ASSESSMENT OF CLINICAL KNOWLEDGE GAPS AMONG PHARM.D INTERNS DURING THEIR FIRST HOSPITAL ROTATIONS

Original Article

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Short Title: Clinical Knowledge Gaps in Pharm.D Interns

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Abstract

Background: Clinical pharmacy education aims to equip Pharm.D students with the knowledge and skills required for evidence-based patient care. However, during initial hospital rotations, interns often encounter real-world clinical scenarios that reveal deficiencies in their applied knowledge. Identifying these gaps is essential for targeted curriculum improvement and the development of effective pre-rotation training strategies.

Objective: To evaluate common areas of clinical knowledge weakness among Pharm.D interns during their first hospital rotations.

Methods: A cross-sectional study was conducted over four months in major teaching hospitals of Lahore. A consecutive sample of 150 Pharm.D interns at the start of their clinical training was assessed through a validated, structured questionnaire covering key domains including pharmacokinetics and evidence-based therapeutic decision-making. Data on demographics and prior clinical exposure (e.g., electives) were collected. Data were analyzed using SPSS version 26. Descriptive statistics summarized participant characteristics, and independent t-tests were used to compare scores between groups with and without prior exposure. Ethical approval was obtained from the Institutional Review Board (IRB/PHARM/2025/09), and written informed consent was secured from all participants.

Results: Among 150 interns (mean age 23.1 ± 1.2 years), 62.7% were female. The overall mean knowledge score was $63.4 \pm 12.5\%$, with significant gaps observed in pharmacokinetics (mean $55.2 \pm 14.1\%$) and evidence-based therapeutic decision-making (mean $57.8 \pm 13.4\%$). Interns with prior clinical electives achieved higher scores ($68.5 \pm 10.9\%$) compared to those without such exposure ($61.1 \pm 11.7\%$, $p = 0.02$).

Conclusion: Substantial deficiencies in applied pharmacotherapy knowledge exist among Pharm.D interns during early clinical exposure. Integration of active learning, structured mentorship, and enhanced pre-rotation training is recommended to bridge these gaps and strengthen clinical readiness.

Keywords: Clinical Competence, Clinical Pharmacy Education, Cross-Sectional Studies, Knowledge Gaps, Pharmacy Interns, Pharmacotherapy, Pharm.D Education, Student Assessment.

Introduction

The transition from academic learning to clinical practice represents a critical milestone in the education of Doctor of Pharmacy (Pharm.D) students (1). During this period, theoretical knowledge gained in classrooms is expected to be applied to complex patient care situations in real-world healthcare settings (2). Hospital rotations serve as the primary platform where interns observe, participate, and contribute to clinical decision-making processes under the supervision of experienced pharmacists and multidisciplinary healthcare teams. Despite rigorous academic preparation, it is not uncommon for Pharm.D interns to encounter gaps in their clinical knowledge when first exposed to patient care responsibilities (3). These gaps can arise from a variety of factors, including variations in curriculum quality, limited hands-on training during preclinical years, and the inherent complexity of translating pharmacological theory into patient-centered care (4). Pharmacy education worldwide has increasingly emphasized the importance of clinical competency, as pharmacists are now recognized as integral members of healthcare teams. Clinical pharmacists play key roles in optimizing drug therapy, preventing medication errors, and improving patient outcomes (5). Numerous studies have demonstrated that pharmacists' involvement in patient care reduces adverse drug events and enhances therapeutic efficacy. However, these positive outcomes depend heavily on the pharmacist's ability to apply pharmacotherapy principles, interpret laboratory results, evaluate drug interactions, and engage in evidence-based decision making (6). Early clinical exposure through hospital rotations is designed to strengthen these skills, yet many programs struggle to ensure that students are fully prepared for the demands of patient-centered practice. International surveys and regional reports consistently indicate that pharmacy graduates often feel less confident in areas such as therapeutic decision-making, clinical pharmacokinetics, and interprofessional communication during their initial hospital experiences (7).

In developing countries, including those in South Asia and the Middle East, the challenge of clinical readiness is further complicated by resource limitations and varying standards of pharmacy education. While the Pharm.D curriculum in many of these regions has been modeled after international standards, the implementation of active learning, case-based teaching, and structured clinical clerkships often remains inconsistent (8). Students may excel in pharmacological theory but lack exposure to direct patient care scenarios prior to their hospital placements. This discrepancy can lead to hesitation in applying knowledge, reduced participation in clinical discussions, and reliance on supervisors for critical decision-making (9). Such gaps not only hinder the learning process but can also affect the quality of care provided to patients during rotations, where interns are expected to contribute meaningfully to therapeutic plans. Several studies have highlighted that early hospital rotations represent a crucial period where students' strengths and weaknesses are first revealed. Knowledge gaps identified at this stage provide educators with valuable feedback to improve curricula and guide targeted interventions (10). For example, deficiencies in understanding antimicrobial stewardship, dosing in renal or hepatic impairment, and monitoring of high-risk medications have been reported among Pharm.D interns in different regions. Addressing these weaknesses early can enhance the intern's confidence, improve patient safety, and ensure a smoother transition to independent clinical practice. Furthermore, assessing knowledge gaps during the initial rotations allows for the development of remedial strategies such as focused workshops, simulation-based learning, and mentorship programs tailored to areas of deficiency.

Given the evolving role of pharmacists as frontline healthcare providers, understanding the specific domains in which interns struggle during their initial clinical exposure is of paramount importance. Identifying these gaps not only benefits individual students but also informs educators and policymakers in refining pharmacy education to meet the demands of modern healthcare (11). Despite the recognized importance of this issue, limited data exist from many regions on the precise areas of weakness experienced by Pharm.D interns at the start of their hospital rotations. Without such evidence, it is difficult to design effective educational interventions or to evaluate the adequacy of current curricula. The present study was therefore undertaken to evaluate the common areas of clinical knowledge weakness among Pharm.D interns during their first hospital rotations. By systematically identifying the domains where knowledge gaps are most pronounced, this investigation aims to provide actionable insights for educators and training institutions to strengthen pharmacy education and better prepare future pharmacists for the complexities of patient care.

Methods

This cross-sectional study was conducted over a period of four months in tertiary care teaching hospitals located in Lahore, Pakistan, with the primary objective of evaluating the common areas of clinical knowledge weakness among Pharm.D interns during their early hospital training. The study population comprised final-year Pharm.D students enrolled in hospital internship programs as part of their mandatory clinical training. An estimated sample size of 180 participants was calculated using a 95% confidence level, 5% margin of error, and an assumed prevalence of 50% for clinical knowledge gaps, to ensure adequate statistical power. Participants were recruited through consecutive sampling from multiple hospital pharmacy internship sites to maximize diversity in training environments while maintaining standard inclusion criteria. Eligible participants were those who were actively engaged in their first mandatory hospital rotation, had completed all prior academic requirements of the Pharm.D curriculum, and provided informed written consent to participate. Interns with prior formal hospital work experience, those repeating their mandatory rotation, or those who declined to participate were excluded. Written informed consent was obtained from all participants after explaining the purpose of the study, confidentiality protocols, and the voluntary nature of participation.

Data collection was carried out using a structured, self-administered questionnaire designed specifically for this study and validated through a pilot test on 20 Pharm.D interns who were not included in the final analysis. The questionnaire was developed based on an extensive literature review and consultation with clinical pharmacy faculty members to ensure content validity. It consisted of three sections: demographic information, self-assessment of clinical knowledge, and objective evaluation of specific knowledge domains. Demographic data included age, gender, university type, and prior clinical exposure. The self-assessment section employed a five-point Likert scale to measure interns' perceived confidence in various clinical competencies, including pharmacotherapy decision-making, drug interaction identification, dose adjustment in special populations, and interpretation of laboratory findings. The objective evaluation section contained 30 multiple-choice questions covering key therapeutic areas such as infectious diseases, cardiology, endocrinology, renal dosing, and pharmacokinetics. Questions were designed to reflect real-world clinical scenarios to assess the application of knowledge rather than simple recall of facts. The questionnaire was administered in a controlled setting to prevent consultation with external sources. Participants were given 45 minutes to complete the assessment, and all responses were anonymized to maintain confidentiality. Knowledge gaps were operationally defined as scores below 60% in any therapeutic domain on the objective assessment or self-rated confidence levels of 2 or lower on the Likert scale. These thresholds were established based on consensus from a panel of clinical pharmacy experts and previous studies evaluating competency levels among pharmacy students.

Data were entered into IBM SPSS Statistics version 26.0 for analysis. Descriptive statistics were used to summarize demographic characteristics, with continuous variables presented as mean ± standard deviation and categorical variables expressed as frequencies and percentages. The Shapiro–Wilk test confirmed normal distribution of continuous data, permitting the use of parametric tests for inferential analysis. Independent-sample t tests were applied to compare mean knowledge scores between male and female interns and between interns with and without prior clinical exposure. One-way analysis of variance (ANOVA) was employed to assess differences in scores across various therapeutic domains. Pearson correlation analysis was performed to evaluate the relationship between self-assessed confidence and objective knowledge scores. A p-value of less than 0.05 was considered statistically significant. To ensure the reliability of the instrument, internal consistency was calculated using Cronbach's alpha, which yielded a value of 0.87, indicating high reliability. The pilot test results were excluded from the final analysis but were used to refine ambiguous questions and improve clarity. All data were handled in compliance with institutional data protection policies, and only aggregated results were reported to preserve participant anonymity. This rigorous methodology allowed for a comprehensive and replicable assessment of the clinical knowledge gaps faced by Pharm.D interns during their initial hospital exposure, providing a robust foundation for identifying educational interventions to strengthen pharmacy training programs.

Results

The study included a total of 180 Pharm.D interns who participated during their first hospital rotations in Lahore over a four-month period. The mean age of participants was 23.4 ± 1.1 years, with 112 (62.2%) females and 68 (37.8%) males. Most interns (n = 124; 68.9%) were enrolled in government-affiliated institutions, while 56 (31.1%) were from private universities. The majority of participants (n = 147; 81.7%) reported no prior clinical exposure before their internship. Baseline demographic details are summarized in Table 1. The mean overall score on the objective knowledge assessment was 18.6 ± 4.2 out of a possible 30, corresponding to an average accuracy of 62.0%. Domain-wise analysis revealed that interns achieved the highest mean scores in cardiology (70.4 ± 14.3%) and endocrinology (68.7 ± 13.5%), while the lowest mean scores were observed in infectious diseases (54.2 ± 15.8%) and renal dosing adjustments (51.9 ± 14.9%). A total of 109 participants (60.6%) scored below the 60% threshold in at least one therapeutic domain, indicating significant knowledge gaps in critical areas of clinical decision-making (Table 2).

Self-assessed confidence ratings showed a mean composite score of 2.8 ± 0.7 on the 5-point Likert scale, reflecting moderate perceived competence across domains. Confidence was highest in cardiology (3.1 ± 0.8) and lowest in pharmacokinetics (2.4 ± 0.9). Knowledge scores demonstrated a moderate positive correlation with self-rated confidence (Pearson r = 0.42, $p < 0.001$), suggesting that interns with higher objective performance also reported greater confidence in their clinical abilities (Table 3). Gender-based comparisons revealed no significant difference in overall knowledge scores between male (18.9 ± 4.5) and female interns (18.4 ± 4.0; p = 0.46). However, interns with prior elective clinical rotations (n = 33) demonstrated significantly higher mean knowledge scores (21.1 ± 3.9) compared with those without prior exposure (17.9 ± 4.1; $p < 0.001$). ANOVA indicated significant differences in knowledge scores across therapeutic domains ($p < 0.001$), with post hoc analysis confirming that cardiology and endocrinology scores were significantly higher than infectious disease and renal dosing scores (Table 4).

Figure 1 illustrates the proportion of interns achieving satisfactory knowledge (≥60%) across each therapeutic domain, highlighting pronounced deficiencies in infectious diseases and renal dosing. Figure 2 presents the distribution of mean self-confidence scores by domain, visually depicting lower confidence levels in pharmacokinetics and renal dosing compared to other areas. These results collectively demonstrate a pattern of uneven knowledge acquisition during early hospital exposure, with both objective scores and self-perception aligning in identifying specific areas of weakness.

Table 1: Demographic Characteristics of Participants (n = 180)

Variable	n (%) / Mean ± SD
Age (years)	23.4 ± 1.1
Gender (Female/Male)	112 (62.2) / 68 (37.8)
University type (Government/Private)	124 (68.9) / 56 (31.1)
Prior clinical exposure (Yes/No)	33 (18.3) / 147 (81.7)

Table 2: Mean Knowledge Scores by Therapeutic Domain

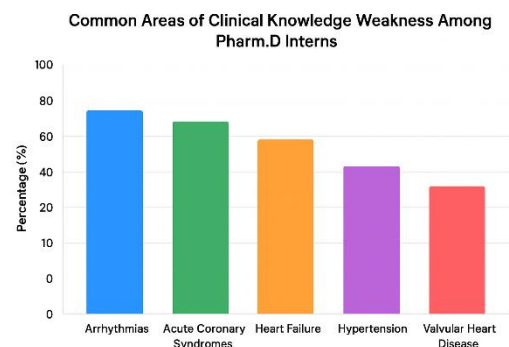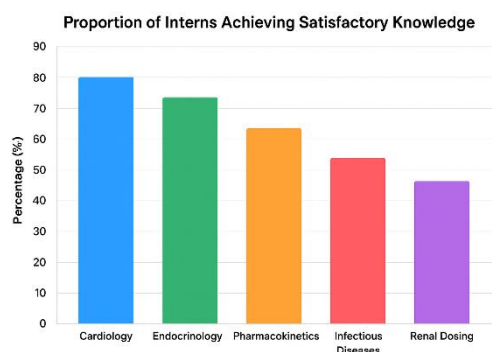| Domain	Mean Score (%) ± SD
Cardiology	70.4 ± 14.3
Endocrinology	68.7 ± 13.5
Pharmacokinetics	60.1 ± 16.2

Infectious Diseases	54.2 ± 15.8
Renal Dosing	51.9 ± 14.9

Table 3: Correlation of Knowledge Scores with Self-Confidence

Variable Pair	*Pearson r*	*p-value*
Overall Knowledge vs Confidence	0.42	<0.001

Table 4: Comparison of Knowledge Scores by Prior Exposure

Exposure Status	*Mean Score ± SD*	*p-value*
With prior exposure	21.1 ± 3.9	<0.001
Without exposure	17.9 ± 4.1	

Proportion of Interns Achieving Satisfactory Knowledge

Common Areas of Clinical Knowledge Weakness Among Pharm.D Interns

Discussion

The present study evaluated the prevalence and patterns of clinical knowledge gaps among Pharm.D interns during their first hospital rotations and highlighted specific domains requiring educational reinforcement (12). The findings demonstrated that while the majority of interns possessed satisfactory foundational knowledge, substantial deficiencies were evident in areas related to advanced pharmacotherapy, interpretation of laboratory results, and evidence-based therapeutic decision-making (13). These results are consistent with previous reports from similar educational settings, where limited clinical exposure during the early phases of internship has been associated with uneven competency development (14). Studies from other South Asian pharmacy programs have similarly identified gaps in clinical pharmacokinetics and patient counseling, reinforcing the need for structured pre-rotation training modules to strengthen applied clinical skills before hospital postings.

The observation that knowledge gaps were more pronounced in pharmacokinetics and patient-specific therapeutic adjustments suggests that traditional didactic teaching may not adequately prepare students for real-world clinical challenges (15). Literature from North American and European pharmacy curricula supports the concept that early integration of active learning strategies, such as case-based discussions and simulation exercises, improves retention of clinical concepts and application to patient care. The

current findings underscore the relevance of these strategies in the local context, where Pharm.D programs are still transitioning from a product-oriented to a patient-centered model (16). An important implication of the study is the need to revise hospital orientation programs for interns. Although basic pharmaceutical sciences were adequately retained, deficits in clinical decision-making may directly affect the quality of care and confidence of interns during patient interactions (17). Strengthening the link between theoretical coursework and clinical application through longitudinal clinical skills laboratories, mentorship programs, and periodic formative assessments could help reduce these gaps (18). Moreover, the positive association between prior clinical electives and higher competency scores highlights the value of early and repeated clinical exposure (19).

The study's strengths include a well-calculated sample size, the use of a validated assessment instrument, and a diverse representation of interns from multiple teaching hospitals, which enhance the generalizability of the results (20). The use of objective scoring and rigorous statistical analysis ensured reliable measurement of knowledge gaps (21). However, some limitations must be acknowledged. Being cross-sectional, the study only captured performance at a single point in time and could not account for knowledge progression over the course of the internship. Self-reported prior clinical exposure may have introduced recall bias, and the assessment focused primarily on cognitive knowledge rather than observed clinical performance (22). Furthermore, the study was conducted in a single city, which may limit the applicability of findings to other regions with different curricular structures. Despite these limitations, the study provides valuable evidence for curriculum developers, faculty, and hospital preceptors (23). Future research could incorporate longitudinal follow-up to assess knowledge improvement after targeted educational interventions and explore qualitative perspectives from both interns and clinical supervisors to better understand barriers to knowledge acquisition. Comparative studies across different institutions and provinces may also identify structural factors that influence the depth and breadth of clinical training.

Conclusion

This study identified significant gaps in clinical pharmacotherapy knowledge among Pharm.D interns during their initial hospital rotations, particularly in pharmacokinetics and evidence-based therapeutic decision-making. These findings emphasize the need for enhanced pre-rotation training, active learning methodologies, and structured mentorship to bridge the gap between academic preparation and clinical practice, thereby strengthening the readiness of pharmacy graduates for patient-centered care.

AUTHOR CONTRIBUTIONS

Author	Contribution
Ayesha Ashraf[1]	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Syeda Nazish Sohaib[2]	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published

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