ISSN: 2966-4837

Brazilian Journal of Respiratory, Cardiovascular and Critical Care Physiotherapy
Jornal Brasileiro de Fisioterapia Respiratória, Cardiovascular e em Terapia Intensiva

Enhancing physiotherapy education through high-fidelity simulation: a case-based approach to critical care training

Aprimoramento do ensino de fisioterapia por meio da simulação de alta fidelidade: uma abordagem baseada em casos para o treinamento em cuidados intensivos

Meredith Tsz Ling Yeung[1]*; Melissa Yi Ching Chan[1]; Clement Chee Kin Yan[1,2]; Katherin Shilin Huang[3]

[1]Physiotherapy, Health and Social Sciences Cluster, Singapore Institute of Technology, Singapore
[2]Sengkang General Hospital, Singapore
[3]Professional Officer Division, Singapore Institute of Technology, Singapore

Abstract

Background: Simulation-based education is increasingly used in physiotherapy training to bridge the gap between classroom learning and clinical practice. High-fidelity simulation (HF-Sim) offers students a realistic yet safe environment to apply theoretical knowledge, practise complex decision-making, and develop the skills in managing critically ill patients. However, evidence on its structured application in physiotherapy curricula, especially for critical care learning, remains limited. **Aim:** To evaluate the impact of HF-Sim on perceived clinical reasoning and reflective practice in physiotherapy students managing a case in the intensive care setting (ICU). **Methods**: HF-Sim was structured around predefined objectives focusing on respiratory pathophysiology, airway/ventilator management, interpretation of investigations, and evidence-based physiotherapy. These guided an HF-Sim scenario where students assessed the patient, interpreted data, and performed interventions. The 26-item Self-Assessment of Clinical Reflection and Reasoning (SACRR) survey was administered pre- and post-simulation to measure the perceived changes in clinical reasoning and reflection. **Results**: SACRR analysis revealed significant improvements in self-perceived clinical reasoning and reflective skills. Post-test results showed increased confidence in patient assessment, interpretation of investigations, treatment planning, and reflective practice, aligning with the learning objectives and emphasising critical thinking and evidence-based decisions. **Conclusion**: HS-Sim shows promise in physiotherapy education by providing a structured, safe environment for managing complex ICU scenarios. It helped students apply theory to practice and increased perceived readiness. Future studies should include objective measures and comparative designs to evaluate their impact better.

Keywords: Critical Care; Physiotherapy Education; Simulation-Based Education; Clinical Reasoning; Critical Thinking.

Resumo

Introdução: A educação baseada em simulação é cada vez mais utilizada na formação em fisioterapia para reduzir a distância entre o aprendizado em sala de aula e a prática clínica. A simulação de alta fidelidade (SAF) oferece aos estudantes um ambiente realista e, ao mesmo tempo, seguro para aplicar conhecimentos teóricos, praticar a tomada de decisão complexa e desenvolver habilidades no manejo de pacientes críticos. No entanto, as evidências sobre sua aplicação estruturada nos currículos de fisioterapia, para o aprendizado em cuidados intensivos, permanecem limitadas. **Objetivo:** Avaliar o impacto da SAF no raciocínio clínico autorreferido e na prática reflexiva de estudantes de fisioterapia no manejo de um caso em ambiente de terapia intensiva (UTI). **Métodos:** A SAF foi estruturada em torno de objetivos predefinidos com foco na fisiopatologia respiratória, manejo das vias aéreas/ventilador, interpretação de exames complementares e fisioterapia baseada em evidências. Esses objetivos nortearam um cenário de SAF no qual os estudantes avaliaram o paciente, interpretaram dados e realizaram intervenções. O questionário de Autoavaliação da Reflexão e do Raciocínio Clínico (SACRR), composto por 26 itens, foi aplicado antes e depois da simulação para mensurar as mudanças percebidas no raciocínio clínico e na reflexão. **Resultados**: A análise do SACRR revelou melhorias significativas nas habilidades autorreferidas de raciocínio clínico e reflexão. Os resultados pós-teste demonstraram aumento da confiança na avaliação do paciente, na interpretação de exames, no planejamento terapêutico e na prática reflexiva, alinhando-se aos objetivos de aprendizagem e enfatizando o pensamento crítico e as decisões baseadas em evidências. **Conclusão:** A SAF mostra-se promissora no ensino de fisioterapia ao proporcionar um ambiente estruturado e seguro para o manejo de cenários complexos de UTI. Auxiliou os estudantes a aplicarem a teoria à prática e aumentou a percepção de prontidão. Estudos futuros devem incluir medidas objetivas e delineamentos comparativos para melhor avaliar seu impacto.

Palavras-chave: Cuidados Intensivos; Ensino em Fisioterapia; Educação Baseada em Simulação; Raciocínio Clínico; Pensamento Crítico.

Presentation of data at an event: Not applicable.

How to cite: Yeung MT, Chan MY, Yan CC, Huang KS. Enhancing physiotherapy education through high-fidelity simulation: a case-based approach to critical care training. Brazilian Journal of Respiratory, Cardiovascular and Critical Care Physiotherapy. 2026;17:e00422025. https://doi.org/10.47066/2966-4837.e00422025en

Submitted on: May 20, 2025
Accepted on: May 06, 2026

Study carried out at: Singapore Institute of Technology, Singapore.

Ethical approval: The Singapore Institute of Technology Institutional Review Board approved the study: approval number RECAS-0640.

***Corresponding author:** Meredith Tsz Ling Yeung.

E-mail: meredith.yeung@singaporetech.edu.sg

INTRODUCTION

Community-acquired pneumonia (CAP) is a significant cause of morbidity and mortality worldwide, particularly among critically ill patients requiring mechanical ventilation[1]. The combination of severe respiratory compromise and the need for mechanical support necessitates a multifaceted approach to patient care. Physiotherapists play a crucial role in the multidisciplinary management of these patients, particularly in optimising respiratory function, facilitating secretion clearance, and preventing complications associated with prolonged mechanical ventilation[2]. Teaching physiotherapy interventions in critical care is traditionally conducted during clinical placements, where students gain hands-on experience[3]. However, the clinical exposure to mechanically ventilated patients may be inconsistent, and the complexities of managing critically ill patients often present significant learning challenges for students[4]. Limited opportunities to practice and apply clinical reasoning in high-stakes environments can leave entry-level physiotherapists with competency gaps.

In contemporary physiotherapy education, there is increasing recognition that traditional clinical placements alone may not provide sufficient or equitable training experiences, particularly in high-acuity settings[3]. As physiotherapist roles expand in scope and complexity, educational programmes must ensure that students develop robust clinical reasoning, confidence, and technical proficiency before entering clinical practice. High-fidelity Simulation-based education (HF-Sim) has emerged as a valuable modality for addressing these challenges. It provides a safe and controlled environment where students can apply theoretical knowledge to realistic clinical scenarios[5]. Simulation has been shown to enhance clinical reasoning, procedural skills, teamwork, and learner confidence, making it an essential component of modern physiotherapy education[6].

Recent advances in educational technology have further strengthened the potential of HF-Sim, advanced monitoring systems, and immersive intensive care unit (ICU) environments, enabling learners to engage with complex physiological responses and dynamic clinical situations that closely resemble real practice. Despite these developments, the integration of HF-Sim into physiotherapy curricula, particularly in critical care training, remains limited and underreported. To address this gap, this study presents an HF-Sim case designed for entry-level physiotherapy students, set in an ICU environment with a critically ill patient diagnosed with CAP and supported by mechanical ventilation. The simulation was structured to require learners to assess the patient, interpret investigations, plan and deliver appropriate physiotherapy interventions, and reflect on their performance.

The objective of this study was to evaluate the impact of a high-fidelity critical care simulation on self-perceived clinical reasoning and reflective practice among Year 3 physiotherapy students managing a simulated case of CAP with Type 1 respiratory failure, using the validated Self-Assessment of Clinical Reflection and Reasoning (SACRR) questionnaire.

METHODS

Study design

This pre-post, retrospective, observational study evaluated the perceived changes in clinical reasoning and reflective practice following an HF-Sim session. The simulation forms part of the routine Year 3 cardiorespiratory physiotherapy curriculum at a local public university. The study design was selected because the simulation activity and SACRR administration are part of routine curricular delivery, with the primary purpose of supporting student learning rather than generating research data. At the time of implementation, the priority was to ensure an authentic, high-fidelity learning experience without introducing additional pressures or performance-related concerns associated with a prospective research study. The anonymised SACRR responses were considered for secondary analysis only after the students completed the sessions, and the pedagogical value was recognised at the end of the academic year.

As this was a retrospective observational study utilising routinely collected educational data from the learners, a priori sample size calculation was not applicable. The enrolment number determined the number of participants, and no additional recruitment was undertaken.

Ethics and consent

Ethical approval was granted by the University Institutional Review Board (approval number: RECAS-0640) for the secondary analysis of fully anonymised SACRR data and for the use of a retrospective opt-out consent process. The SACRR forms were collected anonymously, and no identifying information was recorded, rendering individual responses non-traceable to specific students. In accordance with IRB requirements, students were contacted via institutional email and informed of the intention to use the anonymised data for research purposes. They were given a 14-day period to opt out of data inclusion; non-response was considered consent. As the data were anonymised, withdrawal could occur only prior to analysis, at the dataset level, rather than by removing individual responses. No students opted out during the designated period. All procedures complied with institutional ethical standards and ensured participant privacy and confidentiality.

Development

This HF-Sim is part of the 4-year cardiorespiratory physiotherapy curriculum, focusing on competencies for managing intubated, mechanically ventilated patients with CAP in an ICU. It targets Year 3 students in the module on respiratory pathophysiology, mechanical ventilation, and cardiorespiratory assessment. Supplementary Material 1 outlines settings, objectives, scenario flow, common errors, logic requirements, student instructions, and the debrief guide.

Faculty experts in critical care and simulation-based education designed and piloted the case, refining it based on feedback. Students were expected to understand ICU monitoring, interpret investigations (e.g., arterial blood gases), and apply basic physiotherapy techniques for ventilated patients.

Structure of the simulation

1. Pre-simulation Preparation:

All participants were given a written case file and 30 minutes to review the patient's medical history, clinical notes, and investigations. During this time, the two student physiotherapists were tasked with formulating a physiotherapy plan, which they later reported to the clinical educator.

2. Simulation Session:

Each 25-minute simulation involved assessment, intervention, and reassessment. Student physiotherapists could request a "time-out" for input from observers. About 25 students per tutorial participated, split into four groups. Each group completed one simulation cycle and observed the same case over a 3-hour class, rotating through the roles of primary physiotherapists.

3. Debriefing:

After the simulation, the facilitator led a 25-minute structured debrief using scripted elements and the advocacy-inquiry approach to promote reflection and critical thinking. Students analysed their performance, assessed thoroughness, identified missed signs, and evaluated the effectiveness of interventions, especially airway clearance and ventilatory techniques. They articulated their clinical reasoning, reflected on reassessments, and explored teamwork and communication in the ICU. Constructive feedback improved clarity and role execution. The debrief ended by synthesising key learning points and reinforcing evidence-based principles to consolidate knowledge and readiness for future scenarios.

Participants

Participants were Year 3 physiotherapy students enrolled in the cardiorespiratory physiotherapy module. Eligible participants included those who attended the HF-Sim session and completed the pre- and post-simulation SACRR survey. Students who did not attend the scheduled simulation session (skipped class) or declined to submit to SACRR were excluded.

Facilitator role

The facilitator guided the simulation and ensured that learning objectives were met. During the debrief, they used prompt questions to encourage reflection on performance, focusing on assessment accuracy, treatment planning, execution, and teamwork.

Simulation setting

The HF-Sim was conducted in a university simulation room that replicated an ICU, using a high-fidelity mannequin that simulated vital-sign changes, respiratory mechanics, and airway secretions. Figure 1 illustrates an example of the mannequin and the ventilator used. The setup included standard ICU equipment (e.g., ventilators, monitors, infusion pumps, and suction devices) to enhance realism (Figure 2). Supplementary Material 2 provides the simulated clinical notes.

Equipment/environment

1. Patient Setup:

- A high-fidelity mannequin simulator intubated with a 7.0 endotracheal tube.
- Connected mechanical ventilator set to volume control-assist control (VC-AC) mode.
- A patient monitoring system displaying realistic vital signs, including blood pressure, heart rate, respiratory rate, and oxygen saturation.
- Attached IV drip, indwelling urinary catheter, intra-arterial (IA) line, and central venous (CV) line.

2. Bedside Supplies:

- Fully-equipped bedside table containing:
  - A suctioning pump with appropriate accessories (e.g., an airway suction catheter).
  - Resuscitation bag.
  - Gallipot, 5 mL syringe, normal saline ampoules, and water for irrigation.
  - Airway management tools, including a pressure manometer.
  - Pale yellow-tinted aqua gel simulating airway secretions for realistic suctioning practice.

3. Environmental Elements:

- A hospital bed to simulate an ICU patient setup. Figure 3 depicts the impression of the overall facilities.
- An ICU environment arranged to mirror a typical hospital ward, complete with lighting, audible ventilator sounds, and bedside monitoring alarms.

Figure 1. Models of the mannequin and ventilator used during high-fidelity simulation.
Source: Original photograph provided by the authors.

Figure 2. The layout of the monitoring system in the intensive care unit simulation room.
Source: Original photograph provided by the authors.

Figure 3. Overall impression of the intensive care unit simulation room.
Source: Original photograph provided by the authors.

Personnel

To implement the simulation, the following team members were involved:

- Facilitators: Clinical educators guided the session, debriefed, and supported learners.
- Simulation Technician: Responsible for operating the mannequin and adjusting vital signs based on the learners' interventions.
- Observers: Non-participating students from each group were actively involved during debriefing sessions.

Implementation

The HF-Sim began with a 30-minute pre-brief for case review and preparation. Two self-nominated students served as physiotherapists, with peers observing. The 25-minute simulation involved physiotherapy assessment and treatment of a simulated ICU patient. "Time-outs" enabled observers to offer input and promote shared learning. A 25-minute facilitator-led debrief followed, focusing on clinical reasoning, performance, and teamwork. This structure provided an immersive experience aligned with key learning outcomes in cardiorespiratory physiotherapy.

Assessment

The Self-Assessment of Clinical Reflection and Reasoning (SACRR)[7] survey was administered before and after three 3-hour simulation classes to evaluate the perceived effectiveness of the simulation sessions. The SACRR is a validated 26-item tool using a 5-point Likert scale [Strongly disagree (1), Disagree (2), Undecided (3), Agree (4), Strongly agree (5)] to assess learners' self-perceived clinical reasoning and reflective skills, the key competencies targeted in this simulation. It has demonstrated good reliability and validity (Cronbach's alpha: 0.87–0.92; test-retest reliability Spearman coefficient: 0.60)[8], making it suitable for this study[9].

Statistical analysis

Data were analysed using GraphPad Prism version 8.4.3. Descriptive statistics, including mean scores and standard deviations, were used to analyse pre- and post-HF-Sim responses to summarise students' responses. Changes in pre- and post-HF-Sim scores were evaluated using paired t-tests, with $p < 0.05$ considered significant. To quantify the magnitude of the observed changes, Cohen's d was calculated as an effect size. As no demographic or academic variables, such as age, gender and prior clinical exposure, were collected due to the fully anonymised nature of the dataset, analyses were limited to unadjusted pre-post comparisons, and multivariable modelling or statistical adjustment for potential confounders was not possible.

RESULTS

A total of 147 pre-test and 91 post-test SACRR forms were analysed. Only fully completed questionnaires with no missing item-level data were included for analysis. The difference in numbers indicates that 56 did not complete the post-test voluntary survey during the scheduled lesson or were absent from the scheduled debrief session, resulting in a 38.1% attrition rate. Nil response reverted to opt-out from the retrospective participation opt-out email. It was not possible to compare respondents with non-respondents, which may have led to the preferential retention of students who were more engaged or motivated. Demographic data were not collected during the in-class evaluation.

Table 1 presents changes in SACRR scores. The SACRR assessed students' self-perceived learning, clinical reasoning, and reflective practice, directly supporting the simulation's educational objectives in managing mechanically ventilated patients.

1. Student Engagement and Satisfaction

Survey responses indicated high engagement and satisfaction with the simulation sessions. Participants appreciated the immersive learning environment, which closely mirrored real-world clinical challenges and supported the objective of performing and demonstrating cardiorespiratory physiotherapy assessments and interventions.

2. Self-Perceived Learning and Clinical Reasoning

Comparison of pre- and post-test SACRR scores showed statistically significant improvements in areas directly linked to the educational objectives:

Pathophysiology understanding and evaluation of clinical investigations: Items assessing hypothesis generation, contextual reasoning, and outcome evaluation (Items 5, 19, 22, and 23) showed large effect sizes (Cohen's d > 1.6), reflecting an enhanced self-perceived ability to integrate clinical information and apply it to decision-making.

Table 1. SACRR pre-test and post-test comparisons.

SACRR items	Pre-test		Post-test		p-value
	Mean	SD	Mean	SD	
1. I question how, what, and why I do things in practice.	**4.41**	**0.58**	**4.26**	**0.53**	**0.035***
2. I ask myself and others questions as a way of learning.	**4.47**	**0.57**	**4.27**	**0.50**	**0.006***
3. I don't make judgments until I have sufficient data.	**4.10**	**0.73**	**4.10**	**0.60**	**0.808**
4. Prior to acting, I seek various solutions.	**4.14**	**0.60**	**4.10**	**0.56**	**0.716**
5. Regarding the outcomes of proposed interventions, I try to keep an open mind.	**3.36**	**0.54**	**4.25**	**0.51**	**< 0.001***
6. I think in terms of comparing and contrasting information about a patient's problems and proposed solutions to them.	**4.13**	**0.60**	**4.14**	**0.51**	**0.870**
7. I look to theory for understanding a patient's problems.	**4.25**	**0.60**	**4.21**	**0.60**	**0.578**
8. I look to frames of reference for planning my intervention strategy.	**4.12**	**0.66**	**4.10**	**0.54**	**0.582**
9. I use theory to understand treatment techniques.	**4.27**	**0.53**	**4.21**	**0.51**	**0.348**
10. I try to understand clinical problems by using a variety of frames of reference.	**4.05**	**0.64**	**4.04**	**0.56**	**0.866**
11. When there is conflicting information about a problem, I identify assumptions underlying the differing views.	**3.93**	**0.71**	**4.00**	**0.62**	**0.484**
12. When planning intervention strategies, I ask "What if" for a variety of options.	**4.00**	**0.75**	**4.03**	**0.71**	**0.764**
13. I ask for peers' ideas and viewpoints.	**4.46**	**0.54**	**4.46**	**0.50**	**0.995**
14. I ask for the viewpoints of patients' family members.	**3.76**	**0.74**	**3.93**	**0.79**	**0.038***
15. I cope well with change.	**3.65**	**0.84**	**3.58**	**0.86**	**0.507**
16. I can function with uncertainty.	**3.41**	**0.98**	**3.57**	**0.86**	**0.220**
17. I regularly hypothesise about the reasons for my patients' problems.	**4.03**	**0.60**	**4.07**	**0.55**	**0.675**
18. I must validate clinical hypotheses through my own experience.	**3.95**	**0.74**	**4.04**	**0.61**	**0.416**
19. I clearly identify the clinical problems before planning intervention.	**2.95**	**0.71**	**4.10**	**0.65**	**< 0.001***
20. I anticipate the sequence of events likely to result from planned intervention.	**3.90**	**0.76**	**4.00**	**0.62**	**0.454**
21. Regarding a proposed intervention strategy, I think, "What makes it work?"	**4.01**	**0.64**	**4.19**	**0.54**	**0.039***
22. Regarding a proposed intervention, I ask, "In what context would it work?"	**2.98**	**0.67**	**4.13**	**0.60**	**< 0.001***
23. Regarding a particular intervention with a particular patient, I determine whether it worked.	**3.09**	**0.58**	**4.20**	**0.48**	**< 0.001***
24. I use clinical guidelines/protocols for most of my treatment.	**3.00**	**0.60**	**4.14**	**0.57**	**< 0.001***
25. I make decisions about practice based on my experience.	**2.77**	**0.83**	**3.93**	**0.73**	**< 0.001***
26. I use theory to understand intervention strategies.	**3.14**	**0.54**	**4.14**	**0.54**	**< 0.001***

SD: Standard deviations. Values are presented as mean and standard deviations. Statistical significance ($p < 0.05$) indicated with text in bold and *. SACRR: Self-Assessment of Clinical Reflection and Reasoning. 5-point Likert Scale: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.

Source: Original data compiled by the authors.

Understanding endotracheal tube function and interpreting ventilator settings: SACRR items related to planning interventions and using theory to understand techniques (Items 24 to 26) also showed significant improvements, indicating increased confidence in managing mechanically ventilated patients.

Designing patient-specific management plans: Items reflecting reflective practice, open-mindedness, and peer/family engagement (Items 1, 2, 14 and 21) demonstrated moderate effect sizes (Cohen's d = 0.22 – 0.37), suggesting students perceived enhanced ability to reason through complex scenarios and justify interventions.

In summary, the SACRR results demonstrate measurable gains in students' self-assessed knowledge, clinical reasoning, reflection, and confidence in applying physiotherapy interventions in a critical care context. These findings reflect the simulation's effectiveness in promoting perceived competence and reflective learning, without applying observed behaviour or clinical outcomes.

DISCUSSION

This study examined the impact of an HF-Sim on physiotherapy students' self-perceived clinical reasoning and reflective practice, using pre- and post-simulation SACRR scores. The findings demonstrate statistically significant improvements in students' perceived competence across several key areas of clinical reasoning. Large effect sizes were observed for multiple SACRR items, including items 5, 19, 22, 23, 24, 25 and 26, indicating substantial perceived growth in the ability to keep an open mind when evaluating interventions, identify clinical problems clearly, apply contextual reasoning, evaluate intervention outcomes, use clinical guidelines, and integrate theoretical frameworks into practice. Additional gains were noted in reflective questioning, seeking alternative viewpoints, and making context-dependent decisions (Items 1, 2, 14 and 21). Items that did not change significantly largely reflected areas where baseline scores were already high or skills that may require real clinical exposure to develop. Taken together, these results indicate that the simulation meaningfully enhanced students' self-perceived readiness to appraise clinical information, reason through complex patient scenarios, and justify physiotherapy interventions in a critical care context.

While similar studies specifically in physiotherapy remain limited[10,11], educational research across healthcare disciplines indicates that high-fidelity simulation enhances learners' perceived clinical reasoning, procedural skills, reflective practice, and confidence[6,12,13]. Systematic reviews and empirical studies support the pedagogical value of simulation for bridging theoretical knowledge and clinical application[11,14,15]. This aligns with our findings, demonstrating that even brief, structured simulation experiences can support meaningful learning outcomes.

The development, implementation, and evaluation of this simulation offered valuable lessons. Designing a scenario that closely mirrors clinical practice was essential for engagement and skill acquisition, ensuring that students faced challenges that reflected real-world clinical practice. For instance, interpreting arterial blood gas results and tailoring treatment plans in response to mechanical ventilation settings required integrating multidisciplinary knowledge and fostering critical thinking and teamwork skills.

The simulation's success highlights the importance of structured case design with clear, measurable objectives. Students reported increased confidence and perceived competence in performing patient assessments, interpreting clinical data, and planning treatments, directly addressing gaps in their readiness for clinical practice. The simulation centre provides a safe and controlled environment, both clinically and psychologically, for students to begin experimenting with physiotherapy interventions. This setting allows learners to apply their knowledge and practice complex clinical decision-making without fear of harming real patients. By removing the immediate pressures and risks associated with real-life clinical practice, the simulation environment fosters confidence, encourages active learning, and enables students to refine their skills through trial and error. This foundation is critical for preparing students for the realities of patient care while ensuring they are perceived as ready to deliver safe and effective physiotherapy interventions. This underscores the role of high-fidelity simulation in bridging the divide between theoretical learning and clinical application, fostering the ability to adapt to rapidly evolving healthcare environments.

Moreover, the reflective debriefing process was pivotal in enhancing learning outcomes. By combining scripted content with the advocacy-inquiry approach, the debrief sessions provided a platform for students to critically analyse their actions, understand alternative strategies, and solidify their clinical reasoning. This interactive approach ensures that students learn from successes and identify areas for improvement, promoting lifelong reflective practice.

A further consideration is the cost-benefit and practical applicability of using high-fidelity simulation technologies in physiotherapy education. High-fidelity environments require substantial institutional investment in equipment, technical support, maintenance, and educator training, which may limit accessibility, particularly in resource-constrained programmes. However, the educational benefits, such as safe rehearsal of complex decision-making, practice with mechanically ventilated patients, and structured formative feedback, offer value beyond traditional classroom teaching. When used judiciously, simulation can strengthen students' perceived readiness and competence without replacing authentic clinical exposure.

The evaluation approach also highlighted areas for refinement. While the SACRR scores affirmed significant self-reported growth, impromptu feedback during the sessions highlighted opportunities to improve case flow and timing. For example, ensuring adequate time for thorough patient assessments without rushing other aspects of care could enhance the realism and educational impact of future sessions. Similarly, incorporating more opportunities for students to interact with standardised participants representing healthcare team members could further reinforce teamwork and interprofessional communication.

This study has several limitations that should be acknowledged. First, 38.1% of participants did not complete the post-test survey, and it was not possible to compare respondents with non-respondents. This attrition may have preferentially retained students who were more engaged, motivated, or inclined toward critical care, introducing potential selection bias. Second, demographic and academic variables such as age, gender, prior clinical exposure, and academic performance were not collected, precluding multivariable analyses and statistical adjustment. These factors are well-recognised correlates of performance and learning in complex clinical environments and may have influenced outcomes. Third, outcomes were based solely on the SACRR, a self-reported measure of perceived competence and reflective practice, which, while valuable, cannot substitute for objective assessment of technical skills, psychomotor performance, or clinical decision making in authentic practice. Fourth, the study was conducted at a single public university and focused on one high-fidelity simulation scenario, limiting generalisability to other institutions, clinical contexts, or student cohorts. Finally, we did not collect data on the costs of developing, maintaining, or operating the high-fidelity simulation environment, preventing evaluation of cost-benefit or feasibility in other settings.

Future work should consider incorporating objective performance measures, collecting demographic and academic data, exploring multi-institutional implementations, and evaluating the long-term retention and transfer of skills. Despite these limitations, the study provides meaningful insights into the perceived educational impact of high-fidelity simulation and its role in supporting reflective learning and clinical reasoning in physiotherapy education.

CONCLUSION

This study demonstrates that a high-fidelity simulation scenario can support physiotherapy students' development of perceived clinical reasoning and reflective practice within a critical care context. Statistically significant improvements in several SACRR scores indicate enhanced self-perceived ability to interpret clinical information, justify physiotherapy interventions, and reflect on decision-making processes. These findings suggest that high-fidelity simulation is a useful educational strategy for introducing students to the complexities of managing mechanically ventilated patients. However, as the study relied on self-reported data, focused on a single institution, and examined only one scenario, the results should be interpreted with appropriate caution. Further research using objective performance measures, additional clinical cases, and longitudinal follow-up is recommended to clarify the broader applicability and impact of simulation-based education in physiotherapy training.

FUNDING

The authors received no financial support for the research, authorship and/or publication of this article.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest with respect to the research, authorship, and/or publication of this article.

ACKNOWLEDGEMENTS

The authors would like to thank all those who assisted with their time in this study.

RESEARCH DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ARTIFICIAL INTELLIGENCE USE STATEMENT

The author declares that no generative artificial intelligence (AI) or AI-assisted technologies were used in the writing of this manuscript, the analysis of the data or the creation of any figures or tables.

AUTHOR CONTRIBUTIONS

MTY was responsible for study conceptualisation, data collection, data analysis, and drafting all versions of the manuscript. CCY contributed to the study conceptualisation and data collection. MYC and KSH were involved in data collection. All authors reviewed, edited, and approved the final manuscript.

REFERENCES

1. Sligl WI, Marrie TJ. Severe community-acquired pneumonia. Crit Care Clin. 2013;29(3):563-601. https://doi.org/10.1016/j.ccc.2013.03.009.

2. Pathmanathan N, Beaumont N, Gratrix A. Respiratory physiotherapy in the critical care unit. Contin Educ Anaesth Crit Care Pain. 2015;15(1):20-5. https://doi.org/10.1093/bjaceaccp/mku005.
3. Dhir J, Connell A, Mccaughan M, Hatzoglou D, Ajami D, Fursman A, et al. Development, implementation and evaluation of an acute care physical therapy 'float' placement during the COVID-19 pandemic: a case report. Int J Environ Res Public Health. 2023;20(11):6038. https://doi.org/10.3390/ijerph20116038.
4. Nyhagen R, Egerod I, Rustøen T, Lerdal A, Kirkevold M. Unidentified communication challenges in the intensive care unit: A qualitative study using multiple triangulations. Aust Crit Care. 2023;36(2):215-22. https://doi.org/10.1016/j.aucc.2022.01.006.
5. Alinier G, Oriot D. Simulation-based education: deceiving learners with good intent. Adv Simul (Lond). 2022;7(1):8. https://doi.org/10.1186/s41077-022-00206-3.
6. Elendu C, Amaechi DC, Okatta AU, Amaechi EC, Elendu TC, Ezeh CP, et al. The impact of simulation-based training in medical education: A review. Medicine (Baltimore). 2024;103(27):e38813. https://doi.org/10.1097/MD.0000000000038813.
7. Royeen C, Mu K, Barrett L, Luebben A. Evaluation of a clinical reflextion and reasoning before and after workshop intervention. In: Crist PAH, editor. Innovations in occupational therapy education. Bethesda (MA): American Occupational Therapy Association; 2001.
8. Johnson EE, Seif GA, Coker-Bolt P, Kraft S. Measuring clinical reasoning and interprofessional attitudes. J Stud Run Clin. 2017;3(1). https://doi.org/10.59586/jsrc.v3i1.24.
9. Keiller L, Hanekom SD. Strategies to increase clinical reasoning and critical thinking in phystioherapy education. S Afr J Physiother. 2014;70(1). https://doi.org/10.4102/sajp.v70i1.258.
10. Shoemaker MJ, Riemersma L, Perkins R. Use of high fidelity human simulation to teach physical therapist decision-making skills for the intensive care setting. Cardiopulm Phys Ther J. 2009;20(1):13-8. https://doi.org/10.1097/01823246-200920010-00003.
11. Sandoval-Cuellar C, Alfonso-Mora ML, Castellanos-Garrido AL, del Pilar Villarraga-Nieto A, Goyeneche-Ortegón RL, Acosta-Otalora ML, et al. Simulation in physiotherapy students for clinical decisions during interaction with people with low back pain: randomised controlled trial. BMC Med Educ. 2021;21(1):375. https://doi.org/10.1186/s12909-021-02812-7.
12. Wong FMF, Chan AML, Lee NPM, Luk KKH. Can high-fidelity patient simulation be used for skill development in junior undergraduate students: a quasi-experimental study. Healthcare (Basel). 2023;11(15):2221. https://doi.org/10.3390/healthcare11152221.
13. Jawabreh N, Hamdan-Mansour A, Harazne L, Ayed A. Effectiveness of high-fidelity simulation on practice, satisfaction, and self-confidence among nursing students in mental health nursing class. BMC Nurs. 2025;24(1):622. https://doi.org/10.1186/s12912-025-03300-9.
14. Daneshfar M, Moonaghi HK. The impact of clinical simulation on bridging the theory-practice gap in nursing education: a systematic review. BMC Med Educ. 2025;25(1):1216. https://doi.org/10.1186/s12909-025-07790-8.
15. Rezayi S, Shahmoradi L, Ghotbi N, Choobsaz H, Yousefi MH, Pourazadi S, et al. Computerised simulation education on physiotherapy students' skills and knowledge: a systematic review. BioMed Res Int. 2022;2022(1):4552974. https://doi.org/10.1155/2022/4552974.

Supplementary Material

Supplementary material accompanies this paper.

Supplementary Material 1 – Educator Guide and Simulation Case Specifications

Supplementary Material 2 – Mock Case Records and Patient Medical Documentation

This material is available as part of the online article from: https://doi.org/10.47066/2966-4837.e00422025en