

Information infrastructure of emergency medical service in the smart city solutions

Valerii LOGVINOV

*Ass. PhD prof., National Academy of Public Administration, President Office of the Ukraine, 20, Anton
Tsedic str., Kyiv, Ukraine
E-mail address: egov.tc@gmail.com*

Svitlana MALONOGA

*Dr., Odessa Regional Centre of Emergency Medical Service 5, Vorobiyova ave., Odessa, Ukraine
E-mail address: svetlana.malonoga75@gmail.com*

Abstract

This paper was developed on the base of experience realization of the state pilot project in the field of reform of the emergency medical service (EMS) in the Odessa region (Ukraine). The core idea behind the paper is to propose an information infrastructure that allows medical and other services to get instant messages on problem situations which necessary joint activities for the saving lives of the people. This infrastructure will use for alert about accidents only those service that are needed to perform joint actions to people salvation in the particular situation. For this in the paper is to provide a review, analysis, and identification of opportunities for the EMS community to address information infrastructure developments of emergency medical service as a part of the smart city solutions. Besides, was summarized the overall impact that digital communications, information infrastructure could have on EMS and their influence on how EMS system (in Ukraine it's 112 service) might operate in the year 2020 and after this period; also proposed a model for how these technologies might be used by EMS system and how digital technologies can help avert the bad interoperability of emergency services– and improve the response on the emergency situation when they do occur.

Keywords: digital technology, interaction, information infrastructure, emergency medical service, smart health system, teamwork.

1. Introduction

This paper considers information infrastructure as an instrument' access of EMS and include study about access to EMS as a part of smart city solutions for all using Emergency call number 112 and provides for the coordination with other emergency services.

The value of integrating and coordinating emergency care amongst various agencies is an important factor to be considered: e.g. police, fire brigade and voluntary organizations. Police and fire fighters are very often the first professional witnesses of acute illness or injury, arriving before EMS personnel. It is important that these public officers be informed in the one time.

According to the European Society for Emergency Medicine “Emergency Medicine [1] is a specialty based on the knowledge and skills required for the prevention, diagnosis and management of urgent and emergency aspects of illness and injury in which time is critical. The practice of Emergency Medicine encompasses the pre-hospital and in-hospital triage, resuscitation, initial assessment and management of undifferentiated urgent and emergency cases. It also includes involvement in the development of pre-hospital and in-hospital emergency medical systems”.

The fulfillment of this requirement is impossible without the organization of the relevant information interaction of all structural elements and services of the emergency medical care. Creating a full-fledged analogue of the European call system in Ukraine is ensuring the constitutional right of citizens to personal security and health.

2. Smart emergency infrastructure as a way to improvement of emergency medical services

At the today, Emergency medical services (EMS) use many different types of equipment basic transport vehicles, such as ambulances and helicopters; different medical devices and communications equipment that allows for transmission of patient information between ambulance and hospital. In addition, medical personnel rely on effective communications systems that enable them to summon help of other emergency services when needed.

Over time, technological advances have led to improvements in the delivery of EMS [2], [3]. Automatic crash notification (ACN) technology enables immediate notification of emergency responders.

Set against this backdrop of evolving technology, however, is the basic reality that most EMS systems do not have the resources needed to make major system upgrades. [2], [3] Moreover, not all local EMS providers agree that newer, more sophisticated technology necessarily translates into better or more efficient patient care.

2.1. Emergency medical services: at the crossroad solutions

Emergency service is determined by many factors, among which the information and communication infrastructure plays an important role, which increases the efficiency of providing assistance to the victims. The state of information and communication infrastructure is characterized by a set of indicators that reflect the development of digital technologies: fixed telephony, mobile cellular and satellite communications, information systems and data transmission networks.

One can distinguish the distinctive features of the information and communication infrastructure of the emergency medical aid, which are reflected in:

- the necessity of universal access to the communication system of all involved parties, which are related to the situations connected with the provision of emergency medical care;
- the ability to save a significant amount of time spent in the usual case on the provision of medical care.

The most important characteristics of this are the state of information and communication infrastructure; availability of information and communication technologies; increase the speed of information transfer and improve the quality of communication [4].

When forming the information and communication infrastructure of emergency medical service (ICI EMS), it should be taken into account that it is an integral part of the national information and communication infrastructure (NICI), the cybersecurity, functioning of all branches of the national economy depends on the stable and reliable functioning of all its components [3].

However, today ICI EMS is not only not defined de jure but de facto, since the presence of a single telephony channel in the EMS system can not reflect its potentially necessary infrastructure, components of which are developed by departmental programs, is unsystematic, not interrelated, creating a lot of problems for the interaction of the technical and technological components of the EMS. One of the key issues in the formation of ICI EMS is the lack of a holistic management system built on the use of modern means of communication and digitalization.

An obstacle to its formation is the lack of reliable data on the topology and available resources of telecommunication networks as general use (TCZK), as well as departmental and special, which makes it impossible to organize the centralized use and management of their resources in emergency situations that require the use of emergency, incl. medical measures.

Under these conditions, there is an urgent need for the formation of the ICI EMS, the coordinating center of which should be the Unified EMS and NC management center (emergencies). An important step in this direction is the adoption of the Law of Ukraine "On Emergency Assistance to the Population by Single Telephone Number 112" [5], according to which the creation of the EMS system should ensure the coordination and operational management of the resources of all telecommunication networks and the organization of providing emergency assistance to the population in case of threat Emergency situations. Structural elements and interrelationships between them in the case of the introduction of this system will look as shown (Fig.1).

In addition, its creation will be a real confirmation of the implementation of the provisions of the Law of Ukraine [6], [7] "On Telecommunications" and a number of regulatory acts and will solve the problem of guaranteed provision of telecommunication resources in emergency conditions of centralized alert and emergency assistance systems, monitoring of the state of telecommunication infrastructure, in particular due to the possibility of unusual conditions of joint centralized and decentralized operational management of telecommunication resources of all networks and telecommunications operators.

However, as the practice of EMS shows, there are not only technological and communication problems, but also organizational issues that relate to the emergence of an emergency team of a team of profile specialists to be involved in case of a specific emergency that requires, for example, participation not only physicians, but also firefighters, whether police or aerospace.

In this case, in our opinion, based on the use of classification signs of emergencies [8], it may be expedient to develop a Common Emergency Situation Classification (CESC), which describes and codifies various emergencies and specifies groups of specialists and necessary equipment to be involved and used in a particular situation. This will significantly reduce the time for "calls", which is needed in the emerging situation to form a teamwork for the elimination of emergency situation, for example, in the case as a fire.

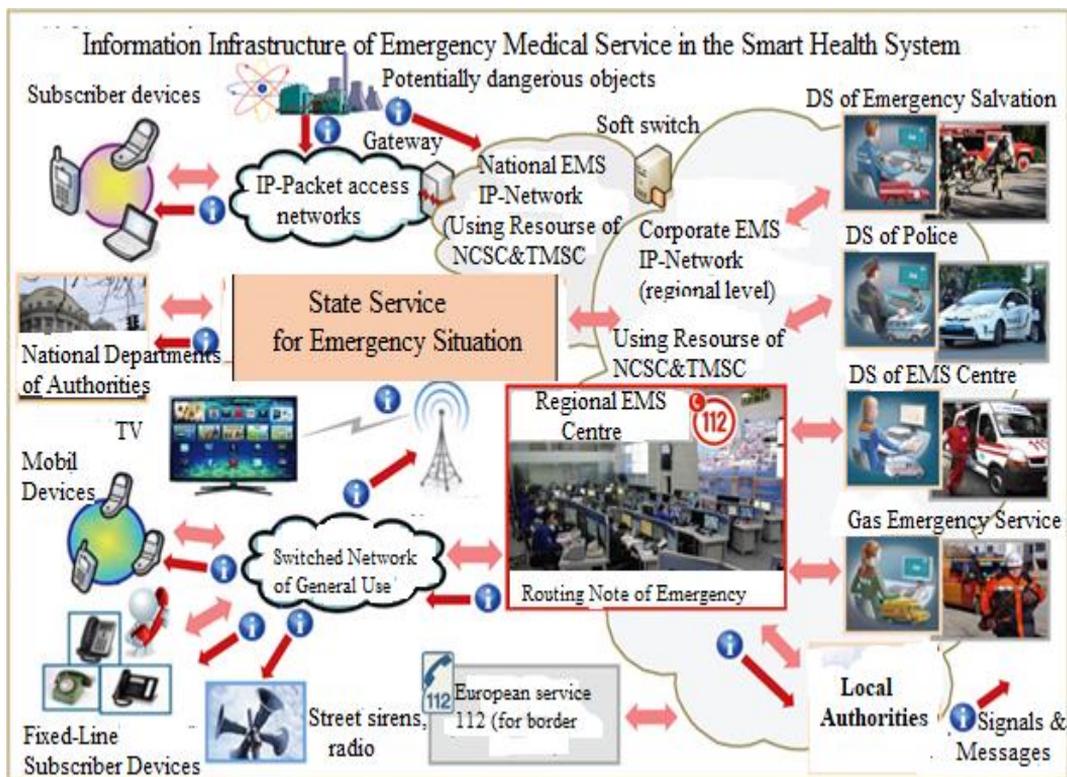


Fig.1. Information Infrastructure of EMS in the Smart Health System of Ukraine

Source: Rybka, S., 2016

The use of CESC as part of the emergency care system for a single telephone number 112 will significantly reduce the arrival time of various emergency teams and provide the necessary medical care to the victims, improve coordination of the activities of the units of all services and the timely provision of emergency medical service.

The aim of EMS focuses on providing timely care to victims of sudden and life-threatening injuries or emergencies in order to prevent needless mortality or long-term morbidity. The function of EMS can be simplified into four main components; accessing emergency care, care in the community, care en route, and care upon arrival to receiving care at the health care facility.

Emergency response. Seconds count when lives are at stake, making it critical to speed first responders to the scene of emergencies. Smart systems can optimize call centers and field operations, while traffic signal preemption gives emergency vehicles a clear driving path. A city with an already low response time of eight minutes could shave off almost two minutes. A city starting with an average response time of 50 minutes might be able to trim that by more than 17 minutes.* At present, no single region-wide EMS model exists for all ukrainian regions and cities.

However, this point is especially important in times of crisis and disaster, where information flow between EMS stakeholders of regions and cities is vital for interoperability and an effective coordinated crisis response.

The overall objective of the pilot project in Ukraine is to improve regions' coordination of EMS structures and forming of organizational arrangements and their link to national health management system. In particular, the project aim is:

- (1) Develop a standardized templates to be used as a messages tool to inform about crisis situations type and the forming of the emergency help team including EMS group.
- (2) Forming EMS information infrastructure on the base of digital technologies and central call centre.
- (3) Collect data on existing emergency management mechanisms intended to manage health threats.

2.2. Description of sections in EMS data collection template

- a) Legislation and financing: Main topics regulated by legislation; financing sources; how EMS providers are reimbursed for services provided; type of institution authorized to run EMS; co-payment.
- b) Out-of-hospital emergency medical services: Public emergency number 112 and its links with emergency medical calls; dispatch centres' basic features; medical equipment of non-medical emergency vehicles; ambulance type distribution; triage protocols.
- c) In-hospital emergency medical services: Access to the emergency department; triage protocols; quality performance.
- d) Education: Specialty; qualification requirements for physicians, nurses and paramedics; professional board certifications.
- e) The role of EMS in crisis management: Role of EMS in the national Crisis Preparedness Plan (CPP); international cooperation protocols in EMS; CPP in EMS legally binding; testing of CPP; leading institution in case of national crisis; EMS representative in the crisis management team; training in crisis management for EMS personnel and safety measures.

These complex systems include different services, from health-care posts or emergency points attended by medical staff, to a call centre (dispatch centre) that is able to answer emergency calls, provide medical advice to the caller and, if necessary, dispatch a mobile medical care unit.

2.3. The importance of a digital infrastructure of EMS for smart cities

In an environment characterized by cooperation and partnership among various actors, a city can take on different roles, ranging from a passive role to a more active, facilitating role in which the city establishes the right conditions for all actors to operate within the smart city area. A city needs to choose its role based on how it can optimally promote the development into a smart city while ensuring good strategic flexibility going forward. With a long-term approach, a city can issue clear targets and guidelines for operations while ensuring favourable conditions for competition, innovation and scope for action over time. Every city needs to establish structures and collaboration models in order to be equipped to meet the changing expectations and preferences of citizens, business, city operations,

colleagues and collaborative partners while maintaining control over the agenda and direction of the city in the future.

The communications infrastructure is a key component in smart city development. Every city needs to ensure that communications platforms are established and accessible in order to achieve the smart city concept in an open and resource-efficient manner. Access to a modern, basic infrastructure for data communications in the form of, for example, fixed networks, mobile networks and dedicated networks for EMS applications will be critical to cities aiming to become “smart” for people.

The technical trends were identified by assessing of trends according to three criteria – relevance, timing and magnitude – in order to identify the trends most important to the information infrastructure of EMS.

3. Reference model of a smart city infrastructure

Rapid development of digital technologies and applications is generating a need to create an overall view and for the capacity to conceptually structure the various components of the Smart city that together create efficient solutions for EMS information infrastructure of the Smart cities. At this case a common method for conceptualizing a field can be to design a “reference model” which, based on simplifications, constitutes a point of departure for building specific, situational models for Smart city including EMS information infrastructure. This reference model is an abstract framework for understanding components of EMS information infrastructure and their interrelationships in a Smart city structure and can therefore be used as a basis for study, as well as to use for construction real EMS digital infrastructure. At this case a reference model is instead intended to provide general approach that can be used across comparisons of the other models.

So, the “main components” are larger digital technology areas that together form the platform of and enable the various applications for Smart City solutions.

The starting point for EMS reference model of information infrastructure for smart city solutions (Fig.2) can be a division of the main components into six distinct “layers” [9]: infrastructure, communications, sensors, data platform, applications, security and as an addition emergency situation classifier (ESC).

3.1. Reference model of EMS information infrastructure

Each specific situation (ESC) is assigned its own code. In accordance with this code, a message is automatically sent to all services that should participate in the elimination of this situation, the necessary specialists and equipment is specified.

The relatively simple model provides an opportunity to communicate and compare specific solutions and models across organizations and interest groups, while enabling comparison of the advantages and drawbacks of specific solutions. In more concrete terms, the model provides the following benefits:

- It constitutes a basis for choosing and comparing the advantages and drawbacks of different market models and for determining how a city can influence/stimulate service development.
- It provides an opportunity for better shared understanding and consensus across a city's various units, administrations and firms with joint responsibility for various Smart City solutions and applications [10].
- It promotes the development of horizontal solutions and elucidates the effects of vertical solutions.
- It creates the conditions and capacity to establish technical standards and specifications for individual solutions.

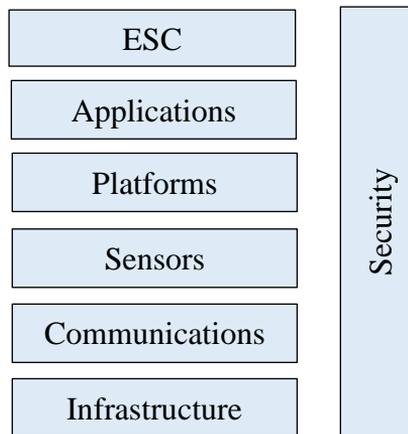


Fig.2. Reference model of EMS information infrastructure
 Source: *Composed by the authors on base (Smart Cities,2017)*

In today's time, implementing Smart City leveraging digital and connected technology helps promote medicine development [11], improve EMS infrastructure & environment, enhance interoperability and optimize costs of EMS.

In the 9 parts [9] for a Smart City solutions are highlighted: Smart Mobility. Smart Health. Smart Finance. Smart Education. Smart Government. Smart Energy & Water. Smart Retail & Logistics. Smart Tourism & Leisure. Smart Buildings & Living. At the same times the Smart Health part include 9 points also: Quantified self; Patient empowerment; Digital platforms connect supply and demand; Personalization of treatments through 'big data'; Artificial intelligence supports the doctor; From institutions to networks (unbundling); 3D printing; Robotics in 'cure' and 'care'; Insurance and financing. However, among these points not indicated information infrastructure of emergency medical service.

4. Conclusions

So, EMS system in Ukraine still need to find their place in the mechanisms for disaster preparedness and response coordination with other stakeholders. Although emergency medical care is the primary objective of all emergency services, the role of preparedness planning is insufficient if simply carried out at the level of each health service [12]. It

should involve the whole EMS system at national or regional level, integrated into the whole health system and in full coordination with other emergency services.

Finally, the most important outcome of the pilot project in Ukraine must be the formal creation of the National Inter-Regional Information Infrastructure in the field of EMS.

The main social effect from the formation of the EMS [13], [14], [15], [16], [17] information infrastructure is the preservation of human health and the compliance of public authorities with the needs of citizens and guaranteeing them the right to protection against threats to their lives.

References

- [1]Juliusz Jakubaszko (2013), Relationship of emergency medicine and critical care, <http://file.atuder.org.tr/atuder.org/fileUpload/OYuA2rDjo7Qd.pdf>.
- [2]Emergency Medical Services (EMS 2007) Data integration to optimize patient care.
- [3]Emergency Medical Services (2007): At the crossroads, <https://www.nap.edu/read/11629/chapter/7>.
- [4]Sultan Al-Shaqsi (2010), Models of international emergency medical service (EMS) Systems / Oman Med Jv.25(4); 2010 Oct, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3191661/>.
- [5]Rybka, S. (2016), Kilchytsky Y., Nerush V. On emergency service at Number 112. / Рыбка С., Кільчицький Є., Неруш В. Про екстрену допомогу за номером 112, <https://ukurier.gov.ua/uk/articles/pro-ekstrenu-dopomogu-za-nomerom-112>.
- [6]The Law of Ukraine (2012), "On the emergency assistance to the population by single telephone number 112" dated 05.07.2012, No. 5081-VI (as amended). Закон України «Про систему екстреної допомоги населенню за єдиним телефонним номером 112» від 05.07.2012 № 5081-VI (зі змінами <http://zakon.rada.gov.ua/laws/show/4499-17>).
- [7]The Law of Ukraine (2017), "On telecommunications" dated May 23, 2017 No. 2059-VIII (as amended). Закон України «Про телекомунікації» від 23.05.2017 № 2059-VIII (зі змінами). <http://zakon.rada.gov.ua/laws/show/1280-15>.
- [8]Uriadovy Courier (2015), On the strategic directions of development of infocommunications, "Uriadovy Courier"/ На стратегічних напрямках розвитку інфокомунікацій, «Урядовий кур'єр» від 06.06.2015 р. №100, <https://ukurier.gov.ua/uk/articles/na-strategichnih-napryamah-rozvitku-infokomunikaci/>.
- [9]Smart Cities (2017), The importance of a smart ICT infrastructure for smart cities, <https://www.stokab.se/Documents/Nyheter%20bilagor/SmartCityInfraEn.pdf>.
- [10]Smart Infrastructure (2017), Improving healthcare. KPMG Report, <https://assets.kpmg.com/content/dam/kpmg/uk/pdf/2017/05/smart-infrastructure-improving-healthcare-may-2017.pdf>.
- [11]Smart Cities (2015), Deloitte. How rapid advances in technology are reshaping our economy and society, <https://www2.deloitte.com/content/dam/Deloitte/tr/Documents/public-sector/deloitte-nl-ps-smart-cities-report.pdf>.
- [12]Strengthening health-system emergency preparedness. Toolkit for assessing health-system capacity for crisis management. Part 1. User manual (2012), http://www.euro.who.int/data/assets/pdf_file/0008/157886/e96187.pdf?ua=1.
- [13]EMS in 2030: What technologies will be widely available? <https://www.ems1.com/ems-products/technology/articles/286969048-EMS-in-2030-What-technologies-will-be-widely-available/>.
- [14]Emerging digital technologies in EMS, <https://www.ems.gov/newsletter/novdec2015/emerging-technologies.html>
- [15]Emerging Digital Technologies (2015) in Emergency Medical Services: Considerations and strategies to strengthen the continuum of care, https://www.ems.gov/pdf/advancing-ems-systems/Reports-and-Resources/Emerging_Digital_Tech_In_EMS.pdf.
- [16]Assessment of health systems' (2009) crisis preparedness, <http://www.euro.who.int/en/health-topics/emergencies/disaster-preparedness-and-response/publications/2010/assessment-of-health-systems-crisis-preparedness-ukraine>.

[17]Re-profiling emergency medical services in Greece (2017), <http://www.euro.who.int/en/health-topics/emergencies/disaster-preparedness-and-response/publications/2017/re-profiling-emergency-medical-services-in-greece-2017>.