Advances in Medical Education and Practice

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REVIEW

Simulation-Based Teaching and Learning in Respiratory Care Education: A Narrative Review

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Abstract: Simulation-based pedagogy has become an essential aspect of healthcare education. However, there is a significant gap in the literature regarding the application of simulation-based modalities in respiratory care education. This review aims to address this gap by providing insight into the theory and current uses of simulation, its effectiveness in respiratory care education, and strategies to enhance faculty development. The study utilizes a narrative synthesis approach to review relevant literature and provide a comprehensive understanding of the topic. The research involved comprehensive searches of electronic databases, including PubMed and Google Scholar, to identify relevant literature, encompassing original articles, reviews, and other pertinent content, focusing on simulation-based teaching and learning in respiratory care education published between 1990 and 2022. Findings suggest that simulation-based education is an effective tool for improving respiratory care education and can enhance the clinical skills of learners. The study concludes by discussing the future of simulation in respiratory care education and the potential benefits it may offer.

Keywords: simulation, learning, respiratory therapy, education, clinical simulation, medical simulator, clinical Skills

Introduction

The evolution of the respiratory care education model from a traditional paradigm to a more contemporary framework has been driven by a confluence of factors, including advances in technology, changing healthcare needs, and evolving educational practices. This transformation reflects a shift towards a more dynamic and responsive approach to respiratory care training. These factors have resulted in a shift towards more innovative curricula that place greater emphasis on clinical skill mastery than knowledge acquisition. One of the key drivers of this transformation has been the increasing use of simulation-based education. Simulation provides learners with a safe environment to practice and refine their clinical skills, allowing them to gain confidence and competence before working with real patients. As a result, simulation-based education has become an integral part of respiratory care education, with many programs incorporating simulation into their curricula. Some allied healthcare institutions which offer respiratory care programs have adopted problem-based learning (PBL) as an educational strategy, which is a student-centered approach, involves presenting learners with real-world challenges to solve collaboratively.[1–3] These immersive methods not only enhance the overall learning experience but also provide students with practical skills and critical thinking abilities essential in their future healthcare endeavours. Unfortunately, students often graduate with a theoretical grasp of the content without obtaining many of the practical skills necessary for meaningful and rapid application in-clinical practice.[4] This highlights the need for innovative educational strategies that can bridge the gap between theoretical knowledge and practical skills such as

Received: 18 February 2024
Accepted: 23 May 2024
Published: 29 May 2024

simulation-based education and problem-based learning. In response, respiratory care education must stress the development of pertinent clinical skills. Clinical skills are considered a crucial learning outcome in several international organizations and medical schools have endorsed them.[2,5] Simulation training aligned with educational theories promotes experiential learning. It amplifies opportunity to develop higher order cognitive functions and encourages the growth of psychomotor skills, especially in resource limited settings.[6] Apprenticeships (process of learning by working alongside experienced professionals in a clinical setting) and other opportunities not available in real-world learning (learners are exposed to the challenges and complexities of working in a clinical setting) are possible through simulation and offer a variety of learning safety nets. In a recent meta-analysis,[7] the efficiency of simulation-based medical education was linked to superior learning results compared to non-intervention or when added to conventional practice. Perhaps the integration of clinical skill training labs and simulation-based learning in respiratory care curricula not only enhances cognitive and psychomotor skills but also provides a secure environment for experiential learning, allowing learners to benefit from apprenticeships and reflective practices, ultimately leading to superior educational outcomes compared to traditional approaches.

Respiratory care education has opportunity for improvement by using a variety of simulation models which emphasize interdisciplinary communication, situational awareness, leadership, and decision-making rather than merely technical skills.[8,9] The quality of care provided to patients with conditions such as acute respiratory distress syndrome, chronic obstructive pulmonary disease, and bronchial asthma could be improved by using simulation to build learner confidence in their ability to recognize and communicate changes in severity of illness, perform high risk clinical skills, and engage in effective disease management and patient education while using effective communication techniques.[10] For simulation to have the desired effect, it must be built on effective teaching methods.[11] These include having clear objectives, providing useful feedback, encouraging repetition, and including simulation in the curriculum. The goal of this narrative review is to comprehensively elucidate the significance and efficacy of simulation as a pivotal teaching strategy within the realm of respiratory care education. Our specific aim is to delve into the multifaceted dimensions of clinical simulation, delineating its inherent benefits, contemporary usage, and evolving status within educational frameworks. By meticulously examining the landscape of simulation-based learning, we endeavour to underscore its indispensable role in fostering the acquisition of essential knowledge, skills, and competencies among students pursuing respiratory care studies. Furthermore, we aspire to illuminate the diverse applications and innovative approaches that characterize simulation-based education, thereby providing insights into its potential for advancing both teaching methodologies and clinical practice in respiratory care. Through this narrative exploration, we aim to contribute to the ongoing discourse on educational strategies in respiratory care, offering valuable perspectives and guiding principles for future research, curriculum development, and pedagogical enhancements in this field.

Materials and Methods

This study provides a narrative overview of the literature on simulation-based teaching and learning in respiratory care education. The research was carried out by searching electronic databases such as PubMed and Google Scholar. All categories of literary sources including original articles, reviews, and other relevant content focusing on simulation-based teaching and learning in respiratory care education published between the year 1990 and 2022, as well as such studies and literature published only in English language included. Additionally, we screened the reference lists from relevant articles to ensure a thorough search. This review excluded those works not written in English and published before or after the period specified in the inclusion criteria. The number of articles screened, included, and excluded, along with other relevant details of the literature search, were documented to ensure transparency and replicability of the review process.

Emergence of Themes

During the data analysis phase, themes began to emerge organically from the synthesized literature. As the researchers reviewed and synthesized the findings of the included studies, common patterns, trends, and recurring topics related to simulation-based education in respiratory care began to surface. These emergent themes were identified and refined through iterative analysis and discussion among the research team. The identified themes were then further developed

and categorized based on their relevance and significance to the objectives of the literature review. This involved grouping related findings and concepts under overarching themes that captured the breadth and depth of the literature on simulation-based teaching and learning in respiratory care education.

Simulation in Respiratory Care Education

Types and Definitions of Simulation Education

The ever-shifting societal norms and evolving patient profiles have heightened the emphasis on accountability in patient care. This reflects the continuous need for precision and diligence in navigating the dynamic landscape of healthcare.[12] Healthcare professional education focuses on developing theoretical background, critical skills and problem-solving capabilities. However, the potential for occurring medical errors remains high and not all critical or uncommon events can be taught on real patients.[13] This emphasizes the need for simulation in education to train safely and effectively to reinforce new and existing knowledge.[14] To address these challenges, healthcare professional education is increasingly incorporating simulation-based training and assessment. Simulation provides a safe and controlled environment for learners to practice and refine their clinical skills, with a range of tools available, including task trainers, virtual reality simulators, standardised patients, virtual patients, and computerised full-body manikins (Figure 1). By using these tools, learners can reinforce their theoretical knowledge and clinical skills necessary for delivering safe and effective patient care.[3]

According to previous research, undergraduate nursing students are more prone to make medical errors because they only have a short window of time to shift from a theoretical to a clinical environment, and the reported adverse events involving medical errors were more common in the first few years following graduation.[15] Undergraduate respiratory care programs have evolved over time and simulation based entry-to-practice education is now provided by numerous higher educational institutions globally.[11] Respiratory care is a competency-based program requiring extensive clinical practice. Although simulation cannot completely replace clinical practice, it offers an appropriate setting for students to practise their abilities and for the learning process.[16] Lack of a multifaceted clinical learning environment and difficulty applying theoretical information in practice are challenges faced by respiratory therapy students globally.[2,17]

By incorporating simulation into formal respiratory care education, with a focus on improving critical thinking skills, students can work in a setting similar to a hospital and develop the skills necessary for providing competent care as respiratory therapists before beginning their professional practice.[3] According to a systematic review by Yilmaz et al there is substantial evidence to support the positive educational effect of simulation-based learning, particularly in the psychomotor domain.[18] Perhaps an essential skill that could be taught to respiratory therapy

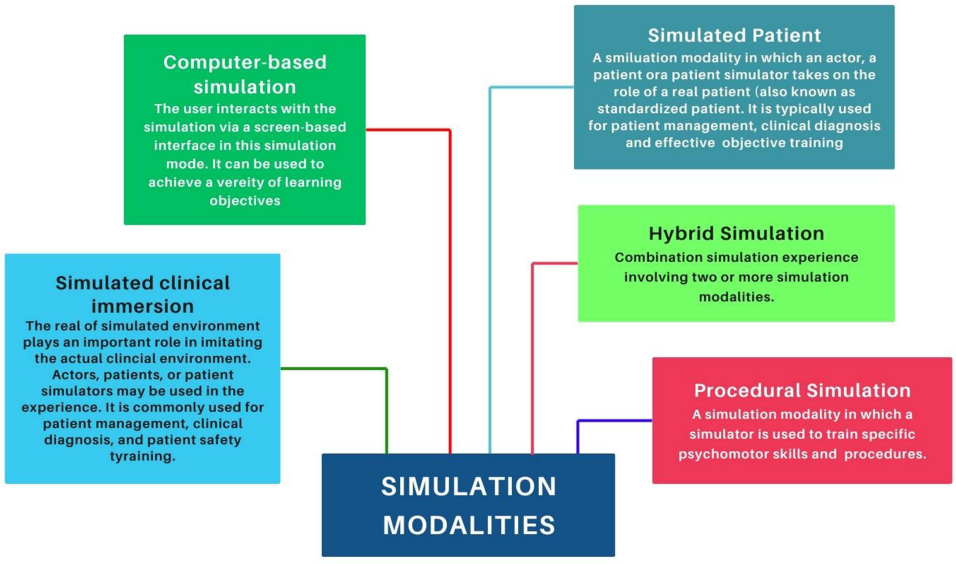

Figure 1 Modalities of simulation.

students is how to recognize error, why it is an error and what to do to avoid and recover from it.[17,19] Studies and literature reviews support the validity of simulations for improving critical thinking skills in medical disciplines.[20,21] However, in respiratory care there is a scarcity of such studies beyond the specific results obtained through individual research.[3]

Simulation in Graduate and Postgraduate Education

Undergraduate programs in respiratory care typically refer to bachelor degree programs that focus on the foundational knowledge and skills necessary for entry-level respiratory care practice. The simulation-based learning allows for the development and reinforcement of foundational skills crucial for entry-level respiratory care practice. Moreover, simulation creates a safe and controlled environment for students to familiarize themselves with diverse clinical scenarios, preparing them for the unpredictability of real-world healthcare settings.[22] The ability to practice in a risk-free setting allows for the cultivation of confidence and competence, essential attributes for success in respiratory care. Additionally, simulation promotes active engagement and critical thinking among undergraduate students. By immersing them in realistic scenarios, it encourages problem-solving and decision-making skills, which are vital in the fast-paced and dynamic field of healthcare.

Integrating simulation into postgraduate respiratory therapy programs, including Master's in Respiratory Care, advanced practice certificate programs, residencies, and fellowships, offers multifaceted advantages.[8] In terms of leadership development, simulation provides a platform for honing managerial and decision-making skills essential for leadership roles in healthcare settings. For research-focused programs, simulation serves as a valuable tool for hands-on experimentation and data collection. It allows postgraduate students to refine their research methodologies and experiment with innovative approaches, contributing to advancements in respiratory care practices. In the context of specialized areas like critical care, transportation, pulmonary rehabilitation, and neonatal-pediatric respiratory care, simulation facilitates targeted training. Postgraduate students can immerse themselves in realistic scenarios specific to their chosen specialization, enhancing expertise and preparedness for real-world challenges. Furthermore, simulation fosters interdisciplinary collaboration, a crucial aspect of advanced respiratory care. Through collaborative simulations, postgraduate students can practice effective communication and teamwork, preparing them for leadership roles that require coordination with professionals from various healthcare disciplines.[8]

Associate degree programs, advanced practice certificate programs, residency programs, and fellowship programs constitute a distinct classification within respiratory care education. This classification is substantiated by authoritative sources such as the Commission on Accreditation for Respiratory Care (CoARC) and the American Association for Respiratory Care (AARC).[21,23] For example, CoARC provides a directory of accredited respiratory care programs that categorizes programs based on their level of education, including associate, bachelor, and master degree programs. Similarly, AARC provides resources for respiratory care professionals to advance their education and career, including postgraduate educational opportunities.

Simulation of Patient Assessment

An example of simulation integration in undergraduate programs is patient assessment where instructors can use simulation to assess students' ability to perform patient assessment and identify abnormalities before beginning their first clinical rotation.[24,25] Another example of integrating patient assessment in simulation is the utilization of cardiology simulators, where the first phase of the program assesses normal cardiology findings, followed by assessment of abnormal cardiology findings in the second phase. This integration proved to be popular among students and effective during the Objective Structured Clinical Examination (OSCE) assessment of cardiology.[21] Based on the examples from the nursing and medical profession discussed above, we recommend that simulation-based teaching and learning be incorporated into the undergraduate respiratory therapy curriculum at different levels to achieve various learning outcomes. The integration of simulation can be expanded over time by assessing current experience and students' feedback.[21]

Assessment of Respiratory Rate (RR) and Respiration Patterns (RP)

Early detection of physiological conditions and cardiorespiratory illnesses can be done by assessing respiration rate and respiration patterns. However, several studies report medical practitioners have difficulty in relaying and correctly identifying major changes to the patient's respiratory rates and patterns. One study found the paucity is due to poor observational skills and equipment management.[26,27] Currently, various simulators provide a physical presentation of respiration, especially in paediatric and neonatal simulations with chest and abdominal movements. However, to our knowledge, there are no simulators available that can accurately simulate the realistic use of accessory muscles and diaphragmatic movement in scenarios such as airway obstruction, particularly in cases requiring demonstration of paradoxical respiration. Such limitations are overcome by using patient actors.[28] Virtual reality (VR) simulation is also an alternative approach. VR software provides numerous real-time scenarios and it is appropriate to include such new technologies in simulation.[29]

Assessment of Breath Sounds

Auscultation, the practice of listening to the internal sounds of the body, typically with a stethoscope, serves as a crucial tool when coupled with a focused medical history and physical examination.[30] Enhancing diagnostic reasoning in the context of auscultation of breath sounds requires exposure to a diverse range of patient presentations. However, relying solely on clinical encounters may prove ineffective. The integration of technology-based simulation, allowing the capture and playback of heart, vascular, and pulmonary sounds in a classroom or learning lab, emerges as a valuable tool for comprehensive training in breath sounds auscultation.[31] This simulation training focuses on identifying the sites of auscultation and recognition and interpretation of breath sounds. There is an array of breathing mannequins available; however, the evidence is limited due to the simulation-based assessment's reliability and accuracy.[24,32] However, according to Bernardi et al individual training sessions lasting one hour with a patient simulator resulted in a remarkable enhancement of auscultation abilities in medical students.[25] The study reported a notable improvement, with 89.7% of experienced students and 71.4% of those with no prior exposure to the training exhibiting significant progress in auscultation skills following the one-hour session. Furthermore, students who underwent patient simulator training demonstrated significantly higher scores in skill tests compared to their counterparts who received traditional bedside training.

Arterial Blood Gas (ABG) Sampling

ABG is an invasive procedure in which blood is collected via direct vascular puncture. Error in sampling can lead to serious complications such as nerve injuries, acute compartment syndrome, thrombosis, and pseudo aneurysm.[33,34] Therefore, it is important that healthcare professionals collecting arterial blood samples are adequately trained and their competence rigorously assessed.[35] Studies report the benefits of simulations in learning the skill.[36] Studies using low-fidelity simulation which involves simpler, cost-effective tools such as arm models, task trainers, or role-playing scenarios, allows students to practice arterial sampling without feedback, have found improvements in student confidence and competency.[37] On the other hand, high-fidelity simulation stands out as an advanced and immersive educational technique that meticulously reproduces real-life scenarios with unparalleled accuracy. Leveraging sophisticated manikins and cutting-edge computer-based technologies, this approach not only replicates clinical settings but, when coupled with virtual reality, creates a comprehensive patient setup. This setup encompasses physical, environmental, and psychological components, delivering a truly realistic experience for learners. Notably, the integration of virtual reality not only enhances the authenticity of the simulation but also contributes to cost reduction by minimizing expenses related to consumable preparatory materials. This approach allows for a more immersive learning experience, leading to increased student engagement and more effective learning outcomes.[38] High-fidelity simulation combined with virtual reality provides a realistic patient environment and lowers costs associated with preparatory materials. Also, simulation processes based on virtual reality and haptic abilities reduced students' anxiety. However, effective simulation-based training can be resource-intensive, which may restrict its implementation in facilities with a limited budget.[38,39] Apart from competency training, the simulation-based assessment also allows educators to identify the most common errors among practitioners.[40]

Simulation of Therapeutic Procedures

Oxygen Administration

Oxygen therapy is commonly used in managing patients with respiratory distress.[41] Simulation training using a low-fidelity mannequin can be used for the correct procedural steps, whereas a high-fidelity mannequin can simulate sophisticated pulmonary mechanics which replicate O_2 uptake and CO_2 production, helping decision-making and choice of appropriate devices eg, CAE HPS simulator [*CAE Healthcare, Human Patient Simulator, ©CAE Inc. 2023]*.[28] Simulation based training can also aid in enhancing procedural exposure and embedment of a new medical service to the hospital. Mallet et al demonstrated a 100% success rate in implementing High Flow Nasal Cannula (HFNC) in hospital wards through the use of multi-professional practical applications and simulated scenarios by involving physicians, nurses, paramedics, and healthcare assistants and 95% (31/33) participants felt significantly more confident in approaching high flow after the session.[42] Alvarez et al finds that simulation can be effectively used in training RTs to safely manage intubated patients undergoing hyperbaric oxygen therapy.[43]

Airway Management

Airway management is a life-saving procedure. Choosing a device for teaching this skill varies according to the learning objective and level of skills and complexity.[44,45] Several studies report the lack of difficult airway management skills in specialists and trainees in acute care.[46] The Fourth National Audit Project (NAP4) of the Royal College of Anaesthetists and the Difficult Airway Society in the UK investigated major complications of airway management during anaesthesia, and they found that major airway complications were rare, occurring in 1 in 2000 general anaesthetics, but were associated with significant morbidity and mortality. The most common causes of these complications were related to inadequate planning, inadequate skills or equipment, and inadequate monitoring.[47] The results of a study done by Hall et al showed that Human Patient Simulator (HPS) was an effective method for teaching airway intubation skill, resulting in significant improvements in the success rates and speed of intubation compared to traditional teaching methods.[48] They also suggest that HPS can be used as a valuable tool for training paramedic students in airway management and their findings show that learning tracheal intubation through simulation is at least as successful as doing so on actual patients.[48] A systematic review and meta-analysis by Zendejas et al found that simulation-based training was associated with significant improvements in airway management skills, including a higher success rate of intubation and a lower incidence of complications.[49] Also, video feedback should be a regular component of simulation training. It helps to identify faults and improve performance.[50] Currently, VR simulations are available for specific areas of airway training, such as surgical airway skills.[51,52]

Simulation of Mechanical Ventilation (MV)

MV is a vital tool to assist ventilation. It finds application in diverse settings, including emergency departments, intensive care units, respiratory medicine wards, and patients' homes for long-term care. New practitioners may pose a significant patient safety risk when managing patients on MV due to their limited experience and familiarity with the complexities of this critical procedure.[53] Studies have shown that simulation can provide lasting knowledge and prepare residents and RTs to safely manage ventilated patients.[54,55] MV simulation is performed by connecting a load (ie connecting a device that simulates the patient's respiratory system and its characteristics to the ventilator, allowing the simulation of different respiratory scenarios) to ventilators which can be programmed to mimic patient characteristics relative to disease states. The Michigan Instrument training and test lung (TTL) simulator and the Ingmar medical ASL 5000 are examples of two popular simulators that are available currently.[56,57] The studies by Hare et al showed that simulation-based education was effective in improving participants' knowledge and skills in NIV management, and they highlighted the importance of incorporating simulation-based education into the curriculum for healthcare professionals to improve their ability to manage NIV effectively.[58] Naran P. et al used simulation-based training to improve staff knowledge and competence in NIV management. Peer-to-peer simulation-based education, where healthcare professionals engage in collaborative learning experiences, was found to be effective in improving knowledge and confidence in NIV management.[59] Leigh. Y. et al study assessing the baseline MV competencies by simulation among residents and RTs shows that initial performance improved drastically with simulation.[55] Skills such as measuring pulmonary mechanics, initiation, and

adjustment of invasive MV settings based on case scenarios improved with simulation, while a higher percentage of errors occurred in managing patient-ventilator asynchronies, troubleshooting, and disease-specific management.[60]

Simulation of Advanced Procedures

The goal of the postgraduate programs is to equip students with higher levels of competencies, including professionalism, leadership, critical thinking, analytical abilities, performing specialized processes and research.[61,62] Also, evidence from various postgraduate specialties has shown simulation can effectively differentiate novices from experts on performance and rate of progress of mastering the skills.[54] A postgraduate respiratory care student requires procedural competence in many technical domains such as basic and advanced procedures in airway management, advanced patient monitoring, vascular access, and diagnostic procedures. Barsuk and colleagues demonstrated that students who received vascular access simulation training improved their technical proficiency and confidence.[63] Trainees who underwent simulation-based training demonstrated a lower average number of needle passes (mean = 1.32, SD = 0.85) compared to traditionally trained residents (mean = 1.74, SD = 0.83). Additionally, the incidence of procedure-related arterial punctures was significantly reduced (1/114, 1%, $p < 0.0005$) among simulation-trained residents, leading to a decrease in catheter-related problems in the ICU.[62] Simulation training for chest tube insertion, thoracentesis, and thoracoscopy are frequent pleural procedures that students benefit greatly from when there learning these procedures prior to performing them on real patients.[64] Ultrasound guided thoracentesis skills training in mannequins and cadavers showed decrease in complication rates and increase in the number of procedures performed after the training.[65]

Simulation in Continuing Medical Education in Respiratory Care

The emphasis is growing for respiratory care professionals and other healthcare practitioners to participate in continuing medical education.[66] As medicine evolves, the volume of medical data increases and respiratory care technologies develop quickly. In recent years, clinical simulation in medical education has grown rapidly as an alternative to the didactic lecture alone.[67,68] Advanced cardiac life support and clinical case scenarios are widely practised simulation areas in medical education. Simulation-based education can be an effective and engaging way to deliver continuing medical education for respiratory therapists, helping to maintain and improve their knowledge, skills, and confidence and ultimately leading to better patient outcomes.

Simulation Education Curriculum and Faculty Development

Several models and concepts have developed the theoretical framework for educational interventions involving simulation. Unifying terminology and pinpointing causal or predictive linkages is one benefit of using a reliable theoretical model.[69] Numerous studies from the nursing profession report the adaptation of such theoretical frameworks and models for integrating simulation into the curriculum. Burns et al discovered significant improvements in knowledge and attitude among students through the implementation of an ADPIE-C framework in simulations, with 82% showing increased knowledge and all students exhibiting positive changes in critical thinking, confidence, and communication skills.[70] Similarly, Alhazmi et al reported a moderately positive attitude towards e-learning among students in health pre-professional students during the COVID-19 pandemic.[71] Benner's *Novice to Expert* model is an example of model-based curriculum implementation. This model has five stages of practice, emphasizing progression across the clinical proficiency spectrum.[25,72] Applying Benner's model to the trajectory of simulation facilitators can provide a framework for the role and common language and terminology related to simulation. This framework can also provide ideas for continuing education for new facilitators and a solid foundation for ongoing research in simulation-based education. Overall, this model emphasizes the importance of systematically examining the pedagogy of simulation and applying scientific principles to further the healthcare professions.[73]

However, metrics need to be repeatable and to connect closely to performance in the real world as the simulation progresses into the high stake's domains of competency verification, certification and licensure. Systematic task analysis - the process of identifying a task or group of tasks to complete a job - is a method for mapping clinical activities with accuracy.[25] A sub-type is the Hierarchical Task Analysis, which enumerates all of the steps in a certain task, analyses the steps and attempts to arrange the steps in the order in which they should or could be completed. Healthcare simulation

practice and education have both shown the value of task analysis techniques.[74] For effective implementation of simulation-based learning, it is important to identify when to implement simulation in the curriculum, what learning objectives can be achieved, what logistics are required and what learning concept can be addressed.[6]

Simulation Based Assessment in Respiratory Care Education

Respiratory care is primarily a practice-based field of study, therefore education must take place in both classroom and clinical practice.[75] In Canadian programs, clinical simulation has become a popular way to learn entry-to-practice competencies. It is strongly linked to better learning, clinical and nonclinical skills, future performance and patient outcomes.[62] Traditionally formative debriefing has been used in clinical simulation, where desired learning outcomes are assessed by using standard methods such as grading tests or awarding qualifications. With enhancement of technology, the assessment has shifted towards assessing competencies such as high stakes testing designed to assess entry-to-practice competencies.[75,76] These assessments have a direct bearing on students' ability to make progress in their education or career.[77]

Faculty Training in Simulation-Based Learning in Respiratory Care

Faculty training plays a key role in conducting simulation with a positive impact on patient care. The success of simulation programs was positively and significantly influenced by both the quantity and quality of instructors.[62] However, it is the least developed aspects of simulation. A structured framework for developing respiratory care simulation is important in order to support increased use of simulation as a teaching tool.[78] For example, The International Nursing Association for Clinical Simulation and Learning Standards Committee has published the Healthcare Simulation Standards of Best Practice ™ Professional Development and the Society of Simulation in Healthcare has developed The Certified Healthcare Simulation Educator® certification program.[68,79]

However, some considerations need highlighting when designing simulation faculty development programs for respiratory care educators. For example, interprofessional education needs to keep pace with new technology and measure the impact of faculty development on learning outcomes.[80] Integrating interprofessional education into the respiratory care simulation-based curriculum relies on a skilled and competent faculty to promote didactic simulation collaborative practice. A time will come when educators will have to apply new technologies such as virtual reality, augmented reality and Metaverse application. Finally, it is important to assess the effectiveness of a faculty development program and to measure the impact on learning outcomes (Figure 2).[67,72,79,81]

Familiarization of educators with technology is necessary for the smooth operation of the simulation programme and training of students. A simulation educator (*is a professional who specializes in designing, implementing, and evaluating simulation-based educational programs for healthcare professionals*) is different from a professor in a nursing school. However, such distinctions are rarely made, and health educators are inadequately trained, often lacking essential skills.[82] Consequently, training in this regard is ineffective. McAllister et al suggest ways to overcome barriers and limitations in simulation and maintain quality in clinical training. These include assisting educators by maintaining student faculty ratios and encouragement of diverse supervision models, giving students direct access to clinical skills videos, focusing on teaching clinical skills, utilizing teams in skill learning documentation, learning communication skills in an entertaining and imaginative way and improving students' time management and prioritization of needs.[83]

Developing a pool of qualified trainers is needed, and a credential system would ensure maintenance of trainer standards. Many trainers in postgraduate healthcare education are full-time healthcare professionals and part-time trainers. They may not have the time to teach frequently and therefore may lose their debriefing skills. It is important that healthcare organizations invest in a viable infrastructure to ensure sustainability and achieve the desired results with simulation training.

The Continuing Evolution of Simulation in Respiratory Care Education

In a recent literature review by Jeeva et al explored the benefits and potential consequences of interprofessional simulation on respiratory care students. Based on their analysis of the literature, the authors concluded that interprofessional collaboration through simulation can lead to positive outcomes such as shared understanding of goals and

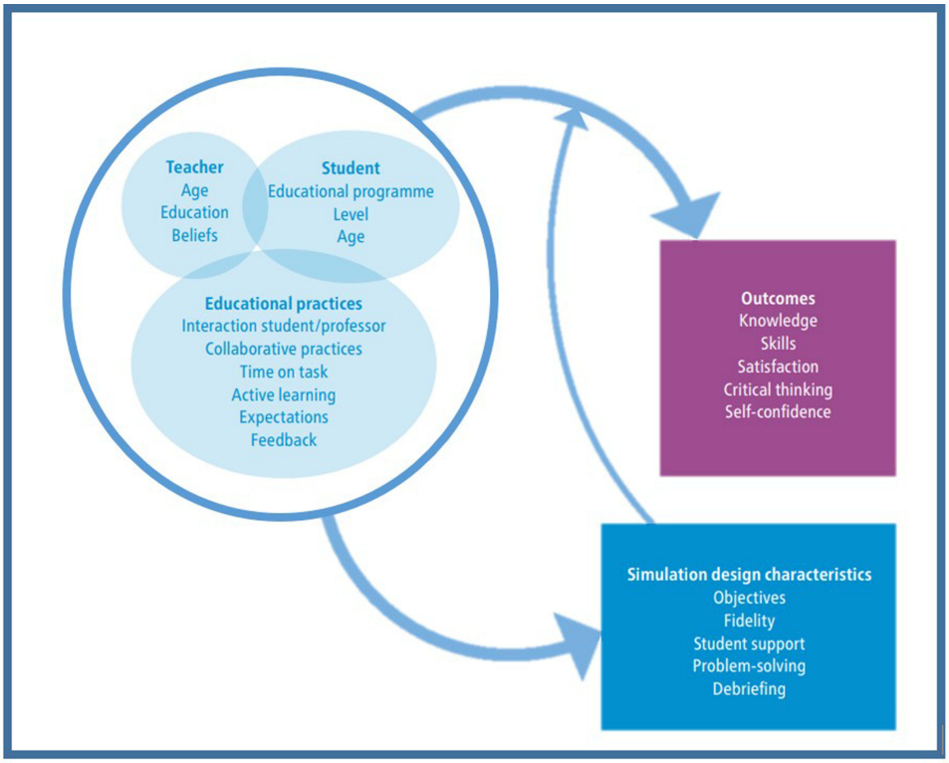

Figure 2 Theoretical model to support simulation-based clinical teaching.

confidence in working with other professions, particularly when combined with didactic material and a supportive learning environment that emphasizes multidisciplinary communication. These findings suggest that interprofessional simulation can be an effective approach to healthcare education that helps prepare respiratory care students for the demands of clinical practice.[84] The goals of the training included to comprehend how health professionals provide effective patient-centred care, minimise airway management adverse outcomes in an emergency, improve effective communication and, because students can make mistakes while training, protect patients from potential harm.[9]

Respiratory care students perceive simulation-based training as an excellent option for standardizing procedures in a safe environment and as a helpful teaching tool.[85] Despite the challenges a respiratory care faculty might face in conducting simulation-based training, the transformation of knowledge into a conceptual framework can be an effective teaching tool. It provides realistic training that allows the faculty to evaluate what the student has learned from the course and to address any mistakes.[86] Studies report simulation has improved participants' confidence and short-term skill enhancement. In a regulated and secure simulated environment, educators can track students as they progress from novice to proficient.[87] However, evidence regarding the sustainability of these improvements and their impact on patient outcomes remains unclear.[7] Respiratory therapists are part of a multidisciplinary team focusing largely on acute care. Simulation training in respiratory therapy revolves around patient assessment, performing therapeutic procedures and practicing critical care scenarios.[88] Accrediting organizations and instructors are moving toward competency-based assessment that includes students in practical training which enables them to receive fast formative feedback.[13]

However, the Commission on Accreditation for Respiratory Care 2020 Entry into Practice Standards does not recommend simulation as a valid substitute for traditional clinical hours or competency assessment but as an add-on to traditional clinical experiences.[89] Simulation-based training has shown its efficiency achieving desired learning outcomes and positive impacts on patient care.[38] It has been integrated throughout the health professions but the respiratory care profession is behind in using and adopting this method.[88] Nursing and paramedic education deem simulation-based training to be a legitimate substitute for regular clinical hours. Students and faculty experiences of implementing methods of simulation are well documented in the literature.[16,88,90–92] However, the literature is immature

in optimising simulation design and debriefing, professional and faculty development, and standards of best practice of simulation-based training in respiratory care. Further empirical studies are warranted to fill in the gaps.

While simulation-based education has gained tremendous popularity across medical and allied healthcare specialties, its adoption and integration within respiratory care lags behind nursing and medicine.[88,93] The lack of continuous faculty development is perceived as a major barrier for respiratory educators to simulation-based education.[80] Simulation professionals must acquire extensive knowledge and experience in simulation, from designing to technical operation and debriefing. This helps in providing more coherent, consistent, and valuable simulation experiences to trainees. This is important because the reliable use of simulation is crucial for ensuring public safety, referring to the effective training and preparation of healthcare professionals to respond adeptly to real-world scenarios, ultimately safeguarding the well-being of patients and the community.[62] The current lack of faculty professional development may be due to insufficient financial support, limited training facilities and scarce evidence of the need for simulation career development.[88] Senior administrators remain resistant to acknowledging simulation-based education as effective and investment-worthy, particularly in respiratory care, which risks inferior recruitment and poor resource allocation for faculty development despite evidence showing the advantages.[2] Ultimately, these may cause a long-lasting negative effect on the future of simulation-based education.

More efforts should be made by respiratory care regulatory bodies to promote development to simulation professionals. Advanced and sophisticated technologies help to mimic real-life multi-discipline and multi-paradigm simulation scenarios. However, such technological and operational advancements, despite being extremely expensive, often require intense training. The Advisory Workgroup assigned by the National Alliance of Respiratory Therapy Regulatory Bodies recommends that educators should develop their own teaching strategies using the best emerging simulation-based education technologies and practices.[94] This can be achieved through professional memberships, attending international conferences and participating in simulation operational workshops. Even though simulation has been employed as a standard assessment strategy, concerns have emerged over simulation-based summative assessment, particularly in high-stake examinations such as the respiratory care professional license exam.[62] Thus, educators and regulatory bodies must exercise caution to ensure that simulation for high-stake assessments does not undermine the efficacy of simulation-based learning.

There is a gap in the literature and need for more scholarly work highlighting the overall effectiveness of respiratory-based simulation education. This could include the use of simulation-based education in developing complex cognitive and psychomotor respiratory-related skills, selecting the optimal structured debriefing approach and assessing entry-to-practice competencies.[88,93] The findings of such novice respiratory therapy-related research would enlighten the policy makers' understanding of the use of simulation-based education to reach the highest quality educational outcomes.

Conclusion

Clinical simulation has significantly contributed to medical education, providing a valid and valuable option for training healthcare professionals. This review has highlighted its advantages and progressive influence on respiratory care education and strategies that make simulation useful in meeting and overcoming multiple challenges. It enables control over the sequence of situations offered to learners, provides opportunities for support and guidance to learners, prevents unsafe and dangerous situations and creates situations that rarely occur in the real world. Additional simulation training can be a valuable tool for supporting clinical practice in respiratory care. It has the potential to enhance motivation and mastery among students, encouraging them to tackle new challenges and explore both real and simulated environments. In this way, simulation becomes a powerful strategy to train health professionals to address the challenges of today's changing world. Future development in simulation should focus on overcoming issues related to technology, research, and cost and faculty development. Further research should be conducted on developing and applying best practice guidelines for simulation-based learning in respiratory care education.

Acknowledgments

Authors thank the Applied Graduate Studies and Research Committee at the College of Health Sciences, University of Doha for Science and Technology (UDST) for their unwavering support and encouragement throughout our research

endeavours. We extend our heartfelt thanks to Professor Dr. Fred Saleh for his invaluable guidance and mentorship, which has greatly contributed to the refinement of our research strategies. Additionally, we wish to extend special appreciation to Dr. Salem Al Naemi, the Honorable President, Dr. Rachid Benlamri - Vice President Academic Affairs, and Dr. JoAnne MacDonald - Dean of the College of Health Sciences at UDST, for their visionary leadership and tireless efforts in establishing one of the most advanced simulation centres in the region. Their commitment to integrating innovative teaching modalities into the curriculum and delivery at the university has been instrumental in shaping our research direction and enhancing the educational experience for students.

Funding

As the authors of this manuscript, we declare that no funding was received for the research, authorship, or publication of this article.

Disclosure

The authors report no conflicts of interest in this work.

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