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Unraveling the Roots: Investigating Etiological Patterns of Acute Kidney Injury in Hospitalized Patients at Khyber Teaching Hospital, Peshawar, Pakistan

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ABSTRACT

Background: Acute kidney injury (AKI) is the main cause of poor outcomes for patients. AKI affects about 13.3 million individuals worldwide annually with eight-five percent living in nations that are developing.

Methodology: It was a cross-sectional study on 74 patients. AKI was diagnosed using the RIFLE criteria, based on serum creatinine levels. Data was collected from patient records, such as demographics, and clinical history. Variables were reported as mean ± SD. Statistical calculation was done using Chi-square test. $P < 0.05$ was considered significant. All the calculations were carried out with the help of software IBM SPSS Statistics 25 version.

Results: This study underscores the impact of HAAKI on patient outcomes, affecting all age groups, with a majority of cases among individuals under 50. The findings highlight infections and trauma, notably sepsis and hypotension, as major causes, making up over two-thirds of HAAKI cases. The severity of kidney injury, classified by the RIFLE criteria, was directly correlated with increased mortality and the need for dialysis, especially for patients in the "Failure" category. Survival outcomes were notably higher for those in the "Risk" stage compared to the "Injury" and "Failure" stages, which experienced higher mortality. This emphasizes the necessity for early detection and management of patients with progressing kidney injury to prevent progression to critical stages. Timely intervention could potentially reduce mortality and improve overall outcomes for HAAKI patients.

Conclusion: HAAKI has significant impact on patient outcomes, showing that sepsis and hypotension are major causes. Mortality risk escalates with RIFLE category severity, particularly in the "Failure" stage. Early identification and proactive management are essential to reduce progression, improve survival, and enhance patient outcomes in HAAKI cases

INTRODUCTION

Acute kidney injury (AKI) poses a significant public health challenge, with high rates of morbidity, mortality, and substantial healthcare expenses. The occurrence of AKI has risen in recent years, affecting individuals in both hospital and community environments. [1,2] It is estimated that over 13 million people globally are affected by AKI each year, with substantial geographic differences based on country, region, and economic status. [1,2] Acute kidney injury (AKI), formerly known as "acute renal failure" (ARF), is a prevalent and serious condition. The Acute Dialysis Quality Initiative (ADQI) introduced a consensus definition and classification for acute renal failure (ARF) in 2002, known as the RIFLE criteria, which include Risk, Injury, Failure, Loss, and End-stage kidney disease stages. [3] In hospitalized patients, AKI is particularly linked to high rates of morbidity and mortality. [4-6] In developed countries, AKI primarily occurs in older

patients and is most often seen in intensive care units. In contrast, in developing nations, it tends to affect adults more frequently, particularly women.[7,8] Despite significant advancements in the field, the mortality rate associated with AKI remains high, estimated at 24% in adults and 14% in children.[2] Most epidemiological studies on AKI have been categorized into two distinct types: (i) hospital-acquired AKI (HAAKI) and (ii) community-acquired AKI (CAAKI).[9,10]

Alongside the high mortality rate, hospital-acquired AKI is linked to substantial resource use, extended hospital stays, prolonged mechanical ventilation, and an increased risk of developing chronic kidney disease (CKD).[11] Recovery from AKI is not always as complete as previously believed, and many patients may go on to develop chronic kidney disease (CKD), progress to end-stage renal disease (ESRD), or experience a deterioration of pre-existing CKD later in life. [12-14] The objective of this study was to evaluate the incidence and etiological patterns of in-hospital AKI at Khyber Teaching Hospital in Peshawar, along with mortality rate.

METHODOLOGY

Study Design

It was a cross-sectional study to evaluate the etiological pattern of hospital-acquired AKI (HAAKI) and related mortality rate.

Study Area

This study was conducted in the Khyber Teaching Hospital, Peshawar, Pakistan.

Study Duration

This study was carried out during the period from 1st July 2024 to 15 October 2024.

Sample Recruitment

A total of 74 patients who developed HAAKI were included in the study during the designated study period.

INCLUSION AND EXCLUSION CRITERIA

Inclusion Criteria

Patients were assumed to have normal kidney function if their serum creatinine level at admission was less than 1.5 mg/dL or their urine output exceeded 0.5 ml/kg/h. AKI was diagnosed using the RIFLE criteria, based on serum creatinine levels. HAAKI was defined as the onset of AKI occurring any time after 48 hours of hospitalization in patients who were admitted with normal renal function. The 48-hour window was chosen to allow the potential development of subclinical CAAKI. To classify patients according to the RIFLE criteria, both peak and baseline creatinine values (taken at admission) were extracted from patient records. The peak creatinine level was identified as the highest serum creatinine value recorded during hospitalization. The study included patients of any age and gender, who met the criteria for HAAKI. All relevant data of the patients like the primary disease for which the patient was admitted, medication, operative or invasive procedure, complications during the course of hospital stay, and co-morbidities were noted.

Exclusion Criteria

Patients of acute on chronic renal failure, CAAKI, and pregnant women developing AKI were excluded.

Data Collection

Data was collected from patient records, such as *demographics* (age, gender), *clinical history* (primary reason for admission, comorbidities, and drug use etc). *Laboratory investigations* (serum creatinine, blood urea nitrogen, and urine output etc). and *Etiological factors* (sepsis, dehydration, nephrotoxic drugs, ischemia, and rhabdomyolysis etc.). The most probable causes of HAAKI were assigned as given below:

a. Nephrotoxic drugs: If a patient had received a drug with known nephrotoxic potential for a minimum period of two days prior to the defined increase in serum creatinine concentration. [15]

b. Sepsis: When two or more of the following were present as a result of systemic infection; (1) temperature >38.0 or <36.0°C; (2) heart rate >90/min; (3) respiratory rate >20/min or pco2 < 32 mm, and (4) white blood cell count >12,000/mm3 or <4000 mm3, or >10% band form. [16]

c. Hypotension: If there was overt/orthostatic hypotension (BP <80 mm hg), because of purely cardiovascular cause. [17]

d. Volume loss: If there was obvious cause of volume depletion along with loss of skin turgor with decrease of more than 5% of body weight. [18]

e. Hospital-acquired Rhabdomyolysis (HAR): If HAAKI was characterized by muscle pain, weakness, swelling, and dark or tea-colored urine, alongside laboratory findings developing after 48 hours of hospitalization, including elevated serum creatine kinase (CK) levels (>1,000 U/L), positive urine dipstick for myoglobin, and contributing factors such as immobility, medication use, or surgical interventions.

(19)

Patients were monitored daily during their hospital stay, but follow-up after discharge was not part of the study. Records of urine output and serum creatinine levels were collected. Renal replacement therapy was initiated based on standard clinical criteria. The outcomes of HAAKI were assessed by treatment outcomes, categorized as either death or discharge with improved renal function. Complete recovery was defined as a serum creatinine level dropping below 1.5 mg/dL and an improvement in urine output during hospitalization.

DATA ANALYSIS

Data was analyzed using IBM SPSS software. Descriptive statistics will be used to summarize patient characteristics and etiologies. Variables were reported as mean ± SD. Statistical calculation was done using Chi-square test. $P < 0.05$ was considered significant.

RESULTS

There were total 40698 admissions in Khyber Teaching Hospital, Peshawar during the period from 1st July 2024 to 15th October 2024. Among these, 74 patients reported to meet criteria of HAAKI (0.0018%). The age distribution of the 74 patients included in the study, showing a mean age of 47.47 years with a standard deviation of 14.92 years. Majority of patients (64.9%) were under 50 years of age, followed by 25.7% between 50-65 years, and 9.5% over 65 years (figure 1). The age distribution suggests that HAAKI affects individuals across all ages without a particular age group being exempt, reinforcing that no age group is immune to the condition, particularly in the hospital setting covered in this dataset. This highlights the importance of monitoring for HAAKI across all age demographics.

In this study, the primary diseases at the time of admission among the 74 patients who developed HAAKI were diverse. The most frequent condition was lower respiratory tract infection (LRTI) with sepsis, accounting for 10.8% of the cases. Gastrointestinal (GIT) bleeding and traffic accidents were each responsible for 8.1% of the admissions. Several other diseases had lower, but notable frequencies, such as coronary artery disease and septicemia with cellulitis, both contributing to 6.8% of the cases. Cirrhosis, liver abscess, pneumonia, malignancy, and intestinal obstruction each represented 5.4% of the cases. Conditions such as acute viral hepatitis, malaria, dengue, intestinal perforation, encephalitis, and urosepsis were less common, each accounting for 2.7% of the admissions. Overall, the distribution of primary diseases at admission highlights a wide range of medical conditions contributing to the development of HAAKI, with infections and trauma-related conditions being prominent causes (Table.1).

Figure 1

This table shows that the majority of patients (64.9%) were under 50 years of age, followed by 25.7% between 50-65 years, and 9.5% over 65 years. (n=74)

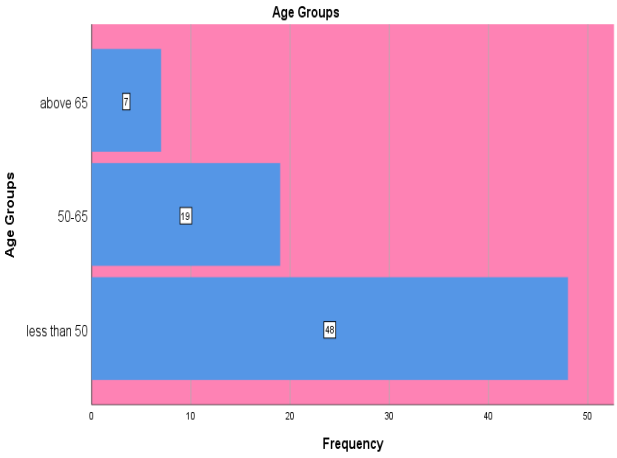


Table 1

Distribution of primary diseases at the time of admission among patients who developed HAAKI (n=74).

Primary Disease at time of admission	Frequency	Percent
Cirrhosis	4	5.4
Liver abscess	4	5.4
Acute viral hepatitis	2	2.7
Pneumonia	4	5.4
Malaria	2	2.7
Dengue	2	2.7
Psoas abscess	3	4.1
Coronary artery disease	5	6.8
Malignancy	4	5.4
Traffic accidenT	6	8.1
Breast abscess	3	4.1
Intracerebellar hemorrhage	3	4.1
Appendicitis in shock	3	4.1
GIT bleeding	6	8.1
Intestinal perforation	2	2.7

Intestinal obstruction	4	5.4
Septicemia with cellulites	5	6.8
Encephalitis	2	2.7
LRTI with Sepsis	8	10.8
Urosepsis	2	2.7
Total	74	100.0

The data on the causes of HAAKI reveals that sepsis is the most prevalent cause, accounting for 37.8% of cases. This is followed by hypotension, which contributes to 28.4% of instances. Drugs are implicated in 16.2% of cases, while volume loss and rhabdomyolysis account for 9.5% and 8.1%, respectively. Collectively, these top four causes explain 91.9% of HAAKI cases, highlighting the significant impact of sepsis and hypotension in the development of this condition (Table 2).

Table 2

Causes of HAAKI (n=74).

Causes of HAAKI		
	Frequency	**Percent**
Sepsis	28	37.8
Volume loss	7	9.5
Drugs	12	16.2
Hypotension	21	28.4
Rhabdomyolysis	6	8.1
Total	74	100.0

In the study, 63.5% of the patients experienced oliguria, while 36.5% did not. The distribution of patients across the RIFLE categories for acute kidney injury (AKI) was as follows: 58.1% of the patients were classified in the "Risk" (R) category, 9.5% in the "Injury" (I) category, and 32.4% in the "Failure" (F) category (Table 3).

Table 3

Distribution of Patients According to RIFLE Categories for Acute Kidney Injury (n=74)

RIFLE Categories		
	Frequency	**Percent**
R	43	58.1
I	7	9.5
F	24	32.4
Total	74	100.0

Additionally, out of the total seventy four, 9 patients (12.2%) required dialysis during HAAKI, while 65 patients (87.8%) did not require dialysis**.** Only patients in the "Failure" (F) category required dialysis, suggesting a significant correlation between the severity of kidney injury (RIFLE Category F) and the need for dialysis. Patients in the "Risk" and "Injury" categories did not require dialysis, indicating that dialysis needs increase significantly as patients progress to the "Failure" stage in the RIFLE classification (Figure 2).

The analysis investigated the relationship between RIFLE categories (Risk, Injury, and Failure) and patient mortality among 74 individuals with HAAKI. In the Risk category, all 43 patients survived, resulting in a 0% mortality rate. In contrast, the Injury category comprised 7 patients, with 3 surviving and 4 succumbing to their condition, leading to a mortality rate of 57.1%. The Failure category included 24 patients, of whom only 4 survived, resulting in a high mortality rate of 83.3%. Overall, 67.6% of patients survived, while 32.4% experienced mortality, indicating a clear trend of decreasing survival rates as the severity of AKI increased. Statistical analysis supported these findings, with the Pearson Chi-Square test yielding a p-value of .000, indicating a highly significant association between RIFLE categories and mortality outcomes. Additionally, the Fisher's Exact Test produced an exact significance of .000. These results highlight the critical correlation between the severity of AKI, as classified by the RIFLE criteria, and the patient mortality (Figure 3).

Figure 2

Relationship between RIFLE categories (Risk, Injury, and Failure) and dialysis requirement (n=74).

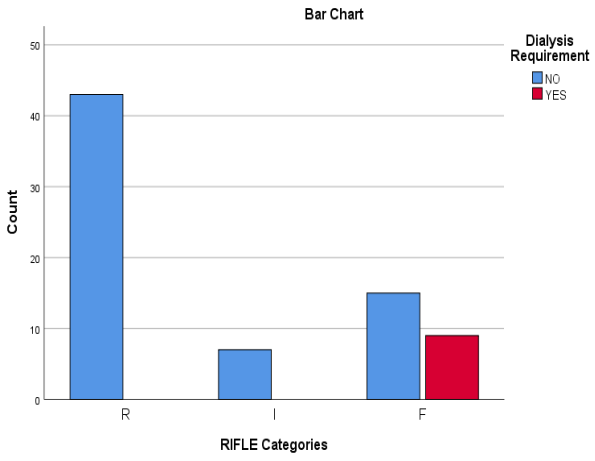
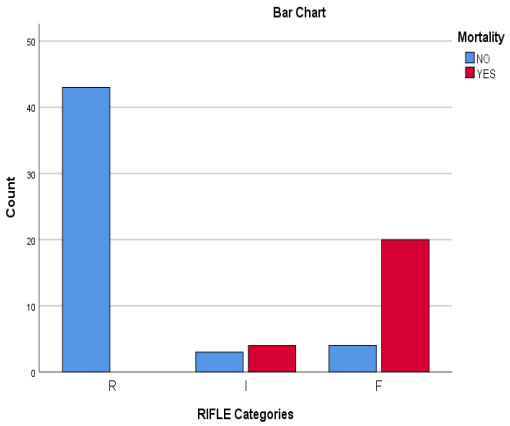


Figure 3

Relationship between RIFLE categories (Risk, Injury, and Failure) and patient mortality (n=74).



The data clearly illustrated a strong association between the severity of acute kidney injury, as classified by the RIFLE criteria, and patient mortality. Patients in the Risk category exhibit excellent survival outcomes, whereas those in the Injury and Failure categories experience significantly increased mortality rates. This emphasizes the importance of early identification and intervention in patients with worsening kidney function to improve survival outcomes.

DISCUSSION

HAAKI is a frequent and severe complication in hospitalized patients, impacting individuals across all age groups, genders, geographic locations, and religions.[15,16] In our hospital, the rate of HAAKI was 0.0018%. In contrast, higher incidences of HAAKI have been reported in other studies conducted in India [17] with even greater rates of AKI in hospitalized patients observed at other centers, ranging from 1% to 4.9%. [18-20] The lower incidence of HAAKI among our patients may be attributed to advancements in the healthcare system and the implementation of effective treatment modalities compared to previous decades. The age distribution suggests that HAAKI affects individuals across all ages without a particular age group being exempt, reinforcing that no age group is immune to the condition, particularly in the hospital setting covered in this dataset. This highlights the importance of monitoring for HAAKI across all age demographics. This is supported by another studies in India.[21]

The most frequent primary condition at time of admission in our study among patients developing HAAKI was lower respiratory tract infection (LRTI) with sepsis, accounting for 10.8% of the cases. In other studies, this pattern was variable, in Indian study, hepatobiliary diseases were the most common primary disease at admission (25.49%) among the HAAKI patients followed by respiratory tract diseases (23.5%).[21]

In the present study, sepsis was the most prevalent cause of HAAKI, accounting for 37.8% of cases, whereas sepsis was the commonest cause in surgical and ICU patients developing HAAKI in an India Study.[21] Additionally, in our study out of the total seventy four HAAKI patients, 9 patients (12.2%) required dialysis during HAAKI, while 65 patients (87.8%) did not require dialysis.

Finally, in our study, 32.4% patients with HAAKI experienced mortality, whereas overall mortality in Indian study was 51.3%. [21] Similar to our finding, the reported rate of mortality of HAAKI ranges from 25% to 70%. [22-24]

CONCLUSION

This study underscores the complexity and critical nature of HAAKI across diverse age groups and medical conditions. Despite HAAKI affecting patients of all ages, no specific age group is immune, emphasizing the need for vigilance across all demographics, especially in a hospital setting. The incidence of HAAKI, although low at 0.0018% among admissions, predominantly stems from severe infections, such as sepsis, and other high-risk factors, including hypotension, volume loss, and drug toxicity. The analysis demonstrates that infectious and trauma-related conditions are key contributors to HAAKI, and that sepsis alone accounts for nearly one-third of cases, establishing it as a primary etiological factor.

The RIFLE classification system provides essential insights into the severity and progression of HAAKI, correlating strongly with both dialysis requirements and mortality outcomes. Patients in the "Failure" category had the highest need for dialysis and the greatest mortality rate (83.3%), in stark contrast to the "Risk" category, where no mortality was observed. This pattern highlights the escalating risk of adverse outcomes as HAAKI severity increases, making early detection and timely intervention essential. The statistically significant association between RIFLE categories

and patient mortality reinforces the clinical utility of RIFLE criteria in stratifying risk and informing treatment decisions.

In summary, this study emphasizes the need for continuous monitoring of high-risk patients, early intervention for those with worsening kidney function, and heightened awareness of HAAKI's multifactorial causes to improve patient outcomes.

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