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Original Research Article

Objective Structured Clinical Examination (OSCE) as a Tool for Competency-Based Assessment in Undergraduate Pharmacology

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Abstract

Background: Competency-Based Medical Education (CBME) emphasizes outcome-oriented training and requires assessment methods that evaluate applied clinical competence rather than factual recall alone. Traditional assessment modalities in undergraduate pharmacology often fail to assess prescribing skills, clinical reasoning, and professional attitudes essential for safe medical practice. The Objective Structured Clinical Examination (OSCE) has emerged as a promising tool to address these limitations.

Objectives: To evaluate the effectiveness, reliability, and acceptability of OSCE in assessing undergraduate pharmacology competencies under the CBME framework and to compare OSCE performance with traditional assessment methods.

Materials and Methods: A prospective, cross-sectional analytical study was conducted among second-year MBBS students (n = 83) in the Department of Pharmacology at a tertiary care teaching institution. Ten competency-based OSCE stations were developed through blueprinting and standardization. OSCE scores were compared with theory examination and viva voce scores. Inter-rater reliability was assessed using the intraclass correlation coefficient (ICC), and student perceptions were collected through a structured questionnaire.

Results: The mean OSCE score was 67.2 ± 8.7. OSCE scores were significantly higher than theory examination scores ($p < 0.001$) and viva voce scores ($p = 0.03$). A moderate positive correlation was observed between OSCE and theory scores ($r = 0.59$, $p < 0.001$). Inter-rater reliability was excellent (ICC = 0.80). Most students perceived OSCE as fair, clinically relevant, and superior to traditional assessment methods.

Conclusion: OSCE is a reliable, valid, and CBME-aligned assessment tool for undergraduate pharmacology. Its routine integration into assessment programs is recommended to enhance evaluation of applied competence, rational prescribing, and patient safety.

Keywords: Objective Structured Clinical Examination; Competency-Based Medical Education; Pharmacology Education; Undergraduate Medical Assessment; Prescribing Skills; OSCE.

Introduction

In addition to measuring learning outcomes, assessment influences student learning behavior and curriculum priorities, making it a crucial part of medical education. Summative tests centered on theoretical knowledge and factual recall have historically played a major role in undergraduate medical education.

However, due to their incapacity to measure clinical performance, decision-making, and professional conduct in the actual world, these assessment techniques have come under growing criticism. Competency-Based Medical Education (CBME), an outcome-oriented approach that stresses the acquisition and demonstration of clearly defined competences required for effective medical practice, has emerged as a response to these limitations in medical education globally [1,2].

CBME focuses on the integrated development of knowledge, psychomotor skills, and professional attitudes, ensuring that learners are capable of applying theoretical understanding to authentic clinical situations. In India, the National Medical Commission (NMC) introduced CBME into the

undergraduate MBBS curriculum with the goal of producing Indian Medical Graduates who are clinically competent, ethically sound, and responsive to societal healthcare needs. This reform places strong emphasis on learner-centered education, early clinical exposure, and continuous formative assessment aligned with defined competencies [3,4].

As the cornerstone of logical treatments and patient safety, pharmacology plays a crucial role in undergraduate medical education. Pharmacology expertise is necessary for proper medication selection, dosage computation, avoiding hazardous drug reactions, and efficient patient communication. Pharmacology assessment has always depended on written exams and viva voce, which primarily measure the cognitive domain, despite its clinical importance. These approaches frequently fall short in evaluating clinical reasoning, ethical decision-making, applied prescription abilities, and communication—competencies that are specifically highlighted under CBME [5,6]. As a result, evaluation instruments that are capable of thoroughly and authentically evaluating pharmacological competencies are required.

The Objective Structured Clinical Examination (OSCE) has emerged as a structured, objective, and standardized assessment tool designed to evaluate performance-based competencies. OSCE involves a circuit of stations where students perform specific tasks under observation, allowing direct assessment at the “shows how” level of Miller’s pyramid of clinical competence. Through carefully designed scenarios and standardized checklists, OSCE enables simultaneous assessment of knowledge application (such as rational drug selection and identification of contraindications), skills (including prescription writing, dosage calculation, interpretation of drug-related information, and adverse drug reaction reporting), and attitudinal attributes (communication skills, professionalism, and ethical conduct) [7-9].

Numerous studies have shown that OSCE is more reliable, objective, and valid than traditional evaluation techniques, especially when it comes to assessing clinical and procedural abilities. Standardized scenarios provide consistency in assessment, while the use of organized checklists and qualified examiners reduces subjectivity and examiner bias. Additionally, OSCE offers chances for quick feedback, which promotes formative learning and continual improvement—two fundamental CBME tenets [10–12].

Within the CBME framework, OSCE is especially relevant to undergraduate pharmacology, as it mirrors real-world prescribing scenarios and encourages integration of basic pharmacological principles with clinical decision-making. Competencies such as rational prescribing, drug interaction management, adverse drug reaction reporting, and patient-centered communication are critical for safe medical practice and are inadequately assessed through conventional written examinations alone. Therefore, evaluating the effectiveness of OSCE as an assessment tool in undergraduate pharmacology is essential to determine its suitability for routine incorporation into CBME-aligned assessment strategies.

In this regard, the current study was conducted to evaluate the OSCE's efficacy in assessing undergraduate pharmacology competencies, investigate its objectivity and reliability, compare student performance with conventional evaluation techniques, and investigate its compatibility with CBME objectives. For curriculum designers and medical educators looking to improve assessment procedures in pharmacology education, the study's conclusions may offer insightful information.

Materials and Methods

Study Design and Approach: Objective Structured Clinical Examination (OSCE), which is part of the Competency-Based Medical Education (CBME) framework, was evaluated in this study by means of a prospective, cross-sectional analytical design with an embedded educational intervention. The research was conducted in the Department of Pharmacology of the Hind Institute of Medical Sciences in Barabanki, Uttar Pradesh, for 7 months (December 2024 to June 2025).

Ethical Considerations: Prior to the beginning of the study, the Institutional Ethics Committee of Hind Institute of Medical Sciences gave ethical clearance (UID: HIMS/ IHEC/2022-23/F. Each student had to obtain written informed consent before participating, and participation was voluntary. Students' identities and assessment scores were strictly kept confidential.

Study Population: Students in their second year of MBBS are enrolled in the pharmacology class। Total population sampling included 120 students.

Inclusion Criteria: 1) Undergraduate students enrolled in pharmacology courses. 2) Students who decided to participate after completing the pharmacology curriculum.

Exclusion Criteria: 1) On days of assessment, students are not present. 2) Students who refused to give permission.

Study Setting: The Pharmacology CAL LAB (Computer Assisted Learning Laboratory) and specific exam rooms on the college campus were used for the assessments. Standardized OSCE stations with resources and qualified assessors were established.

Development of OSCE Stations and Blueprinting: A competency-based assessment blueprint was designed aligning with the Pharmacology learning outcomes prescribed by the National Medical Commission (NMC). Competencies were mapped across:

- Knowledge: Rational drug prescription, mechanism of action.
- Skills: Interpretation of prescription, adverse drug reaction (ADR) identification.
- Attitude: Communication, ethical practice.

Station Construction

A total of 10 OSCE stations were developed covering domains of:

1. Prescription writing
2. Dosage calculation
3. Drug interaction management
4. Adverse drug reactions reporting
5. Rational antibiotic use
6. Case-based therapeutic decision making
7. Drug information interpretation
8. Communication with patient/caregiver
9. Interpretation of laboratory values relevant to pharmacology
10. Identification of drug contraindications

Each station was designed to assess a single competency and lasted 5 minutes.

Validation of Stations and Standardization: Six faculty members from the Pharmacology and Medical Education Unit evaluated the OSCE scenarios and checklists; face and content validity were established; ten non-participating students participated in pilot testing; and any necessary adjustments were performed.

Assessment Tools

Performance Checklists

Structured, task-specific checklists were used at each station. Checklists included:

- Objective items with binary scoring (Yes = 1; No = 0).
- Total score per station: 10 marks.
- Maximum score: 100 marks.

Global Rating Scale: Each station also included a 3-point global rating scale:

1. Needs improvement
2. Satisfactory
3. Excellent

Rater Training: Assessors were trained through a 2-hour standardization workshop focusing on:

- Use of checklists
- Scoring reliability
- Feedback delivery Inter-rater reliability was assessed using intraclass correlation (ICC) with a target ICC > 0.75.

Implementation of OSCE

Pre-OSCE Orientation

Students attended a 60-minute orientation session detailing:

- Purpose and format of OSCE
- Examination rules
- Sample stations demonstration

Assessment Protocol

1. Each student received a unique roll number.
2. Students spent five minutes at each station with a one-minute transition period as they moved through the stations in a circuit style.
3. Every station had uniform instructions.
4. Examiners evaluated each performance on their own.

Comparison with Traditional Assessment

OSCE scores were compared with:

- Internal assessment theory (short-answer and long-answer questions) marks
- Practical viva voce scores

This comparison aimed to evaluate the discriminatory ability of OSCE in identifying applied competence.

Student Perception Survey: Following the OSCE, students completed a structured feedback questionnaire evaluating:

- Clarity of stations
- Relevance to clinical practice
- Stress levels
- Perceived fairness and objectivity

Responses were recorded as percentage.

Data Collection Instruments

1. OSCE Score Sheets: Captured performance per station.

2. Written Examination Scores: Obtained from institutional records.

3. Structured Questionnaire: A validated questionnaire adapted from previous studies measured

Outcome Measures

Primary outcomes:

- Reliability and objectivity of OSCE
- Ability of OSCE to assess applied pharmacology skills

Secondary outcomes:

- Student satisfaction

- Alignment with CBME competencies

Data Management and Statistical Analysis: Microsoft Excel was used to enter quantitative data from OSCE and traditional written exams, which were then analyzed using the Statistical Package for the Social Sciences (SPSS). To describe student performance, descriptive statistics were calculated using continuous variables represented as mean, standard deviation (SD), and percentage. A paired Student's t-test was used to compare student performance on the OSCE and traditional written exams. Pearson's correlation coefficient (r) was used to evaluate the strength and direction of the relationship between OSCE scores and written examination scores. The Intraclass Correlation Coefficient (ICC) was used to measure the degree of agreement between examiners in order to evaluate the inter-rater reliability of OSCE grading. For all inferential analyses, a p-value of less than 0.05 was deemed statistically significant.

Results

Participant Recruitment and Exclusions: At first, 120 second-year MBBS students may take part in the study. Due to predetermined criteria, 37 students were eliminated from the final analysis throughout the recruitment and assessment process. Of these, seven students denied written informed consent, nine students failed to complete all OSCE stations, and twenty-one students were absent on the day of OSCE conduct.

Thus, 83 students, or 69.2% of the initially eligible cohort, were included in the final statistical analysis. To ensure data completeness, all included participants completed the OSCE, traditional evaluations, and post-OSCE feedback questionnaire.

Descriptive Statistics of OSCE Performance

The 83 participants' total OSCE results showed that their pharmacology competence were satisfactorily attained.

- Mean OSCE score: 67.2
- Standard deviation: 8.7
- Median score: 68
- Interquartile range (IQR): 61–73
- Minimum score: 44
- Maximum score: 84

The coefficient of variation (CV) was 12.9%, indicating acceptable dispersion of scores and good discriminatory capacity of the assessment.

Performance Categorization Based on Global Rating Scale

Using the global rating scale applied across OSCE stations:

- **Excellent performance:** 18 students (21.7%)
- **Satisfactory performance:** 51 students (61.4%)
- **Needs improvement:** 14 students (16.9%)
- Nearly one-fourth of students showed advanced applied pharmacology skills, while the majority attained at least a decent level of competence.

Station-wise Detailed Performance Analysis: Performance across individual OSCE stations showed variability depending on the complexity and nature of the competency assessed (Table 1).

Table 1: Station-wise OSCE Performance (n = 83)

Station	Competency Domain	Mean ± SD	% Students scoring ≥7
1	Prescription writing	7.5 ± 1.3	78.3
2	Dosage calculation	6.8 ± 1.7	63.9
3	Drug interaction management	6.3 ± 1.5	54.2
4	ADR reporting	7.0 ± 1.4	70.0
5	Rational antibiotic use	6.7 ± 1.6	61.4
6	Case-based therapeutics	6.4 ± 1.5	56.6
7	Drug information interpretation	7.2 ± 1.2	74.7
8	Communication skills	7.8 ± 1.1	82.0
9	Lab value interpretation	6.1 ± 1.4	49.4
10	Contraindication identification	6.6 ± 1.3	60.2

Effective training in attitude and fundamental prescribing abilities was demonstrated by the highest accomplishment in communication skills, prescription writing, and drug information interpretation. Drug interaction management, case-based therapy, and laboratory value interpretation all regularly had lower grades, indicating areas that needed curriculum reinforcement.

Comparison with Conventional Assessment Modalities: The mean scores obtained in different assessment methods are summarized below (Table 2).

Table 2: Comparison of OSCE with Traditional Assessments (n = 83)

Assessment Method	Mean ± SD	Mean Difference (OSCE – Method)	p-value
OSCE	67.2 ± 8.7	—	—
Theory examination	61.0 ± 9.1	+6.2	< 0.001
Practical viva voce	64.1 ± 8.4	+3.1	0.03

OSCE results were significantly higher than both theory and viva voce scores, according to paired t-test analysis, indicating that OSCE is better at evaluating clinical reasoning and applied knowledge than rote memorization.

Correlation Analysis: OSCE scores and theory exam scores showed a somewhat favorable link, according to Pearson's correlation analysis:

- Correlation coefficient (r): 0.59
- Coefficient of determination (r^2): 0.35
- p-value: < 0.001

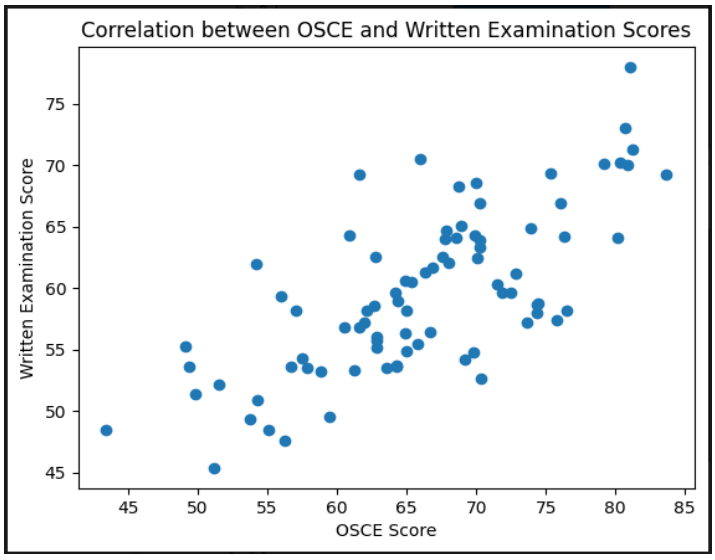

Figure 1: Correlation between OSCE and Written Examination Scores

This suggests that theory examination performance could account for around 35% of the variance in OSCE scores, with the remaining variance reflecting skill-based and attitudinal skills that OSCE specifically captures (Figure 1).

Score Distribution and Graphical Interpretation

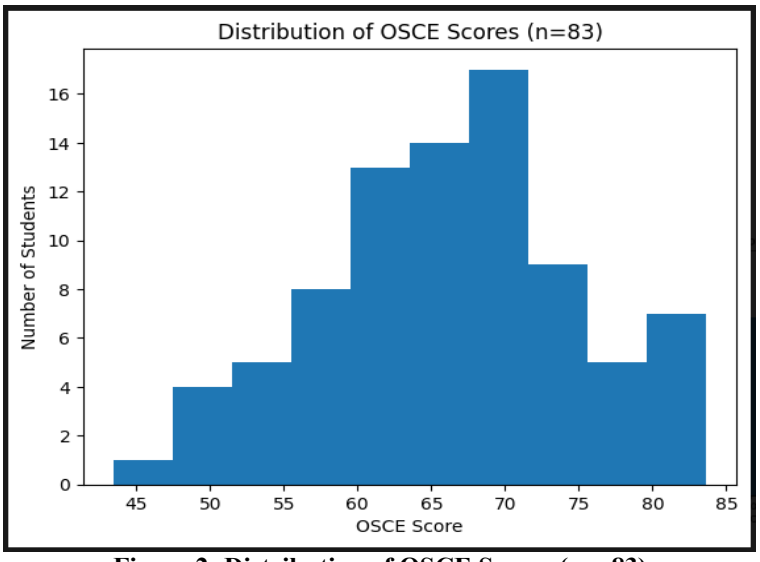

Figure 2: Distribution of OSCE Scores (n = 83)

Due to a tiny percentage of underachievers, the OSCE score histogram showed a nearly normal distribution with a slight left skewness. This demonstrates that the OSCE successfully distinguished between high, average, and low performers without causing score clustering. Further demonstrating the complementing significance of OSCE in evaluating competencies beyond cognitive knowledge alone, the scatter plot comparing OSCE and written examination scores exhibited a linear rising trend (Figure 2).

Inter-Rater Reliability: Inter-rater reliability analysis using the intraclass correlation coefficient showed:

- ICC: 0.80
- 95% CI: 0.74–0.85

This value indicates excellent agreement among examiners and confirms the objectivity and reproducibility of OSCE scoring following rater training and checklist standardization.

Student Perception Analysis

Analysis of student feedback revealed high acceptability of OSCE:

- OSCE reflected real clinical scenarios: 86.7%
- Assessment was fair and unbiased: 91.6%
- Better assessment than viva voce: 88.0%
- Helped identify learning gaps: 84.3%
- Reported higher stress levels: 44.6%

Despite moderate stress perception, 81.9% of students recommended routine integration of OSCE into pharmacology assessments.

Alignment with CBME Competencies

OSCE effectively assessed multiple domains simultaneously:

- **Knowledge:** Rational drug selection, contraindications
- **Skills:** Prescription writing, dosage calculation, ADR reporting
- **Attitude:** Communication, ethical decision-making

This multidimensional assessment demonstrated strong alignment with CBME objectives, which are inadequately addressed by traditional assessment formats alone.

Discussion

Within the context of Competency-Based Medical Education (CBME), the current study methodically assessed the efficacy of the Objective Structured Clinical Examination (OSCE) as a competency-based assessment instrument in undergraduate pharmacology.

The results show that, in comparison to traditional theory exams and viva voce, OSCE offers a more thorough, dependable, and educationally significant evaluation of pharmacology competencies.

OSCE and Competency-Based Assessment in Pharmacology: CBME places a strong emphasis on outcome-oriented education, requiring students to exhibit quantifiable skills necessary for actual clinical practice. Assessment techniques must go beyond factual knowledge to assess applied clinical skills and professional attitudes because pharmacology plays a crucial role in determining prescribing behavior, patient safety, and reasonable therapies. When placed in realistic, task-oriented circumstances, the majority of students were able to integrate pharmacological knowledge with clinical reasoning, according to the study's satisfactory overall OSCE performance. These results support the idea that OSCE, which allows for direct competency observation rather than deduction from written responses, is in line with CBME standards.[13, 14].

Interpretation of Overall and Station-Wise Performance: The OSCE score distribution showed a strong ability to distinguish between high, moderate, and low performers. Any assessment tool should have this functionality, especially in competency-based curricula where decisions about advancement may be based on demonstrated performance. The comparatively high results in drug information interpretation, prescription writing, and communication skills show that the basic talents that are frequently stressed during pharmacology instruction have been successfully acquired.

The complexity of these competences, which call for higher-order cognitive processing and the integration of multidisciplinary information, is reflected in lower performance in laboratory value interpretation, drug interaction management, and case-based therapeutic decision-making.

Previous research has shown that students struggle to apply pharmacological concepts in dynamic clinical settings [15].The OSCE's significance as a diagnostic assessment tool is highlighted by its capacity to identify such domain-specific shortcomings, allowing educators to pinpoint areas in need of targeted remediation and curricular reinforcement.

OSCE versus Traditional Assessment Modalities: The basic distinction between performance-based and recall-based evaluation systems is highlighted by the substantially higher OSCE results when compared to theory and viva voce exams. While the OSCE assesses the application of knowledge in real-world situations, written exams mostly examine cognitive knowledge at the lower levels of Miller's pyramid. Although a solid knowledge base is required for

competent performance, it is insufficient to guarantee clinical competence on its own, according to the study's moderately favorable connection between OSCE and theory scores.

This result is consistent with modern assessment theory, which promotes the use of several complimentary assessment instruments to capture various aspects of competence. Thus, OSCE is an essential supplement to conventional evaluations, especially in pharmacology, where adverse drug responses and prescription errors continue to be major causes of patient harm.[16, 17].

Reliability, Objectivity, and Assessment Quality: When supported by suitable blueprinting, organized checklists, and examiner training, OSCE can be a highly objective and repeatable assessment procedure, as demonstrated by the study's good inter-rater reliability (ICC = 0.80).

Performance-based exams sometimes raise concerns about reliability, however data consistently demonstrates that OSCE reliability increases with more stations, standardized scoring tools, and rater calibration [18].

By capturing both procedural correctness and overall clinical competence, the use of both binary checklists and global rating scales improved assessment validity. Recognizing that expert judgment is crucial for assessing complex professional behaviors that cannot be fully captured by checklist scoring alone, our mixed method mirrors current best practices in medical education assessment [18].

Student Perception and Educational Impact: Student perception is a critical determinant of the educational impact of assessment. The high proportion of students perceiving OSCE as fair, unbiased, and clinically relevant indicates strong acceptability of this assessment format.

Although a moderate level of stress was reported, this is consistent with prior studies suggesting that authentic, performance-based assessments naturally induce stress due to direct observation and time constraints. Importantly, such stress is often perceived as constructive when learners recognize the relevance of assessment to real-life clinical responsibilities [19].

Moreover, the majority of students recommended routine incorporation of OSCE into pharmacology assessments, suggesting that OSCE not only evaluates competence but also enhances learner engagement and self-reflection. By highlighting individual learning gaps, OSCE promotes self-directed learning—an essential attribute of lifelong professional development.

Alignment with CBME Outcomes and Indian Medical Graduate Attributes: This study shows that OSCE's good agreement with CBME outcomes and the characteristics of Indian medical graduates is one of its main advantages. OSCE operationalizes the comprehensive goal of CBME by concurrently evaluating knowledge (rational drug selection, contraindications), skills (prescription writing, dosage calculation, ADR reporting), and attitudes (communication, ethical decision-making).

The ability of traditional assessment formats to evaluate professionalism and patient-centered communication—competencies that are widely acknowledged as essential for safe and efficient medical practice—is intrinsically limited. Because of its multifaceted assessment capabilities, OSCE is especially pertinent to undergraduate pharmacology education in India, where the shift to CBME calls for reliable, genuine evaluation methods [17,20].

Limitations and Future Directions: The study has some shortcomings despite its advantages. External validity may be limited by the single-institution design, and OSCE's resource-intensive character may make widespread deployment logistically difficult. Furthermore, neither the long-term retention of competences nor the OSCE's predictive validity for actual prescribing behavior during internship were evaluated in this study. To determine if OSCE performance is correlated with actual clinical outcomes, such as prescribing accuracy and patient safety indicators, future research should concentrate on multicentric studies with longitudinal follow-up. Competency evaluation in pharmacology education may be strengthened by incorporating OSCE into a programmatic assessment framework and supplementing it with workplace-based assessments.

Conclusion

This study shows that within the Competency-Based Medical Education (CBME) framework, the Objective Structured Clinical Examination (OSCE) is an effective, dependable, and competency-aligned tool for undergraduate pharmacology assessment. OSCE allowed direct evaluation of applied pharmacological knowledge, prescribing skills, clinical reasoning, and communication skills, which were not adequately evaluated by conventional viva voce and theory examinations. The observed reliability and positive student perceptions support OSCE's credibility as an assessment method. OSCE also demonstrated strong alignment with CBME results and the expected competencies of the Indian Medical Graduate. As a result, it is recommended that OSCE be routinely integrated into undergraduate pharmacology assessment as part of a

programmatic assessment strategy in order to improve rational prescribing and patient safety.

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