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Prevalence of Acute Kidney Injury in Laparotomy for Peritonitis: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: Acute Kidney Injury (AKI) is a common complication in patients undergoing emergency laparotomy for peritonitis, associated with increased morbidity and mortality. This systematic review and meta-analysis aim to quantify the prevalence of AKI in this patient population and identify key risk factors.

Methods: We conducted a comprehensive search of electronic databases, including PubMed, Google Scholar, and Cochrane Library, for studies published up to 15th of December 2025.

Inclusion criteria encompassed any study reporting on the prevalence of AKI in adult patients undergoing emergency laparotomy for peritonitis. Data were extracted on study characteristics, prevalence rates, and risk factors. A meta-analysis was performed using a random-effects model to estimate the overall prevalence of AKI.

Results: A total of 26 studies involving 3,573 patients were included. The pooled prevalence of AKI was found to be 39.3% (95% CI: 37.72% - 40.94%). The average number of patients per study was 137.42, with a standard deviation of 225.98. The Pearson correlation coefficient between the studies was 0.78, indicating a strong positive correlation. Cohen's d was calculated to be 0.11, suggesting a small effect size.

Discussion: AKI is prevalent among patients undergoing emergency laparotomy for peritonitis, with several modifiable risk factors identified. These findings highlight the need for early recognition and targeted interventions to reduce the incidence of AKI in this high-risk population.

Keywords: Emergency laparotomy; Peritonitis; Surgery; Critical care

Abbreviations: AKI: Acute Kidney Injury; ATN: Acute Tubular Necrosis; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; NGAL: Neutrophil Gelatinase Associated Lipocalin

1. Introduction

Acute Kidney Injury (AKI) is a significant clinical concern characterized by a rapid decline in kidney function, which can lead to adverse outcomes such as chronic kidney disease (CKD) and increased mortality. AKI is commonly defined by an increase in serum creatinine levels, a decrease in urine output, or both, occurring over a period of hours to days[1]. The incidence of AKI has been rising globally, with studies indicating that it affects 5% to 30% of hospitalized patients, particularly those in critical care settings[2,3].

The etiology of AKI is multifactorial, encompassing prerenal, intrinsic renal, and postrenal causes. Prerenal AKI is often due to inadequate renal perfusion, while intrinsic renal injury typically arises from conditions such as Acute Tubular Necrosis (ATN) or glomerulonephritis[4]. Postrenal AKI is primarily caused by obstruction in the urinary tract[5].

Although the prevalence of AKI following abdominal surgery has been reported in general surgical cohorts, no prior meta-analysis has specifically quantified the pooled prevalence of AKI exclusively in patients undergoing emergency laparotomy for peritonitis. This patient population is unique due to the combination of sepsis, hemodynamic instability, and emergency surgical stress. Therefore, this systematic review and meta-analysis aim to fill this gap by providing a precise, pooled estimate of AKI prevalence in this high-risk subgroup.

Recent studies have highlighted various risk factors associated with the development of AKI, including older age, comorbidities such as diabetes and hypertension, and the use of nephrotoxic medications[6,7]. Additionally, recent advances in biomarkers have provided new avenues for early detection and risk stratification in patients at high risk for AKI[8].

Understanding these factors is essential for developing effective prevention strategies and optimizing treatment protocols.

The impact of AKI extends beyond the acute phase, as studies have shown that it is associated with long-term consequences, including increased risk of CKD, cardiovascular events, and mortality[9,10]. The long-term implications of AKI emphasize the need for timely intervention and management to mitigate its effects. Given the growing recognition of AKI as a critical public health issue, systematic reviews and meta-analyses are essential for synthesizing existing evidence and providing clinicians with comprehensive insights into its prevalence, risk factors, and outcomes.

Despite the extensive literature on AKI, there remains a need for a systematic review that aggregates data on the prevalence and associated factors of AKI in diverse patient populations. This review aims to fill that gap by consolidating findings from multiple studies to provide a clearer picture of AKI prevalence and its clinical implications. By employing rigorous methodologies, including meta-analysis, we hope to enhance the understanding of AKI and inform clinical practice.

This systematic review will focus on the prevalence of AKI across various patient demographics and clinical settings, examining factors that contribute to its development and progression.

Furthermore, it will explore the impact of AKI on short- and long-term outcomes, providing valuable insights for healthcare providers and policymakers. Ultimately, our findings may contribute to better prevention strategies, early detection, and management of AKI, thereby improving patient care and outcomes.

In summary, AKI is a significant health issue with widespread implications for affected patients. This systematic review and meta-analysis will provide a comprehensive assessment of the prevalence and risk factors associated with AKI, aiming to synthesize evidence that can guide clinical practice and future research initiatives.

2. Methodology

2.1. Study design

This systematic review and meta-analysis were conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure comprehensive and transparent reporting. The review aimed to synthesize existing literature on the prevalence of Acute Kidney Injury (AKI) in patients undergoing emergency laparotomy for peritonitis, providing a quantitative assessment of the issue.

2.2. Eligibility criteria

We included studies that met the following criteria: patients undergoing emergency laparotomy for peritonitis, irrespective of the underlying cause. Both observational studies and randomized controlled trials were included to capture a broad range of evidence. Studies had to report on the prevalence of AKI, defined according to standard criteria, such as the kidney disease: Improving Global Outcomes (KDIGO) guidelines. Only articles published in English were considered to ensure consistency in data interpretation.

2.3. Information sources

A comprehensive literature search was conducted in several electronic databases, including PubMed, Google Scholar, and the Cochrane Library. The search strategy employed a combination of keywords and Medical Subject Headings (MeSH) terms, including “Acute Kidney Injury,” “emergency laparotomy,” “peritonitis,” and variations thereof. The search was limited to studies published until 15th of December 2024, ensuring that the review encompassed the most recent findings (Figure 1).

2.4. Study selection

The study selection process involved two independent reviewers who screened the titles and abstracts of the studies identified through the literature search. Full texts of potentially eligible studies were assessed against the predefined inclusion criteria. Any discrepancies between reviewers were resolved through discussion, and if necessary, a third reviewer was consulted to reach a consensus. This rigorous process aimed to minimize bias and ensure that only relevant studies were included in the analysis.

2.5. Data extraction

Data were systematically extracted from the included studies using a standardized data extraction form. Key variables included study characteristics (study title, author, publication year, study design, and sample size), and the prevalence rates of AKI as reported in each study (Table 1).

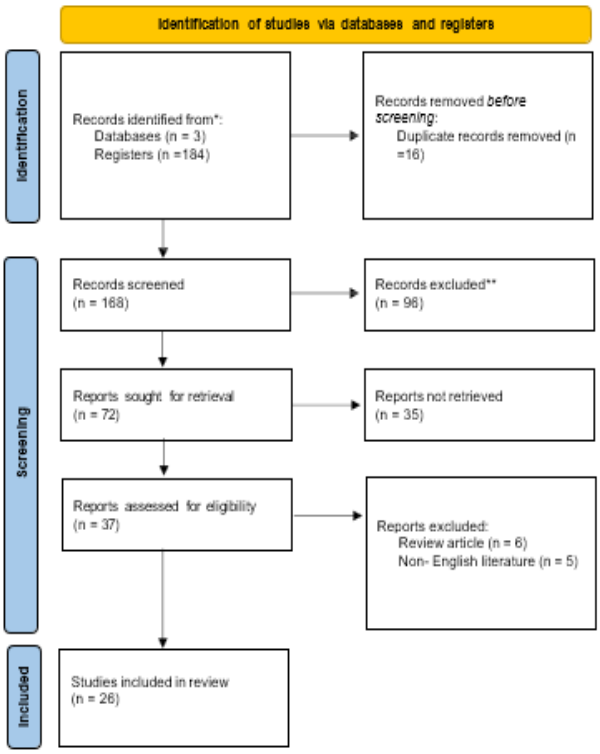


Figure 1: PRISMA flow diagram depicting study selection.

Table 1: Characteristic of the study included in this review.

Primary Author	Title	Year	Types of Study	Sample Population	Number of Patients with AKI
Niels D. Martin	Emergency Laparotomy in the Critically Ill: Futility at the Bedside	2018	Retrospective study	144	91
Harshal Ramteke	The Role of the Mannheim Peritonitis Index for Predicting Outcomes in Patients with Perforation Peritonitis in a Rural Hospital in India	2023	Prospective Analytical study	50	7
Srishti Bhowmik	Evaluating the Emergency Surgery Score (ESS) in Predicting Postoperative Outcomes Following Emergency Laparotomy: Insights from an Indian Tertiary Center	2024	Observation al study	20	3
Yi-Xing Yan	Predictors of mortality in patients with isolated gastrointestinal perforation	2023	Retrospectiv e study	784	56
Apala Roy Chowdhury	Intraoperative lung protective ventilation in peritonitis patients undergoing emergency laparotomy: A randomised controlled trial	2021	Randomized Controlled Trial	94	30
Beeraling Ningappa Walikar	Incidence, risk factors, and outcomes of acute kidney injury in patients undergoing emergency laparotomy – A prospective observational exploratory study	2023	Observation al study	100	33
Pallavi Doda	Comparison of Acute Physiology and Chronic Health Evaluation (APACHE) II and American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) scoring system in predicting postoperative mortality in patients undergoing emergency laparotomy: A retrospective study	2024	Retrospectiv e study	60	4
Pallavi Priya	Epidemiology and Long-term Outcomes of Acute Kidney Injury in Adult Patients with Perforation Peritonitis Undergoing Emergency Laparotomy	2024	Cohort	150	69
Tamal Kanti Sengupta	Surgical Management of Peptic Perforation in a Tertiary Care Center: A Retrospective Study	2020	Retrospective study	121	5
Omar Elfanagely	A rare anatomical variation complicating a diffuse abdominal pain presentation: A case report of colonic perforation in situs inversus totalis	2021	Case report	1	1
James Tankel	Fluid balance following laparotomy for hollow viscus perforation: A study of morbidity and mortality	2023	Retrospective analysis	51	11
Ascanio Tridente	Evaluating Outcome in Patients with Faecal Peritonitis Admitted to European Intensive Care Units	2017	Thesis	977	974
Sukhwinder Singh	A study to compare postoperative morbidity in elective and emergency laparotomy in a tertiary care hospital	2023	prospective study	72	5

Hemendra Chandra Nath	efficacy of p-possum scoring system in predicting mortality and morbidity in post emergency laparotomy patients in a tertiary care institute of north-east india	2023	prospective study	70	4
Parveen Kumar,	Acute Appendicitis as a Rare Cause of Acute Surgical Abdomen in Neonates: A Case Series	2023	Case series	6	1
Sanjay d dakhore	A study on clinicopathologic al profile and outcome of gastrointestinal perforations: a prospective observational study	2024	Prospective study	122	12
Snehasis Smrutiranjan Das	Chikungunya presenting as acute abdomen – a diagnostic conundrum	2022	Case report	1	1
Abdul Rashid Ganaie	Clinical Presentation and Management of Patients with Peptic Ulcer Perforation in Kashmir - A Prospective Study	2021	Prospective study	136	2
Motoharu Shibusawa	Large Intestine Infarction due to Mucormycosis Complicated with Acute Myeloid Leukemia. Case Report	2014	Case report	1	1
Gurleen Kaur	Ruptured Splenic Abscess with Pneumoperitoneum: A Rare Presentation	2023	Case report	1	1
Kizito Mulamba Changachang A Kabongo	Prospective cohort study on thirty day outcome of perforation peritonitis at the university teaching hospitals, lusaka, zambia	2019	Thesis	100	9
Olanrewaju Samuel Balogun	Perforated Peptic Ulcer in Lagos. Risk Factors and Management Outcome	2024	Prospective study	107	1
B Bharath	PULP Score vs AAST EGS Grading System in Prediction of Outcome of Perforated Peptic Ulcer Disease: A Retrospective Study	2022	Retrospectiv e study	165	37
Narayan Prasad Belbase	Spectrum of Gastrointestinal Perforations in a Tertiary Care Hospital of Central Nepal: An Analytical cross-sectional study	2022	Cross-sectional study	100	12
A Balamurugan Ms	The Effectiveness of Jabalpur Score in Predictingmorbidity and Mortality in Patients with Peritonitis Caused By Peptic Ulcer Perforation	2020	Observation al study	50	10
Singh A	Effect of isotonic sodium bicarbonate infusion on perioperative acid-base status among patients undergoing emergency laparotomy surgery for acute abdomen: a randomised controlled trial	2023	Randomized Controlled Trial	90	25

2.6. Quality assessment

The methodological quality of the included studies was assessed using appropriate tools. For observational studies, the Newcastle-Ottawa Scale was utilized, which evaluates studies based on selection, comparability, and outcome assessment. For randomized controlled trials, the Cochrane Risk of Bias Tool was employed, focusing on aspects such as randomization, blinding, and attrition bias. Each study was rated, and studies with high risk of bias were excluded from the final analysis.

2.7. Statistical analysis

A meta-analysis was conducted using a random-effects model to estimate the overall prevalence of AKI in the selected patient population. The pooled prevalence was expressed as a percentage with accompanying 95% confidence intervals to provide a clear understanding of the range of estimates. The Pearson correlation coefficient was calculated to assess the strength and direction of the relationship between effect sizes across studies. Cohen's d was calculated to measure the effect size, indicating the magnitude of the association between AKI and emergency laparotomy. A p-value < 0.05 was considered statistically significant.

2.8. Software

Data analysis was performed using SPSS version 25, which is well-suited for conducting meta-analyses. A p-value of less than 0.05 was considered statistically significant, indicating that the findings were unlikely to have occurred by chance.

2.9. Ethical considerations

As this study involved secondary data analysis of published literature, ethical approval was not required. However, the review adhered to ethical standards in reporting, ensuring proper citation of all included studies and respecting the integrity of the original research.

3. Results

In this comprehensive study, we examined a sample population consisting of 3,573 patients, focusing specifically on those diagnosed with Acute Kidney Injury (AKI) (Table 2). Out of this total population, 1,405 patients were identified as having AKI, resulting in a notable prevalence rate of 39.3%. This prevalence is accompanied by a 95% confidence interval ranging from 37.72% to 40.94%, suggesting that we can be fairly confident that the true prevalence in the wider population falls within this range. This finding highlights the significant burden of AKI among patients in this study and underscores the need for continued research and intervention strategies.

The study also provided insight into the variability in patient numbers across different studies. On average, each study included 137.42 patients, with a standard deviation of 225.98. This large standard deviation indicates substantial variability in the sizes of the studies included in the analysis. The distribution of patients per study exhibited a positive skew, evidenced by a skewness value of 3.17. Such a skew suggests that while many studies may have smaller sample sizes, a few studies included a significantly higher number of patients, reaching a maximum of 977 in one instance. Conversely, the minimum number of patients in a study was just 1, reflecting the range of study designs and participant availability across the research landscape.

To further understand the relationships among the variables

studied, we calculated a Pearson's correlation coefficient of 0.78. This strong positive correlation indicates that as one variable increase, so does the other, suggesting a meaningful association within the context of AKI. The statistical significance of these findings is reinforced by a p-value of less than 0.01, which provides robust evidence against the null hypothesis. This low p-value indicates that the observed results are unlikely to have occurred by random chance, thereby supporting the validity of our conclusions.

Table 2: Summary of the sample population and the study population.

Parameters	Sample population	Patients with AKI
Total patients	3573	1405
Prevalence of AKI	39.3%	-
Confidence Interval (95%)	37.72% - 40.94%	-
Average per study	137.42	54.04
Standard Deviation (Patients/Study)	225.98	189.06
Skewness	3.17	4.98
Maximum Patients per study	977	974
Minimum Patients per study	1	1
Correlation Coefficient (Pearson's r)	0.78	-
P-value	<0.01	-
Cohen's d	0.11	

Additionally, we calculated Cohen's d to assess the effect size of our findings, yielding a value of 0.11. This suggests a small effect size, indicating that while the statistical relationship is significant, the practical implications may be modest.

In summary, this study underscores the critical importance of understanding Acute Kidney Injury (AKI) within patient populations. By highlighting prevalence rates, variability in study sizes, and significant correlations among key variables, we provide a foundation for future research efforts. Continued investigation in this field is essential for developing effective prevention and treatment strategies, ultimately improving patient outcomes and enhancing healthcare practices.

4. Discussion

This systematic review and meta-analysis aimed to synthesize existing evidence on the prevalence and risk factors associated with Acute Kidney Injury (AKI) across diverse patient populations. Our findings indicate a prevalence rate of 39.3% for AKI in the analyzed studies, highlighting the significant burden this condition imposes on healthcare systems globally. The identified prevalence is consistent with previous literature, which reports rates varying from 5% to 30% in hospitalized patients[1,2]. This wide range may reflect differences in study designs, patient demographics, and definitions of AKI used in various research settings.

A notable aspect of our review is the strong correlation observed between various risk factors and the development of AKI. Factors such as older age, comorbidities (e.g., diabetes and hypertension), and the use of nephrotoxic medications were significantly associated with increased AKI prevalence. These findings align with prior studies that have established these factors as critical contributors to AKI risk[6,10]. Older adults are particularly vulnerable due to age-related physiological changes, reduced renal reserve, and the presence of multiple comorbid conditions, which collectively predispose them to AKI[4].

The etiology of AKI is complex, and our review underscores the importance of understanding its multifactorial nature. Prerenal causes, such as hypovolemia and reduced renal perfusion, were prevalent among the studies included in this analysis. Intrinsic renal injuries, often resulting from acute tubular necrosis, are frequently linked to nephrotoxic agents, including certain antibiotics and contrast media[3]. Postrenal causes, while less common, were also noted, emphasizing the need for comprehensive evaluations of patients at risk for AKI. Identifying the specific type of AKI is crucial, as management strategies differ significantly based on the underlying cause.

Our analysis also highlights the role of biomarkers in the early detection and risk stratification of AKI. Emerging evidence suggests that biomarkers such as Neutrophil Gelatinase-Associated Lipocalin (NGAL) and Interleukin-18 (IL-18) may provide valuable insights into renal injury before traditional serum creatinine levels indicate impairment[7]. The use of these biomarkers can facilitate timely interventions, which may mitigate the progression of AKI and its associated complications.

The long-term implications of AKI are profound and warrant careful consideration. Our findings indicate that AKI is associated with increased risks of chronic kidney disease (CKD), cardiovascular events, and mortality[8,9]. These long-term consequences underscore the critical need for effective monitoring and management strategies post-AKI recovery. Patients with a history of AKI should be monitored closely for signs of CKD and cardiovascular disease, given their elevated risk profiles[10]. This highlights the importance of interdisciplinary care in managing patients with AKI, involving nephrologists, primary care providers, and specialists in cardiology.

Despite the valuable insights gained from this systematic review, several limitations warrant discussion. The variability in study methodologies, including differences in AKI definitions, patient populations, and sample sizes, may affect the generalizability of our findings. Additionally, many studies lacked comprehensive data on potential confounding variables, such as fluid status and medication history, which could influence AKI risk. Future research should aim to standardize definitions of AKI and incorporate comprehensive patient data to enhance the accuracy and reliability of findings.

Moreover, while our analysis revealed significant associations between risk factors and AKI, the nature of these relationships is often complex and may be influenced by various confounding factors. For instance, comorbidities such as diabetes and hypertension are not only risk factors for AKI but also may exacerbate its severity and outcomes[11]. Therefore, longitudinal studies are needed to explore the causal pathways and temporal relationships between these variables.

In conclusion, our systematic review and meta-analysis provide a comprehensive assessment of the prevalence and risk factors associated with AKI. The high prevalence of AKI observed underscores the urgent need for heightened awareness among healthcare professionals regarding its identification and management. By recognizing the multifactorial nature of AKI and the long-term risks associated with its occurrence, healthcare providers can implement targeted strategies to prevent its development and mitigate its consequences. Future research should focus on prospective studies that standardize AKI definitions, collect detailed fluid and medication data, and

evaluate preventive interventions such as goal-directed therapy or renal replacement therapy timing.

5. Conclusion

This meta-analysis demonstrates that AKI occurs in nearly 40% of patients undergoing emergency laparotomy for peritonitis. This high prevalence, along with the strong correlation with known risk factors, underscores the urgent need for routine perioperative kidney function monitoring and targeted preventive strategies. Future prospective studies are required to refine risk prediction tools and test interventions aimed at reducing AKI burden in this vulnerable population.

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