

Potential applications of medical simulation in the teaching process within the field of wound prevention and treatment. Literature review and personal experiences analysis

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Abstract

Introduction: The dynamic advancement of simulation techniques in medical universities opens a new chapter in medical education in its broad sense. Education in the field of wound prevention and treatment can enhance and enrich the training opportunities for nurses.

Aim: The aim of this study was to analyze available literature on medical simulation as a practical tool in educating nurses in wound prevention and treatment.

Material and methods: A literature review was conducted regarding medical simulation in the nursing education process. National (Termedia) and English-language (PubMed, Cochrane) databases were searched from 2015 to 2023 using the key words “nurse”, “medical simulation,” “wound treatment.”

Conclusions: Education utilizing medical simulation in the area of wound treatment can be an effective tool in enhancing practical skills among nursing students. Data regarding the utilization of this teaching method in practice are still too limited to draw definitive conclusions. Implementing simulation models in the teaching process is necessary to enhance skills, foster attitudes, satisfaction, and alter perceptions of this issue among nursing students.

Key words: medical simulation; education; wounds; nurse

Introduction

The education of nurses throughout its history has been and continues to be focused on systematically improving the quality of education based on prevailing standards and recommendations. The increase in prerequisite requirements for candidates, adjustment of the number of hours, and duration of education to meet European Union requirements are some of the elements aimed at enhancing the quality of education. In Poland, the utilization of medical simulation in pre-diploma teaching is conditioned by the regulation of the Minister of Science and Higher Education. It is mandatory for higher education institutions, universities, and academies to incorporate medical simulation techniques into the educational process [1].

In the Slovak Republic simulation education is relatively underexplored. This may be particularly related to financial issues associated with providing high-fidelity models for the education of health professions students. Investment in this type of education should be prioritized, as the prosperity of society is closely linked to the quality of healthcare provided by well-educated and trained professionals. Simulation-based education is one of the key factors influencing the evaluation of the educational process. It enables the standardization of clinical situations and supports students' abilities to apply their knowledge in various scenarios, enhance their practical skills, develop their critical thinking and clinical decision-making, improve communication and multidisciplinary collaboration, and increase their satisfaction with education [2].

The implementation of simulation methods in the education process of nurses is an effective approach in undergraduate and postgraduate education. Simulation-based clinical education is an innovative pedagogical approach that provides nursing students with opportunities to improve their clinical and decision-making skills through various real-life situations without compromising patients' health. Simulations allow students to work together on scenarios with clear learning outcomes [3].

The aim of the study was to analyze the available literature on medical simulation as a practical tool in nursing education in the field of wound prevention and treatment.

Material and methods

A literature review was conducted regarding medical simulation in the nursing education process. National (Termedia) and English-language (PubMed, Cochrane) databases were searched from 2015 to 2023 using the key words "nurse," "medical simulation," "wound treatment." Additionally, relevant book publications

were utilized. Studies focusing solely on wound treatment education through lecture materials were excluded, regardless of whether these materials were personal, virtual, or simulation-based interventions that did not primarily focus on wound treatment. Based on the analyzed literature, our own experiences related to conducting simulations in the field of wound prevention and treatment are presented.

Types of medical simulation and their potential applications in the teaching process in the field of wound prevention and treatment

The training system for medical professions (nurses, midwives, physicians, paramedics, pharmacists, etc.) in Poland is regulated by law and supervised by designated institutions [1]. Changes in the education system enable students to delve into practical skills in the context of holistic care based on real-life scenarios. Training based on competencies (Competency-Based Medical Education) is designed with future professional tasks and roles in mind, which graduates will fulfill in a social environment. Competencies are understood as the ability to apply acquired knowledge and skills in specific situations while adhering to principles of professional ethics. An essential aspect of competency-based or outcome-based education is the credible assessment of the degree to which students achieve these outcomes/competencies, enabling them to obtain diplomas and professional qualifications. As competencies encompass various areas (knowledge, skills, and attitudes, also known as social competencies), their assessment requires the use of appropriate and often entirely new methods. This necessitates the continuous updating of knowledge among academic teachers. Simulation is an active learning strategy in which participants engage in practical actions that resemble training conducted in natural conditions, based on feedback between the trainees and simulated patients. Medical simulation is a dynamically evolving branch of medical education closely related to medical technology. It is a teaching method and an educational process that utilizes a range of educational equipment, from simple trainers for learning individual tasks to advanced manikins, also known as patient simulators, which faithfully mimic human anatomy and physiology [4].

This review focuses on the potential of simulation in the field of health sciences, specifically within undergraduate and graduate nursing studies, for wound prevention and treatment. Clinical nursing education conducted by professional teachers and clinicians using simulation is not limited to the use of manikins and simulators alone but is highly creative and dependent on the instructors and their level of engagement. It may involve various activities, including the use of electronic

and audiovisual systems, realistic virtual environments, and role-playing by actors prepared for such activities or by the students themselves [5]. The cornerstone of simulation work is the scenario. A detailed description of the conducted exercise is essential for both low-fidelity and high-fidelity technology-based sessions. Considering the method's universality as a form of medical education, a classification based on its fidelity into low, medium, and high-fidelity simulations has been made.

Low-fidelity medical simulation is used in the teaching of technical-manual skills and isolated clinical procedures, without an extensive clinical context. Low-fidelity simulation utilizes equipment that allows for the repeated practice of a given task. Through the repetition of performed procedures, students gain confidence and develop desired behaviors and habits, enabling them to perform tasks freely and safely, in accordance with aseptic and antiseptic principles. The advantages of this method include simplicity, repeatability, minimizing the risk of error, and exposure of potential patients in clinical reality. Exercises should be conducted under the constant supervision of a teacher who demonstrates the correct execution of each procedure, and then monitors and promptly corrects any errors that occur. The equipment used in low-fidelity simulation mainly consists of trainers and simulators reflecting specific areas of the human body. Exercises utilizing low-fidelity simulation can also be conducted on more advanced simulators. In the field of wound prevention and treatment, within this form of education, one can consider learning simple procedures related to wound assessment and management: describing the depth of injuries, type of tissue in the wound, wound edges, for which clinical scales, trainers, and wound photos can be utilized. Shipton et al. emphasize that to stimulate students' creativity, the replication of wounds on the skin through makeup can be used, which is a very interesting approach given its ability to recreate wounds for subsequent description [6]. Performing the procedure should be concluded with a description of the wound's appearance. Teaching involves conveying knowledge, practical skills, and interpersonal communication. Collecting microbiological material, removing sutures from a wound, and administering injections within the wound area (e.g., local infiltration anesthesia currently performed on a physician's order) are simple procedures commonly used in practice. Many authors emphasize the correctness of performing these procedures, which should involve obtaining tissue scrapings or biopsies, rather than just swabbing the wound [7]. Performing compression therapy using the Kikuhime device to measure pressure under the bandage is another procedure commonly used in the wound healing process. The ability to apply compression therapy should be a mandatory activity in conducting basic nursing classes. The individual procedures are depicted in Figure 1, and their implementation can be conducted in basic nursing classes as well as during physical examination sessions in the first year of diploma training.

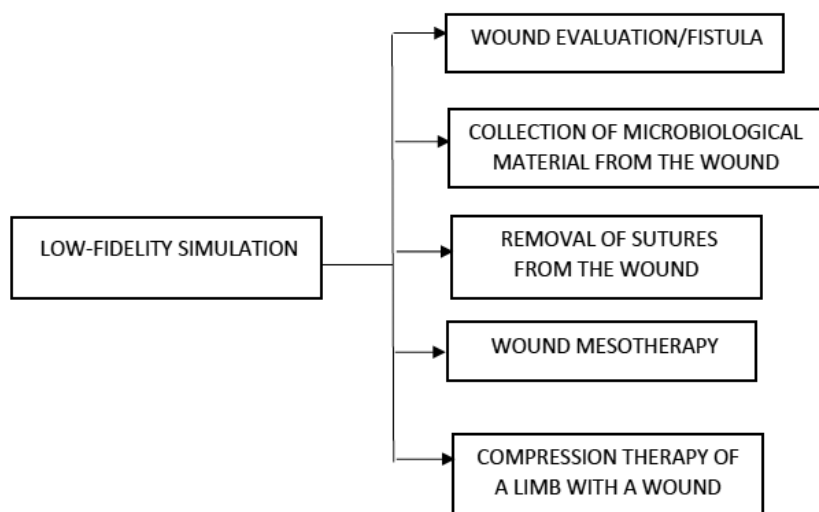


Figure 1. Possibilities for implementing preventive and therapeutic procedures in low-fidelity simulation in undergraduate studies (own elaboration)

The concept of intermediate-fidelity medical simulation is based on gradually introducing clinical context. While performing procedures, students must pay attention not only to the correctness of each task element but also to the patient's situation. Attitude, interdisciplinary communication, and the quality of tasks performed are considered in the assessment process. In this form of education, practical attitudes and behaviors are emphasized using both trainers and more advanced simulators [8]. Intermediate-fidelity simulation involves creating an environment and context through the instructor's creativity, rather than relying solely on equipment. In the teaching process of wound care and management, intermediate-fidelity simulation can be used for diagnostic procedures (evaluation, lower limb examination in diabetic patients, Doppler ultrasound examination, ankle-brachial index assessment) as well as therapeutic procedures (wound debridement through scraping, removal of devitalized tissues, suture removal, wound dressing using specialized dressings, application of negative pressure wound therapy, larval therapy, management of stomas with wounds). Classes suitable for implementing these procedures include basic nursing, physical examination, and modules focusing on wound management in graduate studies. The possibilities of using simulation are presented in Figure 2.

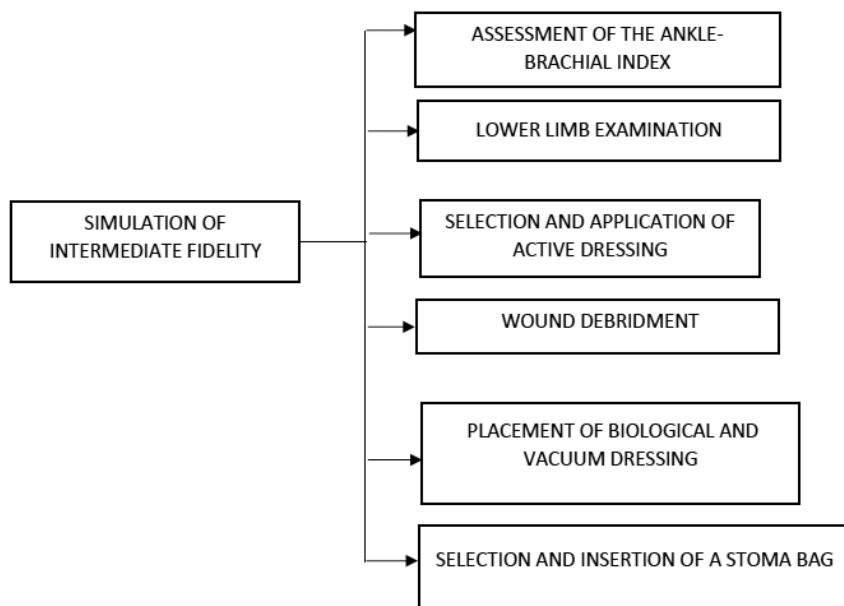


Figure 2. Possibilities for implementing preventive and therapeutic procedures in intermediate-fidelity simulation in undergraduate and graduate studies (own elaboration)

High-fidelity simulation is used for an integrated educational process, which includes theoretical knowledge, practical skills, and attitudes such as patient approach and communication. The main goal of this form of education is to integrate previously acquired knowledge and practical skills into independent or team actions. Implementing complex simulation scenarios involving multiple procedures can engage individual participants or interdisciplinary teams. At this stage, students make decisions independently, based on their knowledge and analysis of the clinical situation. High-fidelity simulations require instructors to pay close attention to technical and substantive training details, which have a comprehensive character. Experiential learning is one of the most effective teaching methods. Students, as simulation participants, solve prepared clinical problems in the form of simulation scenarios, which include numerous tasks to be performed. The student takes responsibility for performing the entire therapeutic-diagnostic process from start to finish. High-fidelity scenarios are conducted in rooms that reflect clinical reality, with audio and video monitoring capabilities, recording, and transmission options. The instructor is located in a separate room behind a one-way mirror (control room) (Photographs 1a and 1b).



Photograph 1a. High-fidelity simulation in the nursing student teaching process at the Center for Medical Simulation, University of Rzeszów (personal material)



Photograph 1b. High-fidelity simulation in the nursing student teaching process at the Center for Medical Simulation, University of Rzeszów (personal material)

Therefore, students should be well-prepared in terms of knowledge and basic skills already mastered. High-fidelity simulation aims to maximize the resemblance of the learning environment to the work environment by faithfully reproducing it, often

including the work subject as well. Typical high-fidelity simulation rooms resemble or closely resemble real hospital emergency departments, intensive care units, or settings resembling apartments for elderly individuals. An important element of high-fidelity simulation room equipment is debriefing systems, including cameras, recording equipment, and appropriate software, allowing for training support and, particularly, conducting debriefing sessions with the trained team based on the audio-video recording of the conducted exercise (simulation scenario). The area of wound prevention and treatment can be addressed in medical simulation at every level; possible clinical situations that can be implemented are presented in Figure 3.

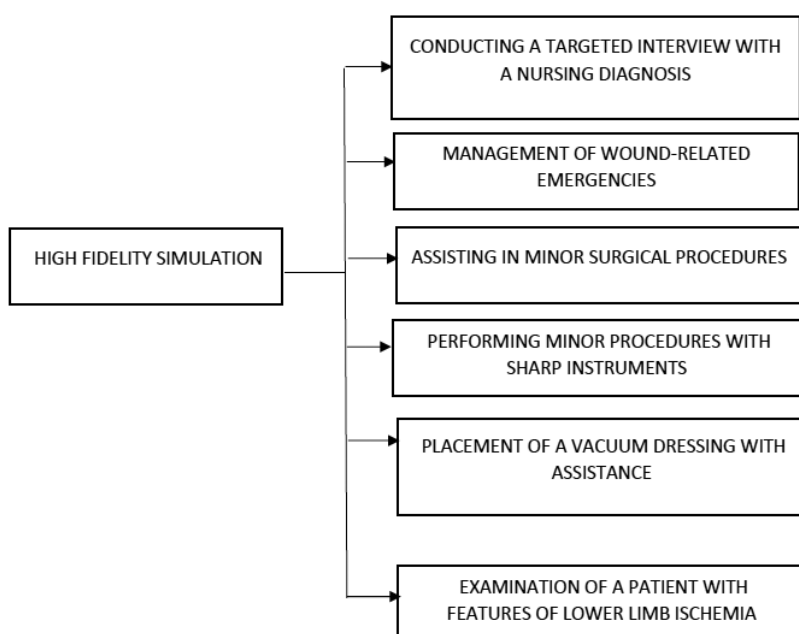


Figure 3. Possibilities for implementing preventive and therapeutic procedures in high-fidelity simulation in undergraduate and graduate studies (own elaboration)

In the teaching process, scenarios can be created in various settings, such as a home environment (long-term care or hospice patient), surgical outpatient clinic (assisting in changing negative pressure wound dressings, obtaining histopathological tissue samples, managing abscesses), and even in emergency nursing scenarios (e.g., hemorrhage from a damaged vessel within a wound or a wound at a metastatic site). The most creative sessions involve actors who are equipped and prepared to portray the roles of elderly individuals, providing a realistic representation of the environment and stereotypes associated with diabetic foot disease [9]. In Photograph 2, the

various stages of teaching wound management with a negative pressure dressing are depicted, from simple procedures to scenarios involving actors. A challenge for contemporary clinical nursing is the development and implementation of new competencies. In anticipation of new teaching standards in nursing education, it is necessary to prepare educators to teach the use of surgical tools, management of necrotic and devitalized tissues, and techniques of modern therapeutic systems such as controlled negative pressure with irrigation capabilities.



Photograph 2. Intermediate and high-fidelity simulation in the nursing student teaching process at the Center for Medical Simulation, University of Rzeszów (personal material)

Both in Poland and in Slovakia, there are various types of models that may include various aspects of wound management, such as moist wound healing, surgical wound management, and nursing aspects. When choosing a model, it is important

to consider its quality, realism, and ability to simulate various stages and types of wounds to provide the best possible preparation for practice. The models are made of materials that are resistant to repeated use and allow the application of various types of treatment. Some models are even equipped with technology that allows monitoring of healing processes and provides feedback for the user. Furthermore, it is important to consider service and operational support [10]. Standardization of certain procedures arises from the influence of both local and global scientific societies, whose representatives recommend procedural models based on scientific guidelines [11, 12, 13]. Chronic wound models are an important tool for education and training, particularly for students of nursing and other health professions. They are constantly updated to reflect the newest scientific knowledge and clinical experience in wound management [14].

In simulation, standard procedures for chronic wound treatment are used and developed based on expert analyses and verified experience. Therapeutic and care procedures may result from educational standards or ministerial recommendations [1]. For example, the standard procedure “Comprehensive Nursing Management of Patients with Chronic Wounds” provides detailed guidance for nurses on how to effectively treat chronic wounds using the latest knowledge and technology [15]. Another important document is “Wound Management,” which contains comprehensive information on the epidemiology of patients with wounds, wound classification, clinical presentation, diagnosis, treatment, and care [16].

The use of simulation methods can be considered an important factor in the evaluation of educational settings. The use of various types of simulation methods in the training of health profession students enhances the practical acquisition of skills. This is achieved through multiple repetitions, visualization, precise execution, and coordination of individual actions, making the learning process much more effective [17, 18]. The educational process, atmosphere, and students’ perceptions and opinions about their own performance have become very important for optimal teaching and affect the evaluation of the educational environment [19].

Discussion

As technology advances, innovative educational methods are preferred alongside traditional ones to develop students’ cognitive, emotional, and psychomotor skills. Conducting theoretical education in practical professions aimed at preparing professionals for patient care is insufficient and does not provide the desired level of knowledge and outcomes, especially in critical situations (e.g., cardiac arrest,

acute life-threatening conditions) burdened with high responsibility, where students cannot practically participate as members of interdisciplinary teams. Simulation provides opportunities to practically deepen highly specialized skills and is one of the breakthrough techniques in the array of methods for assessing experimental learning, offering broad opportunities for practice while ensuring safety and high teaching standards [20].

The dynamic development of simulation techniques in medical universities opens a new chapter in medical education in the broadest sense. Education in the field of wound prevention and treatment can expand and enrich the training opportunities for nurses in this area. The results of research conducted by Silva et al. indicate that simulation enables the acquisition of practical skills for assessing and treating wounds [21, 22]. The obtained results unequivocally indicate that clinical simulation can be an effective strategy for improving clinical outcomes but has a lesser impact on acquiring theoretical knowledge compared to other educational methods [23, 24]. Studies confirming the effectiveness of simulation in knowledge acquisition have combined this method with other teaching strategies, such as lectures, video presentations, and traditional clinical experiences [25].

The authors indicate that learning outcomes may include perceived or distinctly measured gains in knowledge as a result of simulation interventions [26, 27]. Redmond et al. highlight the potential use of virtual patients (VP) to supplement knowledge on wound management in undergraduate studies. The majority of students highly rated the educational value of virtual patients and their support in learning. They reported a noticeable increase in confidence and ability to achieve competency outcomes in wound management. Virtual patients also provided an opportunity to develop clinical reasoning skills. This study provides evidence that virtual patient simulation is an effective pedagogical method for enhancing clinical competencies in wound management. It gives nursing students the opportunity to practice skills and repeatedly apply theory in a safe environment, unconstrained by resource limitations such as access to clinical placements and decreasing faculty [28]. Virtual patient (VP) is defined as a specific type of computer program simulating real clinical scenarios: students take on the roles of healthcare workers to gather history, conduct physical examinations, and make diagnostic and therapeutic decisions.

Additionally, students can receive immediate and timely feedback on their decisions and practitioner skills, which is a significant enhancement to learning. Other advantages of VPs include flexibility in scheduling without time constraints, repeatability, simultaneous use by all students, and minimal cost after the initial investment [29]. Employees at University of Rzeszów's Medical Simulation Center

(Centrum Symulacji Medycznej Uniwersytetu Rzeszowskiego – CSM) have had positive experiences in conducting training sessions using virtual patients, especially in the areas of physical examination and emergency situations. Collaboration with a Portuguese team [30] has provided a framework for evaluating actions in this regard. Literature analysis provides broader insights into the issues of prevention and wound care in nursing. Particularly noteworthy are the studies conducted by Yilimazer et al. among nursing students regarding the prevention and treatment of pressure ulcers. The authors confirmed that the obtained results of the participants were at a high level after comprehensive training involving standardized patients. This study reaffirmed that standardized patient interactions are an effective learning method for nursing students. Furthermore, it was established that knowledge and outcomes may be more enduring through comprehensive training encompassing both summary sessions and theoretical and demonstrative education [27].

Each teaching process should undergo evaluation and final assessment. The use of OSCE (Objective Structured Clinical Examination) to assess the cognitive knowledge and clinical reasoning of participants aims to objectively evaluate acquired skills as well as behaviors in simulated work environments and medical events. Preparing nursing students and training nursing staff in the prevention and treatment of wounds remains a challenge for the education system. Staff shortages and inadequate interest among practitioners continue to present practical problems associated with advanced professional practice in this area [31]. In Poland, nurses acquire qualifications for wound care during the diploma-level education in second-degree nursing studies. These qualifications can also be obtained through specialization or specialized courses in wound care. Continuing education programs offer the opportunity to utilize high-fidelity simulation in the teaching process of applying larval therapy (MDT), negative pressure wound therapy (NPWT), or wound debridement. The primary objective of nursing education programs is the acquisition of clinical competencies. Nursing professional organizations define competencies as a combination of knowledge, abilities, skills, attitudes, and decision-making abilities. Concerns have arisen, both domestically and abroad, regarding the adequacy of the preparation of undergraduate nurses for competencies in wound care. Authors point out issues such as the lack of evidence-based practice, the need for greater education in the biological sciences, and the necessity for significantly improved, structured wound assessment, as well as post-care and education in clinical reasoning skills [32, 33].

Unprofessional wound management and treatment have consequences for patients and the healthcare system, including increased risk of amputation, more frequent hospitalizations, antibiotic overuse, pain leading to decreased mobility, and

predisposition to social isolation. Concerns regarding the competency of nursing students in wound management and treatment may be justified in the context of professional preparation. The global shortage of nursing staff and limited opportunities for clinical practice in wound care are considered contributing factors. Virtual simulation offers potential solutions and enables the evaluation of practical training outcomes.

An important aspect is also the multidisciplinary approach that emphasizes collaboration between various healthcare professionals to achieve the best care possible. In Slovakia, there are educational programs that focus on chronic wound management and use simulations as a key part of the educational process. The programs have been designed to provide comprehensive theoretical information along with practical skills necessary for providing successful treatment. As a result, nurses are better trained to deal with complications associated with chronic wounds and overall treatment outcomes improve. Thus, simulation is an important tool to increase the effectiveness and quality of nursing practice in Slovakia, which has direct positive effects on patients suffering from chronic wounds [34]. Establishing collaboration with foreign institutions offers opportunities for expanding knowledge and horizons related to research design, as well as enhancing the utilization of teaching methods from partners with greater experience.

Conclusions

Education utilizing medical simulation in the area of wound treatment can be an effective tool in enhancing practical skills among groups of nursing students. Data regarding the utilization of this teaching method in practice are still too scarce to draw unequivocal conclusions. It is necessary to implement simulation models in the teaching process to enhance skills, build attitudes, satisfaction, and change perceptions of this issue among groups of nursing students. Thorough research and comparisons of various models and procedures help to identify the most suitable methods for treating chronic wounds according to specific needs. Therefore, high-quality simulations are essential for nurses with varying levels of experience.

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