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# LOOK-ALIKE/SOUND-ALIKE AND HIGH-ALERT MEDICATIONS: A CRITICAL REVIEW OF MEDICATION SAFETY RISKS, PREVENTION STRATEGIES, AND THE ROLE OF PHARMACISTS

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## ABSTRACT

Look-Alike Sound-Alike (LASA) drugs are medications that have similar names, appearances, or pronunciations, which require special caution to prevent medication errors, particularly dispensing errors that may cause patient harm. High-alert (HA) medications are drugs that bear a heightened risk of causing significant patient harm when used in error. Emergency drugs are medications used in life-threatening situations where immediate pharmacological intervention is essential to preserve life or prevent permanent organ damage. Because LASA errors can occur at any stage, preventive strategies must address the entire medication-use system. Pharmacists serve as one of the most critical safeguards in the medication-use system, particularly in preventing errors involving Look-Alike Sound-Alike (LASA) medications, emergency drugs, and high-risk (high-alert) medications. Their role extends beyond dispensing to encompass formulary management, risk assessment, policy development, clinical verification, staff training, and patient counseling. Active pharmacist participation produces wide-ranging benefits at the patient, institutional, and public health levels and contributes to overall healthcare quality improvement.

**Keywords:** LASA medications, high-alert medications, medication errors, patient safety, clinical pharmacist, Tall Man lettering.

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## INTRODUCTION

Look-Alike Sound-Alike (LASA) drugs are medications that have similar names, appearances, or pronunciations, which require special caution to prevent medication errors, particularly dispensing errors that may cause patient harm. Medication errors remain a significant concern in healthcare settings [1-4].

High-alert (HA) medications are drugs that bear a heightened risk of causing significant patient harm when used in error. These medications are often associated with serious adverse events, including sentinel events and severe adverse drug reactions. High-alert drugs include concentrated electrolytes, antidiabetic agents, drugs with a narrow therapeutic index, and cytotoxic (cytostatic) medications [5-7].

LASA drug storage in pharmacies frequently does not meet regulatory standards. Close placement of LASA drugs increases the risk of dispensing errors. Compliance with appropriate storage standards for high-alert medications requires improvement [4,8-10].

Medication errors remain a significant concern in healthcare settings. The World Health Organization identifies high-risk situations as involving high-risk medicines, provider/patient factors, and system factors, emphasizing the need for sustainable strategies to reduce harm associated with medication use [1,11,12].

### 2. Historical Development of Medication Safety Concepts

The formal study of medication safety emerged during the late twentieth century when healthcare systems began systematically documenting adverse events occurring in hospitals. Increasing therapeutic complexity, polypharmacy, and the introduction of high-potency medications contributed to rising concerns about preventable harm. Early investigations revealed that medication errors were not random events but often followed identifiable patterns. Certain drugs were repeatedly implicated in severe adverse outcomes, prompting researchers and safety organizations to classify medications based on their potential risk. This shift from individual blame to system-based analysis marked a significant evolution in patient safety philosophy. Organizations such as the Institute for Safe Medication Practices played a pivotal role in collecting error reports, analyzing trends, and disseminating recommendations aimed at reducing preventable harm. Over time, specific categories including LASA drugs, emergency medications, and high-risk drugs were recognized as requiring enhanced safeguards due to their association

with serious patient injury [2,3,11].

**Background and Medication-Use Risk**

Administering the wrong medication remains one of the most serious and preventable complications in healthcare practice. In anesthesiology and emergency care, this risk is amplified because clinicians often prescribe, prepare, and administer medications independently, frequently under intense time pressure. This combined responsibility increases professional accountability while simultaneously heightening vulnerability to medication-related errors. During critical events such as cardiac arrest, trauma resuscitation, obstetric emergencies, or status epilepticus, medications are often delivered rapidly, sometimes without the complete verification processes used in routine clinical settings [3,11,12,16].

**Emergency Drugs and Their Risk Profile**

Emergency drugs are medications used in life-threatening situations where immediate pharmacological intervention is essential to preserve life or prevent permanent organ damage. Examples include adrenaline (epinephrine), atropine, amiodarone, dopamine, tranexamic acid, magnesium sulfate, and neuromuscular blocking agents used in rapid sequence intubation. These drugs are commonly stored in crash carts, emergency trays, and operating rooms for quick access. Because they are administered in high-stress, time-sensitive environments, the margin for error is extremely small. Even minor confusion in labeling, packaging, or dosing can result in catastrophic consequences [2,11,12,16].

**High-Risk (High-Alert) Medications**

High-risk or high-alert medications are defined as drugs that carry a heightened risk of causing significant patient harm if used incorrectly. According to the Institute for Safe Medication Practices (ISMP), these medications may not be more prone to error, but the outcomes of errors involving them are often severe. Common high-alert drugs include insulin, anticoagulants such as heparin, opioids, concentrated electrolytes like potassium chloride, chemotherapy agents, and neuromuscular blocking agents. These medications require precise dosing, strict monitoring, and careful administration techniques. Any deviation from correct practice may lead to life-threatening complications [5-7,12].

**Table 1. High-Alert Medication Categories and Typical Examples**

| Category | Examples / safety concern |
|---|---|
| Adrenergic agonists, IV | epinephrine, phenylephrine, norepinephrine |
| Antiarrhythmics, IV | lidocaine, amiodarone |
| Antithrombotic agents | warfarin, heparin, direct oral anticoagulants, thrombolytics |
| Insulin | insulin products, including concentrated formulations |
| Concentrated electrolytes | potassium chloride and other concentrated electrolytes |

| | |
|---|---|
| Opioids | opioid medicines requiring dose and monitoring safeguards |
| Chemotherapy agents | cytotoxic and antineoplastic medicines |
| Neuromuscular blocking agents | agents requiring clear labeling and restricted storage |

Source: Adapted from the ISMP list of high-alert medications in acute care settings.[5]

**Look-Alike/Sound-Alike (LASA) Medications**

Look-alike and sound-alike (LASA) medications represent one of the most frequent contributors to medication errors. LASA drugs may resemble one another in packaging, labeling, ampoule size, or share similar names in spelling and pronunciation. The problem is continuously evolving due to frequent changes in pharmaceutical branding, packaging redesign, introduction of new medications, and drug shortages that require alternative sourcing. Sudden changes in vial appearance can disrupt clinicians' visual familiarity, especially in emergency settings where quick decisions are required [1,9,10].

**High-Risk Routes of Administration**

The danger increases significantly when emergency or high-alert medications are administered through high-risk routes such as intravenous bolus, epidural, or intrathecal injection. Documented cases of accidental intrathecal administration of tranexamic acid instead of local anesthetics demonstrate how packaging similarity can lead to fatal neurological toxicity. In such instances, patients may develop seizures, cardiovascular instability, and rapid deterioration [5,12,16].

**Complexities in Drug Naming and Packaging**

A single medication may have multiple identifiers, including a chemical name, a generic (international nonproprietary) name, and several brand names that vary across regions. Additionally, medication containers often share similar cap colors, label layouts, and vial sizes. In busy emergency departments, intensive care units, and operating rooms, healthcare professionals may rely on visual recognition rather than careful label reading. When emergency and high-alert medications are stored in close proximity, these similarities increase the likelihood of selection errors [1,8,14].

**Incidence and Underreporting of LASA Errors**

Accurately determining the true incidence of LASA errors is difficult due to underreporting and variability across institutions. These medication pairs represent one of the most frequent underlying causes of drug-related mistakes in healthcare settings. Despite ongoing efforts by regulatory authorities, healthcare institutions, and professional organizations, LASA errors continue to be reported in clinical practice [1,10,16].

The true incidence of LASA errors is difficult to establish because of underreporting and

differences in definitions, reporting systems and clinical settings. Recent reviews therefore support a system-based interpretation of LASA risk rather than reliance on a single prevalence estimate [1,10,13].

**Documented LASA Medication-Error Examples**

The Institute for Safe Medication Practices Canada (ISMP Canada) has documented four separate incidents in which lamotrigine (LAMICTAL) was confused with three entirely different medications. In these cases, patients were inadvertently dispensed[9]

Lamivudine (HEPTOVIR), is an antiretroviral agent, Terbinafine HCl (LAMISIL) is an antifungal, and Liothyronine (CYTOMEL) is a thyroid hormone replacement [9].

Each mix-up arises from striking similarities in drug names or packaging, resulting in potentially serious clinical consequences. These reports underscore the imperative for heightened pharmacy verification steps such as Tall Man lettering, barcode scanning, and double-check systems to catch LASA errors before they reach the patient [9,13,15].

A young adult male presented to an emergency department with headache, numbness in the extremities, and shortness of breath approximately two hours after taking a newly prescribed medication for anxiety and insomnia. He brought the prescription bottle with him, which had been dispensed as hydrALAZINE 25 mg with instructions to take one to three tablets every six hours [9].

Hydralazine is an antihypertensive agent indicated for the management of moderate to severe hypertension, whereas hydrOXYzine is an antihistamine commonly prescribed for anxiety and insomnia. Because hydralazine is not indicated for anxiety, emergency department staff suspected a prescribing or dispensing error. Both medications are well recognized as look-alike and sound-alike (LASA) pairs [1,9].

Upon contacting the community pharmacy, it was confirmed that an error had occurred during dispensing. The pharmacy had received a printed prescription for hydroxyzine from an urgent care center but mistakenly entered it into the computer system as hydralazine. Approximately three hours after ingesting 50 mg of hydralazine, the patient's blood pressure was recorded at 105/57 mmHg, consistent with the pharmacological effects of an antihypertensive drug [1,9].

This case underscores the importance of verifying the indication on prescriptions and ensuring appropriate patient counseling when initiating new therapy. Although prescribers are encouraged to include the treatment purpose on prescriptions, pharmacists also carry responsibility for confirming that the dispensed medication matches the patient's clinical condition. For more than a decade, the Institute for Safe Medication Practices has reported recurring confusion between hydralazine and hydroxyzine, emphasizing the need for Tall Man lettering, barcode verification,

and clear storage separation to reduce the risk of substitution errors [1,9,15].

Medication errors are not limited to phonetic similarity. Brand name duplication across countries can also create serious safety risks [1,10].

These cases illustrate multiple layers of risk associated with LASA medications and international brand variability. Errors may occur at prescribing, transcription, dispensing, or administration stages. Contributing factors include phonetic similarity, orthographic resemblance, international naming differences, absence of indication on prescriptions, and inadequate medication reconciliation for patients traveling across borders [1,3].

The Indian generic pharmaceutical market has inadvertently become a significant source of Look-Alike Sound-Alike (LASA) medication errors. With thousands of manufacturers producing similar formulations under distinct brand names, the risk of phonetic and orthographic confusion is significant. Many generic brands adopt names that closely resemble existing products in an attempt to gain market traction, most of the time without adequate regulatory screening for name uniqueness. This leads to confusion at the prescribing, dispensing, and administration stages, particularly in resource-limited settings where electronic verification tools may be lacking [1,10,17,18].

**System Factors Behind LASA Errors**

A medication error rarely happens due to oversight. The Swiss Cheese Model explains that layers of system failures like poor labeling, fatigue, or sound-alike names align to allow such errors through [3].

In busy surgical or emergency settings, these issues compound and lead to fatal outcomes [1,3,12].

**Prevention Strategies for LASA and High-Alert Medication Errors**

Recognizing the persistent threat posed by LASA medications, several regulatory bodies have implemented strategies to minimize risk [9,11,12].

The Joint Commission recommends that healthcare institutions develop and maintain their own customized list of LASA medications rather than relying solely on generic lists. These lists should reflect medications used within the specific institution and incorporate data from internal error reporting systems. Annual review and updating of the list are advised [9,17-19].

The Food and Drug Administration has adopted the use of “Tall Man Lettering” (TML) to differentiate drug names that are easily confused. This method involves capitalizing distinct portions of similar drug names to emphasize their differences. For example, dexmedeTOMidine and dexameTHASONE are written using selective capitalization to reduce confusion. The FDA has also developed analytical tools to evaluate phonetic and orthographic similarities when

approving new proprietary drug names, aiming to prevent the introduction of names that may contribute to medication errors [9,14,15].

Professional organizations such as the American Society of Anesthesiologists have issued guidance on pharmaceutical labeling in anesthesiology, including recommendations for addressing LASA medications commonly used in perioperative care [10].

The Institute for Safe Medication Practices (ISMP) maintains an updated list of frequently confused drug names and provides recommendations to reduce errors at every stage of the medication-use process [9].

LASA-prone medications need to be kept physically apart, particularly in intensive care units, emergency rooms, and operating rooms [8-10].

The following measures are included among the prevention strategies [8,13]:

**7.1 Evidence on Tall Man Lettering**

Used to highlight differences in similar drug names (eg- vincristine vs. vinblastine), this has been endorsed by the FDA and implemented in many EMR systems [9,15].

In controlled studies, Tall Man lettering has improved readability and sometimes reduced selection errors, but evidence from real-world clinical settings is limited and mixed. A systematic review concluded that Tall Man lettering should be used as one part of a larger medication-error reduction strategy rather than as a standalone intervention [8,13,15].

A systematic derivation of an Australian Tall Man standard used a risk matrix to prioritize confusable drug-name pairs and recommended periodic updating as new names and error reports emerge [14].

**7.2 Technology-Assisted Medication Safety**

Incorporating barcode technology for verification during dispensing and administration reduces manual selection errors [1,16].

Machine learning models and image-matching algorithms are being piloted to verify pills, especially in outpatient or home care settings [20].

A deep learning-based pill identification system using pill images and imprinted characters demonstrated top-1 identification accuracies of 85.6% in a South Korean database and 74.5% in a United States database for pills not used in training, illustrating the potential of artificial intelligence to support medication identification [20].

**8. Regulatory and Institutional Medication-Safety Expectations**

The Joint Commission International (JCI) is a globally recognized healthcare accreditation body that sets rigorous standards for patient safety and quality of care. It supports hospitals and health systems worldwide in improving clinical practices, including medication safety and LASA error

prevention [19].

Accredited hospitals are required to maintain an active list of LASA drugs, assess risk potential, and implement preventive strategies such as the following:

JCI mandates that organizations implement Medication Management and Use (MMU) protocols, which include:

The Joint Commission introduced National Performance Goals for hospitals effective January 1, 2026, replacing the former National Patient Safety Goals chapter and organizing requirements into measurable safety topics, including medication management [19].

**8.1 Stage-Specific Risk Reduction Measures**

Because LASA errors can occur at any stage, preventive strategies must address the entire medication-use system [3,11,12]:

Purchasing: Healthcare facilities should avoid procuring products in which branding elements overshadow the drug name. New or substitute medications should be evaluated for potential LASA risks before being added to inventory [1,9].

Prescribing and Ordering: Abbreviations, truncated names, and shared drug stems should be avoided. Both generic and brand names should be displayed clearly in electronic systems. Drug search functions should require sufficient characters to minimize the appearance of multiple similar names simultaneously [1,9,15].

Administration: The administration phase is particularly vulnerable because errors are less likely to be intercepted at this point. Clinicians must read the full medication label carefully and avoid relying solely on cap color, partial labeling, or visual familiarity [1.16].

Stocking and Storage: Medications should be stored with labels facing upward rather than cap-up positioning. Look-alike products should not be stored adjacent to one another, and high-risk medications should be physically separated [8-10].

Nomenclature: Tall Man Lettering should be incorporated into prescribing systems, automated dispensing cabinets, infusion pump libraries, and medication administration records [8,9,13].

**Table 2. Stage-Specific Risk-Reduction Measures**

| Medication-use stage | Key safety measures |
|---|---|
| Purchasing | Evaluate new or substitute products for LASA risk; avoid branding that obscures drug names. |
| Prescribing and ordering | Avoid abbreviations and truncated names; display generic and brand names clearly; improve electronic search functions. |
| Dispensing | Barcode scanning, visual verification, standardized labeling and independent checks for high-risk medications. |

| | |
|---|---|
| Administration | Read full labels; avoid reliance on cap colour or visual familiarity; use barcode administration and standardized route labeling. |
| Storage | Physically separate LASA and high-alert products; use label-up orientation and restricted storage where appropriate. |
| Monitoring and quality improvement | Report incidents and near misses; conduct root cause analysis; review and update institutional LASA lists. |

**Role of the Pharmacist in Managing LASA, Emergency, and High-Risk Drugs**

Pharmacists serve as one of the most critical safeguards in the medication-use system, particularly in preventing errors involving Look-Alike Sound-Alike (LASA) medications, emergency drugs, and high-risk (high-alert) medications. Because these categories of drugs are frequently associated with severe patient harm, pharmacists must adopt a proactive, system-based, and multidisciplinary approach to minimize risk. Their role extends beyond dispensing to encompass formulary management, risk assessment, policy development, clinical verification, staff training, and patient counseling [21-23].

A fundamental responsibility of pharmacists is the identification and periodic revision of institutional LASA drug lists. National and international safety bodies such as the Institute for Safe Medication Practices regularly publish lists of commonly confused drug names. However, these lists must be customized to reflect the hospital's specific formulary, commonly used medications, and locally reported incidents [9,21].

Pharmacists analyze internal error reports and near-miss data to identify patterns of confusion. This continuous monitoring allows them to update LASA lists annually or whenever new medications are introduced. During formulary additions, pharmacists evaluate phonetic and orthographic similarities between new drug names and existing medications to prevent introducing additional risks into the system. They also implement Tall Man Lettering in electronic health records, automated dispensing cabinets, medication administration records, and pharmacy labeling systems to highlight dissimilar portions of confusing drug names [9,21].

Pharmacists play a decisive role in procurement decisions. When medications are sourced from different manufacturers due to shortages or cost considerations, packaging and labeling variations may increase confusion. Pharmacists must evaluate these changes carefully before introducing them into clinical areas [1,9].

They ensure that products with oversized logos that obscure drug names are avoided, similar-looking ampoules are not purchased simultaneously when safer alternatives exist, emergency medications are supplied in clearly differentiated packaging, and concentrated high-risk medications are restricted to pharmacy control. When unavoidable substitutions occur,

pharmacists must communicate these changes clearly to clinical staff, especially in high-risk settings such as operating rooms and intensive care units [1,5,9].

Safe storage practices are a cornerstone of medication safety. Pharmacists design storage systems that minimize visual confusion. LASA medications must be physically separated and not placed adjacent to one another in automated dispensing cabinets [8,9].

High-alert medications including insulin, anticoagulants, opioids, neuromuscular blocking agents, concentrated electrolytes, and chemotherapeutic agents—require additional safeguards. Warning labels, restricted access drawers, and independent double-check protocols are often implemented [5,7].

In anesthesia carts and emergency trays, pharmacists recommend storing vials in a label-up orientation rather than cap-up to reduce reliance on cap color as a visual identifier. Intrathecal medications must be stored separately from intravenous drugs to prevent catastrophic route errors [5,12].

Pharmacists function as a critical checkpoint during the prescribing stage. Each medication order should undergo comprehensive review for appropriateness, indication, dosage, route, frequency, drug interactions, and patient-specific variables such as renal or hepatic function [21,23].

For LASA medications, pharmacists must confirm that the prescribed drug aligns with the documented diagnosis. If the therapeutic indication does not match the medication class, clarification should be sought immediately. Encouraging prescribers to include the purpose of therapy on prescriptions enhances this safety net. Electronic systems can be configured to require minimum character entry during drug searches, reducing the likelihood that similar names appear simultaneously [1,9,21].

High-risk medications require enhanced vigilance. Independent double checks are often mandatory for insulin infusions, anticoagulant dosing, chemotherapy protocols, and pediatric weight-based calculations [5,7].

During dispensing, pharmacists ensure correct product selection through barcode scanning, visual verification, and standardized labeling. They must avoid relying solely on packaging color or vial shape [1,8,21].

For emergency medications, pharmacists standardize concentrations and dilution protocols to minimize bedside calculations. Prefilled syringes and ready-to-use formulations reduce preparation errors, particularly during resuscitation when time pressure is high [5,21,23].

Although administration is typically performed by nurses or physicians, pharmacists influence safety by designing administration protocols. Strategies include barcode medication administration systems, smart infusion pumps with dose-error reduction software, mandatory

independent double verification for high-risk drugs, standardized labeling for epidural, intrathecal, and intravenous routes, and segregation of emergency medications [5,16,21].

Continuous professional education is essential. Pharmacists conduct training sessions highlighting common LASA pairs, high-alert medications, and documented case reports of medication errors. Simulation exercises in operating rooms and emergency departments reinforce safe practices under realistic conditions [21].

Education should include recognition of Tall Man Lettering, importance of reading full drug names, avoidance of abbreviations, proper verification procedures, and awareness of packaging changes. By maintaining awareness, pharmacists help cultivate a culture of safety rather than blame [13,21].

Pharmacists actively participate in medication safety committees and root cause analyses of reported errors. System-based approaches, often explained through safety models, emphasize that errors result from multiple aligned system failures rather than individual negligence [3,21].

Data collected from internal reporting systems and international safety organizations such as the World Health Organization guide institutional improvements. Accreditation bodies including Joint Commission International require hospitals to maintain documented risk-reduction strategies for LASA and high-alert medications, with pharmacists playing a leadership role in compliance [11,19].

In emergency care settings, pharmacists ensure that crash carts are routinely audited, expired medications are replaced promptly, and standardized concentrations of resuscitation drugs are maintained [5,21,23].

They also prepare contingency plans during drug shortages, ensuring that substitute products are clearly labeled and that staff are informed of appearance changes. Rapid communication prevents confusion when emergency drugs differ in packaging from previously stocked items [9,21].

In community settings, pharmacists serve as the final checkpoint before medication reaches the patient. Counseling patients about the purpose of therapy, expected effects, and potential side effects can reveal dispensing errors before harm occurs [21].

Patients receiving high-risk medications should be educated about dose schedules, monitoring requirements, and warning signs of toxicity. Clear communication reduces clinical risk and strengthens patient safety [21].

Pharmacists are central to the safe management of LASA, emergency, and high-risk medications. Their responsibilities span procurement, storage, prescribing review, dispensing verification, administration safeguards, staff training, and continuous quality improvement. By integrating technological tools, standardized protocols, and system-based safety strategies, pharmacists

significantly reduce the risk of catastrophic medication errors and contribute to a stronger culture of patient safety across healthcare settings [21-23].

**Benefits of Effective Pharmacist Involvement**

Active pharmacist participation in the management of Look-Alike Sound-Alike (LASA) medications, emergency drugs, and high-risk (high-alert) medications produces wide-ranging benefits at the patient, institutional, and public health levels. Because these medications are frequently associated with severe harm when errors occur, pharmacist-led safety systems function as a critical barrier against preventable adverse events. The impact extends beyond simple error prevention and contributes to overall healthcare quality improvement [21,22].

One of the most important benefits is the marked decrease in adverse drug events (ADEs). High-alert medications such as insulin, anticoagulants, opioids, neuromuscular blocking agents, chemotherapeutic drugs, and concentrated electrolytes have a narrow therapeutic index. Even minor dosing or selection errors can result in hypoglycemia, hemorrhage, respiratory depression, cardiac arrest, paralysis, or death [5,7].

Through systematic order verification, independent double-check systems, standardized dilution protocols, and barcode scanning, pharmacists substantially reduce the probability of catastrophic medication errors [5,21].

In emergency and critical care settings, time-sensitive medication administration is essential. Standardized crash cart organization, prefilled emergency syringes, and uniform drug concentrations minimize confusion during cardiopulmonary resuscitation and trauma care [5,23]. Pharmacist oversight ensures that resuscitation medications such as adrenaline, amiodarone, atropine, and vasopressors are correctly stocked, labeled, and periodically audited. This reduces delays and dosing miscalculations during high-pressure scenarios. Faster, safer emergency drug delivery improves survival rates and neurological outcomes [23].

Implementation of Tall Man Lettering, physical segregation of similar packaging, and optimized automated dispensing cabinet layouts significantly decrease look-alike sound-alike errors [8,13]. For example, distinguishing hydrALAZINE from hydrOXYzine or separating tranexamic acid from spinal anesthetics in operating rooms prevents selection errors that could otherwise lead to severe complications. By customizing institutional LASA lists and continuously updating them, pharmacists create dynamic prevention systems rather than static policies [1,9,15].

Pharmacists review medication orders with consideration of patient-specific factors including age, weight, renal function, hepatic function, drug interactions, and comorbidities. This individualized review improves therapeutic appropriateness and prevents overdosing or underdosing [21,23].

Medication errors often occur during transitions of care such as hospital admission, transfer between departments, or discharge. Pharmacist-led medication reconciliation ensures that high-risk drugs are accurately continued, discontinued, or adjusted [21,23].

This reduces duplication, omission, or unintended continuation of therapies. Continuity of care is strengthened when pharmacists verify home medications and detect potential LASA confusion arising from brand variations or international drug names [9, 21].

Preventing medication errors reduces healthcare costs associated with prolonged hospital stays, ICU admissions, emergency interventions, and long-term disability care. High-alert medication errors often lead to expensive litigation and reputational damage for healthcare institutions.[11,12,7]

Pharmacists encourage non-punitive reporting of medication errors and near misses. Participation in root cause analysis allows institutions to identify system weaknesses such as poor labeling, inadequate lighting, workflow interruptions, or confusing packaging [3,21].

The adoption of system-based models of error prevention reinforces that medication errors result from multiple aligned failures rather than individual incompetence. This fosters openness, learning, and continuous quality improvement [3].

Pharmacists advocate for integration of advanced technologies including [16,20,21].

These innovations reduce manual selection errors, enhance verification processes, and support real-time alerts for dose limits or drug interactions. Technology, when combined with pharmacist oversight, creates multilayered protection against errors [16,20,21].

Pharmacists enhance communication between physicians, nurses, and administrators. Encouraging prescribers to include therapeutic indications on prescriptions improves clarity. Clarifying ambiguous orders prevents incorrect drug selection [21].

In both hospital and community settings, pharmacist counseling improves patient understanding of medication purpose, dosing schedule, side effects, and warning signs. Patients receiving high-risk drugs such as anticoagulants or insulin benefit from education regarding monitoring requirements and emergency symptoms [21,23].

This empowerment enables early detection of adverse effects and improves medication adherence. Counseling also serves as a final safety check to identify dispensing errors before harm occurs [21].

Structured systems designed by pharmacists reduce cognitive burden on healthcare providers. In high-pressure settings such as emergency departments and operating rooms, standardized storage and labeling decrease reliance on memory and visual assumptions [1,3].

At a broader level, pharmacist-led medication safety programs contribute to national and global patient safety initiatives. Reduced medication errors decrease morbidity and mortality rates

associated with preventable drug events [11,12].

Expanding pharmacist involvement in the management of LASA, emergency, and high-risk medications yields extensive benefits. These include improved patient safety, enhanced emergency response efficiency, optimized therapeutic outcomes, reduced healthcare costs, strengthened regulatory compliance, technological advancement, interprofessional collaboration, and promotion of a robust safety culture [21-23].

Pharmacists function as essential risk managers within the healthcare system. Their systematic, evidence-based interventions create multiple layers of defense against medication errors and significantly improve overall quality of care [21,22].

**Evidence from Indian Healthcare Settings**

Medication prescribing errors in a public teaching hospital in India were prospectively studied among 304 patients; 103 patients (34%) had at least one error and 157 errors were identified. Drug-drug interactions accounted for the largest proportion, followed by incorrect dosing interval and dosing errors, and the number of errors increased with age and the number of medicines prescribed [17].

A tertiary care hospital study from India reported 403 medication errors among 1109 patients, highlighting the continuing need for structured medication-safety systems in hospital practice [18].

An Indian tertiary-care study of clinical pharmacist-led medication-error evaluation in a medical intensive care unit detected 271 medication errors among 228 patients. The clinical pharmacist interventions were implemented in 86% of cases, and preventable adverse drug events were significantly fewer among patients whose pharmacist recommendations were implemented [22].

A 2025 Indian tertiary-care study found that integrating clinical pharmacists into discharge medication reconciliation resolved 166 discrepancies (99.4%) during the intervention phase, supporting the role of clinical pharmacy in medication safety and continuity of care [23].

**Table 3. Selected Indian Evidence Relevant to Medication Safety**

| Study | Setting / design | Key finding relevant to review | References |
|---|---|---|---|
| Pote et al. 2007 | Public teaching hospital, India; prospective study | 103/304 patients had at least one medication error; 157 errors identified. | [17] |
| Patel et al. 2016 | Tertiary care hospital, India; prospective observational study | 403 medication errors among 1109 patients. | [18] |
| Aradhya et al. 2023 | Indian medical ICU; clinical pharmacist approach | 271 medication errors among 228 patients; 86% interventions implemented. | [22] |

| | | | |
|---|---|---|---|
| Dawaiwala et al. 2025 | Indian tertiary care hospital; quasi-experimental medication reconciliation | Clinical pharmacists resolved 166 discharge discrepancies (99.4%). | [23] |

**Critical Interpretation of the Evidence**

The evidence supports a layered approach to medication safety. High-alert medicines are not necessarily more likely to be involved in error, but errors involving them are more likely to result in severe harm. Systematic reviews also show that the evidence base for some individual interventions is heterogeneous; therefore, medication safety strategies should combine standardized processes, technology, education, reporting, and pharmacist oversight rather than depending on a single safeguard [5-7,13,16].

Tall Man lettering remains useful as a visual cue, but the current evidence does not support treating it as a complete solution. Physical separation, improved labeling, barcode verification, electronic decision support, independent double checks, and continuous review of locally relevant LASA pairs provide complementary barriers [8,9,13,15].

For Indian hospitals, the practical value of the pharmacist is especially important because medication safety depends on institutional implementation. Indian studies demonstrate clinically relevant medication errors and show that pharmacist-led review, intervention, and medication reconciliation can intercept discrepancies and prevent harm [17,18,22,23].

## CONCLUSION

In summary, although awareness of LASA, emergency, and high-risk medications is relatively high among healthcare professionals, consistent implementation of safety measures remains a challenge. Strengthening training programs, enforcing standardized safety protocols, improving labeling and storage systems, and promoting multidisciplinary collaboration are essential steps toward minimizing medication errors. Ensuring systematic and proactive management of these drug categories is fundamental to safeguarding patient welfare and achieving excellence in healthcare delivery. Pharmacist-led medication safety programs should be integrated with institutional LASA lists, high-alert medication policies, standardized storage, electronic safeguards, barcode systems, medication reconciliation, incident reporting, staff education, and continuous quality improvement. This system-based approach is consistent with international medication-safety priorities and provides a practical direction for strengthening patient safety in Indian healthcare settings.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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