

## Developing emergency medical transportation services for a turbulent future

**Madalina-Cristina Gogu\***, National University of Political Studies and Public Administration, Bd. Expozitiei, 30A, Sector 1, 010324 Bucharest, Romania.

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### Abstract

The purpose of the emergency medical transportation services is to save human life, irrespective of political, economical, social or military situation in which the people, seeking help, find themselves in. The direction towards which the populations health is heading, is unsure due to the lack of drinkable water, quality food, access to medical care, pollution, stress, new viruses, economic, social, political and military problems, terrorism, fires, floods, earthquakes and other events and processes with a high risk for human health. The objective of the paper presents the challenges that citizens and the emergency medical transportation service will face, in terms of a turbulent future; and the necessity of applying the principles of adaptive management and the analysis of the possibility of applying those principles in emergency medicine using analytical, theoretical and comparative methods. The result shows that the emergency medical transportation services will cope with the uncertainties and the challenges of a turbulent future.

**Keywords:** Adaptive management, emergency medicine, ambulance, complex adaptive systems.

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\* ADDRESS FOR CORRESPONDENCE: **Madalina-Cristina Gogu**, National University of Political Studies and Public Administration, Bd. Expozitiei, 30A, Sector 1, 010324 Bucharest, Romania. *E-mail address:* [cristina.gogu.sd15@administratiepublica.eu](mailto:cristina.gogu.sd15@administratiepublica.eu) /  
Tel. : +40 725 888 938.

## 1. Introduction

The direction towards which the population's health is heading is insecure due to the lack of drinking water, food quality, access to medical services due to pollution, stress, new viruses, economic, political, social, military problems, terrorism, fires, floods, earthquakes and other events that have a high-risk impact on human health.

Catastrophic events 'are an ongoing part of life, affecting society both locally and globally' (Fulmer et al., 2007, p. 1), in the future, disasters will become more and more frequent, 'future catastrophic disasters with the potential for harming millions of people are probable due to the increase in population densities in flood plains, along vulnerable coastal areas and near dangerous faults in the earth's crust; the development and transportation of thousands of toxic and hazardous materials; and rapid industrialisation in developing countries' (Noji, 1996, p. 298).

The term disaster 'denotes a low-probability but high-impact event that causes a large number of individuals to become ill or injured' (Warden, 2007, p. 175), so the International Federation of Red Cross and Red Crescent Societies states that a disaster (Bravata, McDonald & Owens, 2004, p. 1) 'that causes more than 10 deaths, affects more than 100 people or leads to an appeal for assistance by those affected' (Warden, 2007, p. 175), disaster that exceeds the communities possibility to 'prepare fully or respond completely' (Waeckerle, Lillibridge, Burkle & Noji, 1994, p. 716) and 'involve economic dislocation; the collapse of political structures; violence ranging from banditry, through civil conflict, to all-out international war, famine and mass population displacements' (Noji, 1996, p. 298).

Examples of 'different types of disasters: Natural disasters (earthquakes, extreme heat, floods, drought, tropical cyclones, landslides, tornadoes, tsunamis, volcanoes, wildfires, winter weather and infectious disease outbreaks), technological/human-induced disasters (radiation emergencies from nuclear blast or accidental spills of radioactive material, accidental release of hazardous chemicals, bioterrorism, oil spills, bombings or destroying a nuclear reactor) and complex emergencies (war and conflict)' (Centers for Disease Control and Prevention (CDC), 2014, p. 91).

Immediately after a disaster takes place, the following actions take precedence to any other: saving human lives through emergency medical services and ensuring public health through primary and routine medical services. In order to ensure quality medical services, the transportation to and from the disaster site is essential (to the disaster site of the medical personnel and medical equipment and the transportation of the patients from the disaster site to hospitals).

## 2. Emergency medical services

Emergency medical services are 'pre-hospital and out-of-hospital emergency medical services, including 9-1-1 and dispatch, emergency medical response, field triage and stabilisation and transport by ambulance or helicopter to a hospital and between facilities' (Warden, 2007, p. 25). Emergency medical services come into play in case 'a serious and unexpected situation involving illness or injury and requiring immediate action' (Oxford English Dictionary, [https://en.oxforddictionaries.com/definition/medical\\_emergency](https://en.oxforddictionaries.com/definition/medical_emergency)), this service 'is the medical speciality dedicated to the diagnosis and treatment of unforeseen illness or injury' (Annals of Emergency Medicine, 2016, p. 142), in practice it includes 'the initial evaluation, diagnosis, treatment, coordination of care among multiple providers and disposition of any patient requiring expeditious medical, surgical or psychiatric care' (Annals of Emergency Medicine, 2016, p. 142). Emergency medicine 'is not defined by location, but may be practiced in a variety of settings, including hospital based and freestanding emergency departments, urgent care clinics, observation medicine units, emergency medical response vehicles, disaster sites or through telemedicine' (Annals of Emergency Medicine, 2016, p. 142).

Seen as a whole, the emergency medical services constitutes a system whose components are the following: public access, communication systems, clinical care, human resources, medical direction,

evaluation, integration of health services, information systems, research, legislation and regulation, system finance and education. The delivery of these emergency medical services is made through: dispatch, first responder, basic life support, advanced life support, transport, emergency department facilities, speciality care, patient rehabilitation, prevention awareness and public education. Figure 1 illustrates the system approach to ‘delivering emergency medical services (EMS) system and the multiple components’ (National Academy of Sciences, Engineering, and Medicine, 2006, p. II-4).

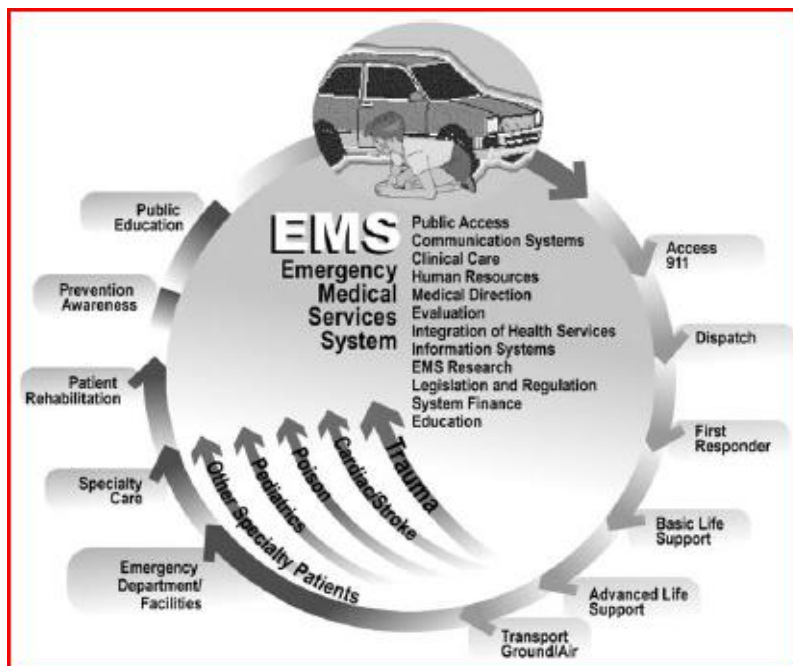


Figure 1. EMS system (National Academy of Sciences, Engineering, and Medicine, 2006, p. II-4)

In the framework of the EMS system, we have professional standards, organisational structures and coordination mechanisms that differ from country to country; even in the EU they ‘vary widely across Member States’ (Directorate-General for Health & Consumers, 2008, p. 6).

In Romania (Ministry of Health Romania and Ministry of Internal Affairs Romania, 2006), an EU Member State, the basic pre-hospital first aid is given with or without first-aid sanitary materials by the persons at the site of the incident, observing the instructions of the specialist staff from the emergency dispatch centre until the arrival of the intervention crews. Qualified first aid is provided by a team, in an institutionalised setting, by paramedical staff from the emergency situations inspectorates or other institutions which, according to the legislative provisions, have the right to have this category of personnel.

In Romania (Ministry of Health Romania and Ministry of Internal Affairs Romania, 2008), in the event of collective accidents or calamities, with particularly have rapid manifestations and limited effects over time resulting in multiple victims, the Red Plan of Intervention is activated, the functions of this plan are: a) triage and first aid, b) advanced medical post, installation, location and the way of organisation, c) medical triage of victims at the level of advanced medical post, d) provision of advanced emergency medical assistance and preparation for evacuation, e) organisation of evacuation triage and evacuation of patients, f) preparation of reception at the level of emergency units and emergency departments of the emergency hospitals and other hospitals in the accident area and g) triggering of the white plan at the level of the hospitals involved. The White Plan is developed at the hospital level and includes the necessary organisational elements in case of a massive influx of victims, this plan includes: a) alerting, b) triggering, c) creating a command and control point at the hospital level, d) the level of emergency

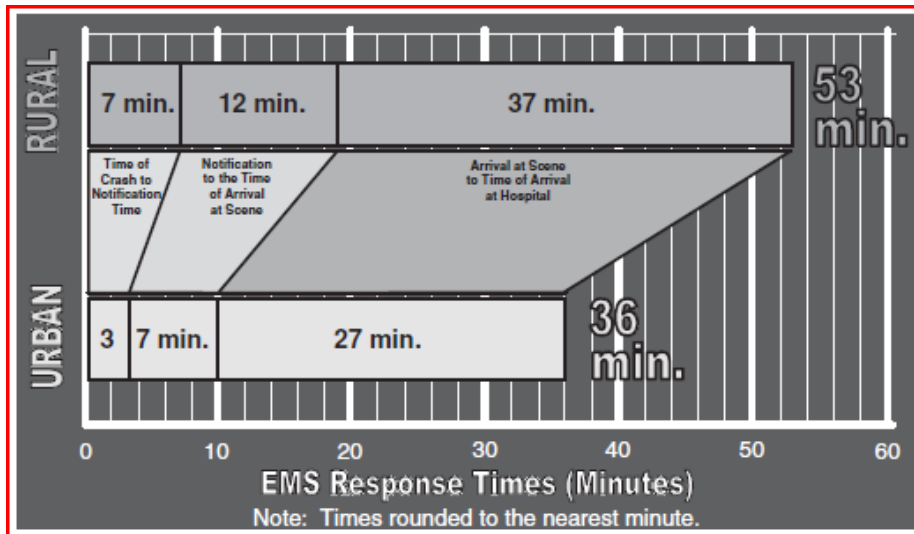
primary unity, e) the triage, f) the organisation of the investigations, g) the release of the places of hospitalisation, h) the reception of the non-emergency activities and the directing of the resources to resolve the emergency situation, i) decontamination of the victims in the event of their contamination with chemical, radiological or biological substances and j) the organisation of internal and external communications, including with the mobile command point of the emergency inspectorate.

Among the people, there are a series of misconceptions regarding emergency medical services, like the one about the transportation of victims and so according to the beliefs of the population, victims reach the hospital by ambulance whereas in reality they are transported to the hospital by private car, police vehicle, bus, taxi, on foot, etc. In Table 1 are presented the commonly held misconceptions about disasters, assumption and research observation.

**Table 1. Commonly held misconceptions about disasters (Auf der Heide, 2006, p. 36)**

<b>Assumption</b>	<b>Research observation</b>
Dispatchers will hear of the disaster and send response units to the scene	Emergency response units, both local and distant, will often self-dispatch
Trained emergency personnel will carry out field search and rescue	Most initial search and rescue is carried out by the survivors themselves
Trained EMS personnel will carry out triage, provide first aid or stabilising medical care and decontaminate casualties before patient transport	Casualties are likely to bypass on-site triage, first-aid and decontamination stations and go directly to hospitals
Casualties will be transported to hospitals by ambulance	Most casualties are not transported by ambulance. They arrive by private car, police vehicle, bus, taxi, on foot, etc.
Casualties will be transported to hospitals appropriate to their needs, and no hospital will receive a disproportionate share	Most casualties are transported to the closest or most familiar hospitals
Authorities in the field will ensure that area hospitals are promptly notified of the disaster and the numbers, types and severities of casualties they will receive	Hospitals may be notified by the first arriving victims or the news media rather than authorities in the field. Often, information and updates about incoming casualties are insufficient or lacking
The most serious casualties will be the first to be transported to hospitals	The least serious casualties often arrive first

In the emergency medical services framework, the transportation of the victims from the disaster site to the hospital is vital, and so from the time of the accident until the hospitalisation of the victims, there are six time intervals, namely: the time between the time of the accident and the announcement of the emergency medical system, the response time of the emergency medical transportation services (from the receipt of the referral to the departure of the ambulance), time spent by the ambulance to the scene of the accident, the stationary time of the ambulance at the scene of the accident, the patient's transport time to a hospital, and the time the patient is stabilised within the emergency department. In Figure 2 are compared the average response times of the US emergency medical system to urban and rural accidents. It is noticed that the average response time is higher in rural areas (53 minutes) than in urban areas (36 minutes).



**Figure 2. National average EMS response times for fatal crashes in 2002 (National Academy of Sciences, Engineering, and Medicine, 2006, p. III-6)**

The fact that the emergency medical transportation is vital as a service provided by the emergency medical services is presented in Table 2, where it is shown the comparative situation of the emergency medical interventions in the night clubs West Warwick and Colectiv. The emergency situations were similar, the solution, from a medical point of view was different, organised in the case of USA and with breaches of the norms and regulation in the case of Romania.

**Table 2. The comparative situation between the emergency medical interventions at the fires in the nightclubs West Warwick and Colectiv**

<b>The West Warwick nightclub fire (Warden, 2007, p. 190), Rhode Island, USA</b>	<b>The Colectiv nightclub fire (Romanian Government, 2015), in Bucharest, Romania</b>
Fire has killed 100 people and injured more than 200 people The fire took place in February 2003 at 11:07 p.m. On-site management: <ul style="list-style-type: none"> <li>- Two senior officers triage the victims</li> <li>- The deceased were moved to a separate area</li> <li>- The wounded were moved to 100 meters from the club. Here, critically ill people were taken over by the available ambulances in a maximum of 5 minutes</li> <li>- Less critical people were moved to the second area where they were reassessed and sent out into ambulances to hospitals</li> </ul>	The fire killed 64 people and injured 164 people The first announcement to 112 was made at 10:32 p.m. The first ambulances arrived at 10:42 p.m. On-site management: <ul style="list-style-type: none"> <li>- Lack of coordination of the intervention teams in the first minutes after arrival</li> <li>- Not performing the triage by qualified medical personnel</li> <li>- Resuscitation of victims occurred in improper conditions</li> <li>- The transport of the victims has encountered problems due to the fact that, as ambulances arrived, they were besieged by the victims in shock</li> </ul> The ambulances carried wounded to 11 hospitals in less than 2 hours after the fire started Some of the injured were moved to hospitals with their own means of transport

The presented situations reveal the necessity of learning from mistakes (Matei & Gogu, 2017), the need to carry out training exercises, to amend the legislation accordingly, to provide advanced techniques for interventions, for communication and for monitoring interventions, in order to prepare the emergency medical system for a turbulent future.

It is noted that the emergency medical services 'are always among the first to respond in the event of a disaster. However, they are also the least supported in fulfilling this role among all public safety personnel nationwide, lacking both adequate training and proper equipment for disaster response' (Warden, 2007, p. 176), at the same time the emergency medical services is 'ill prepared to handle large-scale emergencies, whether a natural disaster, an influenza pandemic, or an act of terrorism' (Warden, 2007, p. xiii), and the transport of patients 'to available emergency care facilities is often fragmented and disorganised' (Warden, 2007, p. xiii). The emergency medical services are 'extremely limited in rural areas' (Schur, Berk & Mueller, 2004, p. 2) in case of a large scale disaster.

### 3. Adaptive emergency medical services

Lately, we are dealing with disasters more often, they are more diverse, more violent and with more and more victims, from this point of view the future is turbulent and so uncertainty will rule the future both from the point of view of disasters and also, from the perspective of the medical emergency services. Uncertainty constitutes the working material for adaptive management.

Adaptive management 'is a formal iterative process of resource management that acknowledges uncertainty and achieves management objectives by increasing system knowledge through a structured feedback process' (Allen, Fontaine, Pope & Garmestani, 2011, p. 1340). According to Allen, Fontaine, Pope and Garmestani (2011) adaptive management has two phases: structured decision making (define the problem, identify objectives, formulate evaluation criteria, estimate outcomes, evaluate trade-offs and decide) and learning (implement, monitor, evaluate and adjust).

The emergency medical system has the characteristics of an adaptive system (Gogu, 2017b), having an area of structured decision making and one of learning.

The complex adaptive system 'is a way of thinking about and analysing things by recognising complexity, patterns and interrelationships rather than focusing on cause and effect' (The Health Foundation, 2010, p. 6) The emergency medicine is a complex adaptive system (Schmitz, 2010, p. 349) because of the following characteristics (The Health Foundation, 2010, p. 8):

- There are a large number of elements that interact dynamically (solicitors, doctors, nurses, ambulances, technical equipment, hospitals, etc.).
- Any element in the system is affected by the other elements and, in turn, affects one or more elements of the system (a request for an emergency service may be affected by another patient with a higher urgency, the patients are affected by doctors, delay of the ambulance, etc.).
- Interactions between elements are non-linear, so a small change can have large effects (e.g. a tire burst can contribute to late ambulance and the patient's death) and vice versa (a large change in an element of the system can have a small effect, for example, the introduction of an expensive computer system that proves to be useless).
- The system is open (all applicants have access to it) and closed at the same time (due to confidentiality and data security), so that it is difficult to define the boundaries of the complex adaptive system.
- There is a steady stream of force (e.g. state interest) that maintains a high level of organisation of the system.
- There is a history of the system, so the past helps shape the current system behaviour.
- Elements in the complex adaptive system are not aware of the system's overall behaviour, they only respond to what is available or known locally.

The emergency medical system has the ability to adapt to a turbulent future to diminish potential harm, take advantage of opportunities and deal with the consequences (World Health Organization, 2003, p. 26), but this system cannot be judged separately from the adaptive capability of the people, the communities, the nations, the institutions (Gogu, 2017a) or the private sectors. The main factors (World Health Organization, 2003, p. 27) of the adaptive capacity of a community, implicitly of the

emergency medical system, are: economic resources (wealthy nations are better able to adapt because they have the economic resources to invest, and to offset the costs of adaptation.), technology (many health protecting adaptive strategies involve technology—some of which is well established, some new and still being disseminated, and some still being developed to enhance coping with a changing climate), information and skills (health systems are labour-intensive and require qualified and experienced staff, including those trained in the operation, quality control and maintenance of public health infrastructure), infrastructure (general public health infrastructure enhance adaptive capacity), institutions (countries with weak institutional arrangements have less adaptive capacity than countries with well-established institutions) and equity (adaptive capacity is likely to be greater when access to resources within a community, nation or the world is equitably distributed).

The feedback process is very important in the framework of adaptive systems, the elements of the feedback process according to Wilkinson, Lynch, Bharadwaj and Woodham (2016) are the following: collection, analysis, decision and action. Adaptive systems include 'active refinement of parameters through the feedback process, whereas non-adaptive systems use either fixed parameters or parameters that are passively selected from a preconfigured set' (Wilkinson, Lynch, Bharadwaj & Woodham, 2016, p. 7).

Given that the emergency medical system is a complex adaptive system, there is the possibility to learn from mistakes, so after the intervention at the Colectiv nightclub, a report on the lessons learned (feedback process) after the fire was published, this report mentions the 'Process of lessons learned' which is an analysis mechanism that starts from specific circumstances related to the preparation, design and development of a particular activity or project, highlighting strengths, weaknesses, identified problems, negative or positive developments, and which has the main purpose of changing or reshaping the way of action in the future in similar activities or projects to achieve optimised results' (Borcea, Stoian & Alexandru, 2016).

Learning through practice constitutes the solution with the help of which emergency medical services will cope with a turbulent future. The adaptive management cycle for lessons learned from practice is the following:

1. Elaboration of a structured decision: a) defining the problem, e.g., drawing up lessons learned from a fire, b) identification of objectives, for example, the lesson learned report must capture the essential elements such as: trigger factors, fire propagation and fire extinguishing methods, how it affects the life and health of people, how people react to fire and the population that lives in the vicinity, fire-fighters, medical staff, what protection measures were or were not useful, etc., c) formulation of the evaluation criteria regarding the lesson learned report, d) estimating and evaluating the report if the report is complete and useful in identical or similar cases and e) the decision to approve and make public the lessons learned and the decision to amend the legislation, instructions, mode of action etc.
2. Learning: a) publishing the report, b) implementing technical, legal solutions etc., c) monitoring speciality publications around the world to study other events of the same type and monitoring the implementation of established solutions, d) periodic evaluation of the lessons learned report and e) adaptation whenever necessary of the lessons learned with other lesson.

#### **4. Conclusions and proposals**

The future of humankind is turbulent due to the lack of drinking water, quality food, access to medical services due to pollution, stress, new viruses, economic, political, social, military, terrorism, fires, floods, earthquakes and other phenomena and processes with a high-risk for health. Emergency medical services 'are always among the first to respond in the event of a disaster'.

The emergency medical system, as a complex adaptive system, has the ability to adapt to a turbulent future to mitigate potential harm, take advantage of opportunities and deal with the consequences, but

this system must be judged together with the people, the communities, the nations, the institutions and the private sector. The main factors of the adaptive capacity of a community, implicitly of the emergency medical system, are: economic resources, technology, information and skills, infrastructure, institutions and equity. Communities, implicitly emergency medical systems that have these factors, can adapt more easily to a turbulent future, learn from mistakes, quickly recover their losses and better protect the population against disasters.

Following the emergency medical interventions at the West Warwick and Colectiv nightclubs, it was found that, although the emergency situations were similar, from a medical point of view, they were different, ordered in the case of the United States and with deviations from the rules and regulations in the case of Romania. The presented situations highlight the need for the emergency medical system to learn from the mistakes made, to carry out training exercises, to amend the legislation accordingly, to provide advanced techniques for interventions, for communication and for monitoring interventions.

In Romania have taken place over time, disasters, like earthquakes, fires, floods etc. and for each of these events there is more or less information, this information can be transformed in reports regarding lessons learned following a catastrophic event. At the same time, in the world have existed different disasters, for some there are reports regarding lessons learned like the 'Lessons Learned from the Fukushima Nuclear Accident for Improving Safety of U.S. Nuclear Plants' (Nuclear and Radiation Studies Board & Division on Earth and Life Studies, 2014). These lessons learned must be gathered in a database like Big data, they must be processed and adapted in case of potential disasters. The lessons learned adapted to potential dangers from Romania, must contain also the chapter medical emergency services. On the basis of lessons learned, political, legal, technical etc., measures must be adopted in order to improve the safety of the buildings, nuclear installations and of other nature etc. but also to protect the life and health of the population. In the future, which is said to be turbulent, catastrophes will be more and more violent. After each catastrophe, new reports on learned lessons must be prepared and the existing reports must be improved, after which, based on lessons learned, measures adapted to the new reality (political, legal, financial, technical, etc.) must be adopted. The Lessons Learned Report should include a section listing the misconceptions of the population about a catastrophe (see Table 1), what is the reality and what measures should be taken.

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