Data Exchange Between Ambulance and Trauma Center: Interview Study About the Needs of Emergency Trauma Room Staff

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Abstract. Background: In emergency trauma room, adequate preparation of all resources prior to the patient's arrival is essential to ensure optimal continuation of the treatment. Therefore, a good transfer of information between pre-hospital and hospital is very important, for example through networking technologies. Objectives: The aim is to identify what pre-hospital information is needed to ensure that all necessary resources in the ETR are optimally prepared for the incoming trauma patient. Methods: A qualitative, semi structured interview was conducted with physicians of ETR team at four trauma centers. Results: Physicians mentioned similar requests for pre-hospital information. The workflow in ETRs differed in alerting of team members and transferring of pre-notification information. Conclusion: Clinical needs for pre-hospital information for future development of support systems in the networking of accident site and hospital could be identified.

Keywords. Emergency Trauma Room, Clinical Needs, Pre-Hospital Information, Hospital Pre-Notification

1. Introduction

The emergency trauma room (ETR) in the emergency department of a hospital is an important connection between pre-hospital and in-hospital care. Thus, a good transfer of information between first responders and hospital is essential for a sufficiently prepared ETR for the patient [1][2]. In Germany, severely and multiply traumatized patients are treated in the ETR on the basis of the German S3 guideline for the treatment of polytrauma and the severely injured, which was last updated in 2016 [3]. A multidisciplinary team of physicians and nurses works together in the ETR. The *German Society for Trauma Surgery* defines the structure of the basic ETR team according to the level of care of the trauma center [4].

The trauma centers are divided into three levels of care according to specific personnel, organizational, and structural criteria: local (LTC), regional (RTC) and supraregional (STC) trauma centers. In this system, the LTC assumes responsibility for ensuring comprehensive care and initial treatment of severely injured patients with

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onward transfer to another higher-certified trauma center. The RTC and STC have extensive capabilities for emergency and definitive care of the most severely injured. The STC is located in maximum care hospitals and, compared to the RTC, has a larger capacity of emergency rooms and more capabilities to treat more complex injuries [4].

If an injured patient is transported to the ETR by emergency medical services (EMS), a pre-notification call by the EMS with important patient information, e.g., vital signs and mechanisms of injury, is of outmost importance for the ETR [5]. A following trauma alert of the hospital notifies all ETR team members. This allows the ETR team to prepare personnel and material resources before patient's arrival to ensure a continuous treatment from the pre-hospital to the in-hospital care, e.g., preparation of medications, specific equipment, blood supplies, and operating room capacity [6][7]. However, pre-notification calls can be inaccurate. Communicating incomplete patient information to the hospital can result in activation of wrong resources in the ETR, leading to over or under triage and affecting the continuation of the patient's treatment [8]. Only during the clinical handover between EMS and ETR team at the hospital, the ETR team receives more information about the patient's health status. This results in immense pressure on the handover, which is characterized by high stress or time pressure and can lead to loss of information [9] [2]. The utilization of divers networking technologies can facilitate the transfer of data from the site of an accident to the hospital prior to patient's arrival.

The contribution of this paper is to capture and systematically examine the workflows and needs in the ETR regarding the arrival of trauma patients. In order to prepare future development of support systems, a user study was conducted as part of a research project. The current paper deals with the initial requirements analysis with a focus on the needs of the clinical users in the hospital prior to the patient's arrival. The aim is to identify what pre-hospital information is needed to ensure that all necessary resources are optimally prepared for the incoming trauma patient.

2. Methods

A qualitative in-depth interview study with ETR team members from four hospitals in Germany and Switzerland was conducted. The data collection took place from May to October 2022.

2.1. Participants

22 physicians, who are part of the ETR team, were recruited for this study (Table 1). The respective hospitals were selected to have trauma centers from all three levels of care represented. In addition, both urban and rural areas should be covered.

STC   *Leipzig University Hospital* (Germany),
        University Hospital Zurich (Switzerland)
RTC   *Military Hospital Berlin* (Germany)
LTC   *Asklepios Clinic Uckermark* in Schwedt/Oder (Germany)

Compared to the other hospitals, *Asklepios Klinikum Uckermark* is located in a rural environment. The nearest RTC is approx. 50km away, and the nearest STC is approx. 100km away.

Table 1. Demographic Characteristics of Participants

Professional Title	N	Department	N	Working Experience	N
Chief Physician	4	Trauma Surgery	15	0-5 years	3
Senior Physician	10	Anesthesiology	6	6-10 years	8
Medical Specialist	3	Radiology	1	11-20 years	8
Assistant Physician	6	General Surgery	1	21-30 years	3
Total	22		22		22

2.2. Procedures

The research method used was the semi structured interview with following questions:
1. What is your professional title?
2. How long have you been working in this profession?
3. How many patients have you already treated in the ETR?
4. What is your role in the ETR and what are your responsibilities?
5. How are you informed about a new patient who has been registered for the ETR and what happens after that in the ETR until the patient arrives?
6. What happens when the patient arrives in the ETR?
7. Let's assume, a patient is on the way to the ETR in the emergency ambulance and you could receive live information from the emergency ambulance: What information would that be?

Follow-up questions were asked after each initial question to ensure that the participants' responses, opinions, and needs were sufficiently understood by the interviewer. The interviews were conducted by the same person at the respective hospitals. Depending on the time available, a second person was present to take notes. All interviews were recorded after participants signed the data protection consent form.

2.3. Data Analysis

For the analysis, questions 1-3 were used for demographics. Question 4 was used to evaluate the structure of the ETR teams. For this purpose, the statements of all physicians were summarized per hospital. Question 5 was used to evaluate the workflows in the ETR before patient's arrival. The statements were summarized and compared between the hospitals. Problematic aspects were then identified and information needs were derived. Question 6 was asked to provide a comprehensive overview of workflows in ETR, but is not considered in this data analysis. Question 7 was used for the evaluation of pre-hospital information. The statements were summarized and categorized. The data were then compared and the information needs were derived.

3. Results

Structure of ETR team. Depending on the level of care, the number of ETR team members differed. All ETR teams are structured according to the recommendations of the *German Society for Trauma Surgery*, consisting of at least one surgeon and one anesthesiologist in an LTC and members of further specialties in RTCs and STCs. [4]. However, the task distribution between assistant physicians and senior physicians varied between the ETR of surveyed trauma centers. The trauma lead position varied also across the trauma centers and was held by different physicians of the team. In contrast to the other trauma centers, one trauma center always had an assistant physician for neurosurgery present in the ETR when the patient arrives.

   Workflow in ETR before patient's arrival. All ETRs generally had the same workflow between pre-notification until patient's arrival. However, they differed in alerting of team members and transferring the pre-notification, as well as the technologies used for this purpose (beeper, phone, dashboard). From the analysis, issues were identified regarding alerting, timing of meeting of all team members in ETR, and preparation of ETR as well as briefing team members according to pre-notification.

   Pre-hospital information requests. The following categories of pre-hospital information could be derived: patient data, patient status, therapeutic measures, imaging, other info. The following is a small selection of the physicians' requests. For patient data, physicians mentioned date of birth, previous illnesses. For patient status, information about vital signs and accident mechanism were stated to be helpful. In therapeutic measures, physicians named updates on medication or intubation. For imaging and other information, physicians mentioned ultrasound images and photos from the accident site as helpful. All physicians mentioned similar pre-hospital information as necessary. However, a different degree of complexity and scope of information was reported. The reasons were different transport distances between accident site and hospital as well as the time available to prepare the ETR and the team for the patient.

4. Discussion

The aim of this study was to explore, through interviews, what information basic ETR teams need to be prepared for an incoming trauma patient and to use resources optimally.

   Structure of ETR team. The results showed that the structure of the ETR teams is aligned with the level of care of the trauma centers and according to the recommendations of the *German Society for Trauma Surgery* [4].

   Workflow in ETR before patient's arrival. The trauma centers adapt their workflows to the recommendations for the treatment of trauma patients and internal hospital regulations in order to avoid delays in the treatment of patients [4]. From the overall interview results, the following information needs can be derived (Figure 1). Firstly, a faster and easier alerting of the required team with automatic transfer or automatic access to the pre-notification information could improve workflows. There would be no need for a dedicated person, e.g., trauma leader, to notify all team members individually. Furthermore, the team members do not need to call back or go to ETR just to receive the pre-notification information. This would save personnel and time resources and would allow the team to take on other important tasks before the patient arrives. In addition, it can be assumed that this information might be forgotten due to stress or a longer period between alerting and patient arrival, e.g., if it was transmitted verbally.

Secondly, a visualization of a precise arrival time of the ambulance could support the ETR team members in their work, because the time can vary depending on the patient's condition or the traffic situation. The ETR team rarely or never receives information from the EMS during transport about changes in arrival time or patient's health status. As a result, the ETR team may have to wait a long time in the ETR for the patient to arrive. If the exact time of arrival were known, the time to arrival could be better planned. Thirdly, by providing more real-time prehospital information, the ETR team could adjust resource preparation to that information. Any resources that can be prepared prior to patient's arrival allow more time for the treatment. It might also be a mental preparation for the ETR team, especially for more inexperienced physicians.

Figure 1. Findings on the current state of workflow and clinical needs of physicians in the ETR

Pre-hospital information requests. In the analysis of the data, physicians mentioned similar requests for pre-hospital information. However, they differed in terms of complexity and scope of information. Therefore, the information should firstly represent a comprehensive overview of the patient's health status and the pre-hospital situation. Secondly, the visualization of pre-hospital information should be configurable to enable different use cases. Transport distances between accident site and ETR can influence the time of resource preparation. It can be assumed, that for short distances, the ETR team has little or no time to gather a large amount of information, as all necessary preparations must be completed in a very short time. For longer transport distances, especially for hospitals in rural areas, the patient's health status may change during transport. In this case visualization of complex pre-hospital information would be beneficial to adjust and prepare for any changes. Furthermore, LTCs, which are often part of hospitals with lower capacities, may need to decide whether the treatment options are sufficient for the incoming patient. In this case the patient must be taken by ambulance or helicopter for direct onward transfer to a higher-certified trauma center e.g., from LTC to STC. This process requires lead time. In addition, organizing operating rooms and patient beds may require a longer lead time at LTC than at larger hospitals with more personnel and structural capacity.

The study has some limitations. There was an overrepresentation of STCs. Due to the method of data analysis, it can be assumed that this fact had no noticeable influence on the results. However, it would be interesting to include more trauma centers from all levels of care, and different rural and urban regions to get a more representative overview. Furthermore, the group of traumatologists was overrepresented. Due to working hours or important surgeries, not all physicians could be interviewed as planned beforehand. As a consequence, it is possible that the opinions of other professional groups have

tended to be marginalized. Moreover, it would be important to include nurses in a follow-up study. As part of the team, they arrive in the ETR very early to prepare it for incoming trauma patients. For this reason, their perspective should also be considered.

In this paper, the clinical needs of physicians in the basic ETR that occur before patient's arrival could be identified. These results can be used for the future development of support systems in the networking of accident site and hospital. Better provision of pre-hospital information to the ETR team can potentially counteract the loss of information of pre-notification and take pressure off the handover. This could reduce the likely occurrence of over and under triage in the ETR. The task of the ETR team, consisting of physicians and nurses, is to simultaneously gather information and act when the patient arrives. If this information was known beforehand, they could act more directly. This would allow for appropriate treatment of the patient and assist the ETR team in its work.

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