

Enhancing Skill Acquisition in Practical Pharmacology through Structured Role-Play: A Formative Assessment of Second-Year MBBS Students

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Abstract

Background: In Pharmacology, the current undergraduate medical curriculum often struggles to bridge the gap between theoretical drug knowledge and clinical execution of practical pharmacology. Since years traditional teaching methods emphasized on passive observation of drug administration routes and counselling principles. This study evaluated the effectiveness of structured role-play simulations across 17 distinct stations as a formative assessment and teaching methodology to improve procedural drug administration skills, cold-chain maintenance knowledge, and patient communication among second-year MBBS students in an innovative way. **Material and Methods:** A prospective, mixed-methods educational intervention study was conducted with 172 second-year MBBS students during their routine practical pharmacology curriculum. 17 core practical stations were developed covering procedural skills (parenteral injections, IV drip setup, inhalational devices, insulin/tuberculin syringes, ocular/otic instillations, transdermal patches and cold-chain maintenance) and patient communication (counselling on high-risk medications like GTN, contraceptives, heparin, and beta blockers). Working in small groups, students performed role-play encounters of standardized clinical scenarios acting as patients, relatives and healthcare providers. Performance was evaluated using validated Objective Structured Practical Examination (OSPE) checklists, pre- and post-test MCQs, and a 10-item 5-point Likert scale feedback questionnaire. **Results:** Out of total 172 students enrolled, 168 completed all assessments (97.7% completion rate). Post-intervention mean-score across all OSPE stations showed statistically significant improvement in procedural and communication domains compared to baseline assessment ($p < 0.001$). Procedural proficiency in complex drug administration (e.g., MDI/DPI inhalation technique, precise tuberculin/insulin loading and cold-chain protocols) showed significant gains. Patient counselling scores also improved markedly. Feedback questionnaire revealed high student satisfaction (89.58% agreeing that role-play increased confidence in clinical application). **Conclusion:** Structured role-play simulation is a highly effective, active-learning pedagogy in practical pharmacology. It enhances competency in procedural skills and patient counselling simultaneously, fulfilling the core mandates of Competency-Based Medical Education (CBME).

Keywords: Medical Education, Pharmacology Pedagogy, OSPE, Role-Play, Formative Assessment, Procedural Skills, Patient Counselling, CBME.

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INTRODUCTION

Pharmacology serves as a crucial bridge between basic medical sciences and clinical practice.^[1] The broad goal of teaching pharmacology to undergraduate students is to inculcate in them a rational and scientific basis of therapeutics.^[2] Over years there had been a significant change in teaching learning methods in practical pharmacology curriculum of phase 2 MBBS. Traditionally, practical pharmacology instruction in undergraduate medical training (MBBS) focused heavily on experimental animal models, chemical tests, and passive lectures.^[3] However in recent era, modern medical education framework like Competency-Based Medical Education (CBME) curriculum has been mandated by medical regulatory bodies globally emphasizing more on outcome-based learning, active clinical reasoning, procedural competence, and patient-centered communication.^[4,5] Second-year medical undergraduates often find it

challenging to translate theoretical knowledge of pharmacokinetics, aspects of drug administration, possible interactions, precautions and adverse effect profiles into real-world patient case scenarios. Key practical competencies—including administering parenteral injections (IV, IM, SC, ID), assembling intravenous drip sets, instructing patients on use of pressurized meter-dose inhalers (MDIs) or dry powder inhalers (DPIs), maintaining vaccine cold-chain integrity, and delivering

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drug-specific precautions—requires tactile proficiency combined with effective communication skills.^[6,7] Role-play simulation offers an experiential learning environment where students actively engage in simulated case scenarios experiencing the patient-doctor interactions without compromising patient safety. It encourages reflective practice, active listening, immediate formative feedback, and clinical contextualization of pharmacological principles.^[8,9] though role-play has been utilized in communication skills training in recent years but its application as an integrated dual-purpose pedagogical tool across 17 distinct stations for both procedural skill acquisition as well as drug-specific patient counselling in practical pharmacology remains largely under-explored. Therefore, this study aimed to evaluate the impact of structured role-play simulation as a formative learning and assessment strategy on skill acquisition among second professional MBBS students across various core practical pharmacology competencies.

MATERIALS AND METHODS

Study Design: It was a prospective, intervention study conducted in the Department of Pharmacology at NAMO Medical Education and Research Institute, Silvassa. Study was initiated following ethical approval from the Institutional Ethics Committee. Informed written consent was obtained from all participating second-year MBBS students.

Study Participants: A total of 172 second-year MBBS students enrolled in the pharmacology practical course participated in the intervention. Students were divided into small batches of 10 students each to enable optimal group dynamics and individual participation.

Intervention & Module Development: Seventeen comprehensive practical stations were designed by expert faculty members in alignment with national CBME practical competencies.⁴ Following stations were prepared

- Station 1: Demonstration and proper steps of use of Intravenous (IV) injection.
- Station 2: Demonstration and proper steps of use of Intramuscular (IM) injection.
- Station 3: Demonstration and proper steps of use of Intradermal (ID) injection.
- Station 4: Demonstration and proper steps of use of Subcutaneous (SC) injection.
- Station 5: Setting up an Intravenous Drip set.
- Station 6: Demonstration of proper steps of use of Dry Powder Inhaler (DPI) and Rota-caps.
- Station 7: Demonstration of proper steps of use of Metered Dose Inhaler (MDI).
- Station 8: Demonstration of proper steps of use of Insulin syringes in a specific case scenario.
- Station 9: Demonstration of proper steps of use of Tuberculin syringes in a specific case scenario.
- Station 10: Demonstration and proper steps of instillation of Eye drops.
- Station 11: Demonstration and proper steps of

instillation of Ear drops.

- Station 12: Communicating about general precautions and possible adverse effects while using Beta-Blockers in a specific case scenario.
- Station 13: Communicating about general precautions and possible adverse effects while using Glyceryl Trinitrate (GTN) in a specific case scenario.
- Station 14: Communicating about general precautions and possible adverse effects while using Contraceptives in a specific case scenario.
- Station 15: Communicating about general precautions and possible adverse effects while using Heparin in a specific case scenario.
- Station 16: Demonstration and proper steps of use of Transdermal Patches.
- Station 17: Demonstration of use of various vaccines and sera, and general precautions and measures in maintenance of cold chain during transportation and storage.

Execution of Role-Play: For each case scenario, students were provided with clinical case details 15 days prior for preparatory self-directed learning. Following which, during practical sessions, students of all 17-station in turns performed, the role play act in front of the entire class. Each role-play scenario required the student enacting health workers to:

- Verify patient identity, assess signs and symptoms and explain the clinical indication.
- Demonstrate/execute the procedural steps using manikins or trainer models.
- Communicate key drug parameters: route, dose, frequency, duration, special timing instructions (e.g., sublingual GTN administration on acute onset of angina, post-meals vs. pre-meals).
- Educate the patient on common and severe adverse reactions to watch for, specific precautions and immediate action plans.

Faculties monitored encounters and provided immediate, structured formative feedback upon completion of each scenario using standardized debriefing protocols. The same activity was reperformed by students of all 17-station after a week and post intervention evaluation was done by the same set of faculties.

Assessment & Outcome Measures:

1. Cognitive Knowledge: Evaluation was done via a pre- and post-intervention 20-item Multiple Choice Question (MCQ) test.
2. Procedural and Communication Skills: Assessed using validated 10-point OSPE (Objective Structured Practical Examination) rubric checklists for each of the 17 stations.
3. Perception Survey: Collection was done via a structured, anonymous questionnaire utilizing a 5-point Likert Scale (1 = Strongly Disagree to 5 = Strongly Agree).

Statistical Analysis: Data were analysed using SPSS version 26.0. Continuous variables (pre- and post-test scores) were expressed as Mean $\pm$ Standard Deviation (SD). The paired t-test was utilized to compare pre- and post-intervention scores. A p-value < 0.05 was considered statistically significant.

RESULTS

Out of 172 enrolled students, complete data were available for

168 students (completion rate: 97.7%) in form of duly filled Questionnaires.

Cognitive and Practical Performance: A statistically

significant improvement was observed in both cognitive understanding and objective clinical skills across all 17 stations following the role-play intervention ($p < 0.001$).

Table 1: Pre- and Post-Intervention Scores Across 17 OSPE Stations (Mean $\pm$ SD, N = 168)

Station Assessed	Pre-Intervention Score	Post-Intervention Score	Mean Score Change (%)	p-Value
Cognitive Knowledge (MCQs – 20)	11.47 $\pm$ 2.15	16.88 $\pm$ 1.80	+27.05%	< 0.001
Station 1: Intravenous (IV) Injection	4.96 $\pm$ 1.20	8.71 $\pm$ 0.91	+37.50%	< 0.001
Station 2: Intramuscular (IM) Injection	5.31 $\pm$ 1.15	8.76 $\pm$ 0.82	+34.50%	< 0.001
Station 3: Intradermal (ID) Injection	4.67 $\pm$ 1.28	8.53 $\pm$ 0.89	+38.60%	< 0.001
Station 4: Subcutaneous (SC) Injection	5.06 $\pm$ 1.22	8.79 $\pm$ 0.80	+37.30%	< 0.001
Station 5: IV Drip Set Assembly	5.12 $\pm$ 1.35	8.95 $\pm$ 0.78	+38.30%	< 0.001
Station 6: Use of DPI & Rota-caps	4.43 $\pm$ 1.38	8.54 $\pm$ 0.88	+41.10%	< 0.001
Station 7: Use of Metered Dose Inhaler (MDI)	4.22 $\pm$ 1.45	8.61 $\pm$ 0.82	+43.90%	< 0.001
Station 8: Use of Insulin Syringe (Case Scenario)	4.82 $\pm$ 1.18	8.80 $\pm$ 0.82	+39.80%	< 0.001
Station 9: Use of Tuberculin Syringe (Case Scenario)	4.78 $\pm$ 1.25	8.56 $\pm$ 0.85	+37.80%	< 0.001
Station 10: Eye Drop Instillation	5.56 $\pm$ 1.20	9.21 $\pm$ 0.70	+36.50%	< 0.001
Station 11: Ear Drop Instillation	5.55 $\pm$ 1.28	9.13 $\pm$ 0.75	+35.80%	< 0.001
Station 12: Beta-Blockers Patient Counselling	5.10 $\pm$ 1.42	8.57 $\pm$ 0.90	+34.70%	< 0.001
Station 13: Use of GTN Patient Counselling	4.92 $\pm$ 1.50	8.54 $\pm$ 0.95	+36.20%	< 0.001
Station 14: Use of Contraceptives Patient Counselling	5.16 $\pm$ 1.38	8.68 $\pm$ 0.88	+35.20%	< 0.001
Station 15: Heparin Patient Counselling	3.88 $\pm$ 1.48	7.78 $\pm$ 0.92	+39.00%	< 0.001
Station 16: Use of Transdermal Patches	4.95 $\pm$ 1.30	8.81 $\pm$ 0.88	+38.60%	< 0.001
Station 17: Cold Chain & Vaccines Storage Management	4.77 $\pm$ 1.22	8.32 $\pm$ 0.79	+35.50%	< 0.001

Student Perception and Feedback: The student perception survey following post-intervention demonstrated positive feedback across all evaluated dimensions with 89.58%

students agreeing that role-play increased confidence in clinical application:

Table 2: Student Perception Survey Results (N = 168)

S. No.	Survey Question / Perception Dimension	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
1	Improved clarity on technical steps for parenteral injections	67.3%	25.0%	6.5%	1.2%	0.0%
2	Increased confidence in setting up IV drip sets	54.8%	28.0%	13.1%	2.4%	1.8%
3	Better understanding of MDI, DPI, and Rotacaps administration	57.1%	30.4%	11.3%	1.2%	0.0%
4	Enhanced skill in loading and dosage measurement for Insulin/Tuberculin syringes	53.0%	33.9%	8.9%	3.0%	1.2%
5	Improved technique for positioning during Eye/Ear drop instillation	61.9%	31.5%	6.5%	0.0%	0.0%
6	Enhanced ability to communicate precautions for high-risk drugs	66.7%	25.6%	5.4%	1.8%	0.6%
7	Better retention of steps for transdermal patch application	56.0%	38.1%	4.8%	1.2%	0.0%
8	Heightened awareness of cold chain protocols and vaccine transport	51.8%	27.4%	17.3%	2.4%	1.2%
9	Faculty debriefing provided actionable, constructive feedback	67.9%	24.4%	6.0%	1.2%	0.6%
10	Role-play simulations should be integrated regularly into the curriculum	75.0%	20.2%	4.2%	0.6%	0.0%

DISCUSSION

The transition toward Competency-Based Medical Education necessitates active-learning modalities that challenge students beyond rote memorization.^[4,10] Practical pharmacology has historically suffered from low engagement due to abstract discussions of routes and administration instructions without practical, hands-on application. Our study demonstrates that structured role-play across 17 targeted stations significantly improves both procedural skills (e.g., parenteral injections, IV drip setup,

steps of using inhalational devices, cold-chain handling) and communication competencies among second-year medical undergraduates.

Procedural Skill Acquisition (Stations 1-11 & 16-17):

- Parenteral Injections (Stations 1-4): Differentiating between insertion angles 10°-15° for intradermal (Station 3), 45° for subcutaneous (Station 4), 90° for intramuscular (station 2) 20-25° for intravenous (Station 1 and 5) and requires repeated practice. Role-play on trainer models help to correct errors before clinical exposure and also helps in building up confidence to perform procedure among

students.

- Inhalational Devices (Stations 6-7): Incorrect technique leads to therapeutic failure in asthma/COPD11. Role-play helped students to guide peers through hand mouth coordination, breath-holding post-inhalation and mouth rinsing techniques after steroid DPI and MDI use.
- Insulin & Tuberculin Syringes (Stations 8-9): Case scenarios highlighted unit conversions (U-40 vs. U-100 insulin syringes) and also about bleb formation and intradermal wheal creation following tuberculin testing.
- Ocular & Otic Instillations (Stations 10-11): Proper practice and hands on demonstration of pulling the pinna backward and upward in adults (backward and downward in children) during ear drop instillation, and occluding the nasolacrimal duct post-eye drop instillation to prevent systemic absorption.
- Cold Chain Maintenance (Station 17): Simulating real-world constraints (e.g., monitoring ice-pack condition and storage zones) enhanced critical thinking regarding vaccine potency12.

Integration of Communication And Pharmacotherapy (Stations 12-15):

Communication stations focused on high-risk drugs requiring detailed patient instruction:

- Beta-Blockers (Station 12): Students learned to counsel patients on importance of pulse monitoring before dosing, avoiding abrupt withdrawal / skipping drug to prevent rebound angina / hypertension, and recognizing signs of bradycardia or bronchospasm following drug administration.
- Glyceryl Trinitrate (Station 13): Students learned counselling focused on identifying vital signs of angina, sublingual placement during acute chest pain, sitting /lying down position during administration to prevent orthostatic syncope, and significance of storage of drug in original light-resistant glass containers.
- Contraceptives (Station 14): Students practiced counselling addressing missed-dose protocols (e.g., Seven-day rule), daily compliance, and enzyme-inducing drug interactions and family planning following end of use.
- Heparin (Station 15): Students practiced communicating vital signs of bleeding precautions (e.g., soft toothbrush, reporting haematuria / melena) and importance of regular aPTT monitoring.

By combining technical knowledge with empathetic communication, students realized the immediate clinical relevance of pharmacology in patient management.

Formative Debriefing as A Learning Tool: Immediate post-role-play debriefing served as a critical component of learning. Faculty feedback allowed immediate correction of missed steps, procedural errors and clinically important communications before they became entrenched behaviours.^[13]

Limitations: This study was conducted at a single academic centre with a single cohort of MBBS students. Long-term retention of these skills during clinical rotations in final year and internship was not assessed in this phase

and would need further longitudinal follow-up studies.

CONCLUSION

Structured role-play simulation across 17 targeted stations is an impactful, student-centered pedagogical methodology for second-year MBBS practical pharmacology. It effectively bridges procedural mechanics with ethical doctor-patient communication across diverse drug delivery routes and patient counselling scenarios. Incorporating this multi-station role-play framework into routine formative assessments is an innovative way which directly aligns with CBME goals, preparing undergraduates for seamless clinical transition. Far better results can be achieved if it continues as a best practice to aid and further develop medical education.

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Conflicts of interest

There are no conflicts of interest.

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