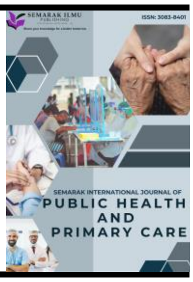
Semarak International Journal of Public Health and Primary Care

Journal homepage:
https://semarakilmu.my/index.php/sijphpc/index
ISSN: 3030-5519



Assessing Acute Kidney Injury Risk in Cancer Patients Undergoing Surgery: Insights from a Public Teaching Hospital in Kuala Lumpur

Nooreena Yusop[1,*], Muhammad Ishamuddin Ismail[2], Ruslinda Mustafar[3] , Vasudevan Ramachandran[4,5]

1 Faculty of Nursing, University College MAIWP International, 61800, Kuala Lumpur, Malaysia
2 Head of Cardiothoracic, Head of Heart and Lungs Centre, Hospital Canselor Tuanku Muhriz, 56000, Malaysia
3 Department of Medicine, Faculty of Medicine, Universiti Kebangsaan Malaysia, 43600, Malaysia
4 Department of Medical Science, Faculty of Science , University College of MAIWP International, 61800, Kuala Lumpur, Malaysia
5 School of Pharmaceutical Sciences, Vels Institute of Science Technology and Advanced Studies, Velan Nagar P.V. Vaithiyalingam Road Pallavaram, Chennai 600117, Tamil Nadu, India

ARTICLE INFO

Article history:
Received 3 November 2024
Received in revised form 19 November 2024
Accepted 29 November 2024
Available online 15 December 2024

Keywords:
Acute kidney injury; cancer; nursing risk assessment

ABSTRACT

Acute Kidney Injury (AKI) is a critical complication among cancer patients undergoing surgical interventions. This study aimed to assess the association between patients with malignancy/ tumour and the risk of AKI in the surgical department of a public teaching hospital in Kuala Lumpur. The prospective observational study included 193 patients and involved seventy-five surgical nurses who underwent an AKI nursing risk assessment education program. Utilizing the Nursing Risk Assessment of Acute Kidney Injury (NURA-AKI) tool, the risk assessments were conducted from July to December 2022. The data was collected during three distinct assessment phases. Results showed AKI risk factors among surgical patients include age > 65 years (40.9%), male gender (58.5%), comorbidities like hypertension (56.5%), DM (43.5%), malignancy/ tumors 20.7% of patients, infection/sepsis at 22.8% and least patients with CKD were 11.9%, chronic liver 7.3% and hypotension 6.2%. The risk of AKI clinical parameters such as elevated serum creatinine (34.2%), blood loss/dehydration (25.4%), and low hemoglobin levels (23.3%). Patients with malignancy/ tumour had elective surgeries 43.5%, emergency surgeries 32.6%, meanwhile, 36.8% of patients consumed nephrotoxic agents. The Chi-square test was used to analyze the association between patients with malignancy/ tumour and the risk factors of AKI in the surgical department HCTM. There was a significant association between patients with malignancy/ tumour and the risk factors of AKI and the patients admitted to the different units in surgical department ($p < 0.05$). The general surgery and urology ward reported more than 40% of patients had malignancy/ tumour. However, there was no significant association between AKI risk factor consuming nephrotoxin agent and AKI risk factor surgery within patients had malignancy/ tumour with AKI risk (p-value> 0.05). The results demonstrate the prevalence of AKI among cancer patients in the surgical setting, identifying key risk factors and informing strategies for early detection and prevention.

* *Corresponding author.*
E-mail address: nooreena@ucmi.edu.my

https://doi.org/10.37934/sijphpc.2.1.4558 b

1. Introduction

Acute kidney injury (AKI) represents a significant clinical challenge, particularly among cancer patients who frequently undergo surgical interventions. The complexity of managing these patients is heightened by the interplay between cancer treatments and renal function. Studies indicate that cancer patients are at an increased risk for AKI due to various factors, including nephrotoxic medications, dehydration, and the physiological stress of surgery [1]. The prevalence of AKI among cancer patients undergoing surgical procedures is a critical concern in oncology and nephrology. Studies indicate that AKI occurs in a significant proportion of cancer patients, with reported rates ranging from 12% to 66.5% depending on various factors, including the type of cancer, treatment modalities, and patient comorbidities [2]. Specifically, a retrospective study conducted in Palestine found that 6.9% of cancer patient admissions were complicated by AKI, with varying severity classified under the RIFLE criteria (risk, injury, failure) [3].

Research further indicates that critically ill cancer patients are at an especially high risk of developing AKI, with incidence rates ranging from 11% to 22%. Certain types of malignancies, particularly hematological cancers like multiple myeloma and leukemia, are linked to an increased risk of AKI. This heightened risk is due to the combined impact of the malignancy itself and the nephrotoxic effects of chemotherapy agents [4]. Another study by Yusop *et al.,* [5] demonstrates the multifactorial etiology of AKI and highlights key clinical biomarkers as tools for early detection in at-risk populations. This review provides an integrated perspective on risk stratification in surgical patients, offering a valuable framework for understanding AKI development in cancer patients undergoing surgery. The inclusion of clinical biomarkers, such as serum creatinine levels and urine output metrics, into risk assessment protocols enhances the precision of early detection strategies, particularly in fast-paced surgical units [5].

A recent study by Floris *et al.,* [6] found that the incidence of AKI in cancer patients varies significantly based on factors such as cancer type, disease stage, treatment approach, and hospitalization status, with rates ranging from 7% to 20%. Cancer patients who develop AKI experience notably higher in-hospital mortality rates compared to those without AKI, highlighting the severe impact of renal complications on patient outcomes [6]. The incidence of AKI in this population can lead to prolonged hospital stays, increased healthcare costs, and worse overall outcomes, highlighting the necessity for effective risk assessment strategies. In surgical departments, timely identification of patients at risk for AKI is crucial. Research suggests that implementing standardized assessment tools can enhance the early detection of renal impairment, allowing for prompt interventions that may mitigate kidney damage [7,8].

AKI represents a critical concern in cancer patients undergoing surgical procedures, significantly impacting postoperative outcomes and overall survival. Evaluating the risk factors associated with AKI in this patient demographic is essential for enhancing clinical management and improving prognoses. Preoperative health status is a fundamental determinant of AKI risk in cancer surgeries. Ota *et al.,* [9] identified several preoperative risk factors, including advanced age, male sex, elevated ASA-PS scores, hypertension, cardiovascular diseases, and diabetes, which contribute to the development of ileostomy-associated kidney injury in colorectal tumor surgeries [7]. Similarly, Ben Kridis *et al.,*[10] demonstrated that higher cumulative doses of cisplatin and increased numbers of chemotherapy cycles are associated with a higher prevalence of AKI in patients receiving cisplatin-based treatments [10]. Additionally, Marques *et al.,* [11] found that restrictive intraoperative vascular filling and postoperative sepsis are independently linked to AKI following radical cystectomy in bladder cancer patients [11]. These studies collectively highlight the significance of preexisting comorbidities and patient-specific factors in assessing AKI risk prior to surgery.

The type of surgical intervention and the specific chemotherapeutic agents employed are pivotal in influencing AKI incidence among cancer patients. Solanki *et al.,* [12] reported an AKI incidence of 23.36% following cytoreductive surgery combined with hyperthermic intraperitoneal chemotherapy (HIPEC), with cisplatin-based regimens exhibiting notable nephrotoxicity [12]. Grillo-Marín *et al.,* [13] conducted a meta-analysis that revealed an 18.6% incidence of AKI post cisplatin-based HIPEC, emphasizing the variability in nephrotoxicity rates depending on the chemotherapeutic agent and the use of nephroprotective strategies [13]. Furthermore, Ben Kridis *et al.,* [10] confirmed that cisplatin-induced renal toxicity is dose-dependent, with higher cumulative doses correlating with an increased risk of AKI. These findings underscore the necessity for meticulous selection and management of chemotherapeutic agents to mitigate AKI risk in surgical oncology patients.

Intraoperative management, particularly fluid administration, plays a critical role in postoperative outcomes, including the risk of AKI. Takahashi *et al.,* [14] examined the impact of intraoperative fluid volume in minimally invasive esophagectomy for esophageal cancer and found that higher infusion volumes were associated with increased rates of anastomotic leakage but not directly with AKI [14]. However, the study did not establish a significant correlation between total infusion volume and AKI incidence, suggesting that other intraoperative factors may influence renal outcomes. This indicates the complexity of intraoperative management and the need for balanced fluid strategies to optimize patient outcomes.

The development of AKI in the postoperative period has significant implications for patient survival and long-term health. Imamura *et al.,* [15] demonstrated that in head and neck cancer patients undergoing chemoradiotherapy, AKI negatively impacted overall survival in those receiving 3-weekly cisplatin regimens, whereas no such impact was observed in the weekly regimen group [15]. This suggests that the administration schedule of cisplatin can influence not only the risk of AKI but also long-term survival outcomes. Additionally, Marques *et al.,* [11] linked postoperative AKI with the occurrence or worsening of chronic kidney disease within two years following radical cystectomy, further emphasizing the long-term consequences of AKI in cancer patients.

Early risk assessment in surgical cancer patients is crucial in identifying those at higher risk for developing AKI and implementing preventive measures. Factors such as pre-existing renal impairment, advanced age, comorbidities, and certain types of cancer and surgical procedures can increase the likelihood of AKI [16]. The risk assessment and early recognition of AKI are essential to prevent its progression to more severe stages and to reduce the need for renal replacement therapy. Implementing a systematic approach to AKI risk assessment and monitoring in surgical cancer patients is critical for optimizing care and improving outcomes. This approach should include comprehensive kidney function monitoring through laboratory tests and clinical evaluations at key intervals—preoperatively, intraoperatively, and postoperatively.

For example, a study conducted in Sweden examined the occurrence and implications of postoperative acute kidney injury (PO-AKI) in patients undergoing major abdominal surgery. The findings highlight the critical role of early detection and management in preventing the progression of AKI to chronic kidney disease (CKD) and reducing other adverse outcomes. However, frequent hospital admissions and multiple diagnostic tests can complicate the monitoring of renal abnormalities. To address this, the study introduced electronic alerts (EAs) as a tool for identifying AKI and supporting clinical decision-making [17]. Identification of AKI implemented using electronic alerts (EAs) to aid in diagnosing AKI and supporting clinical These tools aim to improve care quality, enhance patient safety, and increase clinical care efficacy in addition vigilant monitoring and intervention are crucial for identifying AKI in cancer patients due to their high risk of renal complications.

Postoperative AKI in surgical oncology varies widely by procedure type. Marques *et al.,* [11] reported a high incidence (58.2%) of AKI following radical cystectomy for bladder cancer, associating restrictive fluid management and postoperative sepsis with elevated risks. Similarly, Imamura *et al.,* [15] found that AKI significantly influenced overall survival in head and neck cancer patients undergoing cisplatin-based chemoradiotherapy. These studies demonstrates the need for personalized perioperative care protocols to mitigate AKI risks [11,15].

In the surgery unit, where patients frequently experience fluctuating conditions due to the impact of major procedures and anesthesia, the high volume of admissions and complex diagnostic requirements can make it challenging to monitor renal function consistently [18]. This environment intensifies the need for efficient systems that support timely intervention, as early signs of AKI risk can often be subtle but critical to detect. Given these challenges, using an effective tool for early AKI detection becomes essential to enhance patient safety and outcomes. By prioritizing the integration of reliable early detection tools, the surgical team can more effectively monitor, assess, and manage AKI risks, thereby improving patient safety and fostering better long-term recovery outcomes for surgical patients.

Predictive modeling has emerged as a valuable tool in stratifying AKI risk among patients undergoing cancer surgeries involving nephrotoxic agents. Krause *et al.,* [19] developed a predictive model incorporating preoperative characteristics such as cisplatin dose, body mass index, male sex, and hemoglobin levels, achieving a high accuracy with an AUC of 0.82 [17]. Similarly, Imamura *et al*., [15] introduced a risk prediction model specific to head and neck cancer patients receiving chemoradiotherapy, identifying primary tumor site, cisplatin administration method, serum albumin, and creatinine clearance as key predictors. These models offer clinicians the ability to identify high-risk patients preoperatively, enabling tailored interventions to reduce the incidence of AKI.

Literally, cancer patients undergoing surgery are at a heightened risk of developing AKI due to factors such as the effects of malignancy, complex treatments, and the stresses of major procedures. Early detection is critical in cancer patients, as AKI not only complicates recovery but also increases the risk of severe kidney complications and impacts long-term prognosis. Therefore, this study aims to evaluate AKI risk assessment among cancer patients in the surgical department and enhance early AKI detection through structured risk assessments, allowing healthcare providers particularly nurses to monitor kidney function rigorously and respond to early warning signs that might otherwise be missed in the fast-paced surgical environment. Despite advancements in identifying risk factors and developing predictive models, existing research presents certain limitations. Many studies are retrospective in nature, which may introduce selection bias and limit the generalizability of findings. Additionally, variability in AKI definitions and measurement scales across studies hampers the ability to uniformly compare results. There is a need for prospective studies with standardized AKI criteria to validate predictive models and assess the effectiveness of preventive strategies. Future research should focus on multicenter collaborations to establish robust, evidence-based guidelines for AKI risk assessment and management in cancer surgery patients.

2. Material and Methods

This was a quantitative, prospective cohort study conducted from July to December 2022 in ten divisions of the surgical department at Hospital Canselor Tuanku Muhriz, Kuala Lumpur, Malaysia (HCTM). These divisions included male and female general surgery wards, urology, neurosurgery, ophthalmology, cardiothoracic, plastic and Ear, Nose, and Throat (ENT) wards, High Dependency Unit (HDS), Burn Unit, and Cardiothoracic Intensive Care Unit (CICU).

The study sample comprised ninety registered nurses from HCTM's surgical department. Fifteen nurses on extended leave (maternity, study, unpaid leaves, planning for retirement or resignation) were excluded. Raosoft's sample size calculation, using a 5% standard error, 50% response distribution, and a 95% confidence interval, determined a recommended sample size of 75 out of the initial 90 nurses. Probability-based proportional stratified random sampling was then used to select 75 registered nurses with at least 1-year working experience, whether permanent or contract staff, currently working in the surgery department. Temporary staff like attachment nurses or nursing students in the surgical department were not part of the study.

2.1 Research Tool

The NURA-AKI form underwent a systematic and comprehensive development process, starting with an in-depth literature review to understand the essential components of Acute Kidney Injury (AKI) risk assessment. The researcher meticulously analyzed various sources to identify best practices, validated assessment items, and critical factors crucial for accurately evaluating AKI risk among surgical patients.

Following this, the NURA-AKI form, consisting of 10 main items, underwent a rigorous content validity assessment by a panel of experts. The overall content validity index for the entire instrument, averaged across items (Ave-CVI), was an impressive 0.95, indicating a high level of relevance. The scale-level content validity index universal agreement method (UA-CVI) also achieved a commendable 0.80, meeting the acceptability criteria [20,21].

These results highlight the NURA-AKI form's strong content validity, affirming its appropriateness and relevance for assessing AKI risk in surgical nursing contexts. The thorough development process and expert validation underscore its reliability and utility in clinical practiceThe NURA-AKI form underwent a systematic and comprehensive development process, starting with an in-depth literature review to understand the essential components of Acute Kidney Injury (AKI) risk assessment. The researcher meticulously analyzed various sources to identify best practices, validated assessment items, and critical factors crucial for accurately evaluating AKI risk among surgical patients.

2.2 Ethical Approval

The study received ethical approval from both the Research Ethics Committee of Universiti Kebangsaan Malaysia (UKM) and the Director's Office at Hospital Canselor Tuanku Muhriz (HCTM), with the ethics reference number UKM PPI/111/8/JEP-2022-161. Furthermore, the researchers obtained permission to conduct the study in the nursing department of HCTM.

2.3 Data Collection Procedure

In this study, a cohort comprising seventy-five nurses, were selected through random sampling from diverse surgical units. The nurses were invited to participate voluntarily after signing a consent form. The researchers conducted an educational program on nursing risk assessment for AKI for these participants. Following the completion of the education program, the nurses were tasked with performing risk assessments for surgical patients using the specialized Nursing Risk Assessment of Acute Kidney Injury tool.

These assessments were conducted for various scenarios, including new admissions, inter-facility or intra-facility patient transfers, and patients returning from the operating theater (OT). This encompassed a wide range of surgeries, including emergency, elective, minor, and major procedures. However, patients with non-surgical medical or psychiatric conditions were excluded from the assessments, as were those undergoing ongoing kidney replacement therapy.

The data collection process occurred in three distinct series: the first series took place in July 2022, followed by the second in September 2022, and concluding with the third series in December 2022. This timeline allowed for a comprehensive evaluation of AKI risk assessment practices among surgical nursing staff over six months, capturing different patient scenarios and surgical contexts.

2.4 Statistical Analysis

Data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 26. The significance level was set at $p<0.05$, and a 95% confidence interval (CI) was applied to ensure the reliability of the results. Descriptive statistics, including frequencies and percentages, were used to summarize the demographic characteristics of the patients and nurses involved in the study. These statistics provided a clear overview of the sample's distribution across key variables, such as age, gender, comorbidities, and malignancy status, which are important in understanding the factors contributing to AKI risk.

To assess the relationship between malignancy and the risk of AKI, a chi-square (χ^2) test for independence was employed. The chi-square test is suitable for categorical data, allowing us to evaluate whether differences in AKI risk are associated with malignancy or other factors such as comorbidities and nephrotoxic drug use. Specifically, this test compares the observed frequency of AKI occurrences in patients with malignancy to those without and determines whether the observed differences are statistically significant. The chi-square test was chosen based on its ability to handle large categorical data sets and provide insight into associations between multiple variables without assuming a linear relationship. This method also supports our study's design, where the goal was to explore associations rather than predict specific outcomes, making the chi-square test an appropriate choice for this analysis.

For all statistical tests, a p-value of less than 0.05 was considered statistically significant, indicating that the probability of the observed results occurring by chance was less than 5%. This threshold is commonly used in medical research to ensure the robustness and reproducibility of findings. Additionally, confidence intervals were calculated to estimate the precision of the results, with a 95% CI providing a range within which the true value of the population parameter is likely to fall.

3. Result and Finding

A total of 193 patients underwent risk assessments conducted by 75 actively participating nurses from the surgical department, utilizing the Nursing Risk Assessment of Acute Kidney Injury tool. The patients' mean age was 56.9 years, with a standard deviation of 16.6 years. Gender distribution among the patients showed 58% were male and 42% were female. Ethnicity breakdown revealed a majority of Malay patients (63.2%), followed by Chinese (27.5%), Indian (8.3%), and other races (1.0%). Regarding admission routes, 70 patients (36.3%) were admitted via planned admission (counter admission), 66 (34.2%) through the emergency department, 12 (6.2%) from the operating theater, 26 (13.5%) from the clinic, 6 (3.1%) from critical care units, 2 (1.0%) from semi-critical units, and 3 (1.6%) were transferred from other hospitals. As for the AKI risk factors among surgical patients include age > 65 years (40.9%), male gender (58.5%), comorbidities like hypertension (56.5%), DM (43.5%), malignancy/ tumors 20.7% of patients, infection/sepsis at 22.8% and least patients with CKD were 11.9%, chronic liver 7.3% and hypotension 6.2%. During the assessment, the risk of AKI clinical parameters such as elevated serum creatinine (34.2%), blood loss/dehydration (25.4%), and low hemoglobin levels (23.3%). Patients with malignancy/ tumour had elective surgeries 43.5%, emergency surgeries 32.6%, meanwhile, 36.8% of patients consumed nephrotoxic agents (see Table 1).

Table 1
Distribution of Risk Factors of AKI

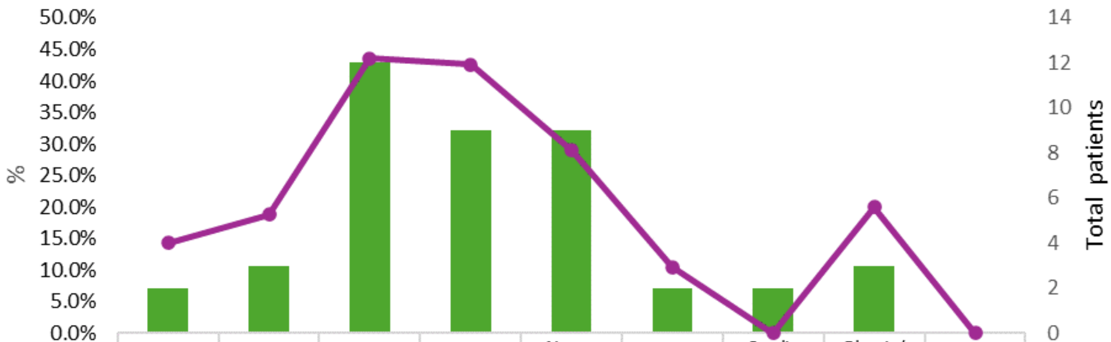
Risk of AKI	n(%)
Age > 65 years	78 (40.9%)
Factor Male Gender	113 (58.5%)
Patient's comorbidity	
Hypertension	109(56.5%)
Hypotension	12(6.2%)
DM	84(43.5%)
Chronic liver disease	14(7.3%)
Cardiovascular disease	47(24.4%)
Chronic kidney disease (eGRF <60ml/min per 1.73m^2)	23(11.9%)
Malignancy/tumor	40(20.7%)
Sepsis	44(22.8%)
Clinical/ laboratory parameters	
Dehydration/ blood loss	49(25.4%)
SrCreatinine >26.5mmol/L within 48 hours	66(34.2%)
Albumin level <34 or > 50g/dL	45(22.5%)
Sodium level <135 or >145mmol/L	34(17.6%)
Potassium level >5.5 mmol/L	12(6.2%)
Hb level <10g/dL	45(23.3%)
Urine Output < 0.5ml/kg/hour for 6 hours	28(14.5%)
Protein level >80g/dL	11(5.7%)
Surgery procedure	
Elective	84(43.5%)
Emergency	63(32.6%)
Not performed	0(0%)
Type of surgery	
Major	71(36.8%)
Minor	76(39.4%)
Not performed surgery	0(0%)
Involved cardiac procedure	
YES	29(15.0%)
NO	164 (85.0%)
Nephrotoxin	
Consuming nephrotoxin drugs including radiocontrast	
YES	71(36.8%)
NO	122(63.2%)

The most common reasons are gastrointestinal (GI) issues or injuries, accounting for 17.1% (n = 33), followed by cancer-related conditions at 15.0% (n = 29), and sepsis or infection at 14.5% (n = 28). Neurological and heart diseases each represent 12.4% of admissions (n = 24). Other reasons for admission include ophthalmological issues at 7.3% (n = 14), urological problems at 6.7% (n = 13), and kidney stones at 4.1% (n = 8). Vascular diseases account for 3.6% (n = 7), while ORL (ear, nose, and throat) problems make up 3.1% (n = 6). Fewer cases are due to thoracic issues (1.0%, n = 2) and plastic/burn injuries (0.5%, n = 1). This distribution highlights the diversity of reasons for admission in the patient population, with a focus on GI issues, cancer, infections, and cardiovascular and neurological conditions (see Table 2).

Table 2
Reason of admission across surgical units in HCTM

Reason of admission	n=193	% patients
Vascular disease	7	3.6%
Heart Disease	24	12.4 %
Sepsis/ infection	28	14.5 %
Tumor/Malignant/Ca	29	15.0 %
ORL problem	6	3.1 %
Urological problem	13	6.7 %
Neurological problem	24	12.4%
Plastic/ Burn	1	0.5%
GI problem/ injury	33	17.1%
Opthal problem	14	7.3%
Kidney stone	8	4.1%
Thoracic problem/ injury	2	1.0%
Others	4	2.1%

The highest risk percentages of cancer patients at risk of AKI are observed in the General Surgery (43.6%) and Urology Wards (42.6%), indicating a substantial concentration of AKI-risk patients in these units. The Neurosurgery Ward also shows a significant proportion at risk, with 29% (n = 9), which, while lower than General Surgery and Urology ward, still highlighted the importance of targeted AKI risk assessment in this setting. Lower percentages of AKI risk are observed in Ophthalmology (10.5%, n = 2) and Cardiothoracic Wards (10.5%, n = 2), possibly reflecting different patient profiles or treatment approaches. The Plastic/Maxillo/ENT Ward has 20% of patients at risk (n = 3), while no patients at risk were recorded in the Burn Unit. This distribution highlights the varying degrees of AKI risk across units, suggesting that wards with higher percentages, such as General Surgery and Urology, may benefit from enhanced AKI monitoring protocols (see Figure 1).



	CICU	HDS	General Surgery	Urology Ward	Neuro surgery Ward	Ophtalmo logy Ward	Cardio thoracic Ward	Plastic/ Maxillo/ ENT Ward	Burn Unit
N	2	3	12	9	9	2	2	3	0
%	14.3%	18.8%	43.6%	42.6%	29.0%	10.5%	0	20.0%	0

Fig. 1. The flow of article using a search strategy

Chi-square tests of independence were performed to examine the associations between risk of AKI and potential risk factors in surgical patients. Table 3 showed there are significant associations were found between AKI and nephrotoxin agent exposure including radiocontrast ($x^2(1, n=193) = 25.785, p < 0.001$), cardiac procedures ($x^2(1, n=193) = 16.683, p < 0.001$), emergency surgery ($x^2$(1, n=193) = 6.574, p = 0.011), and type of surgical procedure (x^2(1, n=193) = 14.062, p < .001). No significant associations were found between AKI and type of surgery (x^2(1, n=193) = 0.109, p = 0.741) or malignancy/tumour comorbidity (x^2(1, n=193) = 2.546, p = 0.112). These results suggest that nephrotoxin exposure, cardiac procedures, emergency surgery, and surgical procedure type are significantly associated with AKI risk in surgical patients (see Table 3).

Table 3
Chi-Square Analysis of Associations Between AKI and Potential Risk Factors Among Surgical Patients

Chi-square analysis of AKI Risk Factor (n=193)			
Risk Factors	x^2 value	p-value	Association
Nephrotoxin exposure	25.78	<0.001	strong
Cardiac procedure	16.68	<0.001	strong
Type of surgical procedure	14.06	<0.001	strong
Emergency procedure	6.57	0.011	moderate
Malignancy/ tumour	2.54	0.112	none
Type of surgery	0.09	0.741	none

4. Discussion

The data indicates that certain surgical departments, particularly General Surgery and Urology ward, exhibit significantly higher concentrations of AKI-risk patients, with rates of 43.6% and 42.6%, respectively. This distribution demonstrates the importance of targeted surveillance and preventive strategies to these specific units. The stark variation in AKI risk across different surgical specialties—from as high as 43.6% to 0%—suggests that a one-size-fits-all approach is insufficient. Instead, unit-specific protocols that account for the unique patient demographics and procedural complexities are essential for effective risk management [22]. Implementing specific protocols such as early monitoring of kidney function and tailored interventions for high-risk patients can help mitigate AKI in these units and improve patient outcomes [6].

Interestingly, the analysis reveals a non-significant association between the presence of malignancy and AKI risk (χ^2(1, n=193) = 2.546, p = 0.112) demonstrate the assumption that cancer itself is an independent risk factor for AKI. A detailed counterexample to the assumption that cancer is an independent risk factor for AKI could be seen in cases where patients with malignancy undergo chemotherapy, which is known to be a potential cause of AKI. Consistent with this findings, another large-scale study conducted in China surveyed over 374,000 hospitalized adults and found that while certain cancers such as renal cell carcinoma and multiple myeloma were associated with higher rates of AKI, the overall incidence was significantly affected by other comorbidities and treatment modalities [23]. The findings indicated that advanced age, intensive chemotherapy use, and exposure to nephrotoxic agents were more critical determinants of AKI risk than the cancer diagnosis itself. This further supports the idea that malignancy may not independently dictate AKI risk but rather interacts with a host of other clinical factors [24]

The presence of malignancy can amplify the impact of other risk factors, such as nephrotoxin exposure and the type of surgical procedure, both of which were strongly associated with AKI in this study (χ^2(1, n=193) = 25.785, p < 0.001; χ^2(1, n=193) = 14.062, p < 0.001). A recent study from Egypt supports these findings, highlighting chemotherapy as a significant risk factor for nephrotoxicity and AKI in cancer patients, with 57% of patients receiving nephrotoxic drugs like gemcitabine and carboplatin [25]. This underlines the necessity for healthcare teams to be vigilant about nephrotoxic risks and potential interactions with malignancy.

While statistical significance indicates the relevance of these risk factors, it should not detract from the broader need for comprehensive monitoring and proactive management. Effective AKI prevention in surgical cancer patients requires a holistic approach that addresses cancer status alongside modifiable contributors to AKI. This aligns with findings by Suleyman *et al.,* [26] which emphasize the value of multidimensional risk assessment strategies.

Engaging nursing staff in these assessments through involvement of 75 nurses in this study can enhance early detection and intervention efforts. Furthermore, understanding patient demographics reveals a mean age of 56.9 years with prevalent comorbidities such as hypertension (56.5%) and diabetes mellitus (43.5%). These factors contribute to a complex risk profile that necessitates a thorough evaluation prior to surgical interventions [27]. Nevertheless, cancer patients often face an increased risk of AKI due to their underlying health conditions, chemotherapy toxicity, and the stress of surgical interventions [28]. These comorbidities add to the complexity of their risk profile, making it essential for nursing staff to use specific assessment tools to monitor kidney function and identify any renal impairment promptly. To support this, regular assessment by nursing staff using specific tools to identify AKI risk is beneficial to ensure that any potential complications are identified and addressed promptly, ultimately improving patient outcomes and satisfaction [24].

Addressing this implementation ultimately enhancing patient outcomes and minimizing renal complications in this high-risk population is crucial. Furthermore, ensuring close collaboration between multidisciplinary teams, including nephrologists, oncologists, and surgeons, is essential for successful implementation of these prevention strategies. For example, an AKI Risk Assessment (ARA) algorithm, which involves a systematic evaluation of patients in high-risk situations to prevent AKI based on a four-step process called the 'Fantastic 4' (AKI F4), which includes assessing the clinical scenario, reviewing past history, conducting a physical examination, and analyzing laboratory results. This model aims to trigger the activation of a Nephrology Rapid Response Team (NRRT) to improve patient outcomes [28]. The authors stress the importance of a multidisciplinary approach, involving various medical specialists working together with nephrologists to manage AKI. They also discuss the need for continuous monitoring of high-risk patients and the implementation of preventive strategies to mitigate the risk of AKI.

Future research directions should focus on evaluating the impact of specific cancer treatments, including novel chemotherapeutic and immunotherapeutic agents, on AKI risk. Understanding the interaction between cancer biology and nephrotoxicity could lead to the development of tailored prevention strategies. Moreover, cost-effectiveness studies on targeted interventions and the implementation of predictive models for high-risk patients are crucial. Collaborative approaches involving nephrologists, oncologists, and surgeons, such as the AKI Risk Assessment (ARA) algorithm and multidisciplinary response teams, have shown promise in improving outcomes and warrant further exploration Incorporating patient-centric outcomes is also essential. Quality-of-life assessments and patient-reported metrics would provide a more comprehensive evaluation of AKI's impact [6,28]. Such outcomes can guide interventions that improve not only clinical parameters but also patient satisfaction and overall well-being [27,29,31]. By addressing these aspects, research can contribute to a nuanced understanding of AKI in cancer patients, ultimately informing clinical practices that reduce the burden of this complication. Future research should prioritize investigating why certain surgical units exhibit higher rates of AKI and explore the interplay between cancer treatments and AKI risk factors more deeply. Methodologically detailed studies are needed to validate existing risk assessment tools prospectively and examine long-term outcomes in cancer patients at risk for AKI. Furthermore, evaluating the cost-effectiveness of targeted prevention strategies will provide valuable insights into optimizing resource allocation within healthcare settings. By addressing these gaps in knowledge and practice, we can improve patient outcomes and reduce the burden of AKI among vulnerable populations.

5. Limitation

The findings regarding the prevalence and risk factors of acute kidney injury (AKI) among cancer patients in surgical settings underscore the necessity for comprehensive risk assessment and management strategies. The study highlights the need to consider the type of surgical procedure, patient-specific characteristics such as age, comorbidities, and baseline kidney function. Despite these insights, several limitations affect the study's scope and applicability, necessitating a broader discussion of gaps in current knowledge and future research directions.

A notable limitation of the study is its relatively small and single-center sample size, which may restrict the generalizability of its findings. Studies by Jin *et al.*, [23] and Ismail *et al.,* [25] have emphasized the importance of larger, multicenter cohorts to capture a broader range of demographic and clinical variables [23,25]. Expanding the sample size and including patients from diverse geographical and healthcare contexts would provide more robust and representative insights into AKI prevalence and risk factors. Additionally, the observational design, while useful for identifying associations, limits the ability to infer causality. Incorporating experimental or longitudinal designs in future studies could address this shortcoming and strengthen the validity of the [13,22,27].

The absence of long-term follow-up data is a notable limitation, as it hinders a comprehensive understanding of the chronic implications of acute kidney injury (AKI) in cancer patients. Longitudinal studies are essential for elucidating the progression from AKI to chronic kidney disease (CKD), its impact on long-term survival, and broader quality-of-life outcomes. For example, Marques *et al.* [11] identified a strong association between AKI and the development of CKD within two years following radical cystectomy. This indicates the importance of extended follow-up to capture the full trajectory of renal impairment and its implications for patient management. Without longitudinal data, the long-term burden of AKI on healthcare systems and patient outcomes may be underestimated, limiting the ability to design effective interventions [25,27,31]. Another critical gap in the current research is the insufficient exploration of recurrent AKI episodes and their cumulative impact on renal function and overall health. Studies have shown that recurrent AKI episodes exacerbate renal injury, increasing the likelihood of progression to CKD and end-stage renal disease (ESRD). Marques *et al.,* [11] highlighted the role of repeated nephrotoxic insults, such as chemotherapy or surgical interventions, in accelerating renal decline [11] . Understanding the frequency and consequences of recurrent AKI episodes is crucial for implementing preventive measures, such as modifying chemotherapeutic regimens or optimizing perioperative care to minimize repetitive renal insults [13,26].

In addition to long-term renal outcomes, the absence of patient-reported outcomes (PROs) and quality-of-life (QoL) metrics limits the holistic evaluation of AKI's consequences. Cancer patients experiencing AKI often face significant physical, psychological, and social challenges that are not captured through clinical parameters alone. For instance, Melo *et al.,* [29] emphasized the importance of integrating PROs to understand the broader impact of AKI on daily functioning and emotional well-being. Including QoL assessments in future longitudinal studies could guide interventions that address not only clinical recovery but also improve patient satisfaction and overall care experiences [13,14].

By addressing these gaps, future research can provide a more nuanced understanding of AKI's long-term and multifaceted consequences. A focus on recurrent AKI episodes, their prevention, and the inclusion of comprehensive patient-centric metrics will enhance the ability to design interventions that optimize both clinical outcomes and patient quality of life.

6. Conclusions

In conclusion, the prevalence and risk factors for AKI among cancer patients in surgical settings demonstrate the critical need for comprehensive interventions. While this study highlights the significant role of surgical type, patient-specific factors such as age, comorbidities, and nephrotoxic exposures in AKI risk, several limitations warrant attention. The lack of long-term follow-up data limits understanding of AKI's progression to chronic kidney disease (CKD) and its broader implications on survival and quality of life. Additionally, the absence of patient-reported outcomes (PROs) and quality-of-life measures restricts a holistic evaluation of AKI's impact. Current evidence underscores the necessity of longitudinal studies to address these gaps, particularly in understanding recurrent AKI episodes, their cumulative effects, and the effectiveness of preventive strategies personalized to surgical and oncological contexts. Research trends, such as the development of predictive models and nephroprotective strategies, highlight the potential for early identification and mitigation of AKI risk. However, these efforts require validation in diverse, multicenter cohorts. By integrating patient-centric metrics, vigorous longitudinal designs, and standardized protocols, future studies can optimize AKI prevention and management. This approach will ultimately improve clinical outcomes, reduce the burden of renal complications, and enhance quality of life for cancer patients undergoing surgery.

Acknowledgement
This research was funded by the Research Management Centre, University College MAIWP International, Kuala Lumpur, Malaysia UCMI/TNCPP/ RMC/ Geran/ 2022 (45).

References

[1] Campbell, G. Adam, Daniel Hu, and Mark D. Okusa. "Acute kidney injury in the cancer patient." *Advances in chronic kidney disease* 21, no. 1 (2014): 64-71.

[2] A Mohamed, Mohamed, Abdelmoneim Ahmed, Hiam Abdallah Eleleimy, Shireen Mohsen Salem, and Ahmed E Mansour. "Epidemiology of Acute Kidney Injury and Associated Factors among Patients with Malignancy: Analysis of Hospital Inpatients Database in Benha university Hospital Internal Medicine Departement, Hematology and Oncology Unit." *Benha Medical Journal* 41, no. 2 (2024): 22-37.

[3] Nazzal, Zaher, Fatima Abdeljaleel, Aseel Ashayer, Husam Salameh, and Zakaria Hamdan. "The Rate and Risk Factors of Acute Kidney Injury among Cancer Patients' Admissions in Palestine: A Single-Center Study." *International Journal of Nephrology* 2022, no. 1 (2022): 2972275.

[4] Kemlin, Delphine, Lucie Biard, Lionel Kerhuel, Lara Zafrani, Marion Venot, Luis Teixeira, Benoit Schlemmer, Elie Azoulay, and Emmanuel Canet. "Acute kidney injury in critically ill patients with solid tumours." *Nephrology Dialysis Transplantation* 33, no. 11 (2018): 1997-2005.

[5] Yusop, Nooreena, Muhammad Ishamuddin Ismail, and Ruslinda Mustafar. "Unveiling the Landscape of Acute Kidney Injury in Surgical Patients: A Systematic Review of Risk Factors and Clinical Biomarkers." *Journal of Health and Quality of Life* 3, no. 1 (2024): 13-32.

[6] Floris, Matteo, Francesco Trevisani, Andrea Angioi, Nicola Lepori, Mariadelina Simeoni, Gianfranca Cabiddu, Antonello Pani, and Mitchell Howard Rosner. "Acute Kidney Disease in Oncology: A New Concept to Enhance the Understanding of the Impact of Kidney Injury in Patients with Cancer." *Kidney and Blood Pressure Research* 49, no. 1 (2024): 745-752.

[7] Moore, Peter K., Raymond K. Hsu, and Kathleen D. Liu. "Management of acute kidney injury: core curriculum 2018." American Journal of Kidney Diseases 72, no. 1 (2018): 136-148. https://doi.org/10.1053/j.ajkd.2017.11.021

[8] Lei, Victor J., ThaiBinh Luong, Eric Shan, Xinwei Chen, Mark D. Neuman, Nwamaka D. Eneanya, Daniel E. Polsky et al. "Risk stratification for postoperative acute kidney injury in major noncardiac surgery using preoperative and

intraoperative data." JAMA network open 2, no. 12 (2019): e1916921-e1916921. https://doi:10.1001/jamanetworkopen.2019.16921
[9] Ota, Emi, Jun Watanabe, Hirokazu Suwa, Tomoya Hirai, Yusuke Suwa, Kazuya Nakagawa, Mayumi Ozawa, Atsushi Ishibe, and Itaru Endo. "Preoperative risk factors for ileostomy-associated kidney injury in colorectal tumor surgery following ileostomy formation." *International Journal of Colorectal Disease* 39, no. 1 (2024): 160.
[10] Ben Kridis, Wala, Mayssa Lajnef, and Afef Khanfir. "Acute renal failure during cisplatin-based chemotherapy: A prospective monocentric study." *Journal of Oncology Pharmacy Practice* 30, no. 6 (2024): 1023-1028.
[11] Marques, Mathieu, Marie Tezier, Maxime Tourret, Laure Cazenave, Clément Brun, Lam Nguyen Duong, Sylvie Cambon et al. "Risk factors for postoperative acute kidney injury after radical cystectomy for bladder cancer in the era of ERAS protocols: A retrospective observational study." *Plos one* 19, no. 10 (2024): e0309549.
[12] Solanki, Sohan Lal, Bindiya Salunke, Gauri Gangakhedkar, Reshma Ambulkar, Deepali V. Kuberkar, and Aditi Bhatt. "Acute kidney injury after cytoreductive surgery and hyperthermic intraperitoneal chemotherapy-A systematic review." *European Journal of Surgical Oncology* (2024): 108622.
[13] Grillo-Marín, Cristián, Cristina Antón-Rodríguez, Lola Prieto, Gloria Ortega-Pérez, and Santiago González-Moreno. "Nephrotoxicity Associated with Cytoreductive Surgery Combined with Cisplatin-Based Hyperthermic Intraperitoneal Chemotherapy for Peritoneal Malignant Disease: A Systematic Review and Meta-Analysis." *Journal of Clinical Medicine* 13, no. 13 (2024): 3793.
[14] Takahashi, Misaki, Hiroaki Toyama, Kazuhiro Takahashi, Yu Kaiho, Yutaka Ejima, and Masanori Yamauchi. "Impact of intraoperative fluid management on postoperative complications in patients undergoing minimally invasive esophagectomy for esophageal cancer: a retrospective single-center study." *BMC anesthesiology* 24, no. 1 (2024): 29.
[15] Imamura, Yoshinori, Naomi Kiyota, Makoto Tahara, Takeshi Kodaira, Ryuichi Hayashi, Hiroshi Nishino, Yukinori Asada et al. "Risk prediction model for cisplatin-induced acute kidney injury in patients with head and neck cancer receiving chemoradiotherapy: A re-analysis of a phase II/III JCOG1008 trial." *Oral Oncology* 154 (2024): 106868.
[16] Park, Namyong, Eunjeong Kang, Minsu Park, Hajeong Lee, Hee-Gyung Kang, Hyung-Jin Yoon, and U. Kang. "Predicting acute kidney injury in cancer patients using heterogeneous and irregular data." *PloS one* 13, no. 7 (2018): e0199839.
[17] Zeuchner, Jakob, Louise Elander, Jessica Frisk, and Michelle S. Chew. "Incidence and trajectories of subclinical and KDIGO-defined postoperative acute kidney injury in patients undergoing major abdominal surgery." *BJA open* 12 (2024): 100345.
[18] Zhou, Zhaohui, Zhiyong Li, Kang Ning, Longbin Xiong, Huiming Liu, Yixin Huang, Xin Luo et al. "Long-term effect of acute ischemic injury on the kidney underwent clamped partial nephrectomy." *Iscience* 26, no. 9 (2023).
[19] Krause, Martin, Soraya Mehdipour, Jula Veerapong, Joel M. Baumgartner, Andrew M. Lowy, and Rodney A. Gabriel. "Development of a predictive model for risk stratification of acute kidney injury in patients undergoing cytoreductive surgery with hyperthermic intraperitoneal chemotherapy." *Scientific Reports* 14, no. 1 (2024): 6630.
[20] Lynn, Mary R. "Determination and quantification of content validity." *Nursing research* 35, no. 6 (1986): 382-386.
[21] Yusop, Nooreena, Rasidah Mohamed, Muhammad Ishamuddin Ismail, and Ruslinda Mustafar. "Instrument's Reliability and Validity for Evaluating the Nursing Risk Assessment of Acute Kidney Injury tools for the Surgical Department: A Pilot Study." *Asian Journal of Fundamental and Applied Sciences* 3, no. 1 (2022): 9-21.
[22] Yarandi, Niloufarsadat, and Anushree C. Shirali. "Onco-Nephrology: Kidney Disease in the Cancer Patient." *Medical Clinics* 107, no. 4 (2023): 749-762.
[23] Jin, Juan, Yafang Wang, Quanquan Shen, Jianguang Gong, Li Zhao, and Qiang He. "Acute kidney injury in cancer patients: a nationwide survey in China." *Scientific reports* 9, no. 1 (2019): 3540.
[24] Yang, Li, Guolan Xing, Li Wang, Yonggui Wu, Suhua Li, Gang Xu, Qiang He et al. "Acute kidney injury in China: a cross-sectional survey." *The Lancet* 386, no. 10002 (2015): 1465-1471.
[25] Ismail, Ahmed, Mariam A. Naom, Bahaa M. Refaie, Nesma Magdy Ahmed, Sahar A. Allam, and Ahmed M. Elhalwagy. "Clinical Characteristics, Outcomes, and Prognosis among Cancer Patients with Acute Kidney Injury: A Single-Center Study at Sohag Cancer Center." *Egyptian Journal of Hospital Medicine* 95 (2024) :1402-1410
[26] Suleyman, Geehan, Raef Fadel, Indira Brar, Rita Kassab, Rafa Khansa, Nicholas Sturla, Ayman Alsaadi et al. "Risk factors associated with hospitalization and death in COVID-19 breakthrough infections." In *Open Forum Infectious Diseases*, vol. 9, no. 5, p. ofac116. US: Oxford University Press, 2022.
[27] Realista, Samuel. "Acute kidney injury in the inpatient and outpatient setting." *Critical Care Nursing Clinics* 34, no. 4 (2022): 431-441.
[28] Rizo-Topete, Lilia Maria, Mitchell H. Rosner, and Claudio Ronco. "Acute kidney injury risk assessment and the nephrology rapid response team." *Blood Purification* 43, no. 1-3 (2017): 82-88.

[29] Melo, Geórgia Alcântara Alencar, Renan Alves Silva, Nelson Miguel Galindo, Maria Alzete de Lima, Maria de Fátima Antero Sousa Machado, and Joselany Áfio Caetano. "Knowledge and care practice of nurses of intensive care units regarding acute kidney injury." *Texto & Contexto-Enfermagem* 29 (2020): e20190122.
[30] Ferrari, Fiorenza, Mariangela Valentina Puci, Ottavia Eleonora Ferraro, Gregorio Romero-González, Faeq Husain-Syed, Lilia Rizo-Topete, Mara Senzolo et al. "Development and validation of quick Acute Kidney Injury-score (q-AKI) to predict acute kidney injury at admission to a multidisciplinary intensive care unit." *PLoS One* 14, no. 6 (2019): e0217424.
[31] Zafar, Waleed, Kartik Kalra, and David I. Ortiz-Melo. "Oncosurgery-related acute kidney injury." *Advances in Chronic Kidney Disease* 29, no. 2 (2022): 161-170.