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An Integration of Emergency Department Information and Ambulance Systems

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Abstract. In this paper we propose an Emergency Department Information System that will be integrated with the ambulance system to improve the communication, enhance the quality of provided emergency services and facilitate information sharing. The proposed system utilizes new advanced technologies such as mobile web services that overcome the problems of interoperability between different systems, HL7 and GPS. The system is unique in that it allows ambulance officers to locate the nearest specialized hospital and allows access to the patient's electronic health record as well as providing the hospital with required information to prepare for the incoming patient.

Keywords. Emergency, ambulance, mobile web services, GPS

Introduction

The Emergency Department is considered one of the most important healthcare environments in that it provides initial treatment for many illnesses and injuries, some of which may be life-threatening and require immediate attention. However, the increased number of patients, overcrowding, long waiting times and the unavailability of beds are common problems experienced by most emergency departments. An effective emergency department information system that enables communication and information sharing between the emergency department and other healthcare systems will eliminate most of the commonly reported problems and increase the quality and efficiency of the provided emergency services.

Previous studies have reported improved patient waiting time by using existing Emergency Department Information Systems (EDIS) and other technology such as Radio Frequency Identification Tags (RFID). One study reports that using Radio Frequency Identification (RFID) tags for tracking will improve the patient flow and resources management in the emergency department [1]. Other EDISs include those that are focused on increasing efficiencies in emergency departments and providing integration between the emergency department and other hospital units. For instance, systems that provide communication between the dispatch control center, ambulance system and the emergency department of the hospital [2] and computerized whiteboard system [3].

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Novel EDIS systems include the telemedicine systems that are divided into two modules: mobile station (ambulance) and fixed station (emergency department). The mobile station is responsible for capturing video, audio, images and vital signs, and transmitting them to the fixed station [4-6].

However, despite reports of the various systems available, several drawbacks were found in the literature. These included: developed systems are client-server systems and designed for specific devices and operating systems, systems are not capable of searching and finding specialized hospitals based on patients condition and the lack of real-time access to the patient's electronic health record in which most systems focused on transmitting the patient's vital signs and other information in real-time to the emergency department and receiving instructions and advice for treatment without reviewing the patient's medical history.

In this paper, we propose an Emergency Department Information System to be integrated with the ambulance system. The proposed system aims to improve the communication and facilitate information sharing between the ambulance and the emergency department and to enhance the quality of provided emergency services. The proposed system is part of a larger system known as the "Mobile Comprehensive Emergency System (MCES) [7-9].

1. Methods

In this section we outline the emergency department information system and the proposed processes. The communication between the ambulance system and the EDIS uses HL7 standards. The HL7 message will be warped in the SOAP message and sent to the receiver. The receiver unwarps the SOAP message to receive the HL7 message [9] as shown in the system flowchart in Figure 1.

The system initiates when the ambulance reaches the accident location. After the ambulance crew assesses the patient, they enter the patient's current conditions (such as injuries, type of emergency, and level of consciousness) into the ambulance system. The system then identifies all specialized hospitals (as per the patient's condition) from the system's updated database and sends a check bed availability request to these hospitals. Each hospital receives the request and responds either with available or unavailable. The ambulance system receives responses and locates the nearest hospital by retrieving the GPS coordinates of the hospitals with available beds from the database and compares these coordinates with the ambulance's current GPS coordinates (using the navigation system and not direct distance).

After finding the nearest hospital, the ambulance system displays the road map to that hospital and sends ambulance ID, the ambulance's current GPS coordinates and the patient's ID to retrieve the patient's electronic health record and reserve a bed. If the patient's electronic health record is unavailable, the patient's current condition will be sent to reserve a bed. The EDIS will reserve the bed for the given ambulance ID and the bed status will be changed from "Available" to "Reserved for emergency" on the EDIS.

The ambulance then starts sending its coordinates continuously every 10 seconds to the hospital. To allow the emergency department staff to prepare for the patients arrival, the EDIS of the hospital will display the information received on a large wall screen as a list of patients to arrive along with a map representing the locations of ambulances (using a navigation system).

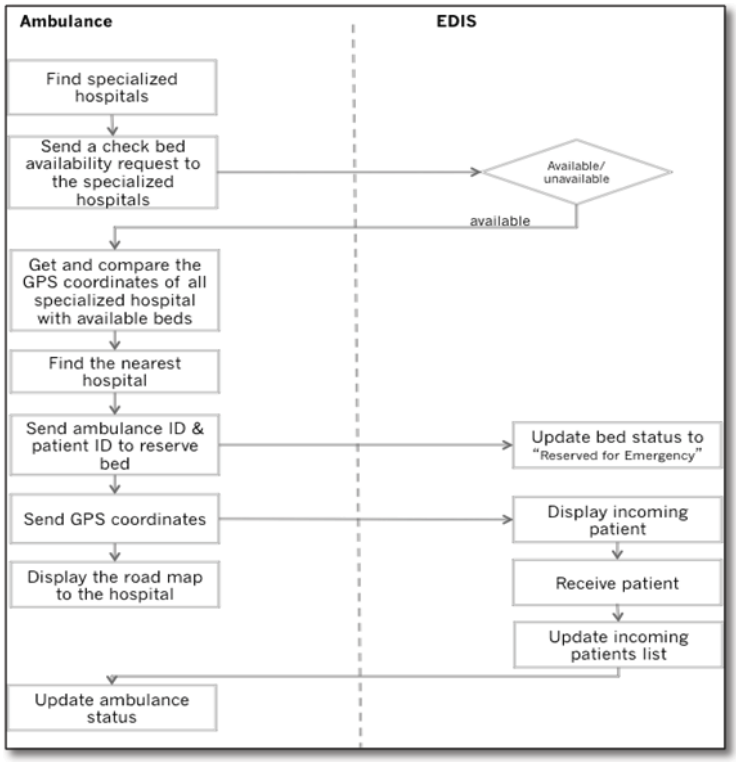

Figure 1. System flowchart

This list consists of four columns; number, ambulance ID, Patient ID and estimated arrival time (EAT) as shown in Figure 2. The patient ID column gives access to the patient electronic health record. Each ambulance location will be displayed as a red dot on the map and will be used to calculate the estimated arrival time.

No.	Ambulance ID	Patient ID	EAT
1	A-030	1277867	10:30
2	A-117	0785056	10:42

Figure 2. Display table for incoming patients

Before an ambulance arrives, the emergency department staff will be waiting for the patient. In order to reduce time the ambulance spends in the emergency department, emergency department staff will be ready to receive the patient from the ambulance

crew. Once the ambulance arrives at the hospital and delivers the patient to the emergency department, two actions will be carried out by the ambulance officers: 1) they will update the list to remove that patient entry and 2) update the ambulance status as following: If ambulance status was "Mission 2" (*carrying a patient and reserved for another job*), then its status will be changed to "Mission 0" (*enroute to pick up a patient)* and if ambulance status was "Mission 1"*(enroute to hospital),* then its status will be changed to "Available*" (ambulance open for a patient).*

2. Results

The proposed EDIS provides three main web services:

CheckBedAvailabilty: when the ambulance sends CheckBedAvailability SOAP request, the EDIS connects to the database and checks bed status. If there is an available bed, the response will be "available". Otherwise, the response will be "unavailable". If a connection error occurs while trying to connect to the database, an error message will be displayed.

ReserveBed: takes the ambulance ID and patient ID as input. When the ambulance sends a ReserveBed SOAP request, the EDIS connects to the database and updates the status of an available bed to "Reserved for emergency". If a connection error occurs or input is missed, an error message will be displayed to resend the request.

DisplayIncomingPatient: this web service will receive the patient ID, ambulance ID and its current GPS coordinates. It will display a list of four columns; number, ambulance ID, patient ID and estimated arrival time that will be calculated using the ambulance GPS coordinates (using the navigation system). Each ambulance location will be displayed as a red dot on the map. The ambulance system will send a DisplayIncomingPatient SOAP request every 10 seconds.

3. Discussion

This system will improve the communication between the ambulance system and the emergency department. Therefore, it will be able to minimize the time required to deliver a patient to the appropriate hospital by allowing the ambulance system to search for the nearest specialized hospital with available bed. The system will also be able to enhance the quality of the provided emergency services. By accessing the patient's electronic health record, the ambulance officer and the emergency department staff will be able to view the patient's historical medical information to provide the appropriate treatment. Reporting patient arrival and displaying the incoming patients list on the emergency department screen, allows emergency department staff to prepare efficiently for patient arrival, thus avoiding delay in treatment, long waiting times and potential overcrowding.

Furthermore, the new proposed Emergency Department Information System will be based on mobile web services. The system will be integrated with the ambulance system and other hospital units. The system overcomes the drawbacks of the previous systems by providing several functionalities. The main advantage of this system comes from the mobile web services technology that overcomes the problems of

interoperability between systems running different applications based on different programming languages on different platforms.

4. Conclusion

The proposed system will improve the communication processes between the ambulance system and the emergency department, as well as facilitate information sharing between them and enhance the quality of the provided emergency services. It has the following advantages:

- Searching capabilities for the appropriate specialized hospital.
- Real-time access to patient's electronic health record.
- Minimizing time the ambulance spends in the emergency department.
- Real-time monitoring of incoming patients.
- Allowing early efficient preparation for incoming patients
- Avoiding overcrowding by preparing hospitals for incoming patients and by notifying ambulances of existing overcrowding.
- Using new advanced technologies.

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References

[1] Sanders D, Mukhi S, Laskowski M, Khan M, Podaima B. A Network-Enabled Platform for reducing Hospital Emergency Department Waiting Time using an RFID Proximity Location System. Proceedings of Systems Engineering 19th International Conference**;** 19-21 Aug. 2008; 538-543.

[2] Su M, Chen H, Lin G, Shyua F, Su S, Cheng P, Shih C, Lin J, Chen S. Application of Wireless Network in a Medical Emergency Service Network. Enterprise networking and Computing in Healthcare Industry. HEALTHCOM Proceedings of 7th International Workshop; 23-25 June 2005: 45-50.

[3] Aronsky D, Jones I, Lanaghan K, Slovis C. Supporting Patient Care in the Emergency Department with a Computerized Whiteboard System. J Am Med Inform Assoc 2008; 15(2): 184–194.

[4] Mandellos G, Lymperopoulos D, Koukias M, Tzes A, Lazarou N., Vaganos C. A Novel Mobile Telemedicine System for Ambulance Transport Design and Evaluation. Proceedings of the 26th Annual International Conference of the IEEE EMBS, 2004: 3080-3083.

[5] Kyriacou A, Pavlopoulos S, Berler,A, Neophytou M, Bourka A, Georgoulas A, Anagnostaki A, Karayiannis D, Schizas C, Pattichis C, Andreou,A, Koutsouris D. Multi-purpose HealthCare Telemedicine Systems with mobile communication link support. Biomed engineering online 2003; 2:7

[6] Tolentino R, Jung-Hwan H, Sun-Ho K, Young-Tae K, Gil-Cheol P, Dae-Joon H. A Proposal of building an early-stage diagnosis system of first-aid through wireless internet. ICHIT '08 Proceedings of the 2008 International Conference on Convergence and Hybrid Information Technology 2008; 70-74

[7] El-Masri S. Mobile Comprehensive Emergency System using Mobile Web Services.Handbook of Research on Mobile Business: Technical, Methodological and Social perspective, edited by B. Unhelkar. Idea Group, 1 (2005) 106-112

[8] El-Masri S, Saddik B. Mobile Emergency System and integration. Proceedings of the 12th IEEE International Conference on Mobile Data Management 2011; 67-72.

[9] Saddik, B, El-Masri, S. Building an Advanced Wireless End-to-End Emergency Medical System, Studies in Health Technology and Informatics, 2011; 168 (1): 141-149