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Pharmacists' Perspectives on Medication Errors in Intensive and Critical Care Units: Causes, Consequences, Prevention, and Management Strategies – A Qualitative Study

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Abstract

Background

Medication errors are common in critical care units (CRCU) in developing countries. Little is known about the causes of these errors and the role of pharmacists in preventing and managing them in Iraqi hospitals. The aim of this study is to get in-depth understanding of the perspectives and practice of Iraqi pharmacists' regarding medication errors in CRCU.

Methods

A qualitative study was conducted by interviewing pharmacists working at CRCU of Al Husain hospital in Almuthanna city/Iraq. The data was analyzed by thematic analysis.

Results

Sixteen pharmacists participated. The emerged study themes included: perceptions and experiences of pharmacists about prescribing errors in CRCU, types and determinants of prescribing errors, and detection, prevention and management of prescribing errors.

Conclusion

Prescribing errors, mainly dosing and drug interactions, are common in CRCU, often caused by physician negligence, limited competence, and workload. Pharmacists rely on general apps for detection. Targeted training and specialized tools are recommended to reduce errors.

Background

Medication errors are defined as preventable events that carry a threat to patient safety, potentially prolong hospital stays, and subsequently increase healthcare costs. They can occur at various stages within the medication process, from prescribing to patient administration; however, prescribing errors are the most common type (1–3). There are many reasons behind the occurrence of medication errors some are personal related such as lack of competency, inability to follow treatment guidelines, workload fatigue; others are institutional related errors including insufficient supervision, staffing shortages, and lack of adequate technical infrastructure (2, 4, 5). Medication errors pose a high risk on the treatment outcome especially for critically ill patients (5–7). Unfortunately, several studies found a high prevalence of medication errors in critical care setting in developed and developing countries (8, 9). In Iraq, this problem seems to be even more significant (10).

Pharmacists, as medication experts, are uniquely equipped to reduce medication errors by monitoring, analyzing, and influencing medication safety practices. They can achieve this through reviewing and approving physicians' prescriptions, as well as educating patients and other healthcare professionals about appropriate medication usage (11, 12).

To the best of our knowledge, there is paucity of knowledge behind the reasons for medication errors and the current role of pharmacists in Iraqi hospitals regarding the prevention and management of medication errors for critically ill patients. Therefore, the current study aimed to get in depth understanding of the perspectives and practice of Iraqi pharmacists' regarding medication errors in critical care (intensive and cardiac care) units. It is expected that the results of the current study will be useful in informing policy development and implementing evidence-based interventions to reduce medication errors and improve patient outcomes in critical care settings.

Methods

Study design

A qualitative study with phenomenological approach was conducted with pharmacistsworking at the critical care units (CRCU) of Al Husain teaching hospital in Almuthanna city/Iraq, to get in-depth understanding of their perspectives and practices regarding prescribing errors in the CRCU.

Ethical considerations

The study was ethically approved by the ethical committee at college of pharmacy – University of Baghdad (ethical approval number: RECAUBCP06262H at 10/06/2025).

Considering cultural factors and the likelihood that many individuals in Iraq may be hesitant to sign documents, ethical committee accepted obtainingverbal instead of written consent from study participants (13).

To ensure maximum confidentiality, participants did not require to disclose their identities during the interview to preserve their confidentiality. Meanwhile, the researcher employed pseudonyms for the participants in the interview transcription.

Development and Validation of the Interview Guide

The study authors developed the interview guide(additional file.1), which consisted of semi structured questions, after taking into account ideas in suitable previous literature (14-18). To validate the contest of the interview guide, it was sent toa panel of six experts in which four of them were academic pharmacists with robust experiencein qualitative studiesand two were senior physicians who have working experience in the CCRU.

The experts were asked to check relevance and clarity of each question. Additionally, they were encouraged to provide feedback on any language and wording issues. To assess the content validity of the interview guide, Lawshe's method was employed (19).There was a consensus among all experts regarding the relevance and clarity of all guide items. However, one expert provided minor linguistic revisions on two items. After incorporating these revisions, all experts approved the guide (appendix A).

Study sample

All pharmacists with at least 3 months of working experience in the CRCU were considered eligible to participate in this part of the study.A purposive sampling strategy was used to enroll the participants in this study. The recruitment strategy was based on the participants' specialty and gender to obtain details from different perspectives. All eligible pharmacists were informed about the study objectives and the need to do audio recording. Only those who provided their verbal informed consent were included in the study. Enrolled participants were contacted before the study to allow scheduling a sufficient time for the interview. All participants were interviewed in a quiet area at the clinical pharmacy room of the hospital.

Data collection and analysis

The interviews were conducted from 10/07/2025 to 01/11/2025in accordance with the interview guide and conducted in Arabic. Probing questions were used to elicit additional comments when necessary. All interviews were audio-recorded using a mobile recorder. Each interview lasted approximately 15-20 minutes.

Interviews with pharmacistswere continued until reaching the saturation point, the point at which no new information will be obtained.

The first author manually coded all the interviews, which were then used for organizing the qualitative data.A codebook was created to maintain uniformity in the coding process across all interviews.Codes were organized into themes and subthemes through the application of a hybrid approach, incorporating both inductive and deductive methods (13). In the inductive approach, the researchers employed a predetermined template derived from the ideas and sequence of questions outlined in the interview guide. In the deductive approach, thematic analysis was conducted in accordance with Braun and Clarke's six-step framework (20). These steps involve familiarizing oneself with the comments, creating initial codes, identifying potential themes, evaluating the themes, clearly defining and naming them, and ultimately documenting the findings.

Results

Sixteen pharmacists participated in this study. Most pharmacists were females (n=10) holding Bachelor degree in pharmaceutical sciences (n=14). The mean age of participated pharmacists was 30.13 years with a range from 26 to 41 years. Half of the participants were working in the intensive care unit (ICU)

and the other half in the cardiac care unit (CCU). Full details about demographics of study participants are shown in table 1.

Table 1: Demographics of study participants

No. of Participant (P)	Age	Sex	Ward working in	Academic degree
P1	40	Female	CCU	Bachelor in pharmaceutical sciences
P2	27	Male	ICU	Bachelor in pharmaceutical sciences
P3	41	Female	ICU	Master in clinical pharmacy
P4	26	Female	ICU	Bachelor in pharmaceutical sciences
P5	27	Male	ICU	Bachelor in pharmaceutical sciences
P6	38	Female	CCU	Bachelor in pharmaceutical sciences
P7	33	Female	ICU	Bachelor in pharmaceutical sciences
P8	26	Male	ICU	Bachelor in pharmaceutical sciences
P9	27	Male	ICU	Bachelor in pharmaceutical sciences
P10	35	Male	CCU	Master in pharmaceutical chemistry
P11	26	Male	ICU	Bachelor in pharmaceutical sciences
P12	27	Female	CCU	Bachelor in pharmaceutical sciences
P13	26	Female	CCU	Bachelor in pharmaceutical sciences
P14	27	Female	CCU	Bachelor in pharmaceutical sciences
P15	27	Female	CCU	Bachelor in pharmaceutical sciences
P16	29	female	CCU	Bachelor in pharmaceutical sciences

The results of this study showed three major themes: perceptions and experiences of pharmacists about prescribing errors in CRCU,types and determinants of prescribing errors**,** anddetection, prevention and management of prescribing errors. Table 2 shows study themes and subthemes.

Table 2: Study themes

Theme	Subtheme
Perceptions and Experiences of pharmacists about Prescribing Errors in CRCU	Frequency of prescribing errors in the CRCU
	Impact of prescribing errors on patients in the CRCU
Types and Determinants of Prescribing Errors	Types of prescribing errors
	Causes of prescribing errors
Detection, Prevention and management of Prescribing Errors	Tools used for detection of prescribing errors
	Pharmacists' action when detecting a prescribing error
	Current institutional measures to prevent or at least reduce prescribing errors
	Recommendations to reduce prescribing errors

Frequency of prescribing errors

All participants reported identifying prescribing errors in the critical care units; however, the majority (n=12) indicated that these errors are very common and occur frequently in such settings. Two participants indicated that such errors occur occasionally. One participant stated that prescribing errors can occur in these units but generally at a lower rate compared to other wards. Another participant acknowledged the occurrence of prescribing errors but did not specify a frequency.

"Medication errors occur frequently about 3 times per week." P2

"Medication errors can occur in the CCU; although I do not have confirmed statistics, they tend to happen less frequently than in other units." P1

Impact of prescribing errors on patients in the CRCU

Most participating pharmacists (n=13) believed that prescribing errors could be harmful to patients. However, four of them thought that while errors might sometimes cause harm, such harm often goes unnoticed due to negligence and inadequate follow-up. Eight participants had witnessed at least one direct adverse outcome, including patient death (n=4), medication toxicity and side effects (n=3), renal failure (n=2), and disease progression due to omission of indicated medication (n=1). Additionally, one pharmacist noted that prescribing errors can indirectly harm patients by leading to irrational medication use and wastage. Conversely, two pharmacists considered such harm negligible because it is usually quickly corrected, while others did not report witnessing any patient harm caused by prescribing errors.

"Although most medication errors can cause significant harm to patients, they often go unnoticed due to negligence and are only detected by chance." P1

"Sometimes, medication errors can lead to drug toxicity and consequently the patient's death. I have witnessed a patient who died due to methotrexate and digoxin toxicity. Sometimes, they can cause kidney failure, such as administering vancomycin, acyclovir, and gentamicin together for a long period without proper drug monitoring." P9

Types of prescribing errors in the CRCU

All participants reported witnessing at least one medication error. The most frequently reported errors included drug-drug interactions (n=12), irrational prescribing of medications (n=12), dosing errors (n=9), issues with the duration of prescribed therapy (n=6), lack of monitoring (n=8), prescribing contraindicated drugs (n=2), duplicate prescribing (n=2), administration errors for propofol (n=1), reconstitution error for omeprazole (n=1), and dosing frequency error (n=2) for omeprazole (5times daily) and for ceftriaxone (4 times daily). Regarding drug-drug interactions, some pharmacists reported encountering more than one interaction. The most commonly reported interactions involved antibiotics (n=8), such as meropenem with valproicacid, ceftriaxone with enoxaparin, Ringer's lactate with ceftriaxone, clarithromycin with atorvastatin;interactions related to omeprazole (n=6), including interactions with clopidogrel and enoxaparin; and interaction of BB with ventolin (n=3) which lead to increase heart rate.

Regarding irrational prescribing (n=11), only one participant reported irrational prescribing of steroids, while the majority highlighted irrational prescribing of antibiotics, often prescribed without a clear indication and without culture and sensitivity testing. For dosing errors, three participants reported such errors in patients with renal impairment, another two reported errors in prescribed antibiotics, and two others identified errors when prescribing enoxaparin. Additionally, two participants noted dosing errors with less frequently prescribed medications such as rifampicin and isosorbide. One participant reported a dosing error with ranitidine, and another identified an error related to the loading dose of clopidogrel.

Lack of monitoring was reported as failure of physicians to monitor patient response to antibiotics (n=6) and albumin (n=1), besides lack of prescribing for tests that useful for monitoring side effects (n=2) of vancomycin (n=1) and dexamethasone (n=1) when prescribed for long period of time.

Duration errors were commonly reported with prescribed antibiotics. Specifically, four participants noted prescribing antibiotics for extended periods without a clear indication, while two participants reported prescribing meropenem for very short durations (1-2 days) due to physicians' belief that it was sufficiently potent to eradicate bacteria within that timeframe.

The reported instances of duplicate prescribing included prescribing two NSAIDs and prescribing another drug from the same class that the patient was already taking, due to a lack of review of the patient's medication history.

"Dosing errors and drug-drug interactions are among the most common types of medication errors. The most frequent examples of drug-drug interactions include administering calcium ampules

*simultaneously with ceftriaxone, as well as prescribing omeprazole alongside Plavix® for the same patient. Dosing errors are common with antibioticsas with meropenem, which is sometimes prescribed once daily because physicians believe it is sufficiently potent to be effective with this regimen. In addition, nearly all antibiotics are prescribed without culture and sensitivity testing."*P10.

"Medication errors occur frequently, such as physicians being unaware of the available dosing strengths of certain medications, particularly those prescribed infrequently. For example, prescribing Rifadin® 500 mg instead of the standard 300 mg, or Isordil 12.5 mg instead of 10 mg. Other common errors include prescribing drug combinations that interact negatively, such as Tramadol with Ondansetron—which can reduce Tramadol's effectiveness—prescribing Omeprazole with Enoxaparin, Azithromycin with antihistamines, and administering Ceftriaxone with Ringer's lactate infusion. Additionally, some physicians prescribe Voltaren injections for patients with peptic ulcers without considering contraindications." P13

Causes of prescribing errors

Regarding the possible causes of prescribing errors, participating pharmacists identified at least one contributing factor. These included physician-related reasons (n=16), institutional-related reasons (n=13), patient-related reasons (n=10), and documentation challenges (n=6).

Participating pharmacists reported at least one physician-related cause of prescribing errors, with many identifying physicians' dependence on their clinical experience rather than clinical guideline (n=15) and negligence (n=13) as main factors. The negligent behaviors reported include at least one of the following: ignoring pharmacists' comments and recommendations (n=4), failing to monitor prescribed medications (n=4), relying on outdated medical information and guidelines (n=4), treating patients without following established protocols (n=3), and neglecting to obtain comprehensive medical and medication histories (n=2). Other physician-related reasons for prescribing errors include limited team working and collaboration with other healthcare professionals, such as pharmacists, nurses, and physicians from other specialties (n=14), limited physician competence (n=13), and failure to accurately diagnose the patient's condition (n=2).

Institutional factors were also identified by several pharmacists as contributors to prescribing errors. Notably, most respondents (n=12) considered the high patient load in public hospitals to be a major factor increasing the risk of errors. Six respondents cited the limited availability of medications in public hospitals as a significant issue, often forcing physicians to prescribe alternative treatments that may not be optimal for the patient. Additionally, one pharmacist highlighted the lack of access to electronic libraries as a barrier to rapid and accurate information retrieval, which can contribute to prescribing errors. Other reported reasons include the absence of punitive measures for physicians who prescribe suboptimal medications (n=1) and inadequate physician training (n=1).

Ten pharmacists cited at least one patient-related reason for prescribing errors. Eight of these pharmacists attributed errors to the seriousness of the patient's condition, which necessitated urgent

treatment. Additionally, three pharmacists mentioned another factor: the presence of multiple relatives accompanying the patient, who often interfere with the physician's decision-making regarding patient treatment.

Documentation challenges were cited by six pharmacists as a cause of prescribing errors. Among them, four considered handwritten prescriptions to be the main issue, as pharmacists often had difficulty reading the handwriting, leading to dispensing incorrect treatments. The remaining 2 pharmacists attributed prescribing errors to disorganized case sheets, which hindered physicians' ability to monitor lab tests and the patient's previous status, thereby increasing the likelihood of errors.

*"Confusion often arises because many cases require urgent intervention and quick decision-making, which can lead to chaos among the entire staff. Sometimes, the workload and the presence of relatives further contribute to this problem. Additionally, there is a lack of effective teamwork among doctors, pharmacists, and nurses. Manual recording in the patient's chart and transferring information across multiple sheets can increase the risk of errors, along with inaccuracies in documenting patient data. The selection of the appropriate medication by the specialist may be hindered by its unavailability in the hospital, leading to the dispensing of alternative drugs. For example, administering dopamine ampoule instead of dobutamine ampoule when the latter is unavailable."*P 3

*"The primary cause of medication errors is the insufficient knowledge among physicians. Additionally, there is no unified and approved protocol for critical cases in our hospitals, unlike in other countries. When pharmacists raise concerns about errors, physicians often refuse, citing that their prescriptions are based on their experience and that no prior harm has occurred in similar cases. The existing laws and regulations are not strict enough to serve as effective deterrents against negligent healthcare professionals. Furthermore, family members of patients sometimes intervene in treatment decisions, which can disrupt workflow. The unavailability of life-saving drugs, also compels physicians to prescribe substitutes based on what is available."*P10

Tools used in detection of prescribing errors

All participating pharmacists reported utilizing websites and mobile applications to assist in the detection and resolution of prescribing errors.In addition to technology,some of the study participants (n=10) also reported reliance on other sources while reviewing prescriptions for errors; these include medical books (n=8) such as BNF, Pharmacotherapy Handbook, Lippincott's Pharmacology, and Stockley's Drug Interactions, NICE guidelines (n=1), or college lectures (n=1); meanwhile, six of these participants reported that they depended on medical books in conjunction with their college lectureswhen checking prescriptions for medical errors.

In regard to the utilized websites and mobile applications, the majority of study participants (n=15) considered these tools to be highly useful, while only one participant believed they provided some benefit. All participants relied on the Medscape application in their work; however, 13 of them depended solely on Medscape. The remaining pharmacists also used additional applications alongside Medscape,

such as Lexicomp (n=1), BNF (n=1), or Puked Infusion (n=1). Most participants (n=14) reported daily use of these applications, whereas 2 respondents indicated infrequent usage.

Despite the positive attitudes of study participants toward the available applications and their support in detecting and managing prescribing errors, most of them (n=15) reported one or more challenges with these applications. Twelve participants viewed these applications as sources of general information about diseases and medications. In this regard, seven participants found searching for information in these applications to be time-consuming, while five participants noted that the applications do not account for individual patient factors such as medical history or current medications. As a result, they may recommend treatments or medications that could interact with or be contraindicated based on the patient's specific medical background. Six participants reported that these applications lack information on commonly used medications in the CRCU. Three participants criticized the applications for insufficient details regarding drug dilution and compatibility with other medications or fluids. Another three participants highlighted the absence of storage information for medications within these applications. Additionally, one participant noted that some information requires an active internet connection, another pointed out the lack of details about extemporaneous preparation procedures, and one more mentioned the absence of information on the necessary monitoring criteria for prescribed medications.

"I use Medscape daily because it is free and useful; however, it lacks certain information regarding drug administration. Additionally, adjusting doses based on specific patient conditions, such as low albumin levels or impaired kidney function, is also challenging with Medscape. I also depend on my college lectures, the BNF, and therapeutic books to get detailed and accurate information." P8

"I rely on Medscape and the BNF on a daily basis and find Medscape highly beneficial; however, it lacks dosing information tailored to specific indications. Sometimes, we need to dispense medications in doses different from those listed in Medscape, depending on what is available in the Iraqi market. Additionally, there is difficulty in obtaining detailed information about drug compatibility with IV fluids. Many applications are slow, and we require rapid access to patient-specific information, which most current applications are unable to provide efficiently." P2

Pharmacists' action when detecting a prescribing error

When detecting prescribing errors, only six pharmacists reported taking action—either correcting the error (n=4) or stopping the offending medication (n=2)—and then informing the responsible physician. In contrast, ten pharmacists simply notified the responsible physician about the error, either by noting it on the patient’s case sheet (n=6) or verbally (n=4), without taking further action and leaving the decision to correct the error at the discretion of the responsible physician.

"I inform the responsible physician with the error, and he/she usually made the final decision." P12

"I correct the error immediately and then inform the physician with these details." P4

Current institutional measures to prevent or at least reduce prescribing errors

Most participating pharmacists (n=8) reported that there are no institutional measures in place to mitigate the risks of prescribing errors in the CRCU. Conversely, two pharmacists were unsure whether any such measures existed. Six pharmacists indicated that specific institutional strategies aimed at reducing medication errors among CRCU patients are in place. In this context, three pharmacists reported mandates requiring them to document notes on patients' cases when medication errors are detected. One pharmacist stated that MOH regulations stipulate the retention of medical staff in the CRCU without rotation for a minimum of 2-3 years; however, such law is still not activated in hospitals. Additionally, one pharmacist noted that regulations mandate pharmacists to supervise the dispensing and administration of medications for CRCU patients. The last pharmacist highlighted the importance of team-based collaboration among healthcare professionals within the CRCU (n=1).

"The MOH has made a decision to permanently assign trained staff to the critical care units for 2-3 years to gain sufficient experience and reduce medication errors. However, this policy has not yet been actively implemented." P3

"There are no any institutional measures to reduce the risk of prescribing errors." P11

Recommendations to reduce prescribing errors

To minimize prescribing errors, all participating pharmacists offered multiple recommendations, including enhancing physicians' competence and skills (n=16), as well as addressing staffing (n=16), scientific (n=8), medication-related (n=5), and administrative issues (n=2).

To enhance physicians' competence and skills, participating pharmacists provided multiple recommendations, including conducting regular training sessions (n=15), holding regular meetings among medical staff to discuss complex cases and medication errors (n=2), monitoring physicians' prescribing behaviors (n=2), and conducting regular exams for CRCU physicians (n=2).

To minimize prescribing errors due to staffing issues, study participants recommended keeping experienced physicians in the CRCU without rotation (n=12), promoting teamwork among physicians and other healthcare professionals (n=8), increasing the number of physicians and patient beds in the CRCU (n=5), and maintaining a 24-hour presence of experienced healthcare professionals in the CRCU (n=2).

The scientific recommendations by study participants included developing and enforcing specific treatment protocols for physicians (n=8), prescribing medications by their scientific names rather than trade names (n=1), developing specific medication management applications to assist physicians in managing CRCU patients (n=2), and providing physicians with access to an up-to-date electronic library (n=2).

To minimize prescribing errors that caused by medication interruption, five pharmacists recommended ensuring a continuous supply of lifesaving medications in hospitals. On the other hand, two pharmacists

suggested strategies to reduce prescribing errors by addressing administrative issues, such as implementing electronic prescriptions instead of handwritten ones (n=1) and offering incentives to medical staff in the CRCU (n=1).

*"Organizing regular lectures and meeting for the staff of the critical care unit, along with providing them with an electronic library containing important resources for them. There is also a need to developmobile applications that include comprehensive and detailed information about the medications used in critical care units.Additionally, maintaining the healthcare team in the critical care unit without rotation. "*P5

*"I recommend fostering teamwork among healthcare professionals working in the critical care units, along with providing ongoing training. Additionally, I suggest motivating these professionals through specific privileges compared to their peers, as I have observed that most are reluctant to work in such units. I also recommend ensuring a continuous supply of life-saving medications to these units. "*P1

Discussion

This qualitative study, conducted within the CRCU at Al Husain Teaching Hospital in Almuthanna City, Iraq, provides a comprehensive and in-depth exploration of prescription errors and their underlying causes in this acute and critical clinical setting. The study findings highlight certain challenges that are frequently driven by the complexities of this environment, as well as identify specific factors that are uniquely exacerbated in resource-limited and high-pressure healthcare contexts.Nearly all participating pharmacists believe that prescription errors are common in the CRCU. This observation aligns with existing literature indicating a high frequency of medical errors among critically ill patients (21). For instance, Kumar M. et al. (2022) reported that 10.7% of critically ill patients experienced prescription errors, with 3.5% classified as severe (9), highlighting the significant risk of medication-related errors in such settings.

The high frequency of prescribing errors among patients in CRCU is not strange due to complexity of patients' cases and polypharmacy among most patients in the CRCU (16).

The present study findings offer a convincing, although concerning, perspective on the practical consequences of prescribing errors. The findings demonstrate a variety of viewpoints and first-hand observations, emphasizing that prescribing errors are not merely administrative issues but have actual consequences for patient safety. Some of the negative consequences for prescribing errors, as documented and reported by participating pharmacists are severe and can result in direct harm to patients, including death. Similarly, Rothschild and colleagues found that 13% of medication errors in the critical care setting being life-threatening or fatal (21). The elevated risk of fatality from prescribing errors among CRCU patients is anticipated, as these patients are often prescribed multiple high-risk medications such as inotropes and anti-arrhythmics, which have limited therapeutic windows(22). Thus, a single mistake in dosage or medication choice can have disastrous consequences for these critically ill patients (23). Despite the high fatality of prescribing errors in the CRCU, the good news is that many of these errors can be avoidable by careful team working (21).

Additionally, the participating pharmacists highlighted another negative consequence of prescribing errors: irrational medication use. This issue can indirectly affect patients, as medications needed for some individuals may be unavailable due to being prescribed to those without a genuine medical need. This problem is particularly significant in countries with limited resources(24), such as Iraq.

On the other hand, some of the participated pharmacist considered prescribing errors to have negligible effect on patient at the CRCU while others thought that it "often goes unnoticed". These perceptions are two sides of the same coin. They draw attention to a crucial problem in patient safety: the "iceberg phenomenon" of medication errors, in which only a small percentage of harms are observable and reported (25).

According to the current study results, drug -drug interaction and irrational antibiotic prescribing were the most common prescribing errors in the CRCU. Close to this finding, irrational prescribing and drug interaction were commonly detected in physician prescription for patients in the intensive care units of other developing countries (26, 27).

These errors are expected due to the critical nature of patient cases that require the use of multiple medications(5, 21), which increases the risk of drug-drug interactions and irrational prescribing. Therefore, careful review of prescriptions by pharmacists is essential and highly recommended by many of the participating pharmacists in the current study to help reduce the likelihood of these errors. Additionally, establishment of Antimicrobial Stewardship Programs in the CRCU are also recommended, as they have been shown to decrease inappropriate prescribing and enhance patient outcomes, especially in the settings with limited culture and sensitivity testing (28).

Other reported prescribing errors included dosing errors, dosing frequency errors, and errors in the duration of prescribed treatment. These errors are expected due to the presence of different organ failure for many patients in the CRCU which necessitate dosing and dosing frequency adjustment (9, 29).

Furthermore, some of the participated pharmacists report prescribing contraindicated medications and duplicate prescribing. Such errors despite being less common but can occur due to the limited knowledge of physicians about medications and their mechanism of action (30).

Therefore, pharmacists must conduct educational meetings and conferences withphysicians to expand their knowledge about medications and hence reduce the chance of prescribing errors.

Despite the importance of monitoring medications' effect and side effects to ensure maximum benefit and safety, especially in critically ill patients (31), this step was neglected by physicians, as reported by half of the study participants. Close to this finding, a systemic review conducted by Assiri and colleagues at 2018, concluded that monitoring errors are very common in community care setting, occurring in 73% of patients (32).

According to the current study, prescribing errors arise from a complex interplay of human, systemic, and environmental factors, rather than a singular cause. Human related causes include both physician and

patient related factors. Regarding physician-related causes of prescribing errors, most reported reasonssuch as physicians' reliance on their clinical experience rather than clinical guidelines, carelessness, limited competence, inadequate training, and poor collaboration with other healthcare professionals. Most of these reasonsare well documented in the literature as factors that increase the likelihood of prescribing errors (33–35). Meanwhile, the reported patient-related reason for prescribing errors included the seriousness of the patient's condition, which necessitated urgent treatment without reflective time for reviewing the prescribed treatment. Similarly, Farzi and colleagues found that healthcare professionals perceive medication errors to often arise from the urgent need for emergent management of patients in intensive care units (16).

Meanwhile, participating pharmacists in the current study considered the presence of multiple relatives accompanying the patient as a source for prescribing errors because they often interfere with the physician's decision-making regarding treatment. Similar finding was not detected in literature, thus, it seems to be unique in Iraqi hospitals and may be influenced by the lenient regulations in Iraqi hospitals that permit a large number of relatives to accompany patients. This environment can increase the risk of assaulting physicians, particularly due to the lack of punitive laws addressing such behaviors.

Furthermore, participating pharmacists in the current study reported that institutional variables, particularly the high patient load and medication shortages as an important systemic drivers for prescribing errors. Similar reasons for prescribing errors were reported in literature. For instance, Mahomedradja RF et al. (2023), found that excessive workload and production pressure in CRCU are significant catalysts for medication errors(33).Additionally, a study conducted by Abdel-Latif (2016) showed that the necessity for therapeutic alternatives due to medication unavailability increases the possibility of improper prescriptions and adverse pharmacological events(36).

On the other hand, handwritten prescriptions were cited by some of the participating pharmacists as a cause of prescribing errors,as they can lead to the dispensing of incorrect treatments due to difficulties in reading these prescriptions.

Similar concerns were already recognizable in literature(37). Additionally, the lack of computerized physician order entry increasing the cognitive burden on physicians and pharmacists to detect errors and hence increase the chance of prescribing errors (38).

The results of the current study showed that nearly all participating pharmacists reported using websites and mobile applications, particularly Medscape, to assist in the detection and resolution of prescribing errors, considering these applications to be highly beneficial in their work. This high reliance on technology suggests a paradigm shift in clinical practice, where electronic tools are no longer viewed as optional aids but rather as essential components for ensuring the accuracy and efficiency of pharmacists' roles in detecting, preventing, and managing medication errors. Similarly, Sutton et al. (2020) found that drug reference apps are among the most favored and respected mobile health technologies among medical professionals, primarily due to their portability and ability to provide prompt responses to drug-related inquiries at the point of care(39).

Thus, the use of these applications can significantly enhance productivity and support informed decision-making; however, most study participants reported that such applications despite their benefits, they do not account for individual patient factors. Therefore, relying solely on applications like Medscape to verify prescriptions may not always be ideal, as they often suggest general treatment options without considering individual patient factors such as allergies, organ function (e.g., renal or hepatic impairment), comorbidities, or current medications. This limitation in currently used applications can increase the time pharmacists spend verifying and customizing therapy, primarily due to the need for extensive cross-referencing of information. This process can lead to delays in patient care and may increase the risk of errors if not managed efficiently. Another challenge for the use of such applications for checking prescriptions at the CRCU as reported by most participated pharmacists is the lack of information on CRCU-specific drugs, besides lacking needed details for drug dilution, compatibility, and storage. A close finding was reported by Shahmoradi et al. (2021), who considered that clinical decision support systems in the intensive care units frequently neglected to incorporate complex dosage regimens necessary for critically ill patients or institution-specific guidelines, which limited their usefulness(40).The last reported challenge for the currently available medical applications is their reliance on an active internet connection which can limit access to the needed information in places with inadequate connectivity—a problem that is clearly noticed in countries with low-resource settings(41). Therefore, some of the participating pharmacists recommended developing specific medication applications to assist Iraqi physicians in managing patients at the CRCU.

To address problems and difficulties with the currently used applications, some study participants reported verifying prescriptions for medication errors by consulting additional sources such as medical textbooks and college lectures. While this approach seems helpful, the information in college lectures is often outdated, not always valid, and not consistently evidence-based. Moreover, medical textbooks frequently rely on outdated guidelines(42). Consequently, relying on these references may be inadequate and could lead to missing some prescribing errors, particularly in the treatment of critically ill patients, where decisions must be based on the most current and evidence-based guidelines. Therefore, it is highly recommended that pharmacists rely on recent clinical guidelines in conjunction with mobile applications when evaluating the appropriateness of prescribed medications for patients in the CRCU.

Regarding pharmacists' actions when detecting a prescribing error, some pharmacists reported directly correcting the error before consulting the responsible physician. This approach contradicts the best practice, which recommends informing the physician about the errorto resolve it through a consensus decision(43–46). Conversely, pharmacists who reported informing the responsible physician about the error often did so without providing any recommendations on how to resolve the issue or prevent similar errors in the future. Additionally, some pharmacists notify the physician about the error by writing notes on the patient's case sheet, which, as opposed to verbal communication, may negatively impact the speed at which errors are addressed and may be less convincing to physicians in accepting the pharmacist's recommendations(47). In summary, the currently reported actions reflect poor and unethical practice by pharmacists working at the CRCU.

Regarding the current institutional measures to prevent or at least reduce prescribing errors at CRCUs in Iraqi hospitals, only a few pharmacists were aware of these measures. This may be attributed to the possibility that these regulations are not adequately communicated to pharmacists or are not effectively implemented or reinforced within hospitals, leading to limited awareness of the existing protocols and their importance. Meanwhile, few pharmacists were aware of the current institutional measures to reduce prescribing errors. Those who were aware, reported that these regulations include mandates for pharmacists to supervise the dispensing and administration of medications for CRCU patients, collaborate with physicians, and document notes on patients' case sheets when medication errors are detected.All these measures are well documented in the literature as effective in preventing prescribing errors(45, 46).Therefore, it is highly recommended to inform pharmacists about the current institutional regulations and to monitor their adherence to these measures in order to enhance patient safety in the CRCU.

To minimize prescribing errors and thereby improve patient safety, all of the participating pharmacists in the present study provided multiple recommendations. In this regard, most participating pharmacists concentrated their suggestions on physicians, emphasizing the importance of involving physicians in ongoing training and education to strengthen their skills and competence, as well as keeping them up-to-date with the latest treatment guidelines. Similarly, Likic and Maxwell(48)also highlighted the importance of ongoing professional development in safeguarding patients against prescribing errors.

Additionally, the participating pharmacists in the present study emphasized the importance of addressing staffing issues through retaining physicians in the CRCU without rotation. This recommendation is highly valued, as it can enhance physicians' experience (49)and can improve their familiarity with the healthcare team dynamics and unit-specific protocols(50). Another recommendation to lessen staffing issues was increasing the number of physicians in the CRCU and encouraging them to work as a team with pharmacists and other healthcare professionals. Both of these recommendations were already recommended by a study conducted in Hilla Hospital, Iraq, at 2009 (51). Indeed, these recommendations are reasonable since workload on physicians and disjointed work with pharmacists can increase the risk of medication errors(52).

Moreover, some of the current study participants provided scientific recommendations to minimize prescribing errors; these included developing specific medication management applications to assist physicians in managing CRCU patients, developing and enforcing specific treatment protocols for physicians, and providing physicians with access to an up-to-date electronic library (n = 2).Such recommendations are highly valued in previous literature for their effectiveness in reducing medication errors (53, 54).

To minimize prescribing errors that caused by medication interruption, five pharmacists recommended ensuring a continuous supply of lifesaving medications in hospitals. This recommendation is highly reasonable since medication interruption is a major cause for medication error as shown in a recent systematic review study(55).

On the other hand, one pharmacist suggested reducing prescribing errors by implementing electronic prescriptions instead of handwritten ones. Similarly, a systematic review found that electronic prescriptions to be effective in reducing medication errors(56).

The current study has several limitations. First, it was conducted in a single hospital; however, this was the largest and main hospital in Al-Muthanna Governorate. Second, there is a potential risk of social desirability bias, which may have led participants to conceal certain facts; nonetheless, this issue is common in most interview-based studies (57, 58). The final limitation relates to the necessity of translating quotations into English, which may impact the preservation of their original meaning; however, this challenge is also common in studies conducted in Iraq (59, 60).

Conclusion

Prescribing errors are prevalent among patients in the CRCU and can be life-threatening. The majority of these errors relate to incorrect dosing and drug-drug interactions. Contributing factors include physician negligence, limited clinical competence, and high workload. Pharmacists primarily rely on general mobile applications to identify prescribing errors. It is highly recommended to provide targeted training and education for physicians and to develop specialized mobile applications to effectively reduce prescribing errors in the CRCU.

Abbreviations

CRCU: Critical Care Units

ICU: Intensive Care Unit

CCU: Cardiac Care Unit

Participant : P

Declarations

Ethics approval and consent to participate

The study was ethically approved by the ethical committee at college of pharmacy – University of Baghdad (ethical approval number: RECAUBCP06262H at 10/06/2025).

Considering cultural factors and the likelihood that many individuals in Iraq may be hesitant to sign documents, ethical committee accepted obtaining verbal instead of written consent from study participants.

Consent for publication

No need consent for publication because the participants did not require to disclose their identities during the interview to preserve their confidentiality. Meanwhile, the researcher employed pseudonyms for the participants in the interview transcription.

Availability of data and materials

All information and data supporting the results reported in the article

Competing interests

"The authors declare that they have no competing interests"

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Authors' contributions

The two researchers collaborated to complete this work after discussing the details. Zina Tahsin Ali conducted the interviews with the participants, recorded, analyzed, and archived all their answers, while Dr. Ehab Mudher Mikhael supervised all the details of the work, reviewed and analyzed all the answers, and the two of them jointly wrote the article.

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