Improving the documentation in mass casualty incidents by combining electronic and paper based approaches

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Abstract. This work presents a concept for combining paper based and electronic objects in order to improve information access in mass casualty incidents. We propose to improve the relief workers' documentation task by combining PBPTs (paper based patient tags) with RBPTs (RFID based patient tags). This combination, which we call RFID Enhanced Patient Tags (REPTs), is capable of combining advantages from both approaches. On the paper part paramedics can easily scribble down medical results, it can be read and extended easily by succeeding relief units, colored paper bars can be identified even from far away and for extending patient related information nothing but a pen is needed. The use of electronically readable tags enables the paramedics to log their patient contacts, provide the incident commanders with evolving information and to acquire the patient location.

Key words: Triage, RFID Tags, MCIs

1 Introduction

In mass casualty incidents (MCIs), relief units have to take care of a large number of victims spread out across a sizeable area. There are not enough relief units to focus on individual patients. Rather, they have to move around between many patients and synchronously go through several work phases. In the initial phases, information from individual relief units and patients has to be propagated to the incident commanders and then relegated back to all units, providing them with both spatial and temporal information on the current state of the relief operation. This situation is prototypical of scenarios generating and spreading ambient intelligence that involves increasingly detailed information both for the individual relief units and at the coordinating incident commanders.

1.1 Paper based approach

Currently, Paper Based Patient Tags (PBPTs) with unique ids are attached to every patient to accumulate and document all treatments. At first contact, during the triage, the condition of each patient is quickly assessed. The paramedics

hang a new card around the patient's neck. A color bar signals the emergency of required care. During the next contact with the patient, another medical team adds a short diagnose and the patient's vital signs to the PBPT while administering first medication. Later, the patient is transported to the local medication center. There, further medical treatment is provided and the patient is registered by name, with all information and the time being recorded on the PBPT. Finally the patient is transported to a hospital. The transportation vehicle, transportation modalities, destination and the transport priority are written on the PBPT.

1.2 Electronic approach

Inoue et al. developed a triage system which uses RFID tags [5]. They showed the capability of their system in a disaster control exercise with 82 injured persons. They assumed, however, that for the communication between the mobile RFID readers a mobile network is either available or can be built up easily. Chao et al. proposed a similar solution to identify patients with RFID tags in combination with a wireless network [1]. Massey et al. proposed a decentralized triage and sensing system [7]. Their disaster aid network (AID-N) consists of embedded systems which are connected to sensors which monitor the vital signs of the patients. The approach by Gao et al. [3] is quite similar to the AID network. Patient identification is performed with mobile hand-held devices which are equipped with 2D barcode scanners capable of scanning the 2D barcodes on patients' driver's licenses. The intelligent triage tag (ITT) is an electronic device to coordinate patient field care. The system which was developed by Lenert et al. combines a microprocessor, non-volatile memory and wireless transmission capabilities [6].

1.3 Comparison

The major advantage of paper based patient tags (PBPTs) is that information can easily be scribbled down during triage and medication. The PBPTs guarantee that the information can be read and extended by succeeding relief units. A large colored bar at the bottom of the card helps the relief units identify patients' triage categories even from far away. Using PBPTs guarantees that all relief units who medicate the patient have an immediate overview of previously performed triage processes or medications and can easily extend the existing information if required [4], [2]. In contrast, purely digital solutions (RBPTs) depend on more complex tools (hand-held devices) or even on the permanent availability of a wireless network [5], [1], [6]. Furthermore, identifications methods are slow and error-prone [3] and decentralized data storage is lacking [7]. However, RBPTs are better than PBPTs in providing the incident commanders with evolving information on the number and status of patients. The incident commanders are thus able to react more decisively and to adjust the motions of the relief units to go to the most critical areas.

2 Combination of both approaches

In order to capture the advantages of both PBPTs and RBPTs without duplicating their disadvantages, appropriate trade-offs have to be made when to store information digitally and when to continue using pens. Data entry must be fast and convenient and inconsistencies between data on paper and on chip must be avoided. These can occur, if relief workers sometimes enter information digitally and sometimes by pen. To this end, we separate information with respect to use (see Table 1): data needed for treating the patient and data needed for obtaining an overview of the disaster site. Both are provided by relief teams during their interaction with a patient - yet, they are entered and viewed very differently.

Table 1. Data presentation scheme

	on Paper	**on RFID**
Patient ID	fixed	fixed
Category	initialized, modifiable	initialized, modifiable
Surname	text field	-
Name	text field	-
Gender	select box	-
Medication	accumulated list	-
Team ID	-	accumulated list
Location	-	accumulated list
Time	-	accumulated list

Patient Data Patient data is most urgently needed whenever a paramedic team is at the patient. At that point in time, relief workers need to be able to see and add to the medication record without delay. Paper-based presentation is the most direct solution. Relief workers can use their pen to make proper annotations according to current work procedure. Also patient data or such medical annotations can be detailed and would be laborious to enter on a mobile device

Disaster Control Data Information to support an overview of the disaster site is closely related to temporal and spatial aspects. Such information can be sampled whenever a support team makes contact with a patient. When the relief worker places the mobile device close to the paper tag and presses a button, a time stamp and the id of the relief team can be transmitted to the RFID chip. Using a location tracking system, such as GPS, location information can be also provided by the mobile device completely automatically. All information plus the patient id and the current classification can also be stored on the mobile device and transmitted to the incident commanders whenever wireless network

access is available. Should the network be inaccessible, the data is automatically sent at a later point in time when the network can be reached.

Overarching Data The unique patient id and the patient classification are data items that are critical both for the patient data on the PBPT and for the disaster control data on the RBPT. The id is permanently set when the card is created. But the patient classification cannot be guaranteed to be always consistent since a relief worker might reassess a patient's degree of injury and change the color label without updating the RFID (e.g. because no mobile device is at hand or because the relief worker was interrupted). We suggest giving top priority to the paper based classification because of backward compatibility.

3 Conclusion and future work

The proposed solution shows how RFID technology can help relief workers in MCI scenarios to perform the necessary documentation more quickly. Since information can be duplicated automatically, the relief workers have more time for medication and transport of the injured. This application shows that RFID technology can not only be used for straight-forward identification; a powerful distributed database results from the sum of all REPTs in the field. The presented concept is promising, therefore we are in the progress of determining its suitability for practical use.

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