REVIEW ARTICLE

SIMULATION TRAINING BASED ON REAL CLINICAL CASES

Trening symulacyjny oparty na rzeczywistych przypadkach klinicznych

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Abstract: Advanced functionalities of medical simulation tools can be used in the improvement of medical personnel skills. This applies in particular to complicated clinical situations involving patients in serious or life-threatening condition. Difficult and rare clinical cases can be the background for the preparation of simulation scenarios. Performing them in practice and discussing during the debriefing session helps to prepare doctors to make similar procedures in a real clinical environment. The method of problem-based and case-based learning is especially valuable. It enables active participation in the didactic process, focussing attention on a given issue in a holistic approach. The knowledge of the rules of conduct and the practical ability to act in such events increases the safety of treated patients. The simulation training based on real clinical cases can also be used to train medical personnel of the Polish Armed Forces.

Streszczenie: Zaawansowane funkcjonalności narzędzi symulacji medycznej mogą być wykorzystywane w doskonaleniu personelu medycznego. Dotyczy to skomplikowanych sytuacji klinicznych u pacjentów w stanie ciężkim lub z zagrożeniem życia. Trudne i rzadkie przypadki kliniczne mogą służyć do przygotowania scenariuszy symulacyjnych. Praktyczne ich przećwiczenie oraz omówienie w trakcie sesji debriefingowej pozwala na przygotowanie lekarzy do realizacji podobnych procedur w rzeczywistym środowisku pracy. Szczególnie cenna jest metoda nauczania problemowego oraz opartego na przypadkach klinicznych. Pozwala ona aktywnie uczestniczyć w procesie dydaktycznym, skupiając uwagę na zagadnieniu w ujęciu holistycznym. Znajomość zasad postępowania oraz praktyczna umiejętność działania, w tego typu zdarzeniach, niewątpliwie podnosi bezpieczeństwo leczonych pacjentów. Technika doskonalenia symulacyjnego oparta na przypadkach klinicznych może być również wykorzystywana do szkolenia personelu medycznego Sił Zbrojnych RP.

Key words: medical simulation, simulation training, clinical case.

Słowa kluczowe: symulacja medyczna, trening symulacyjny, przypadek kliniczny.

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Introduction

Medical simulation for over 50 years has been establishing its role as a didactic tool. In many countries, including Poland, it is used in university training, allowing students to improve their practical skills without risk to the health of real patients [1, 2]. Using various simulation tools makes it possible to develop practical and interpersonal skills, filling in the gap between theoretical knowledge and clinical practice. Improving students' skills in the controlled environment of simulation centres becomes a standard in teaching, completing the classical training at the patient's bed under master's supervision.

Advanced functionalities of medical simulation tools can also be used effectively to improve the skills of experienced medical personnel. This applies in particular to complicated clinical situations involving patients in a serious or life-threatening condition [3]. In these cases, a high risk of complications and balancing on the verge of therapeutic failure does not leave any room for mistakes. Therefore, it is necessary to find alternative methods of gaining experience in procedures that are dangerous or associated with unusual or rare situations, for which practice has the greatest value [4]. In these cases, the proper combination of the traditional forms of

teaching, the simulation-based improvement of skills and the actual experience in patient care is challenging.

Tools and environment of medical simulation

Depending on the educational purpose, medical simulation offers various tools: trainers, phantoms, advanced patient simulators, virtual reality and even simulated patients [5–14]. Their functionalities allow learners to practice practical and interpersonal skills and to use the acquired competences in clinical practice. In order to achieve a high degree of realism, the combination of different types of tools is possible via hybrid simulation [3]. It makes possible to imitate procedures as closely as possible to real life. Implementation of simulation scenarios in the controlled conditions of a simulation room or in a real work environment (*in-situ simulation*) additionally increases the sense of reality, increasing the didactic value of the training process [15, 16]. Medical simulation allows participants to move beyond the traditional learning methods by offering them the ability to perform selected procedures in practice, in a safe simulation environment or in a real clinical setting. The controlled simulation environment creates the conditions for practical learning through acting and independent decision-making; it provides exposure to rare situations that may be challenging in daily practice, often posing a direct threat to a patient's health and life [17]. It allows to gradually develop the experience-gaining process, from a basic level to proficiency in a given procedure, before it is performed in a real clinical setting.

Problem-based learning

In the classical approach, the process of gaining knowledge and practical skills in medicine involves a step-by-step transition from theory to practice. In some countries, the Problem-Based Learning (PBL) approach, based on solving clinical problems, is gaining advantage [18–20]. This is due to the need to confront one's knowledge and experience with the disease symptoms presented by a patient [20, 21]. In this sense, the participant must switch from the role of a learner, passively receiving information, to an active participant in the learning process. It allows learners actively participate in the didactic process from the beginning, and focus on a given issue via a holistic approach. PBL is based on the concept of learning through the analysis of complex situations resulting from practice[19]. It requires from participants integration of knowledge from various areas and a high level of activity and engagement. Characteristic for the method is a team-based approach to problem-solving, whose goal is full engagement of all participants in achieving the planned educational purposes [19–20]. The process is supervised by an experienced mentor, but independent problem-solving by participants is promoted. Independence in decision-making is an important element of this method, as it allows learners to develop valuable skills, show their strengths and discover their own talents and predispositions. Problem Based Learning is associated with a similar concept of Case Based Learning (CBL) which uses real-life examples, adding reality to the didactic process [18, 20–26]. CBL is defined as a structured educational experience in which realistic clinical cases are used to solve or explore a clinical problem [25, 26]. Didactic sessions are realised under the guidance of an experienced teacher. Compared to PBL, advantages of CBL include a higher level of focusing on the didactic objectives and the potential for deeper learning due to the acquired critical thinking skills [26]. This methodology is widely used in medical teaching, allowing learners to gain also experience in the areas that are not encountered in everyday practice or are challenging due to their complexity or difficulty of the problem [20]. It helps to prepare personnel professionally for the implementation of newly learnt procedures in a real-life work environment.

Simulation-based medical education

High-fidelity simulations, including hybrid simulations, are advanced didactic techniques that ensure effective implementation of the teaching process and professional training [3–6]. Simulation sessions in which scenarios are based on real-life cases offer the most advanced level of practical education. Due to the complexity of the problems presented, they are intended for participants with clinical experience. They are excellent for postgraduate education, in particular to achieve competence and expertise to perform procedures that pose a challenge in daily clinical practise. To successfully complete a simulation session, participants must know how to operate medical equipment and devices, and demonstrate a general understanding of the organisation of treatment and the course of the practised procedures. Familiarity with the environment is also required, especially when simulation takes place in a real-life facility (Emergency Room, operating block, ICU, endoscopy unit, etc.). For an effective session, knowing the simulation environment, the principles of interaction with the simulation tools, and understanding their natural limitations is also important.

A simulation session allows participants to interact with a simulator imitating a real patient and clinical situation. It forces them to act and take therapeutic and organisational decisions, according to learner's knowledge and competences [6–10]. During the session, depending on the goal of the scenario, participants are confronted with situations that could happen in real life. It allows them to identify areas for performance improvement in their future daily work environment. A simulation session is followed by a debriefing session, the most valuable element in the didactic process [27–29]. In the debriefing, the team participating in the simulation together with an experienced teacher discuss the course of the exercise and analyse the problems identified during the simulation. Positive aspects of the

performance, as well as the identified potential errors are indicated. This is a time for reflection, discussion on the proper line of action in a given case and solution of the clinical problem, as well as for group work on solutions that could prevent similar problems in the future [27]. Simulation-based learning helps to improve critical thinking and to use knowledge and experience in the therapeutic process, initially in a simulated, and finally in a real-life clinical setting. It also allows participants to make mistakes and learn about their consequences in controlled conditions, without any risk to a real patient.

Simulation scenarios based on clinical cases

Practising medicine requires constant self-improvement. It applies to all specialties, but in particular to those that involve dealing with life-threatening medical emergencies on a daily basis. Typical for these situations is the need to act quickly, under time pressure; the need for coordinated team-work; the risk of disturbed situation awareness and, often, limited personal and technical resources. In unfavourable circumstances, these factors may lead to incorrect action, adversely affecting the treatment outcome. A lack of practice in the implementation of complex procedures may also be related to work in lower-reference centres that have limited experience in treating patients in a life-threatening conditions. Moreover, their condition may be due to a particularly rare casuistic pathology. All that will negatively affect the safety of treated patients. In order to prevent failures, in the light of the above limitations, forms of training other than daily practice need to be found. Simulation of difficult cases, including training in the principles of crisis management and communication in a simulated environment or in a real-life clinical setting, may provide an effective method of gaining expertise in various procedures [15, 16, 30].

An example of a real event used as a model for creating a training programme was the tragic case of Elaine Bromiley, described in the literature [31]. The 37-year-old patient died as a result of errors made by the medical team while anaesthesia for a planned laryngology surgery. The inadequate management of the unexpected difficulties with ensuring respiratory patency (CICV – *can't intubate, can't ventilate*), apnoea, extreme hypoxia and the dramatic consequences of this situation provided the background for a discussion regarding the necessary change in the approach to the management of crisis situations and implementation of a range of procedures and simulation trainings in *Anaesthesia Crisis Resource Management* (ACRM).

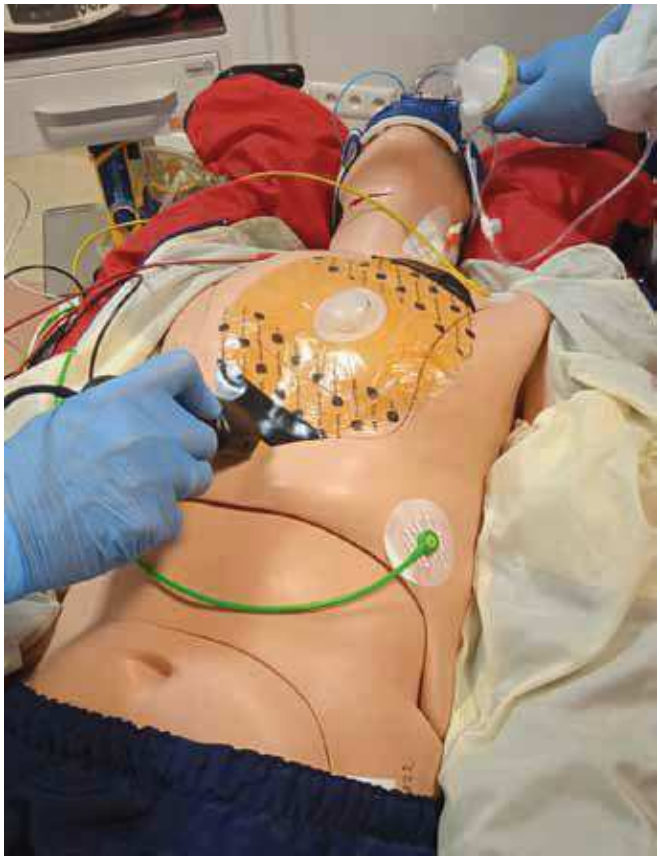

Fig. 1. *Multiorgan injuries*

It was possible due to the determination of the patient's husband, Martin Bromley, an airline pilot, whose initiative and actions allowed doctors to learn from the mistakes made in case of his wife. It increased the awareness of the importance of the human factor in healthcare. Similar actions were undertaken by D. M. Gaba and A. De Andy (*Department of Anesthesia, Stanford University School of Medicine, Palo Alto, California*). They created the Comprehensive Anaesthesia Simulation Environment (CASE), which they used to test the skills of anaesthesiologists in critical situations occurring during anaesthesia [33]. Their studies provided the basis for the principles of ACRM, and of the simulation-based learning programme for anaesthesiologists [33–36]. With time, the principles of ACRM were adopted in leading medical centres across the world. The ACRM-based approach was extended to many other medical specialties characterised by complexity and dynamism, such as emergency medicine, traumatology, surgery and intensive care [37–43]. These rules are used in practical training of rapid response teams and resuscitation teams [37, 38]. Maintaining a high level of services requires constant training. Such trainings, based on the CRM principles, are expected to become a standard in many healthcare facilities across the world, improving the safety of patients treated by multidisciplinary medical teams [42].

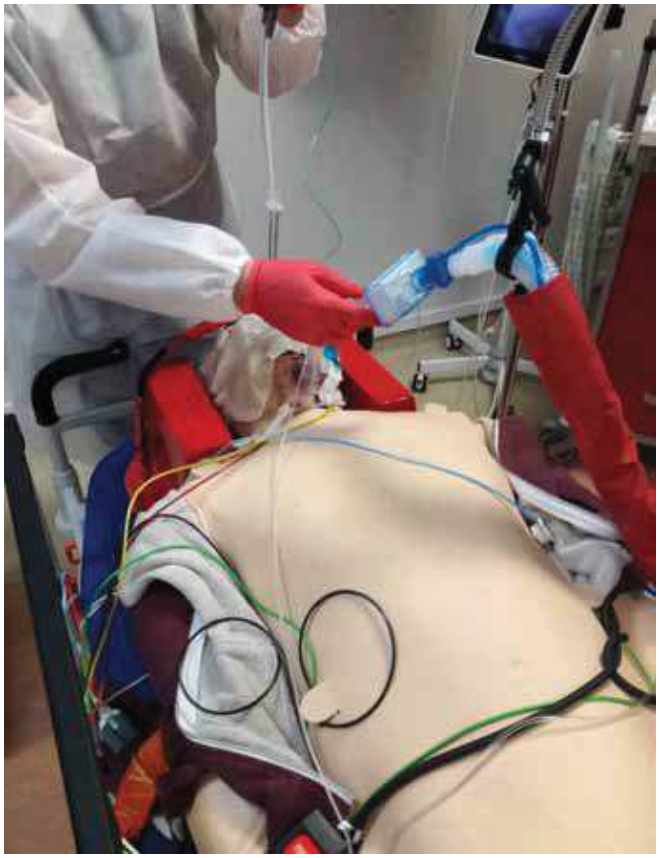

Fig. 2. *Airway burns*

Apart from practical skills, medical simulation also helps to improve interpersonal competences [44]. Literature data demonstrate that numerous preventable medical errors result from dysfunctional teamwork and poor communication [45–49]. To improve the status quo, the American Agency for Healthcare Research and Quality, and the Department of Defense together developed Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS) [50]. Simulation-based trainings with the use of this system are intended to improve patient safety by educating healthcare workers on communication and teamwork skills [50]. In the light of reports demonstrating that effective teamwork enhances treatment outcomes [51, 52], the principles of teamwork are incorporated in training programmes [53, 54]. Most of them use active learning methods, including simulations of critical incidents and scenarios based on real clinical cases [55, 56]. Many teachers agree that alternative methods of teaching teamwork and communication skills need to be developed [51–53]. There is evidence that adults learn best by active participation, self-reflection and using multi-modal learning strategies [57]. Improvement through experience is an effective approach in adult education [57]. Simulations combined with a structured summary not only allow participants to acquire the desired knowledge and practical skills, but may also increase the chances that they will be able to use these competences when confronted with real cases in a clinical setting [58].

Simulation training based on real clinical cases –-own experiences.

The authors have their own experience in providing trainings using simulation scenarios based on clinical cases. In our centre, they are used as elements of practical continuous training of doctors specialising in e.g. emergency medicine. Performing simulation scenarios in practice allows doctors to prepare for conducting similar procedures in a real clinical setting. They practice practical understanding of applicable guidelines, the methods and order of performing individual procedures, but also the specificity of the decision-making process and interpersonal skills. It takes place in a controlled simulation environment, without exposing real patients to a risk of complications. The discussed simulation scenarios involve e.g. procedure in the case of unexpected difficulties with ensuring airway patency, as a result of a thermal inhalation injury and management of massive intraperitoneal haemorrhage in trauma patient. During simulation sessions, participants improve their skills in ensuring airway patency following the Difficult Airway Society (DAS) guidelines and following the Damage Control procedures in multiorgan injuries (Fig. 1.) (Fig. 2.). Knowledge of the rules of conduct in these cases, the awareness of potential consequences of faulty decisions and the practical ability to respond to such incidents undoubtedly enhances the safety of patients treated in a real clinical setting. It allows also participants to maintain or regain lost competences in situation when they do not deal with similar cases in their daily professional practice. Recreating realistic situations in a safe simulation environment creates the opportunity to improve teamwork and communication, necessary in the management of a multidisciplinary medical team in a crisis situation [44]. In the future, such simulations, conducted in a real or virtual work environment, can be used to assess the qualification of personnel for work in the most demanding areas, thus minimising the risk of adverse events resulting from inadequate actions due to so called human factor [1, 2, 11–13].

Simulation-based training for military medical personnel

The continuous development of simulation technologies allows us to move beyond the traditional training methods not only in the civilian setting, but also in the training of medical personnel in the Polish Army. Due to the unique features of a combat setting, new methods of training need to be sought, both regarding the procedures conducted in the theatre of war, and during the individual stages of medical evacuation. The functionalities of medical simulation enable learners to practise simple practical skills (evacuation, maintaining airway patency, decompression of tension pneumothorax, stopping haemorrhage, etc.) [59], and to improve on complicated medical procedures performed as part of prolonged field care [60] and at the higher

levels of medical evacuation, including 2nd and 3rd level facilities [60]. The nature of operations in these areas requires from the personnel proficiency in performing procedures relevant for saving the lives of injured and ill patients. Medical simulation tools allow us to practise the procedures whose knowledge is essential during evacuation and treatment of the injured and ill patients in a combat setting [60]. To adjust the training process to the conditions typical for combat field medicine, most modern simulation equipment must be used. It is possible due to the solutions used in the civilian setting, including extensive teleinformatic infrastructure, using trainers and advanced patient simulators, as well as advanced technologies for creating virtual and augmented reality. These solutions, the most advanced achievements of medical simulations, allow learners practise scenarios based on real clinical cases in a simulation environment that reflects an actual tactical environment. The objective is to create in the participants the impression that they are working with real patients and to achieve a high level of training before performing tasks in a real tactical setting.

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