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Simulation-Based Training vs. Traditional Bedside Teaching: An RCT on Clinical Skills Acquisition

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Abstract

Clinical skills acquisition is a cornerstone of medical education, traditionally imparted through bedside teaching (BT). However, the increasing complexity of medical practice and the imperative for patient safety have catalyzed the integration of simulation-based training (SBT) into medical curricula. This randomized controlled trial (RCT) aimed to compare the efficacy of SBT versus traditional BT in enhancing clinical skills among medical students.

A total of 120 2nd -year medical students were randomly assigned to either the SBT group (n = 60) or the BT group (n = 60) at Al Aleem Medical College. The SBT group engaged in high-fidelity simulations encompassing scenarios such as myocardial infarction and reactive airways disease, facilitated by experienced clinical educators. The BT group participated in conventional bedside teaching sessions in hospital wards under faculty supervision. Clinical skills were assessed using Objective Structured Clinical Examinations (OSCEs) at baseline, post-intervention (week 8), and at a three-month follow-up.

Post-intervention analysis revealed that the SBT group exhibited a significant improvement in OSCE scores, with a mean increase from 62.5 ± 8.3 to 81.3 ± 7.9 ($p < 0.001$). In contrast, the BT group demonstrated a modest enhancement, with scores rising from 61.8 ± 8.1 to 71.1 ± 8.5 ($p = 0.002$). The between-group difference was statistically significant ($p < 0.001$). Additionally, self-reported confidence levels in clinical skills escalated by 35% in the SBT group, compared to an 18% increase in the BT group ($p = 0.002$). At the three-month follow-up, the SBT group maintained higher OSCE scores, although the intergroup disparity slightly diminished.

These findings underscore that SBT is more effective than traditional BT in augmenting clinical skills and confidence among medical students. The structured and immersive nature of SBT offers a safe environment for repetitive practice and immediate feedback, thereby enhancing learning outcomes. Integrating SBT alongside traditional BT could optimize medical education by balancing theoretical knowledge with practical proficiency. Future research should explore the long-term retention of skills acquired through SBT and its impact on patient care outcomes.

Keywords: Simulation-based training, Bedside teaching, Clinical skills acquisition

Introduction

The acquisition of clinical skills is fundamental to medical education, serving as the bedrock upon which competent and safe patient care is built. Traditionally, bedside teaching (BT) has been the primary modality for imparting these skills, offering students direct patient interactions under the mentorship of experienced clinicians. This method not only facilitates the development of technical competencies but also fosters the cultivation of professional attributes such as empathy and communication. However, the evolving landscape of healthcare, characterized by increased patient acuity, reduced hospital stays, and heightened emphasis on patient safety, has necessitated the exploration of alternative educational strategies. Simulation-based training (SBT) has emerged as a prominent pedagogical approach, providing a controlled and risk-free environment for learners to practice and refine their clinical skills.[1-5]

Simulation in medical education encompasses a spectrum of modalities, ranging from low-fidelity task trainers to high-fidelity mannequins and virtual reality platforms. These tools enable the replication of clinical scenarios with varying degrees of complexity, allowing students to engage in deliberate practice without compromising patient safety. The immersive nature of SBT facilitates experiential learning, where learners can apply theoretical knowledge to simulated clinical situations, receive immediate feedback, and reflect on their performance. This iterative process aligns with Kolb's experiential learning theory, which posits that knowledge is constructed through the transformation of experience.[6-8]

Several studies have investigated the efficacy of SBT in medical education. A randomized controlled trial by Wayne et al. demonstrated that residents trained using high-fidelity simulation exhibited superior advanced cardiac life support (ACLS) performance compared to those receiving traditional education. Similarly, a meta-analysis by Cook et al. reported that simulation-based interventions were associated with large effects on knowledge, skills, and behaviors, as well as moderate effects on patient-related outcomes. These findings suggest that SBT can enhance clinical competencies effectively; however, the extent to which it surpasses traditional BT remains a subject of ongoing debate.[9-12]

The integration of SBT into medical curricula also addresses several challenges inherent to traditional BT. The variability in clinical exposure, limited opportunities for hands-on practice, and the unpredictable nature of clinical environments can impede the consistent acquisition of essential skills. Simulation offers a standardized platform where specific learning objectives can be targeted, and scenarios can be tailored to the learner's level of proficiency. Moreover, the opportunity for repetitive practice in a safe setting allows students to achieve mastery learning, a concept emphasizing the attainment of a high level of competence before progressing to more advanced tasks.[13-14]

Despite the purported advantages of SBT, its implementation is not without challenges. Resource intensiveness, including the need for specialized equipment, trained personnel, and dedicated space, can pose significant barriers, particularly in resource-constrained settings. Additionally, the fidelity of simulation—defined as the degree to which it accurately replicates real-life scenarios—can influence its effectiveness. High-fidelity simulations, while more immersive, are also more costly and complex to administer. Therefore, it is essential to evaluate the cost-benefit ratio of SBT and determine the optimal balance between fidelity and educational outcomes.

Furthermore, the impact of SBT on non-technical skills, such as communication, teamwork, and decision-making, warrants consideration. These competencies are integral to effective clinical practice and have been linked to improved patient outcomes. Simulation provides a unique platform to cultivate these skills through interprofessional education and team-based scenarios. For instance, a study by Robertson et al. found that simulation-based team training led to significant improvements in team communication and adherence to safety protocols in obstetric emergencies.[15]

In light of the evolving educational landscape and the growing body of evidence supporting SBT, it is imperative to conduct rigorous evaluations comparing its effectiveness to traditional BT. Such studies should employ robust methodological designs, including randomized controlled trials, to generate high-quality evidence that can inform curriculum development and educational policies. Moreover, the perspectives of learners and educators regarding the acceptability and perceived value of SBT should be explored to facilitate its seamless integration into existing educational frameworks.

This randomized controlled trial (RCT) aims to compare the effectiveness of simulation-based training versus traditional bedside teaching in enhancing clinical skills acquisition among medical students. By assessing objective measures of clinical competence and subjective perceptions of confidence, this study seeks to elucidate the relative merits of each educational approach and provide insights into optimizing medical education strategies.

Methodology

This randomized controlled trial was conducted at Al Aleem Medical College to compare the effectiveness of simulation-based training (SBT) and traditional bedside teaching (BT) in enhancing clinical skills among 2nd year medical students. Ethical approval was obtained from the Institutional Review Board (IRB), and verbal informed consent was secured from all participants prior to enrollment.

A total of 120 medical students were recruited and randomly assigned to either the SBT group (n = 60) or the BT group (n = 60). Randomization was performed using a computer-generated sequence to ensure allocation concealment. The sample size was calculated using Epi Info software, considering an expected effect size of 0.5, a power of 80%, and a significance level of 0.05, resulting in 50 participants per group. To account for potential dropouts, the sample size was increased by 20%, totaling 60 participants per group.

Inclusion criteria encompassed 2nd year medical students and exclusion criteria included prior exposure to formal simulation training, previous completion of an Objective Structured Clinical Examination (OSCE) within six months, and inability to participate due to scheduling conflicts.

The SBT group underwent eight weeks of structured simulation-based training using high-fidelity mannequins and standardized patients. Each session focused on core clinical scenarios, including cardiac arrest management, respiratory distress, and neurological examination. Training was conducted in small groups under the supervision of experienced faculty members and incorporated immediate feedback and debriefing. The BT group participated in traditional bedside teaching sessions in hospital wards, where they observed and performed clinical assessments on real patients under the guidance of attending physicians.

Clinical skill acquisition was assessed at three time points: baseline (week 0), post-intervention (week 8), and three-month follow-up (week 20). OSCEs were used as the primary outcome measure, consisting of ten stations evaluating history-taking, physical examination, procedural skills, and clinical reasoning. Each station was scored using standardized checklists by blinded evaluators. Secondary outcomes included self-reported confidence in clinical skills, measured using a validated questionnaire, and students' perceptions of training effectiveness.

Results

Table 1: Baseline Demographic Characteristics of Participants

Characteristic	SBT Group (n = 60)	BT Group (n = 60)	p-value
Mean Age (years)	23.2 ± 1.4	23.5 ± 1.3	0.44
Gender (M/F)	30/30	28/32	0.67
Prior Clinical Training (months)	4.1 ± 0.8	4.0 ± 0.7	0.56
Pre-Intervention OSCE Score	62.5 ± 8.3	61.8 ± 8.1	0.72

There were no statistically significant differences in baseline characteristics between groups, ensuring comparability at study entry.

Table 2: Comparison of OSCE Scores Between Groups

Timepoint	SBT Group (Mean ± SD)	BT Group (Mean ± SD)	p-value
Baseline	62.5 ± 8.3	61.8 ± 8.1	0.72
Post-Intervention	81.3 ± 7.9	71.1 ± 8.5	<0.001
Three-Month Follow-up	79.5 ± 8.1	69.4 ± 8.7	0.002

Post-intervention, the SBT group exhibited significantly greater improvement in OSCE scores compared to the BT group ($p < 0.001$). Although both groups showed skill retention at follow-up, the SBT group maintained a higher level of proficiency ($p = 0.002$).

Table 3: Self-Reported Confidence in Clinical Skills

Timepoint	SBT Group (Mean % Increase)	BT Group (Mean % Increase)	p-value
Baseline	0%	0%	-
Post-Intervention	35%	18%	0.002
Three-Month Follow-up	30%	15%	0.009

Self-reported confidence in clinical skills improved significantly more in the SBT group than in the BT group, both post-intervention and at follow-up ($p < 0.01$).

Discussion

The findings of this RCT highlight the superior efficacy of simulation-based training over traditional bedside teaching in clinical skill acquisition among medical students. The significantly greater improvement in OSCE scores in the SBT group underscores the advantages of simulation-based methods in structured skill development. These results align with recent studies demonstrating the effectiveness of simulation in medical education. A meta-analysis conducted in 2023 reported that students trained using high-fidelity simulation scored significantly higher in clinical assessments compared to those trained through conventional bedside methods[16].

The enhanced performance observed in the SBT group can be attributed to the controlled environment of simulation training, which allows for repetitive practice, immediate feedback, and deliberate error correction. Unlike bedside teaching, where clinical exposure is variable and dependent on patient availability, simulation provides a standardized learning experience. Studies have indicated that repeated exposure to simulation scenarios significantly improves skill retention and reduces procedural errors in real clinical settings.[17]

Additionally, the marked improvement in self-reported confidence among students in the SBT group suggests that simulation training fosters a sense of preparedness and competence. Confidence in clinical skills is a critical determinant of performance, influencing decision-making and patient interactions. Research has shown that higher confidence levels correlate with improved diagnostic accuracy and procedural success rates. The results of this study align with findings from previous trials, which reported that medical students trained with simulation-based modules exhibited greater self-efficacy and preparedness for clinical rotations compared to their counterparts receiving traditional training.[18-21]

Importantly, the sustained superiority of SBT at the three-month follow-up suggests that simulation facilitates better long-term retention of clinical skills. The principle of spaced learning, which is inherently integrated into simulation-based training, has been well-documented in cognitive psychology and medical education research. Spaced practice enhances memory consolidation and retrieval, leading to durable learning outcomes. In contrast, bedside teaching, although invaluable for real-patient interaction, lacks the structured reinforcement necessary for optimal skill retention.[22-25]

Despite these advantages, the integration of simulation-based training into medical education poses logistical and financial challenges. High-fidelity simulators are resource-intensive, requiring substantial investment in equipment, faculty training, and maintenance. A cost-effectiveness analysis is warranted to determine the feasibility of widespread adoption, particularly in resource-limited settings. However, considering the demonstrated benefits of simulation in improving patient safety and reducing medical errors, the long-term return on investment may outweigh the initial costs.

Future research should explore the impact of combining simulation-based training with bedside teaching to maximize learning outcomes. A hybrid model that integrates both methods could leverage the strengths of simulation in skill acquisition while retaining the benefits of real-patient encounters. Moreover, longitudinal studies assessing the translation of simulation-based skills into actual clinical practice and patient outcomes would provide valuable insights into its real-world efficacy.

Conclusion

This randomized controlled trial provides compelling evidence that simulation-based training is superior to traditional bedside teaching in enhancing clinical skills and confidence among medical students. The findings underscore the need for integrating simulation into medical curricula to optimize learning outcomes. Future studies should investigate hybrid training models and assess long-term impacts on clinical competency and patient care.

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