

Telemedical support of prehospital emergency care in mass casualty incidents *

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Abstract

In the German emergency medical service system (EMSS) medical treatment can be improved in most of mass casualty incidents (MCI). Currently, the incident commander who is responsible for classification of the victims (depending on their urgency and condition, the so called triage) and ordered transportation uses paper-based documentation. Triage tags are used to identify and classify patients and gather treatment information. This can cause problems in medical treatment and in transportation of injured victims.

Object-oriented modelling, simulation, and visualisation of processes can show deficits in treatment and data processing and thereby help to optimise medical workflow and logistics.

If documentation by paramedics and emergency physicians is done electronically, all patient records could be send to a telemedical centre for central data administration. A telemedical supported triage tag helps identifying victims and managing detailed identification protocols. The paper-based documentation in emergency would become obsolete, if hospitals can query all protocols, diagnoses, and findings from the telemedical centre. Safety and security aspects can be guaranteed.

The complete medical treatment workflow can be supported by telemedicine. Therefore, in case of MCI, telemedicine can optimise

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medical treatment and exonerate the paramedics from unnecessary documentation.

Keywords: telemedicine, simulation, visualisation, mass casualty incident, emergency care

1 Introduction

The aim of emergency medicine is to save lives, minimise sanitary harm and restore the quality of life best possible. This maxim does not change in MCI, but often the huge number of victims complicates optimal primary medical attendance. By analysing the handling of MCI, the advantages of computer-aided coordination becomes apparent. In order to compare the existing situation to an optimised scenario, we explain handling of MCI as done nowadays first [4] [5] [8].

The first emergency physician on the spot becomes triage officer, unless there is a full-time incident commander. His task is to sort and classify the injured victims into four groups according to their urgency and condition. He creates triage tags that stay at the patients showing their triage category. Depending on the classification further steps are taken. The tag contains all data concerning the patient and therefore, is the only source of information for the people treating him [3].

Triage tags are paper-based, so bad weather conditions and illegible handwritings can easily cause unreadable documents which are useless for further medical treatment. Sometimes even victims are missed, because it can neither be determined to where they have been transported nor by whom [2].

The whole process of triage, treatment, documentation, registration, and transportation is called patient leading system (PLS) [1]. Telemedicine can support the triage team, emergency medical technicians (EMT) and emergency doctors by simplifying the triage tag and therefore improving documentation [8]. A telemedical supported PLS could include barcode-identification. Centrally administered detailed identification-protocols would help to organise data management and thereby simplify the search of victims by their relatives and tracing services. Paper-based emergency protocols and emergency documentation become obsolete, because hospitals could query protocols, diagnoses, and findings from a telemedical centre resp. get a fax after identifying the patient using his barcode sticker. Thereby, the documentation's consistency is ensured. Nevertheless, data transmission that includes personal and medical information has to be secure and save, which can be guaranteed by using cryptographic protocols.

An EMT or triage officer supported by a personal digital assistant

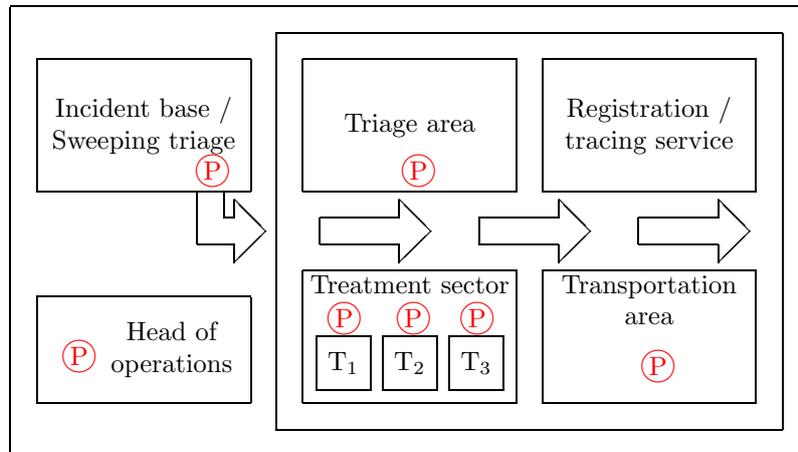


Figure 1: Structure of incident command system (ICS), P=physician responsible

(PDA) could document detailed personal findings and send them to the telemedical centre using digital radio network (DRN). Electronically gathered data enables validity checks. Both, triage tag and barcode are decisive and sufficient for all institutions (triage area, treatment sector, transportation area, emergency medical service (EMS), hospital, and tracing service). Additionally, barcode stickers can be used to mark the patient's personal items. All data would be gathered only once and be accessible to all authorised staff and computer-aided evaluation at any time.

Telemedical supported workflow of medical treatment ensures data security and optimal accessibility. In case of MCI telemedicine can improve medical treatment, exonerate the paramedics, physicians, etc., and secure the quality of documentation [9].

2 Methods

2.1 Status quo - analysis

In Germany in case of MCI different institutions will be alarmed. First of all, full time EMS with paramedics, physicians, ambulances, and helicopters are mobilised. If a huge number of victims exceeds the capabilities of the medical care facilities on the spot, the dispatch centre alarms a rescue squad which is trained to cope with MCI and unpredictable situations. This squad organises triage sectors, treatment areas and transportation with many voluntary people belonging to the Emergency Medical Technician-Basic (EMT-B) (see Fig. 1) [4] [8].

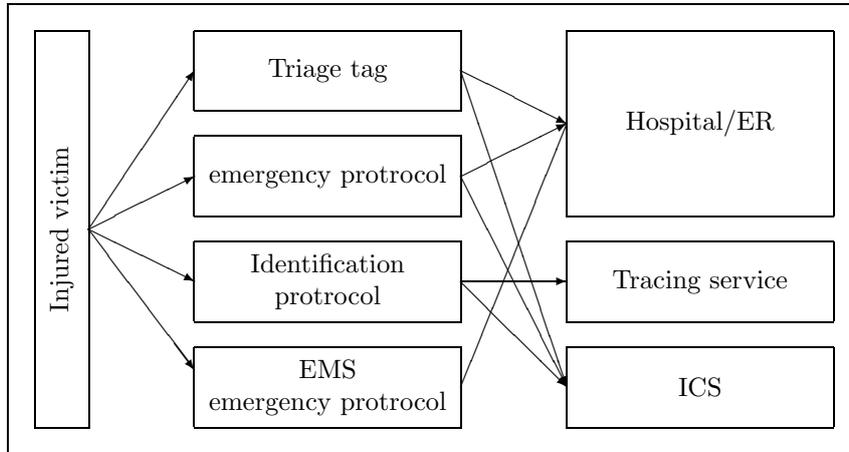


Figure 2: Flow of information and data exchange

In most cases the first physician on the spot is responsible for triage classification and marking of injured victims using triage tags [3]. The victims will be transported to the triage sector where a triage team completes the triage tags and initiates basic life support. The tag contains triage classification, first diagnosis, first treatment, alphanumeric identification stickers, and particulars as far as possible. Depending on their triage classification the victims are transported to the treatment sector. The treatment officer and his team treats the patients, stabilise their circulatory system, continuously control vital signs, and ensure vital functions by advanced life support. They create two new forms: an identification-protocol for the tracing service and an emergency protocol for physicians in hospital [1] [3] [6].

After treatment the victim is transferred to the transportation area. Depending on his injuries the patient is transported to hospital by ambulance or helicopter. In an ambulance, attendance by a physician is optional, whereas, in a helicopter it is indispensable. Copies of all protocols are transferred with the patient. During transportation the physician (paramedic, EMT) has to fill in an EMS treatment protocol containing patient data, medical history, diagnoses, information about medical treatment, values of vital signs, given drugs, and information about transport. Many pieces of data are copied from other forms (see Fig. 2).

The emergency room (ER) staff in hospital receives all patient data and the protocols. Since the physicians were only roughly informed about the diagnosis of a patient by the dispatch centre, they must read his protocols on the patients arrival and inspect him once again [9].

2.2 Problems

In Germany the conventional workflow of MCI contains some problems concerning the data gathering and data handling. In case of emergencies time is a precious factor therefore time used for documentation has to be shortened. On the other hand good documentation is needed to assure the quality of medical treatment. Additionally, accurate documentation helps to provide the patient's relatives with information concerning the whereabouts, medical status, and condition of their beloved [7].

Most pieces of data, e.g. particulars, medical history, first medical diagnosis, differential diagnosis, vital signs, first Glasgow-Coma-Scale classification, etc., are recorded redundantly. This waste of time and human labour can be avoided. Furthermore, mistakes in documentation must be avoided under any circumstance.

If the patient is unconscious, he is identified by his alphanumeric key. Transcription errors or missing key stickers will lead to false identification, therefore it is impossible to trace the transportation of the patient.

2.3 Concept

Based on the preceding statements the workflow of a MCI can be improved by changing the documentation and communication between physicians, EMTs, dispatch centre, and hospital. To ensure that changes do not worsen the system, they are at first analysed in virtual reality. This is necessary, because simply mapping the existing system onto computers would not automatically improve the processes.

To achieve the possibility of simulation existing processes of MCI and PLS must be modelled, neatly done by using object-oriented methods. Simulating the processes without any variations shows the workflow of a status quo incident, whereas changing parameters allows to create, compare, and evaluate variations of processes. Additions to the model, e.g. PDAs, improved communication between physician and dispatch centre, relocation of the treatment sector, etc. can be included, simulated, and evaluated. The visualisation of the modified system with new processes will show assets and drawbacks.

Our approach includes PDAs and a telemedical centre to enable digitally managed triage tags, emergency protocols, identification protocols, etc. The evolving system must easily integrate into the given structures of the object-system "documentation in MCI". It is not allowed to reach out over object-system's borders and should be stand-alone, because modifications in the structure of EMSS are very difficult.

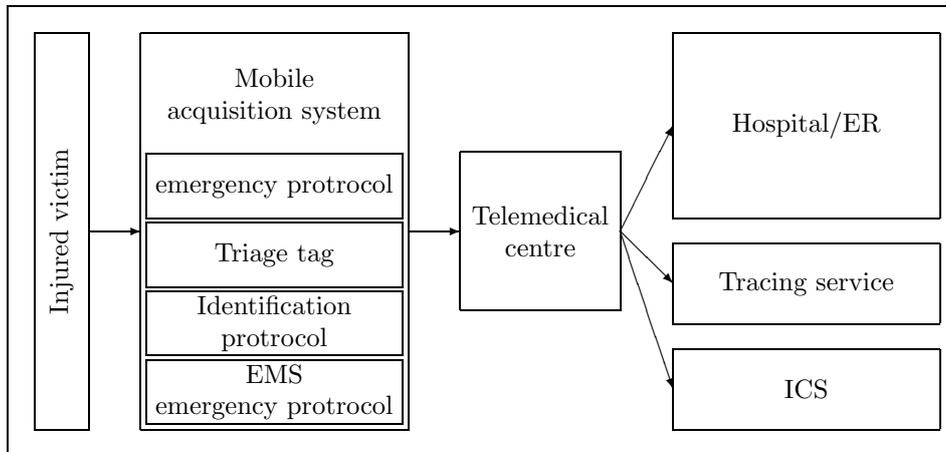


Figure 3: Computer supported flow of information and data exchange

Data redundancy and mistakes by transcription and missing information, as aforementioned, were starting points for the developed system concept. Every patient needs a triage tag, an emergency protocol, identification protocol, and an EMS treatment protocol. The triage officer would stick a barcode to every triage tag. This barcode is used to identify the patients. Only the triage tag will stay at the patient. All other protocols will be recorded using a mobile acquisition system. The data will be transmitted to and saved at a telemedical centre. This forecloses data redundancy and transcription errors, and reduces the waste of time and human labour.

Emerging data can be classified according to type:

- personal data (name, date of birth, ...) resp. barcode,
- technical data (transporting ambulance, destination, ...)
- medical data (medical history, diagnosis, findings, ...)

or by content:

- alphanumeric data (transporting ambulance, ...)
- numeric data (date of birth, ...)
- unstructured text (medical history, diagnoses, findings, ...)
- checkboxes (Glasgow Coma Scale, ...)
- choice data (localisation of injuries, ...)

Data must be gathered simultaneous to medical treatment and has to be fast, easy, and secure to foreclose impairment. To ensure this, unstructured text blocks can be replaced by checkboxes and static defaults. Entering of data can be simplified by supplying dynamic forms

(e. g. some views only appearing, if defined conditions are fulfilled). Documentation in electronic form allows plausibility check that can avoid wrong or illogical entries (see Fig. 3).

2.4 Summary

In case of MCI detailed documentation is absolutely essential for optimal medical treatment and further planning of emergency management. The problem is to develop a system but how for documentation and registration that is sufficient for all contingencies. The system must fulfil many requirements.

A documentation system must support triage classification, medical treatment, and transport decisions. It must be flexible, stand-alone, and has to assure that a victim is recorded only once and uniquely. Additionally, it should improve staff's communication, has to provide simple and easy operation so that staff not trained on the system cause it easily. It should support individual medical documentation (EMS treatment protocol) [6].

Computer-supported PLS for the MCI can fulfil all mentioned points and criteria. Time between arrival of resources, medical treatment, and transport could be shortened. Also hospitals could be informed in advance [6].

By improving the flow of information between emergency staff, dispatch centre, and hospital, many processes and the medical treatment workflow would be enhanced [9].

3 Conclusions

Registration and documentation are two aspects of MCI. Both, emergency medical treatment documentation and determination of whereabouts of patients, are important aspects. Exponents representing the antagonistic sentences are discussing the matter in Germany for long without satisfactory outcome. So in different regions different systems are put into practice. There is no consistence in Germany resp. in Europe [7].

On the other hand there might be a lack of acceptance of PDAs by the emergency staff diminishing our system's applicability. Additionally the purchase costs of the system cannot be neglected. Technical realisation of the system might not cause any problems, because data security would be more a legal than a technical problem and using DRN for data transfer will not result into problems.

Our proposals cannot solve the fundamental problems as aforementioned, but the suggested concept contains all important criteria.

The main aspects are to develop a system, that is easy to handle, usable all the time, and independent of weather conditions. It must record particulars, support gathering of medical data, and support the flow of information [7]. This purpose is fulfilled completely by the suggested computer-supported PLS.

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