JURNAL PHARMA BHAKTA

LITERATURE REVIEW: THE ROLE OF PHARMACISTS IN PREVENTING MEDICATION ERRORS IN PEDIATRIC PATIENTS

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ABSTRACT

Background: Medication errors (MEs) in pediatric patients are a serious patient safety concern. MEs in children often occur due to insufficient understanding of pediatric dosing and non-compliance with standard operating procedures (SOPs) by healthcare professionals. **Objective:** This article aims to review the role of pharmacists in preventing MEs in pediatric patients through an analysis of recent literature. **Methods:** The article was prepared as a literature review using sources from online databases (ScienceDirect, PubMed, Google Scholar) published between 2020 and 2025. Inclusion criteria included full-text availability, relevance to the topic, and focus on the pediatric context. **Results:** Several studies show that pharmacist interventions, such as prescription review, education, audit, medication reconciliation, and participation in ward rounds, can reduce the incidence of MEs by 64–73%. Studies in Indonesia revealed that 92% of pediatric prescriptions did not include body weight and only 16% contained complete information, indicating a high potential for dosing errors. Pharmacist-led education for healthcare providers and parents/caregivers plays an important role in improving understanding and preventing medication administration errors at home. **Conclusion:** Pharmacists play a crucial role in preventing pediatric MEs through clinical and educational interventions. Active pharmacist involvement in multidisciplinary teams is strongly recommended to improve pediatric patient safety.

ABSTRAK

Latar Belakang: Kesalahan pengobatan (*medication error*) pada pasien pediatrik merupakan masalah keselamatan pasien serius. ME pada anak sering terjadi karena antara lain kurangnya pemahaman dosis pediatrik dan ketidakpatuhan SOP (*Standart Operating Procedure*/Prosedur Operasional Standar) oleh tenaga kesehatan. **Tujuan:** Artikel ini bertujuan meninjau peran apoteker dalam pencegahan ME pada pasien pediatrik melalui analisis literatur terbaru. **Metode:** Artikel disusun dengan metode *literature review* menggunakan sumber dari basis data daring (ScienceDirect, PubMed, Google Scholar) dalam rentang tahun 2020–2025. Kriteria inklusi meliputi artikel dengan teks lengkap, relevan dengan topik, dan sesuai konteks pediatrik.. **Hasil:** Beberapa studi menunjukkan intervensi apoteker klinis, seperti telaah resep, edukasi, audit, konsiliasi obat, dan keterlibatan dalam *ward round*, mampu menurunkan kejadian ME hingga 64–73%. Studi di Indonesia mengungkap 92% resep anak

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tidak mencantumkan berat badan dan hanya 16% resep mencantumkan data lengkap, yang menunjukkan potensi besar terjadinya *dosing error*. Edukasi apoteker kepada tenaga kesehatan dan orang tua/*caregiver* berperan penting dalam meningkatkan pemahaman serta mencegah kesalahan pemberian obat di rumah. **Simpulan**: Apoteker berperan krusial dalam pencegahan ME pediatrik melalui intervensi klinis dan edukatif. Keterlibatan aktif apoteker dalam tim multidisiplin direkomendasikan untuk meningkatkan keselamatan pasien anak.

INTRODUCTION

Patient safety is a fundamental priority across healthcare systems and an essential component of high-quality care. Medication errors (MEs) and preventable adverse drug events (ADEs) may occur at various stages of healthcare delivery, posing significant harm to patients (Naseralallah *et al*., 2020). MEs encompass errors that may arise during prescribing, transcribing, preparing, dispensing, administering, and monitoring medications, whereas ADEs refer to injuries or harmful effects resulting from medication use, which may sometimes stem from prescription errors (Keskin *et al*., 2024).

MEs are preventable incidents and are particularly prevalent in pediatric patients due to the complexity of dosing and unique communication challenges associated with children (Zhou, Jia, & Wang, 2021; Alghamdi, Khalil, & Alzahrani, 2022). Pediatric dosing requires highly precise adjustments based on weight or age, making children more vulnerable to errors than adults (Rashed *et al*., 2020). Furthermore, most available drug formulations are designed for adults, creating additional obstacles in pediatric pharmacotherapy. Currently, fewer than 50% of medicines on the market have been adequately studied in pediatric populations (Deswal *et al*., 2025). In clinical pharmacy practice, pharmacists serve not only as medication providers but also as clinical supervisors responsible for assessment, intervention, and education to effectively prevent MEs (Putri, Prasetyo, & Wirawan, 2023; Prabaningrum, Prasetyo, & Wirawan, 2021).

Pediatric MEs often occur during prescribing and dispensing. From a pharmacokinetic and pharmacodynamic standpoint, children differ significantly from adults because their organ function (liver, kidneys) continues to mature, affecting drug distribution and elimination (Maiz, Nurmainah, & Untari, 2020; Zhou *et al*., 2021). Doses must be calculated carefully, often requiring conversions based on weight or body surface area, which increases the likelihood of errors (Santos, Pérez, & Martínez, 2021). Children are especially vulnerable due to individual dose calculations (mg/kg or mg/m^2), variable weights/ages, and immature ADME processes (D'Errico *et al*., 2022; Hannibal *et al*., 2025). Limited pediatric formulations often require dilution, reconstitution, or compounding, increasing the risk of incorrect concentrations (Ghezaywi *et al*., 2024).

Additionally, limited pediatric formulations often force modification of adult products, potentially altering chemical stability (Benawan, Citraningtyas, & Wiyono, 2021; Prabaningrum *et al*., 2021). Clinically, incomplete patient information (e.g., missing body weight), unclear prescriptions, and ineffective communication among healthcare professionals are major contributors to MEs (Ghaleb, Barber, & Franklin, 2020; Santos *et al*., 2021; Kumar, Menon, & Sharma, 2023). Clinical pharmacists are critically important in conducting thorough clinical reviews and verifying doses before medications are administered (Al-Jumaili *et al*., 2022).

From a chemical perspective, MEs may also arise from unit conversion errors (µg–mg–mL), differences in drug salts/bases, lack of standardized IV/syrup concentrations, Y-site incompatibilities, chemical degradation, and the use of high-alert medications (e.g., insulin, concentrated electrolytes, opioids, chemotherapy, heparin, digoxin, concentrated antimicrobials) (Marasabessy & Lerebulan, 2021). Furthermore, rapid changes in renal/hepatic function in children require careful dose-interval adjustments; without adequate monitoring, this may result in sub-therapeutic or toxic effects (Fatimah *et al*., 2021).

High workload, environmental disruptions, interruptions during medication preparation, and limited resources also increase the risk of MEs (Benawan *et al*., 2021; Fernández *et al*., 2021). Thus, the role of clinical pharmacists spans prescription screening, clinical intervention, interprofessional collaboration, education, and oversight of technology implementation—all essential to reducing pediatric MEs.

Integrated, multidisciplinary solutions have been proposed to improve pediatric medication safety. Pharmacists play a significant role in ensuring safe medication use and achieving optimal therapeutic outcomes for pediatric patients (Keuler *et al*., 2021).

METHOD

This article was compiled using a literature review approach, sourcing articles from online databases such as ScienceDirect, Google Scholar, and PubMed. Keywords used included *"Pharmacist Role"*, *"Medication Error"*, and *"Pediatrics"*. Inclusion criteria were full-text accessibility, relevance to pediatric medication safety, and publication within the last five years (2020–2025). Reference lists of identified systematic reviews were also screened manually to ensure comprehensive coverage.

RESULT

Systematic reviews and meta-analyses show that clinical pharmacist involvement in hospital care reduces medication errors and preventable ADEs, including potential harm events occurring before drug administration. Furthermore, these interventions improve patient care quality and reduce healthcare costs, enhancing system efficiency overall (Keskin *et al*., 2024).

Table 1 summarizes six key international and Indonesian studies (2020–2024) on pediatric ME prevention. Generally, clinical pharmacist involvement significantly decreases ME incidence. Two recent meta-analyses report reductions of approximately 64–73% (Jaam *et al*., 2021; Alshammari *et al*., 2024). Jaam *et al*. (2021) reported an odds ratio (OR) of 0.27 (95% CI

0.15–0.49), indicating a significant association between pharmacist involvement and reduced pediatric MEs. Similarly, Alshammari *et al*. (2024) highlighted a 73% reduction in prescribing errors following pharmacist interventions such as prescription review, education, and ward round participation. Their meta-analysis also revealed that pharmacist-provided education to healthcare professionals was among the most effective strategies.

Observational studies in PICUs in the Netherlands showed that audit and feedback programs led by clinical pharmacists resulted in 63% acceptance of pharmacist recommendations and reduced potential harm incidents (den Hollander *et al*., 2022). Indonesian data highlight critical issues: Firdayanti and Rumi (2020) found that 92% of pediatric prescriptions lacked body weight information. Oktianti *et al*. (2021) observed similar findings, with only 16% of prescriptions including weight data. Poor interprofessional communication and high workload were major contributors (Benawan *et al*., 2020).

Table 1. Comparison of Studies on Pharmacist Roles in Preventing Pediatric MEs

Authors (Year)	Country	Study Design	Pharmacist Interventions	Key Findings
Jaam *et al*. (2021)	Qatar & Internasional	Systematic Review & Meta-Analysis	Prescription review, education, ward rounds	Significant reduction in medication errors (OR 0.27)
Alshammari *et al*. (2024)	Saudi Arabia	Systematic Review & Meta-Analysis	Pharmacist-led interventions in pediatric hospitals	73% reduction in prescribing errors
den Hollander *et al*. (2022)	Netherlands	Observational Study	Audit and feedback in PICU	63% acceptance of pharmacist recommendations; reduced harm incidence
Firdayanti & Rumi (2020)	Indonesia (Palu)	Observational Study	Verification of pediatric prescriptions	92% of prescriptions lacked body weight; high potential for dosing errors
Benawan *et al*. (2020)	Indonesia (Tobelo)	Cross-sectional Study	Evaluation of contributing factors	Poor communication and high workload identified as major causes
Oktianti *et al*. (2021)	Indonesia (UNW)	Observational Study	Evaluation of prescription completeness	Only 16% of prescriptions included body weight

DISCUSSION

The unique characteristics of pediatric patients make them significantly more vulnerable to medication errors (MEs). The findings of the aforementioned studies consistently show that incorrect dosing (miscalculation) is the factor most frequently prompting pharmacist intervention (Jaam *et al*., 2021; Alshammari *et al*., 2024). This issue is closely related to the need for precise dose adjustments based on a child's body weight or body surface area, both of which are susceptible to calculation errors. The frequent absence of body weight information in pediatric prescriptions—reported in 92% to 84% of prescriptions in regional hospitals (Firdayanti & Rumi, 2020; Oktianti *et al*., 2021) significantly increases the likelihood of dosing errors. This situation reflects the urgent need to improve prescribing procedures; pharmacists

play a key role in ensuring that every pediatric prescription includes accurate body weight data and correctly calculated doses before the medication is prepared. Without pharmacist verification, pediatric dosing may deviate from the intended therapeutic range, leading to either underdosing or overdosing.

Conversion and unit errors (such as mg vs. µg or mg/kg vs. total dose), along with variations in available drug concentrations, also contribute substantially to pediatric MEs (Santos *et al*., 2021; Ghezaywi *et al*., 2024). Children often require medications in liquid formulations or reconstructed/compounded forms because commercially available products are limited. These processes of dilution, reconstitution, or pediatric compounding increase the risk of concentration errors if not closely monitored (Prabaningrum *et al*., 2021; Kuitunen *et al*., 2025). Similarly, the use of high-alert medications—such as insulin, concentrated electrolytes, opioids, and chemotherapeutic agents—poses elevated risk in pediatric populations due to the immaturity of their pharmacokinetic profiles (Rashed *et al*., 2020; Fatimah *et al*., 2021). The developmental maturation of hepatic and renal function leads to different pharmacological responses compared with adults (Maiz *et al*., 2020). Rapid changes in drug elimination capacity in children also necessitate dose-interval adjustments; without careful monitoring, these fluctuations can result in toxic accumulation or subtherapeutic levels (Hannibal *et al*., 2025). Collectively, these factors explain why children are more susceptible to harmful consequences of medication errors than adults.

From a systems and healthcare environment perspective, ineffective interprofessional communication and high workload are major contributors to pediatric MEs (Benawan *et al*., 2020; Fernández *et al*., 2021). Poor communication may involve unclear transmission of therapeutic information between physicians, nurses, and pharmacists—such as incomplete dosing instructions or undocumented therapy changes. Heavy workloads and time pressures can also cause essential checking steps to be overlooked. Consequently, fostering a culture of communication and collaboration is essential. In this context, clinical pharmacists serve as key communication intermediaries: ensuring that prescription information is complete and unambiguous, conducting medication reconciliation during patient transitions of care, and promoting double-checking practices among healthcare professionals before medication administration. Evidence from a Dutch PICU demonstrated that pharmacy-led audits and feedback reduced error incidence, but the acceptance rate of pharmacist recommendations 63% indicates that persistent barriers to collaboration remain (den Hollander *et al*., 2022). Conversely, other reports show that when pharmacists are fully integrated into healthcare teams, for example, participating in daily ward rounds and contributing directly to clinical decision-making acceptance rates of pharmacist recommendations can exceed 90% (Devilia & Dhamanti, 2024; Zennaro *et al*., 2025). These findings underscore that strong multidisciplinary collaboration maximizes the impact of pharmacist interventions.

From an educational perspective, pharmacist interventions target two main groups: healthcare professionals and caregivers/patients. Education provided to healthcare workers (physicians, nurses) may include training on safe prescribing and administration practices for pediatric patients. Meta-analytic evidence indicates that pharmacist-led training for healthcare staff is among the most effective strategies for reducing prescribing-stage errors (Alshammari *et al*., 2024). Continuous programs covering pediatric dose calculation, unit conversion, and updated medication guidelines can significantly improve clinical competence, thereby reducing errors. Case reports also show that after pharmacist-delivered training sessions, prescribing

errors decreased markedly and physician adherence to formulary standards increased (Jaam *et al*., 2021). Thus, pharmacists function as educators and guardians of quality within pediatric healthcare teams.

Education and empowerment of parents/caregivers are equally important. Many medication administration errors occur at home following patient discharge—examples include incorrect measurement of liquid medications or missed doses. Studies report that ME incidence at home reaches approximately 15.9%, with the most common issues being missed doses and inaccurate measurement of liquid medicines (Kuitunen *et al*., 2025). This correlates with data showing that only around 15% of parents possess adequate health literacy, and low literacy increases the risk of dosing errors by 1.5–2.5 times (Keskin *et al*., 2024). Therefore, pharmacists must ensure that every caregiver receives clear and literacy-appropriate counseling. Repetitive communication methods such as teach-back (having caregivers repeat instructions) and visual aids (illustrated or pictogram-based education materials) have demonstrated effectiveness in improving understanding (D'Errico *et al*., 2022). Randomized controlled trials in pediatric hospitals also show that literacy-sensitive communication interventions significantly reduce caregiver dosing errors compared with standard counseling (D'Errico *et al*., 2022). Additionally, caregiver knowledge about medications—including dose, duration, and potential side effects—increases significantly following such literacy-tailored interventions.

Caregivers show high levels of interest and need for medication-related education. A multicenter survey from China revealed that caregivers are highly aware of the importance of safe medication practices for children, and they are willing to learn as long as information is provided clearly and accessibly (Zhou *et al*., 2021). Healthcare professionals and official medical institutions were identified as their most trusted information sources, emphasizing the strategic role of pharmacists in disseminating this knowledge. Therefore, proactive strategies are necessary: pharmacists should provide public education such as seminars for parents, informational leaflets, or educational videos on proper pediatric medication practices. Improved caregiver understanding can prevent common errors such as dosing with household spoons instead of standardized measuring devices or prematurely discontinuing antibiotics.

CONCLUSION

The literature indicates that pharmacists significantly enhance pediatric medication safety. Their educational role bridges knowledge gaps among healthcare providers and caregivers, reducing medication errors at multiple stages. As integral members of multidisciplinary teams, pharmacists identify and correct errors from prescribing through monitoring, contributing to improved clinical outcomes. Pharmacists are therefore essential in pediatric healthcare systems to prevent MEs and promote optimal patient safety.

RECOMMENDATIONS

Further research is needed in Indonesia, particularly quantitative intervention studies assessing pharmacist involvement in pediatric hospitals. Evaluations of pharmacist-led educational interventions—including teach-back, visual media, and online counseling—are also recommended to determine their effectiveness..

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