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Reducing Nephrotoxicity Risk: A Collaborative Audit Of Nursing Assessment, Pharmacist Consults, And Radiology Contrast Administration

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Abstract

Acute Kidney Injury (AKI) due to nephrotoxicity from medications and contrast media is a major contributor to patient morbidity and hospital cost, with incidence rates approaching 20% in critically ill populations. This literature review evaluates the evidence supporting a collaborative, interprofessional approach to risk mitigation across three critical specialties: Nursing, Pharmacy, and Radiology. The review synthesizes findings demonstrating that each discipline offers unique, evidence-based protection. Nursing is essential for baseline GFR verification, precise volume status assessment using clinical metrics, and timely communication of risk changes. Pharmacy provides dose optimization via therapeutic drug monitoring (TDM) for narrow-index drugs and proactively manages complex drug-drug and drug-contrast interactions through clinical decision support alerts. Radiology is primarily responsible for minimizing contrast volume, selecting appropriate low-osmolar media, and dictating pre-/post-procedure hydration protocols based on established guidelines. The synthesis reveals that the primary failure point in prevention is often the lack of seamless communication during transitions of care, particularly concerning GFR changes and medication holds. Optimal nephroprotection requires unifying these specialized actions into a synchronized, system-wide workflow, emphasizing the Electronic Health Record as the critical tool for enforcement and collaborative communication.

Keywords: Nephrotoxicity, Acute Kidney Injury (AKI), Interprofessional Collaboration, Contrast Nephropathy, Pharmacist Intervention.

Introduction

Acute kidney injury (AKI) remains a significant and pervasive challenge in hospitalized patient care, directly contributing to increased morbidity, extended hospital stays, and substantially elevated healthcare costs (Mehta et al., 2021). AKI incidence is estimated to affect up to 15% of all hospitalized patients and,

critically, up to 40% of patients in intensive care units (ICU), with subsequent mortality rates reaching 60% in severe cases (Chawla et al., 2020). The long-term consequences are equally dire, as a single episode of AKI is now widely recognized as an independent risk factor for the progression to chronic kidney disease (CKD) or end-stage renal disease (ESRD), requiring renal replacement therapy (Himmelfarb et al., 2022). This profound impact underscores the urgency of proactive risk mitigation.

While AKI is widely recognized as a multifactorial syndrome encompassing prerenal, intrinsic, and postrenal causes, preventable injury—specifically nephrotoxicity induced by common medications (such as Vancomycin or Amphotericin B) and iodinated contrast media (resulting in contrast-induced AKI or CI-AKI)—represents a critical and actionable area for quality improvement and patient safety efforts. The pathogenesis of drug-induced nephrotoxicity often involves acute tubular necrosis (ATN), leading to renal tubular cell damage, or acute interstitial nephritis (AIN). Contrast media exposure typically causes a transient, dose-dependent decrease in renal blood flow coupled with direct toxic effects on tubular cells, mediated by reactive oxygen species and medullary hypoxia (Toma et al., 2020).

Nephrotoxic exposure is not a singular event but rather a continuous risk that can occur at multiple, sequential points in a patient's journey, necessitating comprehensive risk stratification and mitigation strategies tailored to patient-specific renal function. The population most vulnerable to these preventable insults includes patients with pre-existing chronic kidney disease (CKD), particularly those with a GFR less than 60 mL/min 1.73 $m^{3,}$ diabetes mellitus, heart failure, advanced age, and those subjected to underlying clinical conditions such as sepsis, volume depletion, or complex polypharmacy (Himmelfarb et al., 2022).

Traditional approaches to AKI prevention have historically relied upon fragmented, specialty-specific protocols. A physician may appropriately order a high-risk medication; a pharmacist may verify the dose based on static lab values; and the radiology technician may proceed with a contrast study based on the scheduled time, with each specialty operating within its own silo. This lack of integration fails to address the dynamic nature of renal risk. For instance, a patient may be euvolemic at admission (Nursing check) but become dehydrated following an overnight surgical prep (Nursing failure to communicate), rendering the pharmacist's dose adjustment instantly obsolete.

The patient's exposure to risk spans multiple departmental hand-offs: from routine medication administration on the ward, to specialized dosage adjustments, and potentially to diagnostic imaging procedures involving contrast. This continuous, multi-point exposure highlights the critical need for a fully integrated, interprofessional care model. This review focuses specifically on the three distinct clinical disciplines most immediately responsible for risk mitigation at the bedside and procedural level: Nursing Assessment, Pharmacist Consults, and Radiology Contrast Administration. These three areas form a "triad of risk mitigation," where a breakdown or failure in information transfer, coordination, or protocol adherence within any one domain can rapidly negate the cumulative preventive efforts of the others.

The necessity of this collaborative approach is underscored by the complexity of modern nephroprotection. It requires a nurse's vigilance in recognizing and managing hydration, a pharmacist's expertise in molecular kinetics to adjust narrow-index drugs, and a radiologist's procedural control to minimize exposure to contrast. The successful linkage of these discrete actions across various time points and specialties is the central hypothesis driving this review. This review synthesizes the current literature to evaluate the empirical evidence supporting collaborative, discipline-specific interventions by Nursing, Pharmacy, and Radiology in reducing nephrotoxicity risk.

Nursing Assessment in Risk Mitigation

The nursing role is paramount in the initial identification, continuous monitoring, and effective communication of patient risk factors, establishing the critical first line of defense against nephrotoxicity (Moore & Smith, 2019). The nurse’s continuous presence at the bedside ensures that risk stratification is

dynamic, not static, and responsive to rapid clinical changes.

Baseline Assessment and Tracking

The most immediate and critical nursing action is the proactive verification of baseline renal function. Nurses are frequently the final checkpoint before a potentially nephrotoxic medication is administered or before a patient is transported for a contrast-enhanced procedure. Current clinical practice guidelines stress the absolute necessity of an up-to-date estimated Glomerular Filtration Rate (GFR) or creatinine clearance (CrCl) within a highly specific timeframe (e.g., within seven days) for all high-risk patients (Sanz et al., 2021). Structured nursing protocols that mandate a hard-stop verification of GFR before administering high-risk medications, such as non-steroidal anti-inflammatory drugs (NSAIDs), intravenous acyclovir, or specific antibiotics, or before contrast media exposure, have been shown to significantly reduce unsafe medication and procedural exposures. Furthermore, nurses bear the responsibility for monitoring subtle trends in laboratory values, recognizing early indications of deterioration (e.g., oliguria, rising creatinine) that necessitate immediate, documented communication to the pharmacy or medical team for drug hold or dose modification (Johnson et al., 2022). The failure to recognize and escalate these changes can lead to unnecessary cumulative nephrotoxic insults.

Fluid Status and Dehydration

Fluid optimization is recognized as an indisputably crucial element of nephroprotection, particularly for patients undergoing contrast-enhanced imaging. The nurse, maintaining continuous bedside presence, is uniquely positioned to accurately assess and manage the patient's volume status (Moore & Smith, 2019). This assessment encompasses accurate intake and output (I/O) records, continuous monitoring of hemodynamic indicators (e.g., orthostatic hypotension, tachycardia, mean arterial pressure 65 mmHg, and physical signs of dehydration (e.g., poor skin turgor, dry mucous membranes), all of which directly affect renal perfusion and the patient's ability to efficiently clear nephrotoxic substances. The timely initiation and meticulous tracking of physician- or radiologist-prescribed hydration protocols falls entirely under nursing management, solidifying their adherence as a vital and non-negotiable link in the collaborative chain. Failure to maintain adequate hydration, particularly in the immediate periprocedural period, significantly increases the likelihood of CI-AKI.

Documentation and Communication

Effective and timely interprofessional communication is fundamentally the backbone of collaborative risk reduction. Nursing documentation regarding patient-reported risk factors (e.g., history of prior AKI, recent use of over-the-counter high-risk medications, herbal supplements) and immediate communication of changes in clinical status (e.g., new-onset fever, gastrointestinal losses leading to dehydration, patient refusal of oral fluids) directly informs the pharmacist's dosage decisions and the radiologist's choice of protocol. Studies show that standardized communication tools, often championed and facilitated by nursing leadership, significantly enhance the likelihood that renal impairment flags trigger appropriate actions from other disciplines, thereby minimizing the crucial lag time between initial risk identification and final intervention (Sanz et al., 2021). This role is evolving beyond simple reporting to include mandatory collaborative sign-offs in the EHR before initiating high-risk medications or procedures.

The Role of Pharmacist Consults in Renal Dosing

The pharmacist serves as the medication safety and pharmacotherapy expert, acting as a crucial interface between broad prescribing practices and patient-specific renal physiology to optimize drug therapy and avoid toxicity. Their role moves beyond simple drug dispensing to include sophisticated clinical evaluation.

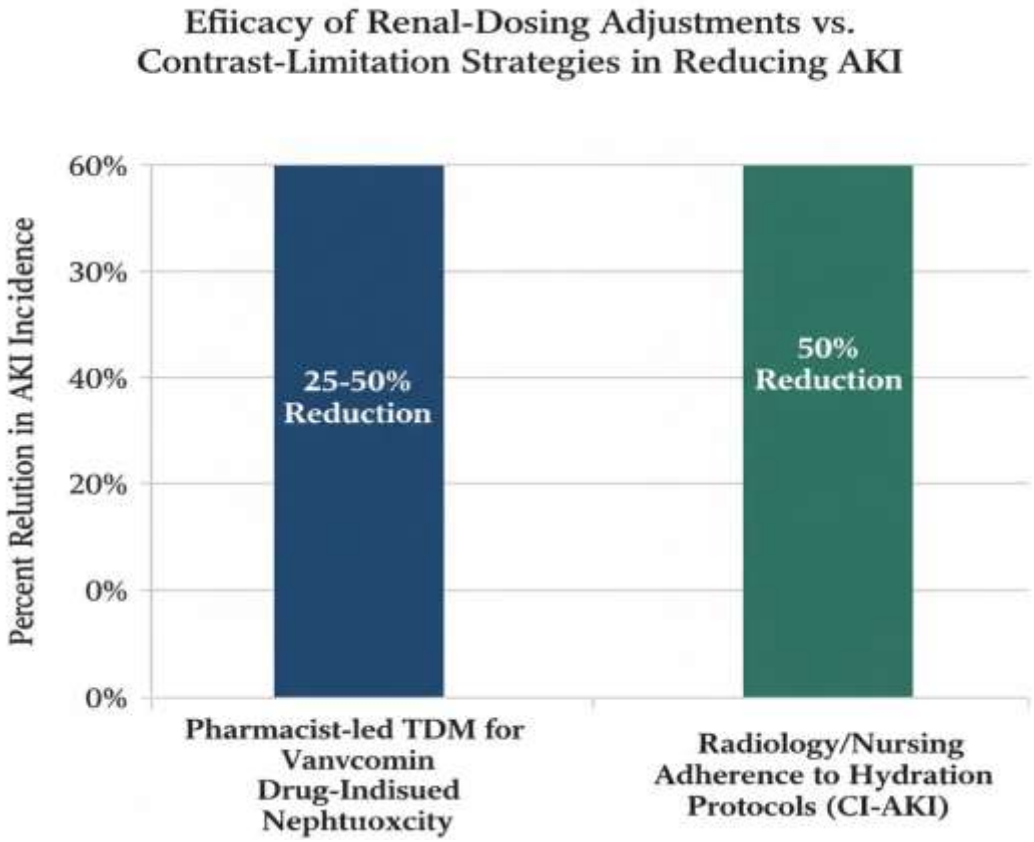
Therapeutic Drug Monitoring (TDM) and Dosing

Pharmacists play an indispensable role in actively preventing dose-related nephrotoxicity, particularly for

medications characterized by narrow therapeutic indices, such as Vancomycin and the Aminoglycosides (e.g., Gentamicin). Renal dose adjustments based on calculated CrCl are critical to prevent drug accumulation and subsequent tubular injury (Riedel & Patel, 2022). High-quality evidence supports pharmacist-led dosing services, where initial loading dose calculations, precise TDM sample timing (troughs), and subsequent dose titrations are managed proactively under specialized protocols. This proactive, data-driven approach ensures that plasma drug concentrations remain within the target therapeutic window while simultaneously minimizing the duration and extent of nephrotoxic exposure. Studies have consistently demonstrated that pharmacist-managed TDM programs significantly reduce the incidence of drug-induced AKI compared to traditional physician-led dosing protocols, often by automating follow-up and ensuring dose rounding is appropriate for renal function (Al-Jafar et al., 2020). The precision required here highlights the necessity of collaboration with nursing for timely blood draws.

Drug-Drug and Drug-Contrast Interactions

Beyond optimization of individual drug dosing, the pharmacist's unique contribution lies in complex polypharmacy risk assessment. They are tasked with identifying synergistic nephrotoxicity caused by combinations such as diuretics, ACE inhibitors (ACEi), or angiotensin receptor blockers (ARBs) paired with NSAIDs or other nephrotoxic agents—a combination often referred to in clinical literature as the "triple whammy" (Gupta & Shah, 2019). This vigilance extends directly to contrast media exposure, where the pharmacist can advise on temporarily holding specific non-essential medications (e.g., Metformin to prevent lactic acidosis, or certain diuretics to aid hydration efforts) around the time of the procedure to reduce the combined renal insult. The pharmacist thus acts as the final, expert clinical check, preventing unintended drug synergy that significantly elevates AKI risk by reviewing the entire medication profile in light of the impending contrast procedure. The ability of the pharmacist to recognize potential



pharmacodynamic interactions often prevents renal insults that neither the ordering physician nor the nurse

may have initially flagged.

Formulary and Protocol Development

System-level, institutional interventions orchestrated by pharmacy departments are highly effective tools for broad-spectrum nephroprotection. This includes developing and rigorously maintaining GFR-based dosing protocols embedded directly within the Electronic Health Record (EHR) and implementing sophisticated clinical decision support (CDS) alerts. When a prescriber orders a high-risk drug for a patient with a documented GFR below a specific threshold (e.g., 60 mL/min, pharmacist-designed CDS alerts can trigger a mandatory dose adjustment recommendation or a severe toxicity warning (Riedel & Patel, 2022). The development of standardized protocols for switching from highly nephrotoxic agents to less toxic alternatives (e.g., using alternative antifungals to Amphotericin B) further illustrates the system-wide protective function of the pharmacy team. This protocol development establishes standardized, evidence-based practices that effectively bridge the gap between abstract guideline recommendations and concrete, uniform clinical action across the entire institution, ensuring that best practices are uniformly applied regardless of the prescriber.

Radiology Contrast Administration & Protocols

Contrast-induced acute kidney injury (CI-AKI) is a specific and significant form of nephrotoxicity requiring mandatory collaboration between the ordering clinician, nursing staff, and the radiology team (ACR, 2021). The radiology department holds the final, specific responsibility for the procedural administration, which includes contrast selection and mitigation protocols.

Contrast Media Selection and Volume

The fundamental radiological intervention is minimizing the intrinsic risk of the procedure itself. Current authoritative guidelines (KDIGO, 2022; ACR, 2021) strongly advocate for the use of low-osmolar or iso-osmolar contrast media due to their established safety profile compared to older, high-osmolar agents. Furthermore, rigid adherence to the "As Low As Reasonably Achievable" (ALARA) principle regarding contrast volume is paramount. Implementing structured departmental protocols that require explicit documentation of the necessity of the contrast study versus an available alternative, non-contrast imaging modality (e.g., ultrasound or non-contrast CT) is an essential component of responsible radiological practice. The radiologist plays a key consultation role in evaluating the diagnostic yield against the patient's renal risk profile.

Pre- and Post-Procedure Hydration

While the nursing staff executes the hydration orders, the radiology protocol definitively dictates the precise timing, type, and volume of the intravenous or oral fluids used. Effective hydration, typically administered with isotonic sodium chloride solution, acts physiologically to expand intravascular volume and reduce renal vasoconstriction, thereby facilitating rapid clearance of the contrast agent (KDIGO, 2022). The literature consistently shows that starting hydration protocols four to twelve hours prior to contrast administration, and continuing for several hours afterward, provides superior nephroprotection compared to post-procedure hydration alone (Toma etal., 2020). The success of this nephroprotective measure, however, hinges entirely on the seamless and accurate transfer of the hydration order from the Radiology team to the ward nurses, who must monitor for fluid overload, especially in patients with heart failure. The precise execution of the hydration order by nursing is critical for the success of the radiological protocol.

Inter-Departmental Hand-Off and Follow-up

Radiology’s responsibility extends beyond the scanner room. Effective risk communication requires the Radiology team to confirm that pre-procedure labs meet safety thresholds and, critically, to ensure that

appropriate post-procedure follow-up is ordered. For all high-risk patients, a mandatory order for a post-contrast creatinine check (typically 48–72 hours later) must be clearly communicated back to the patient's primary care team. The use of mandatory electronic checklists at the time of scheduling the procedure—requiring sign-offs from the ordering provider (confirming need), the nurse (confirming patient preparation), and the radiologist (confirming protocol)—has been shown to reduce procedural errors (ACR, 2021). This critical hand-off closes the loop on the CI-AKI risk mitigation process, ensuring that any subsequent kidney injury is detected early, which then allows for timely intervention by the primary medical team.

Table 1: Discipline-Specific and Collaborative Interventions for Nephrotoxicity Risk Mitigation

Domain of Action	Nursing Role (Assessment & Monitoring)	Pharmacist Role (Dosing & Medication Protocols)	Radiology Role (Procedure & Protocol Adherence)	Collaborative Endpoint (Shared Goal)
Risk Identification	Proactive verification of GFR/CrCl 7 days before high-risk events.	Immediate review of medication profile upon high-risk patient admission (GFR <60 mL/min)	Confirmation of GFR/CrCl clearance before contrast injection is initiated.	Unified, Real-Time Risk Status
Fluid Management	Continuous assessment of patient volume status (I/O, hemodynamics). Timely initiation and meticulous tracking of hydration orders.	Review for medications that impair hydration or renal autoregulation (e.g., holding diuretics, ACEi pre-contrast).	Dictation of precise pre- and post-procedure hydration protocols 0.9% based on GFR.	Optimal Euvolemia Maintained

Drug Optimization	Timely notification of rapid changes in patient status (e.g., dehydration, acute deterioration) that necessitate immediate dose re-evaluation.	Renal dose adjustment for all narrow-therapeutic index or high-nephrotoxic drugs (e.g., Vancomycin, Amphotericin B).	Advising ordering physicians on non-contrast imaging alternatives to avoid drug interaction risk.	Zero Preventable Nephrotoxic Dosing
Communication	Documenting and escalating critical lab values and clinical status changes via mandatory EHR alerts.	Documenting and enforcing medication holds (e.g., Metformin, NSAIDs) prior to contrast exposure.	Ensuring a mandatory post-contrast creatinine check order is placed and communicated to the primary team.	Closed-Loop Safety Chec

Methodology

This paper was conducted as an integrative literature review aimed at synthesizing evidence related to nephrotoxicity risk mitigation across Nursing, Pharmacy, and Radiology disciplines. An integrative review design was selected because it allows for the inclusion of experimental, observational, guideline-based, and conceptual literature, offering a comprehensive understanding of interprofessional nephroprotection practices. The methodology followed the framework described by Whittemore and Knafl (2005), which includes problem identification, literature search, data evaluation, data analysis, and presentation.

Discussion -Synthesis and the Collaborative Model

The literature reviewed consistently demonstrates the high efficacy of individual, discipline-specific interventions. Pharmacist-led TDM reduces Vancomycin toxicity by 25% to 50% (Al-Jafar et al., 2020), while adherence to Radiology hydration protocols effectively halves the incidence of CI-AKI in high-risk groups (Toma et al., 2020). However, despite these strong individual results, the overall incidence of hospital-acquired AKI remains unacceptably high (Mehta et al., 2021). The failure point is not a lack of evidence, but a failure of coordination, which consistently occurs during transitions of care.

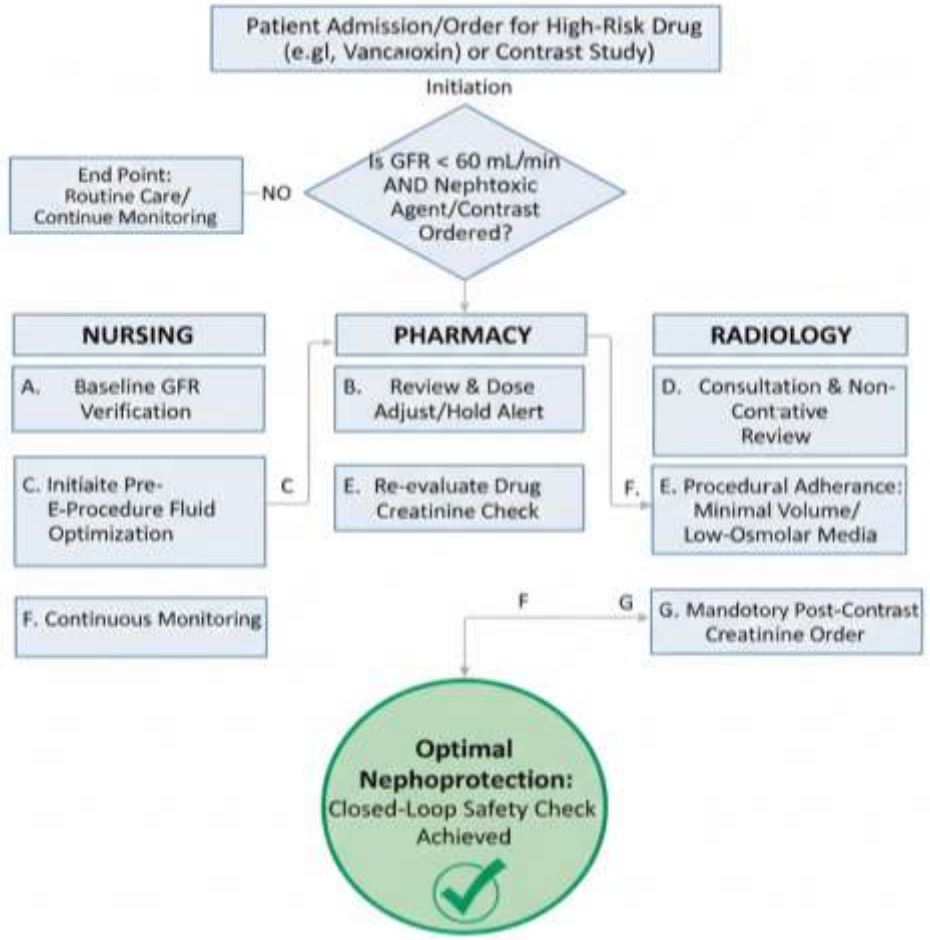


Figure 1. The collaborative nephrotic risk continuum workflow

Failure Modes: Cognitive Drift and System Silos

The primary obstacle identified across multiple studies is the inevitable gap created by system silos, leading to cognitive drift—the dangerous assumption that the preceding or succeeding specialty has completed the necessary safety checks (Gupta & Shah, 2019). This drift manifests in several common failure modes:

1. Nursing-Pharmacy Gap: A patient's GFR status changes acutely (e.g., due to fluid losses) after the pharmacist has verified the initial dose. If the nurse fails to recognize and communicate this change immediately, the next dose administered is toxic.
2. Pharmacy-Radiology Gap: A pharmacist advises holding an ACE inhibitor pre-procedure, but this critical instruction is not relayed to the Radiology unit, which then proceeds with the procedure assuming the patient is prepared per their outdated chart review.
3. Radiology-Nursing Gap**:** Radiology appropriately orders post-procedure hydration, but the lack of a mandatory, high-priority hand-off ensures the order is buried in the EHR or missed during shift change, leading to inadequate fluid management during the critical post-contrast phase (Johnson et al., 2022).

This breakdown highlights that sustained reduction in nephrotoxicity risk is fundamentally achieved not by optimizing each specialized silo in isolation, but by ensuring synchronization across the entire patient journey. True collaboration requires the shared accountability shown in the Collaborative Nephrotoxicity Risk Continuum Workflow (Figure 1).

The Role of Technology: The Electronic Health Record (EHR) as an Enforcer

The synthesized literature consistently drives findings toward a mandate for technology-driven, collaborative protocols. The Electronic Health Record (EHR) emerges as the singular, essential collaborative tool, transforming passive clinical guidelines into active intervention triggers at the point of care (Riedel & Patel, 2022). Optimal nephroprotection exists only in the overlapping space where Nursing assessment, Pharmacist consultation, and Radiology protocol adherence are fully unified, derived from the evidence in this review, illustrates the mandatory, synchronized actions required from each specialty to create a resilient defense system.

The EHR's effectiveness hinges on its ability to enforce cross-disciplinary communication:

1. Active Alerting: Moving beyond passive alerts (warnings that can be easily clicked through) to active alerts (hard stops or mandatory checklists) that require documented sign-offs from multiple specialties when a patient falls into a high-risk category. For instance, when a contrast study is ordered for a GFR mL/min, a mandatory consultation alert should fire not just to the ordering physician, but to the responsible pharmacist for medication review and to the floor nurse for pre-procedure volume optimization confirmation.
2. Shared Dashboards: Implementing shared dashboards that display the *most recent* GFR, volume status (I/O trends), and all related pending medication holds or hydration orders simultaneously to Nursing, Pharmacy, and Radiology staff. This eliminates the uncertainty of "who checked last" and provides a single, unified source of truth.
3. Automated Protocol Triggering: Pharmacist-designed logic can automatically generate a dose adjustment order for Vancomycin the moment the creatinine value exceeds a safe threshold, simultaneously triggering a nursing alert for TDM monitoring and escalation (Al-Jafar et al., 2020).

Technology facilitates the standardized communication (Johnson et al., 2022) required for the intricate hand-offs outlined in the Collaborative Nephrotoxicity Risk Continuum Workflow. By integrating automated GFR calculation alerts, mandatory ordering checklists for high-risk procedures, and cross-departmental communication flags, the EHR enforces the collaborative structure, mitigating the risks inherent in human error and system fragmentation.

Future Research Directions

Future research must shift its focus from merely validating individual interventions (e.g., hydration efficacy) to rigorously testing the efficacy of standardized, EHR-enforced collaborative bundles—measuring overall AKI reduction based on the simultaneous, integrated compliance of all three specialties. This requires robust implementation studies that track not only clinical outcomes but also process metrics like "Triple Compliance Rate" (the percentage of high-risk cases where Nursing, Pharmacy, and Radiology protocols were all followed successfully).

Specifically, more research is critically needed to determine the impact of Artificial Intelligence (AI) and predictive analytics in risk stratification. AI models, trained on vast EHR data, could potentially predict AKI risk hours or days before clinical markers change, providing all three disciplines with a unified, objective risk score at the precise moment of intervention. Such predictive tools could inform the Nursing staff on which patients require immediate volume assessment, signal the Pharmacist to prioritize medication review, and provide the Radiologist with a real-time risk-benefit analysis before administering contrast. Standardization and validation of these collaborative predictive tools will be the next major step in optimizing nephrotoxicity prevention.

Conclusion

In conclusion, reducing nephrotoxicity risk in the hospitalized population is fundamentally and irrevocably a collaborative effort. The substantial body of literature reviewed clearly delineates the critical, non-

negotiable roles of each specialty: Nursing provides essential continuous assessment and fluid management; Pharmacy ensures appropriate drug dosing and manages synergistic drug interactions; and Radiology controls the procedural risks associated with contrast media. Effective nephroprotection relies on the seamless synchronization and communication among these three disciplines, typically facilitated through technology-driven protocols and standardized communication checkpoints. Future quality improvement and research efforts must focus intently on unifying these specialized actions into resilient, institution-wide collaborative models to achieve the highest standards of patient safety and quality care, ultimately moving toward the elimination of preventable AKI.

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