

Medication Safety and Error Prevention: Advancing Quality Patient Care

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Abstract

Medication safety is a fundamental component of patient safety and quality healthcare. Medicines provide substantial therapeutic benefits, but unsafe medication practices and medication errors can result in preventable patient harm, prolonged hospitalization, increased healthcare expenditure, disability and death. Medication errors may occur at any stage of the medication-use process, including prescribing, transcribing, dispensing, preparation, administration and monitoring. The World Health Organization (WHO) identifies medication-related harm as a major global patient-safety concern and estimates that the cost associated with medication errors is approximately US\$42 billion annually. WHO's Medication Without Harm initiative emphasizes the need for coordinated action involving patients, healthcare professionals, medicines, and medication-use systems.

This review article examines the major causes and types of medication errors, high-risk situations, the role of nurses and other healthcare professionals, technological interventions, patient involvement, medication reconciliation, reporting and learning systems, and organizational strategies for preventing medication-related harm. Particular attention is given to high-alert medications, polypharmacy, transitions of care, look-alike/sound-alike medicines, communication failures, workload, interruptions and inadequate knowledge. Recent evidence indicates that nurse-led interventions, including educational programmes, workflow technologies, protocol-based interventions and electronic medication-management systems, can reduce medication administration errors, although effectiveness varies among individual interventions.

The review emphasizes that medication safety should not be viewed solely as an individual healthcare-worker responsibility. Effective prevention requires a systems-based approach combining professional education, standardized procedures, technology, multidisciplinary communication, patient engagement, incident reporting, safety culture and continuous quality improvement. Advancing medication safety through these integrated strategies can contribute significantly to safer care, improved clinical outcomes and higher quality of patient-centered healthcare.

Keywords: Medication safety, medication errors, patient safety, error prevention, nurses, medication administration, high-alert medications, quality patient care, medication reconciliation, healthcare quality.

Introduction

Medication therapy is one of the most common and important components of healthcare. Medicines are used to prevent disease, manage acute and chronic conditions, control symptoms, treat infections and improve survival. Despite their therapeutic benefits, medicines can cause significant harm when they are prescribed, prepared, dispensed, administered or monitored incorrectly.

Medication safety refers to practices and systems designed to prevent medication-related errors and minimize avoidable harm associated with medication use. The medication-use process is complex and involves several professionals, technologies and organizational systems. Consequently, an error occurring at one stage can progress to another stage and ultimately reach the patient.

The WHO states that unsafe medication practices and medication errors are among the leading causes of injury and avoidable harm in healthcare systems worldwide. Errors may result from weaknesses in medication systems as well as human factors such as fatigue, poor working conditions and staff shortages.

The WHO's Medication Without Harm initiative was established as the third Global Patient Safety Challenge, with the goal of reducing severe avoidable medication-related harm globally. Its strategic framework recognizes four major domains: patients and the public, healthcare professionals, medicines, and systems and practices of medication use. It also emphasizes three important action areas: high-risk situations, polypharmacy and transitions of care.

Medication safety is therefore a multidisciplinary responsibility. Nurses, physicians, pharmacists, patients, caregivers, administrators and policymakers all contribute to safe medication use.

Global Burden of Medication-Related Harm

Medication-related harm represents a substantial global patient-safety challenge. WHO reports that the estimated annual cost associated with medication errors is approximately US\$42 billion. Errors may occur during prescribing, transcribing, dispensing, administration and monitoring.

WHO's 2024 policy brief emphasizes that harm associated with medicines and therapeutic options accounts for nearly half of preventable harm in medical care. The policy brief recommends action across four domains: patients and the public, health and care workers, medicines as products, and systems and practices of medication use.

Medication-related harm can have consequences at several levels:

- direct patient injury;
- adverse drug events;
- treatment failure;
- prolonged hospitalization;
- increased healthcare costs;
- psychological distress;
- loss of confidence in healthcare;
- additional workload for healthcare professionals; and
- increased healthcare-system burden.

The global burden reinforces the importance of moving from reactive responses to proactive medication-safety systems.

Understanding Medication Errors

A medication error is generally understood as a preventable event that may lead to inappropriate medication use or patient harm while the medication is under the control of a healthcare professional, patient or consumer.

Medication errors should be distinguished from unavoidable adverse drug reactions. An adverse drug reaction may occur despite appropriate medication use, whereas many medication errors are potentially preventable.

Medication errors may occur during:

1. prescribing;
2. transcribing;
3. dispensing;
4. preparation;
5. administration;
6. monitoring;
7. documentation; and
8. transitions between healthcare settings.

This broad perspective is important because focusing only on administration errors may overlook earlier system failures.

Types of Medication Errors

1. Prescribing errors

These include:

- wrong drug;
- inappropriate dose;
- incorrect route;
- contraindicated medication;
- incomplete prescription;
- drug-drug interaction;
- allergy-related prescribing; and
- failure to consider renal or hepatic function.

2 Transcription errors

Transcription errors may occur when medication information is transferred from one document or system to another.

3 Dispensing errors

Examples include:

- incorrect medicine;
- incorrect strength;
- incorrect quantity;
- incorrect labeling; and
- confusing similarly named products.

4 Administration errors

These may involve:

- wrong patient;
- wrong medication;
- wrong dose;
- wrong route;
- wrong time;
- omitted dose;
- incorrect infusion rate; and
- failure to monitor the patient appropriately.

5 Monitoring errors

Failure to monitor therapeutic response, laboratory values or adverse effects can result in preventable harm.

Major Factors Contributing to Medication Errors

Medication errors rarely result from a single cause. They often occur because several contributing factors interact.

1 Human factors

Important factors include:

- fatigue;
- stress;
- inadequate knowledge;
- inexperience;
- cognitive overload;
- distraction;
- poor communication; and
- excessive workload.

2 Work environment

Unsafe environmental conditions may include:

- inadequate staffing;
- excessive workload;
- frequent interruptions;
- poor lighting;
- noise;
- inadequate medication-storage arrangements; and
- insufficient access to drug information.

3 Communication problems

Communication failures may occur:

- between doctors and nurses;
- between nurses and pharmacists;
- during shift handover;
- during patient transfer;
- during discharge; and
- between healthcare providers and patients.

4 Knowledge deficits

Lack of knowledge concerning unfamiliar drugs, dosage calculations, contraindications and drug interactions can increase medication-error risk.

5 System failures

Medication errors may result from poorly designed systems, unclear policies, inadequate technology integration and insufficient safety checks. A systems approach is therefore more appropriate than simply blaming an individual healthcare worker.

High-Risk Situations in Medication Safety

WHO identifies high-risk situations, polypharmacy and transitions of care as priority areas for medication-safety action.

High-risk situations may involve three broad factors:

1. Medication factors, especially high-alert medicines;
2. Patient/provider factors; and
3. System or workplace factors.

These factors may act independently or interact with one another.

High-alert medicines require particular attention because errors involving these medicines are more likely to cause serious harm.

Examples may include:

- insulin;
- anticoagulants;
- concentrated electrolytes;
- opioids;
- certain intravenous medicines; and
- chemotherapy agents.

Hospitals should establish specific protocols for storage, prescribing, preparation, administration, double-checking and monitoring of high-alert medications.

Polypharmacy and Medication Safety

Polypharmacy refers to the use of multiple medications by an individual, particularly when the number or combination of medicines increases the potential for adverse outcomes.

Polypharmacy may increase the risk of:

- drug-drug interactions;
- duplicate therapy;
- inappropriate prescribing;
- non-adherence;
- confusion;
- dosing errors; and
- adverse drug events.

Medication review and reconciliation are particularly important for older adults and patients with multiple chronic diseases. Healthcare professionals should regularly assess whether each medication remains necessary, appropriate, effective and safe.

Medication Safety During Transitions of Care

Transitions of care occur when patients move:

- from home to hospital;
- between hospital departments;
- from intensive care to general wards;
- from hospital to another healthcare facility; or
- from hospital back to home.

Medication discrepancies can occur when information is transferred between settings.

Medication reconciliation can reduce these discrepancies by systematically comparing:

- medicines taken before admission;
- medicines prescribed during hospitalization; and
- medicines prescribed at discharge.

Patients and caregivers should receive clear information about medication names, doses, schedules, purposes and potential adverse effects.

Role of Nurses in Medication Safety

Nurses occupy a central position in medication safety because medication administration is a major component of nursing practice.

Nursing responsibilities include:

- verifying medication orders;
- identifying the patient correctly;
- checking allergies;
- verifying medication dose;
- checking route and timing;
- performing drug calculations;
- assessing relevant patient conditions;
- administering medications safely;
- monitoring therapeutic effects;
- recognizing adverse effects;
- documenting medication administration; and
- reporting errors and near misses.

Recent systematic-review evidence involving 26 studies found that nurse-implemented interventions included educational programmes, workflow smart technologies, protocolized improvement strategies, low-resource ward-based interventions and electronic medication management. Overall, the meta-analysis found nurse-led interventions were effective in reducing medication administration errors compared with usual care, although individual interventions differed in effectiveness.

Medication Administration Safety

Traditional medication administration principles commonly emphasize verification of:

1. right patient;
2. right medication;
3. right dose;
4. right route;
5. right time;
6. right documentation;
7. right assessment;
8. right education;
9. right response; and
10. right to refuse.

These principles should not be regarded as merely a checklist. Nurses must apply clinical judgment and verify whether the medication is appropriate for the individual patient.

For example, administration of a medication should consider:

- allergies;
- vital signs;
- laboratory values;
- renal function;
- hepatic function;
- drug interactions;
- contraindications; and
- previous adverse reactions.

Technology and Medication Error Prevention

Healthcare technology has created new opportunities for medication-error prevention.

1 Barcode medication administration

Barcode systems can help verify the patient and medication before administration.

2 Electronic prescribing

Electronic prescribing can improve legibility and facilitate decision support.

3 Electronic medication administration records

Electronic medication administration records can improve documentation and provide medication schedules to nurses.

4 Clinical decision-support systems

Decision-support systems may provide alerts regarding:

- allergies;
- drug interactions;
- dose limits;
- contraindications; and
- laboratory abnormalities.

5 Smart infusion pumps

Smart infusion technologies can assist with intravenous medication administration by providing programmed safety limits.

Recent evidence suggests workflow smart technologies may be particularly effective among nurse-led interventions, although implementation must consider the clinical setting and technology limitations.

Technology, however, should support rather than replace professional judgment.

Look-Alike/Sound-Alike Medicines

Look-alike/sound-alike (LASA) medicines are medicines whose names, packaging or appearance may be easily confused.

Errors can occur when healthcare professionals:

- select the wrong medicine;
- misread the medication name;
- confuse similar packaging; or
- rely on memory.

Preventive strategies include:

- separating confusing medications;
- using clear labeling;
- emphasizing differences in names;
- avoiding unsafe abbreviations;
- implementing electronic verification; and
- educating staff about commonly confused medicines.

WHO recognizes LASA medicines as an important medication-safety concern.

Medication Error Reporting and Learning Systems

Reporting systems are essential for identifying medication-safety weaknesses.

A strong reporting system should encourage reporting of:

- medication errors;
- near misses;
- adverse medication events;
- unsafe conditions; and
- system vulnerabilities.

A non-punitive safety culture encourages healthcare professionals to report incidents without fear of inappropriate punishment.

The objective should be to ask:

What happened, why did it happen, and how can recurrence be prevented?

rather than simply:

Who made the mistake?

Root-cause analysis can identify contributing factors and support corrective actions.

Patient and Family Engagement

Patients and families are important partners in medication safety.

WHO's 5 Moments for Medication Safety initiative encourages patients and caregivers to participate actively in medication-related decisions and safety checks.

Patients should be encouraged to know:

- the name of each medication;
- why they are taking it;
- the dose;
- when to take it;
- possible adverse effects;
- important precautions; and
- what to do if a dose is missed.

Patients should also be encouraged to ask healthcare professionals questions whenever medication instructions are unclear.

Education and Continuing Professional Development

Continuous education is an important component of medication-error prevention.

Medication-safety training should include:

- medication administration principles;
- drug calculations;
- high-alert medications;
- adverse drug reactions;
- medication reconciliation;
- LASA medications;
- documentation;
- incident reporting;
- patient education;
- communication; and
- safe use of medication technologies.

Education should not be limited to new employees. Regular refresher training and competency assessment are necessary because medications, technologies, guidelines and clinical practices change over time.

Multidisciplinary Approach

Medication safety requires collaboration between:

- physicians;
- nurses;
- pharmacists;
- patients;
- caregivers;
- clinical managers;
- quality-improvement teams;
- information-technology professionals; and
- hospital administrators.

Multidisciplinary medication-safety committees can review medication incidents, identify trends, develop protocols and monitor improvement.

Collaboration is particularly important during transitions of care and for patients receiving multiple medicines.

Proposed Framework for Medication Error Prevention

A comprehensive medication-safety framework can be represented as:

Healthcare Worker Competence

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Standardized Medication Processes

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Technology and Decision Support

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Effective Communication

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Patient/Family Engagement

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Medication Error Detection & Reporting

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Root-Cause Analysis

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Organizational Learning

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Quality Improvement

↓
Reduced Medication-Related Harm

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Improved Patient Outcomes

This systems-based approach is consistent with WHO's medication-safety strategy, which emphasizes patients, healthcare professionals, medicines and systems, together with high-risk situations, polypharmacy and transitions of care.

Challenges in Medication Error Prevention

Despite advances in medication safety, several challenges remain:

1. Inadequate staffing.
2. Heavy workload.
3. Frequent interruptions.
4. Inconsistent training.
5. Poor communication.
6. Inadequate medication reconciliation.
7. Under-reporting of medication errors.
8. Fear of blame or disciplinary action.
9. Incomplete integration of technology.
10. Alert fatigue from electronic systems.
11. Polypharmacy.
12. Complex medication regimens.
13. Limited patient health literacy.
14. Inconsistent implementation of safety policies.

Conclusion

Medication safety is a cornerstone of quality patient care. Medication errors can occur at multiple stages of the medication-use process and may cause preventable harm. Current evidence and international patient-safety guidance demonstrate that medication-related harm cannot be effectively addressed through individual vigilance alone. Instead, prevention requires a comprehensive systems approach.

WHO's Medication Without Harm initiative emphasizes high-risk situations, polypharmacy and transitions of care as major priorities and calls for coordinated action involving patients, healthcare professionals, medicines and healthcare systems.

Nurses have a particularly important role because they participate directly in medication administration, monitoring, documentation and patient education. Recent evidence demonstrates that nurse-led interventions—including education, protocol-based strategies, workflow technologies and electronic medication-management systems—can reduce medication administration errors.

Ultimately, advancing medication safety requires a culture in which healthcare professionals are educated, systems are designed to anticipate errors, patients are empowered to participate, incidents are reported and analyzed, and organizations continuously learn from failures and near misses.

Medication safety should therefore be regarded not as an isolated nursing or pharmacy responsibility, but as a shared organizational commitment to delivering safer, more effective and higher-quality patient care.

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