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Problem Oriented Training in Emergency Medical Care Under the Conditions of Extremal Technogenic Situation (the Example of Solving a Situational Task)

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ABSTRACT The article provides a situational task with a detailed solution, reflecting the principles and procedure for the provision of emergency medical care outside a medical organization during a technogenic emergency (explosion followed by a fire) with several victims. This type of educational technology is applicable both during practical exercises with elements of simulation training, and monitoring the level of training of medical personnel.

Keywords: technogenic disaster, explosion, fire, mass lesions, pre-hospital stage, post-graduate training, situational task
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EMS — emergenccy medical services
TBI — traumatic brain injury

Today, the number of emergencies, including man-made ones, is steadily increasing [1]. At the same time, one of the most common types of technogenic emergencies is fires [2]. Elimination of the medical consequences of emergencies at an early stage implies the need for organizational and therapeutic measures with temporarily limited forces and means at the optimum time. The results of numerous studies indicate the occurrence of a large number of possible diagnostic and tactical errors in such conditions, which inevitably leads to an increase in mortality among victims [3].

In our opinion, the aim of preparing mobile team of emergency medical services (EMS) for work in emergency situations is minimizing erroneous actions in typical situations of industrial accidents (fires, explosions, collapses). One of the effective tools for achieving this goal in basic and permanent vocational training is the solution of situational clinical problems (cases) [4].

CONDITIONS OF THE PROBLEM

Two general specializedmobile teams arrived at the place of the call with the pretext “Fire in a residential building” at the same time: the medical team (general medical mobile team) and the paramedic (general paramedic mobile team) in full force. Upon arrival, there is intense smoke inside the five-story building under repair with a partial collapse of the external panel and balcony of the third floor apartment. According to the Ministry of Emergency Situations at the scene, during the repair and construction work in the apartment there was an explosion of a gas cylinder with subsequent fire and collapse of some structures. The building was resettled before renovation. Search and rescue work continue inside the building.

Six victims were found, four of them were evacuated to an ambulance (injured 1–4), two (injured 5–6) were in the immediate proximity of the damaged building:

Victim 1. A 30-year-old man, agitated, inadequate, there is no traces of soot on his face, there are no visible injuries, hinders the examination and medical assistance to other victims.

Victim 2. A 50-year-old man is sitting, his ability to move independently has been preserved, inhibited, crying, asks for immediate assistance to a relative lying near the building. In victim No. 2, there is ongoing bleeding from the left external auditory canal, a sedimented wound of the frontal and zygomatic areas on the left.

Victim 3. A man, about 30 years old, was taken out by the Ministry of Emergency Situations from the fire, lying on his back, extensive burns to the face of the 2nd to 3rd degree, upper half of the trunk, both hands, opens his eyes at the command, speech is incoherent, a protective reaction is noted when an attempt to examine burn injuries, stridor breathing, auxiliary respiratory muscles

are involved in the act of breathing, respiratory rate 30/min, pulse 78 beats /m, the rhythm is correct.

Victim 4. A man, about 40 years old, with a lack of consciousness and spontaneous breathing, was delivered from the building by the Ministry of Emergency Situations at the time of arrival of the ambulance brigades. No visible damage.

Victim 5. A man with obvious signs of an open traumatic brain injury (TBI) and brain matter escaping to the outside motionlessly lies against the wall of the building under overhanging damaged building structures.

Victim 6. A man, about 20 years old, half-sits against the wall of a building under an overhanging damaged balcony and screams loudly in pain, assuring that his leg is broken. Visually, the left lower leg and foot of the victim are blocked by a fragment of a fallen reinforced concrete slab, a severe deformation of the left thigh with signs of continued bleeding from the wound in this area, burns to the face, upper limbs.

TASK ISSUES

1. Indicate the sequence of actions of the ambulance teams at the scene.
2. Indicate the amount of information that must be transferred to the operational department of the EMS station as the situation develops.
3. Locate the ambulances at the scene.
4. Conduct medical sorting with justification of the sorting group of each of the victims.
5. Determine the required number of additional EMS teams to organize the rational conduct of medical and evacuation measures.
6. Indicate the procedure and amount of medical care for victims.
7. Indicate the amount of information about the victims, which must be transferred to the brigade of the territorial center for disaster medicine when it arrives at the scene.

REFERENCE ANSWERS

Answer 1. The sequence of actions of the ambulance teams at the scene is as follows:

a) inform the operational department of the EMS station about arrival at the scene of the incident (carried out by each EMS team independently);

b) identify the person responsible for medical support at the scene.

Responsible for medical support during mass incidents is an employee of the EMS (doctor or paramedic), who was the first to arrive at the scene [5–7]. Considering (according to the conditions of the task) the simultaneous arrival of general specialized medical and paramedic teams of the ambulance, the management of the situation related to medical support at the scene of the incident is primarily taken by the ambulance doctor.

c) establish interaction with emergency operational non-medical services;

d) provide primary information to the operational department of the EMS station about the situation at the facility (carried out by the EMS doctor responsible for medical support);

e) carry out primary medical sorting of the injured by the forces of both teams of the EMS;

f) to re-inform the operational department of the EMS station according to the results of the primary medical sorting (carried out by the EMS doctor responsible for medical support);

g) carry out a secondary medical sorting and begin conducting emergency medical measures by the forces of both teams of the EMS;

h) take the leadership of the newly arriving general-purpose ambulance teams until the arrival of a specialized ambulance team or the team of the territorial center for disaster medicine (carried out by the ambulance doctor responsible for medical support).

Answer 2. The primary care physician responsible for medical support must first be informed of the following information in the operational department of the emergency care facility:

a) the nature of the incident (taking into account information received from the Ministry of Emergency Situations);

b) the presence at the scene of the emergency service personnel, including medical personnel.

After the initial medical screening, you should contact the Operations Department of the EMS Station again to transmit the following information:

a) the specified number of victims indicating the contingents (children, pregnant women) and the severity of the condition;

b) the presence at the scene of the emergency service personnel, including medical personnel;

c) on the additionally required number of EMS teams, including specialized ones.

If the situation at the facility changes (including the appearance of more victims), you should re-contact the operations department of the EMS station to transmit relevant information:

a) the specified number of victims indicating the contingents (children, pregnant women) and the severity of the condition;

b) on the additionally required number of EMS teams, including specialized ones.

Answer 3. The ambulance cars with the flashing lights turned on should be located on the border of the exclusion zone determined in this situation by the Ministry of Emergencies, but not closer than a distance equal to one and a half heights of the emergency building in case of collapse (Fig. 1). Together with the Ministry of Emergency Situations, the doctor responsible for medical support of the EMS needs to determine the evacuation for the smooth conduct of timely medical evacuation of victims. Also, the EMS doctor responsible for medical support determines the optimal access path for additional EMS teams and transmits this information to the operational department of the EMS station.

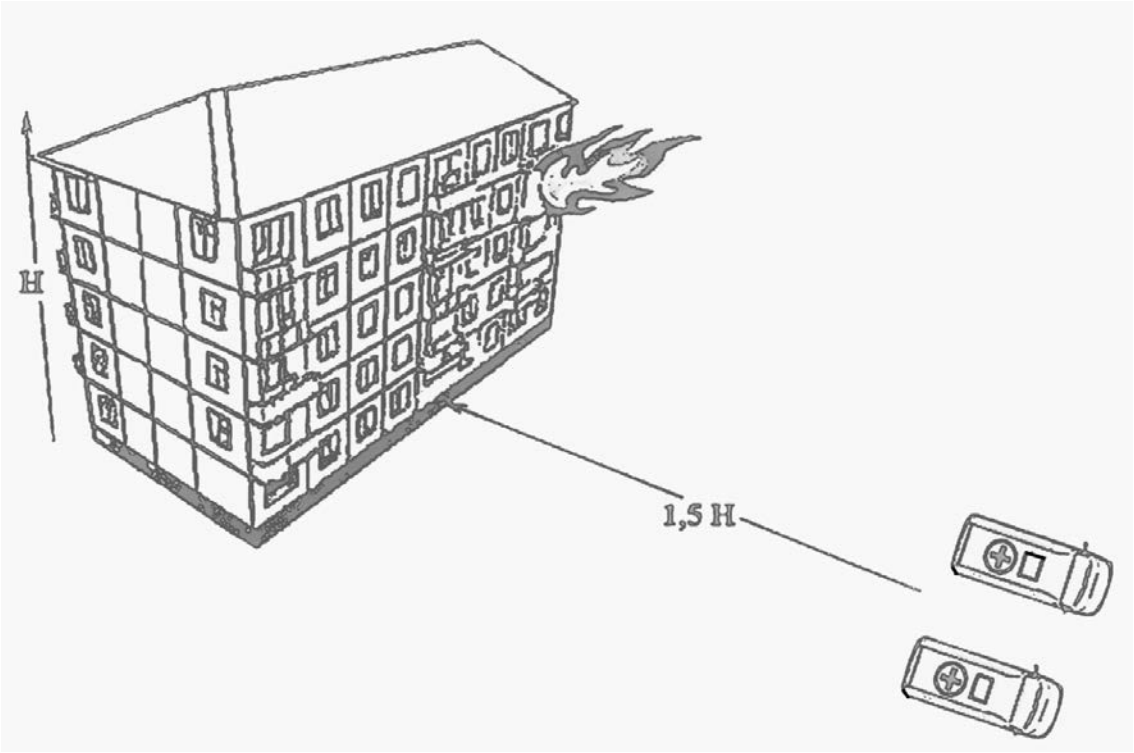

Fig. 1. The location of the ambulance at the border of the exclusion zone (H - the height of a building)

Answer 4. As a result of medical sorting:

Victim 1 can be assigned to the 3rd sorting group (a severe lesion without disturbance of vital functions requiring dynamic observation), given the presence of thermal and toxic damaging factors. Traces of soot on the face may indicate a thermo-inhalation lesion, which is potentially dangerous due to the possibility of an increase in airway obstruction. Mental changes (excitation, inappropriate behavior) may be a manifestation of acute reactive state and one of the early symptoms of CO poisoning and increasing hypoxia. It should be taken into the account, that the entire classic symptom complex of carbon monoxide poisoning at this stage may not manifest. Also, in this pathology, the data of blood saturation obtained by pulse oximetry are not informative for determining the degree of hypoxia, and portable devices for quantitatively measuring the blood carboxyhemoglobin content resulting from carbon monoxide poisoning are still not widely used at the prehospital stage.

Victim 2 also can be attributed primarily to the third group of sorting on the basis of possible signs of severe head injury in the "lucid gap" phase: retardation, continuous bleeding of external auditory meatus, abraded wound of facial soft tissues. Inhibition can also be one of the symptoms of poisoning by combustion products or a manifestation of an acute reactive state. Continued bleeding from the external auditory meatus characteristic baro injury due to explosion, but it can not be ignored as a possible symptom of fracture of bones of the skull base. In the conditions of the pre-hospital stage, an express test for the presence of cerebrospinal fluid in the hemorrhagic discharge is justified, which is considered positive when a pale yellow cap is formed around a blood stain on a hygroscopic surface (gauze or bandage).

We want to draw attention to the fact that, given the specifics of the damaging factors, the absence of obvious signs of severe lesions at the time of examination of **victims 1 and 2** (consciousness, the ability to move independently) should not allow them to be attributed primarily to the “mild” sorting groups (fourth or fifth). Dynamic monitoring of their condition is necessary for the timely detection and correction of possible threatening complications.

Victim 3 should be assigned to the 2nd sorting group (severe lesion with impaired vital functions) due to a burn and increasing obstruction of the upper respiratory tract, extensive burns of the 2nd – 3rd degree, and burn shock.

Victim 4 in a state of clinical death should formally be assigned to the 1st sorting group. Although cardiopulmonary arrest without signs of injury incompatible with life is an indication for resuscitation in normal clinical practice, in case of mass emergencies, basic or expanded cardiopulmonary resuscitation begins only with sufficient medical resources.

Victim 5 should be assigned to the 1st sorting group, and the obvious signs of an injury incompatible with life (open head injury with visible damage to the substance of the brain) clearly do not imply any therapeutic measures.

Victim 6 should be assigned to the 2nd sorting group (severe injury with possible impairment of vital functions requiring medical attention) based on the presumptive diagnosis of “Combined injury. Open hip fracture. Burns to the face and upper limbs. Traumatic shock. Thermo-inhalation injury (?). ”

Since employees of EMS provide medical assistance outside the exclusion zone, treatment and diagnostic measures (including sorting) for **victims 5 and 6** are carried out only after their evacuation from the lesion.

Answer 5. When determining the required number of additional ambulance teams, the following scheme is recommended: 3 ambulance teams for 5 victims, including one specialized mobile team for anesthesiology and intensive care. That is, in this emergency situation, it would be primary to involve one specialized visiting team of anesthesiology and resuscitation to the existing 2 ambulance teams. However, taking into account the presence of 3 seriously injured patients, medical measures to be performed on the spot (**victims 3, 4, 6**), an additional ambulance team is required to ensure medical evacuation of victims 1 and 2.

When evacuating of lots of victims with MES staff, the person responsible for medical support at the scene of the incident will have to inform the operational department of the EMS station about the additional required number of EMS teams, including specialized ones.

Answer 6. First of all, medical care should be provided by the medical team of the ambulance to the **victim 3**, belonging to the second sorting group. The clinic of severe hypoxia (depression of consciousness, shortness of breath, lack of tachycardia), due to increasing obstruction of the upper respiratory tract, requires immediate respiratory support after restoring patency. The sequence of therapeutic measures for this victim is presented in Fig. 2. Against the background of starting mask inhalation of 100% oxygen, it is necessary to provide vascular access, with intraosseous access at the proximal lower leg due to extensive burn lesions of the upper limbs. Given the level of consciousness (11 points on the Glasgow Coma Scale), prior to tracheal intubation, an anesthesia is indicated, along with benzodiazepine, it is rational to include ketamine, which also has an analgesic effect. The attempt of orotracheal intubation should be single. In case of unsuccessful intubation of the trachea, surgical restoration of patency of the upper respiratory tract (conicotomy) is necessary. The use of supraglottic devices (laryngeal mask or laryngeal tube) is contraindicated in this clinical situation. After ensuring airway patency, mechanical or artificial ventilation of the lungs with 100% oxygen is performed. Intensive therapy for burn shock also includes infusion therapy and the application of antiseptic dressings on the affected surface of the skin. Upon completion of these measures, the victim must be immediately evacuated to the hospital with the existing ambulance transport, accompanied by a paramedic of the general profile paramedic mobile team or by an additional ambulance team.

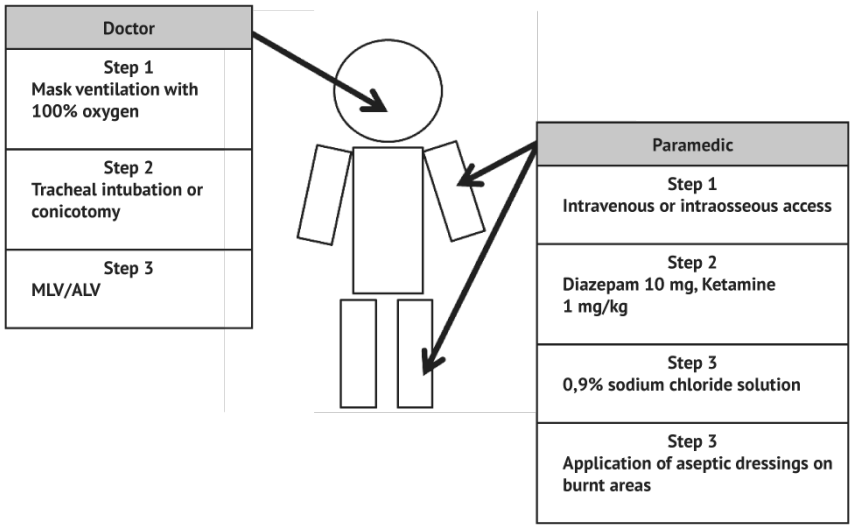

Fig. 2. The procedure of providing medical assistance to a victim 3 (explanation in the text)

Given the current situation, in the absence of signs of biological death, the paramedic team of the EMS justified the beginning of resuscitation in a **victim 4** at the same time as intensive care for the **victim 3**. When medical situation changes (additional admission of serious patients or deterioration in **victims 1 and 2**) EMS staff must act according to priciples of sorting.

In **victim 2**, assigned to the 3rd sorting group, medical assistance is delayed after the implementation of emergency medical measures in **victim 3**. In the absence of negative dynamics in the state of **victim 2,** the volume of medical care is limited to the application of aseptic dressings on wound surfaces and pain relief in the presence of pain.

If **victim 1** has aggressive behavior that hinders the provision of assistance to seriously injured people, it is advisable to temporarily isolate him by the employees of the internal affairs bodies with subsequent follow-up to exclude hidden life-threatening pathology.

Answer 7. When transferring organizational powers to the arrived team of the territorial center for disaster medicine, it is necessary to inform:

a) information about the EMS teams;

b) the total number of victims, the type of their lesions, the volume of therapy;

c) passport data of the victims (surname, name, patronymic, age, citizenship of foreigners);

d) the place of hospitalization (in the case of medical evacuation of some of the victims before the arrival of the brigade of the territorial center for disaster medicine).

Similar examples of medical support in case of emergencies in the form of situational tasks make it possible to carry out step-by-step and final control of the level of postgraduate training of emergency medical personnel, including as part of continuing medical education.

It is also important that the conditions of such situational tasks can serve as a structural basis for seminars and trainings.

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