



Haemodialysis for COVID-19 patients admitted in cardiac ICU: a tertiary care centre study from Northern India.

ISSN 2545-2533

Received: 07.04.2023

Accepted: 10.06.2023

First online: 25.04.2023

Published: 30.06.2023

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Funding Acquisition - D
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Methodology - F
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Validation - K
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Writing (Review & Editing) - N
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ABSTRACT

INTRODUCTION: COVID-19, initially thought to be a lung disease, is now known to have multisystem impact raising the unprecedented need for intensive care units and holistic treatment modalities, such as haemodialysis, more so ever in patients with compromised cardiac health. Objective - to study the impact of haemodialysis on COVID-19 patients with acute kidney injury (AKI) admitted in cardiac ICU.

MATERIAL AND METHODS: A retrospective observational study in which data of COVID-19 positive patients admitted to cardiac ICU at a tertiary care centre with pre-existing cardiac co-morbidities, intervened with haemodialysis for AKI was collected from July 2020 to January 2022.

RESULTS: Total 126 patients (survivors =79, non-survivors =47) were included. The percentage of patients with various pre-existing cardiac co-morbidities (ischemic, valvular, cardiomyopathies, and others) were more or less equally distributed between survivors and non-survivors. The non-survivors were older ($p<0.001$), had majority percentage of males ($p=0.009$), higher mean BMI, pulse rate, respiratory rate, and a lower mean systolic blood pressure, and lower SpO₂ ($p<0.001$). The non-survivors had a higher mean TLC, NLR, D-dimer levels and lower mean platelet count ($p<0.001$). The non-survivors also had a higher mean blood urea, serum creatinine level ($p<0.001$), and potassium level ($p=0.003$). The survivors received significantly more haemodialysis sessions as compared to non-survivors ($p<0.001$).

CONCLUSIONS: The study establishes haemodialysis as a boon for COVID-19 positive cardiac patients with added renal insult. Additionally, it suggests that, via early decision-making haemodialysis threshold be lowered and frequency increased for better outcome.

KEY WORDS: Haemodialysis, boon, COVID patients, cardiac ICU

INTRODUCTION

The wildfire of COVID-19 (coronavirus disease) that started in 2019 in Wuhan, China spread globally culminating into a pandemic, consuming humanity and leaving death, destruction along with a lot of unanswered questions in its wake. The causative virus SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2), akin to ten headed demon king “Ravana”, has numerous notorious faces, and extensively affects essentially all the organs. It binds to ACE-2 [1] (angiotensin converting enzyme 2) receptors present in lungs, heart, kidney, brain, liver, intestine, vascular endothelial cells, etc., leading to inflammation, endotheliitis, vasoconstriction, hypercoagulability, and oedema. A catecholamine surge and cytokine storm lead to ARDS, multi-organ dysfunction, shock and eventually death [2].

Most deaths in COVID-19 were attributed to cardiac and renal involvement [3]. In patients with history of coronary artery disease, COVID-19 via compromised oxygen supply and thrombosis increases the risk aggravating the cardiac injury. The virus directly or via systemic inflammation can cause myocarditis, heart failure, and arrhythmias [4]. Adding to this cascade, injury to renal tubular cells and podocytes leads to acute kidney injury (AKI).

This multisystem involvement is a recipe for increased mortality, and therefore calls upon us to holistically approach critical care and actively intervene these moribund patients, to improve in-hospital survival. Our study explores impact of haemodialysis on COVID-19 patients with AKI admitted in cardiac ICU as an answer to this medical conundrum.

MATERIAL AND METHODS

Study Design

This was a retrospective observation study. 126 participants included were patients admitted to Cardiac ICU wards, in Swaroop Rani Nehru Hospital, Prayagraj, India from July 2020 to January 2022.

Inclusion Criteria

1. All patients age > 18 years, males and females were taken.
2. Patients with history of pre-existing cardiac involvement (ischemic, valvular, cardiomyopathy, others).
3. Patient in AKI stage 3 according to KIDGO guideline 2012.

Exclusion Criteria

1. Patients aged < 18 years.
2. Patients with history of CKD (chronic kidney disease).
3. Patients treated with nephrotoxic drugs as remdesivir, amphotericin B.

Study Procedure

Records of all the patients who were admitted to Cardiac ICU wards with a pre-existing cardiac involvement (ischemic, valvular, cardiomyopathy, others), and underwent haemodialysis were obtained. Patients were tested for COVID-19 using RT-PCR or Truenat. Patients were categorised into two groups Survivors and Non-survivors on the basis of their outcome. Patients with AKI stage 3 of KIDGO-2012 guideline were intervened with haemodialysis. Patients' history, baseline investigation parameters like complete blood counts, liver function test, kidney function test, HbA1C (glycated haemoglobin), D-dimer were obtained from records which were done on the day of admission. Patients were monitored for urine output, blood pressure, respiratory rate, pulse rate, oxygen saturation, KFT and other parameters daily. Based on the changes in kidney function and urine output, patients were haemodialysed using Fresenius Polysulfone membrane.

Statistical Analysis

The categorical variables was in the form of number and percentage (%). On the other hand, the quantitative data were presented as the mean $\pm$ SD. The final analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, ver 21.0. For statistical significance, p value of less than 0.05 was considered statistically significant.

Ethical Consideration

Institutional ethics committee–human research approved the study. Study procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000. The protocol was approved by the ethics committee (*Registration No ECR/922/Inst./UP2017 issued under rule 122DD/ of the Drugs and Cosmetics Rule 1945*) of Moti Lal Nehru medical college, Prayagraj, Uttar Pradesh, India.

RESULTS

Total 126 patients were included in this study. They were divided into two groups survivors (n=79) and non-survivors (n=47). As shown in Table 1, the non-survivors were older with a mean age of 57.49 years with majority of them being males (n=37, 78.72%) in comparison to survivors where mean age was 45.19 years and males (n=44,55.69%). Percentage of smokers 51.06% and alcohol 38.29% consumers were higher in the non-survivors, although this difference failed to meet the criteria for statistical significance.

Patients in non-survivors vs survivors group had significantly higher ($p<0.001$) mean BMI 23.13 vs 20.48 kg/m², a lower mean systolic blood pressure 118 $\pm$ 29.25 vs 134 $\pm$ 19.61mm Hg, higher mean pulse rate 108.86 $\pm$ 18.55 vs 94.09 $\pm$ 14.59 bp, higher mean respiratory rate 31.47 $\pm$ 5.20 vs 21.49 $\pm$ 4.65 cpm and lower mean SpO₂ 82.11 vs 93.13% respectively.

Table 1. Comparison of baseline characteristics of COVID-19 survivors and non-survivors.

	Survivors (n=79)	Non-survivors (n=47)	P-value
Demographics			
Age (years)	45.19±13.32	57.49±15.51	<0.001
Males	44 (55.69%)	37 (78.72%)	0.009
BMI (kg/m ²)	20.48±3.72	23.13±3.78	<0.001
Smokers	30 (37.97%)	24 (51.06%)	0.151
Alcohol	23 (29.11%)	18 (38.29%)	0.287
Vitals			
Systolic BP (mm Hg)	134.17±19.61	118±29.25	<0.001
Diastolic BP (mm Hg)	82.6±13.09	79.95±16.92	0.246
Pulse rate (bpm)	94.09±14.59	108.86±18.55	<0.001
Respiratory rate (cpm)	21.49±4.65	31.47±5.20	<0.001
SpO ₂ (%)	93.13±4.26	82.11±6.62	<0.001
Etiological diagnosis			
Ischemic	33 (41.77%)	20 (42.55%)	0.872
Valvular	18 (22.78%)	11 (23.40%)	0.712
Cardiomyopathy	22 (27.85%)	13 (27.66%)	0.838
Others	6 (7.59%)	3 (6.38%)	0.321

Table 2. Comparison of haematological parameters of COVID-19 survivors and non-survivors.

	Survivors	Non-survivors	P-value
Hemoglobin (g/dl)	9.92±2.35	9.31±2.44	0.169
TLC (x 10 ³ /uL)	11.18±4.91	22.30±7.67	<0.001
NLR	6.63±3.45	14.16±6.07	<0.001
Platelet count (lac/mm ³)	1.93±0.37	1.33±0.54	<0.001
D-dimer (mg/l)	1.72±1.71	6.49±2.86	<0.001

Table 3. Comparison of baseline kidney function tests of COVID-19 survivors and non-survivors.

	Survivors	Non-survivors	P-value
Blood Urea (mg/dl)	146.82±40.21	232.28±74.03	<0.001
Serum Creatinine (mg/dl)	7.16±1.41	10.41±4.42	<0.001
Na ⁺ (mEq/l)	140.76±5.20	142.84±8.51	0.133
K ⁺ (mEq/l)	4.73±0.75	5.20±0.90	0.003
No of HD done	2.53±0.58	1.76±0.99	<0.001

On evaluating the indications for admission in cardiac ICU, the percentage of patients with various cardiac co-morbidities were more or less equally distributed between survivors (ischemic 41.77%, valvular 22.78%, cardiomyopathies 27.85%, and others 7.59%) and non-survivors (ischemic 42.55%, valvular 23.40%, cardiomyopathies 27.66%, and others 6.38%).

On comparison of haematological parameters as shown in Table 2 and Figure 1, The non-survivors had a significantly higher ($p<0.001$) mean TLC 22.30 ± 7.67 ($\times 10^3/\mu\text{L}$), NLR 14.16 ± 6.07 , D-dimer level 6.49 ± 2.86 , and lower mean platelet count 1.33 ± 0.54 (lac/mm^3). Haemoglobin was slightly lower with a mean of 9.31 ± 2.44 gm/dl in the non-survivors vs 9.92 ± 2.35 gm/dl in survivors but it was of no statistical significance.

Table 3 and Figure 2 shows the comparison between the baseline kidney function test of non-survivors and survivors. On admission, the non-survivor's vs survivors had a significantly higher ($p<0.001$) mean blood urea level 232.28 ± 74.03 vs 146.82 ± 40.21 mg/dl and serum creatinine level 10.4 ± 4.42 vs 7.16 ± 1.41 mg/dl. Significantly higher ($p=0.003$) mean potassium level 5.20 ± 0.90 mEq/l was seen in non-survivors as compared to survivors 4.73 ± 0.75 mEq/l. On the contrary, there was no significant difference in the mean sodium level between survivors (140.76 ± 5.20 mEq/l) and non-survivors (142.84 ± 8.51 mEq/l). Mean number of haemodialysis received by survivors 2.53 ± 0.58 was significantly higher ($p<0.001$) in comparison to non-survivors 1.76 ± 0.99 .

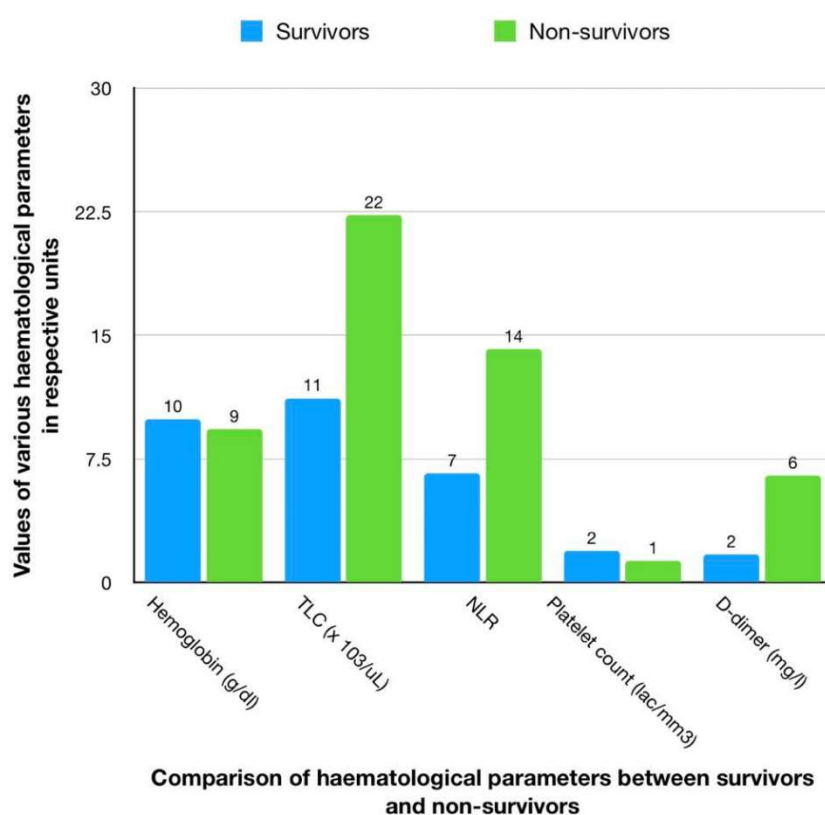


Figure 1. Comparison of haematological parameters of COVID survivors and non-survivors.

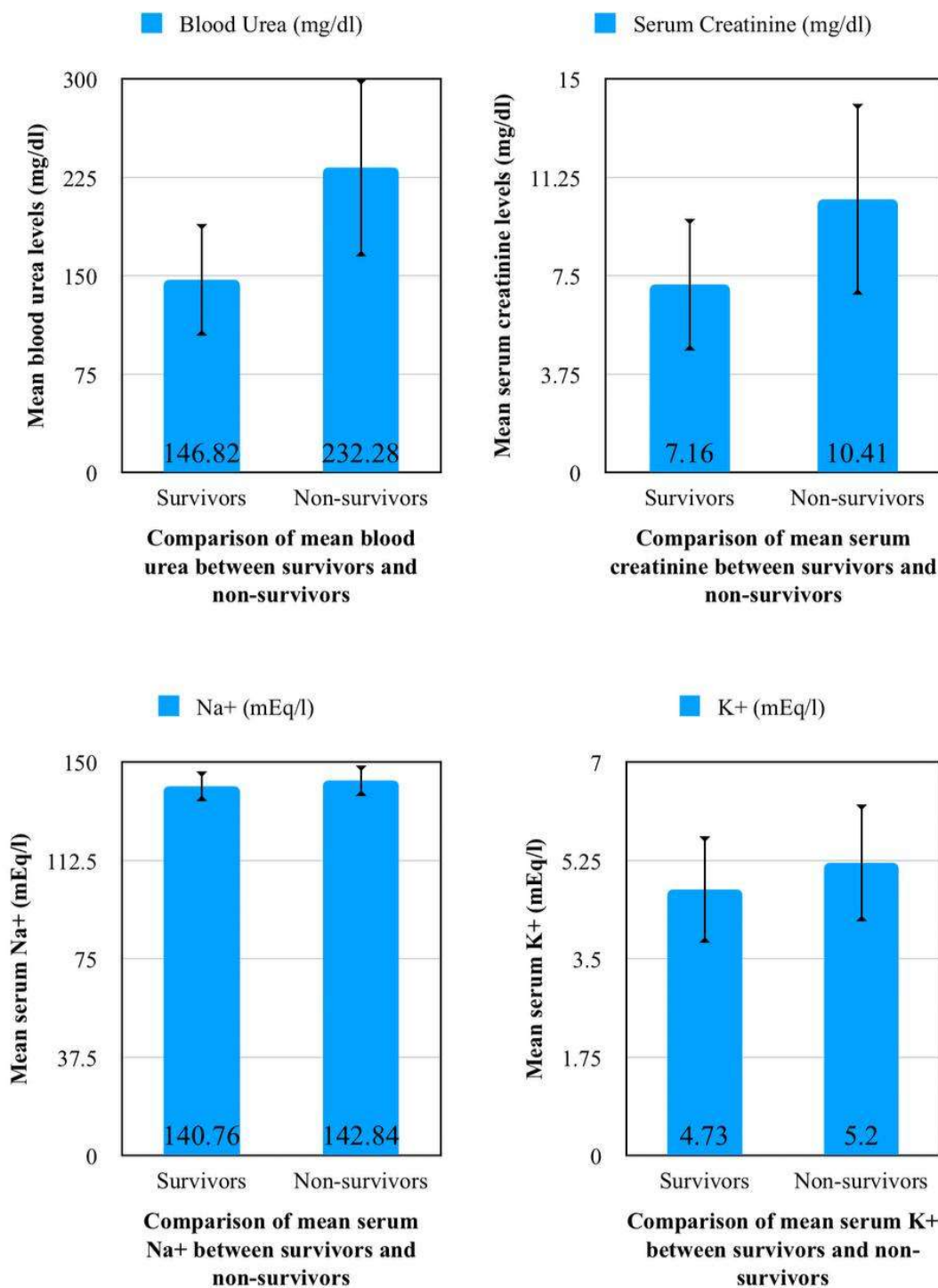


Figure 2. Comparison of baseline kidney function tests of COVID-19 survivors and non-survivors.

DISCUSSION

Selecting COVID-19 positive patients in cardiac ICU with acute renal insult makes our study unique stratifying the most vulnerable population with the worst prognosis and hence establishing haemodialysis as a lifesaving interventional modality, which to our best knowledge has not been explored previously.

Upon inspection of our demographic data, we find that higher mean age was seen in the non-survivors group ($p < 0.001$) which is in consistency with the existing literature. A meta-analysis by Biswas et al including 20 studies and a total of 64,476 patients, showed a relative risk of mortality of 15.44 with age ≥ 50 years [5].

Higher mortality amongst the male sex ($p = 0.009$) in our study is coherent with previous COVID-19 studies. For instance, a large multi-center retrospective cohort study involving 4300 females and 3808 males with COVID-19 infections compared the two sexes for their outcomes. Multivariate model correcting for age and comorbidities was applied and showed a significant association between mortality and male sex (OR 1.96, $p = 0.001$) [6]. Since our patients had cardiac as well as renal involvement, comparison with existing literature on mortality of cardiac ICU and dialysis patients becomes imperative. Comparison of mortality rates among men and women in cardiac ICU has been done by Herscovici et al. 6963 patients (39% women) were studied. Similar mortality rates were observed in both the sexes [7]. Females had a better survival rate than males in a Korean study involving 4994 patients with a female-to-male mortality of 0.77 [8] though this study included patients on maintenance haemodialysis and ours did not.

The statistical insignificance of smokers and alcohol consumers among survivors and non-survivors, although apparently odd, adds to the credibility of the other risk factors since the confounding effect of smoking and alcohol was ruled out to some extent. Similarly, almost equal percentage distribution of various aetiologies of cardiac involvement is important to interpret the data because the inherent differences in the mortality of the various causes could have been eliminated.

The higher mean pulse rate, respiratory rate and a lower SpO₂ and a systolic BP in the non-survivors ($p < 0.001$) is in consistency with data on cardiac ICU as well as our clinical experience. Patients with a lower blood pressure and a higher pulse rate especially with a compromised heart are more likely to suffer from worse outcomes. The higher respiratory rate and a lower O₂ saturation adding to the mortality can be justified by both COVID-19 and cardiac involvement. Haematological parameters are also consistent with our knowledge. A study from Saudi Arabia with clinical data of 6026 COVID-19 patients showed that higher D-dimer, TLC, and percentage of neutrophils were associated with mortality [9]. Similar results were shown in another study by Chapanduka et al [10], though the platelet count was similar among survivors and non-survivors, in contrast to our data. Multiple factors could be at play here, for eg, more patients with MODS, co-existing causes of fever like malaria, dengue, etc.

Since the patients were being dialyzed, a look at their kidney function tests becomes mandatory. Non-survivors had a significantly higher ($p < 0.001$) mean blood urea, serum creatinine and potassium level ($p = 0.003$) than the survivors. This is true for patients with renal involvement, in general. Although multiple factors could underlie this finding such as, severity at presentation, longer hospital stay, threshold for deciding on haemodialysis, etc, it must not be denied that significantly greater number ($p < 0.001$) of dialysis was performed in patients who survived as compared to non-survivors. This can be interpreted as non-survivors failing to receive timely and adequately frequent sessions of haemodialysis.

Limitation of Study

A multi-centric study with larger sample size is required to redefine haemodialysis initiation protocols in Cardiac ICU patients.

CONCLUSIONS

COVID-19 isn't the first global pandemic and won't be the last. Hence, as clinicians, it calls upon us to improve our diagnostic and therapeutic medical prowess to save every life possible however grave the prognosis may be. COVID-19 positive cardiac ICU patients with renal involvement represent those most in need of critical care and timely intervention to improve the outcome. In our study two-third of all the patients haemodialysed managed to survive proving haemodialysis to be a beneficial therapeutic modality for COVID-19 patients with cardiac comorbidities. That being said, higher number of haemodialysis sessions in the survivor group point towards the need for redefining the decision-making process regarding the initiation threshold and frequency of haemodialysis in comorbid COVID-19 patients with acute renal injury..

SUPPLEMENTARY INFORMATION

Funding: No fund was received related to this study.

Institutional Review Statement: The study was conducted according to the guidelines of the Declaration of Helsinki.

Informed Consent Statement: Not applicable

Data Availability Statement: The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest: The authors declare no conflicts of interest.

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