The Prognostic Value of Volume Status Assessment by Bioelectrical Impedance Analysis And Lung Ultrasound on Mortality in Septic Acute Kidney Injury Patients Undergoing Continuous Renal Replacement Therapy

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Background

Septic acute kidney injury (AKI) is one of the most common causes in critically ill patients requiring continuous renal replacement therapy (CRRT). The fluid status of the patient is known as a significant risk factor for mortality in those patients. Therefore, it is necessary to find an objective assessment of volume status. The aim of present study is to elucidate the impact of fluid status assessed by bioelectrical impedance analysis (BIA) and lung ultrasound on clinical outcomes in septic AKI patients with CRRT.
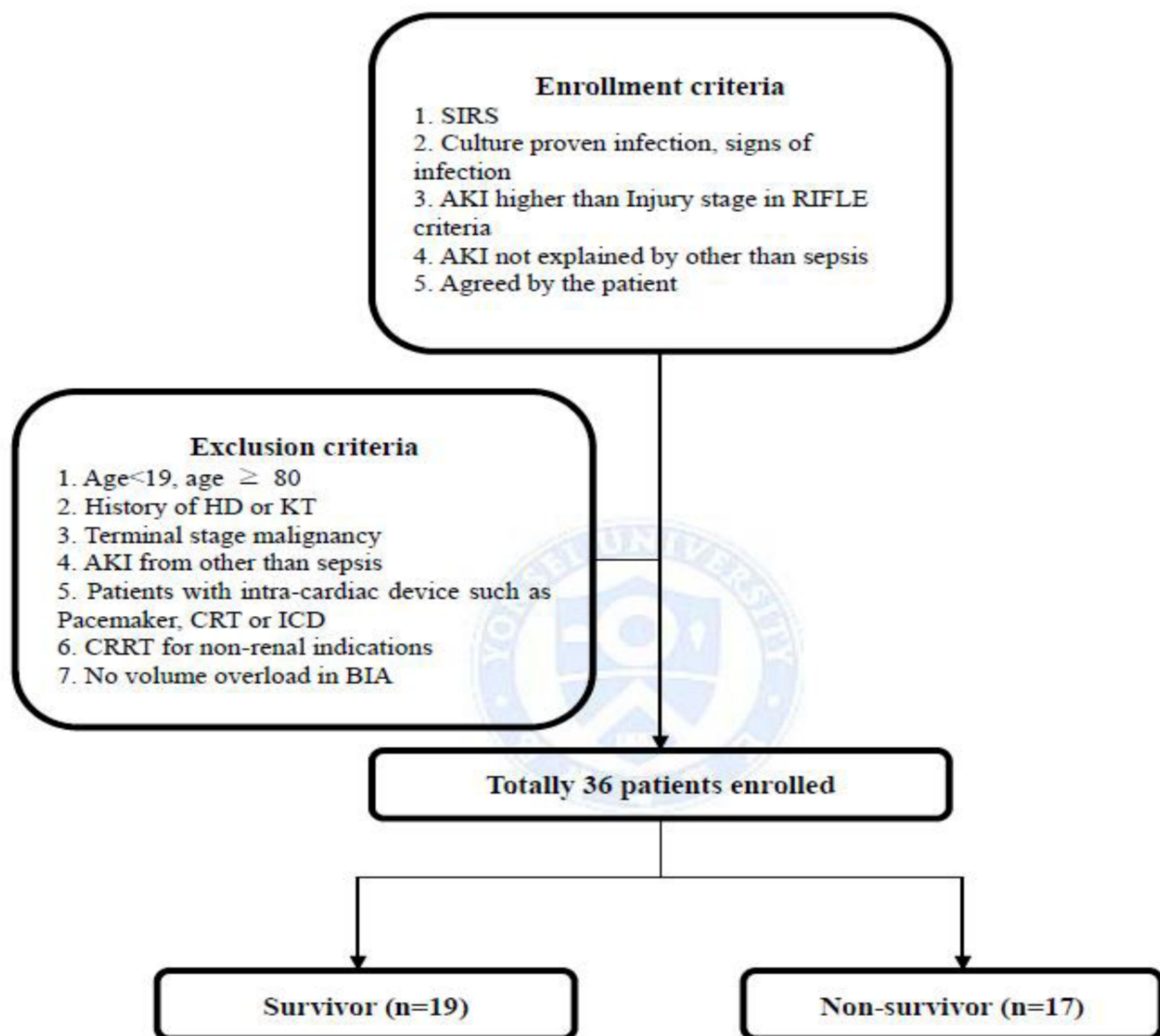
Methods

Enrollment criteria
1. SIRS
2. Culture proven infection, signs of infection
3. AKI higher than Injury stage in RIFLE criteria
4. AKI not explained by other than sepsis
5. Agreed by the patient

Exclusion criteria
1. Age<19, age ≥ 80
2. History of HD or KT
3. Terminal stage malignancy
4. AKI from other than sepsis
5. Patients with intra-cardiac device such as Pacemaker, CRT or ICD
6. CRRT for non-renal indications
7. No volume overload in BIA

Totally 36 patients enrolled

Survivor (n=19) **Non-survivor (n=17)**

Figure 1. Flow chart of the study population

Results

Table 1. Baseline characteristics of patients with septic AKI on CRRT

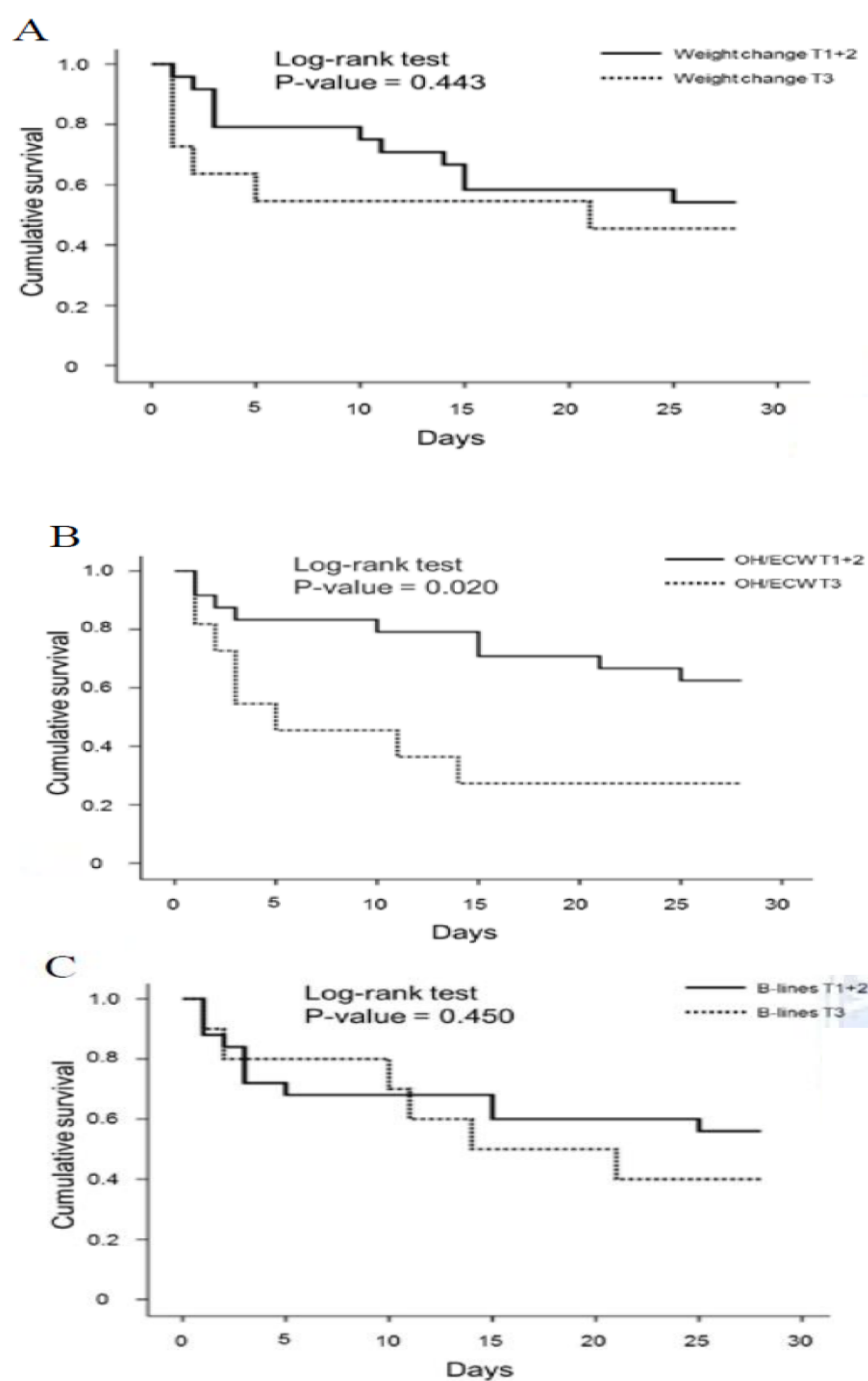|	Total	Survivor	Non-survivor	p-value
No. of patients, n (%)	36 (100)	19 (52.8)	17 (47.2)	
Age at CRRT (yr)	64.6 ± 14.6	65.3 ± 13.1	63.4 ± 16.4	0.702
Male sex, n (%)	22 (61.1)	12 (63.2)	10 (58.8)	0.790
Vital sign				
SBP (mmHg)	131.4 ± 23.6	136.8 ± 24.6	125.4 ± 21.4	0.149
DBP (mmHg)	65.9 ± 13.5	67.6 ± 15.4	64.0 ± 11.2	0.790
MAP (mmHg)	87.7 ± 15.1	90.7 ± 16.3	84.5 ± 13.3	0.223
Heart rate (beats per minute)	101.4 ± 22.7	94.6 ± 19.1	109.0 ± 24.6	0.057
Body temperature (°C)	36.8 ± 0.9	36.8 ± 0.7	36.8 ± 1.0	0.991
Respiratory rate (per minute)	20.5 ± 4.3	19.3 ± 3.6	21.9 ± 4.7	0.073
Body weight				
Body weight on admission (kg)	59.5 ± 8.7	57.8 ± 8.9	61.4 ± 8.2	0.213
Body weight on CRRT initiation (kg)	61.6 ± 9.3	59.9 ± 8.6	63.6 ± 9.8	0.239
Weight change (%)	5.3 ± 20.6	5.7 ± 21.7	4.9 ± 20.0	0.913
Urine output at CRRT initiation				
Anuria, n (less than 100ml/day, %)	17	8 (42.1)	9 (52.9)	0.516*
Average urine output (ml)	738.6 ± 1351.6	1017.9 ± 1545.2	426.5 ± 1055.5	0.194
Medical history				
CKD, n (%)	5 (13.9)	4 (21.1)	1 (5.9)	0.206*
DM, n (%)	14 (38.9)	9 (47.4)	5 (29.4)	0.270**
COPD, n (%)	4 (11.1)	3 (15.8)	1 (5.9)	0.345*
Liver disease, n (%)	4 (11.1)	1 (5.3)	3 (17.6)	0.260*
HTN, n (%)	18 (50.0)	10 (52.6)	8 (47.1)	0.500**
CAOD, n (%)	6 (16.7)	3 (15.8)	3 (17.6)	0.614*
Initial Lab				
WBC ($\times 10^3/\mu\ell$)	15.0 ± 10.0	15.7 ± 9.6	14.1 ± 10.7	0.644
Hemoglobin (mg/dL)	10.1 ± 1.7	10.4 ± 1.4	9.8 ± 2.0	0.294
Platelet count ($\times 10^3/\mu\ell$)	136.0 ± 139.6	144.2 ± 142.8	126.8 ± 139.8	0.716
BUN (mg/dL)	49.3 ± 25.6	51.7 ± 25.6	46.6 ± 26.1	0.556
S_{Cr} (mg/dL)	2.9 ± 1.7	3.7 ± 2.0	2.0 ± 0.7	0.002
Sodium (mmol/L)	139.5 ± 4.9	138.9 ± 3.9	140.1 ± 5.9	0.505
Potassium (mmol/L)	4.3 ± 0.8	4.3 ± 0.6	4.3 ± 0.9	0.902
Total CO_2 (mmol/L)	19.2 ± 5.9	20.6 ± 4.7	17.7 ± 6.9	0.149
Calcium (mg/dL)	8.4 ± 1.1	8.5 ± 0.9	8.4 ± 1.3	0.676
Phosphate (mg/dL)	4.5 ± 1.9	4.5 ± 1.7	4.4 ± 2.1	0.832
Albumin (g/dL)	2.7 ± 0.6	2.8 ± 0.4	2.6 ± 0.7	0.276
High sensitive-CRP (mg/dL, IQR)	101.5 (40.1-175.5)	81.4 (36.9-139.3)	136.0 (26.4-244.5)	0.149
Lactate (mmol/L)	6.0 ± 6.4	3.4 ± 4.3	9.3 ± 7.2	0.007
APACHE Ⅱ	24.1 ± 6.5	21.5 ± 5.4	26.9 ± 6.7	0.011

Figure 2. Kaplan-Meier analysis of 28-day mortality according to A) weight change, B) OH/ECW by BIA, and C) B-lines by lung US

Table 2. Univariate Cox proportional hazard model for 28-day mortality

	HR (95%CI)	p-value
Weight change T3 (vs. T1+2)	1.461 (0.539-3.960)	0.456
OH/ECW T3 (vs. T1+2)	2.929 (1.110-7.727)	0.030
B-line T3 (vs. T1+2)	1.453 (0.536-3.937)	0.463
Age (year)	0.995 (0.964-1.027)	0.778
Female (vs. male)	1.033 (0.393-2.717)	0.947
DM (vs. non-DM)	0.596 (0.210-1.694)	0.331
CKD (vs. non-CKD)	0.268 (0.035-2.026)	0.202
LVEDD (mm)	1.044 (0.972-1.121)	0.237
LAVI (per ml/m2)	1.022 (0.997-1.048)	0.089
Urine output/body weight (per cc/kg)	0.982 (0.951-1.013)	0.252
tCO2 (per mmol/L)	0.922 (0.858-0.991)	0.027
Lactate (per mmol/L)	1.138 (1.051-1.232)	0.001
APACHE Ⅱ	1.126 (1.031-1.230)	0.008

Table 3. Multivariate Cox proportional hazard models for 28-day mortality according to OH/ECW tertiles.

Variables	Model 1		Model 2		Model 3	
	HR (95% CI)	P-value	HR (95% CI)	P-value	HR (95% CI)	P-value
OH/ECW T3 (vs. T1+2)	2.929 (1.110-7.727)	0.030	4.924 (1.408-17.22)	0.013	3.826 (1.043-14.03)	0.043
Age (per year)			1.019 (0.981-1.058)	0.331	1.023 (0.981-1.066)	0.289
Female (vs. male)			0.877 (0.326-2.355)	0.794	1.094 (0.379-3.156)	0.868
DM (vs. non-DM)			0.323 (0.082-1.271)	0.106	0.314 (0.088-1.120)	0.074
CKD (vs. non-CKD)			0.319 (0.041-2.477)	0.274	0.219 (0.025-1.905)	0.169
APACHE Ⅱ					0.079 (0.989-1.213)	0.079
tCO2 (per mmol/L)					0.946 (0.861-1.039)	0.247

Abbreviations: HR, hazard ratio; CI, confidence interval; OH, over-hydration; ECW, extra-cellular water; DM, diabetes mellitus; CKD, chronic kidney disease; APACHE Ⅱ, Acute Physiology and Chronic Health Evaluation Ⅱ

Conclusion

• Higher OH/ECW measured by BIA was an independent risk factor for 28-day mortality in septic AKI patients undergoing CRRT.

• Determining fluid status by BIA could be a useful method to stratify mortality risk in this patient group.