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MEDICATION SAFETY IN CLINICAL PRACTICE: ERROR PATTERNS, PREVENTION STRATEGIES, AND PHARMACISTS' CONTRIBUTIONS

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ABSTRACT

Medication errors can occur at any point from prescribing to follow-up and remain a preventable source of patient harm. This narrative review examined contemporary evidence on error patterns, contributing conditions, preventive interventions, and pharmacists' roles. English-language human studies indexed in PubMed and published between 1 January 2018 and 21 June 2026 were considered through focused searches covering medication safety, error prevention, clinical pharmacy, reconciliation, decision support, electronic prescribing, hospitals, and clinical practice. Twenty-eight articles were selected to provide representative evidence from systematic reviews, intervention studies, observational analyses, qualitative research, reporting datasets, and digital-system evaluations. Across care settings, dose errors, omissions, wrong-drug events, incomplete orders, infusion-rate errors, and discrepancies during care transitions were recurring problems. No single intervention addressed the entire medication-use pathway. Medication reconciliation, structured review and deprescribing, electronic prescribing with carefully governed decision support, standardisation, education, incident reporting, and multidisciplinary communication improved medication processes in selected settings; effects on readmission, mortality, and length of stay were less consistent. Pharmacists contributed most effectively when they were integrated into clinical decisions and transitions of care, had access to relevant patient

information, and could resolve identified problems. Sustainable improvement depends on adequate staffing, interoperable medication information, meaningful outcome measurement, and a non-punitive learning culture.

KEYWORDS: Clinical pharmacy; medication errors; medication reconciliation; medication safety; patient safety; pharmacists.

INTRODUCTION

Medication use is a sequence of linked activities: prescribing, communicating the order, dispensing and preparing the product, administering it, monitoring the response, and transferring information when care changes hands. A preventable failure at any point may be intercepted without harm or may contribute to prolonged hospitalisation, disability, or death. Because every step depends on people, records, devices, and local workflow, medication errors are better examined as failures within a system than as isolated mistakes by an individual.[1-2,13]

Errors have been documented in hospitals, outpatient services, long-term care, and transitions between settings, although their reported frequency varies widely. The outpatient review by Naseralallah and colleagues identified prescribing and dosing as leading error types.[1] National and institutional datasets show a different distribution, with administration, dose, omission, and wrong-drug events prominent.[2-4] These estimates are not directly comparable because studies use different definitions, detection methods, case mixes, denominators, and reporting systems. A high count may indicate closer surveillance, whereas a low count may reflect under-detection.

Risk is greater when treatment is complex. Polypharmacy, renal or hepatic impairment, high-alert medicines, critical illness, advanced age, paediatric weight-based dosing, and repeated transfers of care increase the opportunity for error and the possible severity of harm. Digitalisation has changed this risk rather than simply removing it. Electronic prescribing eliminates illegible handwriting and some transcription steps, but unsafe defaults, crowded interfaces, excessive alerts, incomplete data, and automation bias can introduce new problems.[11-12]

Pharmacists work at several points in this pathway and can link an individual prescription problem to a wider system defect. Their work includes medication reconciliation, prospective

review, deprescribing, therapeutic monitoring, patient education, incident analysis, stewardship, and the design of decision-support rules. This review addresses four practical questions: which errors recur in clinical care, why they occur, which preventive approaches are supported by recent evidence, and where pharmacist involvement adds value without assuming that every intervention changes a distal outcome such as mortality.

LITERATURE SEARCH AND REVIEW APPROACH

A focused narrative search of PubMed was undertaken on 21 June 2026 to identify English-language human studies published from 1 January 2018 to the search date. Search concepts covered medication safety, medication errors, pharmacists, prevention, medication reconciliation, clinical decision support, electronic prescribing, hospitals, and clinical practice. The purpose was to identify representative contemporary evidence addressing the four review questions, rather than to estimate the total number of eligible publications.

Articles were considered when they described recurring medication-error patterns, contributing conditions, preventive interventions, or pharmacists' contributions in clinical care. Selection was purposive to represent different medication-use stages, care settings, study designs, and clinically useful outcomes. Twenty-eight articles formed the principal evidence set, comprising systematic reviews and meta-analyses, randomised and non-randomised interventions, observational and qualitative studies, reporting-database analyses, and digital-system evaluations.

One author conducted the searching, selection, appraisal, and narrative synthesis. Duplicate screening, formal risk-of-bias scoring, and meta-analysis were not undertaken. Because the review was not designed as a systematic review, PRISMA-style retrieval and exclusion counts are not reported. Findings were compared across sources and interpreted in light of differences in setting, definitions, detection methods, denominators, and outcomes.

RESULTS AND DISCUSSION

Common medication errors across the medication-use process

Medication errors are best classified by the stage at which the failure occurs and by the nature of the deviation. Prescribing errors include inappropriate drug selection, contraindicated therapy, wrong dose, frequency or route, therapeutic duplication, incomplete orders, failure to adjust for organ function, and omission of indicated treatment. Communication and transcription errors include ambiguous abbreviations, incomplete handover, inaccurate

medication histories, and differences between electronic systems. Dispensing and preparation errors include selection of the wrong product or strength, labelling errors, calculation or compounding mistakes, and incorrect storage. Administration errors include omitted, extra, late, wrong-patient, wrong-drug, wrong-dose, wrong-route, and wrong-rate administrations. Monitoring errors arise when laboratory results, drug concentrations, clinical responses, or emerging toxicity are not obtained or acted upon. Transition errors occur when medicines are unintentionally omitted, duplicated, continued, or changed during admission, transfer, or discharge.

Table 1: Common medication errors in clinical practice.

Medication-use stage	Typical errors	Frequent contributing mechanisms	Potential consequences
Prescribing	Wrong drug, dose, frequency, route or formulation; contraindication; duplication; omission; incomplete order	Insufficient patient information, knowledge gaps, calculation errors, failure to adjust for organ function, time pressure	Ineffective therapy, toxicity, interactions, avoidable deterioration
Communication and transcription	Ambiguous abbreviation; incorrect copying; incomplete verbal order; loss of information between electronic systems	Poor handover, fragmented records, non-standard terminology, interruptions	Mismatch between intended and delivered therapy
Dispensing and preparation	Wrong medicine or strength; labelling error; compounding or dilution error; incorrect storage	Look-alike/sound-alike products, workload, inadequate checking, confusing packaging	Wrong product reaches the care area or patient
Administration	Omission; wrong patient, drug, dose, route, time or infusion rate; unauthorised medicine	Staffing constraints, interruptions, identification failure, pump programming error, unavailable medicine	Immediate harm, under-treatment, overdose, severe or fatal events
Monitoring	Failure to order, review or respond to laboratory tests, drug levels, vital signs or symptoms	Unclear responsibility, alert overload, delayed results, inadequate follow-up	Undetected toxicity, accumulation, preventable treatment failure
Transitions of care	Unintentional discrepancy, omission, duplication, continuation of temporary therapy, inaccurate discharge list	Incomplete medication history, multiple prescribers, rushed discharge, non-interoperable records	Post-discharge adverse events, readmission, non-adherence and confusion

Source: Author's synthesis of evidence reported in references.[1-6,11-13]

Burden, patterns, and clinical significance

How errors are sought largely determines how many are found. Direct observation and active pharmacist review usually identify more events than voluntary reports, which tend to capture unusual or harmful incidents. In outpatient and ambulatory care, Naseralallah and colleagues reported estimates ranging from 23% to 92% of prescribed medicines; prescribing errors reached 91% in some studies and dosing errors 41%. These figures describe a heterogeneous evidence base and should not be combined into a single prevalence estimate.[1]

National incident-report data provide a different view by emphasising error type and severity. In Norway, 3,372 hospital medication-error reports were analysed; 68% occurred during administration and 24% during prescribing. Dose, strength, or frequency errors accounted for 38%, omissions for 23%, and wrong-drug errors for 15%. Sixty-two percent were classified as harmful, 5.2% caused severe harm, and 27 reports were fatal.[2] These findings demonstrate that administration remains a critical final barrier, even when prescribing and dispensing safeguards are present.

Reporting studies from Qatar and Saudi Arabia underscore the contribution of pharmacists to error detection. In Qatar, 5,103 reports were reviewed; pharmacists submitted 91.5% and prescribing errors represented 87.9% of the total.[3] A more recent Saudi analysis of 19,645 reports from nine hospitals found that 69.1% were intercepted before reaching patients, prescribing accounted for 94.8%, and pharmacists submitted more than 90% of reports.[4] High detection by pharmacists is encouraging, but it also indicates that reported error distributions can reflect who has access, time, training, and responsibility to report.

Context-specific studies reveal additional risk patterns. In an Iranian internal-medicine department, the mean number of errors was 2.42 per medical record, administration of non-prescribed medicine was most frequent, and night shifts were associated with more errors.[5] In paediatric critical care, pharmacist observation identified potential errors in 72% of reviewed prescriptions; abbreviations and incorrect administration rates were particularly common.[6] Paediatric and neonatal care amplify risk because doses are frequently weight based, concentrations may need individualised preparation, and small calculation deviations can have large clinical effects.

Reporting volume alone is therefore a poor measure of safety. When a pharmacy service or reporting programme starts, recorded errors may increase because staff are finding and

documenting events that previously remained hidden. Conversely, few reports can reflect fear of blame, an inaccessible system, or failure to recognise an error. Evaluation needs a denominator and should describe the detection method, level of harm, interception before exposure, and any change in reporting behaviour.

Contributing factors

Most medication errors arise from a chain of weaknesses rather than one cause: a vulnerable patient, a complex regimen, missing information, time pressure, and a safeguard that is absent or fails when needed. Grouping contributory conditions into patient, medicine, professional, team, organisational, technological, and cultural domains helps identify where the system can be redesigned instead of attributing the event only to the last person involved.

Patient-related factors include advanced age, frailty, multiple chronic conditions, polypharmacy, impaired renal or hepatic function, cognitive or sensory impairment, language barriers, limited health literacy, and dependence on caregivers. Frequent admissions and transfers expose patients to repeated reconciliation and communication failures. High-risk medicines add complexity through narrow therapeutic indices, weight- or organ-function-based dosing, drug interactions, and the need for laboratory monitoring. Pharmacists interviewed about direct oral anticoagulants emphasised dosing uncertainty, patient understanding, access to guidelines, multidisciplinary collaboration, and the need for consistent risk assessment.[7]

Professional factors include insufficient knowledge, calculation difficulty, unfamiliarity with protocols, fatigue, interruptions, and failure to communicate uncertainty. Survey evidence indicates that willingness to report does not necessarily correspond to adequate technical knowledge. Among healthcare professionals in Sudan, medication-error reporting knowledge was moderate but attitudes and practices were low, and lack of knowledge was the most frequently reported barrier.[8] A Saudi survey found that most participating pharmacists had limited medication-error knowledge despite strongly positive attitudes toward reporting.[9] These findings support targeted, role-specific education rather than generic exhortations to be more careful.

Team and workflow factors are especially important during handover. A qualitative study of intensive-care-to-ward transfer identified process complexity, time pressure, communication difficulties, technology and system interfaces, and beliefs about consequences as interacting

determinants of medication safety.[10] Medication information may be technically available yet clinically unusable because it is distributed across screens, not reconciled, or not accompanied by the rationale for starting or stopping treatment. Rushed discharge, unclear ownership of follow-up, and delayed communication with primary care can convert a correct inpatient plan into an unsafe transition.

Staffing, workload, interruptions, medicine availability, physical layout, local policy, training, and the design of reporting systems all shape performance. The association of errors with night work and high workload suggests that vigilance alone cannot compensate for poor working conditions.[5] Near misses and intercepted events are useful only when organisations review them and change the process; a punitive response makes those events less visible.

Technology is both a safeguard and a source of new error. Computerised provider order entry can reduce illegibility, transcription, and transmission errors, but poorly configured order sets, drop-down selection, duplicated alerts, inaccurate default doses, interface failures, and electronic medication-administration-record usability problems can introduce new hazards. In a paediatric hospital, computerised order entry reduced errors related to acknowledgement, transmission, and transcription, but administration errors persisted and technology-related errors emerged.[11] A Delphi study in paediatric intensive care showed that clinicians could readily agree that smart-pump scenarios represented errors, while consensus was more difficult for several electronic-prescribing scenarios, reflecting the complexity of defining technology-generated failures.[12]

Table 2: Contributing factors and corresponding safety responses.

Domain	Examples of contributing factors	Priority safety response
Patient	Polypharmacy, frailty, organ impairment, cognitive impairment, health literacy and language barriers, multiple care transitions	Risk stratification, simplified regimens, patient/caregiver engagement, reconciliation at every transition
Medication	Narrow therapeutic index, high-alert medicines, complex calculations, multiple strengths, look-alike/sound-alike names	Standard concentrations, independent checks, dosing protocols, stewardship and monitoring
Healthcare professional	Knowledge gaps, fatigue, unfamiliarity, calculation error, overreliance on memory	Competency-based education, accessible guidelines, supervision, pharmacist consultation
Team and communication	Incomplete handover, unclear responsibility, fragmented documentation, limited	Structured handoff, shared medication plan, multidisciplinary rounds and closed-loop communication

	interprofessional contact	
Workflow and organisation	Interruptions, inadequate staffing, time pressure, unavailable medicines, weak policy, poor feedback	Human-factors redesign, protected medication tasks, staffing review, incident learning and accountability
Technology	Alert fatigue, unsafe defaults, interface problems, fragmented systems, automation bias	Usability testing, clinically prioritised alerts, governance, monitoring for technology-induced errors
Safety culture	Fear of blame, low reporting, normalisation of workarounds, limited learning from near misses	Just culture, confidential reporting, regular feedback, multidisciplinary review of incidents

Source: Author's synthesis of contributing conditions described in references.[5,7-12]

Prevention strategies

No preventive measure works independently of the system in which it is introduced. A Cochrane review found that medication reconciliation, computerised provider order entry or clinical decision support, barcoding, feedback on prescribing errors, education, and selected dispensing changes may reduce medication errors or adverse drug events, but the certainty and consistency of benefit varied.[13] Local workflow, staff engagement, implementation quality, and the interaction between safeguards determine whether an intervention works in practice.

Medication reconciliation and transition management

Medication reconciliation aims to create the most accurate possible medication list, compare it with current orders, resolve unintended discrepancies, and communicate the reconciled plan. It is particularly valuable at admission, internal transfer, and discharge, where omissions and duplications are common. A systematic review and meta-analysis of adult intensive-care transitions found that medication-related interventions reduced inappropriate continuation of medicines at intensive-care discharge and hospital discharge; multicomponent interventions involving education and guidelines were especially effective for deprescribing by hospital discharge.[14]

Two transition studies show what reconciliation changes in practice. A pathway intervention for hip-fracture patients linked admission reconciliation, inpatient review, discharge documentation, rehabilitation review, and follow-up. Medication information improved and potentially inappropriate medicines decreased, although readmission and mortality were unchanged.[15] At psychiatric admission, a complete medication history identified 82 errors in 72 patients; dose discrepancies and omissions were common, and most errors could have

caused harm if left uncorrected.[16] Reconciliation is therefore a clinical assessment of what a patient is taking and why, not merely a comparison of two lists.

A safe discharge record must communicate therapeutic intent as well as the final list of medicines. The next care team and the patient need to know why treatment was started, stopped, or changed, how long it should continue, and what monitoring is due. This requires access to primary-care and community-pharmacy information, clear documentation of the rationale, counselling, and confirmation that the plan reached the intended recipient.

Structured medication review and deprescribing

Medication review identifies drug-related problems by assessing indication, effectiveness, safety, adherence, interactions, duplication, dose, monitoring, and patient goals. The approach is particularly relevant to older adults and patients with polypharmacy. A systematic review and meta-analysis of emergency-department programmes for older adults found that multidisciplinary approaches involving pharmacists or geriatricians improved deprescribing of potentially inappropriate medicines. Educational interventions and computerised decision support also reduced inappropriate prescribing, although effects on admission, length of stay, and falls were inconsistent.[17]

Recent controlled studies report improvements in process and medication outcomes. Closed-loop management combining clinical pharmacists, digital risk alerts, and full-process tracking was associated with lower potentially inappropriate medication use and fewer adverse drug reactions in older inpatients with rheumatic and immunologic disease, although its retrospective single-centre design limits causal inference.[18] Pharmacist-led review and deprescribing in older patients with hip fracture reduced medicine burden, potentially inappropriate medicines, and reported adverse drug reactions, but allocation based on acceptance of recommendations introduces selection bias.[19] In long-term care, a one-time pharmacist review generated more medication changes and resolved approximately half of forwarded drug-related problems, yet falls, hospitalisation, and mortality did not improve.[20]

Medication optimisation and downstream clinical outcomes should be reported separately. A review may correct drug-related problems without changing readmission or mortality, which are also influenced by disease severity, social circumstances, and access to follow-up. Evaluations should include proximal outcomes—resolved discrepancies, appropriate prescribing, and actionable monitoring—alongside patient-centred outcomes. The number of

pharmacist recommendations is an activity measure, not proof of clinical benefit.

Electronic prescribing and clinical decision support

Electronic prescribing and clinical decision support can prevent errors by checking allergies, interactions, duplicate therapy, dose limits, organ function, laboratory values, and monitoring requirements. Their benefit depends on specificity and workflow integration. In the HIGEA evaluation, a multidisciplinary team developed 211 clinical rules addressing renal dose adjustment, anticoagulant and antiplatelet therapy, biochemical or hematologic toxicity, and therapeutic drug monitoring. Pharmacists reviewed 1,086 alerts; 51% generated an intervention, and 368 required a documented therapy modification after interception of a real prescribing error.[21]

Machine-learning approaches seek to prioritise review rather than present every possible warning. A hybrid system trained on 133,179 orders achieved better discrimination for prescriptions requiring pharmacist review than conventional decision-support alerts or a multicriteria query.[22] A later prediction tool used electronic health-record data to identify patients at high risk of medication discrepancies at admission; in retrospective simulation it selected a substantially higher proportion of patients with discrepancies than the existing prioritisation method.[23] These tools may help allocate limited pharmacist capacity, but prospective external validation, monitoring for bias, transparent governance, and demonstration of patient benefit are required before widespread reliance.

Decision support needs to fit the work it is intended to improve. Repeated low-value warnings promote alert fatigue, whereas rigid rules can interrupt a deliberate clinical exception. High-priority alerts should show the relevant patient data, state the recommended action, and allow a reasoned override. Governance teams should also review unsafe defaults, duplicate order routes, interface failures, and incidents introduced by the technology itself.

Standardisation, administration safeguards, education, and reporting

Standardisation reduces unnecessary variation through approved order sets, standard concentrations, dose-range checking, clear labelling, segregation of look-alike products, independent verification for high-alert medicines, barcode-assisted administration, and smart-pump libraries. The burden of administration errors in national incident data indicates that digital prescribing alone cannot protect patients after the order has been generated.[2] Paediatric studies further support removing ambiguous abbreviations, standardising weight-

based calculations and infusion concentrations, and ensuring that pump programming is consistent with the prescribed dose and concentration.[6,12]

Education is more useful when it addresses errors observed locally and is reinforced during practice. In an emergency-care study, a TeamSTEPPS-based programme using films, online learning, virtual simulation, and co-debriefing improved interprofessional performance and increased reporting of prescription near misses; harmful errors did not fall significantly.[24] More near-miss reports after training can indicate better recognition and greater willingness to speak up rather than poorer care.

Reporting systems should be quick to use, confidential, and followed by visible feedback. Structured fields are needed for the medication-use stage, error type, contributing conditions, interception, and harm, but the free-text account often explains how the event developed. Pharmacists generated most reports in the Qatar and Saudi datasets, demonstrating strong engagement while also showing that nurses, physicians, technicians, and patients need practical routes to report.[3-4] Multidisciplinary review should lead to a named action and a later check for recurrence.

Table 3: Evidence-informed medication-safety interventions.

Intervention	Primary mechanism	Evidence signal	Important limitation
Medication reconciliation	Identifies and resolves unintended discrepancies at admission, transfer and discharge	Reduces discrepancies and inappropriate continuation; strengthens medication information across care settings.[13-16]	Resource intensive; clinical outcome effects are inconsistent
Structured medication review and deprescribing	Assesses indication, dose, interactions, monitoring, adherence and patient goals	Improves appropriateness and reduces potentially inappropriate medicines in selected populations.[17-20]	Process benefits may not translate into mortality or readmission reductions
CPOE and clinical decision support	Prevents illegibility, applies rules and links orders with patient data	Can reduce prescribing and transcription errors and support pharmacist intervention.[11,13,21]	Alert fatigue, unsafe defaults and technology-induced errors
AI-based risk prioritisation	Ranks patients or prescriptions by probability of clinically important error	Improves targeting of pharmacist review in retrospective and validation studies.[22-23]	Needs external prospective validation, bias monitoring and outcome evaluation
Standardisation and administration safeguards	Reduces variation through protocols, standard concentrations, barcodes and smart pumps	Targets common dose, omission, wrong-drug and infusion errors.[2,6,12]	Safeguards can be bypassed or misconfigured
Education,	Builds shared mental	Improves team	Knowledge gains may

simulation and teamwork	models, communication and response to high-risk scenarios	performance and near-miss reporting.[24]	not directly reduce harmful errors
Incident reporting and feedback	Creates organisational learning from errors and near misses	Identifies recurring stages, medicines and system factors.[3-4,8-9]	Voluntary systems underestimate incidence and reflect reporting culture

The role of pharmacists in medication safety

Pharmacists contribute at the bedside, within the clinical team, and in medication-system governance. Their training helps them detect inconsistencies in drug selection, dose, monitoring, and medication histories. The service has greater value when pharmacists can see the relevant clinical information, participate before a decision is final, and communicate directly with the person able to resolve the problem.

Prospective prescription review and error interception

Prospective review can intercept problems with dose, route, frequency, interactions, duplication, allergy, contraindications, and monitoring. Pharmacists submitted most reports in the Saudi multi-hospital study, where many errors were stopped before reaching patients.[4] In neurosurgery, weekly review produced 996 interventions among 1,795 patients, and 78% were implemented in audited cases. Length of stay and mortality were lower than in historical data, but that comparison cannot establish causality.[25] High-risk services should therefore measure the clinical relevance, acceptance, and timeliness of review rather than counting interventions alone.

Medication reconciliation and continuity of care

Pharmacists frequently lead best-possible medication history collection and reconciliation. Their contribution is most valuable when they have access to several sources, including patient or caregiver interview, prior records, community pharmacy data, and medicine containers. In mental health Hospital-in-the-Home care, the service with an integrated clinical pharmacist achieved substantially higher completion of reconciliation, accurate adverse-reaction documentation, medication profiles, discharge lists, and chart review than a comparable service without a pharmacist.[26] These process measures directly address the information failures that cause transition errors.

The IMMENSE trial provides an important counterpoint to positive process studies. Its intervention combined reconciliation, medication review, a reconciled discharge list,

counselling, and communication with primary care for older hospitalised adults, yet emergency visits, mortality, and other outcomes did not improve over 12 months.[27] Including this result prevents an exaggerated account of pharmacy benefit and shows why an evaluation must distinguish implementation success from effects on complex service-use outcomes.

Optimisation of high-risk and complex therapy

Pharmacists support dose individualisation, renal and hepatic adjustment, therapeutic drug monitoring, deprescribing, and management of high-alert medicines. Their participation in anticoagulant safety includes indication and dose verification, interaction assessment, renal-function review, counselling, adherence evaluation, peri-procedural planning, and ensuring that monitoring and reversal pathways are understood. Pharmacists interviewed regarding direct oral anticoagulants emphasised professional and patient education, clinical guidelines, reporting systems, multidisciplinary work, risk assessment, and an expanded pharmacist role.[7]

Technology governance and data-driven improvement

Pharmacy expertise is also needed when electronic prescribing, decision support, smart pumps, and artificial intelligence tools are designed and maintained. Pharmacists can define clinically useful thresholds, review false positives and missed events, monitor overrides, and ensure that rules reflect the local formulary and workflow. Alert performance should be judged by actionability, response time, burden on users, and whether the resulting change in treatment is appropriate.

Medication-use evaluation and trend analysis extend this role beyond individual cases. In an interrupted time-series study, error reports increased after pharmacists joined ward rounds and performed reconciliation and review, while medicine use decreased in older patients.[28] The authors interpreted the rise in reports as improved detection. Safety programmes must therefore separate a true change in occurrence from a change in how closely events are being observed.

Patient education, shared decision-making, and safety culture

Patients and caregivers are an additional safety barrier when they understand the purpose, dose, schedule, duration, monitoring, and warning signs of therapy. Pharmacists can use teach-back, updated medication lists, adherence assessment, and simplified regimens to

identify discrepancies that are invisible in the electronic record. Education should be prioritised at initiation of high-risk therapy, discharge, and any major regimen change.

Pharmacists can strengthen safety culture through case discussion, practical training, and non-punitive reporting. Surveys in Sudan and Saudi Arabia found a gap between favourable attitudes and knowledge or reporting practice.[8-9] Training should therefore cover error definitions, harm classification, documentation, and system analysis. Medication safety should remain a shared responsibility: pharmacy expertise supports prescribers, nurses, technicians, managers, patients, and information-technology teams rather than replacing their accountability.

Table 4: Pharmacist roles across the medication-use continuum.

Stage or function	Pharmacist activities	Suggested indicators
Prescribing	Prospective clinical review; dose and interaction assessment; organ-function adjustment; high-alert stewardship	Clinically important errors intercepted; acceptance and time to resolution
Admission and transfer	Best-possible medication history; reconciliation; identification of omissions, duplications and unintended changes	Patients reconciled; discrepancies identified and resolved
Dispensing and preparation	Product selection controls; labelling; compounding standards; independent checks; storage oversight	Dispensing and preparation errors; near misses; turnaround time
Administration support	Standard concentrations; compatibility guidance; smart-pump libraries; nurse consultation; education	Wrong-rate and administration errors; compliance with safeguards
Monitoring	Therapeutic drug monitoring; laboratory surveillance; toxicity and effectiveness review	Overdue monitoring; actionable results addressed; preventable adverse events
Discharge and follow-up	Reconciled discharge list; counselling; communication with primary care and community pharmacy	Accuracy of discharge information; follow-up completion; post-discharge discrepancies
System improvement	Incident analysis; medication-use evaluation; CDSS governance; protocol development; training	Recurring error trends; alert value; implementation of corrective actions

Source: Author's synthesis of pharmacist activities and indicators described in references.[3-4,15-16,21,25-28]

Challenges in implementing medication-safety interventions

Implementation is constrained first by capacity. Reconciliation, review, counselling, and monitoring require protected time, reliable records, and enough trained staff; services built

around a few motivated individuals are difficult to sustain. Workflow fit is equally important. A sound intervention can fail when it adds data entry during a rushed discharge, produces low-value interruptions, or reaches the clinician after the treatment decision has been made.

Outcome choice can also mislead. Counting interventions favours activity over importance, while mortality and readmission may be too distant from the medication process to detect a realistic effect. A balanced assessment should examine interception of clinically important errors, discrepancy resolution, appropriateness, preventable harm, patient understanding, workload, equity, and implementation fidelity. Generalisability remains limited when evidence comes from single centres, narrow patient groups, short follow-up, and inconsistent error definitions.

Digital interventions add a further maintenance burden. Models developed from local historical data may perform poorly elsewhere or reproduce outdated and inequitable practice. They should assist professional judgement, not replace it. External validation, monitoring for performance drift, understandable recommendations, cybersecurity, clear responsibility for overrides, and rapid investigation of technology-related incidents are continuing requirements rather than one-time checks.

LIMITATIONS OF THE REVIEW

This review has several limitations. PubMed was the only bibliographic database searched, and the focused, purposive approach was not intended to retrieve every eligible record. Relevant studies indexed only in Embase, CINAHL, Scopus, or regional databases may therefore have been missed. One author conducted study selection and narrative synthesis, which introduces a risk of subjective selection and extraction error. The review did not use duplicate screening or a formal risk-of-bias instrument, and the included studies differed substantially in definitions, denominators, settings, and outcomes. The conclusions should therefore be read as a critical overview of representative recent evidence rather than a comprehensive estimate of intervention effectiveness.

Future directions

Medication-safety work is more likely to endure when it becomes part of a learning system rather than a short project. Shared medication records should preserve the indication, intended duration, dose rationale, recent changes, monitoring plan, and responsible clinician across hospital, primary-care, and community-pharmacy settings. Consistent error

taxonomies and core outcomes would also make studies easier to compare.

Risk-based deployment of clinical pharmacy services deserves prospective testing. Predictive tools may help identify patients with polypharmacy, organ dysfunction, high-alert medicines, previous discrepancies, or complex transitions, but better prioritisation is useful only if it reduces preventable harm without increasing workload or inequity. Multicentre studies should report usability, false-alert burden, subgroup performance, and unintended effects as well as model accuracy.

Continuity between hospital, primary-care, and community pharmacists is another practical priority. Shared documentation and closed-loop communication would allow high-risk patients to receive targeted follow-up while others receive standardised education and an accurate digital medication list. Research now needs to establish which patients benefit, which components are essential, and what staffing level is sustainable.

Near misses become useful only when staff can report them safely and see what changed afterwards. Regular case review, feedback to reporters, simulation of high-risk situations, patient participation, and accountable leadership can turn incident data into better-designed work. Technical controls, clinical expertise, and patient knowledge are complementary safeguards; none is sufficient on its own.

CONCLUSION

Medication errors recur during prescribing, communication, dispensing, administration, monitoring, and care transitions. Dose errors, omissions, wrong-drug events, incomplete orders, infusion problems, and medication discrepancies appear across health systems, although recorded rates depend heavily on the method of detection and the local reporting culture. The underlying conditions include patient complexity, high-risk treatment, gaps in knowledge and communication, workload, fragmented information, weak processes, and technology-related hazards.

Prevention therefore requires several coordinated safeguards: accurate reconciliation, structured review and deprescribing, standardised processes, well-governed electronic prescribing and decision support, targeted education, useful reporting and feedback, and reliable communication between care settings. Pharmacists connect patient-specific pharmacotherapy with improvement of the wider medication-use system, but their

contribution should be judged critically. Better appropriateness and error interception do not automatically reduce mortality or readmission. Sustainable progress depends on adequate staffing, interoperable information, patient involvement, a just culture, and continued measurement of both benefit and unintended harm.

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The author declares no conflict of interest.

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Not applicable. This article is a narrative review of published literature and did not involve human participants or animals.

AUTHOR CONTRIBUTIONS

Dr. Shubham Kumar Vohra conceived the review, performed the literature searches and study selection, appraised and synthesised the literature, drafted and critically revised the manuscript, and approved the final version.

REFERENCES

1. Naseralallah L, Stewart D, Price M, Paudyal V. Prevalence, contributing factors, and interventions to reduce medication errors in outpatient and ambulatory settings: a systematic review. Int J Clin Pharm., 2023; 45(6): 1359-1377. doi: 10.1007/s11096-023-01626-5.
2. Mulac A, Taxis K, Hagesaether E, Granas AG. Severe and fatal medication errors in hospitals: findings from the Norwegian Incident Reporting System. Eur J Hosp Pharm., 2021; 28(2): e56-e61. doi: 10.1136/ejhpharm-2020-002298.
3. Thomas B, Pallivalapila A, El Kassem W, Al Hail M, Paudyal V, McLay J, et al. Investigating the incidence, nature, severity and potential causality of medication errors in hospital settings in Qatar. Int J Clin Pharm., 2021; 43(1): 77-84. doi: 10.1007/s11096-

020-01108-y.

4. Alghamdi SA. Medication errors reporting and analysis: a comparative study for advancing medication safety practices in Ministry of Health hospitals in Saudi Arabia. Saudi Med J., 2026; 47(1): 102-113. doi: 10.15537/smj.2026.47.1.20250755.
5. Tabatabaee SS, Ghavami V, Javan-Noughabi J, Kakemam E. Occurrence and types of medication error and its associated factors in a reference teaching hospital in northeastern Iran: a retrospective study of medical records. BMC Health Serv Res., 2022; 22(1): 1420. doi: 10.1186/s12913-022-08864-9.
6. Brennan-Bourdon LM, Vázquez-Alvarez AO, Gallegos-Llamas J, Koninckx-Cañada M, Marco-Garbayo JL, Huerta-Olvera SG. A study of medication errors during the prescription stage in the pediatric critical care services of a secondary-tertiary level public hospital. BMC Pediatr, 2020; 20(1): 549. doi: 10.1186/s12887-020-02442-w.
7. Al Rowily A, Aloudah N, Jalal Z, Abutaleb M, Baraka M, Paudyal V. Medication errors in relation to direct-acting oral anticoagulants: a qualitative study of pharmacists' views and experiences. Int J Clin Pharm., 2023; 45(3): 681-688. doi: 10.1007/s11096-023-01555-3.
8. Issak MA, Mohamed ZFA, Mohammed KAA. Knowledge, attitudes, practices towards medication errors and adverse drug reactions reporting among healthcare professionals in Dongola, Sudan: a cross-sectional study. Sci Rep., 2025; 15(1): 43336. doi: 10.1038/s41598-025-27221-4.
9. Alahmari A, Ahmed N, Alkheran A, Alotaibi A, Alhamdani M, Alhrbi R, et al. Pharmacists' knowledge of medication errors and their attitudes toward reporting them in Saudi Arabia. Medicine (Baltimore), 2025; 104(26): e43035. doi: 10.1097/MD.0000000000043035.
10. Bourne RS, Jeffries M, Phipps DL, Jennings JK, Boxall E, Wilson F, et al. Understanding medication safety involving patient transfer from intensive care to hospital ward: a qualitative sociotechnical factor study. BMJ Open, 2023; 13(5): e066757. doi: 10.1136/bmjopen-2022-066757.
11. Liang MQ, Thibault M, Jouvet P, Lebel D, Schuster T, Moreault MP, et al. Improving medication safety in a paediatric hospital: a mixed-methods evaluation of a newly implemented computerised provider order entry system. BMJ Health Care Inform, 2023; 30(1): e100622. doi: 10.1136/bmjhci-2022-100622.
12. Howlett MM, Cleary BJ, Breatnach CV. Defining electronic-prescribing and infusion-related medication errors in paediatric intensive care: a Delphi study. BMC Med Inform

Decis Mak., 2018; 18(1): 130. doi: 10.1186/s12911-018-0713-8.

13. Ciapponi A, Fernandez Nievas SE, Seijo M, Rodríguez MB, Vietto V, García-Perdomo HA, et al. Reducing medication errors for adults in hospital settings. Cochrane Database Syst Rev., 2021; 11(11): CD009985. doi: 10.1002/14651858.CD009985.pub2.
14. Bourne RS, Jennings JK, Panagioti M, Hodkinson A, Sutton A, Ashcroft DM. Medication-related interventions to improve medication safety and patient outcomes on transition from adult intensive care settings: a systematic review and meta-analysis. BMJ Qual Saf., 2022; 31(8): 609-622. doi: 10.1136/bmjqs-2021-013760.
15. Henriksen BT, Krogseth M, Andersen RD, Davies MN, Nguyen CT, Mathiesen L, et al. Clinical pharmacist intervention to improve medication safety for hip fracture patients through secondary and primary care settings: a nonrandomised controlled trial. J Orthop Surg Res., 2023; 18(1): 434. doi: 10.1186/s13018-023-03906-2.
16. Vargas V, Blakeslee WW, Banas CA, Teter C, Dupuis-Dobson K, Aboud C. Use of complete medication history to identify and correct transitions-of-care medication errors at psychiatric hospital admission. PLoS One, 2023; 18(1): e0279903. doi: 10.1371/journal.pone.0279903.
17. Skains RM, Hayes JM, Selman K, Zhang Y, Thatphet P, Toda K, et al. Emergency department programs to support medication safety in older adults: a systematic review and meta-analysis. JAMA Netw Open, 2025; 8(3): e250814. doi: 10.1001/jamanetworkopen.2025.0814.
18. Chen D, Feng J, Chen Z, Chen M. Closed-loop medication safety management reduces inappropriate medication in elderly patients with rheumatic and immunologic diseases. Medicine (Baltimore), 2026; 105(1): e46512. doi: 10.1097/MD.0000000000046512.
19. Hu T, Wang Y, Wu R, Zhang Z, Tian F. Pharmacist-led deprescribing to improve medication safety in older patients with hip fractures. BMC Geriatr, 2025; 25(1): 602. doi: 10.1186/s12877-025-06250-8.
20. Lexow M, Wernecke K, Sultzer R, Bertsche T, Schiek S. Determine the impact of a structured pharmacist-led medication review: a controlled intervention study to optimise medication safety for residents in long-term care facilities. BMC Geriatr, 2022; 22(1): 307. doi: 10.1186/s12877-022-03025-3.
21. Ibáñez-Garcia S, Rodriguez-Gonzalez C, Escudero-Vilaplana V, Martin-Barbero ML, Marzal-Alfaro B, De la Rosa-Triviño JL, et al. Development and evaluation of a clinical decision support system to improve medication safety. Appl Clin Inform, 2019; 10(3): 513-520. doi: 10.1055/s-0039-1693426.

22. Corny J, Rajkumar A, Martin O, Dode X, Lajonchère JP, Billuart O, et al. A machine learning-based clinical decision support system to identify prescriptions with a high risk of medication error. J Am Med Inform Assoc, 2020; 27(11): 1688-1694. doi: 10.1093/jamia/ocaa154.
23. Abdo A, Gallay L, Vallecillo T, Clarenne J, Quillet P, Vuiblet V, et al. A machine learning-based clinical predictive tool to identify patients at high risk of medication errors. Sci Rep., 2024; 14(1): 32022. doi: 10.1038/s41598-024-83631-w.
24. Chu OI, Phutrakool P, Musikatavorn K, Kongchim T, Herabat L, Ritsamdang J, et al. Enhancing interprofessional team performance to prevent medication errors in emergency care: quasi-experimental study using multimodal virtual simulation-based interprofessional education. JMIR Med Educ., 2026; 12: e66999. doi: 10.2196/66999.
25. Lawson McLean A, Schlattl A, Senft C, Hartmann M, Schwarz F. Reducing medication errors in neurosurgery through clinical pharmacy interventions: a prospective observational study. Neurosurg Rev., 2025; 48(1): 687. doi: 10.1007/s10143-025-03849-8.
26. Farag M, Hoti K, Hughes J, Chalmers L. Impact of a clinical pharmacist on medication safety in mental health Hospital-in-the-Home: a retrospective analysis. Int J Clin Pharm., 2022; 44(4): 947-955. doi: 10.1007/s11096-022-01409-4.
27. Johansen JS, Halvorsen KH, Svendsen K, Havnes K, Robinson EG, Wetting HL, et al. Interdisciplinary collaboration across secondary and primary care to improve medication safety in the elderly (the IMMENSE study): a randomized controlled trial. BMC Health Serv Res., 2022; 22(1): 1290. doi: 10.1186/s12913-022-08648-1.
28. Chen KL, Huang CF, Sheng WH, Chen YK, Wang CC, Shen LJ. Impact of integrated medication management program on medication errors in a medical center: an interrupted time series study. BMC Health Serv Res., 2022; 22(1): 796. doi: 10.1186/s12913-022-08178-w.