

The usefulness of the virtual patient program in the nursing care of patients with anaphylactic shock – case report

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ABSTRACT

Anaphylactic shock is a life-threatening condition characterized by a severe and rapid course causing disorders in the digestive, cardiovascular and respiratory systems. The paper presents a virtual patient program. It allows to analyze each phase of the shock safely, which is

often impossible in the real situation due to the fast and progressive course. Right actions and proper patterns of care by nursing staff will help to reduce the risk of death and increase the quality of care.

Keywords: simulations, virtual patient's program, virtual reality, anaphylactic shock, nursing care

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INTRODUCTION

The multidisciplinary clinical simulations are an important part of the educational strategy in nursing.

High-fidelity simulations are generated by data based on scientific evidence in order to reflect the physiology and pathology of the human living organism [1].

Highly useful type of simulation is called virtual reality, which is used to study specific tasks and behavior in a given situation. Students can conduct a clinical test on a virtual patient, while implementing appropriate algorithm [1]. Simulations play a special role in emergency medicine, in which the main factor is the time.

According to the European Academy of Allergology and Clinical Immunology (EAACI), anaphylaxis is a severe, life-threatening systemic or generalized hypersensitivity reaction. Most often associated with IgE-dependent allergic reactions. It may also apply to non-allergic hypersensitivity, which course is not associated with the response of immune mechanisms [2].

An anaphylactic shock directly threat patients' lives is in the nursing care. It is characterized by a severe and rapid course causing problems in the digestive, respiratory and cardiovascular system. Failure to take prompt and effective steps to save life may result in death [3]. Considering the above fact, the knowledge of algorithms among nursing staffs of hospital emergency departments or medical rescue teams, is a priority.

Food allergy is the most common cause of anaphylaxis treated at emergency departments. Large number of allergenic foods was determined, which include, among others: nuts, tomatoes, wheat, and shellfish. Another group includes drug-induced anaphylaxis, which occurs more frequently while taking the correct dose of the drug than in case of an overdose. Non-steroidal anti-inflammatory drugs (NSAIDs) are among the drugs which most commonly cause anaphylaxis, comprising 1.2-4.7% of all reported cases [4].

Strong allergic reactions also occur after B-lactam antibiotics such as penicillins and cephalosporins, and a higher mortality rate was reported after their administration than in case of other drugs [3].

In the elderly, the most common factors causing anaphylactic shock are antihypertensive drugs, angiotensin-converting enzyme (ACE) inhibitors and Hymenoptera venom (Hives, honey bees and hornets) [5].

The presented paper is probably the first attempt worldwide to assess the utility of virtual patient software in the nursing care of a patient in life-threatening condition.

INITIAL CASE PRESENTATION

The subject of the observation was a 21-year-old woman who called the ambulance station about aggravating respiratory problems. The patient experienced tightness in the chest during a meal. Unconscious consumption of shrimps (which she was allergic to) lead to anaphylaxis. Additionally, during the attempt to use the auto-injector with adrenaline, a woman was bitten by a wasp, which intensified allergy. During the physical examination, medical rescue team found the patient was alert and oriented to person, place, time, and date. With time, they observed a growing anxiety. Peripheral heart rate was weak and thready. The skin was pale, cold and clammy. Slight swelling was observed in the area of the face.

The patient reported during the interview that she was allergic to bee venom, shellfish, penicillin and non-steroidal anti-inflammatory drugs. Apart from allergies, there were no other comorbidities. The woman was not on permanent medication. From last year's episode of allergic reaction caused by a bee sting, the patient has an auto-injector with adrenaline prescribed by her doctor.

This case is an example of a virtual patient simulation scenario by METI/CAE Healthcare (MUSE, software license MT SFW-80). Muse is a software that reflects both the physiology and pathology of a virtual METI/CARE Healthcare patient. This model operates on the basis of reliable scientific knowledge in the field of pharmacology, physiology, mathematics and biomedical engineering.

The study was approved by the Bioethical Commission of the Faculty of Medicine, the University of Rzeszów in Rzeszów (No.5 /09/2016). The study was conducted in accordance with the Declaration of Helsinki.

CLINICAL ASSESSMENT

In case of anaphylaxis, the most important is a rapid diagnosis and implementation of a life-saving procedure. Patients suspected of anaphylactic shock require immediate discontinuation of exposure to factors triggering an allergic reaction, the assessment of airways, respiration, cardiovascular system, central nervous system function and exposure (ABCDE scheme) [6].

Therefore, the priority is to ensure airway patency because of the risk of hypoxia, due to laryngeal edema or bronchospasm. It includes positioning the patient in a position optimal in their condition (e.g. dyspnea - a sitting position, an unconscious patient - a recovery position). It is recommended to perform simple maneuvers to clear

the airways. The presence / absence of secretions or foreign body in the oral cavity should be checked and then evacuated. Sometimes it is necessary to perform tracheal intubation [7]. In case of dyspnea and coexisting low arterial oxygen saturation, the patient should be immediately given high-flow oxygen monitored with a pulse oximeter [6].

Lack or improper evaluation of airway patency by medical personnel (including nurses) can result in serious health consequences (Fig.1).

AIRWAY PATENCY

Rough assessment of airway patency or no assessment at all.
Lack of application of direct/ instrumented methods of clearing airway patency.
Lack of mucus suctioning from the airways



Aggravating tongue, oral cavity, throat and larynx oedma
Constriction of the upper respiratory tract
Foreign body in the oral cavity
Plugging the respiratory tract with mucus
Stridor
Muscle spasm/ Bronchial obturation



Obstructed respiration
Aggravating dyspnea
Hypoxia of the organism
Cyanosis
Increasing respiratory failure.
Respiratory failure.



Patient's death due to suffocation or hypoxia

Figure 1. Adverse events of nursing staff due to improper evaluation of airway patency

An important action in the context of nursing care of patients with anaphylactic shock is to assess the parameters of the circulatory system (measurement of blood pressure, pulse rate, Capillary Refill Time). Monitoring the patient and performing ECG allows to visualize the possible changes in the heart rate. It is necessary to

establish intravenous access, supply crystalloid or colloid, along with ensuring venous blood sample for biochemical and morphological tests [6]. Failure to perform described steps leads to the exacerbation of the patient's condition (Fig. 2).

Circulatory system

Rough assessment of circulatory system or no assessment at all.

Failure to monitor the heart.

Lack of Capillary Refill Time assessment

Vascular access not established early enough



Decrease in blood pressure

increase in heart rate

vasoconstriction

Decrease in the cardiac output

Reduced venous return

Dilation of cerebral vessels

Impaired heart capacity

Centralized circulation, problems in inserting peripheral IV

Impossibility to transfer fluids quickly

Confusion. Possible loss of consciousness.

Ischaemic necrosis of the heart cells

Disorders of the heart rhythm



Myocardial infarction/ Sudden cardiac arrest

Figure 2. Adverse events of nursing staff due to improper evaluation of the circulatory system

A person performing physical examination of the patient should also pay attention to changes in the skin and mucous membranes, such as generalized urticaria, swelling of the lips or tongue [5].

EMERGENCY TREATMENT OF ANAPHYLAXIS

First-line drug in anaphylactic shock is adrenaline. It constricts blood vessels, reduces edema, inhibits the release of histamine, dilates the upper airways and bronchi. Adrenaline is administered intramuscularly (anterolateral area of the 1/3 middle part of the thigh) at a dose of 0.5 mg (children above 12 years of age and adults), 0.3 mg (children aged 6-12 years) and 0.15 mg (children under 6 years). In case the patient's condition does not improve, the dose should be repeated every 5 minutes.

Side effects of intramuscular administration of the recommended dose of adrenaline were reported very rarely [6].

The treatment also includes administration of high-flow oxygen (more than 10 l/min) through an oxygen mask with a reservoir bag. If the patient is intubated with coexisting respiratory distress, a bag valve mask is recommended. Fluid intake is recommended due to the increased volume of the vascular bed [6]. The patients with cardiovascular instability are particularly in danger [8,9].

The second-line drugs include antihistamines. They are used mainly in the post-shock phase. They are intended to reduce the biological effects of histamine [6].

Due to the possibility of a two-phase reaction (about 20% of cases), at least 6 hours of observation is recommended after the onset of symptoms of the shock. Before discharge from the hospital, it is reasonable to refer patients with suspected anaphylaxis to a specialist in the field of

allergy. This enables the identification of allergens and reduces the risk of subsequent episodes [10].

BACK TO THE CASE: CLINICAL ASSESSMENT FINDINGS

During the initial examination, the patient showed signs of progressive anaphylaxis, blood pressure 100/50 mm Hg, pulse 90, respiration rate approx. 20, saturation below 90%, fully consciousness). Then, the respiratory failure progressed. The conduct included assisting breathing by means of a bag valve mask with oxygen supplementation. In the last stage of severe anaphylaxis, heart rate was 130 beats per minute, the blood pressure was reduced to 70/40 mm Hg, respiration rate increased to over 20 per minute, the saturation approx. 70%.

After the emergency team administered 0.5 mg (Lm) epinephrine, the patient's condition began to improve gradually. Respiratory rate normalized within the limit of 20, saturation increased to 90%. Lung function returned to the level which was not life-threatening to the patient.

DISCUSSION

Anaphylactic shock is a life-threatening condition that develops rapidly, with initial difficulties in breathing until respiratory and circulatory failure. The most common cause of anaphylaxis is food allergy, primarily to products such as: nuts, crustaceans or tomatoes [11]. Such drugs as: non-steroidal anti-inflammatory drugs or some antibiotics also frequently cause anaphylactic shock [3].

Patients in anaphylactic shock require immediate discontinuation of exposure to the agent that triggered the allergic reaction and ABCDE scheme need to be observed, i.e. Airway, Breathing, Circulation, Disability, Exposure [3,6]. It is extremely important to open the airways quickly and in severe cases to perform endotracheal intubation and administer high flow oxygen [6,7].

High fidelity simulations reflect the physiology and pathology of the human body. Virtual reality is used to learn proper behaviors and specific tasks in a given situation. A clinical examination can be conducted on a virtual patient while implementing an adequate algorithm of conduct that in the real situation will allow proper and fast action on the patient in life emergency [1].

CONCLUSION

The use of a sample virtual patient program allows to analyze every phase of developing anaphylactic shock in a secure manner, which is often impossible due to the rapid and

progressive course. Awareness of the consequences of the actions and knowledge of the patterns of conduct in situations of immediate danger to life by nursing staff reduces the risk of mortality, resulting in an increase in quality of care.

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Conflicts of interest

The authors report no actual or potential conflicts of interests.

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