Original Article

Positive Fluid Balance as a Risk Factor for Acute Kidney Injury: Experience of a Tertiary Care Hospital

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ABSTRACT

Objective: Acute kidney injury (AKI) is associated with increased mortality in the intensive care unit (ICU). Fluid therapy is the mainstay of treatment for AKI. A positive fluid balance has been known to worse AKI and lead to poor long term outcome. We evaluate the role of positive fluid balance and its effect on renal outcome in our setup

Study Design: Retrospective study

Place and Duration of Study: This study was conducted at the Intensive Care Unit of Dr. Ziauddin Hospital Clifton Campus. from January 2021 to December 2021

Materials and Methods: A retrospective study done in patients requiring ICU admission. Patients were excluded for post renal AKI, Stage 5 chronic kidney disease, renal transplant or renal failure on admission day. AKI was defined as per the Kidney Disease Improving Global Outcome creatinine based criteria.

Results: 302 patients were included in the study. Mean age was 64.49±15.92. At the time of admission SOFA score was 4.03±3.82. 274 patients were in positive fluid balance of 5 liters. Among these patients stage 1 AKI was present in 234, stage II in 9 and stage III in 28. Similar trend was observed in negative fluid balance group (p<0.59). In positive fluid balance group 62% patients were discharged from hospital while mortality was observed in 37.95% (p <0.89).

Conclusion: The results suggest that the impact of positive fluid balance on AKI was non inferior to negative fluid balance in critically ill patients.

Key Words: Positive Fluid Balance, Acute Kidney Injury, Intensive Care Unit, Chronic Kidney Disease, Kidney Failure

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INTRODUCTION

Acute renal injury or acute kidney injury (AKI) is one of a complication for the critically ill patients who admitted in intensive care unit[1]. It is also a well-known global public health problem that adversely affects patient's short- and long-term outcomes[1,2]. There is 55 to 66% chance that critically ill patients develop AKI with immediate mortality is 15 to 80%, depending on the severity of renal injury[3].

Multiple risk factors have been described for the development of AKI in ICU including multi-organ failure, low blood pressures requiring inotropes or vasopressors, congestive heart failure, emergency surgery, mechanical ventilation as well as exposure of contrast or other nephrotoxic medication. Modifiable risk factors if identified early and dealt with accordingly, will result in reducing the chances to develop AKI as well as also reduce the risk of progression of AKI if developed.[3,4]

AKI is diagnosed and staged on the bases of two criteria that include serum creatinine and the urine output as per KDIGO guidelines.[5] As majority of patients who admitted in intensive care unit are hemodynamically unstable, fluid resuscitation is fundamental and crucial steps in management of such patients specially with the patients who admitted with septic shock. Early and timely fluid resuscitation improve survival among such patients.[6] There are few conditions like pancreatitis, burn, cancer chemotherapy and bone marrow transplant patients require massive volume expansion, and giving large volume of fluids putting these patients at risk of developing AKI and also increase the mortality.[7]

Point of care ultrasonography (POCUS) is one of the efficient tool through which we can assess physiologic and hemodynamic parameters in relation to the fluid status like kerley B lines, IVC collapsibility, hepatic

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congestion.[8] There is study conducted at multinational level, that includes 1800 patients from 97 intensive care units (ICUs), concluded that AKI develop in 57% of patients within 1 week of admission. And 39% develop severe (stage 2 and 3), and of them 13.5% patients required renal replacement therapy (RRT)[9].

A recent study concluded that patients who develop severe AKI requiring renal replacement in intensive care unit, keep these patients in negative balance either through drugs or ultrafiltration was independently associated with a decreased risk of death and with more ICU-free and hospital-free days. Positive cumulative fluid balance is considered as a severity marker and one of the independent factors for increase mortality in critically ill patients[10]. And for long time it has always been a matter of discussion that which one is better, positive fluid balance or negative fluid balance. Limited studies have been done in Pakistan regarding the fluid strategies used in the intensive care units. This study aimed to evaluate whether positive fluid balance is associated with AKI in critically ill patients in the critical care setup.

OPERATIONAL DEFINITION

Acute Kidney Injury: AKI is defined as per The Kidney Disease Improving Global Outcomes (KDIGO) guidelines and it classifies AKI as:

Rise in serum creatinine by 0.3mg/dl within 48 hours, or rise in serum creatinine to ≥1.5 times the base line within 7 days or decrease in urine volume to 0.5ml/kg/hour for 6 hours.

MATERIALS AND METHODS

It is a Retrospective, cross sectional study that conducted from January 2021 till December 2021 in the intensive care unit of Dr. Ziauddin Hospital Clifton Campus after getting approval from Ethical Review Committee (ERC). All patients who fulfill the inclusion criteria such as admission in ICU and age >18 years were included in study. We excluded patients with pre and post renal AKI, stage V CKD, renal transplant patients, terminal malignancy, renal failure on day of admission, pregnancy, all the patients who were on vasopressors, on mechanical ventilation, on nephrotoxic medications and glomerulonephritis. Data was collected that include patient's demography, laboratory test clinical data like age, gender, source of ICU admission, severity of illness (based on SOFA scores), and hospital outcome. The medical electronic database for fluid intake and output at day 1, day 3 and at day 5 was retrospectively reviewed. Patient were labeled as AKI as per KDIGO clinical practice criteria as stated in the operational definition.

Data Analysis: Data was entered and interpreted by SPSS version 20. Categorical data were expressed as frequency distributions, used Chi-squared test to determine if differences existed between groups. The primary outcome of our study was acute kidney injury in patients with positive fluid balance, while the secondary outcomes were hospital mortality in positive versus negative fluid balance.

RESULTS

There are total of 302 patients were included in our study. Patients Mean age was 64.49± 15.92. Out of these 52 % were male and 48% were female in our study. Among the co-morbidities hypertension was more prevalent 60% followed by diabetes mellitus (44%) and IHD (28%). Mean sofa score in our study was 4.03 ± 3.82. Coagulopathy was present in 10% of patients and liver dysfunction was present in 13%.

Table No.1: Baseline demographical data of patients included in the study (n=302)

Variable	Frequency (%) or Mean ± SD
Age (years)	64.49 ± 15.52
Male	157 (52)
Female	144 (48)
Diabetes	133 (44)
Hypertension	181 (60)
Ischemic Heart Disease	85 (28)
Sofa Score	4.03 ± 3.82
Liver Dysfunction	39 (13)
Coagulopathy	30 (10)
Anuria	11 (4)
Oliguria	43 (14)
Non-oliguria	248 (82)

Table No.2: Cross tabulation of variables with fluid balance (n=302)

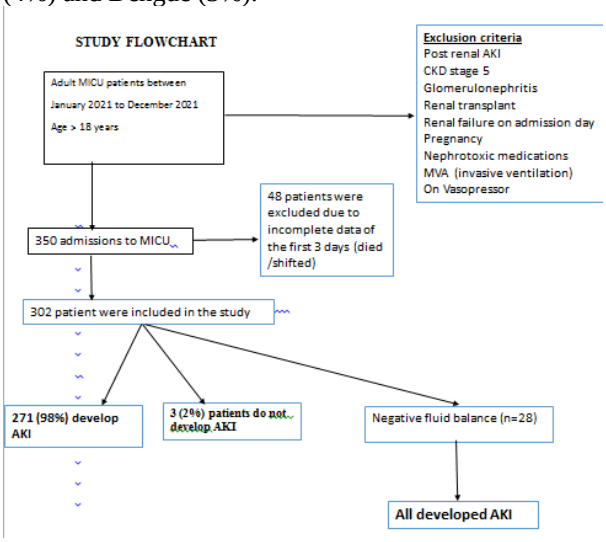
Variables	Positive (n=274)	Negative (n=28)	P-value
Male	141(51.45%)	16(57.14%)	0.58
Female	132(48.17%)	12(42.85)	0.34
Diabetes mellitus	123(44.89%)	10(35.71%)	0.64
Hypertension	163(59.48%)	18(64.28%)	0.64
Ischemic heart disease	76(27.73%)	9(32.14%)	0.63
Liver dysfunction	34(12.40%)	5(17.85%)	0.42
Coagulopathy	28(10.21%)	2(7.14%)	0.60
Stage 1 AKI	234(85.40%)	23 (82.14%)	0.59
Stage 2 AKI	9(3.28%)	2(7.14%)	
Stage 3 AKI	28(10.21%)	3 (10.71%)	
Anuria	9(3.28%)	2(7.14%)	0.30
Oliguria	34(12.40%)	9(32.14%)	0.004*
Non-Oliguria	231(85.40%)	17(60.71%)	0.002*

Table No.3: Cumulative Fluid Balance over 5 days

Fluid Balance day 1 (ml)	2650 ± 1174
Fluid Balance day 3 (ml)	5355 ± 1465
Fluid Balance day 5 (ml)	8556 ±1693

During ICU admission stay, out of the 302 patients who were evaluated 298 (98.67%) with AKI being observed both in positive (n=274) as well as negative fluid balance (n=28) patients. In the positive fluid balance

patients stage 1 AKI detected in 85%, stage II detected in 3.28% and 10.21% of patients develop stage III AKI. All patient in the negative fluid balance group developed AKI. Majority of patients were Non-oliguria (82%), 14% had Oliguria and 4% were Auric. Out of 302 patients, 274 of them were in positive fluid balance. Most of the patients who develop stage I AKI were in positive fluid balance and the same trend was observed on patients with negative fluid balance and the p value was not significant (P <0.59). out of there 170 patients who were in the positive fluid balance group were discharged while 104 patients died. Same results observed in negative fluid balance group (P.0.89). Majority of patients (37%) were admitted with pneumonia followed by 35% for severe sepsis. Other less common conditions were STEMI (8%), stroke (4%) and Dengue (3%).



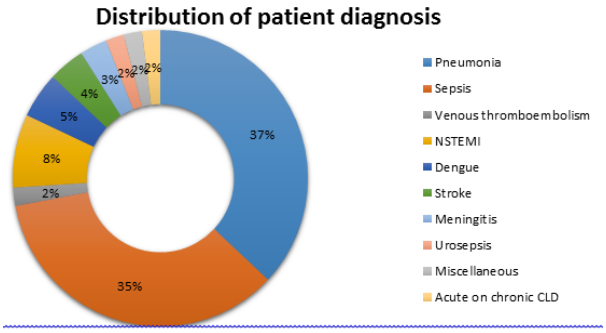


Figure No.1: Graphical representation of Diagnosis of patients included (n=302)

Table No.4: Association between fluid balance (positive or negative) with patient outcome (n-302)

Patient Outcome	Fluid Balance		p-value
	Positive (n=274)	Negative (n=28)	
Discharged	170 (62%)	17 (60%)	0.89
Death	104 (37%)	11 (39%)	

DISCUSSION

Acute Renal Injury is one of the complex clinical syndromes having a broad etiological profile (12). Patients who admitted in intensive care unit due to overall critical condition have multiple etiological cause for the development of AKI including improper fluid management. This study investigated the impact of fluid balance on the development of AKI in patients during the ICU stay and its impact on outcome. Total number of patients in our study was 302 out of which 157(52%) were male and 144(48%) were females. Most common associated co-morbid disease in our patients was hypertension (60%) followed by diabetes (44%) (Table I).

In our study total number of patients in the positive fluid balance group was 274 and in the negative fluid balance group was 28. AKI was common to both groups as 271(98.90%) in the positive balance group while all patients in the negative fluid balance group develop AKI. Fluid management is a key component in the development and progression of AKI[13]. Fluid overload not only lead to pulmonary edema but also results in generalized tissue edema, obstruction of capillary blood flow, impairment of oxygen transport, and organ dysfunction ultimately leading to organ dysfunction such as AKI[14,15].

In our study out of the 271 patients who develop AKI in the positive balance group 234(85%) of the patients developed stage 1 AKI, while stage 2 and 3 AKI was observed in 3% and 10% respectively (Table 2). All the patients in the negative fluid balance group had AKI so there was no major difference and the stages of AKI in both the group (p 0.59). Cumulative fluid balance over 5 days was 8556 ±1693ml (Table 3). Major studies have demonstrated the role of positive fluid balance over restricted or negative fluid balance as a risk factor for AKI (16-20) but this was not observed in our study. Most of the patients in our study in the positive fluid balance group were non-oliguria (85.40% vs 60.71%, p=0.002)

Most common reason of ICU admission in our population group was pneumonia (37%) followed by sepsis (35%) (Graph-1). AKI in intensive care unit has been associated with other multi organ failure and ultimately leads to increase in mortality (21).As in previous studies it was concluded that Positive fluid balance has been associated with increased mortality (22, 23), our study in relation to others showed no major difference in outcome in the positive vs negative fluid balance group (37% vs 39%, p=0.89)(Table- 4).

There are several limitations in this study. First of all , this is a single center study, so a multicenter study is needed to further validate our results. Second, we excluded patients with preexisting renal conditions so a large number of patients could be added if we include those as well. Third, as this is a retrospective review of

data so a prospective randomized trial is needed also looking at the patient population in whom renal replacement therapy was needed along with AKI. Fourth, choices of fluid as well as diuretics were at the discretion of the treating physicians which may have contributed to the development of AKI.

CONCLUSION

This study demonstrated that positive fluid balance strategy was not inferior to negative fluid strategy on the development of AKI and its outcome on mortality. Further multicenter studies are needed to validate our results.

Author's Contribution:

Concept & Design of Study:	Samina Shamim
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Conflict of Interest: The study has no conflict of interest to declare by any author.

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