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Crisis at the Pharmacy Counter: Empowering Pharmacy Technicians to Lead the Charge in Preventing Medication Errors in Complex Healthcare Environments

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Abstract
Medication errors in complex healthcare environments present a critical threat to patient safety, often resulting in increased morbidity, mortality, and healthcare costs. Pharmacy technicians, with their expanding roles, are uniquely positioned to address these challenges through tasks such as medication reconciliation, immunization delivery, and accuracy checking. This review explores the systemic issues contributing to medication errors, highlights the transformative potential of empowering pharmacy technicians, and proposes strategies to enhance their training and integration into healthcare teams. By leveraging their expertise, healthcare systems can improve medication safety, optimize workflows, and reduce errors in high-pressure environments.

Aim of Work
To examine the role of pharmacy technicians in preventing medication errors, identify barriers to their expanded responsibilities, and propose strategies for empowering them to lead medication safety initiatives in complex healthcare systems.

Keywords: Medication errors, pharmacy technicians, patient safety, healthcare systems, medication reconciliation, immunization delivery, accuracy checking, error prevention, healthcare workforce.

Introduction:

Medication errors are a prevalent issue in healthcare, significantly impacting patient safety and healthcare costs. These errors can occur at any stage of the medication process, from prescribing to administration, and are often due to factors such as insufficient knowledge, inadequate communication, and system failures. The consequences of medication errors include increased morbidity, mortality, and financial burdens on healthcare systems. Understanding the causes and implementing preventive strategies are crucial for minimizing these errors and improving patient outcomes. Below are key aspects of medication errors in healthcare:

Causes of Medication Errors: Insufficient Knowledge and Resources: Lack of adequate training and resources among healthcare professionals can lead to errors in prescribing and administering medications (Unnissa et al., 2024).

Communication Failures: Poor communication between healthcare providers, patients, and pharmacists is a significant contributor to medication errors (Unnissa et al., 2024) (Khatun et al., 2024).
Complex Medication Processes: The involvement of multiple steps and personnel in the medication chain increases the risk of errors at various stages (Khatun et al., 2024).
Systemic Issues: Inadequate labeling, similar drug names, and transcription errors are common systemic issues leading to medication errors (Paul & Maiti, 2024).
Incidence and Impact: Prevalence: Medication errors are among the most common adverse events in healthcare, with high incidence rates reported in various countries (Basabih, 2023).
Consequences: These errors can lead to patient harm, delayed discharges, and increased healthcare costs (Khatun et al., 2024) (J, 2023).
Reporting and Detection: Many errors go unreported, highlighting the need for robust error reporting systems to improve patient safety (J, 2023).
Preventive Strategies: Education and Training: Implementing comprehensive training programs for healthcare professionals can reduce the likelihood of errors (Paul & Maiti, 2024).
Technological Solutions: The use of Computerized Physician Order Entry (CPOE) systems can help prevent errors during the prescribing stage (Basabih, 2023).
Medication Reconciliation: Ensuring accurate medication reconciliation can prevent errors related to prescription and administration (Paul & Maiti, 2024). While medication errors are a significant concern, efforts to establish a culture of safety and implement effective strategies can mitigate their impact. Collaboration among healthcare professionals and the use of technology are essential in reducing the incidence of these errors and enhancing patient safety. Addressing medication errors in complex healthcare systems is crucial due to their significant impact on patient safety, healthcare costs, and overall quality of care. Medication errors, which can occur at any stage from prescription to administration, are a leading cause of morbidity and mortality in healthcare settings. These errors not only compromise patient safety but also lead to increased healthcare costs due to prolonged hospital stays and additional treatments. Therefore, implementing effective strategies to minimize these errors is essential for improving patient outcomes and reducing financial burdens on healthcare systems.
Impact on Patient Safety: Medication errors are a major contributor to patient morbidity and mortality, with errors leading to adverse events that can be life-threatening (Unnissa et al., 2024) (Khatun et al., 2024). The Institute of Medicine reported that medical errors, including medication errors, result in 44,000 to 98,000 deaths annually in the United States, highlighting the critical need for error reduction (Sharma & Sodani, 2023).
Financial Implications: Medication errors significantly increase healthcare costs, with estimates ranging from 17billionto17*billionto*29 billion annually due to additional treatments and extended hospital stays (Sharma & Sodani, 2023). Reducing medication errors can alleviate the financial burden on healthcare systems by preventing unnecessary hospitalizations and treatments (Unnissa et al., 2024).
Strategies for Error Reduction: Establishing a medication safety culture that encourages error reporting and open discussions can help identify and rectify errors before they cause harm(Khatun et al., 2024) (Sharma & Sodani, 2023). Implementing technology such as electronic medication management systems and automation can enhance medication safety by reducing human error (Alderman, 2023) (Mammalogy, 2023).
Role of Healthcare Professionals: Clinical pharmacists play a vital role in identifying and assessing medication errors, thereby enhancing patient safety and therapeutic outcomes (Unnissa

et al., 2024). Collaboration among healthcare providers is essential to ensure adherence to medication safety strategies and improve patient care (Khatun et al., 2024). While addressing medication errors is critical, it is also important to recognize the complexity of healthcare systems and the multifaceted nature of solutions required. Factors such as appropriate staffing, environmental design, and the integration of technology must be balanced with the art and science of patient care, particularly for vulnerable populations like the elderly (Alderman, 2023) (Mammalogy, 2023). Pharmacy technicians play a crucial role in healthcare delivery by supporting pharmacists and enhancing the efficiency and effectiveness of pharmacy services. Their roles have evolved significantly, expanding beyond traditional tasks to include more clinical and patient-centered responsibilities. This evolution is driven by the need to optimize healthcare delivery and address the increasing demands on healthcare systems. The following sections detail the various roles and contributions of pharmacy technicians in healthcare delivery.

Immunization Delivery: Pharmacy technicians have been increasingly involved in immunization delivery, a role that has shown to improve pharmacy workflow and technician job satisfaction. Studies have demonstrated that with adequate training, technicians can safely administer vaccines, effectively communicate with patients, and manage immunization-related tasks (Clark, 2022). The involvement of technicians in immunization has allowed pharmacists to focus on other clinical tasks, such as counseling vaccine-hesitant patients, thereby enhancing overall patient care (Clark, 2022).

Pharmaceutical Care Services: In both hospital and community settings, pharmacy technicians are involved in pharmaceutical care services, including dispensing, counseling, and managing medication information. They provide advice on over-the-counter medicines and assist in medication reviews, contributing to patient-centered care (Iheanacho et al., 2022). There are differences in the roles of technicians between hospital and community settings, with hospital technicians more frequently involved in patient intake and counseling (Iheanacho et al., 2022).

Community Pharmacy Sector: In the community pharmacy sector, technicians primarily focus on dispensing and accuracy checking of medicines. However, there is potential for them to take on more leadership and management roles, as well as deliver additional services (Chamberlain et al., 2020). Enablers for expanding technician roles include effective delegation, workplace support, and improved staffing levels (Chamberlain et al., 2020).

Training and Development: Establishing standardized pharmacy technician training programs is essential for developing a skilled workforce capable of meeting the complex demands of modern healthcare. Such programs ensure uniformity in skills and knowledge, facilitating the expansion of technician roles (Vest & Kelm, 2020). While the expansion of pharmacy technician roles offers numerous benefits, it is important to consider the challenges and barriers to this evolution. These include the need for standardized training and certification, as well as the necessity for supportive workplace environments to enable technicians to fully utilize their skills and contribute to healthcare delivery effectively.

- **The Nature of Medication Errors**

Medication errors are a significant concern in healthcare, contributing to patient morbidity and mortality. These errors can occur at any stage of the medication process, from prescribing to administration, and are often preventable. Common causes include communication breakdowns, mislabeling, and environmental pressures, among others. Understanding these causes is crucial for developing strategies to reduce errors and improve patient safety.

Communication Breakdowns: Ineffective communication among healthcare providers, patients, and pharmacists is a major contributor to medication errors. Miscommunication can lead to incorrect medication orders and administration errors (Unnissa et al., 2024) ("How do medication

errors occur in the nursing communication process? Investigating the relationship between error types and error factors", 2023). Transcribing errors, such as non-rational or ineffective medication orders, often result from poor communication practices (Paul & Maiti, 2024).

Mislabeling and Dispensing Errors: Incorrect labeling and dispensing of medications, including wrong doses or dosage forms are common errors that can lead to significant patient harm (Paul & Maiti, 2024). Poor labeling practices and the use of incorrect abbreviations further exacerbate the risk of medication errors (Moini et al., 2023).

Environmental and Systemic Pressures: Environmental factors, such as inadequate staffing and poor facility management, contribute to medication errors by increasing the likelihood of mistakes under pressure (Moini et al., 2023). Limited resources and insufficient knowledge among healthcare staff can also lead to errors in medication management (Unnissa et al., 2024).

Technological Solutions and Risk Reduction: The implementation of technology, such as computerized physician order entry, automated dispensing machines, and barcode medication administration, can significantly reduce the incidence of medication errors ("Medication Errors", 2022). Medication reconciliation and the use of electronic medical records are effective strategies for preventing errors, particularly in complex cases involving polypharmacy(Moini et al., 2023). While medication errors are prevalent, advancements in technology and improved communication strategies offer promising solutions for reducing their occurrence. However, it is essential to continuously evaluate and adapt these strategies to address the evolving challenges in healthcare settings. Patient safety is a critical concern in healthcare, with significant implications for both patient outcomes and healthcare costs. Unsafe care is responsible for millions of deaths annually and imposes a substantial economic burden, comparable to major global health issues like HIV/AIDS. The direct costs of unsafe care can consume up to 13% of healthcare budgets in developed countries, translating to hundreds of billions of dollars annually. Moreover, the broader economic impact, including lost productivity, is estimated to exceed USD 1 trillion globally each year ("The economics of patient safety", 2022) (Slawomirski et al., 2017).

Patient Safety and Economic Costs: Unsafe care results in a significant financial burden on healthcare systems, with direct costs reaching USD 606 billion annually in developed countries("The economics of patient safety", 2022). The economic impact of patient harm, including indirect costs like lost productivity, is estimated at over USD 1 trillion globally each year (Slawomirski et al., 2017). Programs like the Hospital-Acquired Condition (HAC) Reduction Program aim to reduce costs by linking hospital reimbursement to safety performance, although challenges remain in effectively addressing all types of harm (Myers & Stockwell, 2022).

Strategies for Improving Patient Safety: Multi-modal approaches that integrate clinical, corporate, and professional risk management are most cost-effective in improving patient safety ("The economics of patient safety", 2022). System-level initiatives and a culture conducive to safety are essential for minimizing patient harm effectively and efficiently (Slawomirski et al., 2017). The implementation of comprehensive safety programs, such as the IHI's Triple Aim, seeks to improve care quality while reducing costs, though the relationship between expenditure and outcomes is not always linear (Merry et al., 2017).

Challenges and Considerations: Despite efforts to improve patient safety, many current harm reduction programs may be inadequate, particularly as medical complexities and technologies evolve (Myers & Stockwell, 2022). The COVID-19 pandemic has further exposed inadequacies in health systems, emphasizing the need for inclusive and continuous improvement in patient safety practices ("Patient Safety: Preventing Patient Harm and Building Capacity for Patient Safety", 2022). Addressing inequities in patient safety outcomes, particularly those related to racial, ethnic,

and socioeconomic disparities, remains a critical challenge(Myers & Stockwell, 2022). While significant progress has been made in improving patient safety, challenges persist, particularly in addressing the complexities of modern healthcare and ensuring equitable outcomes for all patients. The economic implications of patient harm underscore the need for continued investment in effective safety interventions and systemic improvements.

- **Current Roles and Responsibilities of Pharmacy Technicians**

Pharmacy technicians play a crucial role in addressing medication errors by supporting pharmacists and healthcare teams in various capacities. Their involvement ranges from medication reconciliation to e-prescribing, significantly contributing to patient safety and the reduction of medication errors. The integration of pharmacy technicians into clinical settings has shown to enhance the efficiency and effectiveness of medication management processes. Below are key areas where pharmacy technicians impact medication error reduction:

Medication Reconciliation and Drug-Related Problem Prevention: Pharmacy technicians are instrumental in medication reconciliation, identifying discrepancies in medication lists, and consulting with general practitioners and patients to resolve these issues. This proactive approach helps prevent medication errors, such as incorrect dosages or drug interactions, particularly during patient admissions ("4CPS-274 Evaluation of pharmaceutical interventions documented by a pharmacy technician: where do pharmacy technicians have the biggest impact to avoid drug-related problems?", 2022). In a study conducted at a university hospital, pharmacy technicians documented 468 interventions over 22 weeks, with significant contributions in drug substitution and consultations, which reduced potential medication errors("4CPS-274 Evaluation of pharmaceutical interventions documented by a pharmacy technician: where do pharmacy technicians have the biggest impact to avoid drug-related problems?", 2022).

Reducing Omitted and Delayed Doses: The TECHMED service, involving pharmacy technicians in medication administration, demonstrated a reduction in omitted doses in hospitals. Technicians located drugs and ensured timely administration, which alleviated nursing workload and improved medication adherence (Seston et al., 2019). Another pilot study showed that the introduction of pharmacy technicians in an acute admissions unit reduced omitted doses from 14% to 5%, highlighting their role in enhancing medication administration efficiency (El-Fahimi et al., 2020).

Supporting E-Prescribing and Dispensing: Pharmacy technicians are pivotal in the e-prescribing process, handling tasks up to the point of pharmacist review. Their experience and knowledge help identify and resolve potential errors before medication reaches the patient, thus supporting pharmacists in ensuring patient safety (Odukoya et al., 2015).

Expanding Technician Roles for Proactive Pharmacist Practice: By taking over distribution roles, pharmacy technicians enable pharmacists to focus on direct patient care and medication therapy management. This shift not only reduces pharmacy-related medication errors but also enhances the overall quality of patient care (Newby, 2019). While the integration of pharmacy technicians into healthcare teams has shown positive outcomes in reducing medication errors, challenges such as workload management and adherence to service specifications need to be addressed. Ensuring adequate training and support for pharmacy technicians can further enhance their effectiveness in preventing medication errors and improving patient safety. The current scope of practice for pharmacy technicians is limited by several factors, including regulatory constraints, lack of standardized roles, and insufficient training. These limitations impact their ability to fully support pharmacists and contribute to patient care. The scope of practice for pharmacy technicians varies significantly across different regions and settings, leading to inconsistencies and confusion

in their roles. This variability can hinder the effective integration of pharmacy technicians into healthcare teams and limit their potential contributions to patient care. Below are some key limitations identified in the literature.

Regulatory Constraints: Pharmacy technicians often face strict regulatory limitations that restrict their ability to perform certain tasks, such as dispensing prescription-only medications without pharmacist oversight (Mizranita et al., 2023). Weak regulatory enforcement can lead to inconsistencies in practice, further complicating the roles of pharmacy technicians (Mizranita et al., 2023).

Lack of Standardized Roles: There is a lack of clear and consistent definitions of the scope of practice for pharmacy technicians, which can lead to confusion and overlap with the roles of pharmacists (Mizranita et al., 2023). The absence of standardized practice guidelines can disrupt professional relationships and hinder the effective delegation of tasks (Mizranita et al., 2023).

Insufficient Training and Education: Pharmacy technicians may not receive adequate training to handle the complexities of modern pharmacy practice, limiting their ability to assist with pharmaceutical care activities effectively (Posey, 2001). The need for enhanced education and training is highlighted to ensure pharmacy technicians can meet the demands of their roles and support pharmacists in managing minor ailments (Mizranita et al., 2023). While these limitations present challenges, there is potential for expanding the scope of practice for pharmacy technicians through improved training, clearer role definitions, and regulatory reforms. Such changes could enhance their contributions to healthcare delivery and improve patient outcomes. However, it is crucial to balance these expansions with appropriate oversight to maintain patient safety and care quality.

- **Empowering Pharmacy Technicians**

Empowering pharmacy technicians offers numerous benefits, enhancing both pharmacy operations and patient care. By expanding their roles, technicians can take on advanced tasks such as immunization administration, medication history collection, and process navigation, which can lead to improved efficiency and patient outcomes. This empowerment not only supports pharmacists by freeing up their time for more clinical activities but also increases job satisfaction and morale among technicians. Below are key benefits of empowering pharmacy technicians:

Enhanced Pharmacy Workflow: Pharmacy technicians administering vaccines allow pharmacists to focus on other clinical tasks, such as consulting with vaccine-hesitant patients, thereby improving overall pharmacy workflow(Clark, 2022). Technicians acting as process navigators in oncology settings have significantly reduced the time pharmacists and nurses spend on insurance authorization, increasing efficiency and allowing more focus on clinical activities (Lau et al., 2019).

Improved Patient Access and Outcomes: Empowered technicians can facilitate better patient access to medications, as seen in the increased success rate of obtaining oral anticancer medications when technicians served as process navigators (Lau et al., 2019). The involvement of technicians in immunization processes has led to higher vaccination rates and decreased wait times for patients, enhancing public health outcomes (Clark, 2022).

Increased Job Satisfaction and Professional Development: Technicians experience improved morale and job satisfaction when given new responsibilities, such as immunization administration, which also leads to a more desirable work schedule(Clark, 2022) (Mattingly & Mattingly, 2018). The opportunity for career advancement through expanded roles and additional training can motivate technicians to pursue further professional development (Burke, 2020).

Support for Pharmacists: By taking on administrative and specialized tasks, technicians provide flexibility to pharmacists, enabling them to engage in more clinical services and improve patient care (Mattingly & Mattingly, 2018). While empowering pharmacy technicians offers significant benefits, challenges remain, such as inconsistent training and certification requirements across regions, which can hinder the widespread adoption of expanded roles. Addressing these barriers through standardized training and supportive regulations could further enhance the impact of empowered pharmacy technicians (Burke, 2020).

- **Strategies for Preventing Medication Errors:**

Pharmacy technicians play a crucial role in implementing safety checks within healthcare settings, enhancing the efficiency and safety of medication management processes. Their involvement spans various tasks, from immunization delivery to e-prescribing and medication reconciliation, contributing significantly to patient safety and operational workflow. The following sections detail the specific roles and contributions of pharmacy technicians in safety checks.

Immunization Delivery: Pharmacy technicians have been increasingly involved in administering vaccines, which has been shown to improve pharmacy workflow and technician job satisfaction. This role allows pharmacists to focus on other clinical tasks, such as consulting with vaccine-hesitant patients (Clark, 2022). Technicians are trained to handle all aspects of immunization, including identifying appropriate injection sites and managing vaccine emergencies, which enhances patient trust and reduces wait times(Clark, 2022).

E-Prescribing: In the realm of e-prescribing, pharmacy technicians are pivotal in supporting pharmacists by managing the initial steps of prescription processing. Their experience and certification are crucial in identifying and resolving potential medication errors, thereby ensuring patient safety (Odukoya et al., 2015). Technicians' involvement in e-prescribing helps streamline the medication dispensing process, reducing the likelihood of errors and enhancing the overall safety of medication use (Odukoya et al., 2015).

Medication Reconciliation: Pharmacy technicians are integral to medication reconciliation programs, where they compile accurate medication lists for newly admitted patients. This process is essential in preventing adverse drug events and ensuring continuity of care across transitions (Sen et al., 2014). The implementation of technician-centered medication reconciliation programs has demonstrated effectiveness in identifying discrepancies in medication lists, thus improving pharmacotherapy safety (Sen et al., 2014).

Accuracy Checking: Appropriately trained pharmacy technicians can perform technical accuracy checks of dispensed medications, a task traditionally done by pharmacists. This delegation not only maintains safety standards but also increases time efficiency in medication dispensing (Snoswell et al., 2020). Studies have shown that technicians can be more precise than pharmacists in accuracy checking, supporting the safe delegation of these tasks to trained technicians (Snoswell et al., 2020). While the expansion of pharmacy technicians' roles in safety checks is promising, it is essential to ensure that they receive adequate training and support. This expansion should be carefully managed to maintain high safety standards and optimize the benefits of their involvement in healthcare settings. The use of technology in healthcare has shown significant promise in preventing medication errors, which are a major concern for patient safety. Various technological solutions have been implemented to address this issue, ranging from electronic systems to wearable devices and advanced analytical methods. These technologies aim to enhance accuracy, efficiency, and safety in medication administration. Below are some key technological interventions and their impacts on reducing medication errors.

Electronic-Based Systems: Electronic systems ensure compliance with the "10 rights of medication administration," which include the right patient, drug, dose, time, and route, among

others. This compliance significantly reduces the risk of medication errors (Saho et al., 2024). The adoption of electronic health records and computerized physician order entry systems has been associated with a decrease in medication errors, enhancing patient safety and care efficiency (Saho et al., 2024).

AI-Enabled Wearable Cameras: Wearable cameras equipped with deep learning algorithms can detect and classify drug labels, providing a secondary check before medication delivery. This system achieved high sensitivity and specificity in detecting vial swap errors, demonstrating its potential to prevent errors in real-time(Chan et al., 2024).

Healthcare Failure Mode and Effect Analysis (HFMEA): HFMEA is a proactive risk analysis method used to identify and address potential medication errors. By analyzing organizational and staff factors, HFMEA helps in designing action plans to mitigate risks, thereby preventing errors in clinical pharmacy settings (Giri et al., 2024).

Advanced Technologies: Technologies such as artificial intelligence, blockchain, and biometric authentication have been instrumental in improving medication safety. These technologies help in accurate reporting of adverse drug reactions and medication errors, thus enhancing pharmacovigilance and patient safety (Al-Worafi, 2023). While technology has significantly contributed to reducing medication errors, it is important to acknowledge potential drawbacks. Some studies have noted disadvantages, such as the complexity of technology implementation and the need for continuous updates and training for healthcare providers (Khayyat, 2023). Despite these challenges, the ongoing development and integration of technology in healthcare continue to offer promising solutions for medication safety. Collaboration among pharmacy technicians, pharmacists, nurses, and other healthcare professionals is crucial for preventing medication errors. This interprofessional approach enhances communication, optimizes medication management, and ultimately improves patient safety. The integration of pharmacy technicians into healthcare teams can significantly reduce medication errors through various collaborative strategies.

Interprofessional Communication: Effective communication among healthcare professionals is pivotal in reducing medication errors. High-quality interprofessional communication correlates with reduced prescription and dispensing errors, particularly in hospital settings (Alhur et al., 2024). Training programs focused on improving communication skills, especially for less experienced professionals, can further mitigate errors (Alhur et al., 2024).

Multidisciplinary Teams: Multidisciplinary teams, often comprising pharmacists, nurses, and physicians, are effective in preventing adverse drug events (ADEs). These teams conduct structured medication reviews, which are particularly beneficial for elderly patients in nursing homes (Zaij et al., 2023). Pharmacy technicians play a supportive role in these teams by assisting in medication administration and ensuring adherence to protocols, thereby reducing omitted doses (Seston et al., 2019).

Collaborative Committee Structures: Collaborative committees that include pharmacy technicians and other healthcare professionals can effectively analyze and reduce medication error rates. These committees focus on continuous quality improvement initiatives, such as medication reconciliation and standardized treatment protocols (Hanifin & Zielenski, 2020). Regular meetings and education sessions for staff are integral to the success of these committees, fostering a culture of safety and accountability (Hanifin & Zielenski, 2020).

Shared Responsibility: Medication error prevention is a shared responsibility among all healthcare professionals, including pharmacy technicians. Collaborative efforts ensure comprehensive care and minimize the risk of harm to patients (Horsham, 2015). While collaboration is essential, challenges such as workload management and adherence to service

specifications can impact the effectiveness of pharmacy technician-supported initiatives. Addressing these challenges through targeted interventions and resource allocation is necessary to enhance the operationalization of collaborative efforts in medication error prevention (Seston et al., 2019).

- **Barriers to Implementation:**

Pharmacy technicians face several challenges in addressing medication errors, which are critical to patient safety and healthcare quality. These challenges stem from factors such as inadequate training, high workload, and systemic issues within pharmacy operations. Understanding these challenges is essential for developing strategies to reduce medication errors and improve pharmacy practice.

Inadequate Training and Education: Many pharmacy technicians lack formal education in the medical field, with a significant portion having only a diploma or lower educational qualifications. This lack of standardized training contributes to insufficient pharmacological knowledge, which is directly associated with higher medication error rates (Mohammadbeigi et al., 2018). A study highlighted that only 12% of pharmacy technicians had medical education, and 61% had not completed any pharmacological courses, indicating a gap in essential knowledge required to minimize errors (Mohammadbeigi et al., 2018).

High Workload and Time Constraints: The workload of pharmacy technicians is directly linked to medication errors. Increased work hours and pressure can lead to mistakes in medication dispensing, such as incorrect dosage or medication selection (Mohammadbeigi et al., 2018). Errors in filling unit dose orders, such as incorrect dosage and omitted medications are prevalent and can be exacerbated by the high volume of orders and time constraints faced by technicians (J & M, 1986).

Systemic and Operational Challenges: Pharmacy technicians often encounter systemic issues, such as variability in error rates across different wards and times, which complicates error reduction efforts (J & M, 1986). The implementation of pharmacy technician-centered programs, like medication reconciliation, has shown potential in identifying discrepancies, but the adoption of recommendations remains limited, indicating operational challenges in integrating technician roles effectively (Kraus et al., 2017). While these challenges are significant, there are opportunities for improvement. Implementing comprehensive training programs and optimizing workload management can enhance the capabilities of pharmacy technicians. Additionally, fostering collaboration between pharmacists and technicians can improve the identification and resolution of medication discrepancies, ultimately reducing errors and enhancing patient safety.

- **Case studies:**

Pharmacy technicians play a crucial role in addressing medication errors across various countries by supporting pharmacists and healthcare teams. Their involvement ranges from medication reconciliation to direct interventions in clinical settings, which significantly reduces the incidence of medication errors. The following sections highlight the contributions of pharmacy technicians in different countries, as evidenced by the provided research papers.

United Kingdom:

In the UK, the TECHMED service was piloted in an NHS hospital, where pharmacy technicians supported medicines administration to reduce omitted doses. They performed tasks such as locating drugs and preventing missing doses, which positively impacted nursing staff workload(Seston et al., 2019).

Germany:

At a university hospital in Dresden, Germany, pharmacy technicians are involved in medication reconciliation and clinical prioritization. They document interventions, such as drug substitution

and consultations with general practitioners, which help prevent drug-related problems("4CPS-274 Evaluation of pharmaceutical interventions documented by a pharmacy technician: where do pharmacy technicians have the biggest impact to avoid drug-related problems?", 2022).

Global Perspective:

A global survey revealed diverse roles for pharmacy technicians, from strictly supervised practices to autonomous responsibilities. In some countries, pharmacy technicians operate independently, while in others, they work under pharmacist supervision. This diversity highlights the varying impact of pharmacy technicians on medication error reduction worldwide(Koehler & Brown, 2017).

United States:

Pharmacy technicians in the US are recognized for their role in reducing medication errors, which is considered a public health issue. They identify opportunities to prevent errors, contributing significantly to patient safety(Dunn & Wolfe, 1998). While pharmacy technicians are instrumental in reducing medication errors, the extent of their impact varies by country due to differences in supervision, education, and legal frameworks. In some regions, the lack of regulation or limited scope of practice may hinder their ability to fully address medication errors. However, as healthcare systems evolve, the role of pharmacy technicians is likely to expand, further enhancing their contribution to medication safety.

- **Future Outlook:**

Pharmacy technicians have the potential to take on leadership roles in medication safety, a shift that is increasingly recognized across various healthcare settings. This potential is driven by the evolving roles of pharmacy technicians, which now include advanced tasks such as medication history collection and final product verification. However, the realization of this potential is contingent upon overcoming barriers such as inconsistent education and certification requirements, and outdated regulations (Burke, 2020). The following sections explore the potential for pharmacy technicians to assume leadership roles in medication safety.

Expanding Roles and Responsibilities: Pharmacy technicians are increasingly involved in tasks that directly impact medication safety, such as e-prescribing and error prevention. Their experience, certification, and knowledge are crucial in supporting pharmacists to ensure patient safety (Odukoya et al., 2015). The inclusion of pharmacy technicians in state pharmacy boards, as seen in Illinois, highlights their growing influence and acceptance in leadership roles. This representation allows technicians to contribute to discussions and decisions that affect the pharmacy profession (Traynor, 2022).

Leadership Skills and Multidisciplinary Approaches: Successful medication safety programs require a multidisciplinary approach that leverages the skills of all healthcare team members, including pharmacy technicians. Contemporary leadership skills such as team-building, communication, and innovation are essential for pharmacy technicians to drive transformational change in medication safety (Hertig et al., 2016). The integration of pharmacy technicians into leadership roles within medication safety programs can enhance the effectiveness of these programs by utilizing their unique perspectives and skills (Hertig et al., 2016).

Institutional Support and Career Advancement: Institutions like Novant Health recognize the critical role of pharmacy technicians in health-system pharmacy success. Initiatives to advance pharmacy technicians' roles are essential for their development into leadership positions (Brown et al., 2016). Employers and professional organizations can support this transition by creating career ladders and advocating for expanded responsibilities for pharmacy technicians (Burke, 2020). While the potential for pharmacy technicians to assume leadership roles in medication

safety is promising, it is important to address the systemic barriers that hinder this progress. Ensuring consistent education and certification standards, updating regulations, and fostering institutional support are crucial steps in empowering pharmacy technicians to contribute effectively to medication safety leadership. Empowering pharmacy technicians presents numerous research opportunities, particularly in enhancing healthcare delivery and improving patient outcomes. The expansion of pharmacy technicians' roles, such as in immunization delivery and medication management, has shown promising results in various settings. This expansion not only supports pharmacists by alleviating their workload but also enhances the overall efficiency and effectiveness of healthcare services. Below are key areas where research can further explore the impact of empowering pharmacy technicians.

Immunization Delivery: Pharmacy technicians have been successfully integrated into immunization processes, demonstrating safety and efficacy in vaccine administration. Studies have shown that technicians can administer vaccines effectively, leading to increased vaccination rates and reduced wait times for patients (Clark, 2022). The role of pharmacy technicians as "vaccine champions" in community pharmacies has been piloted, showing potential in increasing vaccine uptake through advocacy and patient education (Hursman et al., 2024).

Medication Management and Patient Care: In Wales, pharmacy technicians have been empowered to enhance discharge medicine review services, adding value to the NHS by improving medication management and patient outcomes ("Empowering pharmacy technicians to boost the discharge medicine review service in Wales", 2022). On oncology wards, pharmacy technicians have supported nursing teams by preparing and administering intravenous injections, reducing adverse events and work-related stress among nurses (Sinclair et al., 2018).

Barriers and Opportunities: Despite the benefits, there are barriers to expanding pharmacy technicians' roles, such as inconsistent training and certification requirements. Research can explore strategies to standardize these requirements and advocate for regulatory changes (Burke, 2020). Opportunities exist for professional organizations and employers to create career advancement pathways for pharmacy technicians, further integrating them into healthcare teams (Burke, 2020). While the empowerment of pharmacy technicians shows significant promise, it is essential to consider the challenges associated with regulatory and educational inconsistencies. Addressing these barriers through targeted research and policy changes can further enhance the role of pharmacy technicians in healthcare delivery.

Conclusion:

Empowering pharmacy technicians is critical to addressing the pervasive issue of medication errors in modern healthcare. Their roles in tasks like medication reconciliation, immunization, and e-prescribing significantly enhance medication safety and operational efficiency. However, challenges such as inconsistent training, regulatory constraints, and workload pressures must be addressed to unlock their full potential. By standardizing education and fostering collaboration within multidisciplinary teams, healthcare systems can elevate pharmacy technicians to leadership roles in medication safety, ultimately improving patient outcomes and reducing healthcare costs.

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