Characteristics, outcomes and 60-day hospital mortality of ICU patients with Covid-19 and acute kidney injury

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Abstract

Background: Acute kidney injury (AKI) has been reported in patients with Covid-19 pneumonia and is associated with higher mortality. The aim of our study is to describe characteristics, outcomes and 60-day hospital mortality of patients with Covid-19 pneumonia and AKI in the intensive care unit (ICU).

Methods: We conducted a retrospective study in which all adult patients with confirmed Covid-19 admitted to ICUs of Montefiore Medical Center and developing AKI were included. The study period ranged from 3/10- 4/11/2020. Sixty- day follow up data through 6/11/2020 were obtained.

Results: Of 300 adults admitted to the ICUs with Covid-19 pneumonia, 224 patients (74.6%) presented with or developed AKI subsequent to admission. Two hundred eighteen (97%) patients required invasive mechanical ventilation for moderate to severe acute respiratory distress syndrome (ARDS). 113 (50.45%) patients had AKI on day 1 of ICU admission. Peak AKI stages observed were stage 1 in 49 (21.8%), 2 in 35 (15.6%) and 3 in 140 (62.5%) patients, respectively. Among patients with AKI, 114 patients (50.8%) required renal replacement therapy (RRT). Mortality rate of patients requiring RRT was 70%. Of the 34 patients who were survivors, 25 (73.5%) were able to be weaned off RRT completely before hospital discharge. Non-survivors were older and had significantly higher admission and peak creatinine levels, admission hemoglobin and peak phosphate levels compared to survivors. The 60-day hospital mortality was 66.5%.

Conclusions: Covid-19 requiring ICU admission is associated with high incidence of severe AKI, necessitating RRT in approximately half of such patients. The majority of
Covid-19 patients with AKI in ICU developed moderate to severe ARDS requiring invasive mechanical ventilation. Timing or severity of AKI did not affect outcomes. Sixty-day hospital mortality is high (66.5%). AKI patients requiring RRT have high mortality, but survivors have good rates of RRT recovery.
Introduction

Acute Kidney Injury (AKI) is a marker of severe disease in Covid-19 patients and associated with higher mortality (1,2,3). Multiple studies have reported hospital incidence of AKI in Covid-19 patients between 0.5-36.6% (3-6). In the ICUs, the incidence of AKI is much higher, ranging from 20.6% to as high as 78% (6-9). The aim of our research is to study the clinical characteristics, complications, outcomes and 60-day hospital mortality of patients with laboratory confirmed Covid-19 who were admitted to the ICU with AKI or developed AKI during the ICU course.

Materials and Methods

We conducted a retrospective observational study in adult ICUs of Montefiore Medical Center. All adult Covid-19 positive ICU patients who developed AKI at ICU admission or during the course of ICU stay were included. The study period was 3/10- 4/11/2020. Patients with end stage renal disease, pregnancy and history of kidney transplant were excluded. The study was approved by the Institutional review board of Montefiore medical center and waiver of informed consent was granted.

Acute kidney injury (AKI) was defined using the Kidney Disease: Improving Global Outcomes (KDIGO) criteria: Stage 1- increase in serum creatinine by 0.3 mg/dl within 48 hours or 1.5-1.9 times increase in serum creatinine from baseline within 7 days; Stage 2- 2-2.9 times increase in serum creatinine from baseline within 7 days; Stage 3- 3 times or more increase in serum creatinine within 7 days or increase in serum creatinine to >= 4 mg/dl or initiation of renal replacement therapy (RRT) (10).
Baseline creatinine was defined using the last creatinine value in the electronic medical record between 7 days to 365 days prior to the current admission (11). If no pre-hospital baseline creatinine value was available, we defined it as the lowest serum creatinine value during the current hospitalization. Baseline creatinine value was not known in 43% of our patients. Data were collected through June 11th, 2020 to provide 60 day follow up. We excluded chronic kidney disease (CKD) as a co-morbid condition since we did not know baseline creatinine in high proportion of our patients and the diagnosis of CKD using electronic health record has low sensitivity and low positive predictive value (12). In-hospital survivors at 60 days were defined as patients discharged alive or alive in hospital at 60-days with censorship either at discharge or at the end of the 60-day follow up period. In-hospital non survivors at 60 days were the patients who died in the hospital by the end of follow up period.

Descriptive statistics were reported as means, medians or counts and percentages and analyses were performed using Fisher’s exact test, t-test or Wilcoxon rank sum test. Fine and Gray multivariable model of risk of in-hospital mortality was created with discharge alive treated as a competing event.

**Results**

**Baseline Characteristics**

Three hundred adults were admitted to our ICUs during the study period. Two hundred and twenty-four (224) patients developed acute kidney injury with a cumulative incidence of 74.6%. The mean (+- SD) age was 60 (+-11.78) years and 140 (62%) were males. By the end of our follow up period on June 11th, 149 (66.5%) patients died, 75
(33.5%) survived (67 discharged alive, 8 still in hospital). Table 1 lists the baseline characteristics of our patients. Compared to 76 patients who did not develop AKI, patients with AKI were older, had higher body mass index (BMI) and had statistically significant higher incidence of diabetes mellitus, hypertension and history of smoking (Table 1).

**ICU Course and Complications**

Table 2 lists ICU complications and outcomes. 218 (97%) patients needed invasive mechanical ventilation, median number of ventilator days being 10 days. 60% patients had severe and 36% had moderate ARDS respectively. Median ICU length of stay was 11 (6-18) days and median hospital length of stay was 16 (9-28) days.

**Laboratory results**

Table 2 summarizes admission and peak laboratory results during hospitalization for our patients. Non-survivors had significantly higher admission and peak creatinine levels, admission hemoglobin and peak phosphate levels compared to survivors.

**Renal outcomes**

Of 224 patients with AKI, 113 (50.45%) presented with AKI on Day 1 of ICU admission, with the remainder developing AKI during their ICU course. Peak AKI stage was stage 1 in 49 (21.8%), stage 2 in 35 (15.6%) and stage 3 in 140 (62.5%) patients. Mechanical ventilation was required in 96% patients with stage 1 AKI, 91% with stage 2 AKI and 99% with stage 3 AKI. Of 134 (60%) patients with severe ARDS, 66% had stage 3 AKI, 13% had stage 2 AKI and 21% had stage 1 AKI. 114 patients (50.8%) required renal replacement therapy, median number of days of RRT overall was 7 days, 17.5 days in survivors compared to 5 days in non-survivors. Of the total of 114 patients requiring
RRT, 80 (70%) died. Of the 34 (30%) survivors requiring initiation of RRT, 25 (73.5%) were able to be weaned from RRT completely before hospital discharge. The 60 day in hospital mortality was 66.5%. We did not observe any differences in mortality based on timing of AKI development and severity of AKI. Using the Fine and Gray multivariable model, advancing age, serum potassium and hemoglobin levels on admission were predictors of risk of in hospital mortality. (Figure 1).

Discussion

Our study reports an extremely high incidence (74.6%) of AKI in Covid-19 patients in the ICU setting, with high 60-day mortality of 66.5%. 62.5% of our patients had severe stage 3 AKI. Similar findings were reported by Chan et al describing 3235 hospitalized patients with an incidence of AKI of 68% among patients admitted to the ICU, with majority having Stage 3 AKI (6). They reported 34% of ICU patients requiring RRT, whereas in our study, 50% patients required renal replacement therapy. Their in-hospital mortality for Covid-19 patients with AKI in ICU is 52% (study period of 49 days), compared to our in-hospital 60-day mortality of 66.5%. Our higher mortality rate may reflect our longer, 60-day follow up on all patients, as well as our population being mainly comprised of underserved socioeconomic groups (African-american and Hispanic) who have been noted to have a higher burden of Covid-19 related AKI due to multiple co-morbidities, and a higher mortality (13). In the previous cited study by Chan et al, more than 40% of hospitalized patients who were discharged alive did not recover kidney function (6). In our study, we did not report recovery of kidney function, though, libera-
tion from RRT was achieved in only 36 (31.5%) patients, 25 (69%) of them being survivors. Eleven patients liberated off RRT still died due to worsening respiratory failure. Overall, RRT was associated with dismal outcomes as only 34 (30%) patients receiving RRT survived to 60 days follow up.

We did not observe any differences in outcomes based on peak stage of AKI or the severity of AKI. This is in contrast to the study by Lim et al who reported that stage 3 AKI was associated with higher mortality compared to non-AKI or Stage 1 AKI (3). We hypothesize that the likely reason for this disparity in findings is that severe ARDS and septic shock are a greater determinant of poor outcomes than peak stage of AKI in our patients. Also, inconsistencies in determination of peak AKI stage could be a reason given 43% patients with missing pre-hospital baseline creatinine value.

AKI in Covid-19 patients is closely associated with need for invasive mechanical ventilation. These findings are similar to study by Hirsch et al reporting 89.7% patients on mechanical ventilation developing AKI (4). We found that patients who are obese, older in age, have history of hypertension, diabetes mellitus and smoking are at greater risk of developing Covid-19 associated AKI in ICU, similar to risk factors described by Hirsch et al (4). Darmon et al described a rate of AKI of 44.3% in ARDS, whereas we report that Covid-19 associated ARDS has a much higher rate of AKI of above 70% in patients requiring ICU admission (14).
The major strength of our study is that we have 60 day follow up of outcomes for all patients and report the 60-day hospital mortality. Our study had several important limitations. First, we did not include CKD as the co-morbid condition since we did not know baseline creatinine in 43% patients. This could also contribute to inaccuracies in determination of peak AKI stages in our study. Second, we did not collect data on recovery of renal function since we felt it was too short of a period to report accurate renal recovery data. Third, we did not utilize KDIGO urinary output criteria in determination of AKI stage. In summary, Covid-19 requiring ICU admission is associated with an extremely high incidence of severe (stage 2 and 3) AKI, and requirement for renal replacement therapy. The majority of Covid-19 patients with severe AKI in ICU have moderate to severe ARDS and require invasive mechanical ventilation. Timing or severity of AKI did not affect outcomes. We report a high 60-day hospital mortality of 66.5% in our population. Covid-19 patients with AKI requiring RRT have high mortality but survivors have good rates of liberation from RRT (73.5% in our study).

Disclosures
MK Abramowitz reports consulting fees from Tricida, Inc. outside the submitted work. All remaining authors have nothing to disclose.

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Author contributions

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Table 1: Baseline Characteristics of Patients

|                  | Patients with AKI (N=224) | Patients with no AKI (n=76) | p-value | AKI In hospital Survivor at 60 days (N=75) | AKI In hospital Non-survivor at 60 days (N=149) | p-value |
|------------------|---------------------------|----------------------------|---------|------------------------------------------|-----------------------------------------------|---------|
| **Age- years**   | 60.1 (11.78) [26-97]      | 52.1 (13.30) [30-89]       | <0.001  | 55.9(11.1) [26-93]                       | 62.2(11.6) [37-97]                           | <0.001  |
| **Female- n (%)**| 84 (37.5%)                | 33(43.4%)                  | 0.36    | 37(49%)                                  | 47 (32%)                                     | 0.013   |
| **Race- n (%)**  |                           |                            | 0.17 (omnibus) |                                       |                                               |         |
| White            | 33 (14.73%)               | 7 (9.21%)                  |         | 10 (13%)                                 | 23 (15%)                                     |         |
| Black            | 83 (37%)                  | 23(30.27%)                 |         | 28 (37%)                                 | 55 (37%)                                     |         |
| Hispanic         | 84 (37.5%)                | 32 (42.1%)                 |         | 28 (37%)                                 | 56 (38%)                                     |         |
| Other            | 24 (10.71%)               | 14 (18.42%)                |         | 9 (12%)                                  | 15 (10%)                                     |         |
| **BMI-kg/m2 (n=221)** | 31.12 (28.0-37.11)     | 29 (25.80-33.91)           | 0.02    | 32.18(27.1-35.9)                        | 30.77 (28.0-38.35)                           | 0.478   |
| **Diabetes- n (%)** | 107 (47.77%)              | 23 (30.26%)                | 0.008   | 41(55%)                                  | 66(44%)                                      | 0.158   |
| **HTN- n (%)**   | 154 (68.75%)              | 41 (53.94%)                | 0.019   | 45(60%)                                  | 109 (73%)                                    | 0.049   |
| **CAD- n (%)**   | 33 (14.73%)               | 7 (9.21%)                  | 0.15    | 8(11%)                                   | 25 (17%)                                     | 0.318   |
| Condition       | n (%) | Mean (SD) | Median (IQR) | p Value |
|-----------------|-------|-----------|--------------|---------|
| COPD            | 15 (6.7%) | 4 (5.26%) | 0.44 | 4 (5%) | 11 (7%) | 0.778 |
| HIV            | 5 (2.23%) | 1 (1.31%) | 0.26 | 3 (4%) | 2 (1%) | 0.337 |
| HFrEF          | 12 (5.36%) | 4 (5.26%) | 0.58 | 3 (4%) | 9 (6%) | 0.755 |
| HFpEF          | 6 (2.68%) | 2 (2.63%) | 0.67 | 0 (0%) | 6 (4%) | 0.182 |
| Cancer         | 20 (8.93%) | 5 (5.26%) | 0.22 | 4 (5%) | 16 (11%) | 0.221 |
| DVT History    | 5 (2.23%) | 2 (2.63%) | 0.56 | 1 (1%) | 4 (3%) | 0.666 |
| Smoker         | 57 (25.44%) | 8 (10.52%) | **0.006** | 14 (19%) | 43 (29%) | 0.107 |
| NSAID          | 47 (20.98%) | 17 (22.36%) | 0.79 | 15 (20%) | 32 (21%) | 0.863 |
| ACE inhibitors | 39 (17.41%) | 14 (18.42%) | 0.84 | 10 (13%) | 29 (19%) | 0.350 |
| ARBs           | 46 (20.54%) | 17 (22.36%) | 0.73 | 13 (17%) | 33 (22%) | 0.484 |

Abbreviations: BMI=Body mass index, HTN=Hypertension, CAD=Coronary artery disease, COPD=Chronic obstructive pulmonary disease, HIV=Human immunodeficiency disease, HFrEF=Heart failure with reduced ejection fraction, HFpEF=Heart failure with preserved ejection fraction, DVT=Deep vein thrombosis, NSAIDS=Non-steroidal anti-inflammatory drugs, ACE inhibitors=angiotensin converting enzyme inhibitors, ARBs=Angiotensin receptor blockers.

Data is given as mean (SD), median (IQR), N (%) as appropriate

In Hospital Survivors at 60 days- Discharged alive or alive in hospital with censorship at end of 60-day follow up period.
In Hospital Non-Survivors at 60 days- In hospital death at the end of 60-day follow up period.
Table 2: AKI Patient Outcomes and Admission and Peak Laboratory Values

|                          | Overall (N=224) | In hospital survivor at 60 days (N=75) | In hospital Non-Survivors at 60 days (N=149) | p-value |
|--------------------------|-----------------|---------------------------------------|---------------------------------------------|---------|
| ICU LOS- days             | 11 (6-18)       | 14 (8-26)                             | 9(6-15)                                     | <0.001  |
| Hospital LOS- days        | 16 (9-28)       | 29 (17-42)                            | 12(7-20)                                    | <0.001  |
| RRT- n (%) n=114          | 114 (50.8%)     | 34 (29.82%)                           | 80 (70.12%)                                 | 0.259   |
| RRT Days- days            | 7 (4-16)        | 17.5 (8-26)                           | 5 (3-10)                                    | <0.001  |
| First RRT Modality- n (%) n=114 |            |                                       |                                             |         |
| CVVHD                    | 33 (29%)        | 11 (33.3%)                            | 22 (66.7%)                                  | 0.62 (omnibus) |
| IHD                      | 52 (45.6%)      | 13 (25%)                              | 39 (75%)                                    |         |
| PD                       | 15 (13.1%)      | 6 (40%)                               | 9 (60%)                                     |         |
| SLED/SCUF                | 14 (12.3%)      | 4 (28.5%)                             | 10 (71.5%)                                  |         |
| Diuretics- n (%)          | 187 (83.48%)    | 63 (84%)                              | 124 (83%)                                   | 0.999   |
| Steroids- n (%)           | 131 (58.48%)    | 46 (61%)                              | 85 (57%)                                    | 0.568   |
| Mechanical Ventilation- n (%) | 218 (97.3%)  | 72 (96%)                              | 146 (98%)                                   | 0.405   |
| Days on Ventilator-days   | 10 (6-18)       | 11 (7.5-22.5)                         | 9 (6-16)                                    | 0.024   |
| ARDS- n (%)               |                 |                                       |                                             | 0.040 (omnibus) |
| None                     | 5 (2.23%)       | 3 (4%)                                | 2 (1%)                                      |         |
| Mild                     | 4 (1.79%)       | 3 (4%)                                | 1 (1%)                                      |         |
| Moderate                 | 82 (36.6%)      | 32 (43%)                              | 50 (34%)                                    |         |
| Severe                   | 133 (59.3%)     | 37 (49%)                              | 96 (64%)                                    |         |
| Vasopressors- n (%) | 190 (84.8%) | 53 (71%) | 137 (92%) | <0.001 (omnibus) |
|---------------------|-------------|----------|-----------|------------------|
| Norepinephrine- n (%) | 185 (82.6%) | 53 (59.5%) | 132 (97.7%) | |
| Vasopressin- n (%) | 106 (47.3%) | 17 (22.66%) | 89 (59.73%) | |
| Phenylephrine- n (%) | 76 (34.0%) | 17 (22.66%) | 59 (39.6%) | |
| Epinephrine- n (%) | 26 (11.6%) | 4 (5.33%) | 22 (14.76%) | |
| AKI at admission (Day 1)- n (%) | 113 (50.45%) | 35 (46%) | 78 (52%) | 0.480 |
| **AKI post admission- n (%)** | | | | |
| Day 2 | 24 (10.7%) | 6 (8%) | 18 (12.08%) | 0.422 |
| Day 3 | 23 (10.2%) | 7 (9.3%) | 16 (10.7%) | |
| Day 4 | 15 (6.7%) | 8 (10.6%) | 7 (4.7%) | |
| Day 5 | 13 (5.8%) | 4 (5.3%) | 9 (6.04%) | |
| Day 6 | 15 (6.7%) | 6 (8%) | 9 (6.04%) | |
| Day 7 | 4 (1.79%) | 1 (1.33%) | 3 (2.01%) | |
| >7 Days | 17 (7.5%) | 8 (10.6%) | 9 (6%) | |
| Peak AKI stage- n (%) | | | | 0.354 (omnibus) |
| 1 | 49 (21.8%) | 19 (25%) | 30 (20%) | |
| 2 | 35 (15.6%) | 14 (19%) | 21 (14%) | |
| 3 | 140 (62.5%) | 42 (56%) | 98 (66%) | |
| Liberation from RRT- n (%) (n=114) | 36 (31.57%) | 25 (69.4%) | 11 (30.6%) | <0.001 |
| Admission Labs | | | | |
| Creatinine (mg/dL) | 1.27 (0.9-1.7) | 1.1(0.8-1.6) | 1.3(0.9-1.7) | 0.041 |
| WBC (k/uL) | 8.7 (6.1-12.0) | 9.3 (5.8-13.1) | 8.6 (6.2-11.0) | 0.548 |
|                          | Peak laboratory values* |
|--------------------------|-------------------------|
| Lymphocyte (%)           |                          |
| Hemoglobin (g/dL)        | 11 (8.0-17.0)           |
|                           | 12.0 (8.0-18.0)         |
|                           | 11.0 (8.0-15.0)         |
| Platelet (k/uL)          | 209 (157-259)           |
|                           | 214.5 (164.0-269.0)     |
|                           | 204.0 (155.0-257.0)     |
| BUN (mg/dL)              | 22.0 (14.0-33.5)        |
|                           | 19.0 (12.0-35.0)        |
|                           | 22.0 (15.0-33.0)        |
| Na (mEq/L)               | 136.0 (133.0-139.0)     |
|                           | 137.0 (133.0-140.0)     |
|                           | 136.0 (133.0-139.0)     |
| K (mEq/L)                | 4.4 (4-4.8)             |
|                           | 4.3 (3.9-4.6)           |
|                           | 4.5 (4.0-4.8)           |
| Troponin (ng/mL)         | 0.01 (0.01-0.04)        |
|                           | 0.01 (0.01-0.03)        |
|                           | 0.01 (0.01-0.04)        |
| Hematuria (>= 3 RBCs per HPF) | 121 (54%) |
|                           | 40 (60%)                |
|                           | 81 (60%)                |
| Proteinuria              |                          |
| Normal/Trace (up to 30 mg/dl) | 34 (16.5%) |
|                           | 53 (25.8%)              |
|                           | 19 (17.6%)              |
|                           | 21 (22.1%)              |
| 1+ (30-100 mg/dl)        | 78 (38%)                |
|                           | 17 (38%)                |
|                           | 34 (35.4%)              |
| 2+ (100-300 mg/dl)       | 35 (17.07%)             |
|                           | 8 (11.6%)               |
|                           | 27 (23.4%)              |
| 3+ (300-1000 mg/dl)      | 5 (2.44%)               |
|                           | 1 (1.7%)                |
|                           | 4 (3.3%)                |
| 4+ (>1000 mg/dl)         |                          |
| Urine Na (mEq/L)         | 24.5 (20.0-51.0)        |
|                           | 28.0 (20.0-56.0)        |
|                           | 23.0 (20.0-49.0)        |
| Bun/Cr ratio             | 16.7 (13.25-20.75)      |
|                           | 16.8 (13.1-22.5)        |
|                           | 16.7 (13.4-20.4)        |
| Test                      | Value        | Lower Limit | Upper Limit | P Value  |
|--------------------------|--------------|-------------|-------------|----------|
| BUN (mg/dL)              | 104.0        | 61.0        | 140.0       | 0.367    |
| Creatinine (mg/dL)       | 5.5          | 2.95        | 8.56        | 0.007    |
| Phosphate (mg/dL)        | 8.0          | 5.5         | 11.1        | 0.050    |
| Magnesium (mg/dL)        | 3.0          | 2.1         | 4.4         | 0.821    |
| Lactate (mmol/L)         | 3.05         | 2.2         | 4.65        | <0.001   |
| Procalcitonin (ng/mL)    | 4.6          | 1.5         | 15.7        | 0.013    |
| Ferritin (ng/mL)         | 1894.0       | 1141.5      | 3581.0      | 0.957    |
| LDH (U/L)                | 747.5        | 570.0       | 993.0       | 0.448    |
| CRP (mg/dL)              | 31.8         | 20.7        | 41.5        | 0.001    |
| d-dimer (ug/mL)          | 14.85        | 6.84        | 20.0        | 0.158    |
| Fibrinogen (mg/dL)       | 748.5        | 629.0       | 895.0       | 0.107    |
| CPK (U/L)                | 733.0        | 242.0       | 2273.0      | 0.230    |
| Troponin (ng/mL)         | 0.06         | 0.01        | 0.25        | 0.704    |
| Pro BNP (pg/mL)          | 800.5        | 230.0       | 3758.0      | 0.954    |
| AST (U/L)                | 113          | 70.0        | 235         | 0.124    |
| ALT (U/L)                | 78(42-157)   | 93.0        | 41.0        | 0.171    |
| Abbreviations: ICU=Intensive care unit, LOS= Length of stay, RRT= Renal replacement therapy, CVVHD= Continuous veno-venous hemodialysis, IHD= Intermittent hemodialysis, PD= Peritoneal dialysis, SLED= Sustained low efficiency dialysis, SCUF= Slow continuous ultrafiltration, ARDS= Acute respiratory distress syndrome, WBC= White blood count, BUN= Blood urea nitrogen, Na= Sodium, K= Potassium, LDH= Lactate dehydrogenase, CRP= C reactive protein, CPK= Creatine Phosphokinase, Pro-BNP= N-type Pro-Brain natriuretic peptide, AST= Aspartate aminotransferase, ALT= Alanine aminotransferase |
|---|---|---|---|---|
| Bilirubin (mg/dL) | 0.9 (0.5-2.0) | 0.8 (0.5-1.9) | 1.0 (0.6-2.0) | 0.165 |
| Creatinine before initiation of RRT (mg/dl) | 7.05 (5.2-8.8) | 7.07 (4.87-9.3) | 7.05 (5.48-8.3) | 0.86 |

Data is given as mean (SD), median (IQR), N(%) as appropriate

In Hospital Survivors at 60 days- Discharged alive or alive in hospital with censorship at end of 60-day follow up period.

In Hospital Non-Survivors at 60 days- In hospital death at the end of 60-day follow up period.

Liberation from RRT- patients whose native kidney function improved such that they were able to be weaned off RRT completely and no longer required it for clearance or volume removal.

* peak laboratory values measured during entire hospitalization
Figure 1: Fine and grey competing risk multivariate model with adjusted subdistributed hazard ratio N=218, death events=144

*Discharge alive treated as a competing event; patients still in hospital at end of follow-up censored at last day of follow-up.

asHR=adjusted sub-distribution hazard ratio

Units= Admission Potassium- mEq/L, admission hemoglobin- gm/dl, admission creatinine- mg/dl, age- years