

## Screening of Acute Kidney Injury among Critically Ill Patients (Based On RIFLE, KDIGO and AKIN Criteria) In ICU Patients

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**Abstract: Background:** It is now well known that AKI affecting large number of ICU patients with variable incidence, which increases risk of death especially in patients who need RRT. **Aim of the work:** This study aims to screen the critically ill patients admitted to El-Sahel Teaching Hospital cardiac and medical ICUs for acute kidney injury that based on RIFLE, KDIGO and AKIN criteria. **Patients and Methods:** In a cross-sectional study, Patients were screened for AKI during the interval from May 2017 to May 2018, using RIFLE, KDIGO and AKIN criteria. All patients enrolled in the study have subjected to full history taking and thorough clinical examination. The severity of illness of patients admitted to ICUs was assessed using SOFA score. **Results:** Hospital acquired AKI in ICU was documented in 73.26% (200/273). The most independent risk factor for developing AKI was sepsis according to the multivariate logistic analysis (p value: 0.001, estimated odds ratio: 0.217 and confidence interval between 0.086 and 0.547). Dehydration comes in the second place (p value: 0.020, estimated odds ratio: 0.424 and confidence interval between 0.205 and 0.874). Regarding the outcome of AKI, 71/200 (35.5%) patients show improvement ranging from less severe (RIFLE, AKIN and KDIGO) class to baseline; 40/200 (20%) discharged with full renal recovery, 31/200 (15.5%) discharged with partial renal recovery. 69/200 (34.5%) received RRT and 23/200 (11.5%) patients were discharged on chronic hemodialysis for further follow up. Mortality in the patients with AKI was 106/200 (53%) (10 patients in class R or stage 1, 30 patients in class I or stage 2 and 66 patients in class F or stage 3). On the other hand, mortality in the patients without AKI was 43/73 (58.9%).

**Conclusion:** AKI incidence in El-Sahel Teaching Hospital ICU is 73.26%. The most independent risk factor of AKI in ICU is sepsis. AKI, especially class F or stage 3, has a significant risk in mortality.

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**Keywords:** Screening; Acute Kidney Injury; Patient; Mortality

### 1. Introduction

Acute kidney injury (AKI) is a syndrome that affects a marked proportion of critically ill patients and is associated with high consumption of healthcare resources, particularly when renal replacement therapy (RRT) is administered<sup>(1)</sup>.

AKI is associated with 90-day mortality up to 34% and an increased mortality attributable to AKI persists up to 10 years after hospital discharge. Even mild AKI is associated with markedly increased long-term mortality<sup>(2,3)</sup>.

Generally, AKI is the syndrome arising from a rapid fall in kidney filtration ability (over hours to days). It is characterized by retention of both nitrogenous (including urea and creatinine) and non-nitrogenous waste products of metabolism, as well as disordered electrolyte, acid base, and fluid homeostasis. It may occur either preceding normal renal functions or pre-existing renal disease as acute on top of chronic<sup>(4,5)</sup>.

A spectrum of conditions susceptible to AKI was identified, including cardiovascular disease, infections and sepsis, complications from medical care and injury<sup>(6, 7)</sup>. Thus, we may have benefit for better identification of modifiable risk factors to prevent the development of renal failure in critically ill patients after studying AKI rationalities in intensive care units (ICUs).

Major key elements have been fulfilled from which only one criterion needs to be present to define AKI. These elements include increase in serum creatinine more than or equal to 0.3 mg/dl within 48 hour, increase in serum creatinine more than or equal to 1.5 fold from baseline and decrease urine volume less than 0.5 ml/kg/hr for 6 hours<sup>(8)</sup>.

Acute tubular necrosis (ATN) is the commonest diagnosis in AKI especially in critically ill patients and the principal contributing factors are ischemia, nephrotoxic medications and sepsis<sup>(9)</sup>.

### Aim of the Work

This study aims to screen the critically ill patients admitted to El-Sahel Teaching Hospital cardiac and medical ICUs for acute kidney injury that based on RIFLE, KDIGO and AKIN criteria, thus, we may have benefit for better identification of modifiable risk factors to prevent the development of renal failure in critically ill patients.

## 2. Patients and Methods

### 1. Study setting and sampling:

This study was conducted on 273 patients admitted to El-Sahel Teaching Hospital in cardiac and medical intensive care units (CICU and ICUs) during twelve months duration (from May 2017 to May 2018).

### 2. Study subject:

All subjects in the study during the twelve months period will be screened for AKI during hospitalization.

### 3. Study design:

This study is a cross-sectional one.

### 4. Data collection:

**All patients enrolled in this study will undergo the following:**

- Complete present and past history from patient or the relative for:

- Cardiac morbidity (old and recent cardiac events).

- Surgical and medical history.

- Medication history.

- General and local examination.

- Severity of illness in ICU patients will be assessed using the Sequential Organ Failure Assessment (SOFA) score.

### 5. Screening:

Screening of patients will be evaluated using RIFLE, KDIGO and AKIN criteria.

- **Serum creatinine:**

- Serum creatinine was done by Kinetic colorimetric method.

- Its reference values <sup>(10)</sup>:

- Adult male: 0.6 - 1.4 mg/dl

- Adult female: 0.5 – 1.1 mg/dl

- **Glomerular filtration rate (GFR):**

- GFR was calculated by modification of diet in renal disease (MDRD) formula

- $GFR = 186 \times (\text{seum creatinine})^{-1.154} \times (\text{Age})^{-0.203} \times (0.742 \text{ if female}) \times (1.210 \text{ if black})$  <sup>(11)</sup>.

- Its reference values <sup>(12)</sup>:

- Normal GFR values observed in young healthy adult populations are approximately 100–110 mL/min/1.73m<sup>2</sup>.

- Females have less GFR than males with the same creatinine level.

- Caucasians have less GFR than African Americans with the same creatinine level.

- GFR increases in pregnant females.

- GFR normally decreases about 0.5-1 ml by age.

### 6. Exclusion criteria:

**All the patients have the following will be excluded from this study:**

- Chronic kidney disease (CKD) based on medical records and/ or laboratory results showing glomerular filtration rate less than 60 mL/min per 1.73 m<sup>2</sup> at least 3 months before ICU admission.

- Patients with less than 24 hours stay in the ICU.

- End stage renal disease (ESRD) on dialysis.

- Renal Transplantation.

### 7. Ethical considerations:

- After explanation of risk and benefits in this study, a written consent will be obtained from all patients.

- Privacy insurance and complete confidential data will be obtained from patients.

- Every patient file will have a code number which contains all investigations and complete clinical data collected.

### 8. Statistical analysis <sup>(13)</sup>:

- The collected data were organized, tabulated and statistically analyzed using SPSS software (Statistical Package for the Social Sciences, version 19, SPSS Inc. Chicago, IL, USA).

- For quantitative data, the range, mean and standard deviation were calculated. Boxplots were performed to illustrate median, first and third quartiles of the quantitative data.

- For qualitative data, which describe a categorical set of data by frequency, percentage or proportion of each category, comparison between two groups and more was done using Chi-square test ( $\chi^2$ ).

- For comparison between means of two groups of parametric data of independent samples, student t-test was used.

- For comparison between means of two groups of non-parametric data of independent samples, Z value of Mann-whitney test was used.

- For comparison between more than two means of parametric data, F value of ANOVA test was calculated.

- Multiple regression analysis was done, where Logistic regression coefficients (B) are calculated and used to estimate Odds ratios (EXP (B)) for different independent factors as predictors for diagnosis of acute kidney injury (AKI) among the admitted patients at cardiac and medical intensive care units (ICUs).

### 3. Results

This study was conducted on 273 patients recruited from El-Sahel Teaching Hospital cardiac and medical ICUs.

#### Analysis of the results

273 patients were admitted to El-Sahel Teaching Hospital cardiac and medical ICUs from May 2017 to May 2018, the incidence of hospital acquired AKI was 73.26% (200 patients).

#### I. Demographic data

Concerning age in patients with and without AKI, it was ranged between 17-93 years with a mean ( $\pm$ SD) 58.78 $\pm$ 14.67 and between 28-84 years with a mean ( $\pm$ SD) 61.26 $\pm$ 13.36 respectively.

Comparison between two groups showed that the difference was statistically insignificant (P-value 0.208).

**Table (1):** Demographic data of the studied patients (with and without acute kidney injury) (n=273).

Variables	The studied patients admitted to ICUs (n=273)				$\chi^2$	P
	With acute kidney injury (AKI) (n=200)		Without acute kidney injury (AKI) (n=73)			
	n	%	n	%		
<b>Sex:</b>						
Males	106	53.0	39	53.4	0.004	0.950
Females	94	47.0	34	46.6		
<b>Age years:</b>						
Range	17.00-93.00		28.00-84.00			
Mean $\pm$ SD	58.78 $\pm$ 14.67		61.26 $\pm$ 13.36			
t-test	1.263					
P	0.208					

#### II. Assessment of Patients at Presentation:

In patients with AKI, the most common risk factors were; overlapping (95%), hypertension (74.5%), diabetes mellitus (44.5%), cardiac disease (39%) and dehydration (32.5%).

The most independent risk factor was sepsis which showed statistically significant value (P- value 0.007).

**Table (2):** Risk factors affecting renal functions in the studied patients (with and without acute kidney injury) (n=273).

Medical data	The studied patients admitted to ICUs (n=273)				$\chi^2$	P
	With acute kidney injury (AKI) (n=200)		Without acute kidney injury (AKI) (n=73)			
	n	%	n	%		
<b>Overlap</b>	190	95.0	66	90.4	1.929	0.165
<b>Hypertension</b>	149	74.5	48	65.8	2.037	0.154
<b>Diabetes mellitus (DM)</b>	89	44.5	36	49.3	0.500	0.480
<b>Cardiac disease</b>	78	39.0	27	37.0	0.092	0.762
<b>Dehydration</b>	65	32.5	18	24.7	1.554	0.212
<b>Sepsis</b>	49	24.5	7	9.6	7.293	0.007*
<b>Drugs</b>	35	17.5	7	9.6	2.571	0.109
<b>Chest disease</b>	30	15.0	9	12.3	0.312	0.577
<b>Anemia</b>	26	13.0	12	16.4	0.528	0.468
<b>Urinary</b>	21	10.5	5	6.8	0.827	0.363
<b>Liver disease</b>	20	10.0	6	8.2	0.197	0.657
<b>Surgery</b>	9	4.5	10	13.7	6.988	0.008*
<b>Renal</b>	8	4.0	0	0	3.008	0.083
<b>Contrast</b>	6	3.0	0	0	2.239	0.135
<b>Rhabdomyolysis</b>	4	2.0	4	5.5	2.276	0.131

\*Significant (P<0.05)

There were different causes of ICU admission in both AKI and non-AKI groups.

The most common causes of admission in AKI group were cardiogenic shock (25%), sepsis (21.5%), hypovolemic shock (15%), intracranial hemorrhage and stroke (10%), while in non-AKI group were

cardiogenic shock (32.9%), hepatic encephalopathy (27.8%), diabetic ketoacidosis (16.4%) and surgery (9.6%).

Comparison between these causes showed statistically significant value (P- value 0.0001).

**Table (3):** Causes of admission of the studied patients (with and without AKI) (n=273).

Causes of admission at ICU	The studied patients admitted to ICUs (n=273)			
	With acute kidney injury (AKI) (n=200)		Without acute kidney injury (AKI) (n=73)	
	n	%	n	%
Cardiogenic shock	50	25.0	24	32.9
Sepsis	43	21.5	5	6.8
Hypovolemic shock	30	15.0	4	5.5
Intracranial hemorrhage & Stroke	20	10.0	5	6.8
Hypertensive emergency	15	7.5	1	1.4
Hepatic encephalopathy	13	6.5	5	27.8
Diabetic ketoacidosis	10	5.0	12	16.4
Anaphylactic shock	6	3.0	0	0
Surgery	6	3.0	7	9.6
Respiratory failure	5	2.5	5	6.8
Brain abscess	1	0.5	0	0
Accident	1	0.5	5	6.8
$\chi^2$	44.349			
P	0.0001*			

\*Significant (P<0.05)

Concerning serum creatinine in patients with and without AKI, it was ranged between 0.70-9.80 mg/dl with a mean ( $\pm$ SD) 3.73 $\pm$ 2.03 and between 0.4-1.3 mg/dl with a mean ( $\pm$ SD) 0.84 $\pm$ 0.25 respectively.

Comparison between two groups showed that the difference was statistically significant (P-value 0.0001).

**Table (4):** Serum creatinine of the studied patients (with and without acute kidney injury) (n=273).

Variables	The studied patients admitted to ICUs (n=273)			
	With acute kidney injury (AKI) (n=200)		Without acute kidney injury (AKI) (n=73)	
Serum creatinine (mg/dl):				
Range	0.70-9.80		0.40-1.30	
Mean $\pm$ SD	3.73 $\pm$ 2.03		0.84 $\pm$ 0.25	
t-test	12.132			
P	0.0001*			

\*Significant (P<0.05)

Concerning GFR in patients with and without AKI, it was ranged between 4.8-106.7 ml/min per m<sup>2</sup> with a mean ( $\pm$ SD) 23.73 $\pm$ 17.18 and between 50.3-196.6 ml/min per m<sup>2</sup> with a mean ( $\pm$ SD) 97.79 $\pm$ 37.28 respectively.

Comparison between two groups showed that the difference was statistically significant (P-value 0.0001).

**Table (5):** Glomerular filtration rate (GFR) among the studied patients (with and without acute kidney injury) (n=273).

Variables	The studied patients admitted to ICUs (n=273)		Z value	P
	With acute kidney injury (AKI) (n=200)	Without acute kidney injury (AKI) (n=73)		
<b>GFR (ml/min per m<sup>2</sup>):</b>				
Range	4.80-106.70	50.30-196.60	12.224	0.0001*
Mean±SD	23.73±17.18	97.79±37.28		

**\*Significant (P<0.05)**

Severity of illness in ICU patients with and without AKI was assessed using the Sequential Organ Failure Assessment (SOFA) Score. It was ranged between 0-15 with a mean (±SD) 6.17±3.73 and

between 0-11 with a mean (±SD) 4.7±3.53 respectively.

Comparison between two groups showed that the difference was statistically significant (P-value 0.004).

**Table (6):** SOFA Scores among the studied patients (with and without acute kidney injury) (n=273).

Variables	The studied patients admitted to ICUs (n=273)		t- test	P
	With acute kidney injury (AKI) (n=200)	Without acute kidney injury (AKI) (n=73)		
<b>SOFA:</b>				
Range	0.00-15.00	0.00-11.00	2.927	0.004*
Mean±SD	6.17±3.73	4.70±3.53		

**\*Significant (P<0.05)**

According to RIFLE classification, most patients during admission had failure criteria (57.5%).

**Table (7):** RIFLE classification of renal dysfunction among the studied patients with acute kidney injury (AKI) during admission in ICUs (n=200).

Variables	The studied patients admitted to ICUs with AKI (n=200)	
	During admission at ICUs	
	n	%
Normal	0	0
Risk	28	14.0
Injury	57	28.5
Failure	115	57.5

**\*Significant (P<0.05)**

According to KDIGO and AKIN classifications, most patients during admission had stage 3 criteria (57.5%).

**Table (8):** KDIGO and AKIN classifications of renal dysfunction among the studied patients with acute kidney injury (AKI) during admission in ICUs (n=200).

Variables	The studied patients admitted to ICUs with AKI (n=200)	
	During admission at ICUs	
	n	%
Normal	0	0
Stage 1	28	14.0
Stage 2	57	28.5
Stage 3	115	57.5

**\*Significant (P<0.05)****III. Follow up of The Studied Patients with Acute Kidney Injury (AKI) Admitted to ICUs:**

Concerning LOS in patients with and without AKI, it was ranged between 2-29 days with a mean

(±SD) 9.68±6.05 and between 2-18 days with a mean (±SD) 6.83±3.65 respectively.

Comparison between two groups showed that the difference was statistically significant (P-value 0.0001).

**Table (9):** Length of stay (LOS) at ICU of the studied patients (with and without AKI) (n=273).

Variables	The studied patients admitted to ICUs (n=273)	
	With acute kidney injury (AKI) (n=200)	Without acute kidney injury (AKI) (n=73)
<b>Length of stay at ICU in days:</b>		
Range Mean±SD	2.00-29.00 9.68±6.05	2.00-18.00 6.83±3.65
t-test P	3.769 0.0001*	

\*Significant (P<0.05)

According to RIFLE classification; most patients during admission had failure criteria (57.5%). On the other hand, on discharge; 40 (20%) patients had normal renal functions, 31 (15.5%) patients on chronic kidney disease, 23 (11.5%) patients discharged end

stage renal disease on regular hemodialysis and 106 (53%) patients died.

Comparison between classification items showed that the difference was statistically significant (P-value 0.0001).

**Table (10):** RIFLE classification of renal dysfunction among the studied patients with acute kidney injury (AKI) during admission in ICUs and at discharge (n=200).

Variables	The studied patients admitted to ICUs with AKI (n=200)				$\chi^2$	P
	During admission at ICUs		At discharge from ICUs			
	n	%	n	%		
<b>RIFLE lassification:</b>						
Normal	0	0	40	20.0	232.73	0.0001*
Risk	28	14.0	12	6.0		
Injury	57	28.5	19	9.5		
Failure	115	57.5	23	11.5		
Died	0	0	106	53.0		

\*Significant (P<0.05)

Concerning the assessment of RIFLE classification; most of patients discharged on normal kidney functions, had risk criteria during admission (19 out of 40 patients).

Also most of patients discharged on chronic kidney disease, had failure criteria during admission (19 out of 31 patients).

**Table (11):** Assessment of RIFLE classification among the studied patients with acute kidney injury (AKI) (n=200).

Variables	The studied patients admitted to ICUs with AKI (n=200)	
	N	%
<b>Assessment of RIFLE at discharge:</b>		
<b>Failure</b>	23	11.5
<b>Improvement of failure cases:</b>		
Failure to injury (F-I)	19	9.5
Failure to risk (F-R)	2	1.0
Failure to normal (F-N)	4	2.0
<b>Improvement of injury cases:</b>		
Injury to risk (I-R)	10	5.0
Injury to normal (I-N)	17	8.5
<b>Improvement of risk cases:</b>		
Risk to normal (R-N)	19	9.5
<b>Died</b>	106	53.0

According to KDIGO and AKIN classifications; most patients during admission had stage 3 criteria (57.5%). On the other hand, on discharge; 40 (20%) patients had normal renal functions, 31 (15.5%) patients on chronic kidney disease, 23 (11.5%)

patients discharged end stage renal disease on regular hemodialysis and 106 (53%) patients died.

Comparison between classification items showed that the difference was statistically significant (P-value 0.0001).

**Table (12):** KDIGO and AKIN classifications of renal dysfunction among the studied patients with AKI during admission in ICUs and at discharge (n=200).

KDIGO and AKIN classifications of renal dysfunction	The studied patients admitted to ICUs with AKI (n=200)				$\chi^2$	P
	During admission at ICUs		At discharge from ICUs			
	n	%	N	%		
Normal	0	0	40	20	232.73	0.0001*
Stage 1	28	14.0	12	6		
Stage 2	57	28.5	19	9.5		
Stage 3	115	57.5	23	11.5		
Died	0	0	106	53.0		

**\*Significant (P<0.05)**

Concerning the assessment of KDIGO and AKIN classifications; most of patients discharged on normal kidney functions, had stage 1 criteria during admission (19 out of 40 patients).

Also most of patients discharged on chronic kidney disease, had stage 3 criteria during admission (19 out of 31 patients).

**Table (13):** Assessment of KDIGO and AKIN classifications among the studied patients with acute kidney injury (AKI) (n=200).

Variables	The studied patients admitted to ICUs with AKI (n=200)	
	N	%
<b>Assessment of KDIGO and AKIN at discharge:</b>		
<b>Stage 3 not improved</b>	23	11.5
<b>Improvement of stage 1 cases:</b>		
Stage 1 to normal (1-N)	19	9.5
<b>Improvement of stage 2 cases:</b>		
Stage 2 to normal (2-N)	17	8.5
Stage 2 to stage 1 (2-1)	10	5.0
<b>Improvement of stage 3 cases:</b>		
Stage 3 to normal (3-N)	4	2.0
Stage 3 to stage 1 (3-1)	2	1.0
Stage 3 to stage 2 (3-2)	19	9.5
<b>Died</b>	106	53.0

**4. Discussion**

Critical care nephrology is an emerging multidisciplinary science in which the competences of different specialists are merged to provide a unified diagnostic and therapeutic approach to the critically ill patient<sup>(14)</sup>. Acute kidney injury (AKI) is estimated to occur in about 20–200 per million population and 7–18% of patients in hospital<sup>(15)</sup>.

AKI was associated with an increase in hospitalization costs and an increase in length of hospital stay compared to patients without AKI and also increased with AKI requiring dialysis. AKI was associated with higher hospitalization costs than myocardial infarction and gastrointestinal bleeding, and costs were comparable to those for stroke, pancreatitis, and pneumonia<sup>(16)</sup>.

This study aims to screen the critically ill patients admitted to El-Sahel Teaching Hospital cardiac and medical ICUs for acute kidney injury that based on RIFLE, KDIGO and AKIN criteria in a total of 273

patients, regarding risk factors, mortality and length of hospital stay (LOS), thus, we may have benefit for better identification of modifiable risk factors to prevent the development of renal failure in critically ill patients.

In our study, 273 patients were admitted in El-Sahel Teaching Hospital cardiac and medical ICUs from May 2017 to May 2018, 200 (73.26%) patients developed AKI during hospitalization. These results are consistent with those of Kellum et al<sup>(17)</sup> in 2014, they performed a retrospective study that was made during a 8-year period attending eight ICUs at the University of Pittsburgh Medical Center, Pennsylvania, United States. AKI was defined by levels of serum creatinine and/or urine output according to the maximum KDIGO criteria. There were 23,866 (74.5%) developed AKI in this study from total admissions to the hospital 32,045 patients.

Meanwhile, Luo et al, Levi et al, Reddy et al and Wlodzimirow et al<sup>(18-21)</sup> in 2014, 2013, 2014

and 2012 respectively, reported incidence of AKI in ICUs 51%, 63%, 46% and 81% respectively, which show wide variability from our study. Incidence of AKI in ICUs may be influenced by several factors including population demographics, population served by hospital and numerous definitions of AKI according to RIFLE, AKIN and KDIGO criteria<sup>(22)</sup>.

*In our study, the risk factors for developing AKI in ICUs* during hospitalization were hypertension (74.5%), diabetes mellitus (44.5%), cardiac diseases (39%), dehydration (32.5%), sepsis (24.5%), nephrotoxic drugs (17.5%), chest diseases (15%), anemia (13%), urinary diseases (10.5%), liver diseases (10%), major surgery (4.5%), renal diseases (4%), contrast (3%) and rhabdomyolysis (2%). Overlap risk factors were in (95%) of the patients.

These results were comparable with those of **Levi et al<sup>(19)</sup> in 2013**, who conducted a prospective cohort study to determine the incidence, etiology and outcome of AKI in the Hospital Santo Antônio ICUs in northeastern Brazil, between January 1 and December 31, 2011. AKI was defined according the RIFLE, AKIN and KDIGO definitions. They reported that risk factors were hypertension (65.8%), cardiac diseases (46.8%), sepsis (42%), and diabetes mellitus (33%).

Also, our results were comparable with those of **Eswarappa et al<sup>(23)</sup> in 2014**, who conducted a retrospective study to determine the incidence, etiology and outcome of AKI in a teaching hospital in South India, from May 2011 to October 2012. AKI was defined as patients whose serum creatinine and/or urine output fulfilled the RIFLE criteria. They reported that risk factor were sepsis (38.6%), diabetes mellitus (30.6%), hypertension (29.2%) and cardiac diseases (11.4%).

Also, our results were in agreement with that of **Abd ElHafeez et al<sup>(24)</sup> in 2017**, who conducted a multicenter prospective cohort study to determine the incidence, etiology and outcome of AKI in four Alexandria Teaching Hospitals ICUs between February 1st and August 1st 2016. AKI was defined according the KDIGO definition, using serum creatinine measurements and urine output criteria. They had declared that Sepsis (36%) and dehydration (22%) were the most frequent reported etiologies for AKI on ICU admission.

Another report that was found in the study of **Wijewickrama et al<sup>(25)</sup> in 2014**, who tested the incidence, risk factors and outcomes of AKI among patients admitted to the medical ICU, National Hospital, Colombo, Sri Lanka. Diagnosis of AKI was based on AKIN criteria. They prospectively studied 108 patients admitted to ICU over a period of 6 months. They reported that the significant risk factors

are diabetes mellitus (70.4%), hypertension (64.7%), cardiac diseases (64.7%) and sepsis (45.4%).

Our results were not comparable to those of **Brito et al<sup>(26)</sup> in 2009**, who conducted a prospective study involved patients admitted to ICU during the period from January 2003 to June 2006. AKI has been defined as an acute increase in serum creatinine > 0.5 mg/dl from baseline if creatinine < 1.3 mg/dl, or need of RRT. They found that the significant risk factors of AKI included; cardiac diseases (71.4%), hypertension (66.7%) and diabetes mellitus (29.6%).

Also, our results were not in comparable to the results of **Chawla et al<sup>(27)</sup> in 2005**, who conducted a pilot study of ICU patients from August 2002 to April 2003 in the George Washington University Hospital ICU, United States. The criteria for AKI defined as an increase in serum creatinine > 75% from baseline if creatinine ≤ 2 mg/dl or creatinine > 50% from baseline if creatinine > 2 mg/dl. 35 they found that The contributing factors to AKI were diabetes mellitus (36.6%), cardiac diseases (30.4%) and chronic kidney disease (18%).

From the previous studies the most common the risk factors for developing AKI in ICUs were HTN, cardiac and DM but the percent of cases differed from one study to another may be due to number of subjects involved in the study and the different definition of AKI used in methodology. Also sepsis had high percent in some studies as in **Abd ElHafeez et al<sup>(24)</sup> in 2017**, which may give an idea that the risk factor (Sepsis) may be influenced by community health education, anti-biotics abuse, hygienic and infection control measures in Egypt hospitals.

Deficits in recognition and management of patients with AKI have led to practice guidance calling for improved risk assessment according to patients 'exposures' (such as sepsis and circulatory shock) and 'susceptibilities' (such as diabetes mellitus and volume depletion), at which point interventions could be most beneficial with better prognosis<sup>(28)</sup>.

In our study, *we found that the most independent risk factor for developing AKI* was sepsis according to the multivariate logistic analysis (p value: 0.001, estimated odds ratio: 0.217 and confidence interval between 0.086 and 0.547). Dehydration comes in the second place (p value: 0.020, estimated odds ratio: 0.424 and confidence interval between 0.205 and 0.874).

On the other hand, **Cely et al<sup>(29)</sup> in 2017**, who conducted a prospective cohort study at the San Jose Hospital ICU in Bogota Colombia, from September 2015 to April 2016 on 400 patients, stated that the associated risk factors were pre-hospital treatment with nephrotoxic drugs (2.21 odds ratio; 95% confidence interval between 1.12–4.36, p = 0.022), chronic kidney disease (CKD) (3.56 odds ratio; 95%



confidence interval between 1.55–8.18,  $p < 0.003$ ), and venous thromboembolism (5.05 odds ratio; 95% confidence interval between 1.59–16.0,  $p < 0.006$ ). In our study, nephrotoxic drugs show non-significant results ( $p$  value: 0.069, estimated odds ratio: 0.416 and confidence interval between 0.162 and 1.071).

RIFLE, AKIN and KDIGO criteria are recently developed as international consensus classifications for AKI to detect different outcomes of critically ill patients. In this light they appear as a sensitive way to classify AKI and clinical history of patients<sup>(30)</sup>.

***In our study, numbers of patients developed AKI during hospitalization (200 patients) were the same in each stage when we conducted RIFLE, AKIN and KDIGO classifications of AKI***, i.e. among the studied patients who had renal dysfunction during admission in ICU and CCU, 28 (14%) patients were under risk (R) class, 57 (28.5%) patients were in injury (I) class and 115 (57.5%) patients were failure (F). These results were almost the same when we used AKIN and KDIGO classifications of AKI on the same group of patients; 28 (14%) patients were in stage 1, 57 (28.5%) patients were in stage 2 and 115 (57.5%) patients were in stage 3.

These results were comparable with those of the study of **Levi et al<sup>(19)</sup> in 2013**, compared all three definitions in 190 patients. AKI incidences were 63% for all three definitions.

But the comparison of the distribution of different AKI classes was as follows;

RIFLE classification; 30% of patients under risk (R) class, 14% of patients were in injury (I) class and 17% of patients were failure (F). AKIN classification; 37% of patients had AKI stage 1, 7% of patients had AKI stage 2 and 17% of patients had AKI stage 3. KDIGO classification; 37% of patients had AKI stage 1, 7% of patients had AKI stage 2 and 18% of patients had AKI stage 3, but with no significant difference between meta-analysis of different classes. These results may show that AKIN and KDIGO classifications may diagnose more AKI cases due to smaller serum creatinine changes considered in these classifications than RIFLE classification. On the other hand, this distribution of different AKI classes was not in comparable to our study. This may be due to the lack of accurate laboratory methods to detect smaller changes in serum creatinine (0.3 mg/dl).

## Conclusion

Based on our presented results, we favor to conclude that hospital acquired AKI in ICUs is a major complication in patients. Its incidence in this study was (73.26%). The most common risk factors for developing AKI in ICUs were hypertension, diabetes mellitus, cardiac disease and dehydration with sepsis being the most independent one. AKI,

especially class F (stage 3), has a significant risk in mortality. Early treatment of hypertension, diabetes mellitus, cardiac disease, dehydration and control of sepsis may strongly influence outcome.

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