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What Happens After Calling the Ambulance: Information, Communication, and Acceptance Issues in a Telemedical Workflow

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Abstract

In this paper we describe the information, communication, and acceptance issues in a telemedical workflow, taking a pre-hospital emergency medical service (EMS) as an example. EMS workflows are extremely time-critical, impose a high responsibility, and crucially depend on a close, well-trained cooperation between EMS personnel. Though increasingly information and communication technologies (ICT) are used to support this sensitive and life-critical process, still, shortcomings in the emergency workflow are observed, especially in countries as Germany in which EMS are not fully standardized. We empirically examined organizational, communication and information gaps within EMS workflows. Together with emergency staff we schematically modeled a standard workflow circuit and visualized information, communication, and organizational issues including ICT usage. Second, in semi-standardized interviews with emergency physicians, we identified critical communication and information gaps within this workflow. Based on this we derive first recommendations regarding an optimization of the EMS workflow.

1. Introduction

Due to the demographic change, the number of ageing people who have to be provided with health care services will increase dramatically in the upcoming years. This especially applies to emergency cases, which are observed to increase from year to year [1]. According to recent statistics, in Germany, for example, 10.2 millions rescues per year have to be accomplished, 4.7 millions of these are life-critical emergency missions [1]. In addition to the raised requirements of emergency patient care, the supply chain and the availability of medical professionals continuously decline. This poses a major problem especially in rural areas, in which the density of medical care is underdeveloped [2] [3] [4].

The lack of EMS physicians leads to an alarming decrease in quality management and to deficiencies in medical care as well. Alongside, due to economic bottlenecks, the number of EMS-physician stations will be reduced, and the time of arrival of an emergency patient in the hospital is extended [1].

Thus, alternative concepts have to be developed to bridge the emerging supply gap. There is an urgent need for innovative strategies to face the current and future problems in EMS, especially in countries like Germany in which EMS workflows are not fully standardized. Moreover, only a small proportion of emergency medical interventions actually require the manual skills of an EMS-physician [1]. In the majority of emergency situations, in which patients need medical help and a rapid transfer to the hospital, the support of medical staff, such as paramedics, is sufficient and does not require a physician on-site. Accordingly, as reported by [5], the incidence of the sum of individual medical procedures that required an experienced EMS-physician on-site (e.g., intubation, resuscitation, anesthesia induction, etc.) was only 14.3% of all assignments. Thus, in many emergency cases, well-qualified paramedics are sufficient to medicate and care for the patient. The cross-national analysis shows that this is already practiced in other European countries, e.g., the UK or Netherlands [1] [5].
Though EMS physicians do not necessarily have an active handling part on-site, they might still be needed in critical cases as decision-making authority due to their greater medical expertise. Moreover, legal regulations prohibit the administration of medication. Paramedics need the instruction and the permission of a doctor to give a patient drugs. However, this does not require the physical presence in the emergency scene on-site, but could be accomplished by the usage of ICT and telemedical care concepts in the emergency workflow [6] [7].

2. EMS and Usage of ICT

One of the key factors for effective emergency management is designing and implementing ICT within the EMS workflow. ICT has the potential to

effectively support the coordination and cooperation between staff involved in the EMS workflow.

To date, there is an upcoming number of studies reporting on the usage of ICT in the emergency-rescue-chain. In the United States, telemedical consultations between physicians in the hospitals and paramedics on-site are widely used and mostly accomplished via radio. By the use of ICT, the quality of primary care and intra-hospital procedures could be optimized through faster and a more focused transfer of information [8] [9] [10]. As a reaction to recent crises, as 9/11, or the hurricane Katrina in the United States, medical informatics researchers started to develop ICT as corrective measures to be used in disaster situations [11] [12]. Another innovate approach [1] in Germany aims at the broad implementation of a telematic system in EMS. The central element of the system is a competence centre with an experienced emergency medical physician, a so-called "teledoctor". Assisted by advanced mobile data transmission, all vital parameters of a patient, as well as video and pictures of the scene, are transferred in real time to the competence centre. The teledoctor advises the emergency staff operating on scene (EMS-physician and/or the paramedics), providing medical knowledge as well as legal and organizational information. Also, the competence centre is responsible for contacting the hospital, data transfer, and the consultation with other institutions (e.g., family members, physicians, cardiologists, poisoning centers etc.). Thus, EMS personnel on-site can predominately focus their attention on the main task, the patients' care, without being distracted by the multifaceted demands of an emergency situation. Across studies, a major claim is a high quality of ICT data reliability, security and safety, when designing innovative interactive systems for emergency response in a major incident [13]. For example, the importance of high-quality audio in the noisy environment of hospitals' emergency departments had been stressed by [14].

Nowadays, it is widely accepted that ICT plays an increasingly important role in EMS and the workflow in hospital emergency departments. Though, to date, only few studies concentrate on communicative and organizational issues and the coordination and cooperation of the different persons involved in the rescue chain. In a very recent study [15], the coordination between a hospital emergency department and EMS team in the United States was examined, uncovering the enormous importance of social and communication aspects in the EMS workflow. Sociotechnical aspects, as introduced by [16] in the EMS-context are especially multifaceted and highly complex, accompanied by a high time pressure and responsibility. Authors [15] claim that the usage of ICT within the EMS process must be based on a thorough understanding of the workflow, and should face the potential areas of breakdown in the coordination between emergency personnel. In addition, the human factor and the interaction of communication and interaction of humans with technology is an extremely important success factor, which must be considered in technology-supported EMS settings [17] [18] [19]. Among other factors, the technical competence of EMS staff, but also their abilities and acceptance barriers towards technology usage should be carefully studied prior to implementing a technology in such a sensitive area [20] [21] [22] [23].

2.1. Logic of Empirical Procedure

The majority of studies concerning ICT usage in EMS context so far concentrated on the usage of technology as such. Few studies focused on organizational issues and the communicative needs within different emergency teams [15]. Yet, the focus of studies dealing with emergency cases is mainly patient-centered [24], while the perspective of emergency doctors has been widely neglected, even though he/she is the main actor taking the full responsibility for the treatment, organization of the whole operation, and the team coordination [25].

Thus, in this study, we emphasize focus on the emergency doctor's perspective, and the information and communicative needs in an emergency workflow. On this base we analyze potential barriers and breakdowns out of the perspective of emergency personnel, i.e. physicians and paramedics. We explore the influence of telemedicine technology introduced into an established workflow within the German EMS system and identify the perceived benefits of telemedical systems exemplarily represented by the teledoctor system.

Before integrating the teledoctor into the rescue system, the traditional emergency workflow has to be analyzed. When the ambulance is called two paramedics are sent on-site in an emergency vehicle. Depending on the severity of the incident, another vehicle is sent out to bring an additional paramedic and an emergency doctor. After the arrival of the paramedics, a teledoctor could give them advice until the emergency doctor appears or even support him.

First, the current concept has to be modeled out of an emergency doctor's view. Second, communicative and organizational deficiencies of the present system have to be investigated. Finally, the key requirements and demands for the successful launching of a telemedical service are to be identified.

3. Description of the Organizational Workflow

The course of events in an emergency situation usually starts with a person calling the ambulance

and talking to the staff in the primary control unit. They will forward some keywords describing the incident to the medical staff. Two paramedics will be sent to the incident site driving an ambulance car. Depending on the case a second car with the emergency physician and another paramedic is sent out. The telemedical system [3] we are exemplarily exploring includes a teledoctor who has access to further information as online databases, e.g., with detailed information on intoxication, or contact to the patient's general practitioner. The teledoctor can support the staff on-site in two difference scenarios:

Scenario 1 (Figure 1): the emergency physician is in contact with the teledoctor. With access to an extensive range of information and her/his own experience and knowledge the teledoctor can help the emergency physician on-site.

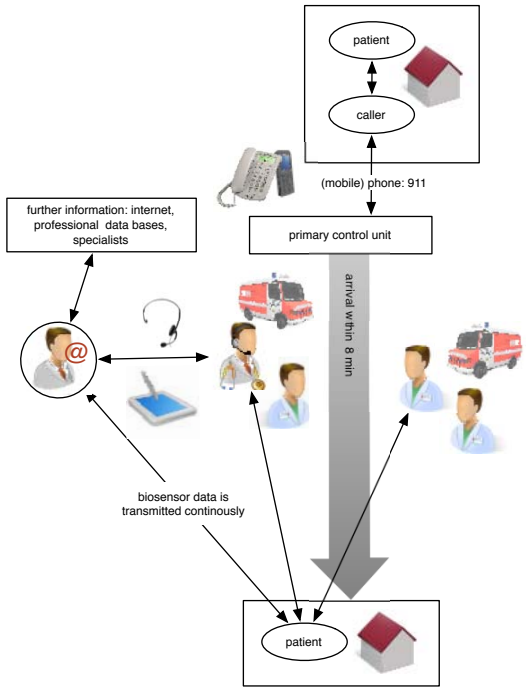

Figure 1. Emergency doctor on-site consults teledoctor.

Scenario 2 (Figure 2): one of the two paramedics on-site is in contact with the teledoctor. S/he can consult them and authorize actions that paramedics are legally just allowed to execute when being instructed by a physician.

In both scenarios information on the patient's vital signs are transmitted continuously and in real-time to the teledoctor, who can talk via headset with the communication partner on-site. The staff on-site can take static images of the patient or details of the site using the camera of a tablet PC. They can enter information about the patient, the incident, and performed medical treatments into a software application. The teledoctor can see this information as well and use it to make a diagnosis.

To reveal information and communication shortcomings between the different parties involved in the "emergency call–rescue–patient care" chain, we need a modeled visualization of the multiple parties, who need to communicate in order to communicate patient care.

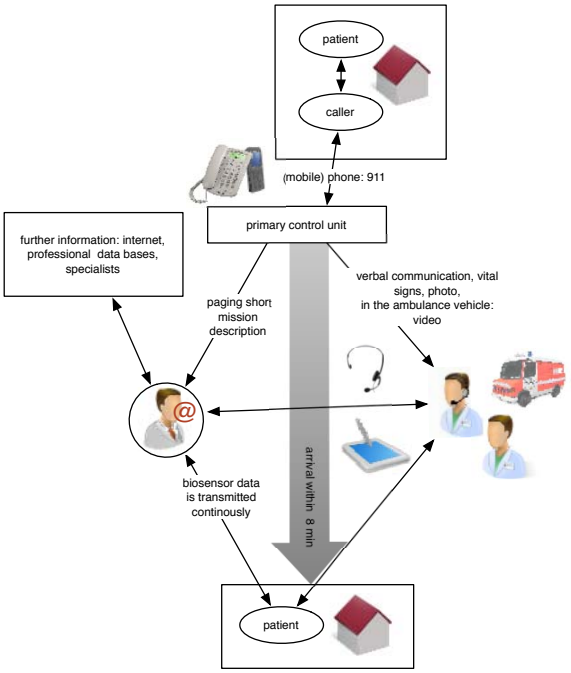

Figure 2. Teledoctor supports and authorizes paramedics on-site.

An emergency case is a situation primarily characterized by high risk and varying conditions: the involved actors, in particular the emergency doctor, paramedics, the patient himself and his relatives, differ from case to case. Also, the rescue operation varies in time, location, information, organization, communication, and finally in the patient's symptoms.

4. Analysis of Information Flow and Usage of Technology

In emergency situations, a lot of dynamic changes within the situation cause the need of information and communication flows. Thus, a flawless flow is crucial to the efficiency of the merging actions in an emergency situation. In the following we describe how we analyzed the model described earlier and discuss our findings.

4.1. Methodology

To get a deeper insight into argumentations, semi-standardized interviews with medical professionals were run. As participants, emergency doctors (n=10) volunteered, who worked as doctors and were on duty in several departments of hospitals (e.g.

intensive care unit, operating room etc). All queried physicians were taking shifts in the rescue service and therefore actually practicing emergency doctors. Partially, they have had experience with telemedical support (n=4). Interviews were recorded and transcribed afterwards. The collected data had been analyzed quantitatively regarding content.

4.2. Results

The respondents named as communicative and organizational tasks of an ED during a rescue operation: investigation of indispensable information, supervision of the rescue team, self-coordination, organization of single actions of the medical treatment in appropriate timeslots while following default schemes depending on the symptoms. Alongside, EDs have to take care of the patient, and family members. After analyzing the information flow in the current EMS, the integration of telemedical elements in the rescue chain is discussed in consideration of acceptance and organization issues.

4.2.1. Information Flow in the Current EMS

After getting the alarm signal, the emergency physician receives only sparse information about the incident as such. The information is mostly limited to logistic facts, and only few details about the patient's condition are given. In special cases, additional information is provided, for e.g. the age of the patient (pediatric emergency). Participants reported that it turns often out that the transmitted medical details were not only incomplete, but even false. Owing to the fact that most people can only interpret symptoms based on personal assumptions and are basically in an emotional state of emergency the real symptoms differ in most cases from the announced.

> „If it is correct what he [the caller] is telling on the phone, then yes [the information is helpful]. But mostly, it does not really occur what was announced in the alarm report. [...] Finally, if you open the door and the first person on-site is telling you something, then I know I get information. You can imagine the rough direction, but you can never know the situation [before your arrival]" (ED_3).

On-site, the ED has to deduce the patient's anamnesis by interviewing him (or relatives) in case the patient is unconscious or in a serious condition. However, the quality of this information varies: in many cases people are not able to give reliable information about the patient's medical history because of communicative misunderstandings.

> "The patient is in a state of emergency as a general rule. This means he is hard to handle. They are literally shocked [...] and answer questions not always truthfully. Not because of malevolence, because they are not getting it [the question]. I often recognize this: the arriving team does first anamnesis, second anamnesis is done by the arriving physician, implies a plus b. The anamnesis or the first talk with the doctor in the hospital includes a, and b and leads to [the new anamnesis] c. So, it is becoming more and more. When patients are feeling safe, getting treated, then they remember 'oh yes, I've had a heart attack before'. But when you have asked them before, they negated it clearly" (ED_8).

Usually, the patient's general practitioner documents medical history continuously. Emergency doctors wish quite often they could have access to these data to get a fast and precise overview. Presently, they rely mainly on the data given by the patient. In any case, the rescue team looks for medical documents, for e.g. medication lists, letters of hospitals or surgeries etc. in the patient's immediate proximity. When an old person is in need of medical aid, the (physical) absence of a living will aggravates the situation, since emergency doctors need to respect a person's last will (ER_1). Apart from gaining information from people and collecting available documents, the rescue team investigates the emergency location (external anamnesis). If an intoxication is assumed for instance, the rescue team investigates the location for drugs, other toxic substances etc. to collect more information.

The rescue team examines the patient and measures his vital data. The ascertained patient condition as well as the collected data serves as a basis of decision-making, diagnosis, and treatment. Due to the fact that EDs are specialists from all kinds of medical branches (mainly from anesthesiology, but also surgery, internal medicine), their specialized expertise varies. An experienced ED is able to deal with most types of emergency cases. But in case their medical knowhow is not sufficient, three major compensation strategies come into fore: (1) looking the issue up in a medical pocket book, (2) if possible, calling an expert of the required medical branch or a more experienced ED and asking for advice, (3) applying the "load-and-go"-strategy what means the patient is transported to the hospital immediately.

After or within the emergency treatment, ED has to check the most suitable hospital with capacity for the patient's further medical care. The ED gives the hospital relevant medical information in advance. After transporting the patient to the emergency department, the ED delivers the patient and the operation report including the collected data.

4.2.2 Telemedical Support in the Rescue Chain

Participants without experience with telemedical support during emergency operations revealed to be very reluctant to technology usage within the rescue chain. They reported to be uncertain whether technology is safe enough and fear medial problems of the teledoctor concept. "A photo would be too static to provide a reliable impression of the patient's

condition and his environment" (ED_3). "To assess the patient's respiration, it is necessary to have video data" (ED_1), "but even a video cannot provide an impression of fine shades of the skin due to the influence of artificial light" (ED_4) or "replace the tactile impression a doctor senses by touching the patient's skin" (ED_8). All interviewed emergency doctors basically concede the need and the potential of the teledoctor concept, however, according to their statements, the success of the teledoctor relies on reliable technical equipment.

In our sample, there were also participants who had already telemedical experience. They remarked that the usage of a teledoctor is shifting the main focus in an emergency operation: the patient will not be exclusively in the centre of attention, and the operation will become less personal (ED_8), but the patient is receiving a qualitatively better treatment.

> "It [the teledoctor concept] will be a support for the patient because a faster and more targeted information flow [...] means a better scheduling and preparation for the hospital personnel. Not so much time will be wasted during the information transfer from ambulance to hospital and in the further processing" (ED_9).

Regarding the scenario, in which an emergency doctor on-site consults a teledoctor (Scenario 1), the patient benefits not only from the expedited information flow, but also from two doctors taking care of him. The expertise of two medical professionals and the access to advanced information takes EMS on a qualitatively higher level. This emergency doctor-teledoctor-relation contains many benefits, but also reveals a competence problem: Both doctors are having the same qualification and are at the same time in charge. As an emergency differs from case to case, the doctor on-site may vary the standardized schemes what could contradict the advise of the teledoctor. Also, another barrier is that the emergency doctor on-site feels observed, controlled, disturbed, and also patronized (ED_3).

Moreover, integrating an actor in a group interaction who is not physically on-site leads to miscellaneous communication problems.

> "The voice connection between teledoctor and emergency doctor on-site confuses other people at the incident site. They do not know to whom he [emergency doctor on-site] is talking and why he is talking at all" (ED_8).

The rescue team does sometimes not know to whom the doctor talks or if he is receiving a message on his headset (ED_8, ED_{10}). Communication paths, and the turn-taking between teledoctor and ED on-site needs extra-training:

> „You have to learn to let people finish speaking, and to announce before asking a question as each question may interrupt actions on-site and deflect [actors'] attention. [...] You must develop an own communication culture" (ED_{10}).

But, the verbal communication via headsets causes confusion also for the patient. For instance, seniors who are rarely in contact with ICT feel irritated by this. In case of a psychiatric emergency, it could even impair the situation (ED_3, ED_9).

5. Discussion

The evaluation of the teledoctor as a possible telemedical support for emergency situations basically showed a positive result, however, there were also shortcomings and concerns from the perspective of emergency doctors. Basically, any technical support in the high-demanding and time-critical rescue-chain is a relief to the emergency staff involved in the process. There is no doubt, and all interviewed emergency doctor agree on this, a teledoctor is a powerful concept and has a high utility. The teledoctor is able to compensate the lack of emergency physicians on-site, to support less experienced colleagues (with a possibly) different specialization, to context-adaptively advise para-medics as well as to authorize medical treatment. Also, respondents agreed on the increasing efficiency of the emergency process: by the help of a tele-doctor, the diagnosis on-site can be accomplished by virtue of a more detailed and targeted medical information, which basically expedites the logistics and the organization of the rescue operation.

However, the interviewed emergency doctors also reported shortcomings and barriers towards the usage of a teledoctor. One concern is the low trust in the reliability of the technology involved. The second one is that the face-to-face experience with an emergency patient on-site seems to be a unique feature, which is – from the perspective of an "old stager" emergency physician – not replaceable by any digital medium. Neither a photo of a patient (too static) nor a video is sufficient to "feel" the actual condition of an emergency patient. Another concern was the alleged attention shift from the emergency situation and the patient as such to the advice or discussion with the teledoctor. Finally, the interviewed doctors had expected also conflicts and a struggle for competence whenever the advice of the teledoctor contradicts the diagnosis and the impression of the emergency personnel on-site.

6. Conclusion

With respect to optimization of the emergency situation, the teledoctor concept seems to be a promising way of meeting the upcoming challenges in emergency medicine. Though, future studies will have to examine if the concerns raised by the emergency doctors will vanish with increasing experience in both roles, as emergency doctor on-site as well as a supervising teledoctor in the primary control unit remotely.

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