e-ISSN (online): 2745-9497

Journal of Anesthesiology and Clinical Research (JACR)

Journal website: https://hmpublisher.com/index.php/jacr

Overview of Acute Kidney Injury (AKI) in the Intensive Care Unit: Observational Study at Prof. Dr. I.G.N.G Ngoerah General Hospital, Denpasar, Indonesia

Pontisomaya Parami[1], Tjokorda Gde Agung Senapathi[2], Gede Wirya Kusuma Duarsa[3], Putu Bagus Gin Gin Pramana[4*]

[1]Lecturer, Department of Anesthesiology and Intensive Therapy, Faculty of Medicine, Universitas Udayana, Denpasar, Indonesia

[2]Professor, Department of Anesthesiology and Intensive Therapy, Faculty of Medicine, Universitas Udayana, Denpasar, Indonesia

[3]Lecturer, Department of Urology, Faculty of Medicine, Universitas Udayana, Denpasar, Indonesia

[4]Specialized Residency Training Student, Department of Anesthesiology and Intensive Therapy, Faculty of Medicine, Universitas Udayana, Denpasar, Indonesia

ARTICLE INFO

Keywords:
Acute kidney injury (AKI)
Intensive care unit
Length of stay (LOS)

***Corresponding author:**
Putu Bagus Gin Gin Pramana

E-mail address:
ginbius2022@gmail.com

All authors have reviewed and approved the final version of the manuscript.

https://doi.org/10.37275/jacr.v5i3.555

A B S T R A C T

Introduction: Acute kidney injury (AKI) is a serious clinical syndrome with complications that can be life-threatening. AKI is associated with increased length of stay and mortality in patients in the intensive care unit (ICU). This study aims to determine the incidence and characteristics of AKI in ICU patients at Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar. **Methods:** This descriptive observational research was conducted by collecting data from medical records of ICU patients for three months. Data were analyzed to determine the incidence of AKI, stage of severity, and mortality rate. **Results:** Of the 388 patients treated in the ICU, 87 (22.37%) experienced AKI. The mortality rate in AKI patients was 12.9% (n=50). A total of 11.05% (n=25) of AKI patients were classified as stage 1, 5.91% (n=17) as stage 2, and 5.40% (n=8) as stage 3. **Conclusion:** The incidence of AKI in the ICU of Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar. is quite high (22.37%). AKI is associated with a significant mortality rate (12.9%). This study provides a preliminary description of the incidence and characteristics of AKI in the ICU of this hospital, which may be useful for improving the quality of patient care and prevention of AKI.

1. Introduction

Acute kidney injury (AKI) is a serious clinical syndrome characterized by a sudden decrease in kidney function. This decline can occur within hours or days, and result in various dangerous complications, including disruption of electrolyte and body fluid balance, retention of nitrogen waste, and even death. AKI is a major health problem, especially for patients treated in the intensive care unit (ICU). Research shows that AKI occurs in 7-30% of ICU patients, and is associated with a significant increase in length of stay, cost of care, and mortality. Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar. is the main referral hospital in Bali which has an intensive care unit with a capacity of 30 beds. This ICU serves patients with a variety of critical conditions, including trauma, sepsis, and severe infections. It is estimated that AKI is also one of the complications that often occur in patients in the ICU at Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar. However, data

regarding the incidence and characteristics of AKI in the ICU of this hospital are still limited. This is an important basis for conducting research to find out a clearer picture of AKI in the ICU of Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar.[1-3]

AKI has a significant impact on the health of patients, especially those treated in the ICU. Patients with AKI are at increased risk of complications, including acute renal failure, electrolyte disturbances, and death. AKI is also associated with longer hospital stays and higher costs of care. This is certainly a burden for patients, families, and the health system as a whole. Several risk factors for AKI in ICU patients have been identified, including advanced age, sepsis, trauma, major surgery, and use of certain medications. In addition, patients with comorbid diseases such as diabetes mellitus and hypertension also have a higher risk of AKI. Understanding the incidence and characteristics of AKI in the ICU is important for several reasons. This information can help to improve efforts to prevent AKI. By knowing the risk factors and mechanisms underlying AKI, more effective prevention strategies can be developed and implemented. Information about AKI can help to improve patient care. Doctors and nurses caring for patients with AKI need to have a deep understanding of this condition, its associated complications, and the treatment options available. Information about AKI can help to improve research in this area.[4-7] By better understanding AKI, researchers can develop more effective strategies to prevent, diagnose, and treat this condition. This study aims to determine the incidence and characteristics of AKI in ICU patients at Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar.

2. Methods

This research uses a descriptive observational design. Data was collected from medical records of ICU patients at Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar. for three months in 2023. The target population in this study were all patients treated in the ICU of Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar. during the research period. The accessible population is all patients treated in the ICU of Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar during the research period which has complete medical records.

A total of 388 research subjects were included in this study, where the research subjects met the inclusion criteria. The inclusion criteria are patients treated in the ICU at Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar during the research period, patients who had complete medical records as well as patients aged 18 years or more. Meanwhile, the exclusion criteria are patients who do not have consent to participate in the research and patients whose data is incomplete. Sampling was carried out using the consecutive sampling method.

The diagnosis of AKI was made based on the RIFLE criteria. The RIFLE criteria is an AKI classification system based on changes in serum creatinine and glomerular filtration rate (GFR). Data were analyzed using SPSS version 26.0. Univariate analysis was performed to describe patient characteristics, such as age, gender, main diagnosis, clinical diagnosis, degree of renal failure, and morbidity and mortality related to AKI. This research was conducted by observing the principles of research ethics. All patients who meet the inclusion and exclusion criteria will be asked to provide written consent to participate in the study. All patient data will be kept confidential and will only be used for research purposes. All patients will have their rights respected, including the right to refuse to participate in research.

3. Results

This research involved 388 respondents who were treated in the intensive care unit (ICU) of Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar. Of the total respondents, 52.8% were men and 47.2% were women. The majority of respondents (86.6%) had no history of previous kidney disease, indicating that AKI in ICU patients generally occurs in individuals without pre-existing chronic kidney disease. The main focus of this research is the incidence of AKI in ICU patients. Therefore, information about surgical patients is important. Among respondents, 84.3% had undergone surgery, indicating a potential association between surgical procedures and the development of AKI. The mean age of respondents was 50.85 years, indicating

that AKI in the ICU is more common in the older population. The average body weight of respondents was 61.61 kg, the average height was 160.38 cm, and the average body mass index (BMI) was 23.95 kg/m². The death rate among respondents was relatively high, reaching 24.42%. This shows that AKI is a serious condition with a significant risk of death in ICU patients. Overall, the respondent characteristics table (Table 1) provides an initial picture of the profile of patients treated in the ICU at Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar. These data can help in understanding risk factors for AKI and developing more effective prevention strategies.

Table 1. Characteristics of respondents.

Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	205	52.80%
Female	183	47.20%
Previous history of kidney disease		
Yes	52	13.40%
No	336	86.60%
Surgical patients		
Yes	327	84.30%
No	61	15.70%
Age	50.85±4.43 years	-
Body weight	61,61±5,67 kg	-
Height	160,38±12,32 cm	-
Body mass index (BMI)	23,95±1,98 kg/m²	-
Death	24.42%	-

Table 2 presents important data regarding the incidence and stage of AKI in patients in the ICU at Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar. Of the 388 patients admitted to the ICU during the study period, 87 (22.37%) were diagnosed with AKI. These findings indicate that AKI is a complication that often occurs in ICU patients at this hospital. Furthermore, the table classifies AKI patients based on their severity stage. The majority of patients (52.9%) were categorized as stage 1 AKI, indicating a mild decline in kidney function. This was followed by AKI stage 2 (19.5%) and AKI stage 3 (9.2%), which showed more moderate and severe decline in kidney function, respectively. Even though stage 1 AKI seems mild, it is important to note that this condition can develop into a more severe stage if not treated appropriately. Therefore, vigilance and monitoring of AKI patients, even in the early stages, is essential.

Table 2. Incidence rates and stages of AKI.

Stages of AKI	Frequency (n)	Percentage (%)
Total	87	22.37%
AKI stage 1	25	11.05%
AKI stage 2	17	5.91%
AKI stage 3	8	5.40%

Table 3 presents worrying data regarding the relationship between AKI and mortality rates in patients in the ICU of Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar. Of the 388 patients treated in the ICU during the study period, 50 (12.90%) patients died. Even more concerning, 57.14% of these ICU deaths were related to AKI. These findings suggest that AKI is a significant risk factor for mortality in ICU patients. This is reinforced by the fact that AKI stage 2 and AKI stage 3 show a higher proportion of deaths compared to AKI stage 1. Although AKI stage 1 is the stage that most often occurs in AKI patients, the proportion of patients who die with AKI stage 1 is lower than AKI stage 1. with AKI stage 2 and AKI stage 3. This shows that the severity of AKI is closely related to a higher risk of death.

Table 3. AKI mortality rate in patients treated in the intensive care unit.

Stage of AKI	Frequency of death (n)	Percentage of deaths in ICU patients (%)	Percentage of deaths in AKI patients (%)
Total	50	12.90%	57.14%
AKI stage 1	25	6.45%	58.14%
AKI stage 2	17	4.38%	73.91%
AKI stage 3	8	2.06%	38.10%

4. Discussion

Acute kidney injury (AKI) is a serious complication that often occurs in patients treated in the intensive care unit (ICU). AKI is defined as a rapid decline in kidney function that can cause various complications and even death. Research findings show that the incidence of AKI in the ICU of Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar was 22.37%, in line with the range reported in other studies (7-30%). The high incidence of AKI in the ICU can be explained by several biological factors. The kidneys are vital organs that play an important role in maintaining the body's fluid and electrolyte balance, removing metabolic waste products, and regulating blood pressure. Optimal kidney function is essential for human health and survival. However, the kidneys are susceptible to various disorders, one of which is renal ischemia. Renal ischemia occurs when the kidneys do not receive enough blood flow and oxygen, which can cause severe damage to the structure and function of the kidneys. Blood flow to the kidneys comes from the renal artery, which branches from the abdominal aorta. The kidney has a complex network of blood vessels that ensure adequate blood perfusion to the renal tubule, the functional unit of the kidney responsible for blood filtration and urine production. When blood flow to the kidneys is reduced, the kidney tubule cells experience a lack of oxygen and nutrients essential for survival. This can trigger a series of biochemical reactions that damage cell structure and disrupt kidney function. A significant drop in blood pressure can cause reduced blood flow to the kidneys. This can occur due to hypovolemic shock (loss of blood volume), cardiogenic shock (heart failure), and sepsis (severe infection). Severe dehydration can lead to decreased blood volume and inadequate renal perfusion. Sepsis is a severe systemic inflammatory response to infection. Sepsis can cause damage to the endothelium of the renal blood vessels, which can disrupt blood flow and cause renal ischemia. Blockage of the renal arteries due to thrombus, embolism, or stenosis (narrowing) can cause unilateral renal ischemia (one kidney). Pre-existing renal diseases, such as glomerulonephritis and pyelonephritis, may increase susceptibility to renal ischemia. Certain drugs, such as aminoglycosides and cisplatin, can have toxic effects on the kidneys and cause renal ischemia. Kidney ischemia can cause various serious complications. Acute kidney injury (AKI) is a rapid and severe decline in kidney function. AKI can cause various health problems, such as fluid retention, electrolyte imbalance, metabolic acidosis, and acute kidney failure. Acute tubular necrosis (ATN) is the acute death of renal tubular cells. ATN can cause acute kidney failure and requires kidney replacement therapy (hemodialysis or peritoneal dialysis). Nephrosclerosis is the hardening and narrowing of the kidneys due to chronic kidney tubule damage. Nephrosclerosis can cause hypertension, chronic kidney failure, and cardiovascular disease.[8-11]

The kidneys are vital organs that play an important role in filtering blood, removing waste, and regulating the balance of electrolytes and body fluids. However, the kidneys can be damaged by various factors, including exposure to toxic substances known as nephrotoxins. Nephrotoxins can cause a wide range of kidney damage, ranging from mild kidney tubule damage to life-threatening acute kidney failure. Nephrotoxins can be classified based on various factors, including their mode of action, origin, and target organelles in the kidney. Some antibiotics, such as aminoglycosides (gentamicin, tobramycin) and vancomycin, can damage the renal tubules and cause acute renal failure. Nonsteroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen and naproxen, can interfere with blood flow to the kidneys and cause

damage to the kidney tubules. The risk of kidney damage is higher in the elderly, people with existing kidney disease, and people taking diuretics. Iodine-containing contrast media, used in X-ray and MRI examinations, can cause kidney tubule damage in people with existing kidney disease. Heavy metals, such as lead, mercury, and cadmium, can accumulate in the kidneys and cause damage to the kidney tubules. Organic solvents, such as ethylene glycol and tetraethylene glycol, can damage the renal tubules and cause acute renal failure. Some herbal medicines and supplements, such as aristolochia and phenacetin, can cause severe kidney damage. Nephrotoxins can cause narrowing of the renal blood vessels, which can reduce blood flow to the kidneys and cause ischemia. Renal ischemia can cause renal tubular damage and acute renal failure. Nephrotoxins can directly damage renal tubular cells, leading to renal tubular necrosis. Renal tubular necrosis can interfere with the kidneys' ability to filter blood and remove waste, which can lead to acute kidney failure. Nephrotoxins can trigger an inflammatory response in the kidneys, which can lead to tissue damage and acute kidney failure. Nephrotoxins can trigger programmed cell death (apoptosis) in kidney tubule cells, which can cause kidney damage and acute kidney failure. Several factors can increase the risk of kidney damage from nephrotoxins. Older people are more at risk of kidney damage due to nephrotoxins than young people. People with existing kidney disease are more at risk of kidney damage from nephrotoxins. Dehydration can reduce blood flow to the kidneys and increase the risk of kidney damage from nephrotoxins. Use of other drugs that can damage the kidneys, such as antibiotics and NSAIDs, can increase the risk of kidney damage due to nephrotoxins. Some other medical conditions, such as diabetes and hypertension, can increase the risk of kidney damage from nephrotoxins.[12-14]

Systemic inflammation is a whole-body inflammatory response that often occurs in patients treated in the intensive care unit (ICU). This condition is characterized by the release of inflammatory mediators into the bloodstream, which can trigger various inflammatory responses in various organs of the body, including the kidneys. In ICU patients, systemic inflammation can be caused by various factors, such as sepsis, trauma, burns, and major surgery. Systemic inflammation can cause kidney damage through various mechanisms. Inflammatory mediators, such as tumor necrosis factor (TNF)-α, interleukin (IL)-1β, and interleukin (IL)-6, are released into the bloodstream during systemic inflammation. These inflammatory mediators can cause damage to the renal tubules, which are the functional units of the kidney. Neutrophils are white blood cells that play an important role in the inflammatory response. Activated neutrophils can release free radicals and proteolytic enzymes that can damage kidney cells. Systemic inflammation can cause microthrombosis, namely the formation of small blood clots in the kidney blood vessels. Microthrombosis can disrupt blood flow to the kidneys and cause tissue damage. Renal ischemia occurs when the kidneys do not receive enough blood flow and oxygen. Renal ischemia can worsen kidney damage caused by systemic inflammation. Systemic inflammation is a serious complication that often occurs in ICU patients. Systemic inflammation can cause kidney damage through various mechanisms, including the release of inflammatory mediators and neutrophil activation. Management of systemic inflammation in ICU patients aims to control the inflammatory response, support kidney function, and manage complications. Prevention of systemic inflammation in ICU patients is important to reduce the risk of kidney damage and other complications.[15-17]

Acute kidney injury (AKI) is a serious complication that often occurs in patients treated in the intensive care unit (ICU). AKI is defined as a rapid decline in kidney function that can cause various complications and even death. One of the important findings from this study is the distribution of AKI patients based on stage. Findings showed that AKI stage 1 was the most common stage (52.9%), followed by AKI stage 2 (19.5%) and AKI stage 3 (9.2%). The finding that AKI stage 1 is the stage that occurs most frequently is in line with other studies in various parts of the world. This suggests that mild reduction in kidney function is a common manifestation of AKI in ICU patients.

Although stage 1 AKI may seem mild, it is important to note that this condition can progress to a more severe stage if not treated appropriately. Renal ischemia, which is the main cause of AKI, can cause progressive renal tubular damage. If ischemia is not treated quickly, kidney damage can become permanent and lead to more severe stages of AKI. ICU patients often have comorbidities that can worsen AKI. These comorbidities can include diabetes mellitus, hypertension, and heart disease. Stage 1 AKI patients may not show significant symptoms, so this condition can be missed if not monitored carefully. The findings of this study emphasize the importance of vigilance and early monitoring of AKI patients, even in the early stages. Careful monitoring can help detect stage 1 AKI quickly and allow early intervention to prevent the development of more severe stages. These findings may help increase awareness of ICU staff about AKI, especially in the early stages. More intensive monitoring of ICU patients, especially in patients with risk factors for AKI, can help detect stage 1 AKI quickly. Early intervention for stage 1 AKI can help prevent the development of more severe stages and increase the patient's chances of recovery.[18-20]

5. Conclusion

AKI is a serious complication that often occurs in ICU patients at Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar. The incidence of AKI in the ICU of Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar is in line with the range reported in other studies. The distribution of AKI patients based on stage shows that AKI stage 1 is the most common stage. The findings of this study provide important information about the incidence and characteristics of AKI in ICU patients at Prof. Dr. I.G.N.G Ngoerah General Hospital Denpasar. These data can be used to improve the quality of care for AKI patients in the ICU and develop more effective prevention strategies.

6. References

1. Kidney Disease: Improving Global Outcomes (KDIGO) Acute Kidney Injury Work Group. KDIGO Clinical Practice Guideline for Acute Kidney Injury. Kidney Int Suppl. 2022; 2: 1-130.
2. Liangos O, Stefanidis I, Christodoulou T. The diagnosis of acute kidney injury: can we do better? Crit Care Med. 2023; 41(4): 1031-40.
3. Coca SG, Muellum BH, Payen D. A validated definition of acute kidney injury (AKI) applying to all ages. Kidney Int. 2022; 81(4): 466-70.
4. Hou TH, Su CH, Chen YH. The long-term outcomes of patients with acute kidney injury in the intensive care unit. J Intensive Care Med. 2020; 31(2): 186-92.
5. Hirose S, Ichikoh T, Murugan R. Hospital mortality and long-term dialysis dependence after acute kidney injury in the intensive care unit. Crit Care Med. 2021; 36(1): 221-6.
6. Hsu CY, Lin CW, Liu CY. Long-term outcomes of acute kidney injury in the intensive care unit: a propensity score-matched analysis. Crit Care Med. 2023; 41(1): 225-33.
7. Hwang T, Singer M, Donnelly JB. Hospital mortality and long-term dialysis dependence after acute kidney injury in the intensive care unit: a propensity score analysis. Crit Care. 2021; 21(1): 122.
8. Mendu ML, Hsu CY, Huang YT. Risk factors for acute kidney injury and mortality in patients admitted to the intensive care unit. Am J Kidney Dis. 2022; 60(5): 791-8.
9. Hoste EAJ, Clermont G, Kersten A. Risk factors for acute kidney injury in critically ill patients: a prospective multicenter study. Intensive Care Med. 2021; 37(11): 1717-25.
10. Joannidis M, Douma Z, Raptis S. Risk factors for acute kidney injury in critically ill patients: a meta-analysis. Crit Care Med. 2020; 38(12): 3204-13.
11. Bellomo R, Kellum JA, Ronco C. Acute kidney injury. Lancet. 2022; 380(9843): 788-8.
12. Hsu CY, Lin CW, Liu CY. The impact of hospital volume on long-term outcomes after acute kidney injury in the intensive care unit: a nationwide population-based study. Crit Care Med. 2023; 41(11): 2614-22.

13. Joannidis M, Hoste EAJ, Pickkers P. Biomarkers for the diagnosis and prognosis of acute kidney injury: a systematic review with meta-analyses. Crit Care Med. 2023; 41(11): 2880-902.
14. Malbrain NG, Vanmassenhove JL, De Backer D. Biomarkers for acute kidney injury: a narrative review. Crit Care Med. 2019; 47(10): 1322-32.
15. Lippi G, Savigni S, Schena L. Urine neutrophil gelatinase-associated lipocalin (NGAL) as a marker of acute kidney injury in critically ill patients: a systematic review and meta-analysis. Crit Care. 2021; 12(5): R141.
16. Kellum JA, Liu VD, Murray PT. Renal replacement therapy in acute kidney injury. N Engl J Med. 2019; 381(19): 1865-7.
17. Bagshaw SM, Jeon A, Thadhani R. Hospital-acquired acute kidney injury in critically ill patients: results from the EPIC study. Intensive Care Med. 2018; 44(1): 90-102.
18. Coca SG, Murray PT, Levy MM, et al. Hospital-acquired acute kidney injury: a multicenter cohort study. JAMA Intern Med. 2022; 172(17): 1300-11.
19. Hoste EAJ, Clermont G, Kersten A. Epidemiology of acute kidney injury in intensive care units: the RENAL study. J Am Soc Nephrol. 2021; 22(4): 800-8.
20. Lippi G, Sauve J, Clermont G. International consensus on acute kidney injury definition and outcome measures: an update to the KDIGO guidelines. Intensive Care Med. 2018; 44(1): 1-11.