

Effectiveness of Simulation-Based Training on Nursing Students' Clinical Competency in Managing Acute Heart Failure: A Quasi-Experimental Study

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Abstract

Background: Acute heart failure is a critical condition that requires nurses to recognize patient deterioration, prioritize interventions, and provide timely and appropriate care. Simulation-based training provides nursing students with a safe environment to develop and practice clinical skills before encountering similar situations in real clinical settings. **Objective:** To determine the effectiveness of simulation-based training on nursing students' clinical competency in managing acute heart failure. **Methodology:** A quasi-experimental one-group pre-test and post-test design was conducted among 50 seventh-semester Generic BSN nursing students enrolled in Critical Care Nursing at a selected nursing institution in Karachi, Pakistan. Total enumeration sampling was used. Students participated in a structured acute heart failure simulation followed by a debriefing session. Clinical competency was assessed before and after the intervention using a structured competency checklist covering patient assessment,

recognition of acute heart failure, ABC prioritization, oxygenation, fluid balance, recognition of deterioration, communication and teamwork, and evaluation of patient response. Data were analyzed using SPSS version 27, and a paired-samples t-test was used to determine the difference between pre-test and post-test scores. **Results:** The

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mean clinical competency score increased from 51.84 ± 8.72 in the pre-test to 78.26 ± 7.15 in the post-test, with a mean improvement of 26.42 points. The difference was statistically significant ($p < 0.001$). **Conclusion:** Simulation-based training significantly improved nursing students' clinical competency in managing acute heart failure. Incorporating structured simulation and debriefing into undergraduate nursing education may enhance students' clinical preparedness, decision-making, and ability to respond effectively to acute cardiac emergencies.

Introduction

Heart failure (HF) is a complex cardiovascular condition characterized by the inability of the heart to pump sufficient blood to meet the body's metabolic requirements. Patients with acute heart failure may experience rapidly changing clinical conditions, including dyspnea, pulmonary congestion, hypoxemia, tachycardia, hypotension, and altered mental status, requiring timely assessment and appropriate nursing interventions (1). Nurses play a central role in recognizing clinical deterioration, monitoring vital signs, assessing respiratory and cardiovascular status, initiating appropriate interventions, and evaluating patients' responses to treatment. Therefore, nursing students need adequate clinical knowledge, critical thinking, decision-making skills, and psychomotor competence to safely manage patients experiencing acute heart failure. Simulation-based education provides an opportunity to develop these competencies in a controlled and safe learning environment before students encounter critically ill patients in clinical practice (2). Traditional clinical education may not always provide nursing students with sufficient opportunities to manage high-risk and rapidly deteriorating cardiac patients. Variations in clinical exposure, limited availability of suitable patients, concerns regarding patient safety, and restricted opportunities for repeated practice can affect students' preparation for complex clinical situations (3). Simulation-based learning can address these limitations by allowing students to repeatedly practice assessment, clinical reasoning, prioritization, communication, and intervention skills without placing actual patients at risk (3,4). Evidence from systematic reviews and meta-analyses indicates that simulation-based learning can improve nursing students' knowledge, clinical skills, self-confidence, and other learning outcomes (3,6). High-fidelity simulation is particularly useful for cardiovascular emergencies because it can reproduce realistic clinical changes and require students to respond to evolving patient conditions. Through realistic scenarios, students can assess a patient, identify abnormal clinical findings, prioritize nursing interventions, communicate with healthcare team members, and evaluate the effectiveness of their interventions. High-fidelity simulation has been associated with improved clinical reasoning and decision-making among undergraduate nursing students, particularly when scenarios involve situation awareness, teamwork, and repeated exposure to clinical problems (5,6). Importantly, recent evidence specifically supports simulation for heart-failure nursing education. Nwokocha et al. conducted a study involving prelicensure nursing students and found that heart-failure high-fidelity simulation based on the NLN Jeffries Simulation Framework significantly improved students' heart-failure clinical knowledge and self-efficacy after the intervention. The simulation incorporated realistic patient-care situations, problem-solving, student support, fidelity, and debriefing, while emphasizing patient safety, patient-centered care, and teamwork (7). More recent research has also demonstrated that simulation can strengthen nursing students' clinical competence, while contemporary work involving virtual simulation has highlighted its potential for developing clinical reasoning when caring for patients with heart failure (8,9). Simulation-based education is also supported by broader evidence showing positive effects on nursing students' clinical competency. A 2024 randomized controlled trial found beneficial effects of simulation-based education on undergraduate nursing students' competencies, while another quasi-experimental study demonstrated

improvements in clinical competence and self-efficacy following simulation-based education (4,10). Furthermore, scenario-based simulation has been shown to improve students' professional knowledge, clinical practice skills, and self-confidence, supporting its use for complex clinical situations that may be difficult to encounter consistently during routine clinical placements (11). Despite the growing evidence supporting simulation-based education, there remains a need for context-specific research examining students' **actual clinical competency in managing acute heart failure**, particularly within undergraduate nursing education. Therefore, the present quasi-experimental study aims to determine the **effectiveness of simulation-based training on nursing students' clinical competency in managing acute heart failure**. The findings may provide evidence for nursing educators regarding the integration of structured cardiac simulation scenarios into undergraduate nursing curricula and may contribute to improving students' preparedness for the safe and timely management of patients with acute cardiovascular deterioration.

Methodology:

A quasi-experimental one-group pre-test–post-test design was used to evaluate the effectiveness of simulation-based training on nursing students' clinical competency in managing acute heart failure. The study was conducted among 50 BSN nursing students enrolled in the seventh semester at a selected nursing institution in Karachi, Pakistan. The participants were studying Critical Care Nursing during the study period and were therefore selected because they had already received relevant theoretical knowledge regarding critically ill patients and cardiovascular emergencies. Total enumeration sampling was used, and all 50 eligible seventh-semester students were included in the study. Students were eligible if they were enrolled in the seventh semester of the BSN program, were studying Critical Care Nursing, had completed the relevant theoretical content, were available during the study period, and provided written informed consent. Students from other semesters, those who had previously received specialized cardiac or critical-care simulation training outside the regular curriculum, and those who were absent during any major stage of the study were excluded. The independent variable was simulation-based training on acute heart failure management, while the dependent variable was students' clinical competency in managing acute heart failure. Data were collected using a structured demographic information form and a clinical competency assessment checklist developed according to the objectives of the Critical Care Nursing course and essential nursing management principles for acute heart failure. The competency assessment included patient assessment, recognition of signs and symptoms of acute heart failure, assessment of airway, breathing and circulation, monitoring of vital signs and oxygen saturation, recognition of respiratory distress and pulmonary congestion, appropriate oxygen therapy, patient positioning, intravenous therapy and medication safety, fluid-balance monitoring, recognition of clinical deterioration, communication with the healthcare team, and evaluation and documentation of the patient's response to interventions. Before the intervention, all participants completed a baseline pre-test assessment of their clinical competency. Following the pre-test, students participated in a structured simulation-based training session involving a realistic acute heart failure scenario in which the simulated patient presented with progressive dyspnea, tachypnea, reduced oxygen saturation, tachycardia, elevated blood pressure, pulmonary crackles, and signs of fluid overload. During the simulation, students were required to perform systematic assessment, identify abnormal clinical findings, prioritize nursing interventions, provide appropriate supportive care, monitor the patient's condition, recognize clinical deterioration, communicate with the healthcare team, and evaluate the patient's response to treatment. After completion of the simulation, a structured debriefing session was conducted in which the facilitator discussed students' clinical decisions, strengths, errors, missed interventions,

prioritization, communication, and patient-safety practices. Following the simulation and debriefing, students underwent a post-intervention competency assessment using the same standardized assessment criteria. The pre-test and post-test scores were compared to determine the effectiveness of the simulation-based training. Data were entered and analyzed using IBM SPSS Statistics version 27. Frequencies, percentages, means, and standard deviations were used to summarize the data, while a paired-samples t-test was applied to compare the mean pre-test and post-test competency scores. A p-value of <0.05 was considered statistically significant. Ethical approval was obtained from the relevant institutional ethical/research committee before data collection, and formal permission was obtained from the concerned nursing institution and academic authorities. Participation was voluntary, and written informed consent was obtained from all participants after explaining the study purpose, procedures, potential benefits, and their right to withdraw at any stage without academic penalty. Confidentiality and privacy were maintained throughout the study by using unique identification codes instead of students' names. The collected data were used solely for research purposes and were securely maintained. Students were informed that their research participation and assessment scores would not affect their academic grades or course evaluation. The simulation was conducted in an educational setting without involving real patients, and all participants were treated equally and respectfully throughout the study. Standardized simulation instructions, learning objectives, assessment criteria, and evaluation procedures were used for all participants to ensure consistency and minimize assessment bias.

Result:

A total of **50 seventh-semester Generic BSN nursing students** participated in the study. The majority of participants were male (**34, 68.0%**), while **16 (32.0%)** were female. Regarding age, half of the participants (**25, 50.0%**) were between 23–24 years, followed by **14 (28.0%)** participants aged 21–22 years and **11 (22.0%)** aged 25–26 years. All participants were enrolled in the **7th semester of the Generic BSN program** and were studying Critical Care Nursing during the study period. The demographic characteristics of the participants are presented in **Table 1**.

Table 1. Demographic Characteristics of Nursing Students (n=50)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	34	68.0
	Female	16	32.0
Age	21–22 years	14	28.0
	23–24 years	25	50.0
	25–26 years	11	22.0
Educational Level	Generic BSN, 7th Semester	50	100.0
Current Course	Critical Care Nursing	50	100.0

The comparison of clinical competency scores before and after the simulation-based intervention showed a substantial improvement among the participants. The mean pre-test clinical competency score was **51.84 ± 8.72**, which increased to **78.26 ± 7.15** following the simulation-based training. The mean difference between pre-test and post-test scores was **26.42 points**. A paired-samples t-test demonstrated that the improvement was statistically significant (**p < 0.001**), indicating that simulation-based training significantly improved students' clinical competency in managing acute heart failure. These findings are presented in **Table 2**.

Table 2. Comparison of Pre-Test and Post-Test Clinical Competency Scores (n=50)

Assessment	Mean	SD	Mean Difference	p-value
Pre-test	51.84	8.72	—	
Post-test	78.26	7.15	26.42	<0.001

The distribution of students according to their level of clinical competency also demonstrated considerable improvement following the intervention. Before simulation-based training, **18 (36.0%)** students demonstrated poor competency, while **25 (50.0%)** had moderate competency and only **7 (14.0%)** demonstrated good competency. No participant achieved an excellent competency level during the pre-test. Following the intervention, the number of students with poor competency decreased to **2 (4.0%)**, whereas **12 (24.0%)** demonstrated moderate competency. The proportion of students with good competency increased to **27 (54.0%)**, and **9 (18.0%)** students achieved an excellent competency level. The competency categories before and after the intervention are presented in **Table 3**.

Table 3. Categorization of Clinical Competency Before and After Simulation-Based Training (n=50)

Competency Level	Pre-Test n (%)	Post-Test n (%)
Poor	18 (36.0%)	2 (4.0%)
Moderate	25 (50.0%)	12 (24.0%)
Good	7 (14.0%)	27 (54.0%)
Excellent	0 (0.0%)	9 (18.0%)
Total	50 (100%)	50 (100%)

The domain-wise assessment further showed improvement in all major areas of acute heart failure management. The mean score for initial patient assessment increased from **6.12 ± 1.31** in the pre-test to **8.42 ± 1.02** in the post-test. Recognition of acute heart failure increased from **5.76 ± 1.42** to **8.18 ± 1.05**, while ABC assessment and prioritization improved from **5.34 ± 1.51** to **8.06 ± 1.12**. Similarly, oxygenation and respiratory management, fluid-balance monitoring, recognition of clinical deterioration, communication and teamwork, and evaluation of patient response all demonstrated higher post-test scores. The domain-wise competency findings are presented in **Table 4**.

Table 4. Domain-Wise Clinical Competency Scores Before and After the Intervention (n=50)

Clinical Competency Domain	Pre-Test Mean ± SD	Post-Test Mean ± SD
Initial patient assessment	6.12 ± 1.31	8.42 ± 1.02
Recognition of acute heart failure	5.76 ± 1.42	8.18 ± 1.05
ABC assessment and prioritization	5.34 ± 1.51	8.06 ± 1.12
Oxygenation and respiratory management	5.21 ± 1.37	8.25 ± 1.08
Fluid balance monitoring	4.98 ± 1.44	7.64 ± 1.21
Recognition of clinical deterioration	4.72 ± 1.56	7.86 ± 1.17
Communication and teamwork	5.41 ± 1.29	8.14 ± 1.09
Evaluation of patient response	4.30 ± 1.48	7.71 ± 1.26

Overall, the results demonstrated a clear improvement in clinical competency following simulation-based training, with statistically significant improvement in the overall pre-test and post-test scores (Table 2) and a marked shift from poor/moderate competency toward good/excellent competency levels (Table 3).

Discussion

The present study demonstrated that simulation-based training significantly improved the clinical competency of seventh-semester Generic BSN nursing students in managing acute heart failure. The mean competency score increased from **51.84 ± 8.72 in the pre-test to 78.26 ± 7.15 in the post-test**, with a mean difference of 26.42 points and a statistically significant improvement (**p < 0.001**). These findings were consistent with a 2024 quasi-experimental study conducted among 65 BSN students in the United Arab Emirates, in which high-fidelity simulation produced a significant improvement in clinical competence and more than half of the students achieved a high level of competency after the intervention. The authors concluded that high-fidelity simulation was useful for achieving clinical learning outcomes and preparing students for clinical practice (12). The present findings were also comparable with the results of a quasi-experimental study that evaluated simulation-based case studies among undergraduate nursing students. That study reported that students who participated in simulation-based case learning demonstrated better knowledge acquisition and clinical judgment than students receiving traditional classroom teaching (13). Similarly, the current study showed improvement in students' ability to assess the simulated patient, identify abnormal findings, prioritize interventions, and respond to clinical deterioration following simulation training. The similarity may be explained by the fact that both approaches provided students with realistic clinical situations requiring them to integrate theoretical knowledge with practical decision-making rather than simply recalling information from lectures. The improvement observed in the present study was further supported by international evidence concerning simulation-based clinical decision-making. A 2024 systematic review and meta-analysis found that simulation-based learning improved undergraduate nursing students' clinical decision-making skills and was particularly useful for exposing students to situations that might not be consistently encountered during routine clinical placements (14). This finding was similar to the present study because acute heart failure can deteriorate rapidly, and students may have limited opportunities to independently manage such patients during their clinical rotations. Simulation therefore provided a controlled environment in which students could repeatedly practice assessment, prioritization, intervention, and evaluation without compromising patient safety. The present study also demonstrated a marked shift in competency categories. Before the intervention, **36.0% of students had poor competency and 50.0% had moderate competency**, whereas after simulation-based training only **4.0% remained in the poor category**, while **54.0% achieved good competency and 18.0% achieved excellent competency**. These findings were similar to a randomized controlled study comparing different simulation approaches among undergraduate nursing students, which found that high-fidelity simulation improved critical thinking, clinical skills, communication, and other competencies compared with lower-fidelity approaches (15). The similarity suggests that realistic simulation may provide students with sufficient opportunities to integrate cognitive, psychomotor, and communication skills during complex patient-care situations. The findings regarding clinical performance were also supported by a quasi-experimental study from Saudi Arabia that examined the impact of high-fidelity simulation exposure on nursing students' OSCE performance. Students who received high-fidelity simulation in addition to clinical training achieved higher OSCE scores than students who received clinical training without the additional simulation exposure. The study reported a significant difference between groups, indicating that simulation exposure enhanced objective clinical performance (16). This finding was comparable with the present study, in which students' clinical competency was assessed through performance-based criteria rather than relying exclusively on theoretical knowledge. The use of an objective competency assessment in both studies strengthens the interpretation that simulation can improve observable clinical performance. Another important finding

of the present study was improvement across individual competency domains, including initial assessment, recognition of acute heart failure, ABC prioritization, oxygenation and respiratory management, fluid-balance monitoring, recognition of deterioration, communication, and evaluation of patient response. Similar improvements have been reported in international research examining structured simulation and debriefing. A 2024 randomized controlled trial from South Korea found that collaborative reflection-based debriefing following simulation significantly improved students' knowledge, problem-solving skills, self-confidence in clinical decision-making, reflective thinking, and satisfaction compared with standard approaches (17). This was similar to the present study because structured debriefing was incorporated after the acute heart failure simulation, allowing students to reflect on their decisions, identify missed interventions, and understand appropriate clinical priorities. However, not all evidence has demonstrated that one specific simulation strategy is superior to another. A quasi-experimental study comparing PEARLS debriefing with standard debriefing found no significant between-group difference in self-reported professional competence or clinical judgment, although professional competence and clinical judgment increased significantly within the PEARLS intervention group (18). This finding was partly in contrast to the present study because the current research demonstrated a statistically significant overall improvement after the complete simulation-based intervention. The difference may be related to variations in study design, outcome measurement, intervention structure, and the specific competency domains assessed. The present study focused specifically on acute heart failure management and used a pre-test/post-test performance assessment, whereas the comparison study primarily evaluated differences between two debriefing approaches. The current findings were also consistent with a 2023 quasi-experimental study from Spain that evaluated high-fidelity simulation among undergraduate nursing students. The study found significant improvements in students' evidence-based practice knowledge and skills following simulation training (19). Although the outcome in that study was evidence-based practice competency rather than acute heart failure management, the findings support the broader educational value of simulation for developing higher-level clinical competencies. In the present study, students similarly had to interpret clinical information, connect assessment findings with the patient's condition, and select appropriate nursing interventions rather than simply reproduce previously learned information. Recent evidence has further supported the role of simulation in developing nursing students' clinical competency. A 2025 study examining simulation-based laboratory training reported improvements in undergraduate nursing students' clinical skills, satisfaction, and self-confidence, while a 2025 mixed-methods study among undergraduate nursing students also identified positive relationships between simulation-based learning, clinical competence, self-confidence, and satisfaction (20). These findings were broadly similar to the present study, particularly regarding improvement in clinical performance following simulation. However, the present research differed by focusing specifically on **acute heart failure management** and by evaluating competency through a structured pre-test/post-test approach among seventh-semester BSN students who were studying Critical Care Nursing. This disease-specific focus may have provided a more targeted assessment of students' ability to manage a clinically complex cardiovascular condition.

Conclusion

The study concluded that simulation-based training was an effective educational strategy for improving nursing students' clinical competency in managing acute heart failure. The findings demonstrated a significant improvement in students' overall competency after the simulation intervention, particularly in patient assessment, recognition of acute heart failure, ABC prioritization, oxygenation and respiratory

management, fluid balance, recognition of deterioration, communication and teamwork, and evaluation of patient response. These findings indicate that structured simulation with debriefing can effectively bridge the gap between theoretical knowledge and clinical practice and enhance students' preparedness to manage acute cardiac emergencies.

Recommendations

It is recommended that simulation-based training should be regularly incorporated into undergraduate nursing education, particularly within Critical Care Nursing courses. Nursing institutions should provide structured acute heart failure scenarios, standardized competency checklists, and effective debriefing sessions to strengthen students' clinical reasoning and decision-making skills. Faculty should receive appropriate training to conduct and evaluate simulation activities, while institutions should ensure adequate simulation equipment and facilities. Future studies should include larger samples, control groups, and follow-up assessments to determine the long-term effectiveness and retention of simulation-based clinical competency.

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