Interoperability in Disaster Medicine and Emergency Management

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***Abstract*-Accurate and timely information is critical for health early warning and effective emergency management. Health Information Technology (HIT) standards address the challenge of integrating information from disparate healthcare resources e.g. devices, people, systems to support not only the effective handling of emergencies, but also their analysis for long-term resource planning. In the management of emergencies, co-operative use of standards facilitates effective sharing of information among the parties involved in search and rescue, disaster assessment and public awareness. This paper discusses the cooperative use of interoperability standards from HL7, OASIS, and other SDOs to harness the power of Information and Communication Technologies (ICT) in emergency preparedness and response. The paper reports on the experience gained from the deployment of ICT in the SAFE civil protection exercise (satellites for health early warning) and interoperability considerations in technical solutions to be deployed in the POSEIDON exercise (earthquake followed by tsunami in the Mediterranean) still at the planning stage.**

I. INTRODUCTION

Time is a critical resource in managing emergencies. Thus, it needs to be compensated by high aptitude, sharp judgment and timely information. Education activities and training within the scope of readiness exercises traditionally support the development of skills. The role of ICT and interoperability standards on the other hand is the key in supporting decision making by delivering the right information to the right person at the right time.

In the aftermath of a disaster everybody is looking for reliable and accurate information. People are looking for their loved ones. ICT can help them register to receive updates and note their present location. Systems like SAHANA used in South East Asia after the Tsunami disaster, as well as social media like facebook are receiving increasing attention [1,2,3]. Commanders on the field need to assess the scene of the disaster. They ask: How many victims are there? What is their location? Is the area safe? How can the available resources assert the highest impact? The emergency operation center looks out for an overall assessment of the disaster, its own extended capacity through trained volunteers, location of response teams & ambulances, availability of healthcare facilities, and potentially external help. At the regional or national level, again assessment of the disaster is needed to understand the type of medical & other means, materials and human resources necessary to support the local population and visitors, transport patients, etc. In this level, decision makers need answers to questions like: What is the extent of the disaster? What is the extent of damage to infrastructures? What are the needs in health, food, shelter, support, etc. of the survivors? What is the status of the hospitals and other healthcare facilities? How many beds are available? Finally, there are also public health issues to be considered, such as: Is the water supply safe? How many people are in the shelter and what are their needs in food, beds, medication, etc.? Do we have indications for the outbreak of an epidemic? In all cases, a GIS system providing on a digital map layers summary information and real time updates could help quickly assess the situation and the development of the crisis.

In SAFE [4], a project co-funded by the European Space Agency, a civil protection exercise demonstrated the value of satellite-enabled applications in providing health early warning after an earthquake disaster. A local WiFi network supported by a vehicle equipped with satellite communications provided Internet connectivity in the crisis zone and in an earthquake refugee camp. In the crisis zone, volunteers would assist in triage entering information about victims on site to be instantly accessed the Emergency Coordination Center. In the earthquake refugee camp, the transfer of information from the Electronic Health Record (EHR) system to an epidemiological investigation system demonstrated the ability to provide early warning in public health at the onset of an epidemic. To achieve this objective, we experimented with the HL7 CDA R2 using ICD9[1], ICPC[2] to code diseases, problems and symptoms. The resulting clinical documents were exchanged using web services in the frame of protocols accepted by the WHO and National Center for Disease Control (http://www.keelpno.gr/en/)

In POSEIDON, a follow-up civil protection exercise co-funded by the European Commission, the theme is severe earthquake following a tsunami in the Mediterranean. Its special focus is collaboration and coordination among the participating member states in the management of disaster and familiarization with the European Civil Protection (ECP) Mechanism[3]. The ECP mechanism was formed in 2001 (European Council Decision of 23 October 2001) to provide added-value to European civil protection assistance by making

[1]WHO International Codification for diseases: http://www.who.int/whosis/icd10/
[2] International Classification for Primary Care: http://www.who.int/classifications/icd/adaptations/icpc2/en/index.html
[3]European Civil Protection Mechanism: http://ec.europa.eu/echo/civil_protection/civil/index.htm

support available on request of the affected country to ensure even better protection primarily of people, their property, but also of the natural and cultural environment. The need to activate the mechanism may arise if the affected country's disaster preparedness is not sufficient to provide an adequate response in terms of available resources. The tools set in place for the European Civil Protection Mechanism include:

- *MIC*: the Monitor & Information Center (MIC) is the operational heart of the mechanism, a one-stop-shop of civil protection means available amongst participating states, through which all affected by a major disaster can make an appeal for assistance. The MIC serves as the communication hub at headquarters level between participating states, the affected country and dispatched field experts and provides useful and updated information on the actual status of an ongoing emergency.
- *CECIS*: the Common Emergency and Information System (CECIS) is a reliable web-based alert and notification application created with the intention of facilitating emergency communication among the participating states.
- *Training Program* to ensure compatibility and complimentarity between the intervention teams from the participating states and to enhance the skills of experts involved in civil protection assistance operations by sharing of best practices through training courses, organization of joint exercises and a system of exchange of experts.
- *Civil Protection Modules* made of national resources from multiple member states on a voluntary basis, constitute a contribution to the civil protection rapid response capability fostering organizational interoperability at the level of the intervention teams. So far 13 modules have been specified, including water purification, search & rescue, field hospital, etc. [5].

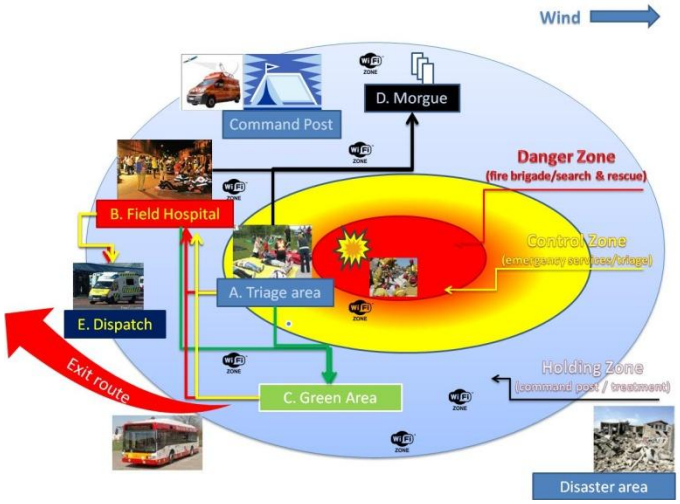

Figure 1: Technical configuration in disaster area for POSEIDON

POSEIDON will organize in April 2011 an operational civil protection exercise in the island of Crete that will engage forces from different EU member states through the European Civil Protection Mechanism. In this exercise, ICT needs to address the issue of interoperability standards in a global setting, whereas specific ICT applications to be deployed conform to these standards and aim at improving:

- *Activation of the European Civil Protection Mechanism:* providing knowledge and wider awareness of the underlying processes and procedures.
- *Management of medical emergencies, triage*: supporting the Emergency Medical Services in effective triage and treatment using innovative eHealth technologies in coordination with the regional health authority (Fig. 1),
- *Public alerts and warnings*: assuring the provision of safety /evacuation tips to the Public across different media, and possibly attempt to reduce the anxiety of people by exploiting the power of social media,
- *Situational awareness:* providing accurate information to decision makers using standardized messages and exploring the possibility to visually assess the extend of the disaster presenting on the map update messages from the field as well as reports of incidents and available resources including hospital beds, ambulances, rescue teams, and so on.

In the next section, the relevant activities and standards from HL7, OASIS, and CEN are presented as they are considered at the forefront of the emergency management and disaster medicine. Then, Section III presents in more detail the ICT applications used in SAFE and designed for POSEIDON focusing on interoperability and standardization aspects. Section IV discusses the main findings in SAFE and technical design considerations for POSEIDON. Finally, section V presents the conclusions.

II. RELATED STANDARDS

II.A. HL7 CDA and IHE Profiles

The Clinical Document Architecture (CDA) from HL7 International (www.hl7.org) is an HIT standard useful in the exchange of clinical documents. In disaster and emergency management, clinical documents need to be exchanged between Emergency Medical Services and the Emergency Department of the hospitals and their EHR systems if operational and interoperable, but also with public health agencies, regional health authorities and civil protection operation centers.

Integrating the Healthcare Enterprise (www.ihe.net) has developed several profiles that relate to prehospital and emergency care. The *EMS Transfer of Care* (ETC) Profile supports the exchange of clinically relevant data between pre-hospital providers and hospital emergency departments [6]. The *Emergency Department Referral* (EDR) profile allows clinicians to refer a patient to an emergency department providing a medical summary that includes besides current problem, past medical history, and medications, structures to provide information on the estimated time of arrival and method of transport. In addition, the *Emergency Department Encounter Record* (EDER) describes the content and format of records created during an emergency department visit. These

profiles use clinical documents in HL7 CDA to exchange clinical information or EHR data.

The Emergency Responder Electronic Health Record Interoperability Specification by ANSI/HITSP [7] has selected specific standards and profiles to track and provide on-site information regarding an emergency episode/victim. These include the IHE profiles reference above, the OASIS Common Alerting Protocol we will examine below, and several infrastructure standards that relate to identification and security. The National EMS Information System (NEMSIS) is an effort to standardize and make sense of the emergency information collected across 50 states in the United States. Its data dictionary reflects more than 400 of the most common terms in the management of emergencies [8]. The table below shows different elements of the EMS Transfer of Care profile and their correspondence to widely used data dictionaries, such as LOINC[4] by the Regenstrief Institute, and DEEDS[5] by the Center for Disease Control.

Table 1: EMS Transfers of Care Data Element Index [6]

Data Element	Opt	LOINC	DEEDS	NEMSIS
Emergency Contact Info	R2	Not available in LOINC	1.14 to 1.17 Emergency Contact	E07_18 to E07_26 Closest Relative
Chief Complaint	R	10154-3 CHIEF COMPLAINT	4.06 Chief Complaint	E09_05 Chief Complaint
Injury Incident Description	R	11374-6 INJURY INCIDENT DESCRIPTION	5.03 Injury Incident Description	E09 Situation E10 Situation/Trauma
History of Present Illness	R2	10164-2 HISTORY OF PRESENT ILLNESS	5.15 ED Clinical Finding	N/A NEMSIS
Acuity Assess	R2	11283-9 ACUITY	4.08 First ED	N/A NEMSIS
		ASSESSMENT	Acuity Assessment	
Active Problems	R2	11450-4 PROBLEM LIST	5.15 ED Clinical Finding	E12_10 Medical/Surgical History
Current Medications	R2	10160-0 CURRENT MEDICATIONS	5.09 Current Therapeutic Medication	E12_14 Current Medications
Allergies	R2	48765-2 ALLERGIES, ADVERSE REACTIONS, ALERTS	5.15 ED Clinical Finding	E12_08 Medication Allergies, E12_09 Environmental/Food Allergies
Immunizations	R2	11369-6 HISTORY OF IMMUNIZATIONS	5.15 ED Clinical Finding	E12_12 Immunization History
History of Past Illness	R2	11348-0 HISTORY OF PAST ILLNESS	5.15 ED Clinical Finding	E12_10 Medical/Surgical History
History of Pregnancies	R2	10162-6 HISTORY OF PREGNANCIES	5.15 ED Clinical Finding	E12_20 Pregnancy
Advance Directives	R2	42348-3 ADVANCE DIRECTIVES	5.15 ED Clinical Finding	E12_07 Advanced Directives
Family History	R2	10157-6 HISTORY OF FAMILY MEMBER DISEASES	5.15 ED Clinical Finding	E12_10 Medical/Surgical History
Social History	R2	29762-2 SOCIAL HISTORY	5.15 ED Clinical Finding	E12_10 Medical/Surgical History
Vital Signs	R	8716-3 VITAL SIGNS	5.15 ED Clinical Finding	E14 Assessment/ Vital Signs
Pertinent ROS	R	10187-3 REVIEW OF SYSTEMS	5.15 ED Clinical Finding	E09_13 Primary Symptom
Physical Examination	O	29545-1 PHYSICAL EXAMINATION	5.15 ED Clinical Finding	E16 Assessment/ Exam
Assessment	R	X-ASSESS ASSESSMENTS	8.30 Patient Problem Assessed	E09_15 Providers Primary Impression
Intravenous Fluids Administered	R	X-IVFLU INTRAVENOUS FLUID DMINISTERED	6.02 ED Procedure	D04_04 E18_04 Medications Given Route, 4205 Intravenous
Medications Administered	R	18610-6 MEDICATION ADMINISTERED (COMPOSITE)	7.04 ED Medication	E18_03 Medication Given
Procedures	R	X-PROC	6.02 ED Procedure	E19_03 Procedure

[4] Logical Observation Identifiers Names and Codes— LOINC: http://loinc.org/downloads

[5] Data Elements for Emergency Department Systems, http://www.cdc.gov/ncipc/pub-res/deedspage.htm

Within HL7, besides the Structured Documents WG which works on clinical document specifications and implementation guides for CDA and the EHR WG that works on functional specification for different cases of EHR use, Emergency Care (EC) and Prehospital Health Emergency (PHER) are Working Groups specifically looking into issues that relate to emergency management. The EC WG aims to "*bring the unique understandings and perspectives of prehospital care, emergency medicine, and emergency nursing to the HL7 standards process*", focusing on the development of comprehensive EHRs. The PHER WG is focusing mostly on public health issues.

S. Renly et al. discuss in [9] the use of HL7 CDA in a cross-border setting in the Middle East. Schnürer and Oemig in [10] support that Aarden syntax, a standard produced by the HL7 WG with that name, can be used along with terminology codings to trigger alerts and reminders to health practitioners in the presence of specific findings according to the epidemiological protocols defined by public health agencies.

II.B. OASIS-Emergency: Structured Information Standards

OASIS is a non-for-profit consortium for the advancement of Structured Information Standards founded in 1993 as SGML Open. The objective of OASIS as it relates to emergency management is twofold. First is to accelerate the development, adoption, application, and implementation of emergency interoperability and communications standards. Second is to represent and serve the needs of all constituents, from practitioners to technology providers and national, international and multinational oversight agencies. The emergency interoperability member section of OASIS was formed in 2007 and consists of a steering committee and two affiliated technical committees: Emergency Management -EM TC- (formed in 2003) and Emergency Management Adoption –EMA TC- (formed in 2009). EMA addresses Events & Demos, Collateral & Documents SC, as well as Education and Outreach [11].

The emergency standards developed or under development in OASIS include the following:

- Common Alerting Protocol (CAP), which became an ITU Recommendation x.1303 in 2007
- Emergency Data eXchange Language (EDXL) – Distribution Element (DE) (2006)
- EDXL – Resource Messaging (RM) (2009)
- EDXL – Hospital Availability (HAVE) (2009)
- EDXL – Situation Reporting (SitRep) work in progress.
- EDXL – Tracking of Emergency Patients (TEP), analysis
- EDXL – Tracking of Emergency Clients (TEC), analysis

The CAP v1.2 Integrated Public Alert and Warning System (IPAWS) Profile v1.0 was approved as a Committee Specification in 2009. The Department of Homeland Security's Federal Emergency Management Agency (FEMA) has decide to adopt an alerting protocol in line with CAP 1.1 as the standard for Public Alerts and Warnings [12].

The OASIS EDXL standards today provide the capability to support Alerts and Warnings, seamless routing of information, hospital availability to know where to route patients, and to request, commit, track, status and return resources. Important standards under development are those for Situation Reporting about any incident and its response (SitReps), to track patients (TEP), and extension of TEP to track any person displaced, evacuated, sheltering in place, expired, and/or requiring medical attention in the context of any scale incident (TEC). EDXL-SitReps aims to standardize the operational picture of the incident namely information about the situation and cross agency/jurisdiction response between responders, government officials, coordinating entities and the public [13,14].

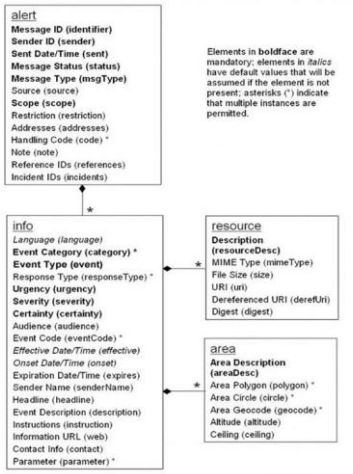

Figure 2: Basic entities of the Common Alerting Protocol [12].

In Europe, CAP has been used along with the Tactical Situation Object (TSO) developed in the frame of the OASIS project[6], in the EU co-funded project REACT[7]. The objective of REACT was to facilitate effective electronic communications among operation centers using standards [15]. TSO is the result of CEN Workshop Agreement supported by the OASIS project to facilitate the exchange information in the context of disaster and emergency management. TSO comprises a message syntax and a dictionary [16]. Thus, a TSO can describe different types of events, the resources engaged in the operation, and the tasks in progress (i.e. Context, Event, Resource, Mission). The approach advocated by REACT was to combine CAP (see fig. 2) with the TSO dictionary and was quite successful as it has been adopted by the Italian Firecorps [17].

III. HIT IN THE MANAGEMENT OF EMERGENCIES

III.A. Experience from SAFE

SAFE[8] – Satellites for Epidemiology and health early warning project, set out to demonstrate the value of satellite-enabled applications in the acute phase of the disaster as well in a settlement of earthquake victims. A vehicle equipped with satellite & local WiFi communications accompanied by a mobile biochemical laboratory provided the supporting infrastructure on the field within 30' of arrival, while a number of satellite terminals provided auxiliary telecommunication capabilities to key locations including the Operations Center of Civil Protection, a central Hospital, and the Emergency Coordination Center. Dedicated generators provided autonomy to each of these sites and a WiFi network provided the mobile teams with a live connection to the civil protection operation center, independent of the regular telecommunications infrastructure, which may be damaged or severely overloaded by the disaster. Thus, despite the disaster each of these sites was able to communicate through the Internet along horizontal and vertical lines of command.

Figure 3: Triage application used by Red Cross volunteers in SAFE.

In the acute phase of the disaster volunteers with Personal Digital Assistants (PDAs) entered triage information (fig. 3) that was immediately conveyed to the Emergency Coordination Center through the Satellite/WiFi network.

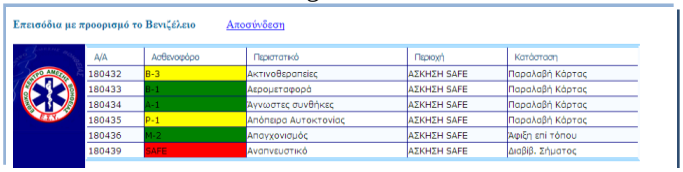

Figure 4: An application in the Emergency Department providing advance information on the episodes about to arrive.

In the emergency ward of the hospital, a screen listed the ambulances en route to the hospital (fig. 4). In the earthquake settlement, a group of volunteers with PDAs supported the management of the camp by recording the health needs of the population, facilitating the creation of reports on the status of the settlement and requesting medication, and other needs. The use of open standards was limited, since both applications were clients to the emergency information system. The use of non-standard unstructured reports via email worked at the local level, but overall scalability is limited in relation to the exchange of information with third-party systems.

In the medical office of the shelter an EHR system was deployed, and was extended to support selected protocols of

[6] OASIS EU project: Open Advanced System for Disaster and Emergency Management, http://www.oasis-fp6.org/

[7] REACT EU project: Reaction to Emergency Alerts using voice and Clustering Technologies, http://www.react-ist.net/

[8] SAFE - Satellites for Epidemiology and health early warning project: http://www.medes.fr/home_fr/telemedecine/teleepidemiologie/safe.html

the National Center for Disease Control. The symptoms (in ICPC) and diseases (in ICD9) that were recorded during the patient visit to the office, triggered an alert to report the incident, by presenting the appropriate form with selected fields were automatically retrieved from the EHR. After the physician digitally signed the form, the later could be submitted through a web service, in HL7 CDA format to the epidemiological surveillance system. Additional reports from the mobile clinical laboratory were linked to the original report based on a unique id. The HL7 CDA implementation guide created in this context was adapted from implementation guides used elsewhere.

III.B. POSEIDON: Resilient & Robust Interoperable Systems

Building on the experience gained in SAFE, efforts concentrated on creating resilient and robust applications that address the information needs of different groups including decision makers, emergency workers, and the public targeting the efficiency of the underlying processes. In particular, application focus areas that were selected to support with appropriate interoperability standards were:

- Situational Awareness for civil protection agencies and informed decision about the activation of the European Civil Protection Mechanism
- Management of Emergencies, Triage, and Telemedicine
- Alerts and Warnings to the Public.

Each of these areas is described in the paragraphs below.

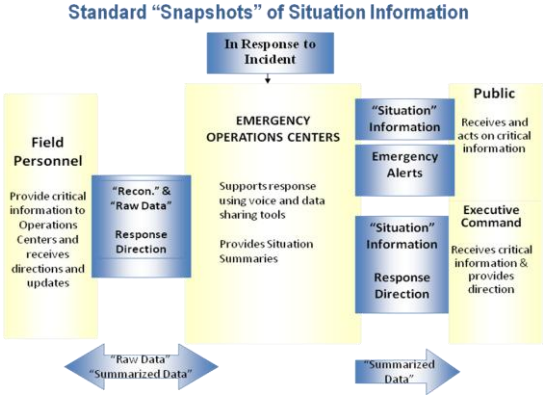

Figure 5: Types of Situation Information from in EDXL-Sitops [14].

III.B.1 Supporting Situational Awareness

Situational awareness is a process rather than a state where people are aware of emergency situations and pending risks and take measures to address them. Recent advances in ICT can support situational awareness by providing up-to-date information to collaborating civil protection agencies on the unfolding emergency incidents. Digital maps showing with clear marks information on the severity of incidents, the status of the infrastructure and the allocation of resources would facilitate not only decision making, but also horizontal and vertical coordination and communication. SmartPhones with GPS and GIS support will provide updates to commanders over the hybrid emergency satellite/WiFi network. The CAP protocol will be the message format. However, specification of the data dictionary is pending as TSO, EDXL-SitOps, RM, TEP are analyzed together with relevant medical dictionaries in the specific POSEIDON context. The REACT project used the TSO dictionary together with CAP to communicate information on the status of the crisis in different languages. In "POSEIDON" we need to use custom codes in Greek, which need to be translated in English and French. Recent developments in OASIS-Emergency for EDXL standards as SitOps (Fig 5), as well as HL7 Domain Analysis Models and IHE profiles for emergency are quite promising and of potential use to POSEIDON that addresses a specific use case dealing with Earthquake and Tsunami.

III.B.2 Management of Emergencies – Triage- Telemedicine

Significant part of the data feeding situational awareness is provided by the actual emergency workers on the field, doing triage, engaging in emergency treatment, transferring victims to a healthcare facility or a shelter. The transfer of information on the number, type, and severity of emergency episodes from the crisis area to the Operation Center of the Civil Protection, the Emergency coordination center and the receiving hospitals can help take important decisions about the management of resources and possibly the request for external assistance. Additional issues related to the use of interoperability standards at the site of the crisis concern information on hospital resources and the use of telemedicine services to support emergency health workers in field hospitals. The interoperability need is stronger if the EHR/PHR is promoted as the central repository for all citizen related health data.

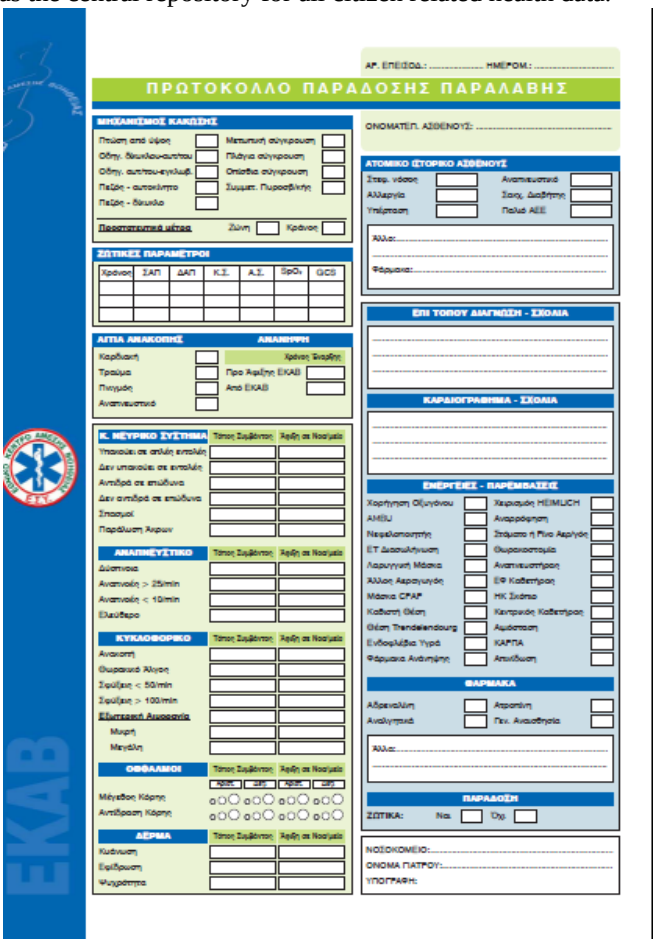

Figure 6: Form provided upon delivery to the ED by EMS services.

The form shown in Fig. 6 has been designed by emergency management personnel to be used during secondary triage-treatment (left part) and upon arrival to the hospital (right part). If standardized and widely adopted not only for disasters but also daily practice, it could improve to accountability, resource management, and eventually patient outcome.

This is an area where the HL7 CDA seems to be particularly useful is the exchange of data between the ECC and the Emergency Department component of the hospital information system. The IHE ETC profile has been analyzed to examine whether it suffices to accommodate the information. In addition to IHE profiles elements of the ongoing work on EDXL TEP/TEC need to be taken into account.

If the ability to evacuate the patients is limited, telemedicine could be a viable alternative, in the absence of specialized health professionals. From a standards perspective, clinical documents in HL7 CDA based on different templates could form parts of a teleconsultation folder, presenting an overview of an episode to be shared with experts. Patient connecting health monitoring devices can provide volunteers with important insight on their progress, while they can also support telemedicine.

```
<have:HospitalBedCapacityStatus>
<have:BedCapacity>
 <have:BedType> AdultICU </have:BedType>
 <have:Capacity>
  <have:CapacityStatus> Available
</have:CapacityStatus>
 </have:Capacity>
 <have:SubCategoryBedType> Surgery
</have:SubCategoryBedType>
 <have:Capacity>
  <have:CapacityStatus> Vacant/Available
</have:CapacityStatus>
  <have:AvailableCount> 40 </have:AvailableCount>
 </have:Capacity>
 <have:SubCategoryBedType> General
</have:SubCategoryBedType>
 <have:Capacity>
  <have:CapacityStatus> Vacant/Available
</have:CapacityStatus>
  <have:AvailableCount> 20 </have:AvailableCount>
 </have:Capacity>
</have:BedCapacity>
```

Figure 7: EDXL-HAVE message example

Another important aspect of our work relates to the EDXL-HAVE standard, which specifies an XML document format that allows communicating the status of a hospital, its services, and its resources. These include bed capacity and availability, emergency department status, available service coverage, and status of a hospital's facilities & resources (Fig. 7).

III.B.3 Alerts, warnings and *Guidance to the public*

Alerts and Warnings for the public traditionally use different media, e.g. sirens, loudspeakers, radio, internet, TV, short messages. As far as standards are concerned, CAP provides the right standardization framework. However, the actual message format and content need to be analyzed, confirmed with, and endorsed by the national civil protection authorities for limited experimental use by exercise participants. Currently in Greece, there is no legal framework for the use of electronic communication in alerting the Public on the occasion of pending natural disasters such as tsunamis. Thus, the evaluation results of this public Alert service in the POSEIDON exercise will be reported to relevant authorities and may serve in the revision of the relevant legislation.

In the USA, National Oceanic and Atmospheric Administration (NOAA), already produces tsunami alerts using CAP on the Internet (see fig. 8). As already mentioned the Common Alerting Protocol (CAP) is an XML-based data format for exchanging public warnings and emergencies between alerting technologies. CAP allows a warning message to be consistently disseminated simultaneously over many warning systems and media including internet, radio, SMS, TV, etc. Thus, CAP increases warning effectiveness and simplifies the task of activating a warning.

Figure 8: NOAA is using CAP in tsunami alerts

IV. RESULTS - DISCUSSION

The "SAFE" exercise demonstrated the value of ICT in the management of disasters. However, in a larger European or global context, interoperability issues turn out to be quite critical in providing timely information to decision makers.

ICT applications built for emergencies primarily need to be usable, robust, and resilient. In SAFE security and privacy concerns were deemed unfriendly to users facing unstable network connectivity. While delivering integrated services is important, unavailable components should not hinder the operation of working ones. One should not assume that the information infrastructure remains intact. Flexibility and alternative ways of use are keys to the success. Our use of ICT in the context of the SAFE exercise revealed the overhead of security and privacy mechanism in the backdrop of fluctuating network infrastructure. Finally, the availability of HL7 CDA implementation guides from www.hl7.org were very helpful in the process of creating the specific clinical document templates.

For POSEIDON, the challenges are higher as we try to bring HIT applications work closer to standards from HL7, OASIS and other relevant SDOs, while addressing the interoperability issues present both at the technical and the organizational levels. Information should flow in from different sources to be cross-checked and leveraged. This is a quite challenging task as information and messages should be developed in Greek and translated in English and French. Moreover, the legal framework needs to be reexamined reflecting on the

experience gained and the evaluation results of the POSEIDON exercise.

Although selection of applications and configuration in POSEIDON is still in the design and configuration stage, early indications show that cooperative use of standards is feasible, despite the presence of gaps and partly overlapping standards in emergency management.

V. Conclusions

Time is the most precious resource in disaster management and emergency response and that is a challenge for systems and the people dealing with the emergency. The grant challenge for engineers in service design and implementation is to cooperative deploy standards from different organizations to create robust, resilient and flexible integrated services, and leverage information from different sources to support decision making. The call of HL7 International and other Standards Development Organizations (SDOs), interoperability initiatives and consortia is to work together to cultivate a spirit of cooperation and collaboration that will bring out effective services build on global agreed standards to advance interoperability not only at the technical but more importantly at the organizational level leading to more effective and informed Disaster Management and Emergency Response.

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