Challenge Patient Dispatching in Mass Casualty Incidents

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ABSTRACT

Efficient management of mass casualty incidents is complex, since regular emergency medical services structures have to be switched to a temporary "disaster mode" involving additional operational and tactical structures. Most of the relevant decisions have to be taken on-site in a provisional and chaotic environment. Data gathering about affected persons is one side of the coin; the other side is on-site patient dispatching requiring information exchange with the regular emergency call center and destination hospitals. In this paper we extend a previous conference contribution about the research project e-Triage to the aspect of patient data and on-site patient dispatching. Our considerations reflect the situation in Germany, which deserves from our point of view substantial harmonization.

Keywords

Patient dispatching, mass casualty incident, triage.

INTRODUCTION

MCIs are very often sudden incidents with little lead time only, but there are stringent requirements in terms of logistics efficiency. E.g., the out-of-hospital time for trauma patients should be less than one hour (golden hour of shock), so that one of the first challenges in MCI management is identifying the most severely injured (or diseased) persons among all other affected persons. Our descriptions in this article are based on the situation in Germany, but the main concepts are comparable to MCI management approaches in many other countries. In fact, the federalism in Germany has lead to a multitude of different concepts, which are all similar, but not necessarily compatible to each other.

The transition from regular emergency medical services (EMS) to an MCI is blurred and is not a matter of a certain number of patients. On the one hand an MCI always arises from a misbalance between available EMS resources and patients needing medical care, on the other hand alerting of rescue forces is based on initial unreliable estimations. Considering the development of the rescue operations over time described above, an IT-based management support system for MCIs has to be fully scalable, both in temporal and spatial dimensions. Our previous work (Adler et al. 2011) describes an approach for such an electronic management support system which is currently under study within the German research project "e-Triage". The reader will find in this article a reference list to related articles and earlier works, too, which we do not want to repeat here.

Instead, we want to extend these considerations. First, we underline our previous statement, that data gathering and data processing technologies for MCIs have to be integral components of regular EMS documentation. Second, we briefly describe the tasks of the incident command during an MCI and the inherent communication complexity. Patient dispatching is a key process, and decisions to be taken involve several players, which are located in the operation area, in remote control centers, and in hospitals. All of our descriptions are research work in progress, and a field test is pending. Finally, we discuss psychological factors to be considered in patient logistics.

DATA MANAGEMENT

Figure 1 shows the fully developed supply chain of an MCI consisting of the stations: patient repository (patient staging area outside the actual hazard zone), point of care (field hospital), transport (ambulance cars, helicopters, etc.), and hospital or accommodation. This approach can be adapted to the actual requirements of the incident. E.g., in some cases a dedicated patient repository is not necessary, and the functionality of the point of care – if needed at all - can range from simple weather protection to (pre-)clinical patient treatment.
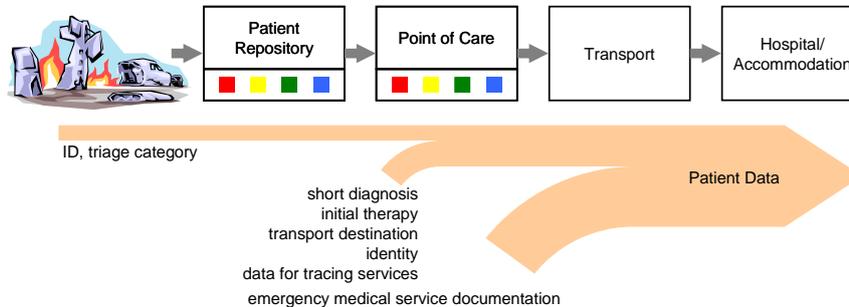
Figure 1. MCI supply chain stations and patient data.

After the initial triage a patient data set consists at least of a unique ID and a category. Depending on the triage algorithm the category can be e.g., immediate, urgent, minor, or deceased. Several rescue organizations document basic findings, too (e.g., craniocerebral injury, burn), which is needed for subsequent transport planning.

Electronic patient registration allows additional documentation of e.g., GPS coordinates and a photo of the patient/location. At the entrance to the point of care the triage algorithm is repeated (typically performed by an emergency physician), and depending on the actually available personnel resources additional data about the affected person may be collected (identity etc.). Most important are supplied pharmaceuticals, but also a short diagnosis for finding an appropriate specialized hospital is required. Finally, there is normal EMS documentation during transport for billing and quality management purposes.

In fact, MCI patient data is only a small extension to the standard EMS documentation. From this point of view it is straightforward to think about electronic EMS documentation with dedicated software modules for MCI management (Adler et al. 2011). In any case, the chosen approach may not be limited to collecting patient data only. Patient dispatching is of key importance, which we will detail in the following.

PATIENT DISPATCHING

Many international incidents have shown the permanent necessity for mitigation (Latasch et al. 2006). Not only because of the commencement of the "Zivilschutzneuordnungsgesetz" in Germany in 1997 (law for reorganizing the civil defense) and the closing of former medical storage places and auxiliary hospitals, the medical care capacities and the stock of available treatment capacity in hospitals were significantly reduced after the end of the cold war. This begs the question what the adjusting screws to optimize the processes of patient dispatching in an MCI are.

Pre-clinical and tactical operating conditions

To fix the interface problem between EMS and hospitals we start with a look at the German pre-clinical and tactical operation conditions. The incident announcement is normally reported to the nearest rescue control center (112 call center for medical and technical rescue). The rescue dispatcher sends the EMS, incident command and required fire brigades to the emergency site by using the local alarm and march out order. The alarm is tailored to the actual needs of the reported incident (there is a list of pre-defined incidents and alarm levels), which means that e.g. fire brigades with the right technical equipment (breathing protection, on-board fire-fighting water, specialists for chemical incidents etc.) are called.

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The first paramedic team and the first emergency physician (very often rendezvous-system[1]) are the temporary incident command until the incident command on duty arrives. Among other things the incident command is responsible for establishing: (initial) triage management, patient repository, point of care, decontamination place, helicopter landing site, EMS management, task force management, psychosocial care management, sustenance management, and transport coordination.

To ensure a successful and optimized parallelization of the patient rescue and transport processes it is essential to get timely overviews of the number of patients and their triage categories. Caused by the continuous cost pressure in health care, treatment capacities and available beds in hospitals were significantly reduced in the past. Thus, medical treatment and the transport priorities of the patients have to be defined as early as possible.

Control center, pre-clinic, hospital - technical interface challenges

In most cases each district or division (control center, EMS, hospital) makes use of another method for documenting the developed data. Control centers usually use dispatching software for daily rescue operations (i.e. incidents with less than five involved persons). They dispatch individual ambulance vehicles and assign (special) hospitals to each patient. In case of an MCI, transport coordination is not the task of the control center any more, but task of the on-site incident command. In an MCI the incident command establishes operational headquarters using dedicated software to coordinate rescue resources and manage rescue and transport priorities.

Once again, relevant questions in this level are:(i) How many patients are there? (ii) Which patient has to be transported first? (iii) How many transportation means do we need?

An approximation for defining the heaviness of a disaster (S) might be the formula (Bail et al. 2009)

$$S = (\text{number of } T_1 + \text{number of } T_2) / \text{number of } T_3$$

with T_x the triage categories: T_1 = immediate; T_2 = urgent; T_3 = minor.

For this you need to have an overview of all patients as soon as possible. Electronic data transmission while triaging and registering the victims can speed up the heaviness rating a lot.

Apart from the number of injured/diseased persons and the heaviness of a disaster, the number of required transportation means is another important factor. It depends on:

- The number of injured people (N);
- The distance of the hospitals to the place of action (t);
- The number of patient, that can be transported at the same time (n);
- The entire travel time (T).

You can calculate the required transport capacity (X) as follows (Bail et al. 2009):
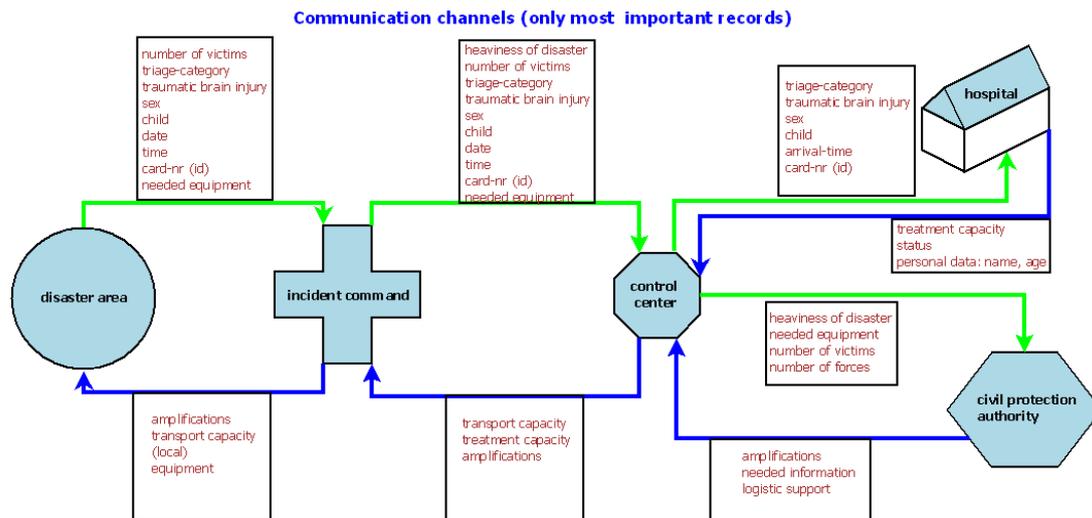
$$X = (N \times t) / (T \times n)$$

Most of these variables are used for planning of disaster reduction. Nevertheless, computation of these parameters in real-time using paper-based registration systems is simply not possible. Figure 2 illustrates the communication channels in an MCI in Germany. Obviously, is practically impossible to synchronize these information streams in real-time without using an electronic management support system. Voice-based approaches are definitely not suitable for transmitting data.

Within e-Triage up to now, an interface for acquiring the important on-site data (e.g., number of victims, triage categories, location of patient repositories) to commercial staff- and control-center-dispatching-software LUMIS[TM] (provided by the e-Triage project partner Euro-DMS Ltd) was developed. This enables aligning the required with the available transportation means and at the same time considering the stock of available treatment capacities in hospitals which is reported to the local control center (Sefrin and Kuhnigk 2008) to ensure a contemporary patient dispatching.

In the next steps, new data interfaces will be integrated into the e-Triage system. The pending tests will serve to evaluate data combination for optimized patient dispatching at the incident command or control center. More precisely, the above-mentioned formulas will be evaluated and tested for real-time usability. For these purposes,

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[1] Regular EMS in Germany is very often based on a so called rendezvous system. Paramedics with their ambulance vehicle and an emergency physician with a dedicated car drive separately to the emergency site. This approach allows more flexibility and faster reaction times.

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Communication channels (only most important records)

Figure 2. Communication channels in an MCI (situation in Germany).

the additional interfaces send data to a subsidiary victim transport management system that consists of four components.

One component is a distribution matrix for optimal hospital-victim balancing. The distribution matrix is used for $T_{1/2}$ victim assignment in phases. The hospitals are chosen circularly around the disaster area from near to far. One special column states the actual stock of available treatment capacity for each hospital if it is synchronized with the corresponding hospital information system. Another component handles all medical rescue forces that have been dispatched to the disaster area to transport patients (transport capacity). To transmit this data automatically an electronic interface between incident command- and control center software was implemented.

The result of real-time data synchronization between e-Triage on-site victim data and the staff-/control center software is shown as well (component no. 3). The incident command or control center dispatcher has to combine victim with unit and hospital via drag and drop only. With the 4th component, it is possible to monitor the current patient dispatching.

PATIENT DISPATCHING IN MCIS – A BOTTLENECK

Triage is an ethically difficult task for medical personnel and means to decide how to use limited personnel and material most efficiently in order to provide a maximal number of injured and diseased persons with help. Because of the operation dynamics expanding second by second it is not possible to compensate the discrepancy between shortage of resources and required patient care. Triage in the sense of prioritizing the seriously injured persons, who need immediate treatment and/or transport into a hospital, is a process of patient dispatching.

The status quo in Germany is that some of the federal countries use the mSTaRT (modified simple triage and rapid treatment) algorithm for the initial triage, which was developed in preparation of the FIFA World Cup 2006 in Munich. The concept is based on the STaRT algorithm. Furthermore the structured emergency treatment on-site and a prioritized transfer of patients is regulated within the mSTaRT concept. The algorithm also distinguishes between first initial triage which is performed by trained emergency medical personnel (paramedics), and second triage performed by an emergency physician, who uses a more detailed algorithm.

A mixed-method approach was chosen: qualitative methods (e.g., GABEK® WinRelan® (Zelger et al. 2008, Zelger and Schönegger 1994–2011), think aloud protocols, KATKOMP (Badke-Schaub 2002), observations of trials and quantitative methods (e.g., video-sequence-analysis, ergonomics, system usability scale, team situation awareness, standardized questionnaires, such as KAB (Müller and Basler 1993), ISTA (Semmer et al. 1999)).

Patient dispatching is a bottleneck: triaged patients have to be distributed by the incident commander and the control centre. Observational research within the e-Triage project found a delay in time for processing information between the disaster area and the command/control centre $\geq$20 min. Strategic planning is made under wrong presumptions (number of victims, categories, needed resources). Regulation problems measured with ISTA analysis over three weekends at a major event (Fürst 2012) are high at the factor "Kooperationsenge". If person "A" makes a mistake it has a direct influence on the work of the other people involved. High complexity leads to high uncertainness to reach goals. Higher concentration is needed, more mental workload under stress deregulates fulfilling the tasks of emergency personnel on-site and at command level. Common situation aware-

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ness (Strohschneider and von der Weth 2002) helps to find appropriate solutions. e-Triage as an integrated concept has to enable real-time communication and to support exchange of relevant information to all group members in order to achieve common situation awareness and to reduce stress.

CONCLUSION

Electronic MCI management requires a patient data concept both for daily use and for use in the MCI scenario itself. Another important pillar is patient dispatching support. Key challenges for patient dispatching are the involved decision makers who are located both in the operation area and in remote coordination centers and hospitals. Generally, coping with MCIs is extremely incriminatory for the rescue forces that have to interact with a bundle of stressors. Carefully designed electronic support can be a valuable means since it can be conducive to prevent stress-related diseases like post traumatic stress disorder (PTSD).

Each federal country of Germany has its own legal framework for civil protection, and there are many different rescue organizations with different approaches and concepts. Apart from the technical design one of the main challenges for the e-Triage project was to find a common denominator of the actual requirements. Currently we are spending considerable effort together with other stakeholders and interest groups on harmonization of approaches and processes within Germany. From this point of view electronic patient registration is not only an improvement for MCI management, but also a chance for improving the co-operation between various rescue organizations in Germany.

ACKNOWLEDGMENTS

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[2] We apologize for the high number of references in German language, but the situation in Germany is very specific and not comparable to other states.

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