Epidemiology of acute kidney injury in Intensive Care Units in Aswan University Hospital

Mohammed Zein Eldeen Hafez, Soumaia Ahmed Kassem, Saleh Ahmed Saleh*
Department of Internal Medicine - Faculty of Medicine - Aswan University
*** Corresponding author:** Saleh Ahmed Saleh, **Mobile:** (+20) 01024304560, **E-mail:** ibnelqiem1@gmail .com

ABSTRACT

Background: Acute kidney injury (AKI) is a frequent complication in patients admitted to the intensive care unit (ICU) and is associated with adverse outcomes including increased length of ICU and hospital stay, development of chronic kidney disease (CKD) and increased short- and long-term mortality risk.

Objective: To screen critically ill patient admitted to ICU in Aswan University Hospital for acute kidney injury from September 2017 up to September 2018. **Patients and methods:** In this study 538 patients were admitted to the ICU in Aswan University Hospital in Egypt, from August 1st, 2017 to August 1st 2018. This study was a prospective, randomized; hospital based clinical study on critically ill patients in Intensive Care Unit. With inclusion criteria patients who were 18 years or older and admitted to the Intensive Care Unit (ICU).

Results: Out of 583 patients admitted to ICU, there were 97 patients had AKI, 64.9% of them already had AKI on the admission while the rest of them (35.1%) developed AKI after admission. There is more than one third of mortality among ICU patients related to AKI (35.1%), while (64.9%) were related to other causes.

Conclusion: AKI is associated with high mortality in our ICU setting. Further studies are needed to estimate the burden of AKI among patients before ICU admission.

Keywords: Epidemiology, AKI, ICU, Aswan University Hospital.

INTRODUCTION

Establishing an accurate event rate for AKI is important for health policy, quality initiatives, and for design of clinical trials. However, analyzing AKI in the ICU setting from existing databases is often limited by missing data elements needed for application of these definitions (e.g., inclusion of urine output, selection of baseline serum creatinine, etc.). Administrative databases are limited, as billing codes do not capture many cases of AKI **(1).** Together with differences in patients' baseline characteristics, this may explain the wide variation in the occurrence of AKI reported in ICU patients, with an average reported occurrence of 30–40 % **(2)**.

Since the publication of the RIFLE consensus classification for AKI, and the modifications by the Acute Kidney Injury Network (AKIN), and Kidney Disease: Improving Global Outcomes (KDIGO), these definitions have been used in the majority of studies reporting on AKI **(3)**.

RIFLE Classification in 2002, the Acute Dialysis Quality Initiative (ADQI) was created with the primary goal of developing consensus and evidence-based guidelines for the treatment and prevention of AKI. The first order of business was to create a uniform, accepted definition of AKI. Hence, the RIFLE criteria were born. RIFLE is an acronym of Risk, Injury, Failure, Loss and End-stage kidney disease **(4).** Studies have used different classification systems to study the epidemiology of AKI. Not surprisingly, incidence and prevalence rates vary depending on the classification system used, associated comorbid factors and subset of population studied. The same patient may be classified differently - or may even not fulfil the AKI criteria - depending on the classification system **(5).** The high frequency of AKI amongst inpatients means that it has a major impact on patients and a major economic impact. According to NHS Kidney Care, the cost of AKI to the NHS (excluding AKI in the community) is estimated to be between £434 million - £620 million per year. This is more than the expenditure on breast cancer, lung cancer and skin cancer combined **(6).**

Therefore any steps to prevent or treat AKI should have a positive outcome, at an individual patient level and at the health care system level. AKI also carries increased short and long term morbidity and mortality and a significant risk of ESRD **(7).**

AIM OF THE WORK

The aim of the present study was to screen critically ill patient admitted to ICU in Aswan University Hospital for acute kidney injury from September 2017 up to September 2018.

PATIENTS AND METHODS

This study was a prospective, randomized, hospital based clinical study on critically ill patients in Intensive Care Unit (ICU).

Inclusion criteria: Patients who were 18 years or older and admitted to the Intensive Care Unit (ICU).

Exclusion criteria:

1- Chronic renal replacement therapy (RRT).

2- Kidney transplantation within 3 months before ICU admission.

All Patients enrolled in this study were subjected to the following:

1. Full medical history taking from the patient or the relatives on admission and include: Previous medical and surgical history and previous drug history.

Received:12/09/2019
Accepted:21/10/2019

2. Clinical examination on admission with stress on the level of consciousness, blood pressure, pulse rate, respiratory rate, temperature and urine output.
3. Investigations included:
   - CBC
   - Serum urea, serum creatinine and serum uric acid
   - Serum calcium and phosphorus
   - Serum sodium and potassium
   - ABG
   - Urine analysis
   - Pelvic abdominal ultrasound
   - ECG.

Study design: cross sectional study, Intensive Care Unit (ICU) at Aswan University Hospital.

Ethical approval:

An approval of the study was obtained from Aswan University academic and ethical committee. Every patient signed an informed written consent for acceptance of the operation.

Confidentiality: The confidentiality of all participants admitted to this study were protected to the fullest extent possible. The study participants were not identified by name in any report or publication resulting from data collected in this study.

Research statement: Ethical aspects whether substantial or procedural were implicated in this study. Before participants are admitted in this study, the purpose and nature of the study as well as the risks were explained to them. The participants had the rights to terminate participation in this study without affecting their rights in having proper health care in the study site, whom to contact with questions regarding the study and that they are freely given an informed consent to participate in this study.

Informed consent: The signed informed consent form was a permanent part of the participant's study records and was maintained in the same manner as other records.

Statistical analysis

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- Independent-samples t-test of significance was used when comparing between two means.
- Chi-square (x^2) test of significance was used in order to compare proportions between two qualitative parameters.
- The confidence interval was set to 95% and the margin of error accepted was set to 5%. The p-value was considered significant as the following:

- P-value <0.05 was considered significant.
- P-value <0.001 was considered as highly significant.
- P-value >0.05 was considered insignificant.

RESULTS

Table (1): Baseline characteristics of the studied sample in ICU in Aswan University Hospital, Egypt.

	Variable	No. (n=97)	%
Age: (years)	<40 ψεαρ	12	12.4
	40 year-60 year	25	25.8
	>60 year	60	61.9
	Mean ± SD	60.38 ± 15.11 (22 -85)	
Gender:	Male	51	52. 6
	Female	46	47.4
District:	Edfow general		24.3
	Komombo		12.7
	Draw		28.2
	Aswan		34.8
Residence:	Rural	52	53.6
	Urban	45	46.4
DM:	Yes	44	45.4
	No	53	54.6
HTN:	Yes	45	46.4
	No	52	53.6
Cardiac:	Yes	38	39.2
	No	59	60.8
Hepatic:	Yes	9	9.3
	No	88	90.7
Drug history:	Yes	8	8.2
	No	89	91.8
Smoking:	Current smokers	37	39.1
	Ex-smokers	60	60.9

Table (1) presented the baseline characteristics of the included AKI patients. The age of them ranged from 22 to 85 years old with a mean of 60.38 ± 15.11 years and sixty percent were in the age group > 60 years. Males constituted 52. 6% of the AKI patients. More than half of patients (53.6%) were from rural areas while urban patients represented 46.4%. Moreover, nearly half of studied patients had DM (45.4%) and hypertension (46.4%). 39.2 % had cardiac problems. Out of 583 patients admitted to ICU from August 1st, 2017 to August 1st, 2018, there were 97 patients had AKI, 64.9% of them already had AKI on the admission while the rest of them (35.1%) developed AKI after admission (Figures 1 and 2).

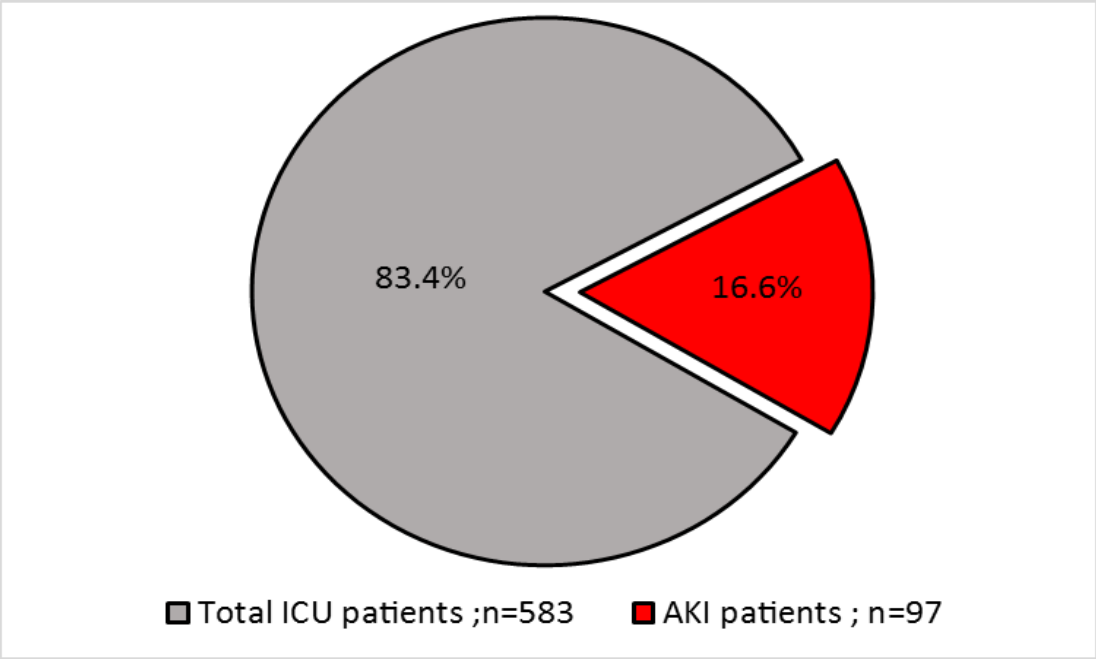

Figure (1): Magnitude of AKI among patients admitted to ICU in Aswan University Hospital, Egypt from August 1st, 2017 to August 1st, 2018.

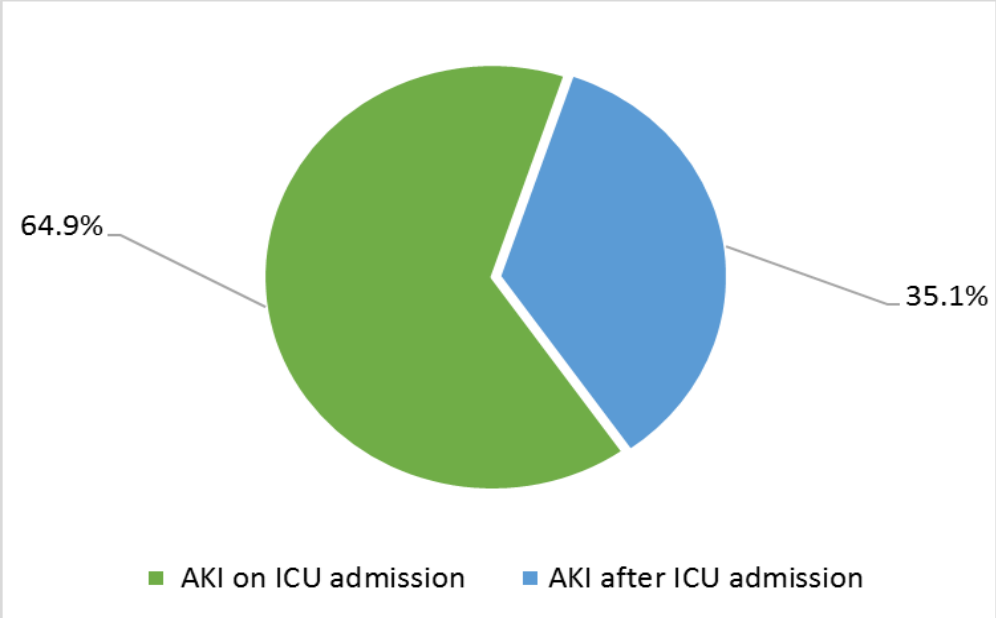

Figure (2): Distribution of AKI by timing of diagnosis among studied sample in ICU in Aswan University Hospital, Egypt.

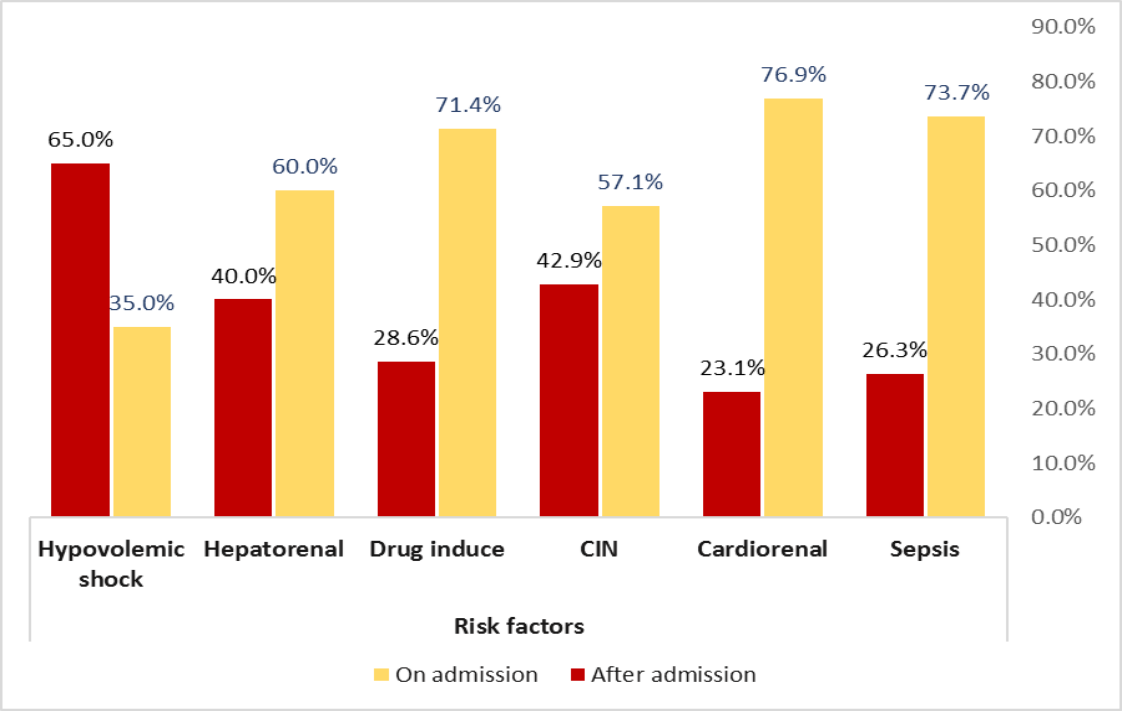

Figure (3): Distribution of etiology/ risk factor of AKI by timing of diagnosis: at ICU and after ICU admission among screened sample in ICU in Aswan University Hospital, Egypt.

Figure (3) showed the most common causes for developing AKI, cardiorenal, sepsis and drug-induced were the most common causes for developing AKI on admission, while hypovolemic shock and CIN were the most common causes for developing AKI after admission.

Table (2): Definitions of AKI according to RIFLE stage among screened sample in ICU in Aswan University Hospital, Egypt

RIFLE classification [ref]			**No. (n=97)**	**%**
	Serum Cr criteria	**Urine output criteria**		
R (Risk)	Increase in serum Cr × 1.5 or GFR decrease >25%	<0.5 mL/kg/h for 6 hours	43	44.3
I (Injury)	Increased serum Cr × 2 or GFR decrease >50%	<0.5 mL/kg/h for 12 hours	29	29.9
F (Failure)	Increase in serum Cr × 3, GFR decrease >75%, or serum Cr > 4mg/dL	<0.3 mL/kg/h for 24 hours or anuria for 12 hours	25	25.8

Table (2) explained the changes occurred within each RIFLE category classification that used for the definition of acute kidney injury in intensive care units, the proportion of ICU admitted patients who were in Failure stage represented about one quarter of the AKI patients (25.8%). While, the proportion of ICU-admitted patients that were in the risk stage represented (44.3%).

Figure (4): Mortality among ICU patients in relation to AKI in Aswan University Hospital, Egypt.

Figure (4) demonstrated that more than one third of mortality among ICU patients related to AKI (35.1%), while 64.9% were related to other causes.

Table (3): Logistic regression analysis of the risk factors for AKI mortality Predictors of mortality among ICU patients

Variables	Adjusted OR	P-value	95.% C.I.	
			Lower	Upper
Age	1.20	0.023	1.02	1.03
Gender (Ref. = female)				
male	2.043	0.071	1.176	3.551
Residence (Ref. = urban**)**				
Rural areas	1.932	0.092	0.889	4.201
AKI **RIFLE**		0.000		
Injury	1.96	0.001	1.88	2.17
Failure	2.95	0.001	1.83	3.05
Duration of ICU stay	2.44	0.014	0.166	3.99
Constant		**0.000**		

*R^2=0.441

Table (3) showed the logistic regression model that examined the impact of the different baseline characteristics on the appearance of acute kidney injury mortality predictors among ICU patients. Increasing age, being in failure stage and increasing the duration of ICU stay were significantly increasing the risk for AKI mortality (OR=1.20; p- value= 0.023), (OR=2.95; p- value= 0.001), (OR=2.44; p- value= 0.014).

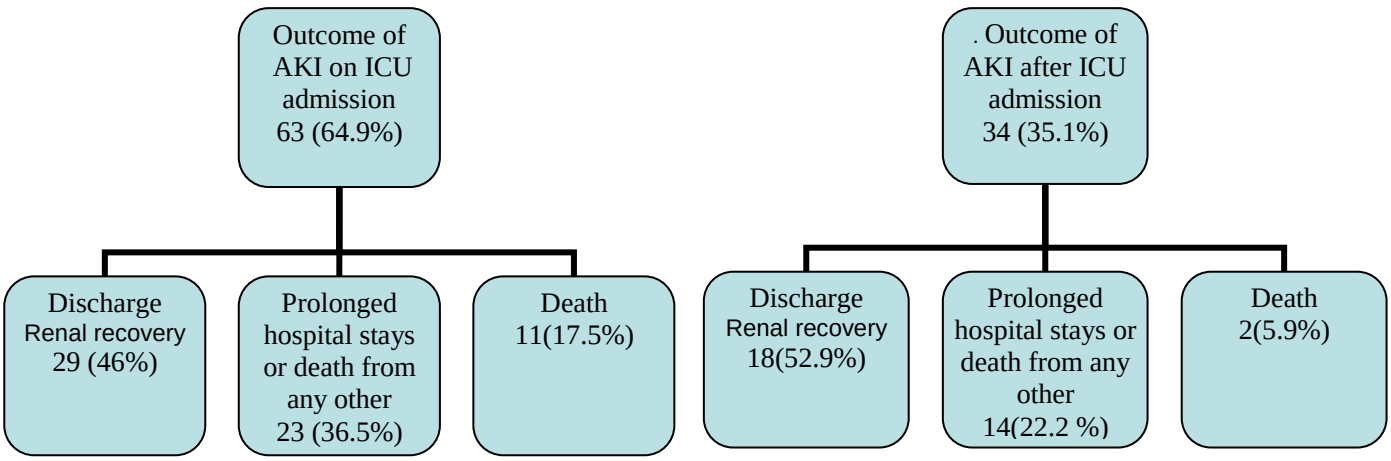

Figure (5): Flow chart of the study sample in Aswan University Hospital, Egypt

Flow chart showed different outcomes among the study sample. AKI at ICU admission indicated people

diagnosed with acute kidney injury (AKI) when they were admitted to intensive care unit (ICU). AKI after ICU admission indicated people who were AKI free when they were admitted but developed AKI during the study. Hospital stay refers to the need to remain in the hospital beyond 30 days from ICU entry. Death refers to AKI mortality.

Renal recovery was considered when the last available creatinine on ICU admission fell within 0.3 mg/dl or 50% of the baseline value, without requirements for renal replacement therapy.

DISCUSSION

Acute kidney injury is a complex disorder that occurs in a variety of settings with clinical manifestations ranging from a minimal elevation in serum creatinine to anuric renal failure. It is often under recognized and it is associated with severe consequences. Recent epidemiological studies demonstrate the wide variation in etiologies and risk factors that describe the increased mortality associated with this disease [8].

In this study 538 patients were admitted to the ICU in Aswan University Hospital in Egypt. Among all AKI patients, 64.9% of them developed AKI on admission and 35.1% were AKI free on admission and developed AKI during their ICU stay, which is consistent with the results of **Abd El - Hafeez *et al.*** [9] who found that 40% of patients admitted to ICU had AKI at admission and a similar proportion of those who were AKI-free on admission developed AKI during their ICU stay.

AKI patients included in our study showed clinical characteristics similar to those described from other developing countries. The risk of mortality, impact on length of hospital stay and the requirement of renal replacement therapy are similar to other studies [10]. This finding is consistent with a recent World Health Organization report on lower life expectancy in developing countries and the potential influence of age in the selection of people that need access to health care [11].

The most common causes of AKI on admission are sepsis, cardiorenal and hypovolemic shock while the most common causes of AKI after admission to ICU were hypovolemic shock, hepatorenal and cardiorenal. This is similar to what was found in **Abd ElHafeez *et al.*** [9].

In this study mortality from AKI was 35.1%. It is in agreement with **Levy *et al.*** [12] who found that the mortality rate was 34% in patients with AKI versus 7% in patients without AKI.

Variability in the risk of AKI across studies may reflect differences in baseline patient characteristics, criteria used to define AKI (with higher risks reported following the adoption of the new stratification system), study design and the type of ICUs. The spectrum of severity of AKI may also contribute to data variability [13].

However, the risk of mortality, impact on length of hospital stay and the requirement of renal replacement therapy were similar to other studies [10, 14 & 15]. This finding is consistent with a recent World Health Organization report on lower life expectancy in developing countries and the potential influence of age in the selection of people that need access to health care [11].

Many nephrologists and intensivists agree that criteria for AKI are needed to facilitate clinical research and to allow comparison between different studies and institutions [15, 16]. Ultimately, the ideal AKI classification needs to be accurate and predictive of relevant clinical outcomes. We previously showed that the proposed criteria by **Bellomo *et al.*** [4] (acute renal injury, acute renal failure syndrome, severe acute renal failure syndrome) fulfilled this requirement. Application of the RIFLE criteria to the same database again confirms a correlation between severity of AKI and outcome. Patients with AKI had a longer stay in ICU and a significantly higher all-cause ICU and hospital mortality than patients without AKI. Even when we controlled for confounding factors in a multiple variable regression analysis, the RIFLE categories of risk, injury, and failure remained independent risk factors for hospital mortality.

These findings are in keeping with previous studies. **Kuitunen *et al.*** [17] applied the RIFLE classification to a group of 813 patients who had undergone cardiac surgery and found that 156 patients (19.2%) developed AKI postoperatively. Ninety-day mortality was significantly higher in patients with RIFLE failure compared to patients with RIFLE risk (32.5% vs. 8%). **Abosaif *et al.*** [18] applied the RIFLE classification to 183 ICU patients and found that ICU mortality increased from 38.3% among patients with RIFLE risk to 50% in the injury group and to 74.5% among patients.

All studies, including our own data, confirmed that even moderate degrees of kidney dysfunction pose a significant risk of death. However, the question remains at which level of renal impairment mortality increases? that is, where is the exact cutoff between normal renal function and AKI with an increased risk of death? The RIFLE classification requires patients to have a reduction in GFR by 25% or a decrease in urine output to 0.5 mL/kg/hr in order to be classified as being at risk (the mildest category of AKI). However, **Chertow *et al.*** [19] demonstrated that even an increase in serum creatinine of only 0.3–0.4 mg/dL while in hospital resulted in a 70% increase in the risk of dying relative to patients with less or no change in serum creatinine.

The recently established Acute Kidney Injury Network acknowledged this important

finding and accordingly modified the new staging system for AKI (which is based on the RIFLE classification) [20].

CONCLUSION

AKI is associated with high mortality in our ICU setting. Further studies are needed to estimate the burden of AKI among patients before ICU admission.

REFERENCES

1. **Grams ME, Waikar SS, Macmahon B *et al.* (2014):** Performance and limitations of administrative data in the identification of AKI. Clin J Am Soc Nephrol., 9: 682–689.
2. **Siew ED, Matheny ME, Ikizler TA *et al.* (2010):** Commonly used surrogates for baseline renal function affect the classification and prognosis of acute kidney injury. Kidney Int., 77: 536–42.
3. **The Kidney Disease Improving Global Outcomes (KDIGO) Working Group (2012):** Definition and classification of acute kidney injury. Kidney Int., 2: 19–36.
4. **Bellomo R, Ronco C, Kellum J *et al.* (2004):** Acute renal failure – definition, outcome measures, animal models, fluid therapy and information technology needs: the Second International Consensus Conference of the Acute Dialysis Quality Initiative (ADQI) Group. Crit Care, 8 (4): 204–212.
5. **Uchino S, Bellomo R, Morimatsu H *et al.* (2007):** Continuous renal replacement therapy: a worldwide practice survey. The beginning and ending supportive therapy for the kidney (BEST kidney) investigators. Intensive Care Med., 33: 1563–70.
6. **NICE Clinical Guidelines (2013):** Acute Kidney Injury: Prevention, Detection and Management Up to the Point of Renal Replacement Therapy [Internet]. Royal College of Physicians (UK). https://www.ncbi.nlm.nih.gov/books/NBK264189/.
7. **Doyle JF, Forni LG (2016):** Acute kidney injury: short-term and long-term effects. Crit Care, 20: 188-192.
8. **Mehta RL, Kellum JA, Shah SV *et al.* (2007):** Acute Kidney Injury Network: report of an initiative to improve outcomes in acute kidney injury. Crit Care, 11: 31-33.
9. **Abd ElHafeez S, Tripepi G, Quinn R *et al.* (2017):** Risk, Predictors and Outcomes of Acute Kidney Injury in Patients Admitted to Intensive Care Units in Egypt. Sci Rep., 7: 17163.
10. **Koulouridis I, Price LL, Madias NE *et al.* (2015):** Hospital-acquired acute kidney injury and hospital readmission: a cohort study. American journal of kidney diseases. The official journal of the National Kidney Foundation, 65: 275–282.
11. **WHO (2014):** World Health Statistics . http://www.who.int/ healthinfo/global_burden_disease/estimates/en.
12. **Levy EM, Viscoli CM, Horwitz RI (1996):** The effect of acute renal failure on mortality: a cohort analysis. Jama., 275:1489–1494.
13. **Hoste EA, Clermont G, Kersten A *et al.* (2016):** RIFLE criteria for acute kidney injury are associated with hospital mortality in critically ill patients: a cohort analysis. Crit Care, 10: 73-77.
14. **Zeng X, McMahon GM, Brunelli SM *et al.* (2014):** Incidence, outcomes, and comparisons across definitions of AKI in hospitalized individuals. Clinical journal of the American Society of Nephrology: CJASN., 9: 12–20.
15. **De Corte W, Dhondt A, Vanholder R *et al.* (2016):** Long-term outcome in ICU patients with acute kidney injury treated with renal replacement therapy: a prospective cohort study. Crit Care, 20 (1): 256-9.
16. **Case J, Khan S, Khalid R *et al.* (2013):** Epidemiology of acute kidney injury in the intensive care unit. Crit Care Res Pract., 2013:479730.
17. **Kuitunen A, Vento A, Suojaranta-Ylinen R *et al.* (2006):** Acute renal failure after cardiac surgery: Evaluation of the RIFLE classification. Ann Thorac Surg., 81: 542–546.
18. **Abosaif NY, Tolba YA, Heap M *et al.* (2005):** The outcome of acute renal failure in the intensive care unit according to RIFLE: Model application, sensitivity, and predictability. Am J Kidney Dis., 46: 1038–1048.
19. **Chertow GM, Burdick E, Honour M *et al.* (2005):** Acute kidney injury, mortality, length of stay, and costs in hospitalized patients. J Am Soc Nephrol., 16: 3365–3370.
20. **Negi S, Koreeda D, Kobayashi S *et al.* (2016):** Renal replacement therapy for acute kidney injury. Renal Replacement Therapy, 2:31.