Original Article

Outcome of Acute Kidney Injury (AKI) Patients in the Intensive Care Unit of Enam Medical College & Hospital During the Period of July 2018 to May 2019

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Abstract

Background: *Acute kidney injury (AKI) is a public health issue associated with multiple clinical conditions which may occur due to slight elevation in serum creatinine to anuric renal failure with electrolytes and acid-base imbalance, chronic kidney diseases, end-stage renal diseases, impaired innate immunity associated with higher infection rate, and increased duration of hospital stay with higher cost. Sometimes severe AKI patients may need intensive care support and renal replacement therapy. Severe sepsis is the most common cause of ICU admission.* ***Materials and Methods:*** *This observational study was conducted during the period of July 2018 to May 2019 in the Department of Anesthesiology and Intensive Care Unit of Enam Medical College & Hospital, Savar Dhaka. A total of 87 AKI patients were selected among which 48 were male and 39 were female. Acute kidney injury was selected with an increase in serum creatinine >0.3 mg /dL within 48 hours or ≥1.5 mg /dL from the base line within prior 7 days or urine volume <0.5mL/kg/hour. The last recorded lowest value or value within 24 hrs before admission was considered as baseline S. creatinine. Staging was done according to the KDIGO classification. Chronic Kidney Diseases (CKD) patients and acute on chronic kidney diseases patients aged <18 years were excluded from our study.* ***Results:*** *Highest age group was between 41 to 60 years. According to KDIGO definition 27.58% fell in stage-I, 39.8% in Stage-II and 33.33% in Stage-III. Hypertension (34.48%) and diabetes (24.18%) were found common co-morbid conditions. The most common indication for admission in ICU was septicemia (21.83%). Other causes include pneumonia and other respiratory illness (18.39%), gynae and obstetrical cases (16.09%) AGE (acute gastroenteritis) 13.79%, poisoning 9.19%, polytrauma 8.0%, cardiac diseases 6.89%, cerebrovascular diseases 3.44%, malignancy 2.29%. Total 62.06% (54) patients needed ionotropic support, 55.17% (48) needed artificial ventilation. 26.4% patients needed renal replacement therapy (8.04% HD, 12.64% SLED, 5.74% CRRT). Finally, 66 (75.86%) patients survived among which 59 (67.81%) recovered completely from AKI, 7 (8.04%) turned into CKD and 21 (24.13%) expired.* ***Conclusion:*** *Early detection and extensive ICU management may lead to full recovery of renal function which ultimately reduces adverse outcomes, renal replacement therapy and AKI-related morbidity and mortality.*

Key words: *Acute kidney injury; AKI in critically ill patients; Kidney diseases*

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Introduction

Acute Kidney Injury (AKI) is a condition where there is a sudden and often reversible loss of kidney functions over days to weeks and is often accompanied by reduction of urine volume.[1] It has replaced the term 'Acute Renal Failure' in 1917. During the First World War, it was described as 'War Nephritis'.[2]

AKI is a complex disorder that comprises the entire spectrum of acute renal failure for which currently there is no accepted definition. To establish a uniform definition for AKI, in 2012 the KDIGO[3,4] (Kidney Diseases Improving Global Outcomes) group combined elements from prior definitions such as AKIN, RIFLE. According to KDIGO AKI can be defined as any of the followings: increase in serum creatinine by ≥0.3 mg/dL (≥26.5 μmol/L) within 48 hours; or increase in serum creatinine ≥1.5 times baseline, which is known or presumed to have occurred within the prior 7 days; or urine volume <0.5 mL/kg/hour for 6 hours and Staging is based on both urine output and serum creatinine concentrations as follows:

Staging of AKI

Nowadays AKI has become a major public health issue affecting about 21,000 per million populations.[5] It is associated with multiple clinical conditions, leading to increased morbidity, mortality or may turn into slight elevation in serum creatinine to anuric renal failure.[6]

AKI is more common in ICU patients than other general medical or surgical wards. Usually 5%[7]of all hospitalized patients and 30% of intensive care unit patients develop acute kidney injury[8] and of them up to 20% require RRT.[1]

AKI is anatomically classified into three categories[1]**: pre-renal** - kidney hypoperfusion leads to decreased GFR, **renal causes -** intrinsic kidney diseases, primary insult affects the kidney itself, **post-renal causes -** obstructive uropathy or obstruction to urine.

AKI usually presents with a wide range of signs and symptoms[9] which may include abnormal laboratory findings without clinical symptoms, fluid overload, hyperkalemia, hyponatremia, hypocalcemia, hypercalcemia, hyperphosphatemia, hypomagnesemia, hyperuricemia, metabolic acidosis, anemia, bleeding diatheses, increased risk of infection, multi-organ dysfunction including cardiovascular dysfunction, respiratory failure, gastrointestinal complications, and neurological disorder.

Sudden decrease in glomerular filtration rate (GFR) represents with an increase in serum urea and creatinine (usually 1−2 mg/dL/day), Urine output less than 400−500 mL/day or less than 20 mL/hour in a high-risk patient in the absence of volume depletion indicates the presence of AKI.[9]

The common causes of AKI are ischemia, hypoxia and nephrotoxicity which cause vasoconstriction, endothelial damage, activation of inflammatory process, low renal blood flow and decreased GFR. However, a prolonged decrease in renal perfusion causes irreversible ischemic damage leading to ischemic AKI.[10] Sepsis is the most common causes of AKI usually found in the intensive care unit.[11] In developing countries, some community-acquired AKI[12] are also found in ICU in patients admitted for other reasons such as diarrheal diseases, leptospirosis, dengue, animal venoms, surgical complications, obstetric complications, trauma etc.

Stage	Serum creatinine	Urine output
1	1.5–1.9 times baseline or ≥0.3 mg/dL (≥26.5 mmol/L) increase	<0.5 mL/kg/h for 6–12 hours
2	2.0–2.9 times baseline	<0.5 mL/kg/h for ≥12 hours
3	3.0 times baseline or increase in serum creatinine to ≥4.0 mg/dL (≥353.6 mmol/L) or Initiation of renal replacement therapy or, in patients <18 years, decrease in eGFR to <35 mL/min per 1.73 m^2	<0.3 mL/kg/h for ≥24 hours or Anuria for >12 hours

The risk factors of AKI includes pre-existing kidney diseases, sepsis, hypertension, diabetes mellitus, trauma, hypovolemia, multiple myeloma, age more than 55 years, exposure to nephrotoxic agents, antibiotics, methotrexate, cisplatin, intravenous immunoglobulin, use of intravenous contrast, acute coronary syndromes, liver or heart failure etc.[13,14]

Survivors of AKI patients may develop CKD, and dialysis dependent end-stage renal diseases (ESRD).[15] Nephrologists can play a vital role along with ICU specialist in the intensive care unit during managing AKI cases for better outcome as well as to minimize the progression of CKD[16] and other complications.

Management should be started from the maintenance of volume homeostasis, correction of biochemical and hematological abnormalities (anemia, uremic platelet dysfunction), correction of the underlying causes of AKI, avoidance of nephrotoxic agents (radio- or chemotherapeutic agents, antibiotics, heavy metals, NSAIDs, ACE or Angiotensin-receptor blocker etc.) and supportive treatment such as correction of fluid overload by frusemide, severe acidosis with bicarbonate[17], hypoalbuminemia with albumin. Intravascular volume deficit can be corrected with isotonic fluid in accordance with measuring central venous pressure along with the optimization of cardiac function. In case of severe hypotension vessopressor can be used with a goal to maintain mean arterial pressure ≥65 mm Hg.[18,19]Acute tubular necrosis should be treated with discontinuation of the initiating medications.[20] Post-renal (obstructive) AKI should be treated by mechanical relief of the obstruction. Perioperative acute kidney injury[21] is the most common among different types of perioperative organ injury which can be prevented by optimization of normal hemodynamic status, discontinuation of nephrotoxic drugs, expert hand surgery and early RRT.[22]

Severe AKI should be managed by renal replacement therapy (RRT)[23-25] which include intermittent hemodialysis (IHD), continuous renal replacement therapy (CRRT), prolonged intermittent RRT (PIRRT), peritoneal dialysis (PD), extended duration dialysis (EDD) or sustained low-efficiency dialysis (SLED), continuous veno-venous hemofiltration (CVVH).

The aim of our study was to identify the incidence, severity and outcome of AKI patients in the Intensive Care Unit who were admitted for other reasons.

Materials and Methods

This longitudinal type of observational study was conducted in the Department of Anesthesiology and Intensive Care Unit of Enam Medical College & Hospital, Savar, Dhaka. The study was conducted during the period of July 2018 to May 2019. Total 1506 patients were admitted in the ICU during the study period. Among them 87 (5.77%) AKI patients were selected with 48 (55.17 %) male and 39 (44.8%) female.

Acute kidney injury cases were selected with an increase in serum creatinine >0.3 mg/dL within 48 hours or ≥1.5 from the base line within prior 7 days or urine volume <0.5 mL/kg/hour. The lowest value or level within 24 hours before admission was considered as baseline serum creatinine. Staging was done according to the KDIGO classification. Development of AKI (before or during ICU admission) was recorded. Data were recorded in a 'Preformed Record Sheet'. After admission into the ICU at first primary resuscitation was done, then detailed history was taken including co-morbidities, past history, drug history especially about nephrotoxic drugs. Initial vitals, oxygen saturation, heart and lungs findings, anemia, edema, Glasgow coma scale etc were observed and recorded. Central venous cannulation was done where necessary. All patients were monitored as per our ICU protocol. Necessary laboratory investigations such as arterial blood gas analysis, CBC, urine RME, serum creatinine, serum urea, serum electrolytes, SGPT, HBsAg, anti-HCV, X-ray chest, ECG etc. were done. The treatment protocol was taken as per consultation with ICU specialist, nephrology, respiratory medicine, and internal medicine specialist. In special circumstances, opinion was taken from cardiologist, gastroenterologist, neurologist, oncologist, obstetricians and gynecologists.

Initial management was started with maintenance of volume homeostasis, correction of biochemical and hematological abnormalities, fluid overload, hypoalbuminemia, acid-base abnormalities and

avoidance of nephrotoxic agents with strict monitoring of the vitals with special emphasis on intake output chart of the patients.

Afterward, RRT was advised according to the severity of the patients. Femoral or jugular venous catheterization was done in those patients who needed dialysis. After improving the patients' condition when ICU support was no longer required all patients were shifted to the respective wards. After discharge from ICU patients were followed-up for 90 days.

CKD patients, acute on chronic kidney diseases and patients aged <18 years were excluded from the study. In our study, patients were divided into three socio-economic classes based on their monthly income. Patients' whose monthly income was more than 10,000 taka, were included in middle class, from 5,000 taka to 10,000 taka were included in low income class and less than 5,000 taka were included in least income class. Statistical analysis was done using SPSS 20.0 version. All data are presented as mean ± SD. Student's t-test was applied to compare normally distributed means. A p-value <0.05 was considered statistically significant.

Results

Table I shows distribution of study population according to age group. Mean age was found 49.88 years with standard deviation 17.22. p value was found 0.000. All the patients found with AKI during the study period were categorized according to KDIGO definition as Stage-I, Stage-II, and Stage-III (Table II).

Table I: Distribution of patients according to age group

Age group in years	Frequency	Percentage
18–40	27	31.03
41–60	34	39.08
61–80	23	26.43
>81	03	3.44
Total	87	100

Table II: Staging of AKI according to KDIGO definition

Stage	Frequency	Percentage
Stage-I	24	27.58
Stage-II	34	39.08
Stage-III	29	33.33
Total	**87**	**100**

During the study, common co-morbidities found were hypertension 30 (34.48%), diabetes mellitus 21 (24.13%), COPD 16 (18.39%), others 20 (23.0%) with hypertension being the most common (Fig 1).

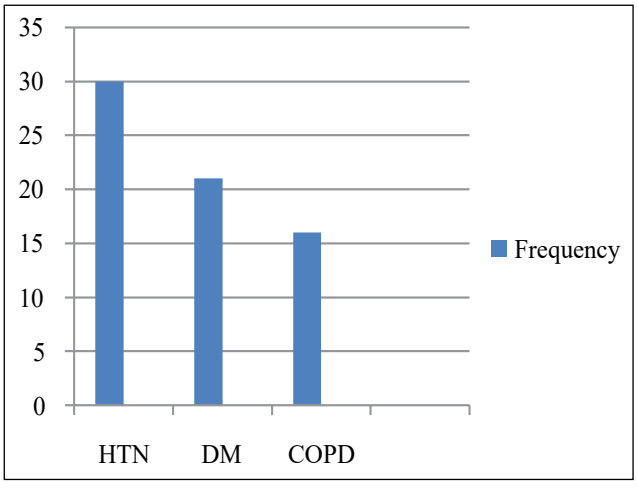

Fig 1. Frequency of co-morbidities

Socioeconomic status plays a vital role in progress of any diseases. In our study 54 (62.06%) patients came from middle class, 21 (24.13%) from low-income class and 12 (13.79%) patients from least income class.

The common primary diseases for which the study people were admitted as pneumonia and other respiratory causes (16/18.39%), septicemia (19/21.83%), polytrauma following accidental injury (7/8.04%), poisoning including OPC, alcohol, snakebite, drug etc.(8/9.19%), cerebrovascular diseases including meningitis, ischemic and hemorrhagic stroke (3/3.44%), cardiovascular diseases including MI, IHD, LVF (6/6.89%), gynecological and obstetrical cases including hemorrhagic shock, DIC, eclampsia, IUD etc. (14/16.09%), acute gastroenteritis (12/13.79%) and malignancy (2/2.29%) are shown in Fig 2.

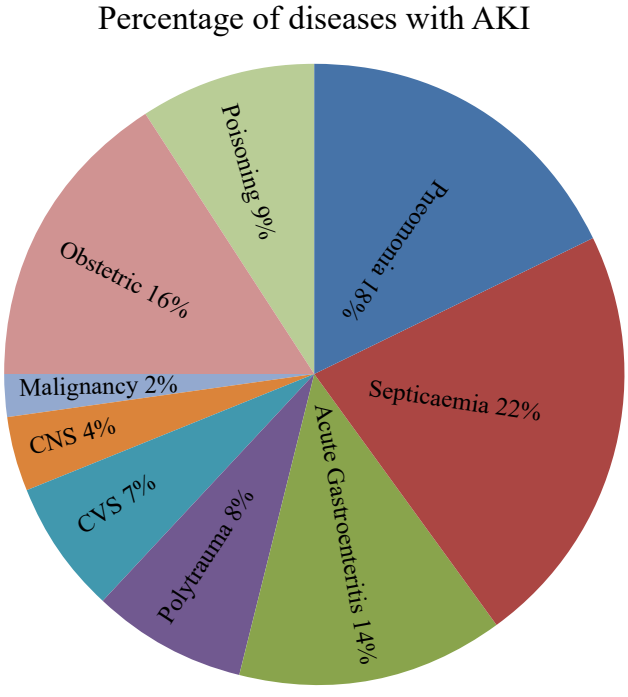

Fig 2. Primary diagnosis of diseases with AKI

In our study ionotropic support was needed for 54 (62.06%) patients. The need for artificial ventilation was observed in 48 (55.17%) patients among which 56.25% (27/48) were successfully weaned off from ventilation.

Out of 87 patients, 23 (26.4%) were advised for RRT among which 07 (8.04%) received HD, 11 (12.64%) received SLEED, 05 (5.74 %) received CRRT the rest 64 patients did not require any type of renal replacement therapy and were improved by conservative treatment (Fig 3).

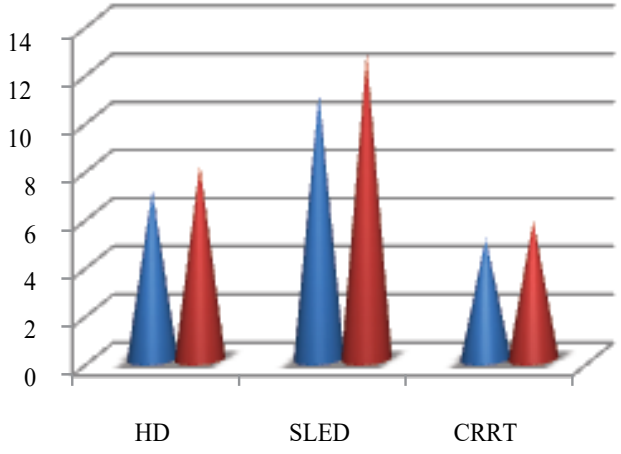

Fig 3. Showing the frequency and percentage of RRT

At the end of the treatment total 66 (75.86%) patients survived among which 59 (67.81%) completely recovered from AKI, 7 (8.04%) developed CKD and 21 (24.13%) expired (Table III), p value was found 0.004.

Table III: Outcome of treatment of AKI patients

Outcome	Frequency	Percentage
Survived	66	75. 86
Recovered	59	67.81
Developed CKD	07	8.04
Expired	21	24.13

The stay time in the ICU played an important role. In our ICU 29 (33.33%) patients stayed only for 1 to 3 days, 38 (43.67%) patients stayed for 4 to 7 days, 14 (16.09%) patients stayed for 8 to 10 days, and 06 (6.89%) patients stayed for >10 days (Fig 4).

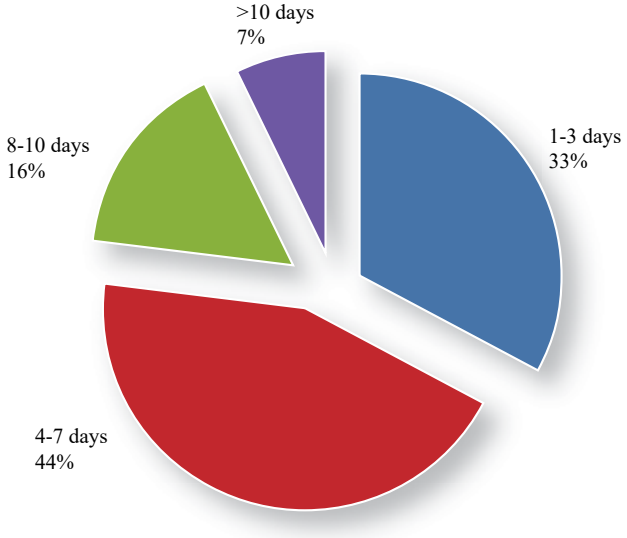

Fig 4. Duration of ICU stay

Discussion

AKI in ICU is becoming a global health problem with clinical and economic consequences both in developed and developing countries.[26,27] It increases in hospitalized patients which ultimately leads to prolonged hospital stay, RRT, development of CKD, increased short- and long-term morbidity and mortality or ESRD.[28] Bagshaw et al[29] found that incidence of

AKI in ICU increased 2.8% annually from 1996 to 2005. The International Society of Nephrology set a goal of eliminating preventable deaths from AKI by 2025 but implementation of this program is a great challenge in developing countries.[30]

Hashemainan et al[31] showed that 33% of all ICU admitted patients developed AKI and Koez et al[32] found 20% AKI in ICU. In our study we found only 5.77% (87/1506) which is comparatively lower than the above findings studies. But Oldimeji[33] found 4.7% AKI which is lower than our study findings.

Advanced age plays a vital role in developing AKI and is often associated with significant morbidity, mortality, and health care costs.[34,35] In addition, more frequent exposure to medications and interventions, alterations in drug metabolism and clearance lead to increased incidence of AKI.[36] Kader et al[36] showed that in a Spanish hospital the incidence of AKI was 3.5 times higher in patients older than 70 years than their younger counterparts and in an Italian hospital the elderly (≥65 years) had 10 times the incidence rate of AKI compared to those <65 years of age. The common age group in our study was between 41 to 60 years (39.08%). In their study Mahmood et al[37] also found higher incidence between 41 to 60 years (42.37%) which is almost similar to our study.

Several studies showed that incidence of AKI was more in male than female. Fatema et al[38] found 67.4% male, Hasmeninan et al[31] found 57.6%, Aylward et al[39] found 58.9% male, Anaele et al[40] found 54.5%, Mahmud et al[37] found 54.23% male, and we found 55.17% were male.

Co-morbidities such as hypertension, DM, IHD, COPD, bronchial asthma and other pulmonary diseases play a vital role in developing AKI in ICU. In our study we found most common co-morbidities were HTN (34.48%), DM (24.13%) and COPD (18.39%). Anaele et al[40] found HTN 53.4%, DM 31.8%, COPD 11%. Schiffi et al[41] found HTN 48%, DM 22%, COPD 14%. Hamid et al[42] found 38.1% HTN, 28.8% DM, and 22.9% pulmonary diseases.

In our study, staging of AKI was done by KDIGO classification. We found 27.58% patients were in stage-I, 39.08% as stage-II, 33.33% were found as stage-III. In a study, Potter et al[43] found 50% as stage-I, 19% as Stage-II, 31% as stage-III. On the other hand, Santos et al[12] found 33.7% stage-I, 29.4% stage-II, and 36.9% stage-III.

For the critically ill patients sepsis is the major cause of AKI, usually 15–20% of patients with sepsis-associated AKI are found in the ICU, also related to morbidity and short term mortality.[44,45] We found that the common indications for ICU admission were: septicemia 21.83% (19/87), pneumonia and other respiratory illnesses 18.39% (16/87), gynaecologic and obstetric cases 16.09%, hypovolumic shock following AGE 13.79%, poisoning 9.19%, polytrauma 8.0%, cardiac diseases 6.89%, cerebrovascular diseases 3.44%, malignancy 2.29%. Severe sepsis usually hampers renal perfusion which is characterized by profound inflammatory response leading to multi-organ failure. A study by ElHafeez et al[46] found 36% sepsis-induced AKI which is slightly higher than in our study. Hussain et al[47] found 20.2% septicemic patients which is almost similar to our study, pulmonary cases 23.4%, malignancy 3.2% which are also closer to our study, but their cerebrovascular diseases (16.9%) and cardiovascular diseases (21.8%) cases are higher than our study which may be due to separate neuro and cardiac ICU in our hospital. In a study Hamid et al[42] found 5.0% trauma patients which is little lower than our study (8.04%). ElHafeez et al [46] found 14% trauma patients which is higher than our study. Some obstetric cases such as sepsis, PPH, eclampsia, HELLP syndrome are the major etiologic factors for developing Pregnancy Related Acute Kidney Injury (PRAKI).[48] In our study we found about 16.09% PRAKI. A study by Ferreira et al[49] found 27.8% PRAKI which is higher than our study. Study by Najar et al[50] found 7.2% PRAKI which is lower than our study.

In our study as a part of respiratory support mechanical ventilation was needed for 55.17% (48/87) patients. But Ponce et al[51] found it 89.2%, Schiffi et al[41] 75%, and Santos et al[12] 65.2%. All of these are higher than our study findings. Anaele et al[40] found it 33.0% which is lower than our study. Fatema et al[38] found that 58.1% patients required mechanical ventilation,

which is almost similar to our study.

In case of unstable hemodynamic status vasopressors or ionotropic support is routinely needed to maintain stable hemodynamic status and to prevent acute tubular necrosis which is a consequence of severe renal hypoperfusion. Vasopressin increases urinary secretion and dopamine increases renal plasma flow, GFR, urinary sodium excretion and urine output.[52] Early reversal of hemodynamic instability usually leads to full recovery. In our study 62.66% patients needed vasopressor or ionotropic support. In the study of Schiffi et al[41] 58% patients needed vasopressor or ionotropic support. Anaele et al[40] found it 40.8% which is lower than our study. Ponce et al[51] found it 78.3%, Fatema et al[38] found it 69.8% which are slightly higher than our study findings.

Usually conservative management may recover AKI but sometimes severe AKI patients need RRT in order to restore kidney function and to prevent further damage particularly to those patients who are hemodynamically unstable.[53] In ICU intensivists generally prefer CRRT than other methods especially for hemodynamically unstable patients as large amount of "Convective Clearance"[54] is achieved through this method. It also permits gradual fluid and solute removal along with greater hemodynamic stability. Besides CRRT nowadays SLEDD is becoming more popular because of logistic burden of CRRT, including the necessity of anticoagulants and high cost.[55,56]

In our study 26.4% patients needed RRT. Hamid et al[42] found it 22.9% RRT which is almost similar to our study. In another study, Peerapornratana et al[57] found it 19.4% which is lower than our study. Ali et al[58] found that 7.8% required RRT which is also lower than our study findings.

Despite proper intense care sometimes death cannot be avoided. In our study we faced 24.13% mortality. A study by Bouchard et al[59] found 22.0% mortality which is almost similar to our study. Hossain et al[47] found it 18.55%, Aylward et al[39] found 13.4%, El-Badawy et al[60] found 14% mortality, both are lower than our study. Anaele et al[40] found 28.5%, Levy et al[61] found 34%, Hafez et al[62] found 35% mortality, all of which are higher than our study findings.

Acute kidney Injury commonly found in the intensive care unit is caused by multiple risk factors. This may lead to adverse outcomes such as CKD, ESRD, increased morbidity, mortality, high cost etc. Increase in awareness of the health care workers, continuous medical education (CME) and training programs for doctors and hospital staffs, updated treatment guidelines, health education programs for all by government and NGOs, international and local nephrology societies, more studies related to AKI, early detection of incidence and quick reversal of abnormal hemodynamic condition may lead to full recovery of renal function, thereby reduce the incidence of morbidity and mortality.

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