RESEARCH PAPER

The Role of Nurses and Pharmacists in Reducing Medication Errors in Hospital Settings

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ABSTRACT
Medication errors represent a persistent and critical threat to patient safety within hospital settings, leading to significant morbidity, mortality, and economic cost. This research paper examines the indispensable and synergistic roles of nurses and pharmacists as the primary defenders against this pervasive challenge. It argues that error reduction is fundamentally dependent on the integration of the nurse's position as the final bedside checkpoint—responsible for vigilant administration, monitoring, and patient advocacy—with the pharmacist's expertise in clinical verification and systemic safety design. The paper explores the scope and impact of medication errors, detailing the specific responsibilities and barriers faced by each profession. A central thesis is that interprofessional collaboration models, such as unit-based clinical pharmacy and joint quality improvement initiatives, create a safety synergy more powerful than isolated efforts. Furthermore, the analysis considers the dual role of technology as both a tool and a potential barrier, emphasizing that its effectiveness is contingent on human-centered design and a robust safety culture. The paper concludes that overcoming systemic, cultural, and logistical barriers through strategic investment, role redesign, and enhanced interprofessional education is essential to strengthen this alliance. By synthesizing current evidence, this research underscores that a fortified nurse-pharmacist partnership is the cornerstone of a resilient medication-use system, directly contributing to the global imperative of reducing preventable patient harm.
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INTRODUCTION

The modern hospital is a complex, high-stakes environment where the margin for error is vanishingly small, especially concerning patient medication. Medication safety constitutes a cornerstone of quality healthcare delivery and patient outcomes. However, medication errors—defined as any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer—remain a persistent and formidable challenge globally [1]. These errors can occur at any stage of the medication use process: from prescribing and transcribing to dispensing, administering, and monitoring. Their consequences range from negligible to catastrophic, including adverse drug events (ADEs), prolonged hospital stays, increased healthcare costs, permanent harm, and even patient mortality [2]. The World Health Organization (WHO) has identified medication safety as a global priority, launching its third Global Patient Safety Challenge, "Medication Without Harm," to reduce severe, avoidable medication-related harm by 50% over five years [3]. Within this urgent framework, the frontline healthcare professionals—nurses and pharmacists—emerge as the most critical and interdependent defenders against this pervasive threat. This research paper will argue that the reduction of medication errors in hospital settings is not solely dependent on technological interventions or systemic protocols, but fundamentally on the synergistic expertise, vigilant execution, and collaborative partnership of nursing and pharmacy professionals. By examining their distinct yet complementary roles, the paper will explore how their integrated efforts form the most robust and human-centric barrier to medication-related harm.

The scope and impact of medication errors are staggering. Studies indicate that medication errors affect nearly one in every 30 hospitalized patients, with a significant proportion being preventable [4]. In the United States, it is estimated

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that medication errors cause at least one death every day and injure approximately 1.3 million people annually [5]. The financial burden is equally profound, with the annual cost of treating drug-related injuries occurring in hospitals alone estimated to be in the tens of billions of dollars [6]. These errors are rarely the result of individual negligence alone; rather, they are often symptomatic of systemic weaknesses. Contributing factors include high workload and staffing shortages, ambiguous communication, look-alike/sound-alike (LASA) drugs, inadequate knowledge, problematic drug labeling and packaging, and failures within the hospital's safety culture [7, 8]. The "Swiss cheese model" of accident causation aptly illustrates how latent systemic failures (holes in the cheese slices) align, allowing a hazard to pass through all defenses and result in an error [9]. In the medication process, each professional—the prescribing physician, the transcribing clerk, the dispensing pharmacist, and the administering nurse—represents a layer of defense. The fortification of these layers, particularly the final checks performed by nurses and pharmacists, is paramount in preventing the hazard from reaching the patient.

Nurses, as the primary administrators of medications and the professionals with the most continuous patient contact, occupy the ultimate and most vulnerable position in the medication chain. Their role in error prevention is multi-faceted and extends far beyond mere administration. It encompasses a continuous cycle of assessment, verification, execution, and evaluation. During medication administration, nurses are expected to adhere rigorously to the "Five Rights": right patient, right drug, right dose, right route, and right time—a foundational but sometimes fallible practice that requires constant vigilance [10]. More critically, nurses serve as the last practical checkpoint before a drug enters a patient's body. They are responsible for reconciling medications, checking for allergies, assessing patient parameters (e.g., renal function, blood pressure) relevant to the drug's safety, and questioning orders that appear unclear, inappropriate, or potentially harmful. This "right to question" is a vital component of a safe culture. Furthermore, nurses are central to monitoring therapeutic effects and identifying adverse drug reactions post-administration, enabling early intervention. Their documentation provides an essential legal and clinical record of the care process. However, nurses often operate under immense pressure, with interruptions during medication rounds being a significant and well-documented contributor to administration errors [11]. Therefore, empowering nurses through adequate staffing, a supportive environment that encourages speaking up, and streamlined processes is crucial to leveraging their frontline position effectively.

Pharmacists, as the medication experts on the healthcare team, provide a specialized, knowledge-based layer of defense that is fundamentally preventive and systems-oriented. Their traditional role in dispensing has evolved dramatically into a central clinical function focused on ensuring optimal therapeutic outcomes and intercepting errors before they reach the patient unit. Clinical pharmacists participate in medical rounds, conduct comprehensive medication reviews, and are instrumental in verifying the appropriateness, safety, and efficacy of every medication order. They possess the expertise to identify drug-drug interactions, contraindications, incorrect dosages based on pharmacokinetics, and therapeutic duplications—issues that may elude other busy professionals [12]. Pharmacists are also key architects and guardians of the hospital's medication safety systems. They design and manage formulary restrictions, standardize medication concentrations, develop protocols for high-alert medications (such as anticoagulants, opioids, and insulin), and lead initiatives to eliminate error-prone abbreviations and improve drug labeling and storage. The implementation of technological aids like Computerized Physician Order Entry (CPOE) with clinical decision support (CDS) and automated dispensing cabinets (ADCs) is most effective when guided and overseen by pharmacy expertise to avoid new, technology-generated errors [13].

The Scope and Impact of Medication Errors: A Persistent Healthcare Challenge

The pursuit of patient safety is the fundamental ethical imperative of any healthcare system. Yet, within the complex, high-stakes environment of the modern hospital, a persistent and dangerous threat undermines this goal: medication errors. These preventable events, which can occur at any stage of the medication use process—from prescribing and transcribing to dispensing, administration, and monitoring—represent a critical and enduring challenge to global health [14]. Their scope is vast, their human and economic impact profound, and their persistence, despite decades of awareness and intervention, underscores the deep-seated systemic nature of the problem. Understanding the full dimensions of this challenge is the essential first step in mobilizing effective, multi-faceted defenses, primarily through the empowered roles of nurses and pharmacists.

Medication errors are not a rare occurrence but a frequent feature of hospitalized care. Quantifying their exact prevalence is difficult due to significant underreporting, but epidemiological studies paint a concerning picture. Research indicates that a medication error occurs in approximately one out of every five medication doses administered in hospitals, with a smaller but significant proportion leading to actual harm, known as adverse drug events (ADEs) [15]. A landmark study estimated that in the United States alone, preventable ADEs cause over 400,000 incidents of harm annually in hospitals, contributing to substantial morbidity and extra healthcare costs [16]. The problem is global, with studies from Europe, Asia, and Australia reporting similar trends, indicating that medication safety is a universal vulnerability, transcending national borders and healthcare funding models [17]. The risk extends across all patient populations but is particularly acute in vulnerable groups such as the elderly, pediatric patients, and those with multiple chronic conditions (comorbidities), who are often on complex and high-risk medication regimens [18].

The impact of these errors operates on two devastating levels: human and economic. On the human level, the consequences range from minor discomfort or temporary illness to permanent disability and death. A patient may receive an incorrect antibiotic dose, leading to treatment failure and sepsis. A miscommunication about a drug allergy could trigger a fatal anaphylactic reaction. A decimal point error in a neonatal insulin order could be catastrophic. Beyond the physical harm, medication errors erode the sacred trust between patients and the healthcare system, leading to psychological trauma for patients, families, and, notably, the healthcare professionals involved—a phenomenon known as the "second victim" effect [19]. The economic burden is equally staggering. The costs associated with medication errors include prolonged hospital stays, additional diagnostic tests, remedial treatments, and increased liability insurance premiums. A comprehensive analysis by the Organization for Economic Co-operation and Development (OECD) estimated that medication-related harm consumes between 5% and 20% of total clinical healthcare expenditure in its member countries, representing hundreds of billions of dollars lost annually to preventable harm [20]. This financial drain redirects crucial resources away from productive care and innovation.

The persistence of this problem is rooted in its multifactorial etiology. Errors are rarely, if ever, the simple result of a single individual's carelessness. Instead, they are typically the end product of a chain of failures within a complex system, a concept famously illustrated by James Reason's "Swiss Cheese Model" [21]. Latent conditions (systemic weaknesses) align with active failures (human errors) to allow a hazard to pass through all layers of defense. Key systemic contributors include poorly designed processes, such as ambiguous handwritten prescriptions, confusing drug nomenclature (e.g., look-alike/sound-alike drugs), and inefficient medication reconciliation procedures during care transitions [22]. Human factors play a critical role, encompassing cognitive overload, fatigue, interruptions during nursing medication administration, knowledge deficits, and implicit bias. Environmental stressors, such as understaffing, high workload, poor lighting, and noisy units, further increase the likelihood of error [23]. Furthermore, a culture that discourages open reporting and discussion of errors for fear of blame creates a major barrier to learning and systemic improvement, allowing the same error-provoking conditions to persist [24].

The Nurse as the Final Checkpoint: Administration, Vigilance, and Patient Advocacy

Within the intricate and multi-step medication use process in hospitals, the nurse occupies a position of unparalleled critical importance. As the healthcare professional who physically administers the medication to the patient, the nurse serves as the ultimate human checkpoint—the last and most crucial barrier standing between a potential error and patient harm [25]. This role extends far beyond the mechanical act of giving a pill or an injection; it is a complex, knowledge-driven practice that integrates technical skill with critical thinking, relentless vigilance, and uncompromising patient advocacy. In the ongoing battle to reduce medication errors, empowering and supporting nurses in this multifaceted role is not merely beneficial but absolutely essential for patient safety.

The cornerstone of safe medication administration is the foundational principle of the "Five Rights": right patient, right drug, right dose, right route, and right time. While this framework is universally taught, its consistent and correct application in the dynamic, high-pressure hospital environment is a profound professional responsibility. Nurses operationalize these rights through rigorous protocols. This includes verifying patient identity using two unique identifiers (e.g., name and date of birth), meticulously checking medication labels against the medication administration record (MAR) at the bedside, independently calculating doses, and ensuring the prescribed route is both appropriate and feasible [26]. The advent of technology, particularly barcode medication administration (BCMA) systems, has been designed to support these checks by electronically verifying the patient, medication, and dose before administration. However, technology is a tool, not a replacement for clinical judgment. Nurses must remain actively engaged, as "workarounds" or over-reliance on automated systems can introduce new risks. The nurse's final visual and cognitive verification—looking at the actual medication, considering the patient's current condition, and confirming appropriateness—remains the indispensable final step [27].

Perhaps the most critical and proactive aspect of the nurse's defensive role is clinical vigilance and the exercise of professional judgment, often manifesting as the "right to question." A nurse is not a passive conduit for physician orders but an active, licensed professional accountable for the outcomes of their actions. This necessitates a deep understanding of pharmacology, therapeutic intent, and individual patient parameters. Effective vigilance involves assessing the patient's clinical status (e.g., renal function, lab values, vital signs) in relation to the medication, screening for potential allergies, and identifying obvious errors like a tenfold dosage miscalculation [28]. When an order is unclear, appears inappropriate, or conflicts with the nurse's assessment, the ethical and professional imperative is to clarify, question, or challenge it. This act of advocacy, whether a simple call to the prescribing physician or a formal consultation with the pharmacy, is one of the most potent error-interception mechanisms in the system. It transforms the nurse from a final passive checkpoint into an active safety agent [29].

Following administration, the nurse's role transitions seamlessly to that of monitor and documentor, closing the safety loop. Therapeutic monitoring for intended effects and vigilant surveillance for adverse drug reactions (ADRs) are crucial nursing responsibilities that can mitigate harm from errors that bypassed earlier defenses. For instance, recognizing early signs of hypoglycemia after insulin administration or detecting a rash after a new antibiotic can trigger life-saving interventions. Accurate and timely

documentation in the MAR is equally vital; it provides a legal record, communicates the patient's status to the entire care team, and is essential for effective medication reconciliation [30]. Furthermore, nurses are often the primary source for reporting medication errors and near-misses through institutional incident reporting systems. Their firsthand accounts provide invaluable data for root cause analyses, which are critical for identifying and remedying systemic flaws rather than blaming individuals [31].

Despite the clear importance of this role, nurses face formidable systemic and environmental barriers that can compromise their effectiveness as the final checkpoint. Chronic understaffing and excessive workloads are primary contributors, leading to fatigue, cognitive overload, and rushed medication passes where standard checks may be compromised [32]. The medication administration environment is notoriously prone to interruptions and distractions—from phone calls and colleague questions to urgent patient needs—which significantly increase the risk of errors. Studies have shown that interruptions during medication administration can double or triple the likelihood of a mistake [33]. Furthermore, hierarchical hospital cultures can sometimes stifle the "voice" of the nurse, making them reluctant to question authority figures like physicians, thereby neutralizing a key safety behavior [34]. The physical environment, such as poor lighting, cluttered medication carts, and poorly organized storage, also introduces unnecessary risk.

Therefore, to truly leverage the nurse's position as the ultimate safeguard, healthcare institutions must move beyond simply assigning responsibility and actively cultivate a supportive ecosystem. This includes ensuring safe nurse-to-patient ratios, designing interruption-free zones or protocols during medication rounds (e.g., wearing visible "do not disturb" vests), and investing in user-friendly technology that supports rather than hinders workflow. Most importantly, fostering a true culture of safety—where questioning is encouraged, reporting is non-punitive, and interdisciplinary collaboration is the norm—is paramount [35].

The Pharmacist as the Medication Safety Expert: System Design and Clinical Verification

If the nurse serves as the indispensable final checkpoint at the bedside, the pharmacist functions as the foundational architect and expert analyst of the entire medication safety system. Their role has evolved dramatically from a primarily dispensing-focused one to a central, clinical, and proactive position embedded within the healthcare team. As the undisputed medication experts, pharmacists provide a critical, knowledge-based layer of defense that operates both retrospectively and prospectively to intercept errors and redesign error-prone processes. Their work in clinical verification and system design constitutes a powerful upstream intervention, aiming to prevent errors from ever reaching the nurse's tray or the patient's bloodstream [36]. In the modern hospital's safety strategy, the pharmacist is therefore not merely a supplier of drugs but a guarantor of their safe and effective use.

The most direct clinical impact of pharmacists lies in systematic medication order verification and proactive review. This goes far beyond checking for dispensing accuracy; it involves a comprehensive clinical evaluation of every prescribed medication for appropriateness, safety, and efficacy. This process, often called "clinical pharmacy verification," leverages the pharmacist's deep knowledge of pharmacotherapy, pharmacokinetics, and pharmacodynamics. Key activities include: identifying and resolving drug-drug and drug-disease interactions; verifying dosing based on renal/hepatic function, age, and weight; checking for therapeutic duplication; confirming appropriate route and formulation; and screening for allergies [37]. The presence of clinical pharmacists on patient care units, participating in medical rounds, has been consistently shown to significantly reduce preventable adverse drug events (ADEs). By providing real-time, point-of-care expertise, they can intervene directly with prescribers to adjust orders before they are executed, serving as a live, intelligent filter for the medication stream [38]. Furthermore, pharmacists lead and perform comprehensive medication reconciliation—a formal process of creating the most accurate list of all medications a patient is taking and comparing it to new admission, transfer, or discharge orders. This is a high-risk point for errors, and pharmacist-led reconciliation is proven to be more effective in identifying and resolving unintended discrepancies than other models [39].

Beyond individual patient review, pharmacists are the principal engineers of the hospital's medication safety infrastructure through system design and control. They apply human factors principles and failure mode analysis to create safer processes. A core responsibility is managing the hospital formulary, a curated list of medications that standardizes therapy and reduces the proliferation of confusing, look-alike/sound-alike (LASA) agents. Pharmacists develop and enforce protocols for high-alert medications—such as anticoagulants, opioids, insulin, and chemotherapeutic agents—which carry a heightened risk of causing harm if used in error. These protocols include standardized concentrations, pre-printed orders, and mandatory double-checks [40]. Pharmacists also design the physical and informational environment: they standardize drug storage (e.g., using tall man lettering to differentiate similar names like DOPamine and DOBUTamine), optimize pharmacy and unit-based automated dispensing cabinet (ADC) profiles to limit error-prone choices, and eliminate dangerous abbreviations from institutional use [41]. In the realm of technology, pharmacists are essential in selecting, implementing, and optimizing safety-focused systems like Computerized Physician Order Entry (CPOE) with clinical decision support (CDS). Their expertise is crucial for building meaningful CDS alerts (e.g., for allergy or dosing checks) that are clinically relevant rather than alert-fatigue-inducing "noise," and for troubleshooting the new types of errors that technology can introduce [42].

Despite their pivotal position, pharmacists face significant challenges in fulfilling this expansive safety role. Barriers include insufficient staffing levels to allow for comprehensive clinical review of all orders, particularly in the absence of 24/7 clinical pharmacy coverage. Physical separation from patient care units can delay interventions and hinder collaboration with nurses and physicians. Furthermore, the very technology designed to aid safety can create obstacles; poorly designed CPOE systems or CDS with excessive irrelevant alerts can lead to pharmacist alert fatigue, causing critical warnings to be overlooked [43]. There can also be resistance from other healthcare professionals who may not fully understand or accept the pharmacist's expanded clinical role, viewing interventions as challenges to autonomy rather than contributions to team safety. Overcoming these barriers requires institutional commitment to adequate pharmacy resources, integration of pharmacists into clinical teams, and co-design of technology and workflows with end-users [44].

Synergy in Safety: Models and Benefits of Nurse-Pharmacist Collaboration

While the individual roles of nurses and pharmacists are formidable defensive layers in medication safety, their true transformative power is unlocked through intentional, structured, and respectful collaboration. In a complex system prone to communication breakdowns and fragmented care, a synergistic partnership between these two professions bridges the critical gap between the systems-focused knowledge of the pharmacist and the patient-centered, bedside execution of the nurse. This collaboration moves beyond mere coexistence to create an integrated, dynamic safety net where shared expertise and mutual vigilance produce outcomes greater than the sum of their parts. Examining the models and multifaceted benefits of this interprofessional alliance reveals it as the cornerstone of an effective, resilient medication safety program [45].

Several proven structural models facilitate this essential collaboration. The most impactful is the integration of **unit-based or decentralized clinical pharmacists**. In this model, pharmacists are physically located on patient care units, working alongside nurses and physicians as integral members of the team. This proximity allows for real-time, face-to-face consultation, immediate order clarification, and joint problem-solving at the point of care. A pharmacist on the unit can quickly answer a nurse's question about drug compatibility, review a complex medication schedule at the bedside, or co-manage a patient on a high-risk infusion, thereby preventing errors of misunderstanding or delayed information [46]. Another critical collaborative model is **joint leadership in medication reconciliation**. This high-risk process is significantly enhanced when nurses and pharmacists combine their unique perspectives: the nurse's direct knowledge of the patient's home regimen and self-reported history with the pharmacist's expertise in drug therapy and ability to access disparate records. Working together, they can more accurately construct a complete medication list at admission and ensure a safe, understandable plan at discharge [47]. Furthermore, **shared participation in quality improvement (QI) initiatives**, such as medication safety committees or root cause analysis teams, allows both professions to contribute their frontline insights. Nurses can highlight practical workflow barriers, while pharmacists can analyze systemic and therapeutic vulnerabilities, leading to co-designed solutions—such as new protocols, packaging changes, or educational programs—that are both clinically sound and pragmatically feasible on the floor [48].

The benefits of this synergy are profound and measurable, impacting patient outcomes, professional practice, and system resilience. The most direct benefit is a **significant reduction in preventable adverse drug events (ADEs) and medication errors**. Collaborative practices, such as pharmacist participation in nursing shift handovers or joint double-checks for high-alert medications, create overlapping verification steps that catch errors missed in serial, isolated processes. Studies consistently demonstrate that hospitals with strong nurse-pharmacist collaboration report lower error rates and fewer instances of patient harm [49]. Secondly, collaboration **enhances communication and breaks down hierarchical silos**. Regular, structured interaction fosters mutual respect and a shared mental model of patient care. When nurses view pharmacists as accessible clinical resources rather than distant dispensers, and pharmacists value the contextual patient assessment provided by nurses, communication becomes more open and effective. This environment empowers nurses to feel confident in questioning orders and reporting near-misses, knowing they will receive a supportive, expert response from their pharmacy partner [50].

Furthermore, this partnership leads to **shared learning and enhanced competency**. Nurses gain deeper pharmacological knowledge through daily interactions with pharmacists, improving their clinical reasoning and monitoring skills. Conversely, pharmacists gain a richer understanding of nursing workflow, patient response nuances, and the practical challenges of administration, allowing them to design more user-friendly systems and relevant alerts. This cross-education strengthens the overall competency of the care team [51]. From a systemic perspective, collaboration **strengthens the safety culture** of the institution. It models non-hierarchical, team-based problem-solving and demonstrates a collective commitment to "checking each other's work" not as an act of distrust, but as a core professional responsibility. This cultivates a just culture where the focus shifts from individual blame to systemic learning and shared accountability [52]. Finally, effective collaboration can **reduce workload and mitigate burnout** for both professions. By resolving medication-related issues quickly and efficiently at the source, it prevents time-consuming call-backs, clarifications, and error remediation later. A nurse who can get an immediate answer from a unit-based pharmacist avoids prolonged delays; a pharmacist who receives a complete and clear medication history from a nurse saves investigation time. This mutual support alleviates frustration and enhances job satisfaction [53].

Technological Tools and Human Factors: Aiding the Defenders

In the multifaceted campaign to reduce medication errors, technological tools have emerged as powerful allies for nurses and pharmacists, offering the potential to automate checks, standardize processes, and provide critical decision support. However, technology is not a panacea; it is a tool whose effectiveness is entirely dependent on its integration with the human elements of the healthcare system—the clinicians who use it. The relationship between technological systems and human factors is thus symbiotic and often paradoxical: while designed to eliminate human error, technology introduces new complexities and demands on human cognition and workflow. A successful medication safety strategy, therefore, requires the deliberate co-design of technological tools that account for human strengths, limitations, and the realities of clinical practice, ensuring they truly aid the defenders rather than inadvertently burden them [54].

A suite of core technologies has become integral to the modern hospital's medication safety infrastructure. **Computerized Physician Order Entry (CPOE)** forms the digital foundation, aiming to eliminate errors stemming from illegible handwriting and ambiguous oral orders. When coupled with advanced **Clinical Decision Support (CDS)** systems, CPOE can provide real-time alerts for drug-allergy conflicts, dose-range checking, drug-drug interactions, and renal dosing adjustments. This offers pharmacists a powerful tool for verification and gives prescribers immediate feedback [55]. For nurses, **Bar-Code Medication Administration (BCMA)** represents a crucial technological checkpoint. By requiring nurses to scan a barcode on both the patient's wristband and the medication package, the system electronically verifies the "Five Rights" against the electronic medication administration record (eMAR) before administration can proceed. This hard stop is designed to intercept errors at the very last moment [56]. Similarly, **smart infusion pumps** with dose-error reduction software (DERS) contain pre-programmed drug libraries with soft and hard limits for high-alert intravenous medications, preventing nurses from inadvertently programming a dangerous bolus or infusion rate [57]. **Automated Dispensing Cabinets (ADCs)** in nursing units, managed by pharmacy, control drug distribution and provide audit trails, though their configuration is critical to safety.

The evidence for the benefits of these technologies is substantial but nuanced. Implemented well, they can significantly reduce specific error types. CPOE with CDS has been shown to decrease prescribing errors, particularly those related to dosing and allergies [58]. BCMA, when used correctly, can dramatically reduce administration errors, especially wrong patient, wrong drug, and wrong dose mistakes [59]. Smart pumps have demonstrated effectiveness in reducing intravenous medication errors and associated harm [60]. However, these positive outcomes are not automatic. The effectiveness of each tool is heavily mediated by **human factors**—the scientific discipline concerned with understanding interactions among humans and other elements of a system. Poorly designed technology that fails to align with clinical workflow can create new hazards. For instance, CPOE systems with poorly designed screens or cumbersome navigation can lead to incorrect order selection. CDS systems that generate excessive "alert fatigue"—a barrage of clinically irrelevant warnings—cause clinicians to override or ignore critical alerts, rendering the safety feature useless [61]. Nurses may develop dangerous "workarounds" to BCMA systems, such as scanning medication packages away from the bedside or using duplicated patient barcodes, to bypass perceived inefficiencies, thereby nullifying the safety mechanism [62].

Therefore, the true challenge lies not in purchasing technology, but in its implementation and sustained use within a human-centered framework. This requires proactive attention to **usability, workflow integration, and organizational culture**. Technology must be designed and customized with direct input from frontline nurses and pharmacists to ensure it fits their cognitive and physical workflow, a process known as **socio-technical design**. Alerts within CDS must be tiered, specific, and evidence-based to maintain their credibility. Institutions must invest in comprehensive, role-specific training that goes beyond basic functionality to include the safety rationale behind protocols, fostering understanding over rote compliance [63]. Perhaps most critically, technology must operate within a **culture of safety** that encourages reporting of tech-related near-misses and problems without fear of blame. When a nurse reports a confusing pump interface or a pharmacist flags a faulty CDS alert, the system must be adaptable enough to be refined. This feedback loop is essential for continuous improvement [64].

Overcoming Barriers and Future Directions: Strengthening the Safety Alliance

The compelling evidence for the synergistic power of the nurse-pharmacist alliance in reducing medication errors stands in stark contrast to the persistent real-world barriers that hinder its full realization. While the ideal of seamless collaboration is clear, its implementation is often challenged by entrenched systemic, cultural, and logistical obstacles. To move from theoretical models to sustained, widespread improvement, healthcare institutions must proactively identify and dismantle these barriers. Simultaneously, the field must look toward future innovations in practice, education, and policy that can strengthen this critical safety partnership. The path forward requires a dual commitment: addressing the immediate, practical impediments to effective teamwork today, while strategically evolving roles and systems to meet the challenges of tomorrow’s healthcare landscape [65].

Significant, interconnected barriers continue to impede optimal collaboration and safety performance. **Resource constraints and staffing models** remain paramount. Chronic nursing shortages and inadequate pharmacist-to-patient ratios force professionals into a perpetual cycle of task completion, leaving little time for the proactive

consultation, joint review, and relationship-building that underpin true collaboration. When nurses are overwhelmed and pharmacists are confined to a central dispensing role due to understaffing, safety reverts to a series of rushed, independent checks rather than a collaborative process [66]. **Siloed workflows and physical separation** further exacerbate this issue. Traditional hospital structures often physically and procedurally isolate pharmacists in the basement pharmacy, creating communication delays and a sense of disconnection from the clinical frontline. This makes the pharmacist a remote resource to be called only in crisis, rather than an integrated team member [67]. A pervasive **hierarchical culture** in some settings can stifle the open communication essential for safety. Nurses may hesitate to question a pharmacist's dispensed product, just as they might hesitate to question a physician's order. Conversely, pharmacists may not always engage nurses as equal partners in system design, leading to impractical protocols [68]. Finally, **technological barriers** persist, where poorly integrated electronic health records (EHRs), medication administration records (MARs), and pharmacy systems create information siloes, duplicate work, and communication gaps between the professions, rather than serving as a unifying platform [69].

Overcoming these barriers demands deliberate, multi-faceted strategies at the institutional and interprofessional levels. Firstly, **leadership must invest in sustainable staffing models and role redesign.** This includes funding for unit-based clinical pharmacist positions and establishing safe nurse-to-patient ratios, not as cost centers, but as essential safety infrastructure with a demonstrable return on investment through error reduction. Implementing structured **interprofessional communication tools**, such as the SBAR (Situation, Background, Assessment, Recommendation) technique for phone conversations or integrated messaging within the EHR, can standardize and streamline interactions [70]. Actively fostering a **culture of psychological safety and flattened hierarchy** is non-negotiable. This involves leadership modeling collaborative behavior, conducting interprofessional training in communication and conflict resolution, and ensuring error reporting systems are non-punitive and focused on system learning. Recognizing and celebrating successful collaborative interventions that prevent harm can reinforce desired behaviors [71]. From a technology standpoint, healthcare organizations must involve **interprofessional design teams**—including frontline nurses and pharmacists—in the selection, customization, and ongoing evaluation of health information technology to ensure it supports, rather than hinders, shared workflow and communication [72].

Looking to the future, several promising directions can further cement and expand the safety alliance. The evolution of **advanced practice roles** will deepen collaboration. The proliferation of Doctor of Nursing Practice (DNP) prepared nurses and specialized nurse practitioners, alongside Pharmacist Practitioners with expanded prescribing authority in certain jurisdictions, will create new opportunities for shared patient management and protocol development, based on mutual expertise [73]. **Predictive analytics and artificial intelligence (AI)** will provide new tools for the alliance. AI-driven risk scores can flag high-risk patients or complex medication regimens, prompting proactive, joint nurse-pharmacist reviews before problems occur. This shifts the paradigm from reactive error interception to predictive risk mitigation [74]. Furthermore, **interprofessional education (IPE)** must begin earlier and be more immersive. Moving beyond simulation, embedding nursing and pharmacy students together in clinical rotations focused on medication safety can build foundational trust, communication skills, and a shared mental model before entering practice, creating a generation of clinicians predisposed to collaboration [75].

Conclusion

In conclusion, the challenge of medication errors in hospitals is a complex systemic issue that demands a multifaceted, integrated defense strategy. This research has delineated the critical, complementary roles that nurses and pharmacists play in this endeavor. Nurses serve as the essential human safeguard at the point of care, employing clinical judgment, vigilant administration, and direct patient advocacy to intercept errors. Pharmacists provide the foundational expertise for safety, conducting clinical verification and redesigning error-prone systems to prevent harm proactively. Individually, each profession is a vital layer of protection; however, their true potential is realized through intentional collaboration. Models such as integrated unit-based teams and shared governance structures foster a synergy where communication, mutual respect, and shared problem-solving lead to measurably safer outcomes.

The path forward requires a committed dismantling of the barriers that hinder this alliance, including inadequate staffing, physical and professional silos, hierarchical cultures, and poorly designed technology. Investment in sustainable resources, the cultivation of psychological safety, and the co-design of workflows are non-negotiable prerequisites. Future directions point toward the evolution of advanced practice roles, the intelligent application of predictive analytics to support proactive risk assessment, and the foundational integration of interprofessional education from the onset of clinical training. Ultimately, strengthening the nurse-pharmacist safety alliance transcends operational improvement; it is an ethical commitment to constructing a healthcare environment where the combined expertise of these frontline defenders ensures that the promise of "first, do no harm" is reliably upheld in every medication delivered.

REFERENCE

1. Gallagher RM, Nadzam DM. Two decades of

coordinating medication safety efforts. https://www.nccmerp.org/ncc-merp-20-year-anniversary-report. Accessed December 5, 2024. [Google Scholar]
2. World Health Organization. Medication without harm – global patient safety challenge on medication safety. https://www.who.int/initiatives/medication-without-harm. Accessed December 5, 2024. [Google Scholar]
3. Armitage G, Knapman H. Adverse events in drug administration: a literature review. J Nurs Manag. 2003;11:130–40. [DOI] [PubMed] [Google Scholar]
4. Alshammari TM, Mendi N, Alenzi KA, Alsowaida Y. Pharmacovigilance systems in Arab countries: overview of 22 Arab countries. Drug Saf. 2019;42:849–68. [DOI] [PubMed] [Google Scholar]
5. Minstry of Health Malaysia. Annual report. https://www.moh.gov.my/moh/resources/Penerbitan/Penerbitan%20Utama/2._MOH_Annual_Report_2022-compressed_.pdf. Accessed December 5, 2024. [Google Scholar]
6. Alsulami Z, Conroy S, Choonara I. Medication errors in the Middle East countries: a systematic review of the literature. Eur J Clin Pharmacol. 2013;69:995–1008. [DOI] [PMC free article] [PubMed] [Google Scholar]
7. Salmasi S, Wimmer BC, Khan TM, Patel RP, Ming LC. Quantitative exploration of medication errors among older people: a systematic review. Drugs Ther Perspect. 2018;34:129–37. [Google Scholar]
8. Brown CL, Mulcaster HL, Triffitt KL, et al. A systematic review of the types and causes of prescribing errors generated from using computerized provider order entry systems in primary and secondary care. J Am Med Inform Assoc. 2017;24:432–40. [DOI] [PMC free article] [PubMed] [Google Scholar]
9. Mamat R, Awang SA, Mohd Ariffin SA, Zakaria Z, Che Zam MH, Ab Rahman AF. Knowledge and attitude toward medication error among pharmacists. Hosp Pharm. 2021;56:765–71. [DOI] [PMC free article] [PubMed] [Google Scholar]
10. Mekonnen AB, Alhawassi TM, McLachlan AJ, Brien JE. Adverse drug events and medication errors in African hospitals: a systematic review. Drugs Real World Outcomes. 2018;5:1–24. [DOI] [PMC free article] [PubMed] [Google Scholar]
11. Alshehri GH, Keers RN, Ashcroft DM. Frequency and nature of medication errors and adverse drug events in mental health hospitals: a systematic review. Drug Saf. 2017;40:871–86. [DOI] [PubMed] [Google Scholar]
12. Alanazi MA, Tully MP, Lewis PJ. A systematic review of the prevalence and incidence of prescribing errors with high-risk medicines in hospitals. J Clin Pharm Ther. 2016;41:239–45. [DOI] [PubMed] [Google Scholar]
13. Williams Wittich CM, Burkle CM, Lanier WL. Mediation errors: an overview for clinicians. Mayo Clin Proc. 2014;89:1116–25. [DOI] [PubMed] [Google Scholar]
14. Goeddecke T, Ord K, Newbould V, Brosch S, Arlett P. Medication errors: new EU good practice guide on risk minimisation and error prevention. Drug Saf. 2016;39:491–500. [DOI] [PubMed] [Google Scholar]
15. Alshehri Z, Conroy S, Choonara I. Medication errors in the Middle East countries: a systematic review of the literature. Eur J Clin Pharmacol. 2013;69:995–1008. [DOI] [PMC free article] [PubMed] [Google Scholar]
16. Mathew B, Thomas A, Hiremath D. Assessment of knowledge attitude and practice on medication error reporting among clinical pharmacists. Asian J Pharm Health Sci. 2021;11:2462–7. [Google Scholar]
17. Samsiah A, Othman N, Jamshed S, Hassali MA. Knowledge, perceived barriers and facilitators of medication error reporting: a quantitative survey in Malaysian primary care clinics. Int J Clin Pharm. 2020;42:1118–27. [DOI] [PubMed] [Google Scholar]
18. Rickles NM, Noland CM, Tramontozzi A, Vinci MA. Pharmacy student knowledge and communication of medication errors. Am J Pharm Educ. 2010;74:60. [DOI] [PMC free article] [PubMed] [Google Scholar]
19. Feinstein MM, Pannunzio AE, Castro P. Frequency of medication error in pediatric anesthesia: a systematic review and meta-analytic estimate. Paediatr Anaesth. 2018;28:1071–7. [DOI] [PubMed] [Google Scholar]
20. World Health Organization. Medication without harm – global patient safety challenge on medication safety. https://www.who.int/initiatives/medication-without-harm. Accessed December 5, 2024. [Google Scholar]
21. Arksey H., O'Malley L. Scoping studies: towards a methodological framework. Int. J. Soc. Res. Methodol. 2005;8(1):19–32. doi: 10.1080/1364557032000119616. [DOI] [Google Scholar]
22. D'Amour D., Ferrada-Videla M., San Martin Rodriguez L., Beaulieu M.-.D. The Conceptual basis for interprofessional collaboration: core concepts and theoretical frameworks. J. Interprof. Care. 2005;19(S1):116–131. doi: 10.1080/13561820500082529. [DOI] [PubMed] [Google Scholar]

23. Banning M. Medication management: older people and nursing. Nurs. Older People. 2005;17(7):20–23. doi: 10.1016/j.ijnurstu.2008.02.009. [DOI] [PubMed] [Google Scholar]
24. Bell H.T., Granas A.G., Enmarker I., Omli R., Steinsbekk A. Nurses' and pharmacists' learning experiences from participating in interprofessional medication reviews for elderly in primary health care—A qualitative study. BMC Fam. Pract. 2017;18:1–9. doi: 10.1186/s12875-017-0598-0. [DOI] [PMC free article] [PubMed] [Google Scholar]
25. Bayraktar-Ekincioglu A., Kucuk E. The differences in the assessments of side effects at an oncology outpatient clinic. Int. J. Clin. Pharm. 2018;40(2):386–393. doi: 10.1007/s11096-018-0590-3. [DOI] [PubMed] [Google Scholar]
26. Braungart C., Watson A., Rubin R. The effects of interprofessional collaboration on nurse managed warfarin program. J. Interprofessional Education & Practice. 2018;13:56–58. doi: 10.1016/j.xjep.2018.09.003. [DOI] [Google Scholar]
27. Celio J., Ninane F., Bugnon O., Schneider M.P. Pharmacist-nurse collaborations in medication adherence-enhancing interventions: a review. Patient Educ. Couns. 2018;101(7):1175–1192. doi: 10.1016/j.pec.2018.01.022. [DOI] [PubMed] [Google Scholar]
28. Chapman E., Haby M.M., Toma T.S., de Bortoli M.C., Illanes E., Oliveros M.J., Barreto J.O. Knowledge translation strategies for dissemination with a focus on healthcare recipients: an overview of systematic reviews. Implementation Sci. 2020;15(1) doi: 10.1186/s13012-020-0974-3. [DOI] [PMC free article] [PubMed] [Google Scholar]
29. Celio J., Ninane F., Bugnon O., Schneider M.P. Pharmacist-nurse collaborations in medication adherence-enhancing interventions: a review. Patient Educ. Couns. 2018;101(7):1175–1192. doi: 10.1016/j.pec.2018.01.022. [DOI] [PubMed] [Google Scholar]
30. Celio J., Ninane F., Bugnon O., Schneider M.P. Pharmacist-nurse collaborations in medication adherence-enhancing interventions: a review. Patient Educ. Couns. 2018;101(7):1175–1192. doi: 10.1016/j.pec.2018.01.022. [DOI] [PubMed] [Google Scholar]
31. Chapman E., Haby M.M., Toma T.S., de Bortoli M.C., Illanes E., Oliveros M.J., Barreto J.O. Knowledge translation strategies for dissemination with a focus on healthcare recipients: an overview of systematic reviews. Implementation Sci. 2020;15(1) doi: 10.1186/s13012-020-0974-3. [DOI] [PMC free article] [PubMed] [Google Scholar]
32. Canadian Patient Safety Institute [CPSI]. (2017). Safety Improvement Projects. https://www.patientsafetyinstitute.ca/en/toolsResources/Safety-Improvement-Projects/Pages/default.aspx. [Google Scholar]
33. Celio J., Ninane F., Bugnon O., Schneider M.P. Pharmacist-nurse collaborations in medication adherence-enhancing interventions: a review. Patient Educ. Couns. 2018;101(7):1175–1192. doi: 10.1016/j.pec.2018.01.022. [DOI] [PubMed] [Google Scholar]
34. Chapman E., Haby M.M., Toma T.S., de Bortoli M.C., Illanes E., Oliveros M.J., Barreto J.O. Knowledge translation strategies for dissemination with a focus on healthcare recipients: an overview of systematic reviews. Implementation Sci. 2020;15(1) doi: 10.1186/s13012-020-0974-3. [DOI] [PMC free article] [PubMed] [Google Scholar]
35. D'Amour D., Ferrada-Videla M., San Martin Rodriguez L., Beaulieu M.-.D. The Conceptual basis for interprofessional collaboration: core concepts and theoretical frameworks. J. Interprof. Care. 2005;19(S1):116–131. doi: 10.1080/13561820500082529. [DOI] [PubMed] [Google Scholar]
36. Dennis S., May J., Perkins D., Zwar N., Sibbald B., Hasan I. What evidence is there to support skill mix changes between GPs, pharmacists and practice nurses in the care of elderly people living in the community? Australia & New Zealand Health Policy. 2009;6(7) doi: 10.1186/1743-8462-6-23. [DOI] [PMC free article] [PubMed] [Google Scholar]
37. Ellenbecker C.H., Samia L., Cushman M.J., Alster K. Chapter 13. Patient Safety and Quality in Home Health Care. 2009;1:40. [PubMed] [Google Scholar]
38. Elliott R.A., Lee C.Y., Beanland C., Goeman D.P., Petrie N., Petrie B., Vise F., Gray J. Development of a clinical pharmacy model within an australian home nursing service using co-creation and participatory action research: the visiting pharmacist (ViP) study. BMJ Open. 2017;7(11) doi: 10.1136/bmjopen-2017-018722. [DOI] [PMC free article] [PubMed] [Google Scholar]
39. Coleman EA, Smith JD, Raha D et al (2005) Posthospital medication discrepancies: prevalence and contributing factors. Arch Intern Med 165:1842–1847. 10.1001/archinte.165.16.1842 [DOI] [PubMed] [Google Scholar]
40. Blix HS, Viktil KK, Reikvam A et al (2004) The

majority of hospitalised patients have drug-related problems: results from a prospective study in general hospitals. Eur J Clin Pharmacol 60:651–658. 10.1007/s00228-004-0830-4 [DOI] [PubMed] [Google Scholar]

41. Freyer J, Kasprick L, Sultzer R et al (2018) A dual intervention in geriatric patients to prevent drug-related problems and improve discharge management. Int J Clin Pharm 40:1189–1198. 10.1007/s11096-018-0643-7 [DOI] [PubMed] [Google Scholar]
42. Naylor MD, Shaid EC, Carpenter D et al (2017) Components of comprehensive and effective transitional care. J Am Geriatr Soc 65:1119–1125. 10.1111/jgs.14782 [DOI] [PMC free article] [PubMed] [Google Scholar]
43. Coleman EA, Boult C, American Geriatrics Society Health Care Systems C (2003) Improving the quality of transitional care for persons with complex care needs. J Am Geriatr Soc 51:556–557. 10.1046/j.1532-5415.2003.51186.x [DOI] [PubMed] [Google Scholar]
44. Aronso n JK (2009) Medication errors: what they are, how they happen, and how to avoid them. QJM 102:513–521. 10.1093/qjmed/hcp052 [DOI] [PubMed] [Google Scholar]
45. Kripalani S, Jackson AT, Schnipper JL et al (2007) Promoting effective transitions of care at hospital discharge: a review of key issues for hospitalists. J Hosp Med 2:314–323. 10.1002/jhm.228 [DOI] [PubMed] [Google Scholar]
46. Sil v a AE, Reis AM, Miasso AI et al (2011) Adverse drug events in a sentinel hospital in the state of Goias, Brazil. Rev Lat Am Enfermagem 19:378–386. 10.1590/s0104-11692011000200021 [DOI] [PubMed] [Google Scholar]
47. Borgsteede SD, Karapinar-Carkit F, Hoffmann E et al (2011) Information needs about medication according to patients discharged from a general hospital. Patient Educ Couns 83. 10.1016/j.pec.2010.05.020. :22–8 [DOI] [PubMed]
48. Lindquist LA, Go L, Fleisher J et al (2012) Relationship of health literacy to intentional and unintentional non-adherence of hospital discharge medications. J Gen Intern Med 27:173–178. 10.1007/s11606-011-1886-3 [DOI] [PMC free article] [PubMed] [Google Scholar]
49. Blix HS, Viktil KK, Reikvam A et al (2004) The majority of hospitalised patients have drug-related problems: results from a prospective study in general hospitals. Eur J Clin Pharmacol 60:651–658. 10.1007/s00228-004-0830-4 [DOI] [PubMed] [Google Scholar]
50. Montane E, Arellano AL, Sanz Y et al (2018) Drug-related deaths in hospital inpatients: a retrospective cohort study. Br J Clin Pharmacol 84:542–552. 10.1111/bcp.13471 [DOI] [PMC free article] [PubMed] [Google Scholar]
51. Elliott RA, Camacho E, Jankovic D et al (2021) Economic analysis of the prevalence and clinical and economic burden of medication error in England. BMJ Qual Saf 30:96–105. 10.1136/bmjqs-2019-010206 [DOI] [PubMed] [Google Scholar]
52. Hohl C.M., Woo S.A., Cragg A., Wickham M.E., Ackerley C., Scheuermeyer F., Villanyi D. Repeat adverse drug events associated with outpatient medications: a descriptive analysis of 3 observational studies in British Columbia. Canada. CMAJ Open. 2019;7(3):E446–E453. doi: 10.9778/cmajo.20180190. [DOI] [PubMed] [Google Scholar]
53. Jones C.D., Jones J., Richard A., Bowles K., Lahoff D., Boxer R.S., Masoudi F.A., Coleman E.A., Wald H.L. Connecting the dots": a qualitative study of home health nurse perspectives on coordinating care for recently discharged patients. J. Gen. Intern. Med. 2017;32(10):1114–1121. doi: 10.1007/s11606-017-4104-0. [DOI] [PMC free article] [PubMed] [Google Scholar]
54. Lee C.Y., Goeman D., Beanland C., Elliott R.A. Challenges and barriers associated with medication management for home nursing clients in Australia: a qualitative study combining the perspectives of community nurses. Family Practice. 2018;36(3):332–342. doi: 10.1093/fampra/cmy073. [DOI] [PubMed] [Google Scholar]
55. Lee C.Y., Beanland C., Goeman D., Petrie N., Petrie B., Vise F., Gray J., Elliott R.A. Improving medication safety for home nursing clients: a prospective observational study of a novel clinical pharmacy service— the visiting pharmacist (ViP) study. J. Clin. Pharmacy & Therapeutics. 2018;43(6):813–821. doi: 10.1111/jcpt.12712. [DOI] [PubMed] [Google Scholar]
56. Jones C.D., Jones J., Richard A., Bowles K., Lahoff D., Boxer R.S., Masoudi F.A., Coleman E.A., Wald H.L. Connecting the dots": a qualitative study of home health nurse perspectives on coordinating care for recently discharged patients. J. Gen. Intern. Med. 2017;32(10):1114–1121. doi: 10.1007/s11606-017-4104-0. [DOI] [PMC free article] [PubMed] [Google Scholar]

57. Hamano J., Ozone S., Tokuda Y. A comparison of estimated drug costs of potentially inappropriate medications between older patients receiving nurse home visit services and patients receiving pharmacist home visit services: a cross-sectional and propensity score analysis. BMC Health Serv. Res. 2015;15 doi: 10.1186/s12913-015-0732-4. [DOI] [PMC free article] [PubMed] [Google Scholar]
58. Hadi M.A., Alldred D.P., Briggs M., Marczewski K., Closs S.J. Effectiveness of a community based nurse-pharmacist managed pain clinic: a mixed-methods study. Int. J. Nurs. Stud. 2016;53:219–227. doi: 10.1016/j.ijnurstu.2015.09.003. [DOI] [PubMed] [Google Scholar]
59. Coleman EA, Smith JD, Raha D et al (2005) Posthospital medication discrepancies: prevalence and contributing factors. Arch Intern Med 165:1842–1847. doi: 10.1001/archinte.165.16.1842 [DOI] [PubMed] [Google Scholar]
60. Davies EC, Green CF, Taylor S et al (2009) Adverse drug reactions in hospital in-patients: a prospective analysis of 3695 patient-episodes. PLoS ONE 4:e4439. 10.1371/journal.pone.0004439 [DOI] [PMC free article] [PubMed] [Google Scholar]
61. Cawthon C, Walia S, Osborn CY et al (2012) Improving care transitions: the patient perspective. J Health Commun 17 Suppl. 10.1080/10810730.2012.712619. 3:312 – 24 [DOI] [PMC free article] [PubMed] [Google Scholar]
62. Seth er SM, Corbett CF, Neumiller JJ et al (2009) Effectiveness of a pharmacist-nurse intervention on resolving medication discrepancies for patients transitioning from hospital to home health care. Am J Health Syst Pharm 66:2027–2031. 10.2146/ajhp080582 [DOI] [PubMed] [Google Scholar]
63. Hohl C.M., Woo S.A., Cragg A., Wickham M.E., Ackerley C., Scheuermeyer F., Villanyi D. Repeat adverse drug events associated with outpatient medications: a descriptive analysis of 3 observational studies in British Columbia. Canada. CMAJ Open. 2019;7(3):E446–E453. doi: 10.9778/cmajo.20180190. [DOI] [PMC free article] [PubMed] [Google Scholar]
64. Brown MT, Bussell JK (2011) Medication adherence: WHO cares? Mayo Clin Proc 86:304 – 14. 10.4065/mcp.2010.0575 [DOI] [PMC free article] [PubMed]
65. Ceschi A, Noseda R, Pironi M et al (2021) Effect of medication reconciliation at hospital admission on 30-day returns to hospital: a randomized clinical trial. JAMA Netw Open 4:e2124672. 10.1001/jamanetworkopen.2021.24672 [DOI] [PMC free article] [PubMed] [Google Scholar]
66. Aronso n JK (2009) Medication errors: what they are, how they happen, and how to avoid them. QJM 102:513–521. 10.1093/qjmed/hcp052 [DOI] [PubMed] [Google Scholar]
67. Prybys KMK, Hanna J, Gee A, Chyka P (2002) Polypharmacy in the elderly: clinical challenges in emergency practice: part 1: overview, etiology, and drug interactions. Emerg Med Rep 23:145–153 [Google Scholar]
68. Laugaland K, Aase K, Barach P (2012) Interventions to improve patient safety in transitional care–a review of the evidence. Work 41 Suppl 12915–2924. 10.3233/WOR-2012-0544-2915 [DOI] [PubMed]
69. Davies EC, Green CF, Taylor S et al (2009) Adverse drug reactions in hospital in-patients: a prospective analysis of 3695 patient-episodes. PLoS ONE 4:e4439. 10.1371/journal.pone.0004439 [DOI] [PMC free article] [PubMed] [Google Scholar]
70. Kor t 34.Sorensen CA, Jeffery L, Falhof J et al (2023) Developing and piloting a cross-sectoral hospital pharmacist intervention for patients in transition between hospital and general practice. Ther Adv Drug Saf 14:20420986231159221. 10.1177/20420986231159221 [DOI] [PMC free article] [PubMed] [Google Scholar]
71. Bulow C, Noergaard J, Faerch KU et al (2021) Causes of discrepancies between medications listed in the national electronic prescribing system and patients' actual use of medications. Basic Clin Pharmacol Toxicol 129:221–231. 10.1111/bcpt.13626 [DOI] [PubMed] [Google Scholar]
72. Kind AJ, Brenny-Fitzpatrick M, Leahy-Gross K et al (2016) Harnessing protocolized adaptation in dissemination: successful implementation and sustainment of the veterans affairs coordinated-transitional care program in a non-veterans affairs hospital. J Am Geriatr Soc 64:409–416. 10.1111/jgs.13935 [DOI] [PMC free article] [PubMed] [Google Scholar]
73. Oliveira J, Cabral AC, Lavrador M et al (2020) Contribution of different patient information sources to create the best possible medication history. Acta Med Port 33:384–389. 10.20344/amp.12082 [DOI] [PubMed] [Google Scholar]
74. Makaryus AN, Friedman EA (2005) Patients' understanding of their treatment plans and diagnosis at discharge. Mayo Clin Proc 80:991–994. 10.4065/80.8.991 [DOI] [PubMed] [Google Scholar]

75. Carollo M, Boccardi V, Crisafulli S et al (2024) Medication review and deprescribing in different healthcare settings: a position statement from an Italian scientific consortium. Aging Clin Exp Res 36:63. 10.1007/s40520-023-02679-2 [DOI] [PMC free article] [PubMed] [Google Scholar]