Internal Security Review
2025, no. 33, pp. 305–326
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https://doi.org/10.4467/20801335PBW.25.033.22650

ARTICLE

The role of emergency medical services and cooperating entities as an element influencing public safety on the example of chemical rescue

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Abstract

Crisis-like events contribute to a heightened sense of threat and the state, in order to restore this imbalance, creates protective systems. One of them is the healthcare system. The law in force in Poland requires the state to ensure that citizens have access to medical services, even in crisis situations. This goal should be pursued in cooperation with medical units and law enforcement, administrative and technical units. This is particularly important in the face of threats related to the release of hazardous substances, which require the use of specialised forces and resources in chemical rescue and related ecological rescue. The aim of this article is to characterise the organisation and operation of rescue entities in situations involving chemical hazards and to identify any perceived shortcomings. The content of this article is the result of the author's research and analysis of available literature, including procedures developed by selected rescue systems operating in Poland.

Keywords

crisis situation, emergency medical system, rescue operations, alarm system, chemical rescue

Introduction

The National Security Strategy of the Republic of Poland from 2007 states that, due to the growing threats to the health and lives of citizens as a result of terrorist acts involving, among other things, chemical weapons, as well as mass accidents and disasters, the country should have adequately prepared and mobile medical resources at the central, provincial and local government levels. These resources should be ready to quickly identify threats and rescue the affected population. At the same time, emergency medical services system needs to be expanded and equipped with modern equipment for rapid diagnosis, rescue and life support[1]. A similar approach to the State Emergency Medical Services (hereinafter: EMS) system includes the *National Security Strategy of the Republic of Poland* (2014). According to this document, the core of the resources consists of National Firefighting and Rescue System (hereinafter: NFRS), EMS system, Emergency Notification System as well as associations and non-governmental organisations whose activities contribute to ensuring safety (e.g. WOPR, GOPR, TOPR, PCK[2]). It draws attention to the need to improve rescue standards, taking into account areas of possible cooperation between rescue services and entities, in order to meet the specific requirements of the EMS system, whose units carry out rescue tasks for people in a state of sudden health emergency[3]. The proper functioning and cooperation of services and entities responsible for broadly understood rescue operations have an impact on citizens' sense of security.

Non-standard events, e.g. involving an external factor in the form of a hazardous chemical substance, show whether and to what extent the entities responsible for conducting rescue operations are prepared to achieve their statutory objectives. In the article, the author analyses issues related to the organisation and functioning of rescue entities whose task is to ensure public safety in situations involving the chemical factor. He seeks answers to the question of how assistance should be organised for people affected by chemical incidents in order to reduce the risk to life and health as well as improve survival rates. The analysis of literature leads to the conclusion that, while there is a lot of material on the organisation of chemical and ecological rescue operations as well as medical rescue operations carried out at the level of qualified first aid[4] (hereinafter: QFA) within the NFRS

[1] *The National Security Strategy of the Republic of Poland*, Warszawa 2007, p. 34.

[2] WOPR – Water Volunteer Rescue Service, GOPR – Mountain Volunteer Rescue Service, TOPR – Tatra Volunteer Rescue Service, PCK – Polish Red Cross.

[3] *The National Security Strategy of the Republic of Poland*, Warszawa 2014, pp. 50–51.

[4] Qualified first aid – the scope of knowledge acquired during a qualified first aid course, organised on the basis of the *Regulation of the Minister of Health of 19 March 2007 on the course in qualified*

structures and specialist medical assistance provided within the EMS system, there is a lack of studies on the cooperation between these entities in incidents involving the release of hazardous substances[5]. The author assumes that there are organisational shortcomings that may affect the lives and health of people affected by such incidents.

The functioning of the State Emergency Medical Service system

The concept of rescue has many definitions. In general terms, it can be described as (…) *organising assistance in the event of unfortunate incidents*[6]. The foundations of the EMS system are government administrative bodies (the minister responsible for health and provincial governors) and units of the system[7]. The functioning of the EMS is based on the integration of teams working together within a system of units ready to provide immediate medical assistance in emergency situations threatening health and life, at the scene of the incident, if necessary transport to a hospital emergency department (hereinafter: ED) or, as a result of injuries sustained, to a trauma centre. These units (separated within the system structures) maintain the readiness of personnel, equipment and medical apparatus in order to

first aid. The framework programme for the QFA course is set out in Annex 1 to the *Announcement of the Minister of Health of 24 February 2021 on the publication of the consolidated text of the Regulation of the Minister of Health on the course in qualified first aid*.

[5] These are generally studies from over a decade ago (S.K. Jałoszyński, *Ratownictwo chemiczne* (Eng. Chemical rescue), vol. 3, Gdańsk 1990; M. Stadniczuk, L. Koksanowicz, *Przygotowanie ratowników do działań w zakresie ratownictwa chemicznego i ekologicznego* (Eng. Preparing rescue workers for chemical and ecological rescue operations), Kraków 2000; A. Wojnarowski, A. Obolewicz-Pietrusiak, *Podstawy ratownictwa chemicznego* (Eng. Basics of chemical rescue), Warszawa 2001; J. Konieczny, J. Ranecki, *Ratownictwo chemiczno-medyczne* (Eng. Chemical and medical rescue), Poznań–Warszawa 2007; *Administracja bezpieczeństwa chemicznego. Analiza zagrożeń, ratownictwo chemiczne, ekologiczne i medyczne* (Eng. Chemical safety administration. Risk analysis, chemical, ecological and medical rescue services), J. Konieczny (ed.), Inowrocław–Poznań–Warszawa 2008; *Medyczne czynności ratunkowe w zatruciach i skażeniach chemicznych* (Eng. Medical emergency procedures in cases of poisoning and chemical contamination), J. Pacz, J. Konieczny (eds.), Inowrocław–Poznań–Kraków 2008; B. Michailiuk, W. Wątor, *Ratownictwo chemiczne. Poradnik. Materiał szkoleniowy dla podmiotów zarządzania kryzysowego oraz służb ratowniczych* (Eng. Chemical rescue. Guide. Training material for crisis management entities and emergency services), Warszawa 2009) or developed and made available to a limited audience (e.g. published by the Fire Service College of the State Fire in Kraków).

[6] B. Michailiuk, *Ochrona ludności. Wybrane problemy* (Eng. Civil protection. Selected issues), Warszawa 2017, p. 62.

[7] P. Gromek, *W sieci ratownictwa* (Eng. In the rescue network), Warszawa 2018, p. 179.

provide emergency medical services[8]. The system consists of EDs and emergency medical teams (hereinafter: EMT), including air emergency medical teams[9], which use rescue helicopters to carry out tasks and provide emergency medical services in the shortest possible time, even in hard-to-reach places. Hospital emergency departments are units of the system established to fill the gap between pre-hospital medical assistance and specialist hospital treatment. They provide healthcare services consisting of initial diagnosis and treatment necessary to stabilise the vital functions of persons in a state of sudden health emergency:

1) transported by:
   a) emergency medical teams,
   b) units cooperating with the State Emergency Medical Service system,
   c) away teams (…),
   d) air search and rescue teams (…),
   e) entities providing sanitary transport (…),
2) self-referral[10].

This is not a ward intended for admitting persons referred for planned hospital treatment[11]. In order to perform their tasks, EDs are equipped with state-of-the-art medical equipment and apparatus and cooperate on an ongoing basis with the anaesthesiology and intensive care unit, the diagnostic imaging laboratory and surgical teams.

The most important aim of EMT's action is to be constantly ready to perform emergency medical procedures directly at the site of an incident causing a sudden health emergency and in the area affected by its consequences, and then to transport the injured to the nearest ED or, in the case of injury, to a trauma centre. Thanks to the EMT being equipped with special medical transport (ambulance), it is possible to reach the scene of an incident in the shortest possible time. EMT can perform medical rescue operations outside of hospitals thanks to the ambulances being equipped with specialist medical equipment and apparatus, medical devices and products used to save health and life, and constant radio communication

[8] Emergency medical procedures – healthcare services within the meaning of the provisions on publicly funded healthcare services, provided by the entity referred to in Art. 32(1) point 2 of the *Act of 8 September 2006 on the State Emergency Medical Services* (hereinafter: the EMS Act), outside of a hospital setting in order to save a person in a state of sudden medical emergency.

[9] Article 32(1) points 1, 2 of the EMS Act.

[10] Article 2(1) of the *Regulation of the Minister of Health of 27 June 2019 on the hospital emergency department.*

[11] Article 2(2) of the *Regulation of the Minister of Health of 27 June 2019 on the hospital emergency department.*

with the emergency call centre (hereinafter: ECC). Emergency Medical Teams are divided into:

- specialist teams consisting of at least three persons authorised to perform emergency medical procedures, including a system doctor and a system nurse or a paramedic,
- basic teams, consisting of at least two persons authorised to perform emergency medical procedures, who are a system nurse or a paramedic[12],
- air emergency medical teams consisting of at least three persons, including at least one professional pilot, a system doctor and a paramedic or a system nurse[13].

In accordance with the provisions of the EMS Act, a system doctor is a doctor holding the title of emergency medicine specialist or a doctor who has completed the second year of specialisation in this field[14]. In turn, a paramedic is a person who completed a first-cycle degree in emergency medical services or a two-year post-secondary school and obtained the title of a paramedic[15]. The job of a paramedic involves:

- providing health services, including emergency medical procedures provided independently or under the supervision of a doctor;
- securing persons at the scene of the incident and taking measures to prevent an increase in the number of persons in a state of sudden health emergency;
- transporting persons in a state of sudden health emergency;
- providing psychological support in a situation causing a sudden health emergency;
- health education and health promotion[16].

EMS system nurse is a nurse, who has a specialist title or specialisation in emergency nursing, anaesthesiology and intensive care, cardiology, surgery, paediatrics, as well as a nurse who has completed a qualification course in emergency nursing, anaesthesiology and intensive care, surgery, cardiology, paediatrics and has

[12] Article 36(1) points 1, 2 of the EMS Act.

[13] Article 37(1) of the EMS Act.

[14] Article 3 point 3 of the EMS Act.

[15] Article 10 of the EMS Act.

[16] Article 1 point 2 of the *Act of 25 September 2015 amending the Act on the State Emergency Medical Services, the Act on Medical Activity and the Act amending the Act on Medical Activity and certain other acts.*

at least three years of experience in wards of these specialities, emergency wards, emergency rooms or emergency services[17].

It is worth to emphasise that Poland is one of the few countries where nurses work alongside doctors and paramedics. It is a profession of public trust regulated by the Act on the professions of nurse and midwife[18]. During postgraduate education, nurses can supplement their knowledge and skills through specialised courses and training programmes. One of many areas of postgraduate education is emergency nursing.

Organisation of emergency medical services in the National Firefighting and Rescue System

The National Firefighting and Rescue System is an integral part of the internal security organisation of the Republic of Poland. Saving human life and health as an integral part of every field of rescue is the most important task imposed on entities operating in NFRS. This becomes particularly important when EMS entities are unable to take effective action. The scope of action of NFRS entities has been defined in the EMS Act and in the Regulation of the Minister of the Interior and Administration of 2021 on the detailed organisation of the firefighting and rescue system[19]. Units operating within NFRS have been designated as cooperating with the EMS system, and rescuers are to provide assistance at the QFA level. In order to define standards for the organisation of emergency medical services and the provision of medical assistance (at the QFA level) to persons in a state of sudden health emergency, rules have been developed for the organisation of emergency medical services in NFRS[20].

Within the structures of NFRS, medical rescue services are provided by all rescue and firefighting units of the State Fire Service (hereinafter: SFS) and fire protection units, in particular units of the Volunteer Fire Brigade incorporated into NFRS, which have operational readiness to undertake medical rescue operations by at least two rescuers in the rescue team (in accordance with the EMS Act). It is

[17] Article 3 point 6 of the EMS Act.

[18] *Act of 15 July 2011 on the professions of nurse and midwife.*

[19] *Regulation of the Minister of the Interior and Administration of 17 September 2021 on the detailed organisation of the National Firefighting and Rescue System.* Paragraphs 17 and 18 of this regulation contain references to emergency medical services, which at this level are limited to providing QFA.

[20] *Zasady organizacji ratownictwa medycznego w Krajowym Systemie Ratowniczo-Gaśniczym* (Eng. Rules for the organisation of medical rescue services in the National Firefighting and Rescue System), Warszawa 2021.

assumed that ultimately all entities operating in NFRS will have the capacity to undertake emergency medical services.

NFRS entities arriving at the scene take medical action in the following cases: absence of EMT, inability of healthcare units to take action when victims are located in a danger zone and access to them is only possible for NFRS unit rescuers using their rescue equipment, and when a multiple or mass incident has occurred. These measures consist of providing QFA to persons who are in a state of sudden health emergency and include, in particular:

- recognising sudden health emergencies in injured persons and conducting primary triage or participating in secondary triage,
- use of techniques and equipment necessary to save lives and protect health, depending on the type, scale, location of the incident and number of injured people,
- ensuring continuity of the process of rescuing persons in a state of sudden health emergency at the scene of the incident, carried out by NFRS entities,
- determining how to handle medical equipment,

and, in addition, documenting the manner in which QFA was provided and its analysis[21].

The activities performed by rescuers as part of QFA include:

- cardiopulmonary resuscitation, without equipment and with equipment, with oxygen administration and, if indicated, use of an automated defibrillator,
- stopping external bleeding and dressing wounds,
- immobilising fractures and suspected fractures as well as dislocations,
- protecting against hypothermia or overheating,
- conducting initial anti-shock treatment by properly positioning persons in a state of sudden health emergency, providing thermal protection for persons in a state of sudden health emergency,
- applying passive oxygen therapy,
- evacuation of persons in a state of sudden health emergency from the scene of the incident,
- psychological support for persons in a state of sudden health emergency[22].

[21] *Ratownictwo medyczne* (Eng. Medical rescue), https://www.gov.pl/attachment/e302a6de-fc4c-4757-9324-2c559e1e1456 [accessed: 11 V 2025].

[22] Article 14 of the EMS Act.

The role of the emergency notification system

In order to ensure effective cooperation between rescue services, including EMS and NFRS, it was necessary to create units to coordinate these services. These units became ECCs operating within the emergency notification system. The idea was to establish a structure that would increase the organisational efficiency of the system's units and implement procedures for the flow of information about incidents and the coordination of rescue operations. According to this, the emergency notification system was to have a knowledge base concerning rescue entities in the province, including their resources, training and operational readiness to participate in rescue operations, as well as the ability to coordinate these operations to an extent ensuring their continuity, as well as the forces and means necessary to carry out these tasks. The necessity of establishing a unified emergency notification system is evidenced by the fact that in September 2012, there were six ECCs operating in Poland, serving an area inhabited by only 8% of Poles[23]. Currently, the system consists of 17 ECCs (one in each provincial capital and in Radom)[24]. The Act on emergency notification system[25], which came into force on 1 January 2014, regulates issues related to emergency notifications, basing the system on ECCs created by provincial governors. The centres handle calls[26] to emergency numbers: 112, 997, 998, 999[27] in a uniform manner, enabling them to forward the calls to the appropriate dispatchers. Moreover, the system can handle emergency numbers: 991, 992, 993, 994, 986, 987[28] and other emergency numbers of entities whose tasks include the protection of life, health, public safety and order, property and environment[29].

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[23] *Jak funkcjonuje system powiadamiania ratunkowego?* (Eng. How does the emergency notification system work?), 9 V 2014, http://web.archive.org/web/20150512074034/https://mac.gov.pl/aktualnosci/jak-funkcjonuje-system-powiadamiania-ratunkowego [accessed: 20 VI 2025].

[24] *Centra Powiadamiania Ratunkowego* (Eng. Emergency Call Centres), https://www.gov.pl/web/mswia/centra-powiadamiania-ratunkowego [accessed: 11 V 2025].

[25] *Act of 22 November 2013 on emergency notification system.*

[26] Emergency call – information about the occurrence or suspected occurrence of a sudden threat to life or health, including acts of violence, as well as a sudden threat to the environment or property, and threats to public safety and order, which is directed to numbers operated within the emergency notification system by a publicly available telephone service provider, from external monitoring systems or using means of communication enabling immediate transmission of this information to the ECC.

[27] 112 – emergency number, 997 – Police, 998 – State Fire Service, 999 – State Emergency Medical Services.

[28] 991 – emergency energy service, 992 – emergency gas service, 993 –emergency heating service, 994 – emergency water and sewerage service, 986 – municipal guard, 987 – crisis management centre.

[29] Article 3 of the *Act of 22 November 2013 on emergency notification system.*

ECC's handling of emergency call consists of:

- receiving an emergency call,
- linking the emergency call with the contact details of the incident location and its geographical position,
- selection of entities (taking into account the specific nature of a given call) to which the collected notification data will be forwarded,
- transferring, when necessary, the collected data electronically using an ICT system[30], and in justified cases – together with redirecting the telephone call in accordance with the classification of the report to the Police, SFS, EMT operators or entities whose telephone numbers are supported within the system,
- exchange of data on emergency calls processed in the ICT system with the Police, SFS, administrators of emergency medical teams or other entities whose telephone numbers are supported within the system[31].

Entities whose numbers are supported by the system have their own teams at their disposal for rescue operations.

Reports are duly recorded and stored in the ICT system for three years. The stored data includes: the content of emergency call, including recordings of telephone conversations covering the entire emergency call, details of the callers and other persons identified during the notification, information about the location and type of incident, as well as a brief description of the incident[32].

In order to gather as much information as possible, relevant analyses related to the functioning of the system in the area served by the ECC are carried out and statistics are compiled covering the number, type and time of emergency call. These relate to:

- cooperation and exchange of information with crisis management centres;
- exchange of information and data, excluding personal data, for the purposes of analyses with the Police, SFS, EMT operators and entities, whose telephone numbers are handled within the system.

When it is not possible to forward a notification alert within the system and when justified by the nature of the call, the ECC shall take steps to forward information about the notification to entities whose numbers are not handled by

[30] ICT systems – a set of cooperating IT devices and software ensuring the processing, storage, as well as sending and receiving of data via telecommunications networks using terminal equipment appropriate for a given type of telecommunications network, used to perform the tasks of an emergency call centre (within the meaning of Art. 2 point 43 of the *Act of 16 July 2004 – Telecommunications Law*, amended on 9 August 2024 by the *Act of 12 July 2024 – Electronic Communications Law).*

[31] Article 8(1) point 1 letters (a)–(e) of the *Act of 22 November 2013 on emergency notification system.*

[32] Article 8(1) point 2 of the *Act of 22 November 2013 on emergency notification system.*

the centre but whose tasks include the protection of life, health, safety and public order, property and environment in order to carry out rescue operations[33].

Emergency number operators have been appointed to handle emergency calls. The number of operators necessary for the efficient handling of calls is provided by the provincial governor. An operator may be a person who:

- has at least secondary or vocational secondary education;
- is proficient in at least one foreign language at a communicative level;
- has completed basic training for emergency number operators and passed the exam;
- speaks and writes Polish to a level sufficient to handle emergency calls;
- enjoys full public rights;
- has not been convicted of an intentional crime or an intentional fiscal offence by a final judgment[34].

The measures taken to create an emergency notification system are linked to the organisation of ICT systems, in particular the promotion of the 112 emergency number, which the Polish government has been obliged to do by the European Union[35]. The system is designed to electronically record data provided by the reporting person and immediately visualise the location of the incident using maps to indicate its location and scale. This is intended to make it easier for emergency number operators to decide on the type and number of entities to be dispatched to rescue operations. The organisation of ICT systems has significantly improved the process of cooperation between entities working within the system and the management of their resources, thanks to which the time from receiving a notification to taking action has been reduced and the effectiveness of rescue operations has increased. This is important because of the role that time plays in rescue operations. It is not only a decisive factor in the fight for health and life, but also one of the basic measures used to assess the effectiveness of the EMS and NFRS systems.

Chemical hazards

The chemical industry is an important link in the economic systems of many countries. In Poland, it is one of the key branches of the manufacturing industry.

[33] Article 8(2) of the *Act of 22 November 2013 on emergency notification system.*

[34] Article 16(1) of the *Act of 22 November 2013 on emergency notification system.*

[35] *Directive 2002/22/EC of the European Parliament and of the Council of 7 March 2002 on universal service and users' rights relating to electronic communications networks and services.*

There are many plants in Poland that produce, store or process hazardous chemicals[36], including those classified as particularly dangerous. These establishments are subject to state supervision in accordance with SEVESO Directive[37]. According to data from the Chief Inspectorate for Environmental Protection, there are 507 industrial plants in Poland (as of 31 December 2024), where a major accident could occur due to the quantity of hazardous materials stored there, including 227 high-risk plants and 280 increased-risk plants[38]. The safety of Polish residents is affected not only by plants located within the country. Border areas are at risk from plants located outside the country's borders (e.g. Ostrava, Schwedt).

A chemical substance may pose a hazard as a result of[39]:

– explosion,
– fire,
– substance release.

A chemical incident, regardless of whether its source is HazMat[40] or CBRNE[41], may, due to its scale and number of victims, take the form of a single, multiple

[36] Data from the Statistics Poland (GUS) for 2024 indicate that there are 12 400 companies operating in the Polish chemical sector. See: *Przemysł chemiczny w Polsce* (Eng. Chemical industry in Poland), Polska Izba Przemysłu Chemicznego, https://pipc.org.pl/o-nas/przemysl-chemiczny-w-polsce/ [accessed: 11 V 2025].

[37] *Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC.*

[38] *Zakłady stwarzające ryzyko wystąpienia poważnej awarii przemysłowej* (Eng. Establishments posing a risk of a major industrial accident), https://www.gov.pl/web/gios/di-zaklady-stwarzajace-zagrozenie-wystapienia-powaznej-awarii-przemyslowej [accessed: 11 V 2025].

[39] A. Trzos, *Triage w zdarzeniach chemicznych* (Eng. Triage in chemical incidents), in: *Administracja bezpieczeństwa chemicznego. Analiza zagrożeń, ratownictwo chemiczne, ekologiczne i medyczne*, J. Konieczny (ed.), Inowrocław–Poznań–Warszawa 2008, p. 288.

[40] HazMat (hazardous materials) – dangerous materials (goods), i.e. any material or article which, according to ADR (Accord Dangereux Routier – European Agreement concerning the International Carriage of Dangerous Goods by Road), RID (Fr. *Règlement concernant le transport international ferroviaire des marchandises dangereuses* – Regulations concerning the International Carriage of Dangerous Goods by Rail) or ADN (European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways) is not permitted for transport by road, rail or inland waterways, or is permitted for such transport under the conditions specified in these regulations. See art. 2 point 4 of the *Act of 19 August 2011 on the transport of dangerous goods.*

[41] CBRNE is an acronym for: C – chemical, B – biological, R – radiological, N – nuclear, E – explosive. It refers to threats arising from the potential use of chemical, biological, radiological, nuclear weapons and explosives.

or mass incident (accident)[42]. In each of these situations, the scope of problems varies – from organisation and logistics to medical security. The risk of an accident involving a hazardous chemical substance exists not only at the place where the material is produced or processed. They are also created by substances stored in sewage treatment plants, water treatment plants and cold stores. This risk is also associated with the transport of hazardous materials, mainly by road and rail (less frequently by water and air). As Andrzej Cenkała et al. point out, (…) *most chemical incidents occur during accidents and disasters involving road transport of tankers carrying hazardous chemicals*[43]. It should be noted that the transport of hazardous substances also includes pipelines.

A large portion of the compounds produced by chemical industry plants are classified as precursors of chemical warfare agents, which poses an additional threat. Semi-finished products manufactured in industrial plants can be used to produce artificial fertilisers, but also chemical warfare agents. Yperite can be obtained from ethylene, and phosphorus trichloride can be used to produce paralytic and convulsive gases (VX, sarin or tabun). Chemical weapons are often referred to as the poor man's nuclear weapons[44] and are classified as weapons of mass destruction.

The diversity of toxic substances – both toxic industrial substances and chemical warfare agents – makes them difficult to classify. Their properties can be considered in many ways. One of these is toxicity[45], which has a negative impact on living organisms and the natural environment. In the case of the human body, it is important to know how a given chemical substance enters the body. There are four routes of absorption[46]:

1) inhalation route – due to the large surface area of the respiratory tract and the thinness of the air–blood barrier, gases and vapours from the respiratory

[42] Multiple and mass decontamination remains a particular challenge. See in more detail: A. Trzos, K. Łyziński, *Potencjał reagowania ratownictwa medycznego na zagrożenia CBRNE w kontekście współpracy wojskowo-cywilnej* (Eng. The potential of emergency medical services to respond to CBRNE threats in the context of civil-military cooperation), "Safety & Fire Technology" 2024, vol. 64, no. 2, pp. 169–170. https://doi.org/10.12845/sft.64.2.2024.10.

[43] A. Cenkała et al., *Realizacja zadań z zakresu ratownictwa chemicznego przez jednostki PSP* (Eng. Performance of chemical rescue tasks by units of the SFS), in: *Administracja bezpieczeństwa chemicznego. Analiza zagrożeń, ratownictwo chemiczne, ekologiczne i medyczne*, J. Konieczny (ed.), Inowrocław–Poznań–Warszawa 2008, p. 278.

[44] P. Durys, *Broń chemiczna: działania na rzecz zakazu i eliminacji* (Eng. Chemical weapons: efforts towards prohibition and elimination), Warszawa 2009, p. 45.

[45] The term: toxicity, Leksykon NIZP-PZH, http://leksykon.pzh.gov.pl/index.php/Toksyczno%C5%9B%C4%87 [accessed: 10 V 2025].

[46] J. Solarz, *Prognozowanie skażeń chemicznych* (Eng. Chemical contamination forecasting), Warszawa 2007, p. 22.

tract are absorbed at a high rate. Depending on the solubility of a given substance, this process may be more or less intense[47]. Volatile substances that dissolve well in water, such as ammonia and hydrogen chloride, are absorbed into the body in the upper respiratory tract. Nitrogen oxides, benzene and phosgene, which are poorly soluble chemicals, reach the alveoli almost entirely and penetrate the body there. Poorly soluble substances such as carbon disulphide, ethylene and cyclopropane are difficult to absorb into the bloodstream. Their absorption increases with the increased blood flow through the lungs, which is influenced by increased physical exertion, high body temperature, ambient temperature or a state of arousal (emotional states)[48].

2) transdermal (dermal) route – human skin consists of the epidermis, dermis and subcutaneous tissue and acts as a natural protective barrier. Chemical substances are usually transported through the skin by passive diffusion[49]. Compounds that are highly soluble in water and lipids are best absorbed into the body through the skin. Substances in the form of gases and vapours, such as hydrogen cyanide, ammonia, benzene and phenol, are also absorbed in this way. Local conditions play a very important role in the rate of transdermal absorption. The presence of wounds (or even cuts) eliminates the protective function of the skin and accelerates penetration. Transdermal absorption is also enhanced by high body temperature and high humidity;
3) gastrointestinal tract – absorption begins in the mouth and continues in the stomach, where it depends on the pH level of gastric juice, the presence of food content and enzymes. Due to the large absorption area, the long residence time of chemicals in the digestive tract and its strong blood supply, most substances penetrate the body quickly and efficiently. Only unstable substances and those that do not dissolve in gastric juice are not absorbed;
4) parenteral route – in the event of major wounds, there is a possibility of toxic substances entering the bloodstream directly. This process may be exacerbated in the case of abdominal wounds and damage to the peritoneum (strong blood supply to the peritoneal cavity and large absorption surface area)[50].

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47 M. Kowalczyk, S. Rump, Z. Kołaciński, *Medycyna katastrof chemicznych* (Eng. Chemical disaster medicine), Warszawa 2004, p. 93.

48 Ibid.

49 Ibid., p. 92.

50 Ibid.

The existence of these threats, as well as the possibility of using toxic industrial agents and chemical warfare agents for terrorist purposes, as exemplified by the 1995 attack on the Tokyo subway, has necessitated the development of rules for mitigating the effects and rescuing victims in incidents involving the release of hazardous chemicals.

Chemical rescue

Chemical rescue is relatively new field of rescue operations that has emerged in connection with the widespread use of chemicals in everyday life. This structure was established due to the high toxicity of chemical substances and the variety of their effects on living organisms in the event of an accident or chemical incident.

Work on legal regulations concerning chemical rescue began in Poland in the 1960s. At a meeting of the Nitrogen Industry Association in Tarnów in 1967, an organisational concept for chemical rescue services was adopted. In 1968, the first services began to be established: first in Puławy, then in Tarnów[51]. The government adopted the Resolution of the Council of Ministers 82/68 of 15 March 1968 on further improvement of health and safety conditions at work, in which § 16 required the establishment of an emergency chemical rescue service in the aforementioned industrial plants[52]. In December 1968, a train crash occurred near Jackowice, in which seven people were fatally poisoned, mainly due to ignorance of the dangers posed by chlorine. This event intensified work related to chemical rescue. The Council of Ministers adopted the Resolution no. 60/70 of 6 May 1970 on combating the effects of accidents involving the transport of toxic substances by land, under which chemical rescue units were established in Brzeg Dolny, Bydgoszcz, Oświęcim, Płock, Puławy and Tarnów[53]. At that time, the emblem of the newly established rescue service was also adopted.

In 1991, chemical rescue (later chemical and ecological rescue) was separated in Poland into the SFS operational scheme, which is the mainstay of operations in this area. Rescue services were established to carry out organisational and technical activities aimed at preventing chemical accidents and, in the event of an undesirable

[51] *Historia ratownictwa chemicznego w Polsce* (Eng. History of the chemical rescue in Poland), kierunekchemia.pl, 29 IX 2020, https://www.kierunekchemia.pl/artykul,79381,historia-ratownictwa-chemicznego-w-polsce.html [accessed: 31 X 2025].

[52] Also known as a chemical rescue station. The structures were created in plants subordinate to the Ministry of Chemical Industry. Quoted after: B. Michailiuk, W. Wątor, *Ratownictwo chemiczne. Poradnik*…, p. 14.

[53] Ibid.

incident, rescuing victims and those at risk in an organised manner, as well as eliminating the source and effects of the accident[54]. According to the definition adopted in Regulation of the Minister of the Interior and Administration of December 1999, chemical rescue operations included (…) *a set of planning and organisational activities and the use of rescue techniques necessary to save the environment, as well as all other activities undertaken to save human life and health by eliminating direct threats posed by toxic industrial agents or other hazardous chemical materials*[55]. These assumptions have been expanded to include an ecological aspect, due to the growing importance of environmental protection and ecological safety since the beginning of the 20th century. The same regulation introduced the concept of ecological rescue, which was to be understood as (…) *a set of planning and organisational activities and the use of technical safeguards necessary to rescue the environment and apply measures to neutralise, limit or eliminate the resulting contamination*[56].

The complexity of industrial processes, the transport of chemical substances and technological developments bring with them the risk of chemical accidents and incidents. In situations where the safety of civilians and their surroundings is threatened, the SFS comes to the rescue. In particularly dangerous situations, it is represented by specialist chemical and ecological rescue groups operating within the SFS. Firefighters are equipped with state-of-the-art equipment for identifying and neutralising hazardous substances and materials, enabling them to save lives and protect human health, as well as take measures to minimise the negative impact of undesirable events on the natural environment[57].

It should be noted that, apart from the SFS operating within the NFRS, chemical rescue services were or are also provided by other rescue entities subordinate to the ministries dealing with internal affairs, national defence, communications and economy, such as:

– chemical rescue teams [formerly: chemical and radiation emergency teams (ChiRZA)], operating in the chemical and engineering forces[58];

[54] S.K. Jałoszyński, *Ratownictwo chemiczne*…, pp. 30–31.

[55] Paragraph 10(1) of the *Regulation of the Minister of the Interior and Administration of 29 December 1999 on detailed rules for the organisation of the National Firefighting and Rescue System.*

[56] Paragraph 10(2) of the *Regulation of the Minister of the Interior and Administration of 29 December 1999 on detailed rules for the organisation of the National Firefighting and Rescue System.*

[57] *Ratownictwo chemiczne i ekologiczne* (Eng. Chemical and ecological rescue), https://www.gov.pl/web/kgpsp/ratownictwo-chemiczne-i-ekologiczne [accessed: 11 V 2025].

[58] See in more detail: B. Michailiuk, W. Wątor, *Ratownictwo chemiczne. Poradnik…*, pp. 16–17.

– chemical rescue stations, operating in the largest chemical industry plants and grouped within national rescue system[59];
– technical rescue trains in the road divisions of the Polish State Railways (railway technical rescue)[60].

The adopted solutions as part of the organisation of rescue operations for the chemical and ecological subsystem have led to a reduction in the time taken to commence operations and an increase in the effectiveness of hazard response. In addition, operational personnel operating in a situation where a hazardous substance has been released are required to provide medical assistance to victims at the level of the QFA. Considering the above and the fact that cooperation between entities involved in rescue operations is necessary to optimise medical activities, the possibility of broader involvement of EMT members in providing medical assistance to victims – even before the decontamination stage – should be considered. In accidents and disasters involving hazardous substances, all persons who were in the danger zone, regardless of their general condition and injuries sustained, should be treated as victims in a life-threatening condition and marked with at least the colour yellow during triage[61]. In incidents involving a large number of casualties, medical triage should be carried out by EMS system operational personnel. Victims of a hazardous substance release delivered by rescue teams consisting of rescue firefighters to the edge of the danger zone just before decontamination should be handed over to members of the EMT, who, wearing light gas-tight clothing, can begin providing medical assistance at the level of emergency medical procedures. After prior medical triage and classification of victims according to the urgency of assistance required, this assistance may be extended to include procedures related to skin incision, intubation (or other instrumental methods of clearing the airways) and the use of a manual defibrillator (after assessment of cardiac arrhythmia) provided by the EMT. These procedures, i.e. emergency medical procedures, may only be performed by personnel operating within the EMS system. The members of EMT perform medical procedures at the scene of the incident in accordance with current knowledge in the field of emergency medicine, and after completing them, prepare the injured for transport to the hospital.

[59] *System Pomocy w Transporcie Materiałów Niebezpiecznych SPOT* (Eng. Hazardous Materials Transport Assistance System), http://systemspot.pl/about/ [accessed: 11 VI 2025].

[60] M. Biniak-Pieróg, Z. Zamiar, *Organizacja systemów ratownictwa* (Eng. Organisation of rescue systems), Wrocław 2013, pp. 74–75.

[61] Yellow colour means that the injured person has sustained injuries requiring medical attention, but this does not need to be immediate, as a delay in providing it does not threaten their life.

Solutions similar to those proposed, i.e. the possibility of taking emergency medical action in the danger zone by operational personnel working in the EMS system, are in force in the US and the UK. In these countries, special teams from the emergency medical services were set up to take immediate medical action in the danger zone. After receiving training and personal protective equipment, members of these teams take action aimed at improving clinical outcomes and increasing the chances of survival for victims of particularly dangerous accidents, including those involving the release of hazardous substances. These teams enable access to victims in the most difficult conditions, including those inside the security cordon. This speeds up the start of medical treatment, thereby increasing the victims' chances of survival.

In the event of a hazard posed by dangerous chemicals, the most appropriate course of action is to assess the condition of the victims as quickly as possible, secure their airways (including the use of instrumental methods) and administer intensive fluid therapy. These procedures, which cannot be carried out by SFS rescuers, should be undertaken by operational personnel working within the EMS system. Equipping EMS rescuers with lightweight gas-tight clothing and filtering respiratory protection systems will enable them to perform basic examinations and necessary medical procedures to save the lives and health of victims. Currently, victims in the area affected by hazardous materials receive specialist medical assistance only after decontamination. This delay can have a negative impact on their health and lives. Therefore, it seems reasonable to extend the powers of EMT members to include the provision of medical services at the level of emergency medical procedures in the danger zone, prior to decontamination.

Conclusions

The aim of the article was to characterise the organisation and functioning of rescue services in the event of chemical accidents and incidents, as well as identification of gaps in this area. Failure to respond adequately can lead to a crisis situation. That is why recommendations for improving chemical rescue operations are so important.

One of the factors complicating rescue operations (as well as ecological) is the large number of substances and mixtures of substances, as well as their considerable diversity in terms of physicochemical properties. Furthermore, chemical products are a combination of compounds and elements which only pose a real threat, sometimes on a large scale, after reacting with another compound or element. This necessitates continuous investment in highly specialised chemical

rescue units (equipment, protective measures, training, development courses, simulations and exercises). As Bogdan Michailiuk and Włodzimierz Wątor rightly point out, (…) *the multifaceted nature of chemical rescue operations (chemical disasters are accompanied by contamination zones, fires and/or explosions) implies a high demand for the involvement of other services, particularly medical services, which in turn raises issues of coordination and comprehensive security measures*[62].

In order to optimise rescue operations in situations involving the release of hazardous substances and to ensure the highest possible survival rate for victims, it is necessary to adapt the training system. Regardless of their level of education, operational personnel working within the EMS system at the scene of an incident involving the release of such a substance should have the knowledge necessary to conduct rescue operations safely and effectively. Specialist knowledge and its development are important (e.g. 'chemical products', 'dangerous goods' and 'hazardous materials' are not synonymous terms, but are often used interchangeably). A lack of knowledge may result in inadequate measures being taken in relation to the dangers associated with the use, transport or storage of such products, goods or materials. In summary, identifying potential hazards and assessing risks based on prior thorough analysis and evaluation play a significant role in minimising the effects. Basic information should be provided during academic studies and postgraduate training, while advanced knowledge and practical skills should be taught after graduation, during specialist training courses. As part of these training courses, participants should be familiarised with issues such as:

- legal and organisational conditions relating to rescue operations in the event of a hazardous substance release,
- the possibility of chemical hazards (taking into account the specific characteristics of the region) – sources, causes and impact on the natural environment,
- physicochemical parameters, toxicity of hazardous chemicals and their impact on the human body,
- hazard identification – labelling of hazardous substances during transport, handling and storage,
- hazard identification – use of control and measurement equipment to identify hazardous substances,
- personal protection – personal protective equipment,
- rescue tactics implemented by EMS personnel in the event of accidents and chemical incidents.

[62] B. Michailiuk, W. Wątor, *Ratownictwo chemiczne. Poradnik*…, p. 62.

Coordinated cooperation between law enforcement, administrative, technical and medical units and authorities is the foundation for effective, professional medical assistance in emergency situations involving explosions, fires or the release of hazardous substances.

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