Comparison of Hybrid-Simulation-Based Teaching with Traditional Teaching of Pharmacology

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ABSTRACT

Objective: To compare the outcome of traditional teaching with hybrid simulation-based teaching for undergraduate medical students.
Place and Duration of the Study: Department of Pharmacology, Jinnah Medical and Dental College, Karachi, Pakistan, from June to August 2023.
Study Design: Quasi-experimental study.
Methodology: One hundred students from MBBS 3rd year were included in the study after taking the informed consent. Participants were divided into two cross-over groups and sampling was done randomly. Group A: (even roll numbers, n = 50) was the control group, taught by traditional lecture on positive inotropic medicines. Group B: (with odd roll numbers, n = 50) was the intervention group, taught the same topic by simulation-based teaching through 5 case scenarios. The teaching of this group was reinforced by role plays. Scores of post-test and retention test were compared by applying the Student's t-test.
Results: Students taught by traditional lectures i.e., Group A, their post-test mean scores were 30.7 ± 5.6, whereas Group B scored 45.7 ± 3.3, taught by hybrid stimulation ($p < 0.001$). Retention test (MCQs based) was conducted after one month in which Group A obtained a mean score of 18.8 ± 9 with a passing percentage of approximately 30, whereas Group B obtained a score of 41.3 ± 5.6 ($p < 0.001$).
Conclusion: Hybrid-simulation-based teaching improved the immediate test scores as well as retention.

Key Words: *Traditional teaching, Hybrid-simulation, MCQs, Retention test, Intervention group.*

How to cite this article: Khan SP, Usmani A, Khan A. Comparison of Hybrid-Simulation-Based Teaching with Traditional Teaching of Pharmacology. *J Coll Physicians Surg Pak* 2024; **34(08)**:963-967.

INTRODUCTION

Hybrid-simulation is a teaching method in which more than one intervention is applied for the learner to have better understanding and retention of the topic, such as the use of trained simulation and scenario along with traditional lecture. Traditional teaching in pharmacology has been mostly memorisation or rote learning. Students learn the names and side effects of medicines without correlation to clinical scenarios. Pharmacology is a highly volatile subject, and understanding and retention of it is crucial for undergraduate medical students. The basic intent of teaching pharmacology to undergraduate students is to give them the knowledge of pharmacokinetics, pharmacodynamics, and toxicology, which they can apply in their future clinical practices.[1]

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Received: January 13, 2024; Revised: May 18, 2024; Accepted: June 26, 2024
DOI: https://doi.org/10.29271/jcpsp.2024.08.963

Instructions on how to manage patient condition, evaluated by vital signs and physical assessment, and drug efficacy and safety are essential for future clinicians. Therefore, undergraduate medical students should gain knowledge of pharmacology including the combination of basic concepts along with clinical applications to improve the quality of patient care.[1,2] In order to achieve this, innovative teaching, modality of simulation-based teaching needs to be integrated into the learning of pharmacology. It is an active learning process; thus, it should be used besides other teaching methods in medical schools to overcome the problems of using actual patients due to ethical issues and legal rights of patients. In this context, simulation-based teaching creates a clinical experience without exposing real patients to any discomfort, for patient-centred care. Thus, in a controlled environment, the mechanism of action, clinical uses, and adverse effects of drugs can be taught in preclinical years. Globally, simulation-based teaching is being incorporated as a part of the medical curriculum to improve the knowledge and skills on the subject without exposing the real patients to any difficulty and allowing the simulation teaching to fill the gap by playing the role of a real patient.[3,4] There are many methods of simulation that can be classified as hybrid-simulation teaching (in which scenario and human simulation such as role-play and standardised patient are useful tools) or non-human simulation such as mannequins and computer-based simulation.[4,5] Simula-

tion-based training has great potential and use throughout healthcare education, from undergraduate up to continuous medical education (CME). It can also be used to improve the knowledge and skills of healthcare providers in different disciplines from novices to experts.[5,6] Hybrid-simulation teaching is the use of two or more simulation modalities (scenarios and trained simulators) used in teaching pharmacology.[7,8] Hybrid-simulation approach may provide colleges and universities with limited budget, a less expensive option for better clinical training.[9] In hybrid-simulation-based teaching, usage of trained simulators along with instructions by use of well-developed scenarios provide students the real-life events of typical diseases or symptoms and treatment with feedback and debriefing.[9,10] Studies have shown that simulation-based teaching has improved knowledge, confidence, and performance of medical students in clinical rotation.[10,11] Problem-solving MCQs made by trained faculty of department and reviewed by other specialists increase the cognitive level and testing validity and reliability.[12]

Most of the Pakistani medical institutes employ traditional teaching and have not adopted simulation-based teaching. Various institutions globally use simulation-based teaching of pharmacology and have reported better outcomes and improvement in the clinical application of knowledge in a challenging subject like pharmacology. The purpose of this study was to compare hybrid-simulation teaching with traditional teaching in improvement of learning, retention, and clinical application of knowledge of pharmacology for undergraduate medical students.

METHODOLOGY

One hundred students from MBBS 3rd year of Jinnah Medical and Dental College, Karachi, Pakistan were included in the study, after taking their informed consent. Participants were divided into two cross-over groups and sampling was done non-randomly. The recruited students were divided into 2 groups by their even and odd roll numbers. Since they are MBBS 3rd year students, they had some prior knowledge of inotropic agents and actions from the pre-clinical autonomic module.

Group A were 50 students with even roll numbers (control group) and they were taught by a conventional 55 minutes' lecture on inotropes by a professor and a senior lecturer from the Department of Pharmacology. Group B were 50 students with odd roll numbers (intervention group) and they were taught the same topic by simulation-based teaching by 5 case scenarios and role-play, depicting the different conditions requiring inotropes' uses, mechanism of action, and adverse effects. Case 1: Drugs used for cardiogenic shock, Case 2: Drugs for septic shock treatment, Case 3: Tachyarrhythmia, Case 4: Digoxin toxicity, and Case 5: Adverse effects of positive inotropic agents.

To ensure the validity and reliability of the scenarios and MCQs test, these scenarios and MCQs were prepared by pharmacology professors and reviewed by cardiologists, physicians, gynaecologists / obstetricians as well as a medical educationist. The scenarios were prepared based on standardised guidelines. Each group of 10 students were rotated among the 5 case-based scenario stations with trained simulation (role-play) for the diagnosis of clinical diseases and these students were asked to correlate the signs and symptoms enacted by the simulated patient to diagnose the condition and to select the appropriate inotropic medicine to be prescribed for this clinical condition. Each group of 10 students were then rotated for different 5 case scenarios. After the session, both Group A and Group B were given MCQs post-test and their test scores were recorded. To assess retention in the memory of the topics taught by two different teaching modalities, an MCQ retention test of the same questions was taken 4 weeks after the initial teaching session. Scores of both tests were recorded. Each MCQ was of 5 marks, total paper of 50 marks was given to the students with no negative marking. Each question marked correctly was given 5 marks and for any wrong answer, no marks were given.

Group A was labelled as a control group and Group B was labelled as an intervention group. Both groups were given 10 MCQs (5 C_2 and 5 C_3 levels). Intervention group (Simulation-task trained patients and scenarios prepared on standardised guidelines and reviewed by subject specialists). Simulation-based teaching was supervised by trained faculty. The control group was given a conventional lecture only on positive inotropics for 55 minutes. Both groups were tested with 10 MCQs (5 C_2 and 5 C_3 levels). MCQs test was repeated after one month without prior preparation time, in order to compare retention scores in both groups. Initially, the traditional lecture of (55 minutes) by a pharmacology professor was given to both groups (n = 100), each simulated patient was trained to perform according to the given scenario. Students of both the groups, the lecture only (Group A) and hybrid-simulation teaching (Group B) were given the same 10 MCQs based post-test (5 marks for each MCQ, out of a total score of 50 marks). The retention test was conducted without any prior information for comparing scores of both groups by the participant undergraduate students of MBBS 3rd year. Scenarios were carefully prepared and trained simulations were given real-life cases of different types of shocks and management options. Trained-simulated patients were to present a lifestyle performance to enhance the understanding of the students and the prescription of inotropic medicines as per case. All the scores were recorded. The post-test and retention-test scores of both groups were compared.

The study design was quantitative (Quasi-experimental design): Students' test scores of both groups were collected for quantitative data analysis.

All the data collected were entered on SPSS 25. Categorical variables were expressed as mean ± SD and percentages. Mean (SD) were obtained by descriptive analysis. Inferential statistical analysis was performed by applying the Student's t-test to compare the post-test and retention scores of both groups. A p-value <0.05 was considered significant.

RESULTS

A total of hundred medical students, the age range of these students was 21-23 years (Table I). Total marks were out of 50 (5 marks for each MCQ). Post-test: Group (A) students included in the study were taught by the traditional method; marks obtained were in the range of (10-35). Group (B) students were taught by hybrid-simulation methods and the marks obtained by them were in the range of (40-50). All the 50 (100%) students in group B taught by the hybrid-stimulation method obtained satisfactory scores (Table I).

The retention test was taken after one month. In group (A), only 30 (60%) students obtained qualifying marks, while in group (B) all 50 (100%) students got satisfactory scores. The score ranges of the students in the two groups are tabulated in Table II.

Table I: Characteristics of both groups of students participating in the study.

Variables n = 100	Traditional teaching Group A (n = 50)	Hybrid simulation-based teaching Group B (n = 50)	p-value*
Gender			0.000
Female	27 (54%)	30 (60%)	
Male	23 (46%)	20 (40%)	
Age (years)	Mean ± SD 21.3 ± 0.6	Mean ± SD 21.2 ± 0.5	0.000
Post-test (out of 50 marks) Pass marks-30	Mean ± SD 30.7 ± 5.6	Mean ± SD 45.7 ± 3.3	0.000
30 days' post-session scores-retention (60% pass marks)	Mean ± SD 18.8 ± 9	Mean ± SD 41.3 ± 5.6	0.000

**Student's t-test was applied. The p-value <0.05 was considered significant.*

Table II: Retention-test scores in each group after one month.

Score ranges MCQs - test Total - 50 marks (MCQ - 5 marks each)	Traditional teaching (control) - Group A n = 50 (%)	Hybrid–stimulation (intervention) - Group B n = 50 (%)
0-25	20 (40%)	0 (0%)
30	20 (40%)	30 (60%)
Cut-off pass marks		
40-50	10 (20%)	20 (40%)
Total pass (%)	30 (60%)	50 (100%)

DISCUSSION

In this study, teaching pharmacology with a hybrid-simulation-based method was found to be more effective with significantly better retention of knowledge and skills by the students compared to traditional teaching methods. Retention test scores were (100%) satisfactory in hybrid-simulation teaching Group B, as compared to traditional teaching (30%) satisfactory in Group A. Also, the interest was greatly enhanced in Group B along with competitively better understanding than in the traditional Group A.

Simulation-based medical education (SBME) trained students to attain better understanding, remembering, and acquiring clinical skills without exposing real patients to unnecessary risk or discomfort.[11,12] Multiple choice questions are the most commonly used and valuable assessment tools for the formative and summative assessment of knowledge in medical students, provided they are well-constructed.[12,13] MCQs are highly a beneficial assessment tool by which large amount of knowledge can be tested in a short time.[13,14]

Simulation-based teaching has also a good application for the teaching skills in emergency medicine training programmes where residents are expected to demonstrate proficiency in the management of time-critical, low-frequency, and highly-morbidity conditions.[15-17] Hybrid-stimulation teaching is a combination of scenarios and the simulators trained to perform according to the scenario, to understand the application of mechanism of action, usage, and adverse effects of inotropic drugs used for various types of shocks (e.g., anaphylactic, septic or cardiogenic shocks). According to the scenarios the medical student can pick the most appropriate option. Thus, this method is active learning which enhances proper understanding and not just memorisation of the topic. Studies have been carried out reporting low- and high-fidelity simulation teaching, having impact of gaining better knowledge and clinical skills. Although high-fidelity mannequins are closer to real life nevertheless they are costly.[18-21] Hybrid-simulation-based teaching being the most cost-effective, could be more appropriate in developing countries.[22,23] Another study was carried out to teach and assess the retention of opioid overdose and the management by intranasal administration of naloxone to overcome toxic effects by the use of trained human simulators. It has also shown improvement in skills and retention of the use of medicines, such as opioids for pain management in post-surgical patients, to the undergraduate medical students, and nursing staff.[18] The simulation-based teaching has provided medical education a realistic standardised, real-life learning experience in a controlled environment without causing harm or discomfort to real patients, leading to an increase in the popularity of simulation-based teaching curricula in medical education. A number of studies done by simulation-based teaching of undergraduate medical students is a recommended option for better understanding and gaining knowledge of pharmacology, patient-safety, and retaining the knowledge with improved clinical application.[19-24] Different simulation modalities including mannequins, standardised patients, virtual patients and high-fidelity simulation-based teaching are being used to enhance learning and retention in the medical undergraduates.[15-19]

Thus, hybrid-simulation based teaching has proved to be a beneficial method of the teaching of pharmacology in developing countries where cost is of great concern. Thus, study done on hybrid-simulation-based teaching for undergraduate medical students is a recommended for better understanding and gaining knowledge of pharmacology, patient safety, and retaining the knowledge of pharmacology with improved understanding of the clinical applications. It has been reported in the study done on simulation-based module training in pharmacology, in doctor-patient communication which showed improvement in writing prescriptions, during and even a few days after the module in undergraduate medical students' performance. Medical undergraduates were provided eight clin-

ical scenarios for simulation-based learning (SBL) of pharmacology.[21] They filled in the questionnaire at the end of the session, which showed overall satisfaction (94%), instant feedback (94%), exposure to rare scenarios (86%), improvement in decision-making, communication, patient safety and skills (89%), reduced dependence on real patient training (73%), emergency training (88%). Thus, learning pharmacology was more interesting (80%) with better retention and recalling.

A pharmacology course was developed for the teaching neuromuscular blockers, the pharmacokinetics, and pharmacodynamics and the use of neostigmine as its antidote for respiratory paralysis.[23] High-fidelity simulation, and computer-based or mannequin-based, are active learning strategies which facilitate in understanding the concepts of pharmacology better than passive learning by traditional lecture.[24] Mannequin-based learning helps remove the gap in knowledge between theory and practice. A study was conducted on simulation-based teaching of pharmacology by mannequin-based stimulation in healthcare training in medical school undergraduates and graduate.[24] The studies support the inclusion of simulation-based teaching for improved retention and understanding of pharmacology.[20-24] Simulation-based teaching may be classified as human (trained simulation) or non-human (mannequins). Specific steps must be taken to get successful applications and better outcomes from these novel teaching methods. The limitations of the study are that the simulators were newly trained and hybrid-simulation teaching method was new for most of the staff and faculty. Also, as these students were promoted to the next class, the retention test could not be delayed for more than four weeks.

CONCLUSION

Teaching pharmacology with hybrid-simulation resulted in better scores and retention among students as compared to the traditional lectures. Thus, hybrid-simulation may be a highly effective tool in teaching and retention of pharmacology.

ETHICAL APPROVAL:

To conduct this study, approval was taken by the Ethical Review Committee, University Protocol #:000294123.

STUDENTS' CONSENT:

Informed consent was taken from all the students of MBBS 3rd year, Jinnah Medical and Dental College, Karachi, Pakistan.

COMPETING INTEREST:

The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:

SPK: Synopsis writing, study design, writing of the manuscript, acquisition analysis and interpretation of data, and writing of the final manuscript.

AU, AK: Synopsis preparation, study design, extensive review, and writing of the final manuscript.

All authors approved the final version of the manuscript to be published.

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