Reducing time in emergency medical service by improving information exchange among information systems

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Abstract— **There are many organized units involved to perform an emergency rescue mission: dispatch center, mobile rescue units and emergency departments (ED) in hospitals. Communication among them is often not fully automated, and then personnel need to cope with unnecessary work. That of course takes time in cases of urgent interventions, while time is one of the most important factors for patient survival. There are several processes in which better performance could be established. Improvement can be made by reducing communication obstacles between actors in processes and among three different information systems involved: hospital information system (HIS) in emergency department, computer aided dispatch (CAD) and records management system (RMS) used by mobile units.**

Verbal information exchange unreliability, paper sharing problems and retyping of data from system to system can be removed in many processes: hospital staff e-ordering from HIS, call taker to dispatcher in dispatch center, dispatcher to mobile unit and mobile unit to emergency department in hospital. With the establishment of paths among these three information systems (HIS, CAD and RMS) priceless saved minutes can be used in the battle for patient's life. Improvements can also be achieved in the cost-effectiveness. Many data exchanged from involved information systems and gathered to a central database can be very useful for the needs of accountancy and EMS operation improvement management and EMS quality assurance management.

Keywords— **information system, information exchange, emergency medical system, XML, HL7**

I. Introduction

This will present the current situation in EMS sector by analyzing actors in that sector and communication flows among them. EMS system usually consists of three organized units, that use different information systems. Every unit has to get proper information in appointed time to take prompt actions. To contribute to the needs of the units, every information flow has to have as less obstruction in its way to the user of that information as possible.

This article will introduce different processes, which that takes place in EMS activity. All of these processes holds their problems when conducting in a old fashion way. For each of the problems we will find the solutions by using knowledge in medical informatics. These problems are:

- Paper information cannot be shared simultaneously
- Availability of a call taker
- Lack of efficient control over mobile units
- Inefficiency of paper on terrain
- Poor and delayed information in ED for further hospital treatment
- Lack of cooperation among mobile units from different rescue stations
- Manual retyping when elaborating accounting and statistic analysis

At the end we will make a sketch of an integrated modular solution to dismiss the problems which occur in processes under investigation and some conclusions will be presented.

II. Problems and solutions for defined problems

A. Paper information cannot be shared simultaneously

Usually, when dispatch center is in full operation, there are at least two dispatchers, handling telephone calls for urgent and non-urgent interventions. Call-taker takes care of proper information acquisition and professional guidance of emergency situation patient/eyewitness. Dispatcher is managing the optimal mobile unit spatial distribution and assigning optimal mobile crews to the incidents according to the data collected by the call taker. While paper communication media can not be shared among many persons at the same time and so, time is spent inefficiently, the computer program could resolve the delay between acceptance of information and allocating the mobile unit to incident. That kind of disturbance can be abolished by establishing user friendly adjusted dispatch application with review of online data. That solution is appropriate even for dispatching centers with separated rooms.

We estimate that time can be reduced for 10 – 30 seconds on average, in some cases up to several minutes, if call taker has a lot of calls to handle and does not have enough time to pass filled paper forms to a dispatcher.

B. Availability of call taker

Call takers receives urgent and non-urgent calls in the order in which their clients call them. Non-urgent calls are continually made from different hospital wards for transportations of patients between different hospitals for several reasons. Call taker can accept that kind of a call for the time, someone else is making an urgent call. Sometimes it takes a lot of waiting online before call taker has a chance to answer emergency call. In between a seriously injured patient on field can blood out if caller cannot get some helpful information how to help the injured or a mobile unit is not fast enough. Sometimes seconds count.

By developing communications between HIS (as a non-urgent transport orderer) and CAD all of standard non-urgent transportations can be ordered automatically with simple transmission of data from a hospital to a dispatch center via XML/HL7 protocol levels. In that case call taker has a free line for eventual call, that urgently needs to be answered. During the day (when hospital majority of staff is working) there are a lot of non-urgent transports ordered. In larger towns and cities on every fifth non-urgent call one urgent is made and could potentially not be answered in-time because of unavailable call-taker.

C. Lack of efficient control over mobile units

In earlier cases we focused mostly on call taker, but for shortening reaction time of an intervention the efficiency of dispatchers are as important as the efficiency of call taker. Assigning intervention to a vehicle must be made by consideration of different factors like:

- Location of the incident
- Clasification of incident
- Availability of mobile units
- Location of mobile units
- Equipment of mobile units
- Knowledge of mobile units staff
- Etc.

Usually dispatcher uses a radio station in order to collect that information or has all available vehicles in a centralized garage. Gathering that information takes a lot of time before locating the nearest capable mobile unit, centralized garage is often not the best solutions, especially if the covering area is relatively large.

Sophisticated software in CAD can gather data automatically, quickly and more efficiently as earlier listed methods. Of course there is a need for some special hardware like GPS positioning, system and communications media sending data through GSM/GPRS, UHF radio, TETRA or other. Information exchange between RMS and CAD has to be as quick and as reliable as possible in order to get the right data at the right time.

Locating nearest mobile units via GPS, automatic checking for their availability, abilities and equipment and automatic delivering of data from dispatch center to mobile unit and vice versa could improve productivity and response times. A rough estimation shows that at least 10% (and up to 50%) of the time spent to assign intervention to an adequate mobile unit can be saved using improved and compatible software in dispatch centre and mobile units.

D. Inefficiency of paper on terrain

Many mobile unit crews use paper to write reports of the interventions they make. That means rewriting data from paper to a central database (for analysis purposes) later, when they come to the central garage. It can also mean rewriting some data for example from EKG monitor device. Paper is easily destructible media to write on (drops of blood, tearing, spilling liquid…) and not always the most appropriate to use in some circumstances.

Mobile units should use sophisticated hardware device, which would store data from an intervention the first time, they enter it. Because of better performance in all kind of condition rugged Tablet PC-s with special RMS software are likely more appropriate then ordinary laptops (too vulnerable). Very important time-saving factor is the synchronization between data in RMS and central data-base (DB), because data from RMS don't need to be re-typed into central data-base (DB). Other connections can be automated too, for example direct automatic connection to EKG and vital signs monitoring. With usage of protocols for intervention procedures, mobile unit software can be used as a paramedic guide through procedures of pre-hospital patient treatment.

Fig. 1 Example of eventual hardware to use in a Mobile unit

E. Poor and delayed information in ED for further hospital treatment

Intervention does usually not end on the terrain but in the hospital ED, where patient receives further treatment by doctors and other medical staff. Urgent patients are treated by special hospital emergency departments. It is very important that preparation of surgery rooms and equipment is made before the patient arrives to the hospital. Life saving activity can be more effective that way.

Delays and miscommunication occurs in transferring data regarding patient's condition from paramedics to doctor in the ED. ED doctors get to little data on patient soon enough to adequately prepare on how to help the patient. If they had all these data before patient arrived, they could have done all the preparations that was mentioned earlier. Data, which would arrive to hospital before patient, could be studied in much more silent circumstances and better medical decision could be made than in rush when patient arrives.

That shows necessary information exchange between RMS and HIS in an ED..

F. Lack of cooperation among mobile units from different rescue stations

A lot of transports between hospitals in a country are made every day for patients who need examinations on another location in the country. Usually mobile unit from one part of the country delivers the patient to a specialist in a hospital in another part and then waits for him/her until the end of an examination. That reduces the total availability of the unit especially if examination of a patient takes longer time or there are many of such transports.

When rescue stations send their mobile units to distant places their capacities are reduced and they cannot use those mobile units. Computer engineering could help fixing that kind of a dilemma with information system that supports mobile unit control exchange among dispatch centers IS. Dispatchers, could use mobile units when the units from another rescue station come into their area of coverage and are waiting the patient to finishes the examination with the specialist doctor. Capacities of mobile units can be stabilized that way and there should be no fear of lack of vehicles available. Therefore response time to non-urgent transport requests can be shortened to about 10-20%, according to some estimations as well as ambulance vehicle utilization can be improved by the same amount.

G. Manual retyping when elaborating accounting and statistic analysis

EMS system is quite a complex and diverse cooperation among several organizations. There are lots of different educated employees (from paramedics, dispatchers, mechanics to doctors, accountants and managers), Vehicle Park with large number of expensive equipped paramedic vehicles and infrastructure. But all these assets that enables the organizations in producing public goods need financing. People need salaries, vehicles and buildings need upkeep. So it is very important to use collected data on business processes made in past for proper accountancy and statistic analysis.

When accounting department uses the data directly obtained form hospital e-order, the data is complete and hold all the insurance and accounting details and there is no need to complete the data by retyping from paper forms that accompanies the patient to billing system that is usually a software module in HIS. This reduces the number of mistakes in accounting procedures and decreases the number ob complaints made by insurance companies.

Statistics is usually elaborated by management of the EMS unit pursuing the economic efficiency and quality assurance. Elaborating statistic analysis automatically is quite a different thing from elaborating statistics manually There is also reporting to a Ministry for Healthcare that is required on monthly basis.

Usage of central database when elaborating statistics can shorten time that is important from economic point of view, can reduce probability of making mistakes that may have heavy impacts. That means more cost efficiency in the EMS unit better management of changes according to pitfalls seen in the past and stronger insight when conducting quality assurance procedures.

III. INTEGRATED MODULAR SOLUTION

Analysis of several problems in the EMS activity showed above bring us to the conclusions on, how to make the entire process more efficient. All of the involved information systems (CAD, RMS and HIS) must be exchange information in a way to reduce verbal communication and paper or any other ineffective way of data exchange. Carefully engineered applications and structured databases can serve as good basis for automatic information exchange among different information systems.

We will show involved information systems, actors and communication flows on a simple picture to get an impression on how we think it should be connected.

Figure 2 shows us processes and data exchange among different information systems and their users from placing an order or calling the dispatch (call) center all the way to final hospital treatment by a doctor in a hospital.

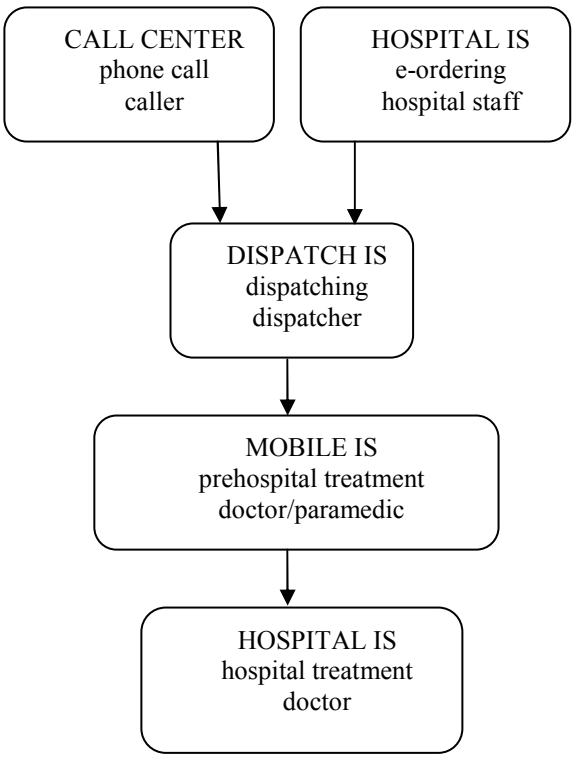

Fig. 2 Full concept of modular structure

IV. Conclusions

We can see that automation of processes and improved information exchange among different information systems involved can spare an EMS system a lot of precious time.

From a life-saving point of view significant progress in response time can be achieved. According to some estimations complete information exchange among IS supported by some organizational changes and work methodologies[1] can:

1. Achieve the standardized 60 seconds in urgent vehicle activation time[2]. by improving up to 5 minutes interval when bearing in mind the worst case scenario where national emergency number 112 is called and later transferred to EMS rescue station and again transferred to doctor to decide if he/she will participate the terrain intervention.
2. Improve the maximum vehicle driving time to urgent incident from 20min to 10min. by carefully allocating vehicles across the terrain. Reducing time to treatment from 20min to 10 min in cardiac arrest conditions means 100% improvement in probability of survival.
3. Shorten waiting queue in non-urgent transports for patients by 10%.
4. Make better utilization of vehicles by 10% means approximately 10% better economic results. That means 4 million EUR per year on national level in Slovenia[3].
5. Cause additional considerable improvements in a field of more productive accounting, management and quality assurance.

Updating (modernizing) the information systems and data exchange among them can solve some economic problems too, from accurate accounting to possible future planning of capacities and organization of EMS unit(s).

In the end we can say that informatization of that kind of institutions has so many positive effects that the investment to build the proper informatic infrastructure is practically negligent.

Acknowledgment

Authors would like to thank emergency medical staff from University Clinical Centre in Ljubljana, especially Mr. Andrej Fink and Mr. Janez Persak for sharing their knowledge. We thank also to Dr. Mitja Mohor for his suggestions for mobile terminals and Mr. Branko Kozar and Mr. Darko Cander for sharing their insight into cooperation between 112 service and EMS.

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