Vol. 2 No. 2 (2025)

ONLINE ISSN :3007-309X
PRINT ISSN :3007-3081

Journal of Medical & Health Sciences Review

FREQUENCY OF ACUTE KIDNEY INJURY IN PATIENT WITH CHRONIC LIVER DISEASE PRESENTING AT JPMC KARACHI

Muhammad Ghufran[1], Muhammad Omer Sultan[2], Abdul Rabb[3], Aqeel Ahmed[4], Jameel Ahmed [5]

[1]Resident Internal Medicine FCPS-II, Department of Internal Medicine, MBBS, Jinnah Postgraduate Medical Center (JPMC), Karachi, Pakistan
[2]Assistant Professor, Department of Internal Medicine, MBBS, FCPS, Jinnah Postgraduate Medical Center (JPMC), Karachi, Pakistan
[3]Professor, Department of Internal Medicine, FCPS, FRCP, FACP, JPMC, Sindh, Pakis Jinnah Postgraduate Medical Center (JPMC), Karachi, Pakistan tan
[4]Resident Internal Medicine FCPS-II, Department of Internal Medicine, MBBS, Jinnah Postgraduate Medical Center (JPMC), Karachi, Pakistan

[5]Postgraduate Department of Internal Medicine, MBBS, Jinnah Postgraduate Medical Center (JPMC), Karachi, Pakistan

ARTICLE INFO:

Keywords:
Acute kidney injury, sepsis, chronic liver disease, nephrotoxic drugs, hepatorenal syndrome

Corresponding Author:
DR Muhammad Ghufran,
Email:
muhammadghufranbaloch42@gmail.com

Article History:
Published on June 30, 2025

ABSTRACT

Background: The most impacted people are those with chronic liver disease (CLD) and acute kidney injury (AKI), who have the largest proportion of such complications. The presence of AKI in such patients has a considerable effect on their survival. Furthermore, renal failure is directly associated with hepatic dysfunction in CLD patients, and this association is complicated, with various factors contributing to it, including infection, underlying renal disease, and the occurrence of hepatorenal syndrome.

Objective: To determine the rate of cases of acute kidney injury (AKI) among chronic liver disease patients who visit Jinnah Postgraduate Medical Center (JPMC), Karachi, and the risk factors.

Methods: It was a cross-sectional study that was carried out in November 2024- April 2025 and included 150 CLD patients. The clinical and laboratory data and incidence of AKI were examined. KDIGO has been used to define AKI.

Findings: A case rate of AKI amongst CLD patients was found to be 26.7 percent. The most relevant etiological factors were determined to be infection, nephrotoxic drugs, and hepatorenal syndrome.

Conclusion: Acute kidney injury is prevalent among people with chronic liver disease, and early detection and intervention of the disease play significant roles in improving the prognosis of the patients.

INTRODUCTION

Acute kidney injury (AKI) in patients with chronic liver disease (CLD) is a frequent, potentially fatal condition, which has attracted recent attention, primarily due to the impact it imposes on patient outcome and treatment. The most affected are people with cirrhosis, which is the major cause of CLD, since they are highly likely to develop AKI that may ultimately worsen their survival rate by a large margin (1). The broken kidney machine in individuals with chronic liver disease is highly complicated. Hepatorenal syndrome (HRS) can be regarded as the most common cause, which is a type of functional renal failure that occurs in cases of cirrhosis and portal hypertension. Basically, the process of HRS is closely related to the dilatation of the blood vessels of the splanchnic area, the decreased volume of the blood circulating in the body, and low blood flow to the kidney, which may result in renal failure if rescue is not done at the right time (2,3).

ACLF, which is defined as the sudden worsening of liver function accompanied by systemic inflammation, is frequently linked to a greater occurrence of AKI, and the chances of survival of the patients become lower (4). As an example, those with cirrhosis who experience AKI have a mortality risk that is five times higher than those without AKI (5). Besides, the occurrence of AKI in such patients usually leads to an extension of hospital stays and a rise in the consumption of resources, causing the healthcare systems to be heavily burdened, especially those in low-resource settings (6). The worldwide harm caused by acute-on-chronic liver failure, which includes AKI, is significant, and its incidence is going up in both developed and developing countries. A series of systematic reviews and meta-analyses have pointed out the increasing acknowledgment of ACLF as the leading cause of the global burden of liver disease, to which AKI is the main factor affecting the patient's outcome (3). It is quite alarming, especially in those countries that have high rates of viral hepatitis, alcohol consumption, and non-alcoholic fatty liver disease (NAFLD), which are common pathological conditions leading to both CLD and AKI (7).

Besides its clinical consequences, AKI in patients with CLD is also a major management problem. The treatment of AKI in this group is difficult because of the liver dysfunction, as well as the limited number of drugs. Generally, the methods of AKI management, for example, renal replacement therapy, are rarely feasible in patients with cirrhosis because of the fear of complications such as infection and bleeding (8). Therefore, the involvement of hepatologists, nephrologists, and intensivists is necessary to ensure the right management of the patients (9). The diagnois of AKI in patients with CLD must be done with a high level of suspicion because this may have an insidious presentation, and the disease may advance to other serious states within a short time unless it is timely identified. Serum creatinine, urine output, and newer biomarkers of kidney injury (e.g., kidney injury molecule-1) could help in the early identification of AKI in such patients. Nevertheless, these markers have some limitations with regard to cirrhosis, and their use is an area of continuing study (10). In addition, imaging, including renal ultrasonography, might fail in these patients because of the presence of ascites and other confounding issues (11).

The risk factors of acquiring AKI among CLD patients are established. These are the severity of liver disease, portal hypertension, taking of nephrotoxic drugs, infections, and systemic inflammation. Research has established that patients with higher Model for End-Stage Liver Disease (MELD) scores, which indicate the extent of cirrhosis, are more likely to develop AKI (12). Moreover, infections, especially spontaneous bacterial peritonitis (SBP), are also a recurrent trigger of AKI in such patients (13). The issue of sepsis-related AKI is thoroughly researched, and it was demonstrated that the inflammatory reaction to infection may

worsen kidney damage in patients with underlying liver disease (14). Treatment of AKI in chronic liver disease patients involves both managing the acute insult to the kidney and liver pathology. In other instances, management of HRS encompasses administration of vasoconstrictors, including terlipressin, to enhance renal perfusion (15). Nevertheless, the application of these agents is not risk-free, and the advantage should be cautiously evaluated against possible side effects, especially among patients with more severe liver disease.

In the case of ACLF patients, the treatment is aimed at enhancing the liver performance and controlling the systemic inflammation, which can prevent additional damage to the kidney and increase the overall survival (16). In spite of an in-depth investigation of the mechanisms and treatment of AKI in such patients, treatment regimens for AKI in patients with chronic liver disease have not been thoroughly refined. Several studies are examining the role of novel therapies such as liver transplantation and artificial liver support systems (17). Moreover, the contribution of first recognition and prevention to the decrease of acute kidney injury occurrences in this group of patients is immensely important, and new studies should mostly concentrate on identifying patients at risk and creating selective interventions (18). The dilemma about AKI in such a population is that it requires continuous studies on the causes behind it, the risk factors, and the remedies to AKI in chronic liver disease (19). As a result of improved understanding of this disorder, more effective treatment modalities are expected to be offered, which improved the quality of care provided to these patients (20).

Chronic liver disease has continued to be on the increase in Pakistan because of the presence of viral hepatitis, non-alcoholic fatty liver disease, and an escalating metabolic disease. Although hepatic and renal dysfunction largely overlap, most of the data is not on the actual burden and the risk factors of acute kidney injury in patients with chronic liver disease in this region. Lack of local research complicates the development of evidence-based preventive and therapeutic measures appropriate in our healthcare setting, where resources are constrained and late presentation is the norm. Determining the incidence of AKI in patients with CLD may be an important finding regarding the trend of morbidity and mortality, hospitalization rates, and the risk of mortality and morbidity in general among patients of tertiary care hospitals like JPMC Karachi.

Additionally, when AKI is detected early in patients with CLD, it is possible to significantly improve the prognosis by controlling infections promptly, preventing the use of nephrotoxic medications, and providing hemodynamic support. The interaction of systemic inflammation, decreased renal perfusion, and hepatic insufficiency requires a combined diagnosis and treatment solution. This puts the pressing responsibility of performing localized research to learn the epidemiological and clinical trends in the region. Evaluation of the relationship between risk factors, including sepsis, nephrotoxic exposure, and hepatorenal syndrome, and AKI development can inform clinicians to develop more specific management plans. Therefore, the purpose of this research is not only to identify the rate of acute kidney injury (AKI) in patients with chronic liver disease (CLD) who seek attention at the Jinnah Postgraduate Medical Center (JPMC), Karachi, but also to find out the most common risk factors that lead to the process. The research results of this study are likely to fill the knowledge gap that exists and offer useful information that will enable the early diagnosis, targeted prevention, and better clinical management of patients with both hepatic and renal dysfunction. Further, the results of this study will be used to design region-specific solutions that can be utilized to improve patient care especially in low-resource

healthcare settings where timely intervention is the significant problem.

Objective: The study aims to identify the incidence rate of acute kidney injury (AKI) in patients with chronic liver disease (CLD) in Jinnah Postgraduate Medical Center (JPMC), Karachi, and to find out the primary risk factors related to the occurrence of it.

MATERIALS AND METHODS

Study Design: Cross-sectional study

Study Setting: Jinnah Postgraduate Medical Center (JPMC), Karachi, Pakistan.

Duration of the Study: November 2024-April 2025.

Inclusion Criteria: All patients that were involved in this study were adults aged 18 years and above and with a clinical diagnosis of chronic liver disease (CLD), cirrhosis, or non-alcoholic fatty liver disease (NAFLD), and with symptoms suggestive of acute kidney injury (AKI). The participants who were enrolled in the study were only those who had signed and subsequently decided to participate in the study.

Exclusion Criteria: Patients with known chronic kidney disease history or those on dialysis, or who have other severe systemic conditions, e.g., active malignancy or heart disease, were not included. The patients whose medical records were not complete or those who refused to provide consent were also not included in the study.

Methods:

It was carried out in Jinnah Postgraduate Medical Center (JPMC), Karachi, in November 2024- April 2025. Patients admitted to the hospital were used as the source of information, using detailed medical history and examinations. The diagnosis of acute kidney injury (AKI) was determined based on the Kidney Disease: Improving Global Outcomes (KDIGO) criteria, the parameters of assessment of serum creatinine levels and urine output. Appropriate lab studies, such as liver functional tests, renal biomarkers and other supportive diagnostic tests were done to ascertain the presence and severity of liver and kidney dysfunctions. The Child-Pugh and MELD scoring systems were used to determine the severity of liver disease, whereas kidney functioning was constantly monitored in the course of the hospitalization. Researchers have recorded demographic (age and sex), laboratory, and clinical results. Statistical analysis was then carried out to find out the prevalence of AKI among the CLD patients and to find out the possible risk factors that could lead to it.

RESULTS

The study included 150 patients suffering from chronic liver disease who served as the basis for the assessment of the frequency of acute kidney injury in this population. Patients' demographic data, clinical features, and the infection rate of AKI were the variables under consideration.

The average age of the participants was 48.2 ± 12.6 years. Most of the patients were males (70%). The top two most common liver-related diseases prior to the study were cirrhosis (58%) and non-alcoholic fatty liver disease (NAFLD) (32%), while only a few patients were infected with hepatitis B or C (10%). Out of 150 patients, forty (26.7%) who did not have AKI initially developed it during their hospital stay, and renal dysfunction was highly prevalent in patients with CLD.

Table 1: Demographic Characteristics of Study Population

Characteristic	Frequency (n)	Percentage (%)
Age (Mean ± SD)	48.2 ± 12.6	-
Gender		
Male	105	70%
Female	45	30%
Underlying Disease		
Cirrhosis	87	58%
NAFLD	48	32%
Hepatitis B/C	15	10%

Regarding the magnitude of the liver disease, most patients were characterized by moderate liver dysfunction, with 42% of patients having Child-Pugh class B liver, 39% with Child-Pugh class A liver, and 19% with Child-Pugh class C liver. Child-Pugh class C patients were more prone to develop AKI (43%) than those in classes A and B, and the incidence of AKI in the two categories was significantly different ($p<0.05$). Moreover, patients with increased MELD scores could develop AKI, and patients with a MELD score of 20 and above had an incidence of AKI of 55%.

Table 2: Liver Disease Severity and Incidence of AKI

Severity (Child-Pugh)	Total Patients (n)	AKI Incidence (%)
Class A	58	18.97%
Class B	63	32.00%
Class C	29	43.00%

Sepsis (40 percent), use of nephrotoxic drugs (26 percent), and hepatorenal syndrome (HRS) (20 percent) were the most common risk factors of AKI in the population. The rest of the cases were blamed on other factors like dehydration and gastrointestinal bleeding. Sepsis experienced the highest prevalence of AKI, followed by those on nephrotoxic drugs. Hepatorenal syndrome was less common but high death rate among the affected population with the death rate of 60 percent of HRS patients dying during hospitalization.

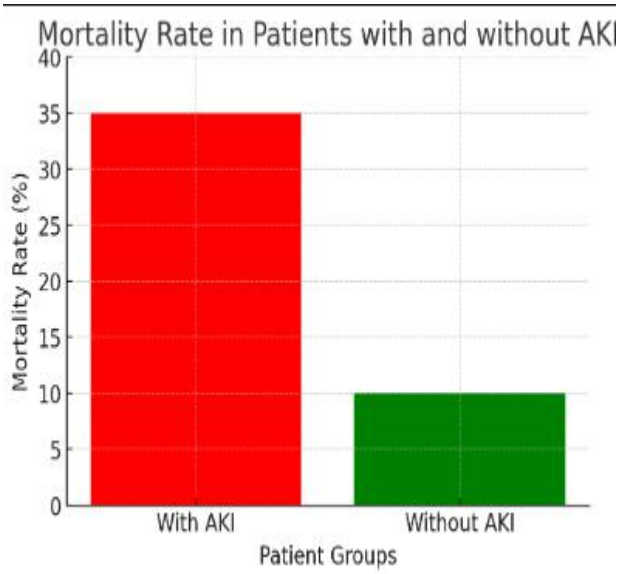
Table 3: Risk Factors for Acute Kidney Injury

Risk Factor	Frequency (n)	Percentage (%)
Sepsis	16	40%
Nephrotoxic Drugs	10	26%
Hepatorenal Syndrome	8	20%
Dehydration	4	10%
GI Bleeding	2	4%

In terms of management outcome, patients with AKI were more likely to need renal replacement therapy (RRT), so 18 percent of AKI patients reported needing hemodialysis during their stay at the hospital. Furthermore, AKI patients had a higher mortality rate of 35% compared to the 10% mortality rate witnessed in patients who did not have AKI. The AKI incidence was also greater among people who were admitted to the intensive care unit (ICU), with a 50 percent incidence of AKI among patients at the ICU.

Graph 1: Mortality Rate in Patients with and without AKI

The graph below shows the mortality rate in patients with and without acute kidney injury (AKI) during hospitalization.



Regarding renal function recovery, 60% of patients with AKI improved with proper treatment, which incorporated the use of vasopressors, diuretics, and termination of nephrotoxic drugs. Nevertheless, 40 percent of AKI patients were found to be in persistent renal dysfunction by the time of discharge.

Table 4: Renal Function Recovery in AKI Patients

Outcome	Frequency (n)	Percentage (%)
Full Recovery	24	60%
Partial Recovery	8	20%
No Recovery	8	20%

To conclude, the research revealed that the occurrence of acute kidney injury (AKI) is very high in patients suffering from chronic liver disease. There is a significant connection between the degree of liver disease, complications, and kidney function deterioration. It is absolutely necessary to first recognize and then control the development of AKI in these patients if the results are to be better and the death rate is to be lower. More studies are warranted to determine safe and effective prevention methods as well as the best treatment regimens for AKI in patients with chronic liver disease.

DISCUSSION

Acute kidney injury (AKI) in individuals with chronic liver disease (CLD) represents a major challenge to the healthcare team and has a sizable influence on the patient's prognosis. As per our research, the occurrence of AKI in CLD patients was significantly high, with 26.7% of the study population being exposed to it. HRS is a case of functional renal failure that happens in patients with cirrhosis and portal hypertension. It is identified with vasodilation of the splanchnic circulation and impaired renal perfusion (3, 4). The occurrence of AKI was, as per our investigation, also significantly elevated in patients with more severe liver conditions, and the statement that those with Child-Pugh class C cirrhosis had the highest frequency of AKI is in agreement with the last paragraph of our study. There have been several studies that have demonstrated that patients with severe liver dysfunction are at a higher risk of suffering from AKI (5). These results shed light on the necessity of diligent assessment of kidney function in patients with serious liver disease, especially those with high MELD scores.

In our study, sepsis has been identified as the leading factor that resulted in AKI and made up 40% of the cases. This finding concurs with the literature that points out the main source of infections and the single most important cause of renal dysfunction in cirrhosis is spontaneous bacterial peritonitis (SBP) (6,7). AKI resulting from sepsis is a consequence of the systemic inflammatory response, which may lead to endothelial dysfunction, microcirculatory failure, and renal hypoperfusion. The measures to control sepsis, such as the use of antibiotics, volume resuscitation, and vasopressors, may relieve the effect of infection on kidney function, and it is still an early intervention that prevents permanent damage.

Another major point in our research was the impact of nephrotoxic drugs on the occurrence of AKI. Over one-fourth of patients (26%) developed AKI as a consequence of the introduction of nephrotoxic agents, including non-steroidal anti-inflammatory drugs (NSAIDs), diuretics, and antibiotics. The kidneys, in such a case, are the organ most sensitive to the toxic effects of these drugs in the presence of CLD since liver dysfunction is capable of changing drug metabolism and clearance, thereby increasing the risk of nephrotoxicity (8, 9). It underlines the point that medication management has to be well executed in patients with CLD, especially in those who have renal function already compromised. Physicians must be careful when giving nephrotoxic drugs and should think about other medications if it is possible to reduce the risk of kidney injury.

Additionally, we explored the correlation between the extent of liver disease and the occurrence of AKI. It turned out that those

patients who had raised Child-Pugh as well as MELD scores were considerably more prone to the development of AKI, and this evidence supports the results of earlier publications (10, 11). The connection between hepatic insufficiency and renal failure is, in fact, well known, since the liver is the organ that is mainly responsible for the management of fluids and ions in the body, and its failure leads to changes in renal hemodynamics and to retention of fluids. In addition to that, the elevation of systemic inflammation, which is usually seen in advanced stages of liver disease, can aggravate renal lesions by the mechanisms of endothelial dysfunction and vascular permeability (12). Therefore, this fact draws attention to the significance of evaluating the severity of liver disease when handling AKI and points to the necessity of the first-line therapy in patients suffering from severe cirrhosis.

Managing AKI in patients with CLD is still a tough puzzle to solve because there aren't many treatment options, and the whole situation of liver disease is quite complicated. In our study, 18% of patients with AKI had to undergo renal replacement therapy (RRT), mostly hemodialysis, during their stay in the hospital. This aligns with what other research works have disclosed, i.e., the requirement for dialysis is more in patients with cirrhosis and AKI (13). Nevertheless, RRT in such patients carries the risk of various complications like bleeding, infection, and deterioration of liver function, so it should be the last option only. One of the possible ways to handle AKI in a cirrhotic environment is the application of vasopressors like terlipressin, which has been proven effective in improving renal perfusion by constricting splanchnic vessels and raising blood flow to the kidneys (14). Nevertheless, the use of vasopressors as a therapeutic strategy is debated, and more research is needed to confirm their effectiveness and safety in this group of patients.

Besides medical treatment, our research highlights the necessity of noticing the development of AKI in patients with CLD at the earliest stage. First of all, traditional markers like serum creatinine and urine output, together with novel renal injury markers (e.g., kidney injury molecule-1), can definitely help to find AKI at the very onset, and the patient will get a timely intervention (15, 16). Secondly, it is very important to secure AKI risk reduction through the implementation of strategies such as fluid management optimization, avoiding nephrotoxic drugs, and, of course, infection treatment. The prevention of AKI is especially significant since the disorder is linked to a high death rate and can result in chronic renal insufficiency and lowered quality of life.

In our research, we have come to a similar conclusion that the death rate of patients with AKI is substantially raised compared to those without AKI. This finding is in line with the reference of a 5-fold elevated risk of death in patients with cirrhosis and AKI (17). The outcome of AKI accompanying chronic liver disease is very grim, and the continuation of life relies on how the liver and kidney function (18). Therefore, it stresses the significance of the first intervention and the careful management in order to enhance the survival rate of these patients in the intensive care unit.

To conclude, acute kidney injury is a common and grave problem that complicates the course of patients suffering from chronic liver disease, especially those with advanced cirrhosis. Our research highlights that sepsis, nephrotoxic drugs, and hepatorenal syndrome are the main factors leading to acute kidney injury in a group of patients with chronic liver disease. The first time AKI happens, it has to be very clear to all the doctors concerned, and they need to take very quick and very effective measures to get it under control, i.e., infection resolution, drug administration with great caution, and supportive care. The implications of the hepatic-renal axis in

chronic liver disease have necessitated additional studies to identify novel therapeutic and prophylactic modalities to address the problem of AKI in patients with CLD and also to comprehend the long-term sequelae of renal impairment in such patients better.

CONCLUSION

To conclude, acute kidney injury (AKI) is a serious and common occurrence in patients with chronic liver disease (CLD), especially in those with decompensated cirrhosis. This study has shown a close linkage of AKI with sepsis, exposure to nephrotoxic drugs, and hepatorenal syndrome. The diagnosis at an early stage and immediate treatment are vital. Infection control, careful drug therapy, and supportive treatment should be administered to enhance the outlook of the patient. The elevated mortality rate of patients with acute liver disease incidence and acute kidney injury is an effective motivation to prevent and intervene in time. The research funding should be based on finding the methods of kidney injury prevention and developing new treatment options that would lower the incidence and increase the level of survival. This will assist in alleviating the long-term effects of acute kidney injury on chronic liver disease patients. Since the occurrence of AKI is high, and this condition is accompanied by serious complications, constant monitoring, risk evaluation, and prevention should become the rule. Multidisciplinary care units with the participation of hepatologists and nephrologists can result in an increase in the outcomes of patients. Moreover, the introduction of preventive educational programs among medical workers and patients regarding the risk factors and warning signs of AKI can help prevent it. It is necessary to conduct future, large-scale, multicenter studies to confirm these results and create specific management guidelines applicable to the Pakistani population.

REFERENCES

1. Huang Y, Cai J, Ha F, Guo B, Xin S, Duan Z, Han T. Characteristics of acute kidney injury and its impact on outcome in patients with acute-on-chronic liver failure. BMC gastroenterology. 2022 May 11;22(1):231.
2. Nadim MK, Garcia-Tsao G. Acute kidney injury in patients with cirrhosis. New England Journal of Medicine. 2023 Feb 23;388(8):733-45.
3. Mezzano G, Juanola A, Cardenas A, Mezey E, Hamilton JP, Pose E, Graupera I, Ginès P, Solà E, Hernaez R. Global burden of disease: acute-on-chronic liver failure, a systematic review and meta-analysis. Gut. 2022 Jan 1;71(1):148-55.
4. Gupta K, Bhurwal A, Law C, Ventre S, Minacapelli CD, Kabaria S, Li Y, Tait C, Catalano C, Rustgi VK. Acute kidney injury and hepatorenal syndrome in cirrhosis. World journal of gastroenterology. 2021 Jul 14;27(26):3984.
5. Mantovani A, Petracca G, Beatrice G, Csermely A, Lonardo A, Schattenberg JM, Tilg H, Byrne CD, Targher G. Non-alcoholic fatty liver disease and risk of incident chronic kidney disease: an updated meta-analysis. Gut. 2022 Jan 1;71(1):156-62.
6. Flamm SL, Wong F, Ahn J, Kamath PS. AGA clinical practice update on the evaluation and management of acute kidney injury in patients with cirrhosis: expert review. Clinical Gastroenterology and Hepatology. 2022 Dec 1;20(12):2707-16.
7. Kahindo CK, Mukuku O, Wembonyama SO, Tsongo ZK. Prevalence and Factors Associated with Acute Kidney Injury in Sub-Saharan African Adults: A Review of the Current Literature. International journal of nephrology. 2022;2022(1):5621665.
8. Abebe A, Kumela K, Belay M, Kebede B, Wobie Y. Mortality and predictors of acute kidney injury in adults: a hospital-based prospective observational study. Scientific Reports. 2021 Aug 2;11(1):15672.
9. Yue S, Li S, Huang X, Liu J, Hou X, Zhao Y, Niu D, Wang Y, Tan W, Wu J.

Machine learning for the prediction of acute kidney injury in patients with sepsis. Journal of translational medicine. 2022 May 13;20(1):215.
10. Yıldırım G, Ali B, Hatice K, Atike TK. Does aspartate aminotransferase to alanine aminotransferase ratio predict acute kidney injury after cardiac surgery?. InThe Heart Surgery Forum 2021 Jun 10 (Vol. 24, No. 3, pp. 506-511). IMR Press.
11. Almazmomi MA, Esmat A, Naeem A. Acute kidney injury: definition, management, and promising therapeutic target. Cureus. 2023 Dec 28;15(12):e51228.
12. Gameiro J, Marques F, Lopes JA. Long-term consequences of acute kidney injury: a narrative review. Clinical Kidney Journal. 2021 Mar 1;14(3):789-804.
13. Liu YB, Chen MK. Epidemiology of liver cirrhosis and associated complications: Current knowledge and future directions. World journal of gastroenterology. 2022 Nov 7;28(41):5910.
14. White KC, Serpa-Neto A, Hurford R, Clement P, Laupland KB, See E, McCullough J, White H, Shekar K, Tabah A, Ramanan M. Sepsis-associated acute kidney injury in the intensive care unit: incidence, patient characteristics, timing, trajectory, treatment, and associated outcomes. A multicenter, observational study. Intensive care medicine. 2023 Sep;49(9):1079-89.
15. Klomjit N, Ungprasert P. Acute kidney injury associated with non-steroidal anti-inflammatory drugs. European journal of internal medicine. 2022 Jul 1;101:21-8.
16. Cai X, Wu G, Zhang J, Yang L. Risk factors for acute kidney injury in adult patients with COVID-19: a systematic review and meta-analysis. Frontiers in Medicine. 2021 Dec 6;8:719472.
17. Prowle JR, Forni LG, Bell M, Chew MS, Edwards M, Grams ME, Grocott MP, Liu KD, McIlroy D, Murray PT, Ostermann M. Postoperative acute kidney injury in adult non-cardiac surgery: joint consensus report of the Acute Disease Quality Initiative and PeriOperative Quality Initiative. Nature Reviews Nephrology. 2021 Sep;17(9):605-18.
18. Sullivan MK, Lees JS, Drake TM, Docherty AB, Oates G, Hardwick HE, Russell CD, Merson L, Dunning J, Nguyen-Van-Tam JS, Openshaw P. Acute kidney injury in patients hospitalized with COVID-19 from the ISARIC WHO CCP-UK Study: a prospective, multicentre cohort study. Nephrology Dialysis Transplantation. 2022 Feb;37(2):271-84.
19. Zarbock A, Nadim MK, Pickkers P, Gomez H, Bell S, Joannidis M, Kashani K, Koyner JL, Pannu N, Meersch M, Reis T. Sepsis-associated acute kidney injury: consensus report of the 28th Acute Disease Quality Initiative workgroup. Nature Reviews Nephrology. 2023 Jun;19(6):401-17.
20. Ng JH, Hirsch JS, Hazzan A, Wanchoo R, Shah HH, Malieckal DA, Ross DW, Sharma P, Sakhiya V, Fishbane S, Jhaveri KD. Outcomes among patients hospitalized with COVID-19 and acute kidney injury. American Journal of Kidney Diseases. 2021 Feb 1;77(2):204-15.