Remote Accessibility to Diabetes Management and Therapy in Operational Healthcare Networks

REACTION (FP7 248590)

D4-5 Integration with emergency centres, results and experiences

Date 2013-03-07

Version 1.0

Dissemination Level: Public

Table of Content

Figures

Document control page

DOC	D4-5_Integration-with-emergency-centres_Results-and-experiences_V10.docx
Version	1.0
Date	2013-03-07
Dissemination level	PU
Category	R
Document Owner	CNET
Participant Partner(s)	CNET, ATOS, IN-JET, FORTH-ICS
Author(s)	Kamelia Khosraviani, Matts Ahlsén, Peter Rosengren, Stefan Asanin, Helene Udsen, Ivo Ramos Maia-Martins, Franco Chiarugi, Vasilis Kontogiannis
Work Package	WP4
Fragment	No
Abstract	This deliverable discusses the importance of information sharing issues and interest among different emergency services within the current workflow for alarm handling in multi-agency services. We investigate how REACTION-based applications for remote patient monitoring can be extended with interfaces for emergency services to improve the efficiency of such services
Status	☐ Draft ☐ Ready for internal review ☒ Task leader accepted ☐ WP leader accepted ☒ Technical Manager accepted ☒ Project Coordinator accepted ☐ Other (please specify if checked)
Previous Versions	

Version Notes

Version	Author(s)	Date	Changes made
0.1	Kamelia Khosraviani	2013-01-28	Initial ToC
0.3	Kamelia Khosraviani	2013-02-10	Content on background, workflows of UK & Sweden, Introduction, Experiences &Future work, Executive summary
0.4	Helene Udsen, Ivo Ramos Maia-Martins, Franco Chiarugi, Vasilis Kontogiannis	2013-02-15	Content on emergency services in different countries.
0.5	Matts Ahlsén	2013-02-20	Content on standards
0.6	Kamelia Khosraviani	2013-02-26	Revision of document
0.7	Peter Rosengren	2013-02-27	Added text about demonstration
0.8	Stefan Asanin	2013-02-27	Added text about IHE-PCD ACM and ORU example
0.9	Peter Rosengren	2013-02-28	Restructured chapter 5, finalised Executive Summary
1.0	Kamelia Khosraviani	2013-03-07	Final version submitted to the European Commission

Internal review history

Reviewed by	Date	Comments made
Enikö Kiss	2013-03-07	Approved with comments
Angelina Kouroubali	2013-03-07	Approved with comments

1 Executive summary

The different actors involved in an emergency situation need to not only communicate but also share important information about the patient with each other. An emergency situation management occurs by multitasking process of several varieties of services and systems that impact on efficiency of the processes in HealthCare chain. Ambulance Trusts have a central role in the treatment of the patient. In an emergency situation, quickly triaging trauma patients, transporting, giving the right treatment based on the patients' needs are important decisions which needs to be made by ambulatory care under a very limited time. These factors cause a lot of stress for Clinical team, patients and their relatives. To manage patient's information in a short time and avoid misinterpretation between the actors, demand a high degree of different technologies, interoperability and procedures orchestrating in each different layer of services and dimensions.

This deliverable reflects current discussion on how to optimize care in real time for an emergency situation while engaging and supporting patients with the new technologies and applications. Improving emergency management for the people with chronic diseases such as diabetes and delivering better care to them may reduce emergency administration and work overload not only to the hospital but also to the ambulance crew. Patient's involvement in the management of her/his own disease is encouraged and supported in REACTION platform by use of different wireless sensors and devices to deliver vital parameters continuously to health professional.

This deliverable discusses the importance of information sharing, issues and interests among different emergency services within the current workflow regarding alarm complexity handling by multi-agency services. We also investigate how REACTION-based applications for remote patient monitoring can be extended with interfaces to emergency services and survey important standards in this area like EDXL and IHE-PCD-ARM.

The integration of the REACTION platform with emergency services will be part of the Demonstration activities during the last iteration of the REACTION project. We will investigate a combination of the current technologies in the REACTION platform interfaced with an emergency system and explore future mobile application such as intelligent e-Triage that could provide automated and accurate vital signs sensing operation in emergency situations.

2 Introduction

In REACTION platform, various medical sensors are used to measure vital signs continuously, related not only to diabetes but also to chronic diseases. Other services that apply sharing of important patient information with primary healthcare centres remotely and continuously have been included and developed.

Even with the high prevalence of diabetes and its complications and the availability of successful prevention strategies, essential healthcare requirements and facilities for self-care management towards emergencies is still inadequate.

2.1 Experiences and previous results on Diabetes Management and Emergency Service

The most common and immediately life-threatening experiences to people with diabetes are diabetic ketoacidosis (DKA) and hyperglycaemic hyperosmolar state (HHS). Too much insulin administration can also cause a low sugar level (hypoglycaemia) and lead to insulin shock and diabetic coma. Critically ill patients with severe hyperglycaemia resulting from DKA or HHS should be treated immediately with regular insulin [1, 2].

Other diabetes emergencies that might occur to people with diabetes are heart attack, stroke and damages to feet and legs. Sometimes stroke may be mistaken for a hypo or vice versa, a hypo for a stroke. Evidences have shown the patients, who get prompt treatment within 1- hour of the start of the event, will have better recovery.

In some European countries e.g. UK, the ambulance service operates as a mobile health resource by providing treatment, assessment and diagnostic services .Thus they play an important role in providing care closer to patient's home [3].

Hypoglycaemia episodes can happen within minutes. Management of hypoglycaemia involves immediately raising the blood sugar to normal, determining the cause, and taking measures to hopefully prevent future episodes. Crisis management can seldom be self-administered so it is of the utmost importance to involve professional emergency and crisis teams as quickly as possible. Some researchers believe that the rate of decrease in blood sugar rather than its absolute low mark is what triggers the hypoglycaemia episodes. A REACTION application can detect both absolute low and relative changes in glycaemic levels and perform rule-driven event handling based on this.

A hypoglycaemia alarm is the most wanted feature in the diabetes community. Using the REACTION platform it would be possible to develop hypoglycaemia alarm handling based on multi-parameter techniques. Hypoglycaemia is one of the life-threatening emergency episodes in relation to abnormal levels of blood sugar or as a complication of treatment with insulin or oral medications. Diabetic ketoacidosis (DKA), hyperglycaemic hyperosmolar state (HHS), and hypoglycaemia , are other diabetes emergencies that are normally characterized by absolute or relative insulin deficiency[4]. Within this task we are not focusing on detecting hypoglycaemia as such but on handling it, what to do once it has happened, how to handle the event and how to respond to it.

As first aid steps in diabetic emergencies are not only to have an emergency plan as an important part of self-management but also know how to use emergency supplies, including diabetic supply kit, in case of natural disaster or other catastrophic event, according to recommendations of The National Institute of Diabetes and Digestive and Kidney Diseases.

Furthermore improving patient's knowledge regarding how to handle emergencies is one major aspect that requires new services by new modern technologies such as sensors, monitoring and intelligent feedback. This will enable patients to get involve into not only self-management in an emergency situation but also to share measured parameters with the emergency crew.

In order to provide better services and efficiency in healthcare, the knowledge of Care logistics model has been adjusted as a basic model both to Swedish HealthCare county council and NHS in UK as a Care processes model. The model is adopted from industries in order to manage and control different activities within the care workflow process. This model emphasizes the meaning of waiting time to get the right care for the right patient at the right level with the right cost. Experiences have shown how the Care logistic model could improve medical care operations and process management and controlled while the patient is still on the focus [5, 6].

In an emergency situation, ambulance nurses are expected to give optimum care to the trauma patients irrespective of limited recourses and an extreme time pressure. With the mobile technology, wireless sensors, field triaging and continuous monitoring of vital information's are transferring the measured data to the trauma canters [7].

However, today mobile technologies neither support sufficiently interoperability (both technical and social) in large- scale emergency nor provide some really fast and reliable network connections for mobile wireless systems [8]. Transport of non- critical patients leads to over triaged and over load patient flow in the trauma centres which in principle could increase the risk of mortality to the patients [9]. Worldwide, diabetes is one of the main contributors to ill health and premature mortality according to World Health Organisation.

In order to make optimum use of the available resources in emergency departments and make correct decision on the destination of the trauma patients, patient classification at the pre-hospital environment is essential [7]. In the UK, most of the ambulances service responds are related to diabetes people who are experiencing severe acute hypoglycaemia are approximately 100,000 per year. In this manner, reducing admission and providing better care for the persons at home has a significant impact on the cost of care in the community and patient's satisfaction [8].

Today's intelligent decision support systems enable medical facilities not only to care provider but also to the patients in emergency conditions even to patients home. In an emergency condition could be sent auto message from patients home to the care provide, e.g. doctor , relatives of patient or ambulance services to get advices and basic instructions regarding his/her health status [10].

The better care can only will be possible to delivered with a better coordination of services and resources between the ambulances services and specialist diabetes team [3]. Information sharing and communication between emergency agencies via several varieties of services with handling of information in different formats and sources will not be able to exchange important data and expected report in such a network, unless by use of heterogonous infrastructure with high degree of interoperability to the systems.

With a better coordination of services via a configured process, information sharing will be orchestrated in which way even multimedia data (e.g., images, video, audio messages, text messages, alert) could be classified , evaluated and prioritized as well as sources and destinations of data and where data should be delivered, this has been explored in the Bridge project[1].

The result of a study from Karolinska Institute 2012, correlated to structuring and developing Command System through Europe, has clearly indicated the necessary improvements to the current procedures which followed by pre-hospital care with use of the modern wireless sensors and technologies that could handle the complicated fragmentation with a common user interface which enable optimum care in a minimum time since the time plays a major factor in an emergency situation. With the regard to first and second evaluation in an emergency situation, on the patients, ambulance nurses need to use different instruments to measure vital signs [11]. Integration with a uniform platform such as REACTION can reduce the time nurses have to spend on this.

The Wireless sensors have shown good reliability and been used in many sectors in the healthcare in the recent decades [11], Implementation of wireless sensors with the ability of continuous monitoring can improve the time efficiency of the ambulatory care with respect to a better and safer care to the patient.

2.2 Purpose, context and scope of this deliverable

The work described in this deliverable is carried out as part of work package 4 "Data Management and Service Orchestration". Monitoring and event handling are important aspects of REACTION services. Any REACTION application will be able to react ubiquitously to change in the patients' health state and/or environment and perform pre-defined activities or alarm handling according to pre-programmed rules or through closed loops involving formal and informal carers. To this end REACTION will combine the orchestration of services with an underlying efficient networked-based event management solution.

The subtask 4.5.1 "Alarm Handling and Crisis Management" are specifically looking into how to involve the professional emergency and crisis team as quickly as possible in acute situations. In an

[1] http://www.bridgeproject.eu

emergency situation, measuring different vital parameters of trauma patient and making clinical decision, constrain a lot of time for ambulance services.

This deliverable is not intended to present clinical guidelines or establish a protocol related to crisis management emergency but to inform professional health team, ambulance trusts and commissioners on these key aspects of outpatient's care which includes diabetic emergencies care and show how REACTION platform can be extended to interface with emergency services.

3 Overview of Emergency Response Services

Emergency response systems in many countries are complicated and involve different organisations, technique, methods and standards for information's sharing and rules within a response operation. Gathering the most important patient's information by different actors and different decision making process may cause long response time that may be a threat to people's life. Figure 1 shows the complexity of an emergency network.

Figure 1 – Actors in pre-hospital care.

In order to understand how the REACTION platform could be integrated with emergency response services we have briefly surveyed how such services are implemented and delivered in 6 different European countries – Sweden, Denmark, Greece, Spain, Norway and UK – and which are the major actors in respective market.

3.1 Sweden

Emergency alarm management has in recent years gained a clearer connection to research and development. Emergency calls show on the importance of early intervention in acute illness accident and emergencies. Greater emphasise is also placed on prevention efforts in rescue, safety and emergency preparedness. Giving right Care in early stages can save lives and but also provides opportunities for effective and cost –effective measures in the next step.

The REACTION platform provides advanced technical support to support and manage emergencies episode in terms of digital mapping, alarm handling, positioning and logistic and large amount of data that could be processed and separated by type of event.

In order to get a better understanding of complexities in alarm handling with different series of activities in emergency situations, the current workflow followed by different actors among HealthCare in Europe has been studied in depth. For this purpose FALCK Nordic based organisation was the most appropriate sample for this study since it operates as a leader in rescue and safety in 35 countries on five continents which included Sweden and Denmark too.

In most emergency situation, identifying the patients who require immediate treatment or transport to the hospital is essential. Problems with under triaging trauma patients are also important to be addressed in order to make a right prognostic classification of patients and decrease risk of mortality as quickly as possible. Whereas if the non-critical patients are over triaged, it will increase the patient flow and the work load in the HealthCare centres which in turn lead to reduce the quality of care to the most needed patients.

Thus the Triage system must not only identify patients who are critically ill and in need of immediate care, but also assist the ambulance staff in making decisions on the most suitable trauma centres with

capacity of high care quality to the patient. Studies show that most of the triage systems precisely predict death, and the sensitivity and specificity for identifying major trauma patients is 70% each [7].

3.1.1 Workflow and current procedures within Emergency situation:

In Sweden all emergency calls will be received by SOS Centre who perform preliminary investigation over the situation before forwarding the call to the ambulance Centres. Depending on how big the causality at the spot is and the needs, ambulance nurses report to SOS to be assisted by other actors like police or firemen. To save the life of the patient, the first evaluation must start immediately. The limited time per patient is 3 minutes.

The patients who are incapable of responding and walking need to be transported to the hospital. The second evaluation starts with continuous measurement of vital parameters and paper based documentation. Some other measurements such as electrocardiogram (ECG) is sent to the hospital by undefined safe alternations in order to get receive advices from a specialist at emergency wards. Once patients arrive to the hospital, all vital information will be updated and recorded. The workflow has been visualised by the diagram below.

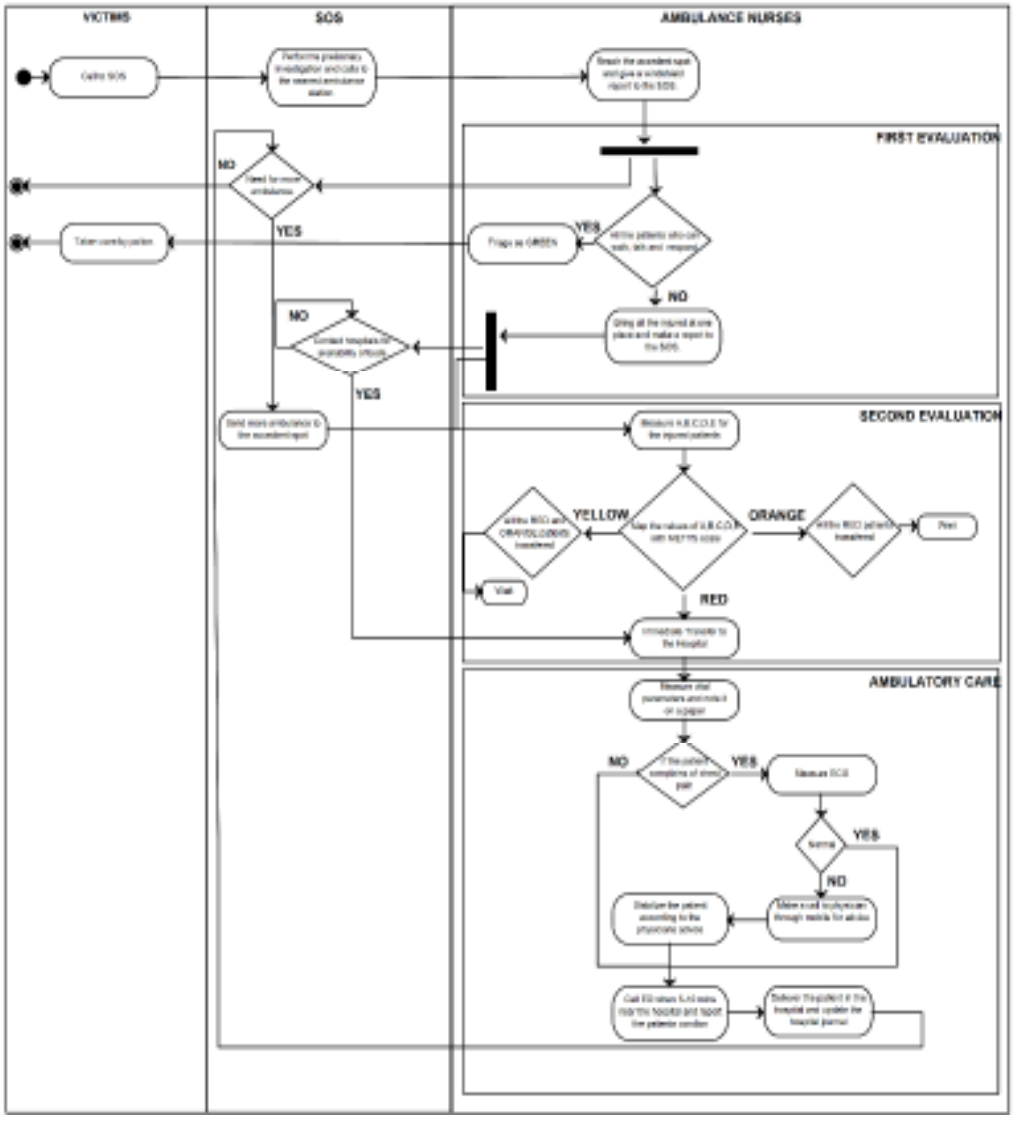

Figure 2 – Workflow of emergency care in Sweden.

3.1.2 Analysis of current workflow:

Despite of development of technologies due to measure the vital parameters, still remains problems with the time constrain in the current process flow to the ambulatory care. Wasting time is one the consequences of paper documentation which in turn leads to the low quality of the given care.

Another important factor is continued or detailed information transferability in real time to the hospital or emergency ward. Quick remote access to important information of patients and current condition requires a common interface between hospital and ambulatory nurses in order to exchange data in a real time without taking time of care on the patient.

Miscommunication through mobile telephone and radio is another issue and disadvantage which cause of manipulation of data. The current information exchange of important data between ambulance nurse's and emergency ward through mobile telephone leads to misinterpretation which effects accurate clinical decisions.

In addition environmental and external factors' impact on capturing data with high quality shall not be underestimated. The cold temperatures and noise can be mentioned such these kind of difficulties since human agent's ability in limited.

The current process shows time constrain to make an evaluation and the ambulance nurses have to take care of multitasking with many instruments due to measure vital parameters, documentation and conversations with the emergency ward at the hospital. The current operational process leads to not only workload for the emergency's team but also manipulation of important data that is not allowed to be missed or changed.

3.2 Denmark

Falck Healthcare is the largest private-sector provider of healthcare services in Denmark, with activities also in Great Britain, Norway, Poland, Slovakia, Sweden, and the United Arab Emirates.

Falck Healthcare's combined team of therapists helps customers overcome both physical and mental problems in support of public and private investment in healthy lifestyles and long-term reduction in healthcare costs. Falck Healthcare employs nurses, doctors, psychologists, physiotherapists and other professionals, helping customers with everything from prevention of lifestyle diseases and reviews of complicated patient cases to psychological crisis therapy and rehabilitation after accidents.

Their services are funded by private subscriptions, pension companies, job-related schemes and the public sector. Falck Healthcare is part of the Falck Group, whose business areas include various emergency services (fire, ambulance, vehicle assistance) and patient transport to and from hospitals.

Falck Healthcare services include:

Employee health

Prevention, case review, medical examinations, cross-disciplinary physical treatment, psycho-social advice and assistance for work-related and private events in addition to psychological crisis therapy in the event of accidents and catastrophes

Public health

Collaboration with public-sector institutions in providing services within areas such as assistive equipment, physical and vocational rehabilitation, accident prevention and establishment of health training centres

Absence management

Quick reviews of complicated patient cases through their network of specialist doctors diagnosing the patients and helping them all the way through the healthcare system In addition Falck Healthcare offers temp healthcare staff services in the Nordic countries.

3.3 Greece/Crete

The mission of Emergency Medical Service (EMS) in Crete is to coordinate the provision of medical care in emergency situation, and in so needed transfer patients to healthcare facilities. EMS all develops and proposes programs in the field of Emergency Medical Response, Pre-hospital Emergency Medicine and Nursing Care. The national EMS is entrusted with the management and massive casualties in the development of a Special Unit for Disaster Medicine (SUDK). EMS in Crete has established several Professional Training Centres, which so far has trained more than 2000 rescuers.

The EMS in Crete is using a **Pre-hospital Health Emergency Management System** currently, consisting of a number of applications providing services to the staff of EMS and other cooperating

healthcare service providers to optimise the provision of medical care in emergency situations. Since 1998 over 420000 episodes have been stored in the database of EMS in Crete. In more detail:

- The **Health Emergency Coordination Centre** application for the operators and dispatchers at the Health Emergency Coordination Centre (HECC) of EMS allows creating, completing and printing the electronic "Incident Card", as well as resource selection and handling of mass accident.
- The use of the **Triage Pre-Hospital Emergency Care Protocols** which includes a set of specific algorithms, offers help with regard to incident severity estimation and the selection of the most appropriate resources (e.g. ambulance car or mobile unit). Special electronic protocols endorse urgent and effective response of the Coordination Centre in contractually and radio-bio-chemical mass accidents.
- The **Episode Monitoring** is the doctors' application at the Health Emergency Coordination Centre (HECC) of EMS, which, in cooperation with the specific subsystems in the mobile units or at a Primary Care Centre (PCC), provides the possibility of patient telemonitoring, based on the vital signs and ECGs being transmitted through telematics from the incident site. Furthermore, by using the "Clinical Evaluation Card", the doctor at the HECC has a means to record in detail and in a well-structured manner the patient condition together with the therapeutic actions taken, during the whole incident.
- The **Episode Monitoring** application for the mobile unit crews takes care almost automatically, for the acquisition and transmission of the patient's vital signs etc., from the mobile unit to the HECC of EMS. The presence of a doctor is not appropriate since the patient can be monitored remotely. The telematics system in the ambulance is supported with the use of a digital electrocardiograph and a vital signs monitor.
- The integrated system of EMS also includes ambulance location-based services (GIS) for better monitoring for effective monitoring and management of available resources.

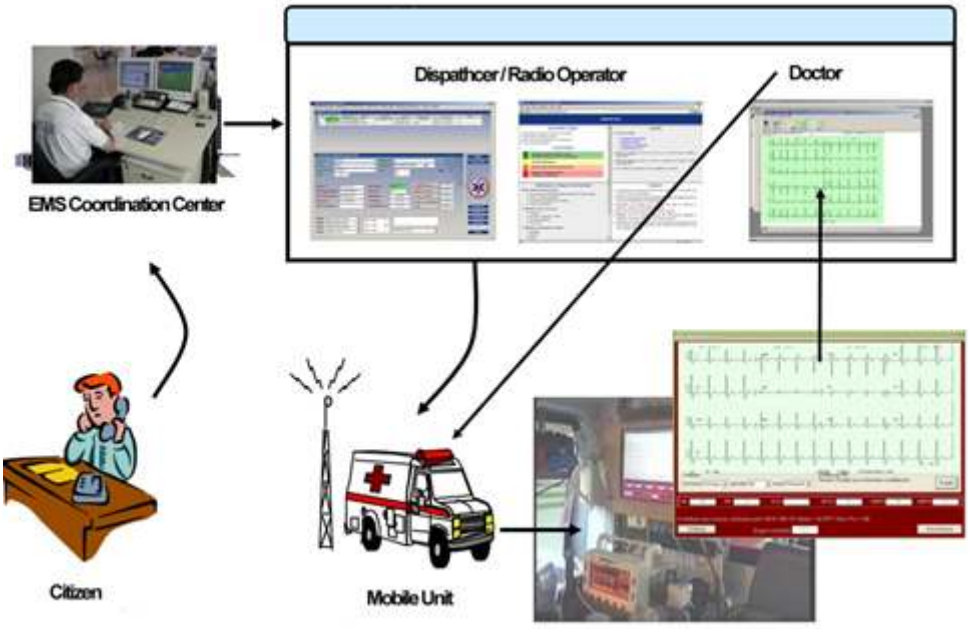

Figure 3 – Operation workflow in EMS.

Furthermore, a Mass Casualty Emergency Response System is supported in EMS in Crete, in the case of mass accidents or disasters. The triage utilizes latest technologies and the use of mobile devices. Triage is used in medical emergency situations by emergency personnel to pragmatic use limited resources to massively injured people. It allows doctors and other healthcare professionals to decide which people can be helped the most and how to help them efficiently.

Figure 4 – Workflow of disaster area.

3.4 Spain

In Spain, the Emergency Care requirements are provided at three different levels and modalities depending on the characteristics of the regional Medical emergency: emergency appointments at the Primary Care Centres (PCC), emergency medical services (EMS) inserted in a community and the hospital emergency departments (ED).

3.4.1 Emergency care provided by primary care centres

There are more than 3,000 PCCs, staffed by family doctors (who are general practitioners and paediatricians). Some of these centres also provide additional specialties such as genecology and orthopaedic surgery. On average, there is 1 PCC for a range of 15,000 – 20,000 inhabitants, and each family doctor is in charge of a range of 1,500 – 2,000 citizens, although less populated zones tend to have lower ratios.

Medical Doctors normally spend part of their duty time providing emergency care to their usual patients taking care of minor emergencies. Patients with a non-scheduled or urgent appointment with their assigned family doctor can usually get it in a 24-72 hours space time. If not, they can be attended in the same day by another doctor from the same centre. Patients with reduced mobility are attended at home.

The complementary immediate medical tests available at the PCCs are limited and consist of electrocardiography, blood and urine sticks. It is also possible to find specific centres that make radiographies, dry biochemistry, blood analysis and pulse oximetry, with specific rooms/wards. Where emergency consultations are attended 24 h a day. Some of them are even equipped with small observation units to maintain patients up from 6 to 12 hours but these new emergency centres are only available in big cities.

3.4.2 Emergency care provided by Emergency Medical Systems

The EMS is responsible on providing emergency care to minor complications. However they contribute hugely to guarantee population coverage in case of extremely emergency situations.

Their teams are usually composed by Emergency Medical Technicians (EMT), nurses and medical doctors who work exclusively in the emergency field. Their role in big cities is crucial, providing continuous home services, especially during PCC non-working hours. Demand of these centres tends to be bigger during weekends between 3 PM and 10 PM influenced by the fact that there are no PCCs open during weekends. The respiratory problems are the main complaint treated by EMS.

Emergency Medical Systems are the most immediate assistance for providing medical care in situations of personal or collective risk. Public spaces are main scenarios for minor emergencies and

accidents but also for mass casualties and catastrophes. For these last two cases, it is important to provide sophisticate point of care health services, including advanced cardiac life support units (ACLS). The number ACLS units in January of 2009 was of 362 operational teams (327 are ambulances and 35 are helicopters) working with a ratio of 1 ACLS unit per 127,308 inhabitants. These figures vary between different geographic areas. EMS also provides patient transportation between hospitals and from isolated areas to the healthcare centres, especially in the archipelagos.

Royal Decree 903/1997 establishes the need for the public telephone network for assisting citizens in case of emergency. Telephone operators and medical services, and integrated services should enable the implementation of the telephone number 112 as single free-of-charge number access to urgent care services across the country.

This number coordinates all public services that could be required in case of catastrophe, not only service health emergency, but also fire fighting and rescue, and public safety Civil Protection, regardless of public administration on which they depend on. This service will be conducted by the Autonomous Communities that should provide reception centres for emergency calls, where experienced doctors, nurses and technicians assign the best resource considering the specific complexity and location of each situation.

3.4.3 Emergency care provided by hospital Emergency Departments

According with statistics, hospital Emergency Departments (ED) manage more than 25 million services only in 2008, which means that one in each two Spaniards went to a hospital ED. They are equipped with a large variety of diagnostic tools that should be reserved for the most risky patients' situations to avoid overcrowding.

3.5 United Kingdom

Against the traditional mode of acute medicine which involves the admission of the patients to the hospital, the new model of ambulatory emergency care provides an appropriate support services based on the patient need in UK.

In order to improve inter-agency interoperability among different actors and layers in healthcare, The UK's National Policing Improvement Agency (NPIA) was developed on behalf of the Ambulance Chief Executive Group, Chief Fire Officers Association and the Association of Chief Police Officers. The guidance of NPIA is established framework for emergency preparedness to improve communications and coordination across the command, information sharing and control structures among multi-agencies services.

In the United Kingdom emergencies are routinely handled by the emergency services and other local responders without the government's involvement. The ambulatory Emergency Care service has major duty for providing emergency care to over 100,000 patients per year in UK. The Ambulatory Emergency Care unit not only manages a whole range of medical emergencies but also applies clinical risk score identifications, diagnosis, prognosis and treatment in an ambulatory way rather than taking a specific individual pathway approach.

With an estimated 2.35 million people with diabetes in England, most of UK ambulance services respond to calls from people with diabetes who are experiencing severe acute hypoglycaemia. Hypoglycaemic attack is a condition that the patient experiences such as increased pulse rate, tachycardia, increased blood pressure, sweating and anxiety.

In the United Kingdom ambulance services have a duty to integrate with local diabetes specialist team care. Ambulance Service NHS Trusts provide 24-hour patient call-back systems through the telephone. The patient's state will be followed by a trained nurse or paramedic in ambulance control between two to four hours when ambulance crew leave the sense to check on the patient's condition. To keep contact with the patient and give advice requires extra time for the emergency staff. Although this system assists in risk management of acute emergencies by reinforcing engagement with routine diabetes care, it is evident that diabetes poses the most considerable challenges to the NHS.

NHS has implemented a guideline to manage the diabetic emergencies. This Care model ensures and provides the most important information regarding diabetic emergencies such as education package's not only to the people with diabetes but also their relative and carer. According to this protocol, most episodes hypoglycaemia can be handled by those mentioned actors around the patient but depending on the patient's grade of consciousness.

However other diabetic emergencies such as diabetic ketoacidosis (DKA) or hyperosmolar state shall be diagnosed and treated by health professionals.

3.6 Norway

Common with other EU countries, the Norwegian emergency management model is managed through three organisational layers: a strategic, an operational and tactical layer. However the roles and responsibilities of actors within layers depending on how big crisis volume is. The three basic principle guidance to civil crisis management in Norway had been reflected to:

Responsibility: The responsible organisation in normal condition, or in charge of an area of competence, also has this responsibility when a crisis situation occurs.

Equality: the organisational structure during an extraordinary situation shall be common with organizational structures during normal conditions.

Proximity: this is the lowest logical organisational level which manage crisis and called often a 'subsidiarity principle elsewhere).

When an operation is initiated, an alarm will be sent to the local police departments, fire brigades and the ambulance service. The local police department establishes the Rescue Sub Centre (RSC) when a 'major incident' is declared and depending on how big the causality requires multi-agency response, it will be normally coordinated by them according to their specific procedures. The police, the fire department and medical authorities are normally an important part of the team.

Whereas Emergency Medical Communication Centres (AMK) establishes at hospitals as part of the medical alert system. These Centres are manned 24 hours a day by health personnel who coordinate medical transport services also. AMK personnel have duty to evaluate the necessary ambulance resource to the scene of the emergency and monitor their part of the operation.

3.7 Summary and Conclusions

It is clear from our short survey that emergency and crisis management is a complex process that involves several different actors that need to share data about the current status of the patient and his/her historical data. There are problems with in-efficiencies and miscommunications due to manual processes.

A diabetic emergency condition can happen at any time, within minutes and requires quickly respond to manage it correctly. Management of diabetic emergency involves other emergency services and actors with several varieties of systems. Given optimum care to a patient with critical condition in a minimum time is an important aspect to rescue life. At the pre-hospital environment, making right decision on patient's diagnosis, classification, prognosis, treatment and transporting/logistic, demands both intelligent advisory systems and adjusting the interoperability to make a collaboration and co-ordination between different several varieties of system and actors who are involved. These challenges encompass all of current services that constitute healthcare provision in real world from public health, through primary and specialist care, to ambulance services and those who commission such services.

The REACTION platform as such is not intended for directly improving the processes emergency and crisis management, but there are opportunities for REACTION to interface with such systems and thus indirectly provide advantages. There are mainly two ways in which REACTION platform and tools can help in improving existing emergency management systems:

- In situations where a patient is already under remote monitoring of the REACTION platform and experiences an acute crisis, for instance diabetes patients experiencing a hyperglycaemia attack. Then REACTION can provide already collected data about patient in a seamless way to the emergency and crisis management system and therefore improve their decision support.

- During the actual emergency handling it would be possible to use REACTION client gateways and wearable sensors to start early collection of data at emergency site and ambulance. This could be valuable both in remote patient monitoring scenarios but also in other types of emergency such as accidents and disasters. This could reduce the time nurses have to spend on setting up devices to measure vital signs, it could also avoid problems of miscommunication from ambulance to hospital.

We will further discuss the details of how REACTION can interface with emergency systems in chapter 5.

4 Standards for data sharing in emergency response

To deliver and share information's quickly in accurate way is one of the important purchases to emergency and crisis management's agencies. To participate and collaborate in a critical condition, all actors need to share and exchange relevant information with each other in order to effort response efficiently.

By construction of emergency information systems with high standard Information sharing and interoperability, other aspects regarding information models, messages formats and protocols shall be taken in account. The followed standards are;

- Alert, warning Messages
- Situation awareness and reporting
- Resource management, i.e., the provision and de-allocation of resources
- Risk Management, e.g., determination of hazardous areas, ,buildings, emission
- Commands and instructions
- Environment sensing
- Victim localization and triaging

A number of standardization actors are involved in this area including ISO (International Organization for Standardization), the IEEE and OASIS (Organization for the Advancement of Structured Information Standards). The latter has developed the EDXL: Emergency Data exchange Language, which is a framework of messaging standards being designed to serve the transformation, exchange and sharing between emergency agencies at different levels, such as risk and resource management, geographical information systems. The formats are XML-based and various message types can be sent using the EDXL Distribution Element (EDXL-DE). The Distribution Element provides the key routing information for dispatching "payload" messages from the categories mentioned above (e.g., Alerts or Resource Messages). It should be noted that the EDXL does not prescribe or provide any specific information model, but allows the use of different domain specific models and nomenclatures to facilitate interoperability.

4.1 EDXL-DE

The EDXL Distribution Element (DE) describes a standard message distribution for data sharing among emergency information systems using the XML-based Emergency Data Exchange Language (EDXL). This format may be used over any data transmission system, including but not limited to the SOAP HTTP binding. In addition various time and addressing Meta data it also defines a payload envelope element for inclusion of different types of EDXL standard messages.

4.1.1 EDXL-CAP

The common alerting protocol CAP is the first OASIS standard. It defines an XML schema that supports to transmit all types of early warnings and notification messages. CAP is has a fairly simple design and meets general interoperability requirements. It allows sending multi-language messages to different alert systems. Besides transmitting alert, event, and area related information, it offers the possibility to include external (non-XML content) documents as images by declaring a resource element. Not least, the message can be sent and routed without the use of EDXL-DE envelope payload element (which would require support for EDXL-DE as pre-requisite), as the routing information is incorporated in its alert element. As a consequence, one needs to accept some redundancy of routing data in case of sending CAP messages as payloads within EDXL-DE envelopes. The standard claims to support the recognition of patterns to derive hints regarding threats. However, enumeration is not applied for detailed information as event Type placing constraints in the early phase of automatic data processing. No particular support for commands supporting strategic decision is considered as part of this protocol.

4.1.2 EDXL-RM

Resource management is a crucial aspect in any emergency response situation, involving both human and material resources (e.g. equipment, tents, IT resources etc.). The EDXL-RM (Resource Messaging is a messaging standard format designed to facilitate exchange of information regarding the inquiry provision, and reallocation of resources, such as emergency equipment and tools, supplies of nutrition, and human resources as specific response personnel and teams. To handle an interactive channel of resource messages, a number of message types have been defined, dealing with an inquiry and its response, update and offerings of resources. The messages types build the common ground for a data model. Therefore not many pre-defined codes have been defined thus far, which can support automatic data processing. The RM messages need to be sent as EDXL-DE payload, as they include no routing information. Same as CAP, EDXL-RM considers no command elements and no further incident notification.

4.1.3 EDXL-HAVE

EDXL Hospital Availability (HAVE) is a messaging standard format that aims to enable the exchange of medical services information between hospitals and further institutions. Besides basic information as name and location, especially the capabilities of medical services as possible treatment and capacities of resources as available beds, or medical items can be expressed through EDXL-HAVE helping emergency response decision makers to improve the forwarding of patients to the proper place. For instance, during the response to an emergency incident a commander can send a message to a hospital for an update on its status and bed availability. After receiving and processing this request the hospital replies with a message containing the hospital's operations and facilities and its bed availability.

4.1.4 EDXL-TEP

EDXL Tracking of emergency patients (TEP) is a messaging standard intended for the exchange of tracking patient information throughout its medical treatment process, from patient encounter through to hospital admission or release. "*TEP supports patient tracking across the EMS incident continuum of care, as well as evacuations from hospitals and day to day hospital patient transfers, providing real-time information to responders, emergency management, coordinating organizations and care facilities involved in incidents and the chain of care and transport*."

4.1.5 EDXL-SitRep

EDXL-SitRep is a standard proposal. It is designed to generate reports about a situation, incident or event and the operational picture of current and required response. Primarily, SitRep emerged to improve the information exchange in all phases of an incident (preparation, response, and recovery) between public and private organizations. The higher goal is to support decision makers receiving compressed situational reports as a reliable base to frame their decisions. Examples of SitRep types of reports are *Field Observation*, a basic report from the perspective of an immediate observe and *Status Information*, a report that describes briefly and concisely the relevant incident and give information about complexity of the incident (e.g. disaster or large-scale crisis) or criminal matters.

4.2 IEEE1512 Incident Management Standards

The IEEE is also promoting the standardization of emergency and crisis management via its incident management working group IEEE1512. Among the set of standards are,

- IEEE 1512 - 2000 (Common Incident Management Message Sets for Use by Emergency Management Centres)
- IEEE 1512.1 - 2003 (Traffic Management)
- IEEE 1512.2 - 2004 (Public Safety)
- IEEE 1512.3 - 2002 (Hazardous Materials)
- IEEE P1512.4 - (Entities External to Centres)

4.3 IHE-PCD ACM

The REACTION project adopts the Continua guidelines and among these are the Integrating Healthcare Enterprise (IHE) standards and HL7. This makes is optimal to consider the IHE-PCD Alarm Communication Management (ACM) as format when sub-contracting external providers after REACTION project end. IHE itself is an initiative designed to stimulate the integration of any supporting healthcare information system. IHE as Continua does not define new integration standards, but rather supports the use of existing standards, HL7, DICOM, IETF, and others, as appropriate in their respective domains in an integrated manner, defining configuration choices when necessary.

The ACM extends the Device Enterprise Communication profile of the IHE Patient Care Devices domain to further specify the communication of alarm data describing states and events. These events and states are transferred from patient care devices to alarm manager systems and their origin may be physiological, that is, representing the physiological state of the patient (e.g. heart rate above or below a caregiver-specified safe range for the patient), or technical, reflecting conditions in the patient care devices themselves that may require action from caregivers (e.g. ePatch ECG battery status).

The idea behind IHE-PCD ACM is provide a uniform way of representing common alarm conditions as described above. They are represented in HL7 messages that facilitate interoperability of systems from different vendors and software developers.

In REACTION, a physiological alarm can be something that reflects the physiological state of the patient but by using IHE-PCD ACM it is possible to subdivide into different types of alarms and sub contexts (Figure 5):

- **Primary alarm system** - the patient care device itself provides visual and aural indications of alarms that can be seen and heard in the immediate patient vicinity, and that are the authoritative primary indicators of alarms resulting from monitoring the patient. Here caregivers shall be in a position to take immediate action excluding the need of any secondary alarm systems for alarm notifications.
- **Secondary alarm system** - a system intended to give the most optimal notification of alarms at additional locations, to additional persons, or for additional purposes such as archiving, but not intended to take the place of a primary alarm system as the authoritative primary indicator of alarms resulting from monitoring the patient.
- **Technical alarm** - an alarm reflecting the state of the patient care device themselves that may require action from caregivers (such as ECG leads off the patient).

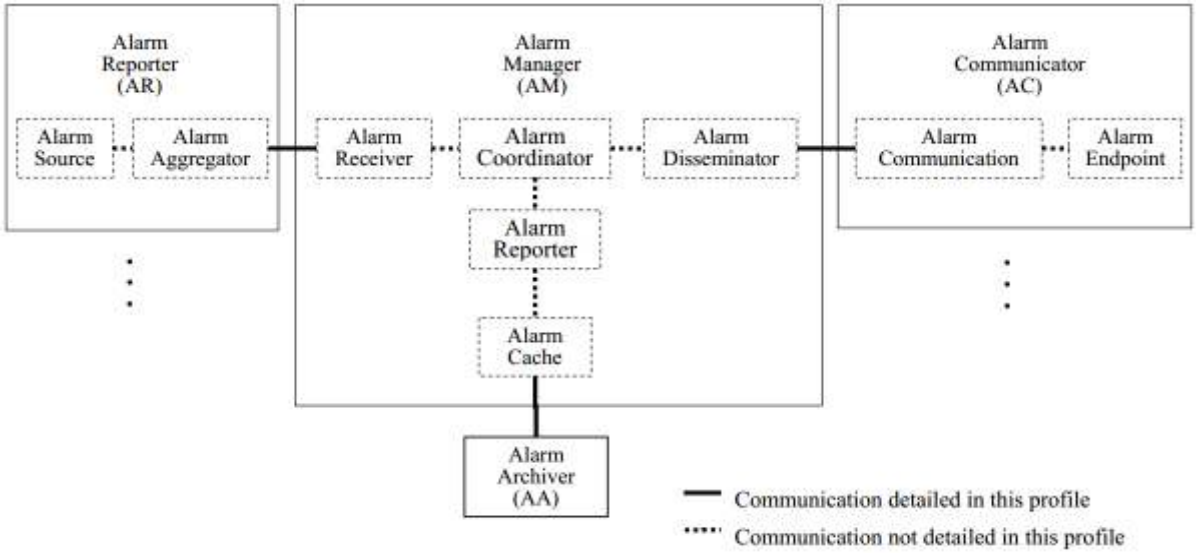

Figure 5 - The intended use of IHE PCD ACM.

IHE-PCD ACM has the purpose to serve in communication of alarm information from patient care devices to an alarm manager system communicating with secondary means of notification to caregivers. Typical secondary notifications are smart phones apps, SMS and e-mail.

From onset of an alarm to the response taken by the caregiver different workflows may be applied depending on the healthcare domain infrastructure and procedures (i.e. use case roles may vary). However, the treatment of event states in the basic form remains the same. Figure 6 shows a typical such transition diagram.

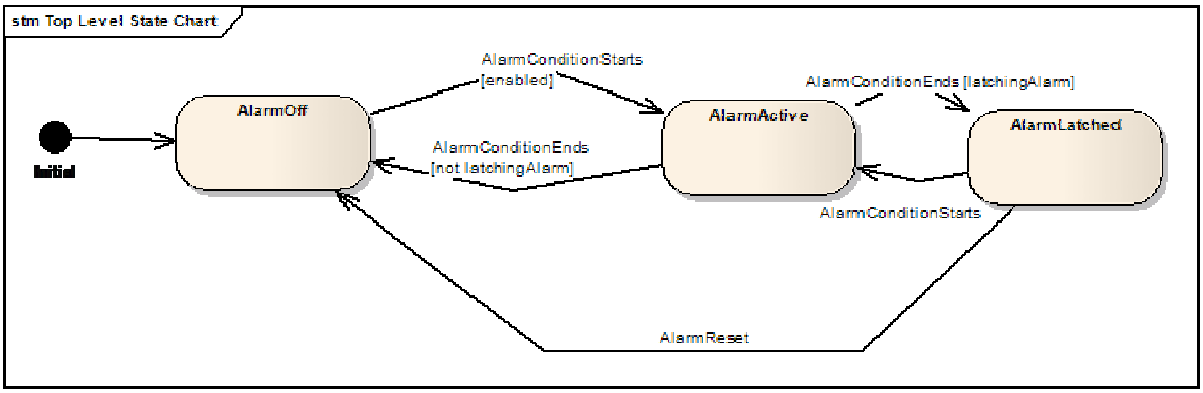

Figure 6 – State transitions for IHE-PCD ACM.

The states of a particular alarm condition are modelled as being: off (alarm condition does not currently exist), active (alarm condition currently exists), or latched (alarm condition formerly exists, does not now exist but is 'latched' so that clinicians can be informed of transient but significant conditions). The valid state transitions are diagrammed below.

5 Integration of REACTION platform with Emergency Services

The REACTION platform and tools have been designed to support development of many different types of applications for remote patient monitoring. In many of these applications it is a need to integrate and interface with crisis management and emergency response services. Out-patients care and emergencies needs and enable diabetes patients to manage their conditions more effectively, has been substantially emphasized by REACTION. The mortality of diabetic emergencies still remains high for the last decades, despite of all sufficient guidelines and protocols with details regarding to fluid electrolyte replacement and insulin therapy. However this trend needs to be emphasised with appropriate identification and management of diabetes emergencies.

In any emergency preparedness, pre hospital care is the only methods to reach the affected patient on the field with an optimum given care to the patient. Depending on the time available per patient, measures must be taken to make the pre hospital care process less stressful to the ambulance nurses and more efficient to the affected patients. Thus Real time monitoring of the measured values by using wireless sensors and with integrated decision support will be a benefit.

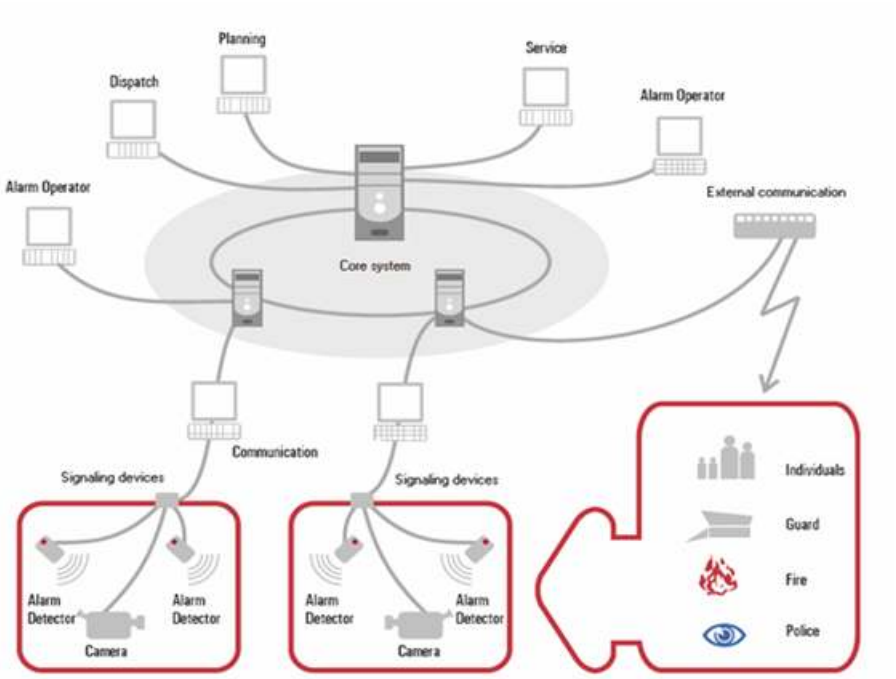

Figure 7 – Architecture of a typical alarm monitoring solution.

During event monitoring of diabetes patients, the REACTION platform could detect dangerous events such as hypoglycaemia, where immediate response from first aid or crisis teams is necessary, often within minutes. The REACTION platform also must be able to forward an alarm safely and securely to a crisis management team using the infrastructure which is in place for standard rescue services or social care services (ambulance, fire, home nurse, etc.). This involves specifying the alarm signalling protocols and conditions and testing the final alarm interface in smaller trials.

Figure 7 shows a typical alarm monitoring architecture. The communications controllers receive signals from different devices using different (open or proprietary) protocols and translate these signals to a uniform standard which can be read and processed by the core system.

The nature and importance of alarm complexity handling within multi- agency emergency services, demands well distributed collaboration of different actors with variety of systems. Therefore the REACTION platform's aim is to handle professional alarm among several different states such as Event occurred, Alarm sending, Alarm acknowledged, Alarm responded and even emergency team dispatched based on management of different rules-based level.

Meanwhile as diabetic emergencies can occur within minutes, immediate decision performance based on patient need is essential. The use of an advance system may become necessary as intelligent information's system to allow clinical team to have convenient access to patient data as well as to

clinical guidelines due to specify recommendation and actions to be taken in different clinical conditions.

These challenges toward crisis and emergency management arise along several interrelated dimensions and analysis of the work flow to emergency services with different layer needs to be well addressed additionally through concreted innovation effort due to continue the state of art on which REACTION project is determined to achieve.

5.1 Communicating alarms

Usually typical physiological measurements carry some key attributes that in the transactions of the DEC profile have been fitted readily into a single OBX segment. This is not the same for alarms. It may have multiple heterogeneous key attributes such as alarm source, alarm priority, and alarm phase called facets that are encoded in multiple OBX segments and hierarchically nested under a single OBR segment (all OBX segments under the OBR must pertain to a single alarm). As such, each different OBX segments pertains to a single alarm and are distinguished by OBX-4 Observation Sub-ID, which identifies the specific source within an instrument while for alarms, the facet represented by a particular OBX segment.

Most alarm message characteristics are identified by a combination of OBX-3 Observation Identifiers and an OBX-4 Observation Sub-ID. These are represented with a value in the OBX-5 Observation Value. The alarm priority and alarm source are given in the OBX-8 abnormal flags field of the facet OBX segment (see more in Figure 8). However, the intention of IHE-PCD ACM is to transmit transparently the key attributes of an event relevant to designated secondary caregiver notification endpoints and may include: 1) the identity of the alarm, 2) whether its source is physiological or technical, 3) its priority (severity), 4) the state transition or persistent state that is being communicated by the current message.

The representation relies on the ISO/IEEE 11073 nomenclature and concepts for alarms, which in turn are consistent with IEC 60601-1-8 alarm nomenclature and concepts.

ORU^R01^ORU_R01	Report Alarm Message
MSH	Message Header
[{SFT}]	Software Segment
{	--- ALARM_begin
[	--- PATIENT begin
PID	Patient Identification
[	--- LOCATION begin
PV1	Alarm Location
]	--- LOCATION end
]	--- PATIENT end
{	--- ALARM_IDENTIFICATION begin
[ORC]	Alarm Common
OBR	Alarm Identification
[{	--- ALARM_OBSERVATION begin
{OBX}	Alarm observation relative to OBR
[[NTE]]	Notes and Comments
}]	--- ALARM OBSERVATION end
}	--- ALARM_IDENTIFICATION end
}	--- ALARM end

Figure 8 – IHE-PCD ACM HL7 ORU message structure.

For REACTION sub-contracted alarm subscribers and management centres a typical HL7 message can look something like below where a physiological limit alarm for pulse rate is exceeded.

```
MSH|^~\&|||||20080515123100||ORU^R40^ORU_R40|MSGID5432346754|P|2.6|||NE|AL|||||IHE_PCD_ACM_001^HL7^2.
16.840.1.113883.9.n.m ^HL7
PID|||123456789||Doe^John^Joseph||19630415
PV1|||SICU^301^2|||||||||||||||11772233
OBR|1||09780979a9879^PHILIPS^ABCD002343785379^EUI-64|MDC_ALARM_EXAMPLE^Sample alarm^MDC^979879-
9879^Example^SNM3|||20080515121000|||||||||800 555 2323
```

```
OBX|1|ST|196648^MDC_EVT_HI^MDC|1.1.1.1.1|PLETH PULSE
HIGH|||H~PM~SP||||||20050515121010||||CD12345^ORIGatewayInc ICU-04^AECF114477885323^EUI-
64|20080515121000
OBX|2|NM|149538^MDC_PLETH_PULS_RATE^MDC|1.1.1.1.2|160|264896^MDC_DIM_PULS_PER_MIN^MDC|40-
140|H~PM~SP||||||20080515121000||||||264896^MDC_UPEXT_FINGER^MDC
OBX|3|ST|EVENT_PHASE|1.1.1.1.3|start
OBX|4|ST|ALARM_STATE|1.1.1.1.4|active
OBX|5|ST|INACTIVATION_STATE|1.1.1.1.5|audio-paused
```

5.2 E-triage using ePatch

Triage means assessing and sorting patients by the medical severity. In most countries Triage is used in medical practice to categorise victims according to their needs for medical attention. This category is distributed to:

- *Red-Immediate*: The patient needs immediate specialized medical attention to survive.
- *Yellow-Delayed*: the patient‘s condition may be serious and will survive in the next hour without medical attention
- *Green-Minor*: The patient’s prognoses is lightly and do not face a threat to the patient’s life for the next few hours up to day.
- *Black –Lifeless*: The patient’s prognoses are very poor who has no chance to survive or dead.

In the most emergency situation, identifying the patients who require immediate treatment or transport to the hospital is essential. Problems with under triaging trauma patients are also important to be addressed in order to make a right prognostic classification of patients and decrease risk of mortality as quickly as possible. Whereas if the non-critical patients are over triaged, it will increase the patient flow and the work load in the HealthCare centres which in turn lead to reduce the quality of care to the most needed patients.

Thus Triage system must not only identify patients who are critically ill and in needs of immediate care, but also assist the ambulance nurses to make decision on the most suitable trauma canters with capacity of high care quality to the patient. Studies show that most of the triage systems precisely predict death, and the sensitivity and specificity for identifying major trauma patients is 70% each.[7]

The E-triage definition proposes replacing of currently used paper tags with a snap –on networked bracelet integrating physiological sensors and GPS unit for location tracking, such as the ePatch platform being used in REACTION. The ePatch enables monitoring the status of the patient and send updates information to the other components involved in the network infrastructure. Thus e-triage concept can be used as responds to: Registration and overview number of the patients in an emergency situation, sensors and monitoring in form of bracelet/ePatch which could measure pulse, heart rate and respiration frequency, o2 saturation, body posture, movements etc. Furthermore, alerting on changes in condition and in advance auto triaged by sensors which would be useful as a bracelet or patch that performs automatic triage.

Using the REACTION-enabled ePatch also provides a good way of extending the REACTION platform into the ambulance and that already collected data could be easily transferred to the ambulance nurses and therefore provides better decision support for them.

5.3 Demonstration of Emergency Service Integration in REACTION

During event monitoring of diabetes patients, the REACTION platform must detect dangerous events such as hypoglycaemia, where immediate response from first aid or crisis teams is necessary, often within minutes. The REACTION platform also must be able to forward an alarm safely and securely to a crisis management team using the infrastructure which is in place for standard rescue services or social care services (ambulance, fire, home nurse, etc.). In order to specify the alarm signalling protocols and conditions and test the final alarm interface in trials, a professional alarm and crisis management centre is needed for a limited period of time.

Originally subcontracting of healthcare economics and regulatory work is part of WP2 and WP9 but due to temporary absence of any plausible emergency centre within the scope of project time, the project needs to focus on the challenges given by the idea of connecting sub-contracted external providers to the healthcare domain ecosystems, tele monitoring services and national and European regulatory landscape in healthcare.

The cost set aside for arranging trials with an emergency and alarm organisation was meant to cover alarm handling operations during the course of a couple of months but as setup involving a crisis management emergency centre will no longer be created. In reality, professional alarm handling involves several different states: event occurred, alarm sent to emergency team, alarm acknowledged, emergency team dispatched, and alarm responded, etc. and handling complex alarm schemes like this thus require a state based approach.

The subcontractor should allow alarms to be submitted to its monitoring and alarm centre and have its personnel perform pre-described actions, such as those normally prescribed for alarm and rescue services. Furthermore, the subcontractor must be willing to provide open specifications for the signalling and participate in performance monitoring, evaluation of services and reporting.

The crisis management can seldom be administered by private so it is of the utmost importance to involve professional emergency and crisis teams as quickly as possible. However, neither the in-hospital trial nor the primary care trials involve the use of crisis management and the partners undertaking the trials do not have connections to specific crisis management and alarm teams.

The work in subtask T4.5.1 has been split in two activities. The first activity encompasses the development of an alarm handling extension to the event handling framework, as was described in section 5.1 and the second task will be transferred to the WP11 Demonstration, where a hypoglycaemia alarm will be demonstrated in a real setting, with the exception that hypoglycaemia will be simulated.

The demonstration will be done in the municipality of Skive, a location chosen because CNET and IN-JET have installed a Telemonitoring platform based on the REACTION Device Development Kit to the social and healthcare department of Skive municipality.

Skive is a municipality in the Central Denmark Region. The municipality covers an area of 682 km² and has a total population of 48,356 (2008). Skive Municipality has the responsibility to provide healthcare and social care services to its citizens. A new health centre with integrated nursing home and a small “acute” bed section has been planned for patients that do not need to be admitted to the hospital, but who are too uncomfortable or worried about their condition to be staying at home.

The new centre will also include a 24/7 Contact Desk for patients that need advice about their condition, about medication or other urgent questions. It is not a crisis management centre in the traditional sense for patients that warrant emergency intervention so it is better suited for performing tests and demonstrations that do not interfere with emergency situations.

We will show patients being monitored using the REACTION platform and having the multi-protocol home gateway installed. When an acute event occurs (for instance heart attack, hypoglycaemia) the REACTION Event Manager will trigger a specific Alarm Handling Service Orchestration which will involve an external emergency service operator we are currently in contact with.

6 Conclusions and Future Work

In this deliverable we have surveyed and analysed how the REACTION platform could be integrated with an Emergency Service infrastructure. The flexibility of the Service-oriented approach of the REACTION platform makes it possible to extend the platform with external services such as Emergency response services.

A diabetic emergency condition can happen at any time, within minutes and requires quickly respond to manage it correctly. Management of diabetic emergency involves other emergency services and actors with several varieties of systems. Given optimum care to a patient with critical condition in a minimum time is an important aspect to rescue life. At the pre-hospital environment, making right decision on patient‘s diagnosis, classification, prognosis, treatment and transporting/logistic, demands both intelligent advisory systems and adjusting the interoperability to make a collaboration and co-ordination between different several varieties of system and actors who are involved.

This requires specific innovation and an approach which could be learned by domain analysis. Therefore it is necessary to provide more analysis on how a multi-emergency agency operates in different emergency situations in the context of European Union. It’s also necessary to provide insights into the underlying structures and working practices between different actors by different data format. Sharing and storing data from the different patients either on line or offline with the high capacity and multiprocessor multimedia server which can improve the quality of care delivered is an important aspect.

Providing a data sharing interface between patient’s side and ambulatory care can be undertaken as a future work and opportunity to share and store important vital information’s in a real time in order to reduce overload work and avoiding misinterpretation of important patient‘s information. Nevertheless, the main demand stays for data exchange standards for all messages that cross over the current organizational boundaries while increasing the data interoperability aspects.

Furthermore, during iteration 4, we will experiment with define advanced rule sets and new service orchestration models to support emergency response applications. Moreover intelligent expert system‘s integration with an integrated platform that could provide quick analysis based on predefined rules or pattern recognition and generating new rules in a minimum time will be significant to make emergency response more efficient.

To assist patients with other equipment such as mobile e-Triage applications as a common interaction between patient’s sphere and ambulatory care may improve the ability of delivery and quality of emergency care through common emergency standards in the REACTION platform, may be beneficial for all European countries healthcare and people with diabetes.

7 References

[1] MF.Magee and BA.Bhatt., "Management of decompensated diabetes: diabetic keto-acidosis and hyperglycemic hyperosmolar syndrome," *Critical Care Clinics,* vol. 17, pp. 75–106, 2001.

[2] AE.Kitabchi and et al., "Hyperglycemic crises in adult patients with diabetes," *Diabetes Care,* vol. 29, 2009.

[3] Uk.Diabetes, "Improving emergency and inpatient care for people with diabetes " National Institute for innovation and improvement, report,March 2008.

[4] M.Candace, S.Wesley-H, and S.Corey., "Diabetes in the Emergency Department:Acute Care of Diabetes Patients," *Clinical diabetes* vol. 29, 2011.

[5] Department of health Health and social care change agent team, "Avoiding and diverting admissions to hospital - a good practice guide", Dh.Health&Hospital, ed. London, 2004

[6] L. Arvidsson, "Vårdlogistik-rätt patient får rätt vård av rätt kvalitet, på rätt nivå, på rätt tidpunkt, rätt kostnad," Swedish Association of Local Authorities and Regions (SALAR), ed., 2007.

[7] T. Gao and et al., "The Advanced Health and Disaster Aid Network: A Light-Weight Wireless Medical System for Triage," vol. 1, 2007.

[8] T. Lind and et at, "Vård IT-Kartan Användare och IT-system inom svensk vård och omsorg," Swedish Association of Local Authorities and Regions (SALAR),2005.

[9] SA.Egnum and et al., "Prehospital Triage in the Injured Pediatric Patient," *Journal of Pediatric Surgery,* vol. 35, pp. 82-87, 2000.

[10] A. Shaheen and W. A. Khan, "Intelligent Decision Support System in Diabetic E-Health Care - From the perspective of Elders," master thesis, School of Engineering Computing Blekinge Institute of Technology, Tekniska Högskolan, 2009.

[11] SM.Sreerama, "Ambulance Nurses Percieved Usefulness of wireless Sensors in Pre hospital care Management : Qulitative analysis of the workflow, user need and attitudes of the ambulance nurses in the natural disasters," master thesis, Dept.Learning, Informatics, Management and Ethics (LIME), Karolinska Institute 2012.