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The role of critical care nursing in managing acute kidney injury following major cardiothoracic surgery

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Abstract
Acute Kidney Injury (AKI) is a significant complication following major cardiothoracic surgery, affecting morbidity, mortality, and healthcare costs. Critical care nurses are pivotal in early recognition, prevention, and management of AKI, as they are directly involved in patient monitoring, fluid management, and implementing evidence-based interventions. This comprehensive review explores the pathophysiology of AKI, the evidence-based roles of critical care nursing, challenges, and future directions. The inclusion of quantitative data, case studies, and tables further substantiates the discussion.

Keywords: Acute Kidney Injury (AKI), cardiothoracic surgery, critical care nursing, post-surgery complications

1. Introduction
Acute Kidney Injury (AKI) following major cardiothoracic surgery is a prevalent and severe issue, with reported incidences ranging from 15% to 30% depending on patient demographics and surgical complexity (Kellum *et al*., 2018) [1]. AKI contributes to prolonged hospital stays, increased readmission rates, and higher healthcare costs. Early diagnosis and effective management are critical for improving outcomes, and critical care nurses are uniquely positioned to address this challenge. Their role spans the spectrum of care, including monitoring renal function, optimizing hemodynamic, preventing nephrotoxic exposure, and ensuring multidisciplinary collaboration. This review synthesizes evidence from global studies and includes relevant data to highlight best practices and challenges in critical care nursing for managing AKI.

1.1 Objective of the paper
The objective of this paper is to critically evaluate the role of critical care nursing in managing Acute Kidney Injury (AKI) following major cardiothoracic surgery.

2. Pathophysiology of AKI Following Cardiothoracic Surgery
AKI results from multiple pathophysiological mechanisms, including ischemia-reperfusion injury, systemic inflammation, and oxidative stress. Cardiothoracic surgery frequently involves cardiopulmonary bypass (CPB), which can cause haemodilution, micro emboli, and systemic inflammatory responses, all of which contribute to renal impairment. According to Joannidis *et al*. (2017) [3], patients undergoing prolonged CPB (>90 minutes) are at a 2.5-fold higher risk of AKI compared to those with shorter durations.

Table 1: Key Risk Factors for AKI in Cardiothoracic Surgery

Risk Factor	Incidence	Impact on Outcomes
Prolonged CPB	40%	Increased length of hospital stays
Pre-existing CKD	25%	Higher mortality rates
Use of nephrotoxic agents	35%	Greater risk of persistent AKI
Hypotension during surgery	30%	Postoperative organ dysfunction

injury. Effective monitoring and preventive strategies are Understanding these mechanisms allows nurses to identify at-risk patients and tailor interventions to mitigate renal vital in reducing the incidence and severity of AKI.

3. Evidence-Based Roles of Critical Care Nursing in AKI Management

3.1 Early Recognition and Monitoring

Early detection of AKI is crucial in preventing its progression to more severe stages. Critical care nurses are responsible for routine monitoring of renal function parameters, including urine output, serum creatinine, and blood urea nitrogen (BUN). Advanced biomarkers such as neutrophil gelatinase-associated lipocalin (NGAL) and cystatin C have gained traction as early indicators of renal injury (Kellum *et al*., 2018) [1].

Nurses' use of real-time data from continuous renal monitoring devices enhances their ability to detect subtle changes in kidney function. A study by Rahman *et al*. (2021) [5] in Bangladesh reported that implementing nurse-led monitoring protocols reduced the incidence of Stage 2 or 3 AKI by 15% among postoperative cardiothoracic patients.

Table 2: Biomarkers for Early Detection of AKI

Biomarker	Sensitivity (%)	Specificity (%)	Clinical Application
NGAL	85	75	Early identification of AKI
Cystatin C	90	80	Prognostic value in AKI

By leveraging these tools, nurses ensure timely interventions, minimizing renal damage and improving patient outcomes.

3.2 Preventative Strategies

Prevention is a cornerstone of AKI management, and critical care nurses are instrumental in implementing strategies to mitigate risks. These include optimizing hemodynamic, avoiding nephrotoxic medications, and ensuring adequate hydration. According to Zarbock *et al*. (2016) [2], a nurse-led protocol emphasizing hemodynamic stabilization reduced the incidence of AKI by 20% in high-risk patients.

In resource-constrained settings, such as Bangladesh, nurses have successfully utilized simple yet effective measures, including perioperative hydration and monitoring of urine output, to achieve similar outcomes (Chowdhury *et al*., 2020). Education on judicious use of nephrotoxic agents and dose adjustments based on renal function further enhances patient safety.

3.3 Fluid Management

Fluid management in AKI involves balancing the need for adequate perfusion with the risks of fluid overload. Nurses play a critical role in assessing fluid responsiveness using advanced tools like stroke volume variation and passive leg raising tests. Joannidis *et al*. (2017) [3] emphasized the importance of individualized fluid therapy, guided by dynamic monitoring, in reducing the severity of AKI.

Table 3: Fluid Management Strategies in AKI Prevention

Strategy	Outcome
Dynamic fluid assessment	Reduced risk of volume overload
Early goal-directed therapy	Improved renal perfusion
Avoidance of hypotension	Decreased incidence of AKI

Nurse-led fluid optimization protocols have been shown to improve hemodynamic stability, supporting renal recovery in postoperative patients.

3.4 Multidisciplinary Collaboration

Effective management of AKI requires collaboration among critical care nurses, nephrologists, intensivists, and pharmacists. Nurses act as central coordinators, ensuring seamless communication and integration of care plans. A study by Hoste *et al*. (2018) [4] demonstrated that nurse-led multidisciplinary rounds improved adherence to AKI prevention protocols by 30%, resulting in better patient outcomes.

In Bangladesh, Rahman *et al*. (2021) [5] highlighted the success of nurse-led care coordination in resource-limited environments, where nurses facilitated timely referrals to nephrologists, ensuring early intervention and improved recovery rates.

3.5 Patient and Family Education

Education is an integral aspect of AKI management. Nurses educate patients and families on recognizing symptoms of AKI, such as reduced urine output or swelling, and the importance of following prescribed fluid and medication regimens. This empowerment fosters better adherence to care plans and early reporting of complications, reducing the risk of severe AKI.

4. Challenges in AKI Management

Challenges in managing AKI include limited staffing, variability in practice standards, and lack of access to advanced monitoring tools. In low-resource settings, such as Bangladesh, these challenges are exacerbated by financial constraints and limited awareness of renal-specific interventions. Addressing these barriers requires investment in training programs and healthcare infrastructure.

5. Conclusion and Recommendations

Critical care nurses are central to the effective management of AKI following cardiothoracic surgery. Through early recognition, preventative strategies, and multidisciplinary collaboration, they significantly improve patient outcomes. Standardizing nurse-led protocols, integrating advanced technologies, and investing in education are essential for optimizing AKI care, particularly in resource-constrained settings.

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