Polish Annals of Medicine

journal homepage: https://www.paom.pl

Review article

Development and implementation of methods for training doctors and dental surgeons using virtual devices and simulation

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ARTICLE INFO

Article history
Received 2 October 2016
Accepted 23 April 2017
Available online 24 January 2018

Keywords
Doctors training
Simulation
Mastery learning
Virtual teaching device

Doi
10.29089/2017.17.00002

ABSTRACT

Introduction: Simulation is increasingly incorporated in medical education to learn and develop cognitive, psychomotor and behavioural skills at the individual level and in teamwork. An advanced medical simulator SimMan 3G and an e-learning platform were created to develop a new approach towards doctors' training.

Aim: A programme for the development and implementation of training methods for doctors and dental surgeons was created, as exemplified by the Simulation Centre of University Hospital in Olsztyn.

Material and methods: The leading component of the project is the SimMan simulation device, along with specially designed rooms for simulation, debriefing and supervision of the training process. The most distinguishing feature of the entire training programme is a specially designed platform for education and training: www.symulatorymed.pl, consisting of knowledge bases, case reports, training scenarios, and tests ultimately compatible and cooperating with the aforementioned medical simulator.

Results and discussion: Importance of medical simulation has been proven in terms of preservation of knowledge and skills for much longer than did previous training methods. The newly designed e-learning platform gives the opportunity to create specialized databases and check the results of on-simulator training sessions, which serve as 'feedback' to all the information provided on-line. This allows for multi-dimensional comparison of the progress and effectiveness of teaching during the successive testing sessions.

Conclusions: The main goal of the newly created simulation infrastructure is to transfer better results of education from the conditions of the simulation room into reality, in order to improve the survival and effectiveness of treatment of patients.

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1. INTRODUCTION

Simulation is increasingly incorporated in medical education to learn and develop cognitive, psychomotor and behavioural skills at the individual level and in teamwork. The overall objective is to determine the desired results of teaching and training using simulators and then incorporating the results into the curriculum with the aim of achieving the previously established objectives. The advanced medical simulator SimMan 3G, along with an e-learning platform created within the infrastructure, is designed to develop a new approach towards doctors' training, regarding situations that require either sustaining or restoring life functions as well as new methods of conduct, especially concerning difficult cases and the system used to validate them. The new methodology of training will also be an element used for scientific analysis, both in the process of acquiring new skills as well as the validation of these on the basis of so-called partial qualifications. Thanks to the research and development (R&D) infrastructure it will be possible to propose a new approach for acquiring knowledge in terms of both diagnosis and treatment of patients in life or in health threatening situations (according to Polish Qualifications Framework). The new system will be based on clear criteria of validation regarding both formal and informal training methods, and it will enable evaluation in terms of analyzing the effectiveness of different methods of acquiring knowledge and skills in sustaining and restoring life functions.

2. AIM

Within the process of the development and introduction of a new methodology into the region of Warmia and Mazury, it is necessary to create a framework project, based largely on past national and international experience in the fields of creating and introducing elements of simulation into medical education. The effectiveness of learning through simulation depends largely on how well and how thoroughly it is planned and subsequently used. It should be complementary to the existing educational program and its implementation should harmonize with the rest of postgraduate education. For this purpose and based on the guidelines of the Society for Simulation in Healthcare among others, a plan for the development and proper utilization of available infrastructure was created, as exemplified by the Simulation Centre of University Hospital in Olsztyn.

3. MATERIAL AND METHODS

The most important component of the Simulation Centre is the SimMan 3G simulation device (Figure 1), along with a specially designed room for simulation (Figure 2) as well as a debriefing room, and another room used for supervision of the training process. This is where data from conducted training sessions as well as audio-video recordings of training-educational sessions are collected. The simulator is necessary to make sure that it is safe to test new methods of research in addition to dealing with difficult cases in terms of sustaining and restoring life functions by creating opportunities for practical verification of various procedures, which also use the remote transmission of data. The SimMan 3G device represents the next generation of simulators, with the following key advantages: ease of use, durability, and full range of complementary products and services. The SimMan 3G simulator's interface, with three modes of operation, is used intuitively, allowing you to prepare effective simulation. It is also important to those developing scenarios for teaching. Prepared and programmed simulation will look exactly the same every time; therefore, each participant can be trained or examined in a standardized way. In addition, the software for the event scenario may include images or sounds and multimedia graphics, allowing materialization of practiced simulated clinical situations. Reports in the form of videos, systems for monitoring patients, programmed medical cases, and planned scenarios all form

Figure 1. SimMan 3G: an advanced simulation device.

Figure 2. Specially equipped room for simulation in hospital environment

grounds to create a comprehensive simulation system that lets you test all sorts of methods and procedures in terms of sustaining and restoring life functions, while at the same time providing absolute safety when testing new solutions. Thanks to this, the implementation of the system is compatible with both the latest recommendations and guidelines in this regard. Selected features of the SimMan 3G simulator are shown in Table 1. The durable and resistant design of the SimMan 3G mannequin lets you carry out training in various conditions; therefore, the instructor can simulate actual circumstances under which medical procedures are performed: in either a clinic, a hospital, or an ambulance.

Table 1. Specifications of SimMan 3G medical simulator (Laerdal).

Selected functions of the SimMan 3G simulator
Multiple airway skills/features: Controllable open/closed airway; automatically or manually controlled Head tilt / chin lift, jaw thrust (articulation of the mandible) Suction (oral and nasopharyngeal) Bag valve mask ventilation Orotracheal intubation, nasotracheal intubation Combitube, laryngeal mask airway and other devices for opening airways Endotracheal tube intubation, fiberoptic intubation, retrograde intubation Transtracheal jet ventilation Needle cricothyrotomy, surgical cricothyrotomy Variable lung compliance, variable airway resistance
Airway complications and difficulties: Detection of proper head position Can't intubate/Can ventilate Tongue edema, pharyngeal swelling Laryngospasm, decreased cervical range of motion, trismus Right main bronchus intubation Stomach distention
Breathing features: Simulated spontaneous breathing Bilateral and unilateral chest rise and fall Normal and abnormal breathing sounds Oxygen saturation and waveform
Respiratory complications: Cyanosis Needle thoracentesis – bi-lateral and Pneumothorax Unilateral & bilateral chest movement in the course of diseases Unilateral, bilateral & lobar breath sounds
Cardiac features: Extensive ECG library Heart sounds - four anterior locations ECG rhythm monitoring (4 wire) 12-lead ECG display Defibrillation and cardioversion Cardiac pacing.
Cardiovascular features: Blood pressure measured manually by auscultation of Korotkoff sounds Carotid, femoral, brachial, radial, dorsalis pedis, popliteal and posterior tibialis pulses synchronized with ECG Pulse strength adjusting to blood pressure Pulse palpation is detected and recorded by the monitoring system.
Vascular access: Intravenous access (right arm), intraosseous access (tibia and sternum) Automatic Drug Recognition System

The most distinguishing feature of the entire training project, addressed to doctors and dental surgeons, as well as other employees of the healthcare system, is a specially designed platform for education and training: www.symulatorymed.pl, ultimately compatible and cooperating with the aforementioned medical simulator (Figure 3). It is an experimental platform consisting of knowledge bases, case reports, training scenarios, and tests to check the acquired knowledge. Communication with the user occurs via a standard web browser, and uses technological solutions that do not require installation of additional or specialized extensions. Users of the platform are subject to authorization and control, and access to selected elements of the scenarios requires authentication. On the other hand, access to the raw results of R&D is open. The e-learning platform gives the opportunity to create specialized, thematic databases based on the scenarios that can be programmed into the training simulator SimMan 3G. Their proper implementation, in particular the analysis of difficult cases, makes it possible to develop new ways of dealing with them. In addition, the ability to control and check the results of training sessions and educational tests completed by registered users serves as 'feedback' to all the information provided on-line. This allows for comparison of the progress and effectiveness of teaching during the successive testing session.

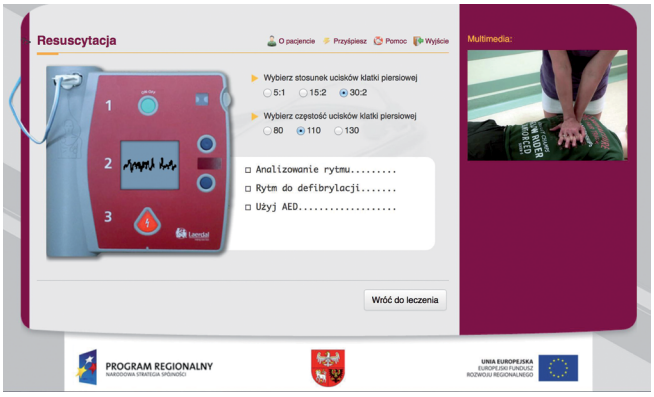

Figure 3. E-learning platform for an online training.

4. RESULTS AND DISCUSSION

Simulation is more often being used in medical education to learn and develop cognitive, psychomotor and behavioural skills not only at the individual level but also in teamwork. The overall objective is to determine the desired results of teaching and training using simulators and subsequent management of education by incorporating simulation into the curriculum with the aim of achieving the previously established objectives.[1] An essential element of education using simulation devices is feedback from trainees and trainers, on the basis of which it is possible to plan further education or verify schemes already created.[2] Conducting simulation sessions should take place in a specific environment, as much as possible, reflecting the environment in which

acquired knowledge and skills are later to be used.[3] Importance of 'mastery learning' based on medical simulation has been proven in terms of improving and achieving high level skills by trainees, which in turn leads to the preservation of knowledge and skills for much longer than did previous training methods.[4] In order to achieve better results during training of medical personnel while making use of simulation applications and devices, more research is needed to confirm the efficacy of scientific methods and those developing new aspects of training based on events observed during the learning process.[1,5] The developed R&D infrastructure will use scientifically-tested and proven training methods in the education process. This will be used to formulate and test new training methods 'in difficult cases' on the basis of planned and conducted scientific research.[5] Every doctor and dental surgeon who is registered to conduct business activity, and the entity of the medical industry, can benefit from the project results and take part in scientific research, provided they have generated both a login and a password to access the website and the learning platform with required written or electronic notification of their desire to participate in the Warmia and Mazury Chamber of Physicians. The programme of the incorporation of the developed R&D infrastructure into the process of instruction and development of skills of practitioners registered to conduct business activity in the area covered by the Warmia and Mazury Chamber of Physicians is very important. The inclusion of simulation and scientific research in the existing training program should greatly improve learning outcome.[6] Determination of the expected results at the end of the project, e.g. to improve the skills of medical personnel of various specialties in sustaining and restoring life functions of patients with sudden occurrence of threats to health or life in different healthcare units, e.g. outpatient clinics, specialist clinics, hospitals of various specialties and profiles, will translate into improved patient safety.[7] It is necessary to precisely identify results, the attainment of which is possible with the simulation in individual research groups, e.g. reduction in response time and appropriate diagnostic and therapeutic procedure in acute pulmonary embolism in patients undergoing orthopaedic surgery or surgery during hospitalization in surgical wards. The target group of trainees requires the determination of the type of chosen simulation - in this case, the use of both the e-learning platform and the medical SimMan simulator to improve access to selected training methods.[8] Original determination of how to conduct training using simulation is also significant. The first stage, for instance, is solving cases available on the e-learning platform, and in the next stage there are exercises using the simulator, which can be done in groups of 3–5 or smaller, of 1–2 persons. Selection of appropriate training groups consisting of only doctors, or of doctors and nurses, depends on the desired effect.[9,10] Logistics of conducting scientific research, as well as sharing research results with the possibility of access granted to economic entities carrying out medical activities, also needs to be developed. As it has been demonstrated repeatedly, only a well-planned simulation leads to successful outcomes.[11] Therefore, the rules of use of feedback coming from the entities involved in the development of new training methods and those participating in education are currently being established, and the pre-established initial training program for a 'test group' is being implemented as a pilot study. Analysis of all the positive and negative experiences of the study, conducted in a pilot group with multiple attempts made in order to best fit the available simulation tools to the actual situation, is to allow for a reliable initial assessment of learning outcomes in the pilot group and for verification of the initial assumptions in order to develop the most effective and efficient training methods for sustaining and restoring life functions as well as procedures applicable to difficult clinical situations.[12] The evaluation of the degree of satisfaction of business entities taking part in both the course of scientific research and the training process will occur through appropriate and validated questionnaires. One of the components of programme adjustment is also the assessment of satisfaction corresponding to the implementation of the curriculum and supervision of the process of scientific research.[13] Based on the results of work analyses carried out, there will be re-verification of the established goals as well as ways to incorporate simulation into the training program. The types of simulation itself, particularly the use of the e-learning platform and getting appropriate feedback from people involved in the programme and analyses, will also be verified. Ideally, it would be a continuous process, regardless of the duration of the project and the results obtained so far.[14,15] The involvement of entities conducting medical business activity involved in scientific research requires close cooperation between the University Hospital and the Warmia and Mazury Chamber of Physicians as well as the Faculty of Medical Sciences at University of Warmia and Mazury. The previous experience with students training gives a stable background for establishing such a network between the subjects interested in medical teaching and professional development. Swamy et al. proved, that working with a simulation device improves significantly students' knowledge and confidence.[16] The major challenge to medical simulation was the fact, that evidence to date was weak in methodology and it was difficult to transfer the knowledge and experience from the students' training room to already practicing professionals. It has not been adequately tested, that learning by simulation is directly transferable to the clinical context,[17] although a few studies have shown a direct positive impact in the clinical outcome from the use of simulation for medical training.[18] Therefore, a great role of the presented programme of R&D infrastructure in establishing methodology for simulation incorporation in professional development is expected.

5. CONCLUSIONS

The main goal of the newly created R&D infrastructure should not only be to support knowledge in sustaining and restoring life functions and final achievement of a satisfac-

tory learning outcome using the simulation device, but also to transfer better results of education from the conditions of the simulation room, in order to improve the survival and effectiveness of the treatment of patients in reality.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgement

The Research and Development infrastructure in the University Clinical Hospital in Olsztyn was created based on the cooperation between the University Clinical Hospital in Olsztyn, the Warmia and Mazury Chamber of Physicians and the Faculty of Medical Sciences at University of Warmia and Mazury with contribution of Regional Development Fund of the European Union.

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