or isn't he. We're going to get him into hypothermia after all just get him up to the ICU. (2) If [you want to get him to CT then-][17] | Looks at AN, Phys1 and Phys3. | AN is looks at Phys2 and nods while she is talking. |
| 315 | NurseAN | Did anyone hear that? [Is there anyone who heard][17] [that there's blood in the tube?][18] | Looks at AN. | |

| | | | | |
|---|---|---|---|---|
| 316 | AN | [No but whether we should do a CT scan or not][18] that's one thing. But there is no rush to get [X][19] | Looks at Phys2. | |
| 317 | EDphys2 | [Blood in the tube.][19] | Looks at EDphys1. | |
| 318 | Phys2 | [No, it's not][19] like you have to sprint up to the ICU [but XX][20] is a CT scan necessary? | Takes a step towards AN and lifts up both hands as she speaks | EDnurse1 loads the ECG machine with paper |
| 319 | EDphys1 | [What?][20] | | |
| 320 | EDphys2 | [Blood in the tube.][20] | Looks at EDphys1 and points back towards the patient with his thumb | AN walks up to NurseAN |
| 321 | EDphys1 | [Blood in the tube.][20] | | |
| 322 | NurseAN | [Look NAME (AN)][21] | Looks at AN and continues suctioning | |
| 323 | Phys3 | [What a CT can tell us][21] is whether there are major signs of anoxic brain injury. And maybe whether there's an additional [component such as when -][22] | Alternates between looking at Phys2 and at the patient. | |
| 324 | Phys1 | [Blood gas. Has that been taken][22] then? | Looks at EDphys2. | |
| 325 | EDphys2 | No. | | |
| 326 | Phys3 | [XX][23] | Looks at EDphys2 and then turns toward Phys1. | |
| 327 | Phys2 | XX blood gas [X.][23] | Shakes head slightly. | |

| | | | | |
|---|---|---|---|---|
| 328 | Phys1 | It would have been helpful to have a blood gas- | | |
| 329 | EDnurse 1 | [He][23] is reacting a bit with his (.) hand here you see. | | |
| 330 | EDphys2 | Yes [X. Could you get][24] [XX?][25] | Looks at Phys1. Points towards the emergency table. | Phys1 goes to the emergency table and gets equipment for blood gas testing which he gives to EDphys2. |
| 331 | AN | [Isn't there any Propofol left?][24] (2) [Give XX at least.][25] (1) Have you got any Propofol then? Don't [we have anything?][26](.) [Have you got Propofol? X][27] | Stands beside the anaesthesia table and looks at NurseAN. | |
| 332 | NurseAN | [What?][26] (2) [It's over there][27] [Over there on the table][28] | Points towards the emergency table. | EDnurse1 takes out the Propofol syringe and hands it to NurseAN who passes it on to AN |
| 333 | Phys3 | [X looks as though it's one of those-][24] [One of those two.][25] And if there's no (2) [risk of XX][26] [that he's not cooled down so quickly-][27] | Stands together with Phys2 at the left side of the bed. | |
| 334 | Phys2 | [Yes but-][28] (2) XX perhaps but that's exactly what is- Because he's not sedated at all (.) is he? | | Phys3's telephone rings. |

| | | | | |
|---|---|---|---|---|
| 335 | AN | [XX][29] | Administers Propofol to the patient | |
| 336 | EDphys1 | [No. Yes][29] yes that is he has of course- was of course sedated during intubation then but [X-][30] | | |
| 337 | Phys2 | [Yes yes][30] but nothing more than that? | | |
| 338 | NurseAN | Oh yes. [XX][31] [XX][32] | Looks downward at the suction catheter | |
| 339 | Phys3 | [Hello.][31] | Answers the telephone. | |
| 340 | EDphys1 | [He is moving his extremities after all][31] | | |
| 341 | Phys2 | [It doesn't matter][32] because it doesn't mean anything | | |
| 342 | Phys3 | The answer is no. @ Thank you. | Answers the telephone. Stands next to Phys2. | |
| 343 | Phys2 | But (.) XX make a decision. If we're going to get him to CT then we get him to CT. Not [XX][33] | Shakes head. Looks out into the air. | |
| 344 | EDphys1 | [Then we'll get][33] that across the corridor here and then we'll go up. | | |
| 345 | Phys3 | What? | Looks at EDphys1. | |
| 346 | EDphys1 | The alternative is to take the CT now here and then we'll take him up to the ICU. | | AN is placing a gastrointestinal tube |

| | | | | |
|---|---|---|---|---|
| 347 | Phys3 | My recommendation is CT now if we can get it fast. | | |
| 348 | EDnurse 3 | Shall I go and check with CT now? | Standing outside the video frame. | |
| 349 | EDphys1 | Yes. | | |

# Appendix 2, Excerpt B

**Abbreviations**: Phys1-2: Physicians from internal medicine department (Phys1 is an intern), EDnurse1-2: Nurses working in the emergency department, AN: Anaesthetist, NurseAN: Nurse anaesthetist.

**Transcript key:** X: word not audible, XX: words not audible, [words][2]: overlapping speech (the numbers indicate the order of the nearby overlap), –: unfinished words or sentences, (.): micropause, (3): seconds pause, (()): authors interpretation.

**Situation:** Patient is > 80 years old, living at home. Indication for hospital admission: inguinal pain and syncope. The patient was nodding adequately when spoken to (yes/no) and had possible face-drooping at ED admission. An oropharyngeal airway is established, and iv-fluid is ongoing. During this phase of work, the nurse anaesthetist is standing at the head of the bed providing the patient with oxygen, the anaesthetist is palpating the patient's inguinal pulse, physician 1 and ED nurse 1 are standing beside the bed, and ED nurse 2 is standing by the logging-desk while physician 2 is outside the room checking CT-lab availability.

| Utterance number | Speaker | Utterance | Speakers action | Other action |
|---|---|---|---|---|
| 288 | AN | [XX][4] we are in the process of ((collapsing)) X | Stands by the bed. | |
| 289 | Phys1 | What did you say? | | |
| 290 | AN | We are in the process of X | | |
| 291 | Phys1 | Yes. | Goes to stand at the head of the bed, then turns and leaves the room | |
| 292 | NurseAN | Take a deep breath. | Looking down at the patient's chest | EDnurse2 goes to the foot of the bed. |
| 293 | AN | I haven't- I haven't fetched the defibrillator. | | |
| 294 | EDnurse 1 | I can get it. Then I'll fetch the automatic chest compression machine at the same time. | Looks at AN and then leaves the room. | |
| 295 | NurseAN | I need a bag-valve-mask. | Low voice. Looks around the room | |
| 296 | AN | Can you find a bag-valve-mask? | Looks at EDnurse2. | |

| | | | | |
|---|---|---|---|---|
| 297 | EDnurse 2 | Yes. | Goes to the wall where the bag-valve-mask is suspended | |
| 298 | AN | I'm losing the radial, no the carotid pulse (1) I'm just going to X. Start X. | Palpates the patient's neck. Turns toward the door as she talks (loudly). Then goes to the doorway | EDnurse2 is handing the bag-valve-mask to NurseAN. |
| 299 | NurseAN | Will you [connect to X?][1] | NurseAN receives the bag-mask ventilator from EDnurse2 and gives back the oxygen tube | EDnurse2 looks for the flowmeter |
| 300 | AN | [I'm losing the carotid pulse now.][1] | Standing in the doorway. | |
| 301 | Phys2 | What? | Comes in to the room. | EDnurse1 (with defibrillator), Phys2 and Phys1 enter the room |
| 302 | AN | I', losing the carotid pulse. | | |
| 303 | Phys1 | XX. | | |
| 304 | EDnurse 2 | Can you take this? | Gives the oxygen tube to AN, who connects it | |
| 305 | Phys2 | But then we must. He's living at home and [active and][2] must start CPR (3) and intubate him. | Leaning over the bed. | EDnurse1 connects the defibrillator. |
| 306 | Phys1 | [Yes, he is][2] Yes. | | |
| 307 | AN | Yes. | Looks at Phys2. | |
| 308 | NurseAN | Then I'll intubate him. | | |

# Appendix 3, Excerpt C

**Abbreviations**: Phys1-2: Physicians from internal medicine department, EDphys: Physician working in the emergency department, EDnurse1-3: Nurses working in the emergency department, AN: Anaesthetist, NurseAN: Nurse anaesthetist. Radiographer.

**Transcript key:** X: word not audible, XX: words not audible, [words][2]: overlapping speech (the numbers indicate the order of the nearby overlap), –: unfinished words or sentences, (.): micropause, (3): seconds pause.

**Situation:** Patient is > 70 years old, living at home. Indication for hospital admission: syncope. The patient was awake and adequate with no pain at arrival. The anaesthetist is performing an ultrasound and preparing to place a central venous line in the patient's neck area. ED nurse 1 is preparing to insert a urine catheter, and the ED physician is standing beside the bed. The nurse anaesthetist is securing the patient's arterial cannula, and physicians 1 and 2 are standing beside ED nurse 2 at the logging desk. The bed is not functioning properly and cannot be tilted head down for the central venous line procedure, and a chest X-ray has just been taken.

| Utterance number | Speaker | Utterance | Speakers action | Other action |
|---|---|---|---|---|
| 311 | AN | [Her venous volume][1] is good. The question is if it's simply turned off- | Looks at the ultrasound screen to be used during insertion of the central venous line. | EDphys leans forward to look at the same ultrasound screen as AN. |
| 312 | EDphys | Is it cardiogenic shock? | Looks at AN. | |
| 313 | AN | Well-. But, I mean. If you take- If you look at the vein here. Can you see it? | | |
| 314 | EDphys | Yes, I see. It's enor[mous][2]. | Looks briefly at the patient. | |
| 315 | AN | [Yes.][2] Yes. | | |
| 316 | EDphys | She is actually lying well X as well. | | |
| 317 | AN | That might [indicate that she has-][3] | | |

| | | | | |
|---|---|---|---|---|
| 318 | EDphys | [We could look at the][3] [vena cava also.][4] | | |
| 319 | Radio-grapher | [Thorax is fine at least][4] or at least technically speaking. Must look at the image yourself. Take this away now. Anyone who could help to lift a bit? (3) [Thank you][5] | Looks towards EDphys. Removes the X-ray cartridge beneath the patient's back. | Phys1 approaches and lifts the patient on the opposite side of the radiographer. AN looks at the X-ray image on the screen at the back of the room. |
| 320 | AN | She does have a [wi-][5-.] [She has- ][6](2) [I think ehm-][7] Come and have a look here (3). What's his name again-? | Switches off the alarm on the monitor. Looks at EDphys. Beckons with her hand, "here" | EDphys stands with his back to AN at the foot of the bed and works at ultrasound machine 2. |
| 321 | EDphys | [Would you fetch more gel?][6] | Looks at EDnurse2, who is standing at the logging desk. Then turns towards AN | |
| 322 | X | I don't know where [XX][7] | | |
| 323 | X | The small heating cabinet innermost over there. | | |
| 324 | NurseAN | NAME (patient)? Are you awake? | Secures the patient's arterial cannula and looks briefly at the patient | |
| 325 | EDphys | XX | Looks at AN and brings ultrasound machine 2 and rolls it towards the bed | |
| 326 | AN | Come and look at the X-ray here. The mediastinum is widened. | Returns to the screen with the X-ray image | EDphys walks around the bed on AN's right-hand side. Together with Phys1 and Phys2 |

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| 327 | Patient | Ouch. | | |
| 328 | NurseAN | Was it your hand that was hurting? | | AN points at the X-ray screen |
| 329 | Patient | [Yes XX][1] | | |
| 330 | AN | [I don't know if there's something ongoing][1] X just- | Looks at EDphys pointing to the X-ray screen | |
| 331 | EDphys | Yes | Looks at the X-ray screen. | Phys1 and 3 look over EDphys's shoulder. AN walks to the patient monitor and pauses the alarm, then turns to EDphys again. |
| 332 | AN | Yes. Eeh that is, it is X. | Standing together with EDphys, Phys1 and Phys2. | |
| 333 | NurseAN | Are you going to take more here? | Taking off her lead apron Looks at the radiographer. | Radiographer is moving the X-ray scanner. |
| 334 | Radio-grapher | [Finished, yes][2] | Pushes the X-ray scanner back into place | EDphys shrugs his shoulders slightly when he turns to walk towards Phys1 and Phys2 |
| 335 | AN | [Now her blood pressure is falling.][2] Do we have some pressor-? | Looks at the patient-monitor. | EDnurse2 is standing with ultrasound -gel in his hand. |
| 336 | NurseAN | What would you like? | Takes off the lead apron and walks around the bed to put it away | |
| 337 | AN | Eeeh. What's the pulse rate then? | Unpacks the kit for central venous line placement. | |
| 338 | Phys1 | [XX][3] | Walks behind EDphys, turning his | |

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| | | | head back to look at Phys2 | |
| 339 | NurseAN | I’ve got phenylephrine, ephedrine and [epinephrine][3] | Walks back around the bed and to the anaesthesia table next to AN at the head of the bed.. | EDphys stands at the foot of the bed next to the ultrasound machine 2. |
| 340 | AN | [Give her][3] [ephedrine now][4] | Looks at the patient monitor. Continues unpacking equipment as she speaks. | |
| 341 | Phys2 | [Could it mean anything other than XX?][4] | Walks up to EDphys, behind Phys1. | |
| 342 | NurseAN | X | stands next to the anaesthesia table next to AN. | |
| 343 | EDphys | Then I will- (2) Chest X-ray shows widened mediastinum. So, we must suspect there's an aortic dissection causing her low blood pressure. | Stands at the foot of the bed. Looks first at EDnurse2, who is standing behind him, then turns towards the room. Talking aloud. | |
| 344-363 | AN asks for a gauze mask. EDphys seeks supplementary information from the patient and then prepares for the ultrasound examination of vena cava. EDnurse1 informs the patient about inserting the urine catheter. | | | |
| 364 | AN | We are working a bit on (.)-. A bit from different angles here now. (4) Eeh. [Look at the liver][6] then eeh vena cava. | Putts on the gauze mask. | EDphys examines the thorax and abdomen using ultrasound. Phys1 leaves the video frame, walking to the left. |
| 365 | X | [XX][6] | | Phys2 stands next to Phys1 at the outer edge of the video frame (left) |
| 366 | EDphys | I’ll look at that too. | | |

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| 367 | AN | Yes. (1) I'm going to insert a central venous line, so we could start with norepinephrine if necessary while- because if it gets XX then it is after all- (2) [But then-][7] | | EDnurse1 is preparing for placing a urinary catheter. |
| 368 | NurseAN | [Do you want ephedrine?][7] | Turns towards AN. | |
| 369 | AN | Yes. But someone mix norepinephrine in like a eeh constant infusion pump? | Does not raise her eyes from what she is doing while she is speaking | NurseAN walks around the bed with medication |
| 370 | EDnurse 2 | Are you inserting one with a temperature sensor? | Standing at the logging desk. | EDnurse1 turns towards EDnurse2. |
| 371 | EDnurse 1 | No sensor on the one I have here now, no. [Did you][8] want one? | Turns toward EDnurse2, who is standing at the logging desk. | |
| 372 | EDnurse 2 | [Not?][8] XX | | |
| 373 | EDnurse 1 | Would you go and get one then? | | |
| 374 | EDnurse 2 | Yes | | |
| 375 | AN | Let's see- | | |
| 376 | EDphys | Doesn't it look widened here then? | Points at his ultrasound screen. | Phys1 and Phys2 stand next to EDphys and look at the ultrasound screen. Phys1 and Phys2 shake their heads |
| 377 | NurseAN | 5 milligram ephedrine given | Adjusts the roller clamp on the IV administration set for the infusion bag connected to the intravenous catheter on the patient's left hand | EDnurse3 enters. |

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| 378 | AN | Then we must keep an eye on XX. Let's see- Take a deep [breath][1] | Looks to the patient monitor and touches the screen | |
| 379-393 | AN asks NurseAN to help her to put on a sterile gown. EDphys says he can see vena cava on the ultrasound screen. | | | |
| 394 | EDphys | The vena cava inferior is hardly moving. [So it][1] is obstructive or cardiogenic shock. | Looks at AN | |
| 395 | AN | [XX][1](3) Yes.(1) But is it-. Should a pericardiocentesis be done, or is it-? (2) Let's see- | Waves her hands and turns toward NurseAN. | NurseAN stands at the cabinet at the back of the room EDphys looks at the ultrasound screen |
| 396 | EDnurse 3 | XX | Brings new urinary catheter | |
| 397 | EDnurse 1 | Yes. Could you help me with this [XX][2] NAME (EDnurse3) | Looks at EDnurse3 | EDnurse3 helps the patient bending her knees. |
| 398 | AN | [Sterile glows?][2] | | |
| 399 | EDnurse 3 | XX. Someone is fetching them. | Looks at EDnurse3, then EDnurse1. | NurseAN walks towards the foot of the bed |
| 400 | AN | Someone's fetching them, OK. | | EDnurse2 brings sterile gloves, which he gives to NurseAN |
| 401 | NurseAN | Bring XX with X and two of X | Takes the package of sterile gloves from EDnurse2 and goes to AN | |
| 402 | AN | Remind me to phone X. (2) Has a thoracic surgeon been called? Or a thoracic anaesthetist- to come and assess- (3) In terms of status. | Opens the glove package | EDnurse1 and EDnurse3 insert the urinary catheter |
| 403 | EDphys | Yes. | | |

## Appendix 4, Excerpt D

**Abbreviations**: Phys1-2: Physicians from internal medicine department, PhysTh2: Physician from thoracic surgical department, EDnurse1-3: Nurses working in the emergency department, AN: Anaesthetist, NurseAN: Nurse anaesthetist, NurseAN student: Nurse anaesthetist student, Radiographers 1-2.

**Transcript key:** X: word not audible, XX: words not audible, [words]$^2$: overlapping speech (the numbers indicate the order of the nearby overlap), –: unfinished words or sentences, (.): micropause, (3): seconds pause.

**Situation:** Patient is > 70 years old, living at home. Indication for hospital admission: cardiac arrest. CPR and ROSC prior to hospital transport. The patient was unconscious but breathing spontaneously at ED arrival and the airway was secured with a supraglottic airway device. During this phase of work, physician 1 is standing beside ED nurse 2 at the logging-desk and two physicians from the thoracic surgical department are called and stand a small distance from the bed. Two radiographers are standing in the back of the room. The anaesthetist is standing near the patient's head and the nurse anaesthetist, nurse anaesthetist student, and ED nurse 1 stand close to the anaesthetist.

| Utterance number | Speaker | Utterance | Speakers action | Other action |
|---|---|---|---|---|
| 186 | AN | X Haven't you taken the chest X-ray yet? | Looks at the radiographers standing behind the head end of the bed. | |
| 187 | Radio-grapher1 | No. We haven't taken it yet. Shall [we-]$^1$ | Looks at AN. | |
| 188 | AN | [NAME (Phys1)]$^1$. (1) [Should we take a chest X-ray?]$^2$ | Turns towards Phys1. | Phys1 standing at the logging desk with his back to the bed. |
| 189 | Phys1 | Yes. | Turns towards AN and walks towards the bed while he answers. | |

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| 190 | Radio-grapher1 | [Should he have any X-rays?][2] | | |
| 191 | Phys1 | Yes. | Looks at AN. | |
| 192 | AN | Shall we take it now before we intubate him? | Looks at Phys1. | |
| 193 | Phys1 | Yes, we'll do that. We'll take a chest X-ray. | Looks at AN. | Radiographers start getting ready. |
| 194 | AN | X cuff-syringe have you seen it? [Isn't it somewhere here?][3] | Looks at EDnurse1 then turns towards the monitor. | |
| 195 | EDnurse1 | [A cuff syringe, OK.][3] (1) [Can just take one like this then, can't you? (.) What XXX?][4] | Gets a syringe from the emergency table and goes towards AN | Radiographer 2 moves the X-ray equipment suspended from the ceiling. Radiographer 1 pushes the patient's bed slightly. |
| 196-202 | Radiographer1 and 2 speaks about preparations; how to position the X-ray unit and the patient. | | | |
| 203 | AN | Take out this [then XX][6] | Looks to NurseAN. | |
| 204 | Radio-grapher1 | [Help me to][6] move. Could you [help me a bit][7] on that side? | | |
| 205 | NurseAN | [What?][7] | Looks at AN. | |
| 206 | AN | We will [take that XX][8] | Stands by the head of the bed. | |
| 207 | Radio-grapher2 | [Yes. Will just see][8] how far down we need it. | Adjusts the position of the X-ray unit. | |
| 208 | NurseAN | Take out - | | |
| 209-212 | EDnurse2 asks for information for documentation. | | | |
| 213 | AN | What is this man's name? | Removes the patient's I-gel airway | |
| 214 | NurseAN student | His name is NAME (patient). | Looks at AN. | NurseAN is looks at NurseAN student. |

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| 215 | NurseAN | NAME (patient) NAME (patient) | Bends over the patient. Speaks loudly | |
| 216 | AN | X suction. Can you find a suction device for me? | Looks at EDnurse1. | |
| 217 | EDnurse1 | Yes. | Goes to find suction device. | |
| 218 | Radio-grapher2 | Then it's ready for chest X-ray. | Moves away from the patient's bed. | Phys1 moves away from the bed |
| 219 | AN | Then you need to hurry up. | Leans over the patient's head. | |
| 220 | Radio-grapher1 | You must move your head away or you'll be included in the picture. | To AN | |
| 221 | Radio-grapher2 | X-ray taken. | Goes back to the bed. | Phys1 goes up to the bed. |
| 222 | EDnurse2 | X-ray taken. | | |
| 223 | AN | NAME (patient) (6) ehh. No contact NAME (Phys1) I think we'll intubate. | Looks at Phys1, who is moving towards the X-ray image behind the patient's bed. | Phys1 turns and looks at AN nodding. NurseAN gets a bag-valve-mask from the wall behind the head end of the bed. The patient monitor alarm starts. |
| 224 | NurseAN | Intubate? [Do you want that?][1] | Puts the bag-valve-mask beside the patient's shoulder and walks over to the anaesthesia table. | |
| 225 | AN | [The question is if I should-][1] | | |
| 226 | EDnurse1 | 85 in saturation. | | |
| 227 | EDnurse2 | 85 in saturation. | | |

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| 228 | AN | Must have suction now! | Turns toward EDnurse1. | EDnurse1 is setting up the suction unit that is standing on the floor. |
| 229 | EDnurse1 | Yes, but I've got no adaptor. | Connects the suction unit standing on the floor. | AN walks towards the patient monitor but turns back. |
| 230 | AN | I need it now! (8) [can you watch out for his arm][2] | Moves from the patient's side to behind the head end of the bed. Has to climb between cables hanging between the patient monitor and the patient. | EDnurse1 is standing next to AN. Suctions secretion from the patient's mouth with a suction catheter. |
| 231 | Phys1 | [I think we must have a CT scan.][2] | Stands at the X-ray screen looking at Radiographer2. | PhysTh2 walks towards Phys1. |
| 232 | Radio-grapher 2 | XX requisition. | Standing next to Phys1. | |
| 233 | EDnurse1 | Yes. | | |
| 234 | AN | Suction in the mouth. | Looks down at the patient. | |
| 235 | Phys1 | It looks as- a bit like- | Looks at the screen showing the X-ray images | PhysTh2 stands next to Phys1 and look at the screen showing X-ray images. |
| 236 | PhysTh2 | XX it looks [as though there's XX][3] | Looks at Phys1. | |
| 237 | AN | [Suxamethonium and fentanyl.][3] | Turns towards NurseAN when he is talking about medications. | |
| 238 | Phys1 | [Yes, mhm][3] It might well be that too. | | |

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| 239 | NurseAN | NAME (NurseAN student) Insert a stylet in the tube here. | Looks at the NurseAN student who is standing by the anaesthesia machine. | |
| 240 | NurseAN student | Yes. A stylet? | | |
| 241 | NurseAN | A stylet. | | |
| 242 | Phys2 | Is there something I should requisition? | Walks towards Phys1. | |
| 243 | AN | XX [turn up-][4] | Holds the bag-valve-mask to his ear then points towards the oxygen flowmeter. | EDnurse1 turns up the oxygen flowmeter. |
| 244 | Phys1 | [Requisition a CT][4] chest (2) and a [CT lung and head.][5] | Facing Phys2. | |