

Case Studies



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Introduction

Fostering the response capacities and increasing the cooperation of the European Emergency Medical Services Systems (EMSS) is of decisive importance for strengthening the resilience of European societies in the light of multiple hazards, calling for close cooperation of public safety and health authorities on an international level.

iProcureSecurity responds to this challenge by identifying the major issues the diversity of the Emergency Medical Services (EMS) ecosystem poses to the capability of working together, stimulate R&I uptake with a focus on increasing harmonisation of operations across Europe, while delivering requirements for R&I activities to boost the development of more homogeneous EMS systems.

To enhance the response capabilities of the EMS organisations across Europe and facilitate a clear needs assessment of a major innovation procurement action, the project seeks to:



MOBILISE practitioners of emergency medical services, researchers and experts from the field to build synergies among existing actor constellations and initiate knowledge exchange.



ANALYSE the European medical emergency services ecosystem, its capability gaps, challenges and needs, monitor R&D initiatives to create a catalogue of innovative solutions.



ADDRESS legal issues, ethical and societal aspects that should be taken into account by the design, development and deployment of new solutions in the emergency medical field.



PROVIDE specifications about common requirements and technical tender documents for the procurement of R&D, ready-to-use by the upcoming PCP action and external procurers.



This chapter describes individual cases and discusses similarities and differences among countries. The selection of cases can be seen below.

Table 1: Overview of Cases

Case	Prioritization	Added Challenges	EMS Operation Duration at the Scene
Heart Attack	Time sensitive	Being alone in a park	Regular - Medium
Road Traffic Accident	Time sensitive	Children with Down Syndrome and Mass Casualty Incident	Longer
Diabetes	Non-time sensitive	Hearing Impairment	Regular
Paragliding Accident	Time sensitive	No added challenges	Longer
Blast in The Subway	Time sensitive	No added challenges	Longer
Stroke	Time sensitive	Being alone at home	Regular
Foreign Body Obstruction	Time sensitive	No added challenges	Regular
Patient Fall	Time sensitive	Being alone at home	Longer
Interhospital Transfer	Non-time sensitive	Neonatal patient	Longer

The country specific information below should highlight some of the various differences that were identified between particular countries. However, in many cases there are also significant differences from region to region within countries. Therefore, the information should be considered as exemplary and should help especially those who work on new innovative solutions to gather some general insights on what elements in individual EMS cases are of relevance and where innovations also might help to harmonize the different systems across Europe and beyond.



Heart Attack

A 65-year-old male patient who is sitting on a bench in the downtown park suddenly falls to the ground with chest pain. People nearby see him and go closer to him. A man calls the EMCC using a mobile phone, gives information to the professionals about the patient's medical condition and location. Patient's condition worsens before the ambulance professionals reaches the scene, heart rate and breathing stop. Two persons who say they know first aid intervene to rescue the patient. They start applying first aid. There is a central camera system in the park showing the patient's location. Park security guards arrive at the scene. The ambulance is located approximately 10 minutes away from the patient's location. The nearest hospital is a 20-minutes' drive from the scene.



Figure 1: Heart Attack

The heart attack case is a highly time sensitive and a frequent case. A challenge is added to Heart Attack case. The patient is alone when the heart attack occurs. Contacting the EMCC and defining the location of the patient are time consuming. Community help is required for calling 112 and starting CPR until the ambulance arrives. EMS operation duration at the scene can be regular or medium; but it depends on the patient's situation.



Country Specific Insights

How can the emergency call be made for the scenario?

For emergency cases that happened in a park, other than home, workplace, school, etc., mainly voice calls from mobile phones are used in all countries to contact an ambulance. However, in some countries, there are some mobile applications which enable describing the incident location (Italy, England, Austria and Hungary). Video call applications are available for the hearing- impaired e.g. in UK.

Which emergency number (or numbers) can be used for the emergency call for the scenario?

While 112 emergency number is used in European countries, some of the countries such as England, Austria, Hungary and Greece have their own national emergency numbers.

What technologies and software(s) are used to support the EMCC to identify the location of the incident and evaluate the patient(s)?

The caller's address can be seen on the digital map in the EMCC in many European countries. However, incoming calls via fixed telephone lines in some countries such as Turkey show exact address of the incoming call, point positioning accuracy varies according to the density of mobile phone base stations. In Germany, AML system and some mobile phone applications are used for precise locating via mobile phones. There are no digital infrastructures in some islands

How will first aid be organized until the ambulance arrives?

First aid interventions are applied by trained bystanders around the cardiac arrest victim until the ambulance arrives. CPR application is usually done by people with first aid training. Support for this is provided by healthcare professionals at the call centre. Related training videos (for support) or some mobile phone applications are used in few countries (e.g. Italy, England, Hungary).

What type of ambulance and ambulance personnel is assigned for the case?

Generally Advanced Life Support (ALS) ambulance is dispatched. A physician can be dispatched in countries such as Germany and Austria.

Which personnel protective equipment and clothing are used for the case?

Ambulance personnel dispatched to the cardiac arrest wear protective clothes. However, the characteristics of these clothes are not the same across countries. There are major differences in personnel clothing in terms of colour, model and protection.

Is there a need for any coordination with other Emergency Services (police, fire department, hospital, etc.) for this case?

In the cardiac arrest case, it is important to coordinate with the EMCC and the receiving hospital and to inform in advance for the selection of the hospital. Radio and mobile phones are generally used for coordination. Police can be involved in some countries like the UK and Germany.

**Which hospitals will be selected to transfer patients? Are there any criteria?
How is the patient's medical information sent to the hospital?**

The hospitals with coronary angio laboratories and cardiologist have to be selected to transfer the cardiac arrest patient. However, there is not a common approach on this issue across Europe. There is huge use of mobile phones for informing the transferring hospitals. It is possible to identify available ICU bed capacity through a software in the EMCC. In Italy and Spain, ambulance personnel are supported by counselling through telemedicine services from the EMCC.

What kind of equipment (medical, technical) is used at the scene while responding to the case and during transportation of the patient in the ambulance?

The medical and technical equipment used in the ambulance during the transportation of the cardiac arrest patients to the hospital have to be the appropriate, but in this case, mechanical ventilator device, mechanical chest compression device and hypothermia equipment are not the same in ambulances in every country. Likewise, the role and responsibilities of ambulance personnel for administering medicine and medical treatments of cardiac arrest patients are not the same in every European country.

Which devices and equipment are used for communication?

Mobile phones and radios are generally used for communication. In some countries (Spain), text messages can be sent over the radio.

How are the patient records are kept at the scene, in the ambulance and at the EMCC?

Records at the scene and in the ambulance are generally recorded on paper forms. Data is recorded digitally at the EMCC and hospitals. For instance, in Spain paper forms are transferred to digital platforms with a camera on a pen. Patient data are recorded with a service tablet in Hungary.

Is there any specific algorithm to be used in this case?

The treatment algorithm is similar in all countries and it is similar for cardiac arrest cases too. ERC guidelines are generally preferred as algorithms.

Innovation Needs

- Mobile phone applications (to call 112, video call, text message, location information);
- Remote monitoring for patients in risk with wearable technologies;
- Apps that relate the case of PCR and respondents and defibrillators;
- Telemedicine for remote counselling (scene - command);
- Intervention of the cardiology specialists in the treatment of the patient remotely;
- Volunteer participation;
- Software for tracking and dispatching the first aid volunteers and AEDs;
- Software to access the city CCTV system from EMCC;
- Smart bracelet to start emergency call in case of arrhythmia;
- Drone ambulances;
- Prehospital use of Extracorporeal membrane oxygenation (ECMO);
- Prehospital use of ultrasound.





Road Traffic Accident

Four children with Down Syndrome attending a special education and rehabilitation centre set off with a minibus arranged by the school to participate in a social event in the city. There are in total 16 people in the minibus including the driver and a teacher. While the minibus is moving at a roundabout to exit the highway, the brake control is broken due to a technical reason and the vehicle accelerates, passes the opposite lane, reverses suddenly and collides with an oncoming vehicle. The opposite vehicle also has a driver and a passenger. There are in total of 18 victims. Citizens who are passing by informing the EMCC by telephone.

The driving distance from the closest ambulance stations to the scene is 8 minutes. There are other stations which are 12 minutes and 15 minutes away by car. Highway police and fire crews are also called and informed.

A 14-year-old boy with down syndrome from the passengers notifies his family of the location using a special watch on his arm and communicates with them by voice informing them of an accident. The family detects the location of the accident via the GPS on the watch and calls the EMCC. The paramedic in the ambulance arriving at the scene evaluates the injured in both vehicles by triage and provides information to the EMCC requesting more ambulances and rescue teams. Meanwhile, the highway police arrive at the scene, cuts traffic and takes measures along the way to make it easier for ambulances to reach the scene.



Figure 2: Road Traffic Accident

The road traffic accident case is a highly time sensitive and frequent case. There are two challenges added to the Road Traffic Accident case. It is a Mass Casualty Incident and the casualties are children with Down Syndrome. EMS teams need to work collaboratively with firefighter and police teams. EMS operation duration at the scene can be longer for MCI.



Country Specific Insights

How can the emergency call be made for the scenario?

The callers might generally use a cell phone and sometimes the emergency phone at highways (if the mobile phones are not in the coverage).

Which emergency number (or numbers) can be used for the emergency call for the scenario?

Usually, the emergency number 112 is used. Some countries (e.g. Spain, Greece, Austria), have their own national emergency call numbers for ambulance.

What technologies and software(s) are used to support the EMCC to identify the location of the incident and evaluate the patient(s)?

The caller's address can be seen on the digital map in the EMCC in many European countries. However, incoming calls via fixed telephone lines in some countries such as Turkey show exact address of the incoming call, point positioning accuracy varies according to the density of mobile phone base stations. In Germany, AML system and some mobile phone applications are used for precise locating via mobile phones. There are no digital infrastructures in some islands e.g. in Greece.

How will first aid be organized until the ambulance arrives?

Police, firefighters and trained drivers at the scene can provide first aid. Trained people can stop bleeding and start CPR. Volunteers are used e.g. in Germany. But there is no common criteria in Europe for first aid.

What type of ambulance and ambulance personnel is assigned for the case?

Several ambulances and rescue vehicles are sent to the scene in Turkey and Spain for MCI. In Germany for instance, more than one rescue ambulance (TYPE C), Mobile Command Vehicle, Medical Equipment Vehicle and Doctor Vehicle and Helicopter Ambulance are sent to the scene. At islands (eg. In Greece) the situation is more difficult as there are not many ambulance vehicles available. HEMS can respond mainly at the mainland.

Which personnel protective equipment and clothing are used for the case?

A complete set of personnel protective equipment like personal rescue garment, gloves, face shield, helmet is used in Germany and Spain while responding to road traffic accidents and / or MCI cases. There are no common rules for this scenario across Europe, only gloves and masks are used in most of the countries.

Is there a need for any coordination with other Emergency Services (police, fire department, hospital, etc.) for this case?

There is coordination among police, fire and rescue teams with chief emergency doctors and psychologists (e.g. in Germany). The teams inform the receiving hospital (e.g. in Turkey). In Spain there are available apps that can be used for coordination.

Which hospitals will be selected to transfer patients? Are there any criteria? How is the patient's medical information sent to the hospital?

The casualties are transported directly to the trauma hospitals e.g. in Germany and Spain. In Turkey the casualties are transported to the nearest hospital or the hospital that is most relevant. There might be no trauma hospitals in islands and rural areas (e.g. in Greece).

What kind of equipment (medical, technical) is used at the scene while responding to the case and during transportation of the patient in the ambulance?

Generally, trauma equipment is used. In some countries like Germany and Spain rescue equipment and more advanced medical devices (ultrasound, blood analyser etc.) are used. Trauma equipment for MCI is well defined in Germany.

Which devices and equipment are used for communication?

Mobile phone and radio systems are mostly used. In addition to these, mobile systems related to hospital selection and triage are also used e.g. in Germany (IVENA Communication system, which gives information about the next available Hospital, which is suitable for the special case and m-start mobile triage system is used).

How are the patient records are kept at the scene, in the ambulance and at the EMCC?

Usually, paper documentation is used at the scene, paper or digital documentation in the ambulance, and digital recording in the call centre are used. Tablets to access specific EMS apps are used in Spain. The patient information at scene is minimal and focused on the patient condition in Ireland. A cloud-based software is used in the UK.

Is there any specific algorithm to be used in this case?

Generally, MCI and trauma algorithms are used.



Innovation Needs

- Drones can be used to detect the images of the scene with artificial intelligent software from the air.
- It can be real time and provides remote analyses of the scene.
- Medical and logistics equipment can be sent to the scene via drones.
- People at risk may be able to use wearable technologies as in this case.
- A call system for the vehicle, mobile applications for first aid should be used.
- Use of automatic face recognition to identify the victims and retrieve the significant data of their clinical story.
- A digital triage system with a built-in decision-support system.
- The ambulances should have devices managed by voice alone.
- EMCC should be able to connect with bystanders and relatives of the victims.
- Better interconnection among police, EMS, fire brigades, and other first responder for coordination of resources.





Hearing Impairment and Diabetes

A hearing-impaired person walks around a hotel's garden with a deaf friend like himself. His friend, who is also suffering from diabetes, suddenly falls to the ground with tremors in his hands, cold and damp sweat, and unconscious movements. He barely asks his friend to call for help with sign language. They are far from the hotel. His friend calls the EMCC with his mobile phone but cannot communicate. Additionally, communication is interrupted. Feeling that there is something weird about the situation, the EMCC personnel redial the same number and try to understand the situation. In the meantime, the deaf friend speaks the sign language to a non-deaf friend who knows the sign language via the cell phone and explaining him the situation through a video call. He wants him to call the EMCC and tell them to send an ambulance to the scene. Since the ambulance professionals do not know the sign language, it is difficult to obtain enough information from the casualties.

They understand the situation through a document which indicates that the deaf impaired person has diabetes. Based on that information medical intervention is made and a decision is taken to transfer the patient to the hospital.



Figure 3: Hearing Impairment and Diabetes

Diabetes can become very quickly a serious health threat if blood sugar levels become either too high or too low. Diabetic emergencies continue to be significant because of premature death in patients with diabetes. In this scenario two things need to be considered: diabetes and hearing impairment. Hearing and speech impaired people have particular difficulties both in alerting the emergency services and in trying to explain what is happening to them or to define the incident location. There are two main challenges: communication with diabetic hearing-impaired patients and the difficulty to explain them the first aid instructions until the ambulance arrives. The diabetes case is a time sensitive and a frequent case. A challenge added to diabetes case: hearing impairment. Reaching out the EMCC and defining the localization are time consuming. EMS operation duration at the scene is regular for this case.



How can the emergency call be made for the scenario?

In such cases, it is usually necessary to ask for help by an application which enables a video call on a mobile phone. However, in many countries, it is not common yet to have video calls or to communicate through an application. This can be achieved in some countries or regions by applications downloaded to mobile phones.

Which emergency number (or numbers) can be used for the emergency call for the scenario?

Usually, the emergency number 112 is used. Some countries (e.g. Spain, Greece, Austria), have their own national emergency call numbers for ambulance.

What technologies and software(s) are used to support the EMCC to identify the location of the incident and evaluate the patient(s)?

In some countries e.g. Ireland text message systems for hearing impaired people exist. However, they must register to become users. Also, the service does not in all cases guarantee real time response.

How will first aid be organized until the ambulance arrives?

Trained first aiders around can help the patient. In the specific scenario also trained staff, a physician or nurse working at the hotel could examine the patient until the ambulance arrives.

Which personnel protective equipment and clothing are used for the case?

BLS ambulance or ALS ambulance can be dispatched for diabetic hearing impairment patients. There is not a common design in Europe for ambulance types and the ambulance personnel and ambulance providers' competencies. For example, there is only one type of ambulance and the ambulance personnel cannot give medication in Greece.

Which personnel protective equipment and clothing are used for the case? Are there special personnel protective equipment for the case?

There is no need for special PPE for this case.

Is there a need for any coordination with other Emergency Services (police, fire department, hospital, etc.) for this case?

Mobile phone and radio systems are mostly used to get in contact with the hospital.

Which hospitals will be selected to transfer patients? Are there any criteria? How is the patient's medical information sent to the hospital?

This patient is usually transported to the closest hospital to the scene. Sending patient information to the receiving hospital differs from country to country in such a case. The patient information is usually provided by mobile phone.

What kind of equipment (medical, technical) is used at the scene while responding to the case and during transportation of the patient in the ambulance?

There is no difference in terms of the treatment of these patients at the scene and the medical and technical equipment used during transportation by ambulance. Blood glucose levels can be measured.

Which devices and equipment are used for communication?

Mobile phone and radio systems are mostly used. In some countries like Spain, tablets are used too.

How are the patient records kept at the scene, in the ambulance and at the EMCC?

Records at the scene and in the ambulance are generally recorded on paper forms. Data is recorded digitally at the EMCC and hospitals. For instance, in Spain paper forms are transferred to digital platforms with a camera on a pen. Patient data are recorded with a service tablet in Hungary.

Is there any specific algorithm to be used in this case?

There is not a common algorithm for the treatment of these patients. Endocrine emergencies and hypoglycaemia algorithm are used. But there are no common communication protocols for hearing impaired patients.



Innovation Needs

- For effective communication with these patients, there is a need for software that can translate video and sign language into a voice or text message in the EMCC.
- Or having 24/7 sign language interpreter in the EMCC is necessary.
- The wearable technologies that can monitor blood sugar levels remotely can also be useful.
- The wearables should connect autonomously to primary care systems to trigger alarms.
- The wearables should be able to store vital parameters in the electronic health record of the patients.
- There exist many apps for monitoring patients with diabetes. These apps should provide support to make automatic emergence calls to EMCC.
- A triage system should include special software and devices to facilitate communication with deaf and blind victims.
- Cybersecurity and privacy issues are critical when connections outside town centre and in bad weather must be ensured.
- The design of support systems to chronic patients should take into account the experience of patient's associations.
- A patient health summary standard has to take into account the particular needs of some of these chronic conditions for the exchange of clinical data.





Paragliding Accident

A person calls the EMCC by a mobile phone. While he was paragliding, he crashed during landing. Now he has pain in both feet (possible fracture). He is asking for help. His location is unclear at that moment. It is an area that is impossible to reach in short time by road. The HEMS can reach him in 20 minutes. The EMCC sends a HEMS to that area. An ambulance is also assigned to the nearest settlement. The helicopter searches the area but cannot find the patient. The EMCC re-communicates with the wounded and asks if he has heard the helicopter. The wounded explained that the helicopter was south from the place where he is located. As a result, the helicopter is redirected and finds the paraglider. The pilot of the helicopter discovers an area without trees 500 meters above the site of the wounded. After landing in this area, the emergency team consisting of a doctor and paramedic with portable stretchers and emergency bags, proceeds to the area where the injured person is located. The patient has a possible fracture under his right ankle and left knee.



Figure 4: Paragliding Accident

The paragliding accident case is a time sensitive and infrequent case. Accessing the EMCC and defining the localization are time consuming. This case scenario is prepared to understand the response capacity of EMS for such rare cases. In this scenario HEMS response is necessary for rapid transport of trauma patients because there is no access by ground ambulances to such incident locations. Typical EMS operation duration at the scene is longer for this kind of cases.



Country Specific Insights

How can the emergency call be made for the scenario?

The emergency call will be made via mobile phones in case of the paragliding accident scenario. There are also some emergency call applications available in some European countries e.g. Spain.

Which emergency number (or numbers) can be used for the emergency call for the scenario?

112 Emergency Number is used in European countries. Some European countries such as Austria, Hungary, Greece and Ireland have their own national emergency numbers.

What technologies and software(s) are used to support the EMCC to identify the location of the incident and evaluate the patient(s)?

The call from the mobile phone is seen on the digital map with a software supported by GPS, but the location is often not accurate. There are applications that allow the location of the mobile phone to be located.

How will first aid be organized until the ambulance arrives?

In such cases usually there are no bystanders that can start first aid. However, dispatchers in some countries can give instructions (e.g. Greece). Land vehicles can be dispatched in case they can get close to the scene.

What type of ambulance and ambulance personnel is assigned for the case?

HEMS are used primarily in such cases. Medical Rescue Teams are also dispatched. For example, National Medical Response Teams are dispatched to the scene in Turkey.

Which personnel protective equipment and clothing are used for the case?

PPE is used while responding with HEMS. If rescue teams dispatched, they can use mountain rescue specific PPEs.

Is there a need for any coordination with other Emergency Services (police, fire department, hospital, etc.) for this case?

112 EMCC provides coordination with police, health and fire brigade teams by telephone and radio. Hospitals are also informed usually via phone. But there are differences in European countries in communication methods.

Which hospitals will be selected to transfer patients? Are there any criteria? How is the patient's medical information sent to the hospital?

Generally, hospitals that can provide trauma care are selected to transport the trauma patient. However, there are no specialized Trauma Hospitals in some countries such as Greece and Turkey. Trauma centres and/ or Level 3 (Tertiary) hospitals are preferred in Spain.

What kind of equipment (medical, technical) is used at the scene while responding to the case and during transportation of the patient in the ambulance?

Trauma equipment (equipment to stabilize the patient, stretchers, etc.) is used. Mobile ICU can be deployed for major trauma case (e.g. used in Spain).

Which devices and equipment are used for communication?

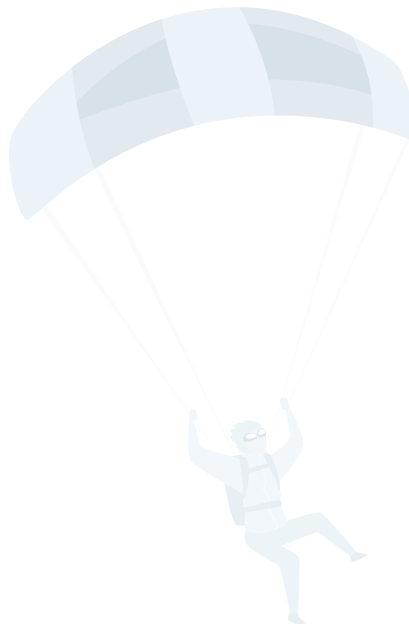
Mobile phones or radio can be used during incidents like this. In some areas where there is no regular network connection satellite phones are needed.

How are the patient records kept at the scene, in the ambulance and at the EMCC?

Usually, paper documentation is used at the scene, paper or digital documentation in the ambulance, and digital recording in the call centre are used. Tablets to access specific EMS apps are used in Spain. The patient information at scene is minimal and focused on the patient condition in Ireland. A cloud-based software is used in the UK.

Is there any specific algorithm to be used in this case?

Generally, the Advanced Trauma Life Support algorithm is used in such cases.



Innovation Needs

- Satellite communication equipment, VOIP and ROIP systems needed.
- Wearable technologies for First Responders and extreme sports people.
- Night operations for HEMS mission.
- Search capacity of the area by drones.
- Training special teams under EMS for mountain rescue.
- In this environments triage should be only digital
- A software-aided allocation system that include all the hospitals in the region should be able to reserve a bed to transport the injured to that hospital and reduce handover
- Telemonitorization in the ambulance is most important when the distance to the hospital is long
- Autonomous vehicles with video cameras can reach the injured before the EMS team and perform a pre-triage to win time
- In-hospital ED must be in communication with the ambulance all along the transportation so no re-triage is needed at the arrival





Blast in the Subway

A subway train in the city centre is moving in a tunnel between two stations. At 08.35 there is an explosion and the subway stops automatically. All passengers are evacuated from the train and metro stations. At the time the explosion happened there were estimated 50 passengers in the train. The subway officer calls the EMCC and asks for a large number of ambulances to be sent to the subway stations on both sides of the tunnel where the explosion happened. Due to excessive smoke, no clear images can be obtained from the camera systems in the subway. The communication is disconnected, and the number of dead and wounded persons has not been established. Rescue and firefighters start with their operation from the tunnel side which is opposite of the smoke stream. Health teams are asked to enter the underground stations. Meanwhile, some passengers, around 25, at the subway station waiting for the train are affected by the smoke. They sit outside of the subway station and ask for help. Ambulance professionals create a triage area in front of the subway station and start to examine the affected people. The police block the road in front of the subway station and create a safe area with lanes. A group of ambulance professionals is preparing to enter the tunnel. Since there is smoke inside, they should wear a mask. The team leaders asked them to take medical equipment and portable stretchers for trauma. There are many ambulances and medical teams at the scene. The nearest 4 hospitals are instructed to prepare the emergency room.



Figure 5: Blast in a Subway

The blast in the subway case is a highly time sensitive and very rare case. No challenges are added to this case. This case is prepared to discuss the challenges and gaps in a very chaotic circumstances where making triage is necessary. EMS operation duration at the scene is longer for this case.



How can the emergency call be made for the scenario?

Landlines can be damaged after explosions. Calls can be made via mobile phone. Emergency telephones, officers' radios and camera systems can be used in the subways. Multiple calls can be received due to high demand. Communication with mobile phones may not be possible in some subways. 112-emergency call application can be used in Spain. In Ireland the personnel at the Emergency Call Answering Service (ECAS) will organize the response based on needs of the incident. In some cases, they will keep callers on the line to provide advice and/or request more information.

Which emergency number (or numbers) can be used for the emergency call for the scenario?

112 Emergency Number is used in European countries. Some European countries such as Austria, Hungary, Greece and Ireland have their own national emergency numbers.

What technologies and software(s) are used to support the EMCC to identify the location of the incident and evaluate the patient(s)?

Advanced Mobile Location (AML) can be detected on mobile phone (e.g. Germany and UK), GPS supported location can be determined on mobile phone. In Spain, Emergency resource management application STE (Emergency Treatment System) is used over the TETRA radio system. The 'What3words' application is used in the UK. Callers are given feedback via SMS in Spain and voice-to-voice in Ireland.

How will first aid be organized until the ambulance arrives?

The first aid interventions can be done by people around. There are AED devices in many European countries in the subways. The US 'Stop Bleeding' and UK-based 'Citizen Aid' practices provide simple and effective guidance for untrained people to offer life-saving care to stop external bleeding. Police and other services are primarily advising unharmed persons involved in a serious incident to stay away from danger zones. An example of such advice is the RUN HIDE TELL concept for situations such as a bomb explosion or a terrorist attack (e.g. in UK).

What type of ambulance and ambulance personnel is assigned for the case?

Many types of vehicles are deployed to respond to a terrorist attack in a subway. For example, ambulances and HEMS. Additionally, Medical Task Force, rapid response cars with physician are sent to scene (e.g. in Germany). HART teams are used in UK. CBRN Vehicles, Mobile Coordination buses, logistic trucks and emergency psychologists are used in Spain. In Turkey Medical Rescue Teams are dispatched.

Which personnel protective equipment and clothing are used for the case?

The use of PPE in such scenarios is not the same across Europe. General PPE and mostly respiratory protective equipment and if necessary CBRN suits are used (e.g. in Spain).

Is there a need for any coordination with other Emergency Services (police, fire department, hospital, etc.) for this case?

Coordination centres with different names and structures are established in European countries during such incidents. Generally, communication and coordination are provided by radio and telephone. Some countries use software for coordination activities (e.g. Spain, UK). In Germany, coordination is established among the police, medical team, fire brigade and psychologist via radio.

Which hospitals will be selected to transfer patients? Are there any criteria? How is the patient's medical information sent to the hospital?

Usually, the hospitals are informed before casualties are transported. Information is usually given to the hospitals on the phone or via radio. Specific hospitals are selected for patients with major trauma. Software that enables the management of patients with hospitals are available for instance in Spain and Turkey. Medical information can be transmitted to the ambulance control desks via radio communication, then transmitted via telephone (landline) or secure messaging platforms / e-mail. The Airwave system also allows direct communication with recipient centres / units in the UK.

What kind of equipment (medical, technical) is used at the scene while responding to the case and during transportation of the patient in the ambulance?

Generally, trauma equipment is used (mainly medical and rescue equipment). Special techniques for trauma in some countries; thoracentesis, thoracostomy, emergency thoracotomy, portable breathing apparatus, automatic blood pressure monitor, pulse oximeter, capnometer, blood analyser, pelvic belt, splints, vacuum bed, endotracheal tubes, venous catheters, intraosseous, advanced medical equipment such as ultrasound is used at the scene.

Which devices and equipment are used for communication?

Digital radio (e.g. TETRA) and mobile phone, IVENA (Communication system providing information on the next suitable Hospital for special occasions), m-start (mobile triage system in Germany). The Emergency Services Mobile Communications Programme (ESMCP), which will provide the next generation of mobile communications for emergency services called Emergency Services Network (ESN) will replace the Airwave Tetra network in UK.

How are the patient records kept at the scene, in the ambulance and at the EMCC?

Usually, paper documentation is used at the scene, paper or digital documentation in the ambulance, and digital recording in the call centre are used. Tablets to access specific EMS apps are used in Spain. The patient information at scene is minimal and focused on the patient condition in Ireland. A cloud-based software is used in the UK.

Is there any specific algorithm to be used in this case?

The Advanced Life Support and Advanced Trauma Life Support algorithms are used in many countries. Special algorithms are used in Germany, Ireland, Spain and the UK.

Innovation Needs

- Unified apps for first responders, prehospital units and hospitals. This could involve integration of the existing digital infrastructure among the EMCC, ambulance professionals and hospitals, and the inclusion of new technological mobile phone applications.
- These systems could integrate all information for all stakeholders for real-time decision-making and further analysis. This would include real-time audio-to-text transcription system to collect the diagnostic and therapeutic sequence of each attendance and decision-making. Important features of such capabilities could include the ability to enable visual recognition of events through the capture of images from the scene.
- Smart clothes (e.g. embedded cameras and sensors) could be used to elicit data from the scene of an emergency.
- Apps for management of mass incidents including tools for triage and registration of patients, management of resources and protocols.
- Artificial Intelligence powered decision-support tools and information management systems could enable casualty tracking and predictive systems modelling and operations.
- The competence addressed both EMS professionals and citizens. Virtual reality training application for triage protocols was recommended for EMS professionals. To support EMS professionals a system for allocating citizens who have received first aid training to emergencies was also recommended.
- Artificial intelligence-supported software for the rapid detection and use of wearable technologies, resources (ambulance, personnel, equipment, hospital, triage of the wounded), which will increase the personal safety and situational awareness of the respondents. Drones and decision support software could accelerate identification, diagnosis and treatment.
- Remote access and intervention opportunities for EMS response ensure continued access to critical resources.
- 3D printing could enable certain items to be produced locally e.g. external fixators used for emergency orthopaedic surgery.
- Modularised/multi-functional medical equipment that can be re-tasked/re-configured depending on the specific need of the EMS case.
- Resilient bio-pharmaceutical capability for rapid production of drugs and the development of active biomaterials, such as artificial skin or blood.
- Blood-derived preservation systems and preservation chain quality for enhanced EMS resource management.
- Personnel protective equipment (PPE) for EMS professionals e.g. PPE helmets; bulletproof vests; special masks.



A 72-year-old female patient who lives alone feels strange after waking up in the morning and getting out of bed. There is a severe headache with difficulty in walking and balance disorder. She barely reaches for the landline phone at home because of a weakness in her right hand. She has difficulty talking to the EMCC officer. It is difficult to understand the questions asked and speaks incomprehensible words. The officer has trouble understanding what she says. He asks if she was drinking alcohol, but she wasn't. She states that she is alone at home, has a headache and difficulty holding the phone with her right hand. This interview has been quite difficult and long. She hardly understands that the officer had her address from the telephone number and that he will send her help. She has to repeat each word. The officer can hardly understand her. She decides to lie back on the bed until the ambulance arrives. When she sees the blood pressure medicine box on her bed, she wonders whether she took the medicine the day before. The headache is getting worse. After a while she hears the siren and the doorbell ringing. She realizes that the ambulance had arrived. However, it is difficult for her to get up. After getting up and taking a few steps she falls to the floor. Meanwhile, the medical emergency teams knock at the door persistently. She tries to get up, but fails, then she faints.

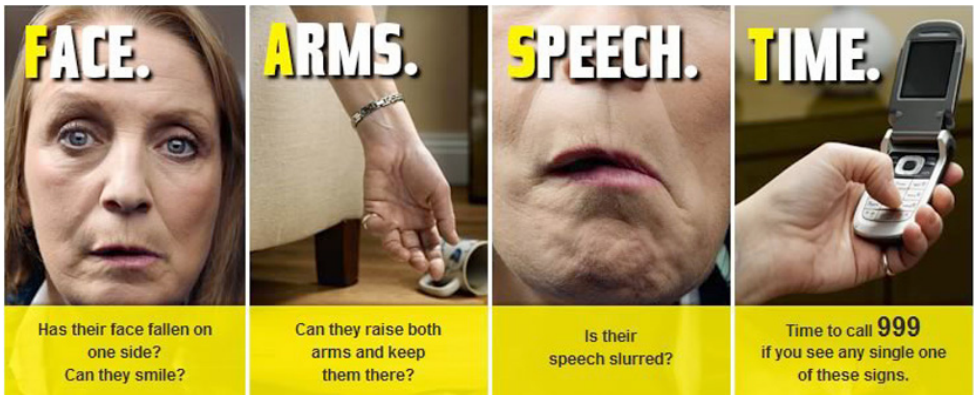


Figure 6: Stroke

The stroke case is a time sensitive and frequent case. "Being alone at home" was added as a challenge to the stroke case. Accessing the EMCC and defining the localization of the patient are time consuming. As EMS providers, the ambulance service plays an important role in identifying a suspected stroke and getting the patient to the right hospital as quickly as possible. EMS operation duration at the scene is regular for this kind of case.



Country Specific Insights

How can the emergency call be made for the scenario?

Citizens access to EMCC generally from a mobile phone or land line. Special mobile phone applications are used in some countries (e.g. Hungary).

Which emergency number (or numbers) can be used for the emergency call for the scenario?

112 Emergency Number is used in European countries. Some European countries (e.g. Austria, Greece, Hungary and Ireland) have their own national emergency numbers.

What technologies and software(s) are used to support the EMCC to identify the location of the incident and evaluate the patient(s)?

The caller's address can be seen on the digital map in the EMCC in many European countries. However, incoming calls via fixed telephone lines in some countries such as Turkey show exact address of the incoming call. Positioning accuracy varies according to the density of mobile phone base stations. Locating the actual position can be difficult especially in rural areas. In Germany, the AML system and smart phone applications are used for precise location via mobile phones.

How will first aid be organized until the ambulance arrives?

People who have received first aid training around the patient start first aid practices until the ambulance arrives. In Hungary, first-aid information is provided to such patients through a mobile phone application of the EMCC. In Spain, public (schools) training is provided on what to do in such situations. First aid certification is mandatory to get a driving license for instance in Germany and Austria.

What type of ambulance and ambulance personnel is assigned for the case?

Advanced Life Support Ambulances with physicians or paramedics in Turkey, Type C Ambulances in Germany, Advanced Life Support Ambulance in Spain, Basic Life Support ambulances in Greek islands are used for stroke patients.

Which personnel protective equipment and clothing are used for the case?

Ambulance personnel dispatched to a stroke case wears mainly standard protective clothes. However, the characteristics of these clothes are not the same across countries. There are major differences in personnel clothing in terms of colour, model and protection.

Is there a need for any coordination with other Emergency Services (police, fire department, hospital, etc.) for this case?

In cases where the patient lives alone, communication with the police and fire department is important to open the door to get access to the patient. Communication with these teams and hospitals is usually provided through mobile phones and radio. In Spain for instance a special code is used for such patients.

Which hospitals will be selected to transfer patients? Are there any criteria?**How is the patient's medical information sent to the hospital?**

These patients are usually transported to the hospital with a stroke centre and Computer Tomography Imaging (in Germany, Turkey and Hungary), the nearest hospital is used on islands (e.g. Greece). There is not an exchange of patient data between the hospital and the ambulance because of data protection issues in Spain.

What kind of equipment (medical, technical) is used at the scene while responding to the case and during transportation of the patient in the ambulance?

Usual equipment in ambulances is used during the transportation of stroke patients. Main stretcher (or other stretchers according to the patient's situation and localization), oxygen and suction units, ECG and defibrillator, etc.

Which devices and equipment are used for communication?

Mobile phone and radio systems are mostly used. A special communication system is used for hospital selection in Germany. A service tablet is used in Hungary.

How are the patient records are kept at the scene, in the ambulance and at the EMCC?

Records at the scene and in the ambulance are generally recorded on paper forms. Data is recorded digitally at the EMCC and hospitals. For instance, in Spain paper forms are transferred to digital platforms with a camera on a pen. Patient data are recorded with a service tablet in Hungary.

Is there any specific algorithm to be used in this case?

The Advanced Life Support and Advanced Trauma Life Support algorithms are used in many countries. Special algorithms are used in Germany, Ireland, Spain and the UK.



Innovation Needs

- Mobile ICU with mobile Computer Tomography.
- Remote maintenance and monitoring systems, early warning software and data sharing should be provided.
- Sending location information with smart wristband with “Emergency Help Button”. When the emergency help button is activated, this information should reach the patient’s relatives and if the patient is alone at home, the patient’s relative is also away, the patient’s relative should be able to open the remote door system.
- Any easily handled home device that could be worn by the elderly, such as a one button gadget.
- Automatic calling system to contact relatives or predetermined persons besides EMS
- Interoperable connection with the electronic health record of the patient to retrieve data and store incident
- Sensors embedded in the floor to activate 112 calls if not stopped before
- Intelligent call filtering in EMCC
- Wearables tuned to detect pre-stroke conditions of vital parameters and make early warnings to primary care GP
- Automatic selection of the closest hospital with a free bed in cardiology ICU





Foreign Body Aspiration

While a man is eating in the restaurant a piece of food suddenly blocks his airway. The restaurant staff calls the EMCC for help. One of the persons in the restaurant tries to help the person as he had first aid training. But he forgets what technique to use in case of foreign body blockage. In the meantime, the ambulance is dispatched by the EMCC. The estimated arrival time is 8 minutes. The person makes unconscious movements. They put the patient to the ground, but his condition gets worse. The restaurant personnel calls again the EMCC and reports that the patient's condition is deteriorating. EMCC dispatcher firstly dispatches the ambulance than give the first aid (pre arrival instructions) instructions to the by stander;

- Get the person to stand up.
- Position yourself behind the person.
- Lean the person forward and give five blows to their back with the heel of your hand.
- Place your arms around their waist.
- Make a fist and place it just above the navel, thumb side in.
- Grab the fist with your other hand and push it inward and upward at the same time. Perform five of these abdominal thrusts.
- Repeat until the object is expelled and the person can breathe or cough on their own.

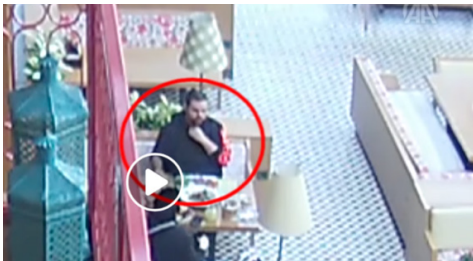


Figure 7: Foreign Body Aspiration

The foreign body aspiration case is a highly time sensitive and infrequent case. Besides choking, there is no additional challenge for this case. First aid interventions are very important for the foreign body aspiration case. EMS operation duration at the scene is regular for this kind of case.



Country Specific Insights

How can the emergency call be made for the scenario?

Emergency calls are usually made by mobile and landline phones. Mobile phone applications are used in some countries too.

Which emergency number (or numbers) can be used for the emergency call for the scenario?

112 Emergency Number is used in European countries. Some European countries such as Austria, Hungary, Greece and Ireland have their own national emergency numbers.

What technologies and software(s) are used to support the EMCC to identify the location of the incident and evaluate the patient(s)?

The caller's address can be seen on the digital map in the EMCC in many European countries. However, incoming calls via fixed telephone lines in some countries such as Turkey show exact address of the incoming call. Positioning accuracy varies according to the density of mobile phone base stations. Locating the actual position can be difficult especially in rural areas. In Germany, the AML system and smart phone applications are used for precise location via mobile phones. Also in Hungary such applications are available.

How will first aid be organized until the ambulance arrives?

Bystanders start CPR and/or apply Heimlich manoeuvre.

What type of ambulance and ambulance personnel is assigned for the case?

Advanced Life Support Ambulances with physicians or paramedics in UK, Turkey and Spain, Basic Life Support ambulances in Greece and Cyprus and any type of ambulance in Hungary are used for choking patients.

Which personnel protective equipment and clothing are used for the case?

Ambulance personnel dispatched to this case wear standard protective clothes. However, the characteristics of these clothes are not the same across countries. There are major differences in personnel clothing in terms of colour, model and protection

Is there a need for any coordination with other Emergency Services (police, fire department, hospital, etc.) for this case?

In general, there is no additional coordination foreseen in most European countries in such cases.

Which hospitals will be selected to transfer patients? Are there any criteria?

How is the patient's medical information sent to the hospital?

Usually, the nearest hospital is selected for transportation in such cases.

What kind of equipment (medical, technical) is used at the scene while responding to the case and during transportation of the patient in the ambulance?

Usual equipment in ambulances is used during the transportation of choking patients. Main stretcher (or other stretchers according to the patient's situation and localization), oxygen and suction units, ECG and defibrillator, etc.

Which devices and equipment are used for communication?

Mobile phone and radio systems are mostly used. A special communication system is used for hospital selection in Germany. A service tablet is used in Hungary.

How are the patient records are kept at the scene, in the ambulance and at the EMCC?

Records at the scene and in the ambulance are generally recorded on paper forms. Data is recorded digitally at the EMCC and hospitals. For instance, in Spain paper forms are transferred to digital platforms with a camera on a pen. Patient data are recorded with a service tablet in Hungary.

Is there any specific algorithm to be used in this case?

In general, the foreign body aspiration algorithm is used.



Innovation Needs

- App for making intelligent voice assisted calls to EMCC to help citizens apply effective T-CPR to victim
- Portable extraction tools for foreign objects in every restaurant
- Automatic voice assisted triage system to support the decision of scaling up the call to a doctor or an ambulance after the incident
- Video training for restaurant workers in Heimlich manoeuvre
- Emergency call systems in mobile phones that connect with EMCC software and provide location, age and other relevant clinical data at the same time





An automatic signal generated from the sensor that a woman of 95 who lives alone wears is received in the EMCC indicating that she may have fallen to the floor. One of the nurses in the watch calls her back but gets no answer. An ambulance is dispatched to the address registered with the sensor. When the doctor in the ambulance gets to the door nobody answers her ring bell. Since there is not relative registered in the same town, the doctor knocks on the neighbours' doors to see if someone else has the keys of the apartment.



Figure 8: Fall

A fall in the own apartment represents most of the times a stressful situation for the patients. This can lead to no consequences or to a hip fracture and rupture of an aorta. Severe injuries can result in case of patients with osteoporosis. Possible consequences are painful fractures and concussions. Alarms can be set through a personal emergency alert system to indicate when people have a problem. Devices used for severe injuries are for example vacuum matrices for hip fractures and potential back injuries. For the vacuum matrices, an air pump is necessary.

Increased age is associated with a higher risk of falling and roughly a third of individuals on the age of 65 and over experience a fall each year. One way in which ambulance services may impact the outcome of such patients is to shorten the time needed for an ambulance to arrive at the scene. Lying on the floor for a long time has been found to be strongly associated with serious injuries, hospital admission and mortality.

The fall case is a time sensitive and frequent case. A challenge added to the elder fall case was being alone at home. Accessing the EMCC and defining the localization are time consuming. EMS operation duration at the scene is longer for this kind of case, because there might be a need for rescue services if the patient is trapped and the door is closed and there is nobody to open it.



How can the emergency call be made for the scenario?

Citizens contact the EMCC generally from a mobile phone or fixed phones.

Which emergency number (or numbers) can be used for the emergency call for the scenario?

112 Emergency Number is used in European countries. Some European countries such as Austria, Hungary, Greece and Ireland have their own national emergency numbers.

What technologies and software(s) are used to support the EMCC to identify the location of the incident and evaluate the patient(s)?

The caller's address can be seen on the digital map in the EMCC in many European countries. However, incoming calls via fixed telephone lines in some countries such as Turkey show exact address of the incoming call. Positioning accuracy varies according to the density of mobile phone base stations. Locating the actual position can be difficult especially in rural areas. In Germany, the AML system and smart phone applications are used for precise location via mobile phones. Also, in Hungary such applications are available.

How will first aid be organized until the ambulance arrives?

First aid interventions are applied by trained bystanders around the victim until the ambulance arrives. However, very often the victim is alone in such cases.

What type of ambulance and ambulance personnel is assigned for the case?

Advanced Life Support Ambulances with physicians or paramedics or BLS ambulances in Turkey, Type A ambulances in Greece, Advanced Life Support Ambulance in Spain, Basic Life Support ambulances in Greek islands are used for fall patients. In some areas of the UK Falls Rapid Response Services including Community Responders are available.

Which personnel protective equipment and clothing are used for the case?

Ambulance personnel dispatched to this case wear standard protective clothes. However, the characteristics of these clothes are not the same across countries. There are major differences in personnel clothing in terms of colour, model and protection.

Is there a need for any coordination with other Emergency Services (police, fire department, hospital, etc.) for this case?

There might be a need for coordination with police, firefighters, rescuers depending on the fall patient's situation. For example: the patient might be alone and cannot open the door or might be trapped. There is a need for informing the receiving hospital. Mobile phones and radio are generally used for this coordination.

Which hospitals will be selected to transfer patients? Are there any criteria?**How is the patient's medical information sent to the hospital?**

The fall patients are transferred to the nearest hospital where examinations and treatments can be performed in terms of trauma, metabolic and cardiac diseases (e.g in Turkey). In UK and Spain the patient is transferred to the next emergency department according to the severity of the fracture.

What kind of equipment (medical, technical) is used at the scene while responding to the case and during transportation of the patient in the ambulance?

Usual equipment for stabilization of trauma cases is used in European countries. There are more specific trauma and lifting equipment in ambulances (e.g. in Spain and the UK).

Which devices and equipment are used for communication?

Mobile phone and radio systems are mostly used. A special communication system is used for hospital selection in Germany. A service tablet is used in Hungary.

How are the patient records are kept at the scene, in the ambulance and at the EMCC?

Records at the scene and in the ambulance are generally recorded on paper forms. Data is recorded digitally at the EMCC and hospitals. For instance, in Spain paper forms are transferred to digital platforms with a camera on a pen. Patient data are recorded with a service tablet in Hungary.

Is there any specific algorithm to be used in this case?

Generally, Trauma algorithms are used in such cases.



Innovation Needs

- A wearable device that can be used in case of an emergency and support voice, video and text call.
- Gyroscope necklace or IP cameras at home to activate 112 call when a person falls.
- Emergency call activated by an app or wearable device that are able to detect a fall incident
- Sensor in the floor of the apartment to detect a person lying and capable of making calls to EMCC
- Video cameras in the apartment connected with the EMCC
- Emergency opening systems for doors actionable only by police
- Emergency call systems in mobile phones that connect with EMCC software and provide location, age and other relevant clinical data at the same time
- Voice activated device to help the communication with EMCC and ambulance team
- Automatic emergency calling relatives or neighbours
- Triage system capable of make an initial assessment by retrieving health data of the person and the data of wearables and cameras at home





Interhospital transfer

A new born baby is brought to the hospital with breathing issues. Her constants are worsening quickly. The hospital is located close to her hometown. It is not a big hospital and its ICU is full of patients suffering from COVID-19 induced diseases. So, the supervisor decides to move her to a bigger hospital with a specialised neonatal ICU. The intended hospital is 100 km far to the east. An ambulance is called for transportation. It is a risky business because it will take more than an hour with a heavy traffic in the highways at this time of the day.

When patients are transported from one special unit of medical care to another that is located in another hospital, special teams have to guide the transport and by this, they need a special equipment. Several of these transports refer to new-born child transportations from neonatology to an imaging facility and back. Therefore, devices like an incubator are necessary. Perfusors and mobile oxygen are devices which are necessary for a full interhospital transfer of intensive patients.



Figure 9: Interhospital transfer

Transferring a neonatal patient is a challenge for this scenario, because there is a need for special equipment. EMS operation duration is longer for this case.



How can the emergency call be made for the scenario?

Mostly mobile phones or fixed phones are used to access EMCC. Since the case is “interhospital transfer”, there is a specific 112 Interhospital Coordination Desk in several countries (e.g. Spain and Turkey).

Which emergency number (or numbers) can be used for the emergency call for the scenario?

Usually, number 112 is used or another telephone line dedicated to interhospital transfer can be used.

What technologies and software(s) are used to support the EMCC to identify the location of the incident and evaluate the patient(s)?

Location information comes from GPS of mobile telephone or it can be a landline of a hospital.

How will first aid be organized until the ambulance arrives?

The interhospital transfer do not need a first aid organization from bystanders, but all health care providers must know how to apply standard procedures such as CPR.

What type of ambulance and ambulance personnel is assigned for the case?

Mobile ICU in Greece and Spain, neonate ambulance in Turkey. The EMS personnel in a neonate ambulance need to have a Neonatal Resuscitation Certificate. Generally, physicians respond to this kind of case.

Which personnel protective equipment and clothing are used for the case?

Ambulance personnel dispatched to this case wear standard protective clothes. However, the characteristics of these clothes are not the same across countries. There are major differences in personnel clothing in terms of colour, model and protection

Is there a need for any coordination with other Emergency Services (police, fire department, hospital, etc.) for this case?

Coordination is established between hospitals and physicians. Police escorts may be required in some cases.

Which hospitals will be selected to transfer patients? Are there any criteria? How is the patient's medical information sent to the hospital?

Mainly hospitals with Newborn Intensive Care Units are selected. After giving information about the patient to the authorities from hospital and physicians, the transportation is performed.

What kind of equipment (medical, technical) is used at the scene while responding to the case and during transportation of the patient in the ambulance?

Mobile incubators with portable monitors and equipment are used.

Which devices and equipment are used for communication?

Mainly mobile phones and radio is used in such cases.

How are the patient records are kept at the scene, in the ambulance and at the EMCC?

Records at the scene and in the ambulance are generally recorded on paper forms. Data is recorded digitally at the EMCC and hospitals. For instance, in Spain paper forms are transferred to digital platforms with a camera on a pen. Patient data are recorded with a service tablet in Hungary.

Is there any specific algorithm to be used in this case?

Interhospital transfer, new-born resuscitation and advanced life support algorithms are used in such cases.



Innovation Needs

- Interoperability to enable sharing of health information and telemedicine consultations that can also provide treatment in many places in order to reduce the need for interhospital transfer.
- EMS Professionals should be trained accordingly.
- Triage system that sends accurately current information about the status of the patient to the referring doctor.
- Telemonitorization on the road on ambulances to support EMS professionals by the specialist doctors of the hospital where the patient is carried to.
- Reduction of the weights of the equipment that professionals have to carry on
- The International Patient Summary standard will be very useful in reducing the numbers of interhospital transportations, but it has to be adapted to paediatrics specificities
- Establish global hospitals bed and resources allocation protocols and software platform that prevent taking the patient to a hospital where no beds or personnel are available to attend
- In cross border regions develop European protocols to use the hospital resources at both sides of the frontiers
- Develop uber-like services to patient transportations that do not require medical assistance
- Cybersecurity and data privacy have to be ensured to enable the impulse to telemedicine that is coming from the pandemics and take profit of it in order to make the health system sustainable.





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