ORIGINAL PAPER

DOI: https://doi.org/10.20883/jms.366

Original educational computer program "Trauma" and its application in education of paramedic students – preliminary results

Magdalena Trzepizur[1, a], Wojciech Statowski[1, b], Dariusz Myrcik[2, c], Joanna Makarska[2, d], Magdalena Syrkiewicz-Świtała[3, e]

[1] Department of Orthopedics of Saint Barbara Hospital in Sosnowiec, School of Medicine with the Division of Dentist in Zabrze, Medical University of Silesia in Katowice, Poland
[2] Emergency Medicine Department, School of Public Health in Bytom, Medical University of Silesia in Katowice, Poland
[3] Department of Health Economics and Health Management, School of Public Health in Bytom, Medical University of Silesia in Katowice, Poland

[a] https://orcid.org/0000-0003-2848-859X
[b] https://orcid.org/0000-0001-6194-2526
[c] https://orcid.org/0000-0003-4754-3988
[d] https://orcid.org/0000-0003-4847-1146
[e] https://orcid.org/0000-0002-1298-7805

ABSTRACT

Education through simulation is becoming increasingly popular in medical academic environment. This is the best teaching method enabling the creation of real situations in risk-free conditions. Decision-making games can be successfully used in the educational process of future medical staff. The aim of the work was to create a didactic computer program "Trauma", analyze its impact on students' knowledge on the direction of medical rescue and evaluate the attractiveness of classes conducted with the use of this method. The results show that the use of the "Trauma" program in didactics has allowed for the improvement of the level of knowledge and skills of students taking part in the study in the field of trauma patients' treatment. In the assessment of students, the classes during which the program was used were interesting. The vast majority of respondents would like to participate in such classes again.

Keywords: trauma patient, didactics, medical rescue.

Introduction

Introduction

A significant development of industry, mechanization of work and means of communication affect the increase of number of trauma among all societies in the world [1]. Injuries which result from trauma often lead to permanent disability or death of the victim. This represents an enormous burden both for individuals and the society at large. In Poland, trauma is the third leading cause of death and in case of children and adolescents (5–19 years) together with poisoning they account for more than a half of all deaths [2, 3]. The most common causes of trauma are traffic accidents, falls, aggression and work-related accidents [4, 5].

Trauma patient constitutes a great challenge for the staff that brings him/her aid, especially for paramedics who often need to implement life-saving treatments at the scene of the accident. The limited equipment they have, potential

risks in the area of their operation and limited human resources are just some of the obstacles. The sole assessment of the condition of trauma patients can also be difficult. That is why a systematized action plan becomes so important [6]. Providing help in a stressful situation requires not only good theoretical preparation but also significant practice. Paramedic students the opportunity for practical application of the theory during medical simulation. Its origins date back to 1960, when Laerdal Company launched manikins used for training of CPR — "Resusci Annne". Currently, there are many advanced phantom models available on the market that allow people to learn and practice almost every medical procedure used in emergency medicine. Universities which educate medical personnel create simulation centers where students can gain knowledge without endangering health and life of patients. Unfortunately, these are costly investments. It is also necessary to arrange the place, adapt the premises and employ additional teaching staff. There is also a limitation on the number of participants who can take part in such classes. Computer simulators are becoming a solution to these problems. They give people an opportunity to learn both basic procedures and complicated treatments. One of the more and more willingly used tools are decision--making games [7, 8].

The original educational program "Trauma" presented in this study is a training method in the field of assessment of a trauma patient, his qualification for a trauma center and emergency medical services performed. Individual tasks of the program are presented in the following bullet points:

- Patient evaluation using the Glasgow scale.
  Information necessary to perform this task (motor response, verbal contact, eye opening) was included in a patient's card. The program required assigning the injured person an appropriate number of points on the GCS scale and, on their basis, identifying possible disturbances of consciousness.
- Trauma recognition
  The educational program "Trauma" enables simulation of trauma which could be sustained by a trauma patient. One of the tasks was a preliminary diagnosis on the basis of information from patient's image and the value of additional parameters, including breath count, heart rate, blood pressure, peripheral and carotid artery pulse, and capillary refill time. Each of the simulated patients had three injuries which the program assigned in a random order.
- Emergency medical services
  Each trauma from the database of the "Trauma" program has some specified procedures that should be performed at the scene of the incident and during the transport of a patient. Based on this, emergency medical services were analyzed. The correctness of the implemented emergency medical services was assessed on the basis of a five-point scale
- Qualification to a trauma center
  On the basis of the overall analysis of data included in a patient's card, the program required determination of a decision regarding qualification or non-qualification of a patient to a trauma center.

Assumptions and aims of the study

Own experience has led to the conclusion that training in the field of approach to a trauma patient is insufficient. Although topics concerning this matter are thoroughly discussed theoretically, they are not fully absorbed by students due to the limited possibilities of practical exercises.

Keeping in mind the improvement of quality of education of paramedic students in the field of trauma patient treatment, an attempt was made to create an educational computer program that would allow for practical training, using the available means, of a large number of people.

The aim of the study was:

- The development of an educational program called "Trauma" which enables the improvement of knowledge and skills of paramedic students in the field of treatment of trauma patients.
- An assessment of the impact of the "Trauma" program on the knowledge of students in the field of approach to trauma patients, with particular emphasis on the assessment of the state of consciousness in the Glasgow scale, initial recognition of injuries and qualification of patients for treatment in a trauma center.

› Assessment of satisfaction of students participating in the study from classes conducted using the educational program "Trauma".

Material and Methods

The study was conducted in the period from 1 January 2016 to 25 April 2016 in a group of 75 students of paramedics students of Silesian Medical University in Katowice. There were 45 (60%) women and 30 (40%) men in the study group. The respondents were students of the first and second year of bachelor, full-time studies.

Educational classes with the use of the "Trauma" program were conducted in three recurring stages. Each of them consisted of a two-hour course, during which students were acquainted with the legal basis of performing the profession of a paramedic and they actively participated in practical exercises realized with the help of the educational computer program "Trauma". The end of the exercises was a lecture summarizing the achieved results and a short discussion about the conducted simulation.

The purpose of the exercises with the use of the "Trauma" program was to introduce students to the issue of multiple and multi-organ injuries. The task of people who participated in the study was to assess the state of consciousness of a patient according to the Glasgow scale, an initial diagnosis of injuries the patient experienced and the qualification or disqualification for treatment at a trauma center. The exercise cycle was based on scenarios, where a total of 225 victims were simulated on the assumption that each of them suffered from three injuries. All necessary information about the patient's condition was included on the patient's card automatically printed after the program drew particular injuries. The exercise cycle was completed by a student satisfaction survey from conducted classes during which the educational program "Trauma" was used.

Statistical analysis

Quantitative variables were presented in the form of frequency and percentage of individual categories. Statistical significances of differences among groups were verified by χ^2 test. Cochran-Armitage's test was used for trend assessment in multi-area tables.

Analyzes were carried out in a statistical package Statistica (version 12) and R (version 3.2.3).

$\alpha = 0{,}05$ is the level of statistical significance that was assumed.

Results

Assessment of patients in the Glasgow scale

The first element analyzed during the simulations with the use of the educational program "Trauma" was patient's assessment using the Glasgow scale. The information needed to complete this exercise (motion response, verbal contact, eye opening) was included in a patient's card. The task of the students was to assign the injured person an appropriate number of points in the GCS scale and to identify on this basis any possible disturbance of consciousness.

Among the 225 injured people simulated by the program 103 (45.8%) presented mild disturbances of consciousness, ranging from 13 to 15 points in the Glasgow scale. Moderate disturbances of consciousness (12–9 GCS points) were present in 84 (37.33%) patients, unconsciousness (8–6 GCS points) in 31 (13.8%), decortication (5 GCS points) in 5 (2,2%), and decerebration in two (0.9%) patients. None of the simulated victims showed brain death (3 GCS points).

During the first exercise cycle, the correct score in the Glasgow scale for simulated trauma patients was given by 42 (56%) students. Even if students correctly calculated the sum of GCS points they had a problem with determining the degree of consciousness disturbance. Only 31 (41.3%) of the respondents reported the correct classification. In the second exercise cycle, the correct score in Glasgow scale was given by 49 (65.3%) of the students. This shows an increase in correct responses by 9.3% in relation to the first exercise cycle. What is more, in this case 55 (73.3%) of the participants of the study correctly classified consciousness disorders. Therefore, an increase was noticed in the correct classification of consciousness disorders by 32% in relation to the first study. Students who took part in the study in the last, third cycle of exercises in a vast majority presented knowledge of the score of patient's consciousness in Glasgow scale and the classification of consciousness disorders. The correct sum of GCS points

was given by 65 (86.7%) of the respondents, while the consciousness disorders were correctly classified by 68 (90.7%) students. This shows that in the third exercise cycle with the use of the educational "Trauma" program, the number of correct responses in relation to the second exercise cycle increased by 21.3% in case of the assessment of points in the Glasgow scale and by 17.3% in the classification of consciousness disorders (**Figure 1**).

In no exercise cycle, statistically significant differences were observed in the distribution of the correct answers between the sum of points of the scale GCS and classification of the disturbances of consciousness. During the research we could observe statistically significant growth of the correct students' answers in each subsequent exercise cycle.

Trauma diagnosis

For the purpose of the analysis of correctness of initial diagnosis made by the students, each trauma was counted separately, giving 225 different

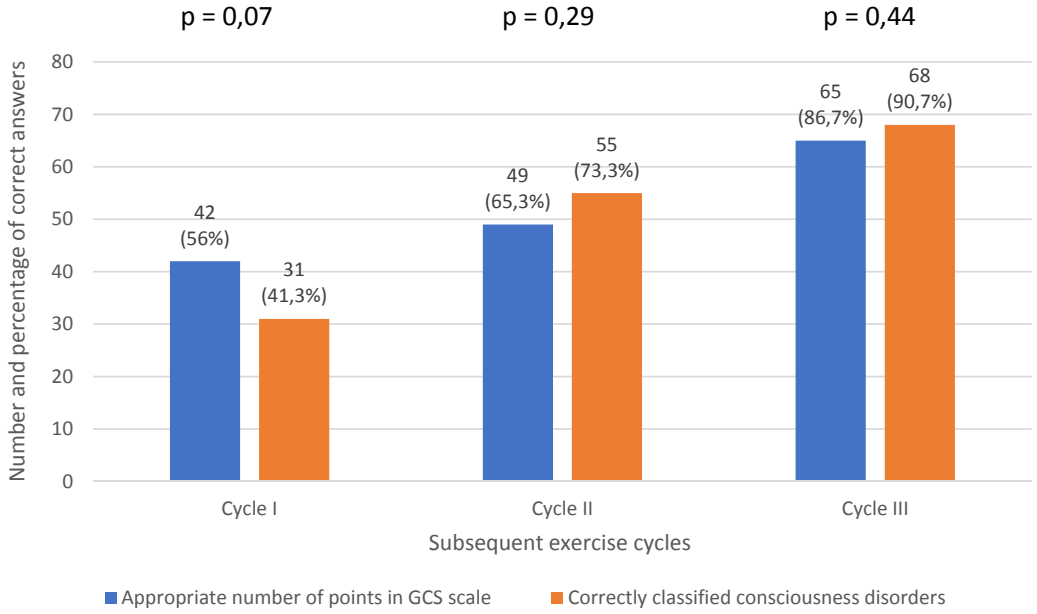

Figure 1. Number and percentage of correct responses concerning consciousness disturbances in the Glasgow scale in subsequent cycles

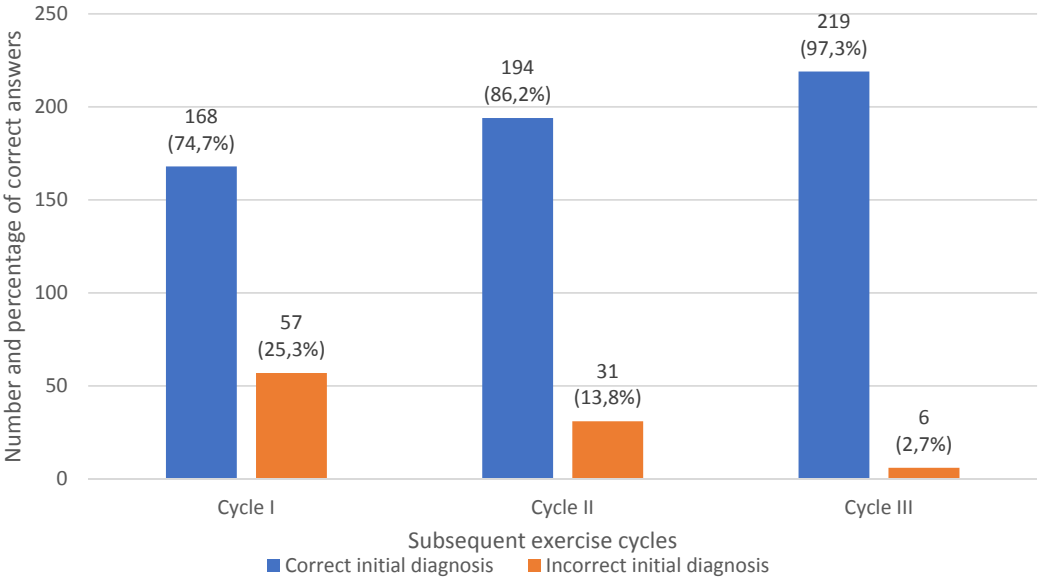

Figure 2. Correctness of the initial diagnosis made by students taking part in the study in each cycle of exercises ($p < 0,01$; Cochran-Armitage's test)

injuries in each exercise cycle and 675 simulated injuries during the three exercise cycles. During the first exercise cycle, a correct initial diagnosis was made in case of 168 (74.7%) injuries. The second exercise cycle showed an increase in the number of correctly diagnosed injuries. In this case, the correct diagnosis was made 194 (86.2%) times. The upward trend was maintained in the third exercise cycle, during which 219 of 225 injuries (97.3%) were correctly diagnosed. The second cycle of exercise with the use of the "Trauma" program showed an increase in the number of correct initial diagnoses of injuries in relation to cycle 1 by 11.6%. In the third cycle in relation to the second cycle, an increase was noted in the number of correct diagnoses posed by the students by 11.1%. A Cochran-Armitage's trend test confirms the above observations (**Figure 2**).

Qualification for treatment in a trauma center

According to the statistics of the "Trauma" program among 225 simulated patients 118 (52.4%) should be qualified for treatment in a trauma center. The first cycle of exercises showed significant errors made by the students in qualification of a trauma patient to a TC. Among 75 victims simulated by the program in the first cycle of training, only 12 (16%) were correctly qualified or disqualified for treatment at a trauma center. This result improved during the second exercise cycle. Correct classification or correct disqualification, in this case selected 32 (42.7%) of the students. The upward trend of correct responses was maintained in the third cycle of exercises during which as many as 68 (90.7%) students correctly qualified or correctly disqualified simulated patients for treatment in a TC. A Cochran-Armitage's trend test confirms the above observations (**Figure 3**).

Satisfaction of students from the exercises

The overwhelming majority of participants of the study expressed a positive opinion about the "Trauma" program and would like the classes to be run in this form more frequently. Among the students taking part in the study, 92% gave the "Trauma" educational program the highest possible rating — 5. The respondents were also asked about the potential of the program in education and their willingness to participate in classes conducted with the use of the program. The overwhelming majority of respondents (96%) think that classes conducted with the use of the educational program "Trauma" were interesting and they were willing to participate in them again. Students were also interested in making the program available for individual use for simulation exercises outside of educational classes (**Figure 4**).

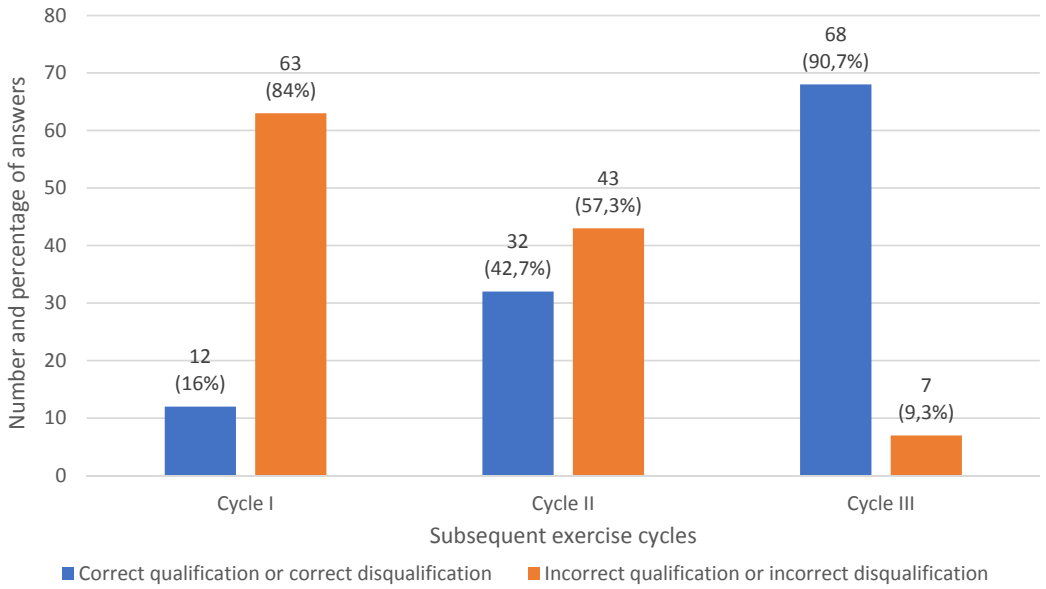

Figure 3. Correctness of qualification or disqualification of simulated patients for treatment in a trauma center in following exercise cycles ($p < 0,01$; Cochran-Armitage's test)

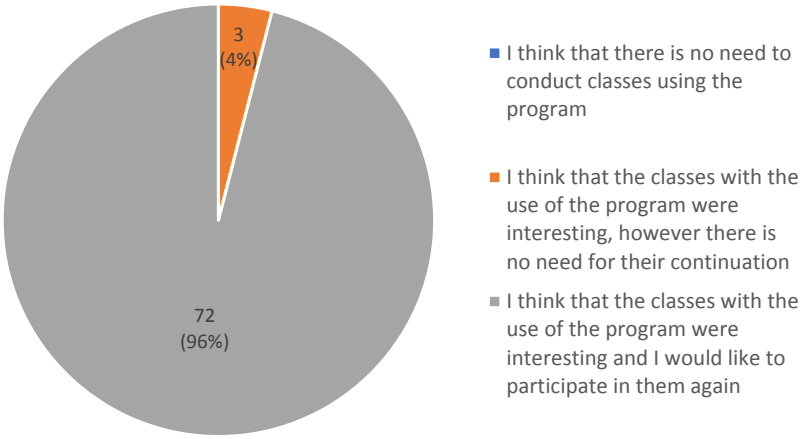

Figure 4. Opinion of students participating in the study about conducting classes with the use of the "Trauma" program

Description of results and discussion

During the three exercise cycles with the use of the educational program "Trauma", there was a clear increase in the number of correct responses given by students. During the training of assessment of consciousness disorders in the Glasgow scale in trauma patients there was an increase by 30.7% of the correctly allocated GCS score in the third exercise cycle in comparison with the first and an increase by 49.3% in the correct classification of consciousness disorders. Training of preliminary diagnosis of trauma basing on symptoms and assessment of physiological parameters showed an increase in correctly diagnosed injuries by the students in the third exercise cycle in comparison to the first by 22.7%. The most effective were exercises in qualification of a patient to a trauma center. In this case, the number of correct qualifications or disqualifications increased by 74.7% in the third exercise cycle in comparison to the first cycle. Students actively and with great engagement participated in classes with the use of the "Trauma" program. Simulation exercises were considered interesting and the program itself was mainly given the highest possible rating. Among the study group, 96% of students would be willing to participate in next classes with the use of the program.

The efficiency of teaching depends to a large extent on how knowledge is transferred. Medical simulation based on modern technology is considered by many authors to be the best tool for training medical staff whose primary purpose is to shape good patterns of behavior. Simulation training is designed to help the future medical staff to adapt to difficult working conditions that differ greatly from the lecture room.

The textbook, published in 1664, describes the use of games during the training of the Prussian army. War games were developed and widely used as training tools for the army until the mid-twentieth century [9]. Significant development of decision-making games was influenced by their use in the training of management personnel of production companies in the Soviet Union and the USA. Currently, these games are widely used in managerial training, where leading a team and making difficult decisions are crucial. Similar situations also apply to the work of a paramedic and that is why decision-making games can be successfully used in training of future paramedics. Numerous studies confirm the effectiveness of using this method in training of medical personnel [10, 11, 12].

In the twentieth century computer programs based on the principles of decision-making games started to be introduced into medical education, but still the dominant form of knowledge transfer was the lecture [10].

Education through simulation is becoming increasingly popular in the academic community. In addition to valuable knowledge gained from books or the latest scientific reports, computer simulations are becoming an increasingly effective form of education. Simulation teaches to transfer the acquired theoretical knowledge onto practical action. By means of multiple repetitions of a given simulated situation, it gives the opportunity to cre-

ate psychomotor skills performed in later practical actions in an automated manner [15].

Huang et al. noted that a valuable teaching tool is especially the test environment, which allows learners to acquire the skills of making many complex decisions in a short time and thereby to work in stress.

Frączek and Cebula in their publication also pointed out the need for medical simulations, which are designed to improve work in crisis situations. In their study they refer to the report of the Medical Institute of the United States of North America from 2000. According to it, in the United States 44,000 to 96,000 people die annually due to medical malpractice, mostly resulting from the staff's difficulty in transferring knowledge into action in very stressful conditions. This publication has influenced the growth of importance of training of medical staff with the use of appropriately adapted simulation stations [13].

The effectiveness of education conducted with the use of decision-making games was also appreciated by Specht and Sandlin. In their study they compared the effectiveness of traditional training led in the form of a lecture with training based on simulation management game. Participants of the study were divided into two groups — one trained through a decision-making game, the other group consisted of people attending lectures. Evaluation of the effectiveness of both trainings was made through tests checking the acquired knowledge, which the participants solved after a longer period of time. This study unequivocally confirmed the superiority of training with the use of a managerial game [14].

Sowizdraniuk et al. conducted a study on a group of 46 second-year paramedic students aimed at assessing the effectiveness of teaching. Students taking part in the study were divided into three groups and attended four-hour classes concerning advanced cardiopulmonary resuscitation and procedures in case of bradycardia and tachycardia. Classes of each group were conducted by different teaching methods: lecture, case study and simulation game. The effect of the conducted classes was measured by a standardized knowledge test concerning the discussed topics held after one month. The highest efficiency of teaching was achieved in the group of students participating in the simulation game. The respondents in this group answered fastest to the questions they were asked, which, according to the authors, could indicate easier decision making. In a subjective assessment of classes most points awarded by the students were obtained by the ones conducted with the use of simulation games. The results obtained by Sowizdaniuk et al. show highly effective teaching with the use of simulation games and the attractiveness of classes conducted in this way, which may cause greater motivation of students to acquire knowledge [10].

Traditional methods of education, especially in case of students of medical universities, seem to be insufficient. More and more attention is being paid to ways to increase the effectiveness of learning. One of them is medical simulation. Young people growing up in a multimedia environment are eager to use electronic methods to improve their knowledge. Trainings conducted with the use of medical simulation based on decision-making games allow not only for development of appropriate habits used later in real life. They also allow people to identify committed mistakes, which in turn may lead to their minimization during real activities. In addition, it is a form of education that is pleasant for participants and that is why they are more likely to engage in classes.

Decision-making games can also be effectively used in exercises for a well-trained staff in order to prevent forgetting skills due to lack of their repetition. This is particularly important in case of medical staff on whose knowledge and skills depends the patient's life. The increasingly popular method of training medical personnel through simulation allows to shorten the learning process while achieving greater efficiency at the same time. It also protects against damage done to real patients while learning, for example, on an internship. The results of many studies on the use of educational games confirm the effectiveness of this educational method, which is appreciated by the participants of the training sessions in which it is used.

Educational program "Trauma" allows for learning how to recognize trauma that patients have experienced, how to properly evaluate their physiological parameters and to qualify them for treatment in a trauma center. It is a cheap method which is also easy-to-use during educational classes regardless of where they are carried out.

It does not require specialized equipment or costly phantoms. In a short time it allows you to train a large group of participants. Thanks to the ability of expansion and modification of the injury database, there is an unlimited number of simulated patients.

Conclusions

1. The creation and implementation of the educational "Trauma" program has made it possible to increase the level of knowledge and skills of paramedic students in the area of trauma patient treatment.
2. Exercises conducted with the use of the educational program "Trauma" showed an improvement of abilities of the examined group of paramedic students in evaluating trauma patients, diagnosing injuries and qualifying patients for treatment in a trauma center.
3. In the assessment of students participating in the study, the classes conducted using the educational program "Trauma" were interesting. The vast majority of respondents would like to participate in such classes again.

Acknowledgements

Conflict of interest statement
The authors declare no conflict of interest.

Funding sources
There are no sources of funding to declare.

References

1. Europejski Raport Zdrowia 2012. Droga do osiągnięcia dobrostanu. Światowa Organizacja Zdrowia. [Internet] http://www.who.un.org.pl/aktualnosci.php?news=84&wid=14&wai=&year=&back=%2Faktualnosci.php%3Fwid%3D14 (Accesed: 2018.07.25).
2. Rutkowska M. Urazy mózgowo-czaszkowe epidemią XXI w. Medycyna Ogólna. 2010;16(XLV),2:192–200.
3. Główny Urząd Statystyczny: Notatka Informacyjna. Podstawowe informacje o rozwoju demograficzny Polski do roku 2014. Warszawa 27.01.2015. [Internet] http://stat.gov.pl/obszary-tematyczne/ludnosc/ (Accessed: 2018.07.25).
4. Brongel L, Duda K. Mnogie i wielonarządowe obrażenia ciała. Wydawnictwo Lekarskie PZWL, Warszawa 2001.
5. Brongel L. Złota godzina — czas życia, czas śmierci. Krakowskie Wydawnictwo Medyczne, grupa Ekonom s.c., Kraków 2000.
6. Campbell JE. International Trauma Life Support. Ratownictwo przedszpitalne w urazach. Medycyna Praktyczna, Kraków 2009.
7. Polak B. Podstawy teorii kształcenia. Szczecińska Szkoła Wyższa Collegium Balticum, Szczecin 2013.
8. Nielepiec-Jałosińska A, Janus T. Nauczanie symulacyjne w medycynie ratunkowej. In: Konieczny J (ed.). Bezpieczeństwo zdrowia publicznego w zagrożeniach środowiskowych. Postępy metodologii badań Garmond Oficyna Wydawnicza, Poznań-Łódź-Inowrocław 2012; p. 707–720.
9. Piskor T. Gra wojenna z dwoma zadaniami taktycznymi. Księgarnia Wojskowa, Warszawa 1920.
10. Sowizdraniuk J, Smerecka J, Chęciński I, Brodzki M. Gry decyzyjne w edukacji studentów ratownictwa medycznego. In: Konieczny J. (ed.). Bezpieczeństwo zdrowia publicznego w zagrożeniach środowiskowych. Postępy metodologii badań. Garmond Oficyna Wydawnicza, Poznań-Łódź-Inowrocław 2012; p. 669- 679.
11. Myrcik D, Sosada K, Żurawiński W, Jędryszek K. Gra decyzyjna „Dyspozytor" — metoda wspomagania nauczania studentów kierunku ratownictwo medyczne. In: Konieczny J. (ed.). Bezpieczeństwo zdrowia publicznego w zagrożeniach środowiskowych. Postępy metodologii badań. Garmond Oficyna Wydawnicza, Poznań-Łódź-Inowrocław 2012; p. 661–667.
12. Makowska K. Symulacja medyczna — nowy wymiar edukacji. Na Ratunek. 2009;4:36–40.
13. Frączek B, Cebula G. Czynnik ludzki, bezpieczeństwo pacjenta i zarządzanie zespołem w sytuacji kryzysowej. Na Ratunek. 2011;3:22–25.
14. Specht L, Sandlin P. The differentia effects of experiential learning activities and traditional lecture classes in accounting. Simulation and Gaming. 1991;22(2):429–445.
15. Olympio MA, Whelan R, Ford R, Sunders I. Failure of simulation training to change residens' management of oesophangeal intubation. British Journal of Anaesthesia. 2003;3:312–318.

Acceptance for editing: 2019-07-23
Acceptance for publication: 2019-09-15

Correspondence address:
Magdalena Trzepizur
Department of Orthopedics
of Saint Barbara Hospital in Sosnowiec
School of Medicine with the Division of Dentist in
Zabrze, Medical University of Silesia in Katowice
19 Kopernika Street, 41–940 Piekary Śląskie, Poland
e-mail: magdalenatrzepizur@icloud.com