

Research Article

Predictors of six-month mortality after emergency haemodialysis for acute kidney injury in adults living with HIV: a retrospective cohort study

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*Corresponding author: Naven2105@gmail.com***ABSTRACT**

Background: Acute kidney injury (AKI) occurring in people living with HIV (PLWH) remains a significant clinical challenge in low- and middle-income countries (LMICs). This study aimed to evaluate the utility of immunovirological status, comorbidity burden, and dialysis indications in predicting six-month outcomes in PLWH undergoing emergency haemodialysis.

Methods: A retrospective study of 150 patients with PLWH who received emergency dialysis for AKI between 2018 and 2023. Predictors of six-month mortality were assessed using multivariable logistic regression. Frailty was measured via the Clinical Frailty Scale (CFS), and the AEIOU (Acidosis, Electrolyte imbalances, Intoxications, fluid Overload, and Uraemia) criteria were applied to dialysis triggers.

Results: The study cohort had a mean age of 46.3±13.8 years, 57.3% were male, 40.7% were hypertensive, and 28% had diabetes. CD4 count and HIV viral load were strong predictors of six-month mortality ($p<0.001$). Patients with advanced immunosuppression and detectable viraemia had a mortality rate of 72.2%, compared with 4.1% in those with preserved immunity and viral suppression ($p<0.001$). Frailty was present in 22 % and was independently associated with mortality. The AEIOU indicators were not predictive of mortality ($p=0.322$).

Conclusion: In PLWH with AKI, frailty and immunovirological compromise superseded acute dialysis indications in predicting six-month mortality. These findings advocate for the integration of frailty and HIV disease markers into dialysis triage protocols in LMICs to optimise survival outcomes.

Keywords: HIV-associated nephropathy, acute kidney injury, emergency haemodialysis, immune status, clinical frailty.

INTRODUCTION

Kidney disease, particularly chronic kidney disease (CKD), poses a significant global health challenge, with a pronounced impact in developing countries. Approximately 10% of the worldwide population has CKD, totalling over 800 million individuals, with the burden disproportionately felt in low- and middle-income nations where healthcare resources are limited.(1,2) The rising prevalence of CKD is attributed to factors such as diabetes, hypertension, and ageing populations, leading to increased morbidity and mortality.(1,3) South Africa has the highest human immunodeficiency virus (HIV) prevalence globally, with an adult prevalence rate of approximately 19.6% and an estimated 7.8 million people living with HIV (PLWH).(4) Kidney disease among PLWH results from a complex interplay of factors, including direct infection by the virus, immune-mediated injury, and antiretroviral drug toxicity.(5) The most commonly

implicated forms of kidney disease include HIV-associated nephropathy (HIVAN), HIV immune complex kidney disease (HIVICK), and tenofovir disoproxil fumarate (TDF)-related nephrotoxicity.(6,7) These conditions progress to acute kidney injury (AKI) or chronic kidney disease (CKD), thereby complicating the clinical management and long-term outcomes of PLWH.

Dialysis remains a cornerstone in the management of kidney failure, be it in the acute or chronic setting, particularly when patients meet the AEIOU indications (severe Acidosis, life-threatening Electrolyte imbalances (especially hyperkalaemia), Intoxications with dialysable toxins, fluid Overload unresponsive to diuretics, and symptomatic Uraemia such as encephalopathy or pericarditis). The AEIOU mnemonic is based on the set of urgent indications for dialysis outlined by the Kidney Disease Improving Global Outcomes (KDIGO) guidelines.(8,9) However, in

PLWH, the predictive value of the number and specific types of dialysis indications for longer-term outcomes, such as morbidity and mortality, remains underexplored. Moreover, despite the high clinical burden, limited empirical data exist regarding how these acute dialysis triggers interact with patient-level variables such as CD4+ T-cell count, HIV viral load, and baseline functional status.

While the link between HIV infection and kidney dysfunction is well established,^(10,11,12) the prognostic significance of dialysis initiation, especially in relation to the number and type of AEIOU indications, remains insufficiently quantified. Although variables such as CD4+ count, HIV viral load, and frailty are individually recognised as significant predictors of outcomes in PLWH, they are rarely incorporated into composite prognostic models. In resource-constrained settings, this lack of robust risk stratification limits timely clinical decision-making and impedes the equitable allocation of life-saving dialysis resources. This study thus aimed to assess the various factors that affected the outcome of PLWH who required emergency dialysis.

METHODS

This was a retrospective study conducted at Victoria Mxenge Hospital (formerly King Edward VIII Hospital), located in Durban, South Africa. The study population consisted of adult patients admitted to the hospital between 1 January 2018 and 31 December 2023 and who met the following inclusion criteria: HIV-positive individuals 18 years or older; received emergency haemodialysis for acute kidney dysfunction as defined by KDIGO guidelines; and in whom baseline CD4+ T-cell count, HIV viral load, and dialysis indication(s) were documented. Data were retrospectively collected from patients' medical records using a consecutive sampling strategy.

To maintain confidentiality, each participant was assigned a unique study identifier. Collected variables included demographic information (age, sex, and race), comorbidities (e.g., hypertension and diabetes mellitus), and HIV-specific parameters, such as CD4+ T-cell count (cells/ μ L) and HIV viral load. The latter was classified as detectable or below the lower detectable limit [LTDL]. HIV viral load values below the lower limit of detection were assigned a value of 25 copies/mL for descriptive analyses, and viral load was additionally analysed as a dichotomous variable (detectable >25 copies/mL vs. LTDL \leq 25 copies/mL). Preserved CD4 count referenced counts \geq 350 cells/ μ L, an intermediate group noted counts between 200–350 cells/ μ L, and advanced disease with counts recorded as <200 cells/ μ L. Dialysis-related variables included the acute indication(s) for haemodialysis, coded numerically from 1 to 5 and corresponding to the AEIOU criteria, and the total number of indications present at the time of dialysis initiation. Frailty was assessed on presentation by the treating physician using the Clinical Frailty Scale (CFS), ranging from

1 to 7.^(13,14,15) Outcome variables were also recorded, including the presence of dialysis-related complications and all-cause mortality at 6 months post-dialysis initiation. Ethical approval of the study was obtained from the University of KwaZulu-Natal Biomedical Research and Ethics Committee.

Data analysis

Descriptive statistics were used to summarise the study cohort. Categorical variables were reported as frequencies and percentages. In contrast, continuous variables were expressed as means with standard deviations or medians with interquartile ranges, depending on their distribution. For bivariate analyses, associations between categorical predictors and outcomes were assessed using the chi-square test or Fisher's exact test, as appropriate. Subgroup analyses were conducted by stratifying patients based on CD4+ count to evaluate potential effect modification.

Binary logistic regression was used to assess dichotomous outcomes, such as mortality and dialysis-related complications. For logistic regression models, calibration was evaluated using the Hosmer–Lemeshow goodness-of-fit test. A p-value <0.05 was considered statistically significant. All analyses were conducted using IBM SPSS Statistics Version 30 and Stata.

RESULTS

A total of 425 patients who were accepted for acute haemodialysis during the study period were screened. 275 of these patients were excluded from the study: negative HIV ELISA tests (250), incomplete data (21), and 4 patients died prior to dialysis initiation. A total of 150 adult PLWH who underwent emergency haemodialysis were included in the study. The demographics and comorbid conditions in the study patients are listed in Table 1. The mean age of the cohort was 46.3 years (standard deviation [SD]: 13.8 years), and 57.3% (n = 86) were male. Race distribution was predominantly skewed toward African Black patients, who represented 76.0% (n = 114) of the study population, in alignment with the local population constituents. Comorbid conditions were common among the study population, with hypertension and diabetes mellitus being the most prevalent.

Although diabetes mellitus and hypertension were stronger predictors of acute dialysis requirement, they were not essential factors in predicting mortality within six months.

HIV-Related parameters and their association with mortality

Table 2 summarises the association between pre-dialysis CD4 count, HIV viral load, and six-month mortality. CD4 count, treated as a continuous variable, was markedly lower among patients who died within six months compared

Table 1: Demographic and Comorbid Characteristics of Patients Living with HIV Undergoing Emergency Haemodialysis

	Mean ± SD	Number	Percent
Age (years)	46.31 ± 13.80		
Sex			
Female		64	42.7
Male		86	57.3
Race			
Black		114	76.0
Coloured		3	2.0
Indian		15	10.0
White		18	12.0
Comorbidities			
Diabetes		42	28
Dyslipidaemia		17	11.3
Hypertension		61	40.7

Table 2: Association of CD4 Count and HIV Viral Load with Six-Month Mortality

	Deceased	
CD4 count	No	Yes
[median (IQR)]	458.00 (360.00–660.00)	90.00 (37.00–414.00)
Mann-Whitney U Test p-value	< 0.001	
HIV Viral Load	No	Yes
	[Count (%)]	[Count (%)]
LTDL	104 (81.9)	7 (30.4)
Detectable	23 (18.1)	16 (69.6)
Fisher’s Exact Test p-value	< 0.001	

with survivors (90 [37–414] vs 458 [360–660] cells/ μ L; $p < 0.001$), indicating a strong association between more advanced immunosuppression and mortality.

For HIV viral load, the majority ($n=114$; 74%) of the study cohort had viraemia below the detectable limit (LTDL). With respect to mortality, survivors were predominantly LTDL (81.9% vs 18.1% detectable), whereas among patients who died, detectable viral load predominated (69.6% detectable vs 30.4% LTDL; Fisher’s exact $p < 0.001$). These findings suggest that a detectable viral load before dialysis initiation is strongly associated with six-month mortality.

To explore the combined impact of immunological and virological status, a subgroup analysis was performed,

Table 3: Association between CD4 classification, HIV viral load, and 6-month mortality

CD4 Classification	HIV Viral Load	Deceased		p-value
		No	Yes	
Preserved (≥ 350 cells/ μ L)	LTDL	47 (95.9%)	2 (4.1%)	0.072
	Detectable	5 (71.4%)	2 (28.6%)	
Intermediate (200–350 cells/ μ L)	LTDL	55 (93.2%)	4 (6.8%)	1.000
	Detectable	13 (92.9%)	1 (7.1%)	
Advanced (≤ 200 cells/ μ L)	LTDL	2 (66.7%)	1 (33.3%)	0.247
	Detectable	5 (27.8%)	13 (72.2%)	

LTDL (lower detectable limit): ≤ 25 copies/mL; Detectable: > 25 copies/mL

stratifying patients by CD4 classification (preserved, intermediate, or advanced) and HIV viral load (LTDL vs. detectable). Table 3 displays the distribution of six-month mortality within these subgroups.

Although the association between CD4 count and viral load showed no statistically significant interaction with mortality, this is likely due to the small number of patients in each subgroup.

Functional Class and Frailty: Association with 6-month Mortality

In keeping with the study objective of assessing functional status at dialysis initiation, the Clinical Frailty Scale was used to categorise patients. Table 4 presents the frailty scores, their frequencies, and the associated 6-month mortality for each group. Among the study patients, the majority were classified as either “Well” (48.7%) or “Managing Well” (28.0%), with only 22.0% meeting frailty criteria (vulnerable to severely frail). When dichotomised, 117 patients (78.0%) were classified as not frail, and 33 (22.0%) were considered frail. The mean frailty score was 2.84 (SD = 1.11), indicating overall a low-to-moderate level of frailty.

Frailty was significantly associated with six-month mortality ($\chi^2 p < 0.001$). Among those who died, frailty was notably more common. A total of 33 patients fell within the vulnerable to frail category, with an overall mortality rate of 33.3% (11/33), as compared to the very fit to managing well categories, in which a much lower mortality rate of 10.2% (12/117) was found.

Acute Indications for Dialysis: Association with 6-Month Mortality

In alignment with the study’s objective to examine whether the type of acute indication for dialysis predicts outcome, the AEIOU criteria were used to categorise clinical triggers

Table 4: Frailty scores among study participants (n = 150) and related deaths

Frailty Category	Frequency (%)	Deaths %
Very Fit	2 (1.3)	0
Well	73 (48.7)	1 (4.3)
Managing Well	42 (28)	11 (47.8)
Vulnerable	18 (12)	5 (21.7)
Mildly Frail	11 (7.3)	4 (17.4)
Moderately Frail	3 (2.0)	1 (4.3)
Severely Frail	1	1 (4.3)
Total	150	23

for dialysis initiation. (Table 5) Among the 150 patients, electrolyte abnormalities (30%), acidosis (24%), and uraemia (21.3%; including uraemic encephalopathy, gastritis, and pericarditis) were the most frequent indications, highlighting the predominance of metabolic and uraemic indications, as well as fluid overload, as immediate drivers of dialysis in PLWH with kidney failure.

To assess whether the AEIOU criteria were associated with six-month mortality, a cross-tabulation of the indication group and its outcome was performed. The overall chi-square test for association between AEIOU group and mortality was non-significant ($\chi^2(4) = 6.984$, $p = 0.322$), indicating no clear univariable relationship between a specific indication category and six-month survival.

Binary logistic regression was then used to evaluate whether any AEIOU category independently predicted mortality. In the unadjusted model, the odds ratios for all AEIOU categories were close to 1 (all $p > 0.05$), indicating that none of the groups were independently associated with death. In the adjusted logistic regression model including AEIOU category, age, and sex, the AEIOU categories remained non-significant, with adjusted odds ratios similar in magnitude to the unadjusted estimates and confidence intervals spanning 1. Age and sex were not associated with outcome.

Overall, these analyses indicate that while AEIOU indications describe the acute clinical presentations prompting dialysis, they do not independently predict six-month mortality in this cohort.

Within the patient cohort, overall outcomes at 6 months post-initial dialysis were grouped into 5 categories, as indicated in Table 6. The public sector in South Africa provides both acute and chronic dialysis support in accordance with provincial and national guidelines.⁽¹⁶⁾ Patient's acceptance onto the chronic renal replacement programme (CRRP) is based on clinical, psychological, and socio-economic factors. Once approved, the programme aims to facilitate insertion of a Tenckhoff catheter and subsequent chronic ambulatory peritoneal dialysis training.

Table 5: Association of AEIOU Dialysis Indication and 6 Month Mortality (N = 150)

AEIOU Group	Frequency	%	Deceased % (n = 23)	Survivors % (n = 127)
A (Acidosis)	36	24.0	10 (43.5)	26 (20.5)
E (Electrolyte)	45	30.0	5 (21.7)	40 (31.5)
I (Ingestions)	8	5.4	0	8 (6.4)
O (Overload)	29	19.3	5 (21.7)	24 (18.8)
U (Uraemia)	32	21.3	3 (13.1)	29 (22.8)
Total	150	100	23	127

Table 6: Outcomes at 6 months post-index dialysis

Outcome:	Number	Percent
Tenckhoff Catheter Inserted	22	14.7
Work up for CRRP done (Temporary exclusion criteria identified)	32	21.4
Recovered to baseline eGFR	38	25.3
Excluded from CRRP	35	23.3
Mortalities	23	15.3
Total	150	100

A portion of the patient cohort (n = 32) was noted to have temporary exclusion criteria, and this included recent antiretroviral initiation with unsuppressed HIV viral loads (n = 20) and those patients with an increased body mass index of >35 kg/m² (n = 12). A significant number of patients (n = 35; 23.3%) were excluded from the state CRRP for a variety of reasons, which included small vessel ischaemia/stroke (n = 12), myocardial infarction (n = 8), peripheral vascular disease/amputations (n = 14), and being of foreign nationality without proper documentation (n = 1). These individuals were given a 4-week grace period of HD; thereafter, they were offered alternate pathways to continue their dialysis regimen.

The majority of deaths (10/23; 43.47%) were related to chronic kidney disease complications and occurred within 4 weeks post-index session of dialysis. These included pulmonary oedema with acute respiratory distress syndrome (n = 4), sequelae of uraemic states (n = 4) such as uraemic gastritis with significant upper gastrointestinal bleed and refractory seizures, and severe metabolic acidosis (n = 2).

DISCUSSION

This study examined six-month outcomes in 150 adults living with HIV who presented with acute kidney injury and underwent emergency haemodialysis. Approximately 25% of this cohort recovered kidney function to baseline.

Metabolic and uraemic complications were the dominant acute clinical problems, with electrolyte disturbances, acidosis, and uraemia together accounting for the majority of AEIOU indications. These categories captured the immediate physiological disturbances at presentation but were not independently associated with six-month mortality, indicating that the nature of the acute trigger alone does not determine medium-term survival once patients have been stabilised and dialysed.

In contrast, markers of HIV disease control and immune function were strongly related to outcome. Median CD4 count was substantially lower among patients who died than among survivors. Mortality was highest in patients with both advanced immunosuppression and detectable viraemia, while those with preserved CD4 counts and viral loads below the detectable limit had very low mortality. This gradient is biologically plausible and reinforces the central role of immune reconstitution and virological suppression in determining prognosis in people living with HIV who develop severe kidney injury.

Frailty added an important functional dimension to risk stratification. Although only 22 % of participants were classified as frail on the Clinical Frailty Scale, this group contributed nearly half of all deaths. Most patients were recorded as “well” or “managing well,” yet even modest degrees of frailty were associated with a higher proportion of mortality. Despite the small sample size, the exclusive presence of “severely frail” individuals among the deceased aligns with this trend. Our findings support the use of frailty scoring alongside standard clinical and laboratory variables to identify individuals with limited physiological reserve who may be more vulnerable to the stress of acute illness and its complications.

The analysis of documented medical comorbidities showed a more complex pattern. Hypertension and diabetes mellitus were common, reflecting the growing burden of non-communicable disease in this population. In unadjusted logistic regression, comorbidities were not associated with increased risk of death. Patients with known chronic disease are more likely to have ongoing contact with health services, regular monitoring, and earlier recognition of kidney dysfunction. By contrast, patients without recorded comorbid conditions may include individuals with undiagnosed disease, poor access to care, or late presentation with more advanced acute kidney injury. In such circumstances, “no comorbidity recorded” may mark underdiagnosis and delayed care rather than genuinely lower baseline risk.

Findings from this study are in keeping with reports from other African and low- and middle-income settings, where late presentation, incomplete viral suppression, and limited dialysis capacity are frequently linked to poorer outcomes in people living with HIV who develop kidney failure.⁽¹⁷⁾ In contrast, cohorts from high-income countries and better-resourced sectors in South Africa describe substantially better survival among HIV-positive patients once antiretroviral therapy is well established and renal

replacement services are reliably available. Across these settings, frailty and impaired functional status are consistently associated with worse outcomes and are increasingly used in decisions about long-term dialysis and transplantation. The current study adds to this literature by showing that in a public-sector tertiary hospital with a high HIV burden, six-month mortality after emergency haemodialysis is more closely related to CD4 count, viral load, and frailty than to the acute dialysis indication.

LIMITATIONS

This study has several limitations. First, its retrospective design limits causal inference and introduces potential information bias by relying on existing clinical records that may contain incomplete or inconsistent data. Second, selection bias is possible, as patients who were severely ill or considered too frail may not have been offered dialysis and thus are not represented in this cohort. Frailty was assessed using the Clinical Frailty Scale, which, although validated, is subject to inter-observer variability. Also, the study was conducted at a single tertiary centre with an established nephrology service, which may limit generalisability to rural or resource-limited settings lacking dialysis infrastructure.

CONCLUSION

In adults living with HIV who underwent emergency haemodialysis for acute kidney injury, six-month mortality was driven primarily by immunovirological status and frailty rather than by the specific AEIOU indication prompting dialysis. These results support incorporating CD4 count, HIV viral load, and structured frailty assessment into prognostic evaluation and treatment planning for this population. Alongside equitable access to renal replacement therapy, strategies that promote early HIV diagnosis, sustained viral suppression, and better management of chronic conditions such as hypertension and diabetes are likely to be central to improving survival in people living with HIV who develop severe kidney injury.

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