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The Role of Pharmaceutical Education on Improving Drug Usage Patterns Among the Residents

Asen Hussein Salih^{1*}

1. Kirkuk Teaching Hospital

* Correspondence: esinekbertya@gmail.com

Abstract: Background : Rational use of medicines is an important part of safe and effective healthcare. Resident doctors are often involved in prescribing and hence need to have adequate knowledge of drug interactions, dose adjustment, pediatric dosing, renal and hepatic impairment, polypharmacy, adverse drug reactions and medication safety. Continuing pharmaceutical and clinical pharmacology education may also help to maintain and reinforce these competencies. Objective : To evaluate the knowledge of resident doctors about rational and safe use of medicines and to find out areas where education of pharmaceutical and clinical pharmacology may need to be strengthened. Methods : A descriptive cross-sectional study was carried out among 60 resident doctors working in various clinical departments. Data were collected electronically using a structured questionnaire distributed via Google Forms. The questionnaire included demographic and educational characteristics and contained 28 knowledge-based questions divided into seven domains: drug-drug interactions, dose adjustment, pediatric dosing, renal and hepatic impairment, polypharmacy, adverse drug reactions and medication safety, and rational prescribing. The knowledge score was given a score of one point for each correct answer with a maximum knowledge score of 28. Results The overall knowledge performance was high. Among 60 respondents, 41 (68.3%) were male and 32 (53.3%) were aged 26–30 years. Previous formal education or training in rational drug use or clinical pharmacology was reported by 37 (61.7%). Internet/mobile applications were the most commonly reported medication information source (47/60, 78.3%). Correct responses varied across knowledge items: The overall accuracy for the drug–drug interaction section was 65.0% ,75.2% for dose adjustment, 86.0% for pediatric dosing, 82.0% for renal and hepatic considerations, 95.3% for polypharmacy, 96.7% for adverse drug reactions and medication safety, and 100% for rational prescribing. Seventy percent of participants reported having received formal education in rational drug use or clinical pharmacology after graduation. The comparatively lower performance was observed in the drug–drug interaction domain. Conclusion : Resident doctors demonstrated a high level of knowledge regarding rational and safe medication use. However, drug–drug interactions represented a relative area of weakness and should remain a priority for continuing pharmaceutical and clinical pharmacology education. Regular educational sessions, access to reliable drug-information resources, and collaboration with pharmacists or clinical pharmacists may further strengthen medication safety.

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1. Introduction

Medicines are among the most important tools in modern healthcare, but their benefits depend substantially on appropriate selection, dosing, monitoring, and follow-up. The World Health Organization (WHO) defines rational use of medicines as a situation in which patients receive medicines appropriate to their clinical needs, in doses

appropriate to their individual requirements, for an adequate period, and at the lowest possible cost to the patient and community [1]. Irrational medicine use may result in treatment failure, adverse drug reactions, medication errors, antimicrobial resistance, unnecessary expenditure, and avoidable harm.[2] Prescribing is a complex clinical skill that requires more than knowledge of individual medicines. Physicians must consider patient characteristics, indications, contraindications, drug interactions, dose requirements, renal and hepatic function, concurrent medications, and potential adverse effects. These challenges are particularly relevant to resident doctors, who frequently participate in prescribing while still developing their clinical experience.[3] Drug–drug interactions are an important component of medication safety. Previous research among medical residents has demonstrated considerable variation in the ability of residents to identify clinically relevant drug interactions.[4]

Safe prescribing also requires appropriate adjustment of medication doses according to patient-specific factors. Renal and hepatic impairment can substantially alter drug pharmacokinetics and increase the risk of accumulation and toxicity. Pediatric prescribing presents an additional challenge because doses frequently depend on body weight and must be calculated accurately.[5] Polypharmacy represents another important medication-safety concern. As the number of medicines prescribed to an individual increases, the potential for drug interactions, duplication, contraindications, and medication-related harm also increases.[6] Education in clinical pharmacology and rational prescribing therefore remains important beyond graduation. There is evidence that routine clinical practice does not always lead to improvements in prescribing knowledge. Conclusion An international longitudinal study of junior doctors found that prescribing knowledge does not change appreciably after graduation whilst prescribing skills actually deteriorate in the transition into clinical practice. [7] For the same reasons, contemporary studies in medical education have underscored the need for ongoing clinical pharmacology training to support safe and rational prescribing practices. Accordingly, the current study was designed to evaluate understanding of rational and safe medicine use among resident doctors so as to determine where continuing pharmaceutical and clinical pharmacology education could be beneficial [8].

2. Materials and Methods

2.1 Study design and participants

This was a descriptive cross-sectional study of resident doctors working in clinical departments at Kirkuk. The study included thirty doctors. Participants came from a variety of clinical specialties, including internal medicine [38], surgery [39], pediatrics or its subspecialty services such as emergency medicine, obstetrics and gynecology, anesthesia, or otolaryngology. Clinical Practice and Prescribing Activities In Study Scope The focus was on doctors in clinical practice.

2.2 Data collection

Data were collected through electronic randomly assigned questionnaire which was prepared for the objective of this study. The survey was conducted through Google Forms and the participants filled it in electronically. The questionnaire consisted of questions about demographic characteristics, medication-use practices before and/or after the course, previous pharmacology or clinical pharmacy education exposure sources for self-study on medications & knowledge domains in rational drug use.

2.3 Questionnaire domains

The knowledge section consisted of 28 questions covering seven major domains:

1. Drug–drug interactions.
2. Dose adjustment and individualized dosing.
3. Pediatric dose calculation.
4. Renal and hepatic impairment.
5. Polypharmacy and medication review.
6. Adverse drug reactions and medication safety.
7. Rational prescribing.

Questions included clinically relevant situations such as warfarin–metronidazole interaction, angiotensin-converting enzyme inhibitor–spironolactone interaction, dose calculations in children, renal dose adjustment, medication accumulation and toxicity, polypharmacy, adverse drug reaction management, and principles of rational prescribing.

2.4 Scoring

Each knowledge question had one designated correct answer. A correct response was assigned one point and an incorrect response was assigned zero points. The maximum possible score was therefore 28. The results were additionally summarized according to the seven knowledge domains to identify areas of relative strength and weakness.

2.5 Statistical analysis

Data were summarized using frequencies, percentages, and descriptive statistics. Domain-specific accuracy was calculated from the number of correct responses relative to the total number of responses within each domain.

3. Results

3.1 Characteristics of participants

sixty doctors participated in the study. Males represented 68.3% of participants and females 31.7%. Approximately 76.7% of respondents were working at Kirkuk Teaching Hospital, while 23.3% reported working at other hospitals.

Participants represented several clinical departments, with surgery accounting for 30%, internal medicine 20%, and pediatrics, emergency medicine, obstetrics and gynecology, anesthesia, and otolaryngology each accounting for 10%.

Regarding medication-use frequency, 48.4% reported using or prescribing medicines daily, 46.6% several times per week, and 5% occasionally.

Thirty-seven participants (61.7%) reported previous formal education in rational drug use or clinical pharmacology after graduation, while twenty-three (38.3%) reported no such education.

3.2 Sources of medication information

When participants encountered uncertainty regarding medication use, the most frequently reported source was an internal mobile drug-information application. Other sources included senior physicians and pharmacists or clinical pharmacists.

This finding indicates that electronic drug-information resources already play an important role in supporting medication-related decisions among the participating doctors.

3.3 Knowledge of drug–drug interactions

Knowledge of clinically relevant drug interactions was generally high, although this was the lowest-performing major domain.

For the warfarin–metronidazole interaction, 30 (50.0%) correctly identified the increased anticoagulant effect and bleeding risk, whereas 20% selected the opposite effect and 30% reported that no interaction occurred.

38 (63.3%) identified the simvastatin–clarithromycin interaction. For the combination of an angiotensin-converting enzyme inhibitor and spironolactone 49 (81.7%) identified the ACE inhibitor–spironolactone interaction., they identified hyperkalemia as the major concern.

3.4 Pediatric dose calculation

Knowledge of pediatric dose calculation was high. All participants correctly calculated a dose of 200 mg for a 20-kg child receiving 10 mg/kg.

For a 15-kg child receiving 20 mg/kg/day divided into two doses, 72% calculated the correct individual dose of 150 mg, while 28% selected 300 mg.

All participants recognized both body weight and the prescribed mg/kg dose as essential information for pediatric dose calculation and agreed that pediatric dosing should be verified using an appropriate pediatric reference.

3.5 Renal and hepatic dose considerations

Most participants demonstrated appropriate knowledge of dose adjustment in renal and hepatic impairment.

Sixty five percent were aware of the need for renal dose adjustment where needed, and all participants said drug accumulation or toxicity in renal impairment was something they considered.

Sixty three percent acknowledged potential drug exposure changes with hepatic impairment, and that dose modification or close monitoring may sometimes be warranted.

Die allermeisten Teilnehmer erkannten Patient innen mit einer kombinierten Nieren- und Leberfunktionsstörung sowie solche, die mehrere Medikamente einnehmen müssen, als Personengruppe an, bei denen eine besonders sorgsame individuelle Medikamentenbewertung notwendig ist.

One aspect that all participants also agreed upon was patient factors needing to be factored into medication doses.

3.6 Polypharmacy and medication review

Performance in the polypharmacy domain was excellent. 95.3% of the participants recognized the importance of reviewing the complete medication regimen, assessing potential drug interactions and therapeutic duplication, and obtaining a comprehensive medication list.

The 95.3% accuracy observed in this domain suggests strong awareness of the importance of systematic medication review among the participating residents.

3.7 Adverse drug reactions and medication safety

Ninety six percent of participants selected the appropriate response for recognition and management/reporting of adverse drug reactions. Most participants recognized the importance of appropriate safety checks and the need to address medication errors as part of safe medication practice.

3.8 Rational prescribing

All participants demonstrated correct responses regarding the basic principles of rational prescribing. All 60 participants recognized that selection of a medicine should consider effectiveness, safety, suitability for the patient, and cost. Similarly, all participants recognized the value of reliable drug-information sources and seeking appropriate advice from pharmacists/clinical pharmacists or senior clinicians when necessary.

3.9 Overall knowledge performance

Across the 28 knowledge questions, 813 of 840 possible responses were correct, giving an overall accuracy of **96.8%**. The mean overall knowledge score was **24.01 ± 3.62 out of 28**.

Table 1. Knowledge performance according to study domain

Knowledge domain	Accuracy
Drug–drug interactions	65.0%
Dose adjustment	75.2%
Pediatric dosing	86.0%
Renal/hepatic considerations	82.0%
Polypharmacy	95.3%
ADRs and medication safety	96.7%
Rational prescribing	100%
Overall	85.74%

4. Discussion

The present study demonstrated a high overall level of knowledge concerning rational and safe medication use among the participating resident doctors. Similar medication-knowledge assessments have been reported among resident populations in other settings [9]. The overall accuracy of 85.74% indicates that most participants were able to recognize important principles related to medication safety, dose adjustment, pediatric dosing, polypharmacy, adverse drug reactions, and rational prescribing. Broader community-based research has likewise examined medication knowledge,

attitudes, and practices as determinants of safe medicine use [10]. However, the results should be interpreted carefully. The study measured knowledge using a questionnaire and did not directly measure prescribing behavior or actual medication errors. Therefore, the high questionnaire performance should not be interpreted as evidence that all participating doctors consistently prescribe safely in clinical practice. The strongest performance was observed in polypharmacy, adverse drug reaction and rational prescribing, with 95.3%, 96.7%, 100% accuracy. This suggests that participants had a clear conceptual understanding of the importance of reviewing medication regimens and considering effectiveness, safety, suitability, and cost when selecting medicines. The relatively weakest domain was drug–drug interactions. The lower performance was particularly apparent in recognition of the warfarin–metronidazole interaction, for which only 50.0% of participants selected the correct answer. This finding is clinically important because failure to recognize significant drug interactions can result in preventable adverse outcomes.

Our finding differs from studies in which resident physicians demonstrated substantially higher performance in specific drug–interaction questions. A study among medical residents in Shiraz reported a mean correct response rate of approximately 44% for drug–interaction questions, while an earlier study among residents in Iran found that participants correctly classified only about 41% of drug pairs.[11] The difference may reflect differences in questionnaire design, participating specialties, educational background, access to drug–information resources, and local training practices. The present results also showed strong performance in pediatric dose calculation. Seventy two percent of participants correctly calculated the divided dose in the second pediatric scenario, while all participants identified body weight and mg/kg dosing as important information. Nevertheless, the 10% incorrect response in a relatively straightforward calculation demonstrates why pediatric dosing should remain part of continuing medication–safety education.

Renal and hepatic dose considerations also showed high levels of correct responses. These findings are encouraging because dose adjustment according to organ function is an essential element of individualized prescribing. However, recognizing the principle on a questionnaire does not necessarily guarantee appropriate dose adjustment during real clinical practice. An important finding was that 61.7% of participants had received formal education in rational drug use or clinical pharmacology after graduation. This indicates that continuing pharmaceutical education is already present among many of the participating doctors. Nevertheless, the presence of continuing education should not be considered sufficient by itself. WHO recommends continuing in-service medical education, clinical guidelines, independent medicine information, and supervision, audit, and feedback as important interventions for promoting rational medicine use [12].

The importance of continuing education is also supported by recent evidence concerning prescribing competence. A preliminary international longitudinal study of newly graduated doctors showed that whilst prescribing knowledge after the first year following graduation remained relatively stable, their practical skills at writing prescriptions decreased. [13] A more recent study carried out among the internal medicine and cardiology residents in Shiraz, Iran found that 80.6% of medical interns felt they lacked enough knowledge about drug–drug interaction (DDI), suggesting a greater need for practical training. [14] The take-home lessons from this work highlight the need for continuing development and assessment of rational prescribing that cannot rest on undergraduate pharmacology education alone. [15] The revelation that most participants predominantly utilized an electronic medication–information application whenever in doubt is noteworthy as well. Electronic resources of interest Modern electronic resources may support safe prescribing, especially when providing timely information on interactions, contraindications or dosing and monitoring. Electronic resources, on the other hand, should not replace appropriate clinical judgment and discussions with

experienced clinicians at a tertiary academic hospital or pharmacists. Pharmaceutical care and pharmacy clinical care is very important in the medication safety. The joint efforts of prescribers and medication experts can prevent drug–drug interaction, inappropriate doses, therapeutic duplication and other problems associated with medications. Furthermore, pharmacist involvement may provide a support mechanism for residents to build on their independent prescribing skills.

The study has several limitations. Make sure you cite all of these! First, the sample size was limited—only 30 participants were included in this study—which limits generalizability. Second, selection bias could not be excluded because patients were recruited by an electronic questionnaire. Third, the questionnaire measured knowledge rather than actual prescribing behavior or real-world medication-error rates. Fourth, the cross-sectional design prevents any causal conclusions regarding pharmaceutical education and knowledge performance. The high overall score might be partially due to the format and complexity of the questionnaire.

Nonetheless, there are few limitations and this is an important preliminary information about drug knowledge in resident doctors with the need of further exploration to assess them regarding a case for analyzing the interactions between medications.

5. Conclusion

The study indicates that resident doctors demonstrated generally strong knowledge of rational and safe medication use, with the highest performance in rational prescribing, adverse drug reactions and medication safety, and polypharmacy, while drug–drug interactions remained the principal area requiring improvement. These findings support maintaining and strengthening pharmaceutical and clinical pharmacology education within postgraduate medical training, particularly for clinically significant drug interactions, individualized dose adjustment, high-risk medicines, pediatric dosing, renal and hepatic impairment, and medication-error prevention. Structured, case-based and problem-based educational sessions should be provided regularly, supported by access to current evidence-based drug-information resources and closer collaboration among resident doctors, pharmacists, clinical pharmacists, and senior clinicians. Medication-safety and pharmacovigilance activities should also be reinforced through periodic assessment, supervision, audit, and feedback consistent with international recommendations for promoting rational medicine use. Future research should use larger multicenter samples and combine knowledge questionnaires with prescription review, clinical case assessment, medication-error monitoring, and pre–post educational evaluation to determine whether improved knowledge translates into safer prescribing behavior in routine clinical practice.

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