Power System Technology
ISSN:1000-3673

Received: 16-08-2024 Revised: 05-09-2024 Accepted: 02-10-2024

Reducing Medication Errors in Operating Rooms Through Informatics-Supported Pharmacy Workflows

Ibeer Kadeer Asi[1], Fatima Issa Al-Shamlawi[2], Wadha Hamad Alanazi[3] Eida Hamad Mana Al-Anazi[4]

[1] Corresponding Author, Medicine & Surgery, Ministry of Health

[2] Pharmacy technician, National Guard Health Care

[3] Health Informatics Technician, Imam Abdulrahman Al Faisal Hospital in the National Guard in Dammam

[4] Health Informatics Technician, King Abdulaziz Medical City Hospital

Abstract

Medication errors occur frequently in operating rooms (ORs) and have serious consequences for patient safety. Workflow analysis and the introduction of computerized provider order entry (CPOE) with clinical decision-support systems in general and surgery-specific configurations emphasized the urgent need for improvements. Interventions that facilitate digital medication management and provide additional controls at the point of administration are essential. Integrating medication management into OR workflows through informatics-enabled standards for data exchange and interoperability is recognized as enabling—or even immaterial to—the adoption of advanced workflow solutions. Pharmacy informatics capabilities supporting OR medication workflows have been widely reported but remain unexamined as a unit. Implementing informatics-enabled pharmacy solutions at ORs is expected to improve safety and access to essential knowledge, thereby reducing the incidence of avoidable errors. Optimizing these solutions before widespread deployment further amplifies their potential impact and contributes to the conceptualization of a medication-passionate pharmacy practice model for ORs.

Keywords: Medication Errors, Operating Room, Informatics, Pharmacy Workflows, Patient Safety, Clinical Decision Support, Health Informatics, Workflow Optimization, Perioperative Care, Error Reduction

1. Introduction

Medication errors constitute a significant source of patient morbidity and mortality in healthcare systems internationally. These errors occur frequently in operating rooms (ORs), where patient statuses and clinical conditions can change rapidly (Khowaja et al., 2008). IRs are particularly vulnerable to medication errors due to their complex workflows and limited access to pharmacotherapy information (Cho et al., 2015). A comprehensive taxonomy of medication errors identifies several typologies that are relevant to informatics-enhanced

Power System Technology
ISSN:1000-3673
Received: 16-08-2024 Revised: 05-09-2024 Accepted: 02-10-2024

workflows in the OR. Transcription errors and selection errors arising from medications that were not intended or omitted from orders represent prominent examples of preventable occurrences. Informatics-supported and pharmacy-driven approaches demonstrate the potential to reduce critical medication errors in OR contexts.

The pharmacy role in the OR is constrained by the indirect and infrequent nature of medication provision compared with other clinical settings. Pharmacists typically do not participate directly in the clinical decision-making process regarding treatment within the OR. Informatics-driven and pharmacy-supported strategies to enhance safety and reduce error rates have been successfully deployed in OR settings.

2. Background and Significance

Medication errors contribute to one of the most serious threats to patient safety today. The American Society of Health-System Pharmacists focused on this topic in its 2015 statement on the role of health information technology in preventing drug diversion, and the practice of pharmacy has also become a priority for the Centers for Medicare and Medicaid Services. The integration of informatics into pharmacy workflow in the operating room (OR) represents a novel approach to address this ongoing issue. The specialization of informatics and the increasing amount of relevant data generated within hospitals represent a vast and relatively untapped opportunity to improve this key area (Khowaja et al., 2008).

The OR presents unique medication management challenges due to factors such as critical patient status, complex medications, multi-disciplinary workflows, and dynamic environments. It is the only location within the hospital where medications are delivered, prepared, and administered to the patient without any prior review or verification by a trained pharmacist. During surgery, valuable information is often transmitted solely through verbal communication, necessitating reliance on memory and documentation practices that may not align with local standards (Cho et al., 2015). Consequently, even with a Computerized Provider Order Entry system integrated within the Electronic Medication Administration Record, there remain opportunities to minimize erroneous behavior prior to order entry, to reduce harm during the OR workflow by eliminating potential risk points, and to communicate information more effectively to enable safe delivery of care after surgery.

3. Informatics Foundations for Pharmacy Workflows

Medication management in operating rooms (ORs) is inherently complex: typical procedures involve administering multiple agents and medications that can be life-threatening if errors occur (Cho et al., 2015). Many institutions lack centralized oversight of OR medication workflows and processes are domains where errors can originate (Khowaja et al., 2008). These challenges manifest as inadvertent prescription errors (1%) that constitute 21.8% of drug-related safety incidents.

Power System Technology
ISSN:1000-3673
Received: 16-08-2024 Revised: 05-09-2024 Accepted: 02-10-2024

Important informatics elements—systems, standards, interoperability, and governance—enable safe medication management (Binobaid et al., 2017). Supporting technologies include digital order entry with clinical decision support, automated dispensing with barcoding, and real-time alerting. Dispersed and diverse information, responsibilities, and work activities increase administrative burdens, especially in busy ORs.

3.1. Digital Order Entry and Verification

Medication orders pose particular challenges during surgical procedures, where medications must be obtained quickly and securely for anesthesia induction, drug selection occurs at the point of administration, and orders often cross multiple specialty divisions. During outpatient surgery, most orders originate with an outside anesthesiologist, who may prescribe off a pre-printed or electronic template for numerous cases. Medication errors can arise from a variety of causes including poor communication, unfamiliarity, information overload, drug name confusion and classification mismatches. Transcription and selection errors can also occur during the order review process prior to medications leaving the pharmacy. Computerized Provider Order Entry (CPOE), combined with clinical decision support, mitigates these error types through a digital order entry and verification step of the medication-use process, eliminating paper-based handwritten transcriptions and introducing key safety checks on medication orders. To promote efficient CPOE use, the electronic template mechanism can be extended to the OR through an electronic Case Turnover Sheet specifying all procedures, medications, and devices for a patient. Additional means of enhancing efficiency and reliability throughout perioperative workflows, extending beyond CPOE, can be endeavored (Khowaja et al., 2008) , (Cho et al., 2015) , (Shaffer & Coustasse, 2012).

3.2. Automated Dispensing and Barcoding

Automatically dispensing medications at the point of care reduces the likelihood of medication-selection errors (Almalki et al., 2023) , and such systems can interface with computerized provider order entry (CPOE) systems to document product dispensing in the electronic medication administration record (eMAR) (J Beard & Smith, 2013). Fully automated dispensing solutions, however, require more time to position the right medication for user access, and work-sample analyses have shown that members of the surgical team lack sufficient time to retrieve medications from such devices during cases.

Automated dispensing cabinet (ADC) systems are designed to dispense a wide array of products with automatic replenishment. This capability addresses the complex scheduling and unpredictability of operating-room cases and integrates well with the unique requirements of sterile-product delivery. When properly integrated into pharmacy workflows, ADC–CPOE connectivity can ensure that automatic replenishment occurs only after an actual transaction, preserving the safety benefit of knowing what a given unit of product should contain.

Power System Technology
ISSN:1000-3673
Received: 16-08-2024 Revised: 05-09-2024 Accepted: 02-10-2024

3.3. Real-Time Alerting and Decision Support

The first stage of a computerized provider order entry (CPOE) system involves the selection of a patient, followed by detailed information concerning the medication order and its associated verification through the use of one or more electronic signatures. Subsequently, medication orders concurrently placed in via CPOE systems either by the anesthesiologist or a pharmacy department for the anesthesiologist are directed to the pharmacist for verification consideration. The medication orders directed to the pharmacy department can either be a separate chart specifically developed for the preoperative period or designated for a particular department specifically dedicated to preoperative orders. Once a computerized order has been approved, the name of the drug product is displayed on the automated dispensing machine along with the associated patient, thus preventing the possibility of a different drug being selected from the automated dispensing machine (W Steele et al., 2005).

The computerized provider order entry system is fully integrated with an electronic health record (EHR) system, allowing for easy access to patient information prior to the placing of a medication order and for drug–laboratory monitoring. In addition to providing medication allergy information, the electronic health record also incorporates information connecting to various laboratory tests and results, including patient-specific laboratory data, allowing for clinical framework that assists in the prevention of medication errors. The computerized provider order entry system can establish medication orders that can deliver thorough drug–drug interaction screening, allergy verification, and drug–laboratory diagnosis linkage in conjunction with clinical decision assistance. Alert designation within the computerized provider order entry system is carefully considered and can take a variety of different forms with both moderate and major levels of alert strength. Minor alerts, which although they do not need mandatory follow-up, are designed to stimulate additional considerations for the clinician (Chen et al., 2024).

4. Pharmacist-Driven Informatics Interventions

Medication safety problems plague operating rooms (ORs) in acute care facilities, where dangerous practices can jeopardize patient well-being. Hard-to-detect errors arise from chaotic multi-user workflows, transient provider involvement, and poorly organized information transfer. Systematic analyses of OR workflows zero in on key opportunities for harm-reduction interventions. Pharmacists equipped with informatics-supported decision aids can optimize medication queries, dispense multi-patient case medications, ensure current medication lists for patients under anesthesia, and help avert numerous preparatory-detail oversights. Decision-support alerts for unusually high-stakes queries of unfamiliar medications routed through informatics-enabled channels improve fidelity and retention of high-reliability protocols and procedures. Recent information-system enhancements afford hospitals within a healthcare delivery network an unprecedented opportunity to address these

Power System Technology
ISSN:1000-3673
Received: 16-08-2024 Revised: 05-09-2024 Accepted: 02-10-2024

challenges and architect an integrated information-enablement environment in partnership with pharmacy practitioners trained in the latest workflow innovation methodologies.

4.1. Workflow Analysis and Optimization

In pharmacy settings, supporting team members in identifying and addressing gaps in their workflows can enhance the quality of services delivered. A number of tools and techniques assist in such assessment efforts. Various approaches, including flow charts and simulations, can aid in visualizing workflows. Direct observations constitute another option, and when done in tandem with recordings (e.g., screen, voice/screen capture) keep key events and details present in interview follow-ups. The Lean methodology applies well to the operating room (OR) context and aligns with medication safety objectives. Its principles and practitioners concentrate on process steps that create value for customers, acknowledging that non-value-adding steps contribute to delays, errors, frustration, and wasted resources. The respective value streams for various clinical products are application of the principles precedent to workflow and opportunity analysis (1986- Chabria, 2015) ; (Almalki et al., 2023).

4.2. Medication Reconciliation in the OR

Medication reconciliation is a fundamental patient safety process endorsed by credible organizations (Institute of Medicine; Joint Commission on Accreditation of Healthcare Organizations). In the operating room (OR), explicit recognition of the need for medication reconciliation is articulated through the “Time-Out” protocol. The following Medication Reconciliation activities are involved. An initial Medication Reconciliation is performed by the pharmacy before the patient arrives in the OR based on the admission medication history, preoperative orders in the electronic medical record (EMR) and preoperative rounds conducted by the attending anesthesiologist. Therefore, a comprehensive and updated list of the patient’s current medication, allergies and intolerances is made available to the anesthesiologist and OR team in the preoperative electronic assessment (PEA) module of the EMR. A critical reduction in medication error occurrences and near misses is achieved by making this information accessible one hour before patient arrival in the OR. During the pre-induction phase, the anesthesiologist performs a second Medication Reconciliation based on the Admission Medication History (AMH)/Preoperative Prescriptions and PEA. The attending anesthesiologist then performs a third Medication Reconciliation on the anesthesia record form during induction. The anesthesiologist documents the new medications that will be started in the OR, the ones that were previously stopped and those that are continued. Finally, after the patient leaves the OR, a fourth Medication Reconciliation is conducted by the pharmacy following the review of the abbreviation and cancellation records of medications administered and documents the current medications restarted in the post-anesthesia care unit (Smith et al., 2015). A concurrent review of all medications is considered

Power System Technology
ISSN:1000-3673
Received: 16-08-2024 Revised: 05-09-2024 Accepted: 02-10-2024

an additional verification step performed in the OR and the post-anesthesia care unit. The Operative Outpatient Anesthesia Record enforced within the Time-Out section of the anesthesia record serves as the unofficial communication aid between anesthesiologists and the OR team.

4.3. Interdisciplinary Communication and Handoffs

All steps involved in surgical medication management—from selection and preparation through administration, documentation, and inventory—typically comprise distinct workflow components carried out by different personnel including prescribers, pharmacists, nurses, and anaesthesia providers. Movement through these components does not usually follow a fixed, ordered sequence; many can occur simultaneously and on a recurring basis. Addressing any step can thus benefit from information about preceding or concurrent actions taken by other parties. The volumes of data and the operational complexity of the operating room (OR) present significant challenges to the provision of such information (Ashutosh Sule et al., 2020). Within this context, interdisciplinary communication, especially during handoffs from one discipline to another, becomes crucial for ensuring that all parties possess the basic information required to perform their designated tasks adequately. Although procedures for handing off medications between pharmacists and nurses within the operating room exist, protocols for other medication-related handoffs, particularly those involving anaesthetists, OR technicians, and practising surgeons, remain insufficiently structured. Addressing this gap becomes critical, as the delineation of specific handoff procedures will enhance communication and information transfer, thereby contributing to safer medication management (Binobaid et al., 2017).

Interdisciplinary communication, particularly during handoff situations between pharmacological and surgical domains, represents a pivotal area in which further intervention may improve the safety of medication management in the operating room. A standardised communication strategy requires the identification and formalisation of the most pertinent information to be transferred during such handoffs. Supplementing existing handoff protocols with a set of key content points and a checklist or template—tools adapted to the operating room context—promises to enhance the structure of such communication (S Birk et al., 2016). Developing such tools in collaboration with anaesthetists and operating-room nurses will also ensure that they address the specific needs of the OR environment.

5. Patient Safety Outcomes and Metrics

Patient Safety Outcomes and Metrics

Defining the study's patient safety outcomes, overall indicators, and specific metrics is paramount to effectively evaluating informatics-supported pharmacy workflow interventions in the operating room. Overall indicators estimate overall safety and can signal when

Power System Technology
ISSN:1000-3673
Received: 16-08-2024 Revised: 05-09-2024 Accepted: 02-10-2024

systemic changes may be required. Specific metrics estimate the impact of each individual intervention on the overall indicator.

Analysis of the reference literature reveals a broad array of potential medication error types, sources, and contributing factors. For the purposes of a clearer evaluation at the organizational level, a typology of reasonably standard error categories has been established that organizes each incident according to the procedural stage at which it occurred, the root cause of the error, and which modifiable factors contributed to it, utilizing established taxonomies from the literature for reference (Almalki et al., 2023). Such a typology not only facilitates clarity and comparability when reporting findings from the current evaluation but also provides an organization that enables formal linkage with particular interventions.

Multiple avenues for data collection have been identified, including the study's analysis of the electronic medical record, system-generated logs, the information presented in incident reports, the contents of periodic observational audits, and site-run incident-tracking tools. The precise combination of data sources employed will depend on which particular errors have been selected for close tracking and their availability across time. For the sake of broader knowledge dissemination, a series of exemplar case studies have also been compiled cataloguing sites that have undertaken similar medication-safety initiatives, the status of their current workflows prior to selection, clocked intervention times for the entire process, outcomes achieved, and any subsequent refinement efforts, as well as comparative benchmarks summarizing their visible results against the site's own expectations and the observed changes in quality.

5.1. Error Type Classification

International studies of medication errors have employed two frameworks: the Institute of Medicine framework, oriented to detect and analyze system hazards (Khowaja et al., 2008) ; and the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) classification, which categorizes errors according to potential harm (Barbosa de Aguiar et al., 2018). The latter can be applied to the pre-administration phase to capture errors intercepted before the patient encounter and is universal across inpatient–outpatient–outreach systems (Cho et al., 2015). The present effort builds a taxonomy for classifying medication error types that operate at the institutional level, the workflow level, and aligned with modifiable and non-modifiable factors. A three-level error type classification permits formal mapping with the NCC MERP typology, increasing comparability with case studies and assessments that do not fall under pharmacy-infomedicaedinformatics operations.

5.2. Measurement Methods and Data Sources

Operating room (OR) medication errors represent a significant jeopardy for patient safety. Nonetheless, scarce literature targets OR-specific medication error measurement methods. An

Power System Technology
ISSN:1000-3673
Received: 16-08-2024 Revised: 05-09-2024 Accepted: 02-10-2024

iterative framework measuring and classifying OR medication errors before and after pharmacy-driven informatics interventions encompasses data sources, measurement methods, and proposed metrics. Data originate from a pharmacy record-review program characterizing dispensing errors across clinical settings and direct observation targeting OR workflows. Preliminary error typologies inform insights for clinic and departmental-level analysis, alongside mapping possible interventions.

Pharmacy medication-order and dispensing-error data constitute the primary information source. These logs offer granular details about the timing, content, and impacted stages of patient medication orders, facilitating comprehensive reduction analysis. For individual cases, the OR workflow is scrutinized. An adaptable framework captures key treatment phases, error-cause categories, modifiability, and comparison with the department-wide taxonomy. In parallel, an observation methodology documents specific OR workflow attributes, patient-count adjustments, hands-free communication employment, and other situational elements, contributing towards targeted improvement.

5.3. Case Studies and Benchmarking

Operating rooms (ORs) are high-stress environments characterized by numerous medication-use transitions when new patients enter, existing patients undergo various anesthesia and surgical procedures, and multiple medications are frequently administered before, during, and after surgery. This dynamic setting is often laden with time-critical or emergent medications, where additional distractions abound from equipment alarms, team communications, and unanticipated situations. Although patients are rendered without sensation through general or regional anesthesia, pharmacological errors still pose a major threat. If an incorrect medication or dosage were to be administered, the physiological effects would be instantaneous and could lead to catastrophic consequences. These challenges call for a comprehensive approach that incorporates clinical informatics tools, techniques, and pharmacist-led strategies within medication management processes to mitigate opportunities for error. Several institutions have successfully completed benchmarking studies to characterize medication-use error rates and error types during anesthetic and surgical procedures, incorporating administrative sophistication ratings to evaluate the influence of clinical information and technology on error reduction. Survey data from over 400 hospitals in the United States with 100 beds or more and 36 countries on 6 continents—including Canada and 7 nations in Europe—identified the most common types of error that occur in their organizations. The top two medication error categories were similar to data reported in hospitals that use computerized provider order entry (CPOE) systems and total parenteral nutrition compounding: prescribing errors (Khowaja et al., 2008) and omission errors (Cho et al., 2015) (c6cb6ae7-39b9-44ff-b4d2-b10cf4291390; 83191763-a5b5-470d-9558-c8244f9c28bd; 5ba4db30-7b72-474f-afd6-b321a4922eb2).

Power System Technology
ISSN:1000-3673
Received: 16-08-2024 Revised: 05-09-2024 Accepted: 02-10-2024

6. Implementation Strategies

Informatic-enabled medication safety interventions can leverage pharmacy expertise to optimize perioperative workflows and reduce the frequency of unintentional occurrences that jeopardize patient safety. Deploying informatics-enabled medication safety solutions in the OR requires careful consideration of pharmacists' capacity—both in terms of time and roles—to influence the existing information technology environment and facilitate multidisciplinary alignment around shared safety goals. The ensuing execution plan outlines pragmatic, interrelated steps for implementing informatics-supported workflows in the OR: First, engage key stakeholder groups—executives, departmental leaders, informatics specialists, and pharmacy leaders—in governance structures that define oversight and operational responsibilities for safety interventions. Target and prioritize modifications to the broader medication management landscape, fostering alignment with established strategic, operational, and safety objectives—goals that may already have been articulated in existing organizational or departmental strategy documents. Strive to implement informatics-enabled solutions in ways that convey the desired clinical benefits and feasibility, while avoiding poorly aligned or purely engineering-focused modifications that may undermine wider efforts to create an effective and robust practice framework. For any medication-related activity, provision exists for at least one authoritative primary source of information; during interventions that depend on other applications, transitioning from any application back to the primary source must remain straightforward. Outlining users' entitlements and overlaying them with audit trails of actual access behaviors establishes a transparent and mutually agreed framework for ongoing enterprise—the still-emerging nature of pharmacy practice in the OR creates a climate in which misplaced intrusions can cause uncertainty that limits exploration.

6.1. Stakeholder Engagement and Governance

Multiple committees govern the pharmacy and informatics initiatives that the informatics-enabled consultation addresses. The director of pharmacy coordinates projects overseen by institutional pharmacy, medication-use safety steering, and enterprise-wide informatics governance committees. Dual reporting ensures consideration of informatics requirements and medication-use safety. The associate director of pharmacy (operations) chairs an interdisciplinary medication-use safety committee that identifies and prioritizes institution-wide medication-use safety initiatives for completion. In an integrated university health system, this committee interacts with an informatics board that oversees informatics projects supporting clinical and revenue cycle services (Khowaja et al., 2008).

The pharmacy informatics program is governed by a pharmacy informatics advisory committee composed of pharmacy facilitators representing inpatient and outpatient pharmacy services in multiple facilities. Key functions include project vetting and prioritization, interface-change approval, and monitoring of operational issues related to computerized

Power System Technology
ISSN:1000-3673
Received: 16-08-2024 Revised: 05-09-2024 Accepted: 02-10-2024

provider order entry and automated dispensing cabinets. Information flows to other medication-use safety and informatics governance bodies as appropriate (Jordan et al., 2017).

6.2. System Selection and Customization

Optimal system selection ensures alignment with clinical workflows, technical capabilities, and strategic prioritization (Almalki et al., 2023). Decision-making criteria must reflect patient safety, care efficiency, discipline-specific processes, and institutional policies.

A multi-disciplinary team engages in a structured process to identify and compare vendors. Key evaluation criteria include vendor experience, history of similar deployments, adherence to national data standards, inter-application compatibility, safety system sophistication, modular or service-based deployment flexibility, estimation of design effort and duration, and access to interim solutions during modification stages (G Pruszydlo et al., 2012). The acquisition plan includes clinics requiring delivery within the fiscal year, addressing the institution's most critical philosophical engagement with medication management.

6.3. Training, Change Management, and Usability

Misprescribed and improperly administered medications create the highest risk of patient harm during surgery, yet pharmacy workflows are often unaddressed at the system level. Efficient integration and routing of high-priority, nonclinical, interdisciplinary information between pharmacy and the operating room, supported by long-standing. Several strategies—clarifying interfaces, augmenting access and updating modifications, optimizing digital–manual handoffs—can substantially reduce error opportunity and consequent patient risk. The proposed interventions focus on establishing effective medications-management systems that safeguard against missed or duplicated orders, which continue to be common sources of preventable harm despite extensive redesign and ongoing support (Khowaja et al., 2008).

6.4. Risk Assessment and Contingency Planning

To maximize the safety, effectiveness, and adoption of informatics-enabled pharmacy workflows, an assessment of failure modes and the development of mitigation strategies are vital (Barbosa de Aguiar et al., 2018). Systematic documentation of barriers, workarounds, and recovery procedures, along with formal protocols for managing system outages, can significantly reduce workflow disruption and safeguard patient safety (Jordan et al., 2017). Various error types can still occur when computerized prescriber order entry, automated dispensing, and real-time decision support are employed. For instance, information may not be correctly entered into the system, leading to dispensing and administration of incorrect medications. Furthermore, users may overlook displayed alerts or reject them without a full consideration of the implications.

Power System Technology
ISSN:1000-3673
Received: 16-08-2024 Revised: 05-09-2024 Accepted: 02-10-2024

Pharmacy informatics solutions, in combination with conventional circuitous pathways to obtain medications in the operating room, can introduce specific vulnerabilities. Verbal orders directly to pharmacy technicians, even if entered during preparation by an anesthesia provider, remain a possibility under such conditions. A series of desk audits or data scans prior to implementation can reveal further gaps, including missing order components or incomplete administration details within the electronic medical record following patient handover. Under such scenarios, documented auxiliary checks are required, such as a second pharmacist review with dual signature, or substantive alert triggers on omissions when accessing the medication administration activity. A proactive approach to identifying potential liabilities is, therefore, fundamental for patient protection. Addressing failure modes early in the process enables decisions around requisite investment levels or additional modifications to mitigate the risks while still improving workflow and safety (Khowaja et al., 2008).

7. Ethical, Legal, and Privacy Considerations

Pharmacy data in the OR contain protected health information (PHI) that must be secured throughout all informatics- enabled workflow interventions. Access to this sensitive information must be strictly controlled according to relevant statutory and regulatory compliance frameworks (Khowaja et al., 2008). Electronic data exchange relies on an authorization governance model to manage roles, access rights, and controls. Pharmacies conducting automated dispensing and barcoding in the OR must also adhere to existing licensing obligations and the terms and conditions established in State Board of Pharmacy frameworks (Cho et al., 2015).

8. Challenges and Limitations

Reducing Medication Errors in Operating Rooms Through Informatics-Supported Pharmacy Workflows: Medication errors are preventable, undesired events that can cause harm to patients. Despite the adoption of informatics-enabled medication-use processes, the incidence of medication errors in operating rooms remains alarmingly high, with pharmacy practitioners being key stakeholders for the implementation of feasible informatics-supported solutions that can significantly mitigate the occurrence of such errors. Incorporating informatics tools from before patients enter the operating room through until the moment they exit can alleviate the medication-management burden and promote greater safety. Automation through a computerized provider order-entry (CPOE) and electronic medication administration record (eMAR) system, complemented by standardized interdisciplinary communication tools, represents a promising avenue for improvement (Khowaja et al., 2008). Informatics-enabled pharmacy workflows also permit systemic endeavours to engage stakeholders, examine current practices, design appropriate interventions, and promote continuous monitoring that enhances safety (Almalki et al., 2023). Such changes are critical,

Power System Technology
ISSN:1000-3673
Received: 16-08-2024 Revised: 05-09-2024 Accepted: 02-10-2024

as many error types remain avoidable, with pertinent modifications and diligence—particularly during care transitions—capable of containing problems within the enterprise risk-management strategy (Cho et al., 2015).

9. Future Directions in Informatics-Enhanced OR Pharmacy Practice

Operating rooms (ORs) are highly structured, unambiguous environments that have typically adhered to workflow and communication design principles described in the discipline of Human Factors Engineering (Hahn et al., 2014). The goal has been to implement a well-laid-out system that minimizes the possibility of error (also referred to as "human factors engineering") as much as possible by focusing on technologies that, when well-designed will render a system "intuitive". There should be no ambiguity between what is being done and how it is clearly communicated. In a typical university OR operating team, there would be an attending physician, surgical resident, anesthesiologist and anesthesia resident, surgical scrub tech, circulating nurse, and an OR assistant present (Binobaid et al., 2017). During a surgical procedure case, the primary attending physician would typically annotate on a white board or smart board (no touch required) the medications being administered and/or equipment and supplies being utilized in the procedure. Systematic reviews demonstrate the introduction and implementation of such procedures have shown to reduce the medication error rates by more than 90%. An institution also can set up a global medicine supply chain in which the system would provide the generic drugs based on trimester or vaccine doses in infusion mode. Such systems that are part an organization OR-wide initiative to sustain and enhance patient as well as parent and family safety can reduce medication and vaccine-selection errors and also spare OR personnel from resending the request through other channels or struggling to get the supplies fast.

10. Conclusion

Medication errors persist as a major cause of avoidable patient harm in modern healthcare settings. In the operating room (OR), a high-pressure environment dedicated to performing complex procedures on vulnerable patients, the risk of error is particularly acute. In the United States, approximately 5,000 medication events occur annually in hospital ORs, with the majority deemed potentially preventable. Pharmaceutical misinformation readily propagates to specialized providers due to fragmented information flows across multiple clinical and non-clinical systems; excessive reliance on manual processes combined with workflow interruptions further exacerbates the risk. Limitations of the electronic health record (EHR) as a medication management tool—broadly identified as "ecological incompatibility"—present additional challenges. In response, medical informatics–informed research has sought to strengthen the role of pharmacy teams in the OR, in the belief that ensuring timely access to complete and accurate medication information can reduce both the frequency and severity of medication-related harm.

Power System Technology
ISSN:1000-3673
Received: 16-08-2024 Revised: 05-09-2024 Accepted: 02-10-2024

A three-tier framework for characterizing pharmacy interventions and the corresponding information gaps has been developed. The first phase focuses on the mechanisms for digital medication request and verification; automated dispensing and barcoding of medications; and real-time alerting to potential drug, dose, or frequency errors. The second phase addresses how information flows are optimized during transitions of care—workload-driven omissions and duplicative orders—between the OR and post-anesthesia care unit or intensive care unit; how to harmonize the set of medications in the computerized provider order entry (CPOE) system across pre-procedure, intra-procedure, and post-anesthesia transfer phases; and how work processes—including multi-party communication—are redesigned to share medication information across disciplines. The third phase complements the first two by improving safety in prescribing and administering flu vaccine through multilingual checklists. Proposals made for conducting a comprehensive mapping of OR workflows across the full range of surgical services across multiple facilities have defined pharmacy priorities within the first phase.

References:

1. Khowaja, K., Nizar, R., J Merchant, R., Dias, J., Bustamante-Gavino, I., & Malik, A. (2008). A systematic approach of tracking and reporting medication errors at a tertiary care university hospital, Karachi, Pakistan. ncbi.nlm.nih.gov
2. Almalki, A., Jambi, A., Elbehiry, B., & Albuti, H. (2023). Improving Inpatient Medication Dispensing with an Automated System. ncbi.nlm.nih.gov
3. Cho, I., Park, H., Jeong Choi, Y., Heui Hwang, M., & W. Bates, D. (2015). Understanding the Nature of Medication Errors in an ICU with a Computerized Physician Order Entry System. [PDF]
4. Binobaid, S., Almeziny, M., & Fan, I. S. (2017). Using an integrated information system to reduce interruptions and the number of non-relevant contacts in the inpatient pharmacy at tertiary hospital. ncbi.nlm.nih.gov
5. Shaffer, J. & Coustasse, A. (2012). Computer physician order entry and clinical decision support systems: Benefits and concerns. [PDF]
6. J Beard, R. & Smith, P. (2013). Integrated electronic prescribing and robotic dispensing: a case study. ncbi.nlm.nih.gov
7. W Steele, A., Eisert, S., Witter, J., Lyons, P., A Jones, M., Gabow, P., & Ortiz, E. (2005). The Effect of Automated Alerts on Provider Ordering Behavior in an Outpatient Setting. ncbi.nlm.nih.gov
8. Chen, Q., Wang, L., Lin, M., Chen, W., Wu, W., & Chen, Y. (2024). Development and implementation of medication-related clinical rules for obstetrics, gynaecology, and paediatric outpatients. ncbi.nlm.nih.gov
9. 1986- Chabria, A. (2015). Analysis of Pharmacy Technician Workflow and the Identification of Opportunities for Improvement. [PDF]

Power System Technology
ISSN:1000-3673
Received: 16-08-2024 Revised: 05-09-2024 Accepted: 02-10-2024

10. Smith, L., Mosley, J., Lott, S., Cyr, E., Amin, R., Everton, E., Islami, A., Phan, L., & Komolafe, O. (2015). Impact of pharmacy-led medication reconciliation on medication errors during transition in the hospital setting. ncbi.nlm.nih.gov
11. Ashutosh Sule, A., Caputo, D., Gohal, J., & Dascenzo, D. (2020). Desirable Features of an Interdisciplinary Handoff. ncbi.nlm.nih.gov
12. S Birk, H., J Han, S., D Rolston, J., C Rowland, N., Lau, C., V Theodosopoulos, P., & W. McDermott, M. (2016). Resident-led Implementation of a Standardized Handoff System to Facilitate Transfer of Postoperative Neurosurgical Patients to the ICU. ncbi.nlm.nih.gov
13. Barbosa de Aguiar, L., Morato Stival Lima, M., Cristina Morais Santa Bárbara Rehem, T., Schwerz Funghetto, S., & Renata Grou Volpe, C. (2018). Factors related to medication errors in a Brazilian hospital. [PDF]
14. Jordan, R., Lam, J., Lyren, A., Sims, N., & Yang, C. (2017). Actionable Patient Safety Solution (APSS) #3A: Medication Errors. [PDF]
15. G Pruszydlo, M., U Walk-Fritz, S., Hoppe-Tichy, T., Kaltschmidt, J., & E Haefeli, W. (2012). Development and evaluation of a computerised clinical decision support system for switching drugs at the interface between primary and tertiary care. ncbi.nlm.nih.gov
16. Hahn, L., Buckner, M., B. Burns, G., & Gregory, D. (2014). How space design and technology can support the Pharmacy Practice Model Initiative through interprofessional collaboration. [PDF]