Epidemiology and Outcomes of Dialysis- Requiring Acute Kidney Injury at Chris Hani Baragwanath Hospital

Mohammed Variava¹, Mduduzi Mashabane¹, Alison Bentley¹ and Saraladevi Naicker¹
¹Department of Internal Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

*Correspondence to: Mohammed Variava, Department of Internal Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa, drmvariava@gmail.com

Abstract

Background: Acute kidney injury (AKI) occurs commonly within the hospital setting and is associated with a high rate of morbidity and mortality. Factors such as social, economic and ethical dilemmas are closely associated with initiation of dialysis in the public health sector.

Methods: A retrospective review of 324 patients presenting with kidney failure who were initiated on acute dialysis at the Chris Hani Baragwanath Hospital was carried out over a 2-year period from July 2009 to June 2011.

Results: The mean age at presentation was 40 ± 13 years; 57% of patients were male and 92% were Black. HIV positivity occurred in 26% of patients. The leading indications for acute dialysis included decompensated chronic kidney disease (38.9%), acute tubular necrosis (ATN) (38.3%), HIV-related kidney disease (13.6%), pregnancy-related kidney disease (7.4%) and glomerulonephritis (7.4%). ATN was the predominant cause of AKI in HIV-positive patients. The overall renal recovery rate was 31%, and the overall mortality rate was 23%. About 44.6% of patients had chronic consequences, with 23% being transferred to chronic renal replacement therapy (RRT) and 21.6% transferred to renal outpatients (ROPD) with cessation of dialysis; 1.4% were lost to follow-up. While HIV-positive patients had a better renal recovery rate compared to HIV-negative patients (36% versus 26%; p < 0.0001), they had a higher mortality rate compared to their HIV-negative counterparts (34% versus 19%; p < 0.0001).

Conclusion: AKI remains a common presentation that often requires dialysis, a precious resource in an already overburdened health system, and occurs at similar rates in HIV-positive and HIV-negative patients. The underlying aetiology of AKI at Chris Hani Baragwanath resembles that of other developing countries with ATN, malaria and pregnancy-induced kidney injury amongst the leading causes. High mortality rates were observed in patients with ATN, in both HIV-positive and HIV-negative patients.

Keywords: acute kidney injury; dialysis; outcomes; mortality

INTRODUCTION

Acute kidney injury (AKI) comprises a diverse spectrum of disease entities, presenting as a syndrome or constellation of features whereby a decline in kidney function occurs and if not recognised and treated adequately, ultimately causes severe morbidity and mortality.

The incidence of AKI around the world is variable.(1) Recent studies have shown an increase in the incidence of AKI. A study in the United States showed an incidence of 23.8 per 1000 patients with a 11% yearly increase from 1992 to 2001.(2) Similarly, a Spanish review published in 1996 showed an increase in the rate of AKI, with a significant contribution by iatrogenic causes as well as the development of AKI in the peri-operative period.(3) AKI has been reported to occur in 1% of hospital admissions.(4) Approximately 2%–5% patients are affected by kidney injury during hospitalisation and as many as 15% of patients develop AKI after certain surgery such as cardiopulmonary bypass surgery.(5)

The pattern of AKI in emerging countries is changing, albeit at a slower pace compared to that in developed countries. A study in Northern India showed a vast difference in the rates of AKI between two different time frames.(5) There was a decline in AKI from 23% to 10% in patients caused by diarrhoeal illness from the periods 1965–1974 and 1981–1986 respectively; a similar decline was also noted with sepsis-related AKI. However, for community-acquired AKI the causes and their frequencies are different from that found in developed countries.(5) A second study by the same group in India assessed the spectrum of
hospital-acquired AKI in developing countries and found that they were similar to that of technologically advanced countries, although the pattern of community-acquired AKI was still vastly different.(6)

The differences in AKI prevalence and aetiology between developed and developing countries are related to a variety of factors, of which financial considerations are probably one of the most important aspects. AKI in Africa has a different pattern when compared to Europe, Australia or United States of America. Infective causes, both HIV-related sepsis and non-HIV-related diseases, are amongst the major contributors to AKI. Naicker et al. reviewed the major causes of AKI in Africa.(7) These authors found that infective causes such as malaria, diarrhoeal illnesses and HIV, obstetrical causes and toxins were the leading causes of AKI in Africa.(7)

In South Africa, the causes of AKI have also changed over the last few decades. An epidemiological study in Durban in 1978 reported that the leading cause of AKI was herbal toxin ingestion.(8) A review of AKI approximately 10 years later showed that sepsis replaced toxin ingestion as the leading cause of AKI in South Africa.(9) More recently, HIV has been reported as a major contributor of AKI.(10) Causes such as malaria, pregnancy-induced kidney injury, glomerulonephritis (GN) and post-surgical-related AKI are still present, albeit at a lower frequency than previously reported.

AKI is commonly observed in patients infected with the HIV.(11) The underlying causes of AKI in HIV are often multifactorial.(12) These can range from the direct invasion of the kidney cells by HIV, opportunistic infections and medication-related factors. HIV has increased the need for dialysis both in the acute and chronic setting.(13) A study in Cape Town showed that patients with HIV and AKI secondary to ATN and CD4 count of more than 200 have a good survival outcome.(14) Risk factors for poorer outcomes in HIV-positive patients included co-existing hepatitis C infection, black race, low CD4 counts and pre-existing chronic kidney disease.(15,16) Interestingly, a Johannesburg study by Vychiat et al. showed that outcomes between HIV-positive and HIV-negative patients were similar when they received adequate support (dialysis and supportive care).(10)

Renal recovery in AKI is defined as normalisation of renal function at 3 months after the initial insult. However, the majority of studies addressing renal recovery included only critically ill patients requiring dialysis and considered renal recovery as dialysis independency at hospital discharge.(17) Higher rates of renal recovery have been documented in developed countries with rates ranging from 56% to 68% in patients with AKI.(18–20) Renal recovery rates have been substantially lower in developing countries, with one study from India reporting a renal recovery rate of 43%. (19) In South Africa, rates of renal recovery as low as 33.3% have been reported in HIV-positive patients.(14)

Chronic kidney disease and requirement for chronic renal replacement therapy (RRT) is often a result of AKI; 15% of patients in one study required chronic RRT after an acute insult.(21) This is consistent with other studies, which have reported approximately 12.5% of patients with AKI requiring chronic RRT.(22) Mortality rates of AKI vary from study to study; AKI independently increases mortality and has been shown to increase mortality by 5.5 fold.(23)

Limited data are available with regard to epidemiology of AKI in South African hospitals over the past few years. Thus the aim of this study was to audit the epidemiology and outcomes of patients requiring dialysis acutely at Chris Hani Baragwanath Hospital.

METHODS
The study was a single-centre retrospective review of patients who were acutely dialysed at the Nephrology Unit of Chris Hani Baragwanath Hospital during a 2-year period (1 July 2009 to 30 June 2011). Patients were selected from the electronic records of the Chris Hani Baragwanath Renal Unit known as ‘BART’, which is an acronym for ‘Baragwanath Active Renal Tracking’ system. A list was obtained from the electronic records and matched with records of patients that were acutely dialysed during the study time frame.

The inclusion criteria included all patients who were older than 14 years of age and any patient who was dialysed in any ward of the hospital. Patients who were solely initiated on dialysis in the intensive care unit (ICU) or who had incomplete records were excluded from the analysis. Approval for the study was obtained from the University of the Witwatersrand Ethics Committee.

Causes of kidney injury were based on clinical, biochemical, sonographical or biopsy criteria, as recorded on BART.

Data collected from patient files were entered into an excel spreadsheet and statistical analyses performed using GraphPad and excel. Normally distributed variables are given as means and standard deviations and compared using a t-test. Non-normally distributed variables are presented as medians and interquartile ranges. Categorical variables are given as frequencies and percentages with differences between groups evaluated using chi-squared tests and Fisher’s exact tests. A p-value of <0.05 was considered as significant.

Definitions of outcomes measured
Renal recovery was defined as sufficient recovery of renal function to result in cessation of dialysis. Transfer to RRT was defined as failure of full recovery after initiation of dialysis and hence the need for continuing dialysis and transfer to the chronic dialysis programme. Transfer to renal outpatients (ROPD) comprised those patients that did not regain full renal function; dialysis was discontinued after it was noted that the patient was a poor candidate for
continuation of dialysis or did not fulfil criteria for acceptance for chronic RRT. Death was defined for a patient who was initiated on dialysis but demised during therapy. Loss to follow-up was defined as unknown outcome or lost to follow-up.

RESULTS
A total of 324 patients met the inclusion criteria of those who were acutely dialysed at Chris Hani Baragwanath Academic Hospital over the 2-year study period. The average age was 40 ± 13 years; 184 patients (57%) of the cohort were male. The majority, 299 patients (92.3%) of the study cohort comprised Black patients, followed by Coloured (3.7%) patients; White (2.5%) patients and Indian (1.5%) patients comprised only 4% of the study cohort.

A total of 83 (26%) patients were noted to be HIV-positive. The HIV status was unknown in 20 patients (6%). Figure 1 depicts the causes of kidney injury in the 324 patients that were reviewed. Patients may have had more than one cause for the AKI.

The leading causes of kidney failure requiring initiation of acute dialysis included decompensated chronic kidney disease (126/38.9%), acute tubular necrosis (ATN) (124/38.3%), HIV-related kidney disease (44/13.6%), pregnancy-related kidney disease (24/7.4%), GN (24/7.4%) and malaria (18/5.7%). ATN and AKI were documented in 124 (38.3%) patients. The underlying cause of ATN included sepsis (106 patients), toxins/herbal ingestion (10 patients), pancreatitis (5 patients) and contrast induced nephropathy (3 patients). A total of 44 patients (13.6%) were noted to have HIV-related kidney disease. Only seven (16%) of these patients had a kidney biopsy that demonstrated HIV-associated nephropathy; the remaining 84% were diagnosed with HIV-related kidney disease based on HIV status, sonar features of hypechoic and enlarged kidney size, presence of proteinuria and clinical features of HIV disease.

GN occurred in 24 patients (7.4%). The GN included both primary GN (10 patients) and secondary GN (14 patients). The primary GN was proven on biopsy in 8 of the 10 patients; membranous GN was diagnosed in 2 patients, crescentic GN in 2 patients, membroproliferative GN in 2 patients and focal segmental GN in 2 patients. In the remaining two patients the diagnosis of primary GN was noted on the system but details of the biopsy were not found. All patients with secondary GN were noted to be secondary to systemic lupus erythematosus.

Pregnancy-related kidney injury accounted for 24 patients (7.4%) of the study cohort. AKI secondary to falciparum malaria needing dialysis was diagnosed in 19 patients (5.9%).

The demographic and clinical data of HIV-positive patients with AKI are shown in Table 1. HIV-positive patients constituted 26% of all patients with AKI. The mean age of these patients was 39 ± 11 years. Male-to-female ratio was approximately 1:1. Co-infection with both hepatitis B and C occurred infrequently. However, more than 35% of patients had unknown hepatitis B and C serology at the time of analysis. The median CD4 count was 153 cells/μl, with a range of 4–621 cells/μl.

Causes of kidney injury

- HUS: 1
- Severe Metabolic acidosis: 4
- Unknown: 7
- Drugs: 9
- Hypotensive: 10
- Malignant Hypertension: 10
- Rhabdomyolysis: 10
- Other: 11
- Malignancy: 11
- Obstructive Uropathy: 12
- Malaria: 19
- Pregnancy: 24
- Glomerulonephritis: 25
- HIV related kidney disease: 44
- ATN: 124
- Decompensated Kidney Disease: 126

**Fig 1:** Causes of kidney injury in the acutely dialyzed patients
The causes of AKI in both the HIV-positive group and HIV-negative group are noted in Table 2. Unknown HIV status was noted in 20 patients. Primary GN, obstructive uropathy, contrast-induced nephropathy and malignant hypertension occurred only in the HIV-negative group.

A comparison of outcomes of HIV-positive and negative individuals is noted in Table 3. Renal recovery resulting in cessation of dialysis occurred in 58 (26%) of HIV-negative patients. HIV-positive patients had a better rate of renal recovery of (30/36%; \( p < 0.0001 \)). Death as an outcome occurred in 42 (19%) of the HIV-negative group and in 28 (34%) of the HIV-positive group; \( p < 0.0001 \). Only a small proportion 3 (4%) of HIV-positive patients qualified for chronic RRT compared to 71 patients (32%) in the HIV-negative group who were offered chronic RRT (\( p < 0.0001 \)). Forty six (21%) of HIV-negative patients were transferred to ROPD with cessation of dialysis compared to 21 (25%) of HIV-positive counterparts (\( p > 0.05 \)).

**DISCUSSION**

In this study, AKI occurred in a relatively young population group (40 ± 13 years), consistent with studies from other developing countries. A retrospective review of patients with AKI in a North Indian tertiary institution also found a mean age at presentation of 39 ± 14 years.(21) A study in Saudi Arabia also had a low mean age (33.7 ± 10.1 years).(24) In contrast to this, an epidemiological study of AKI in Madrid, Spain reported an average age of 64 ± 17 years.(2) A United Kingdom–based study showed that over 90% of its cohort were greater than 70 years of age.(25) The large difference in age at presentation between developing and developed regions is directly related to the various patterns of disease seen. The much higher prevalence of infective causes and pregnancy-associated kidney injury in developing countries is largely responsible for the large discrepancy in the age at presentation between the regions.

Seedat et al. reviewed the causes of kidney injury in a South African setting in 1978.(8) The leading cause of AKI in this study was nephrotoxins.(8) A subsequent audit a decade later by the same study group demonstrated that sepsis had replaced nephrotoxins as a leading cause of AKI.(9) These findings are consistent with our cohort as sepsis accounted for 32.4% of AKI. Higher rates of ATN as a cause of AKI were found in a study from Spain that showed that ATN accounted for 45% of the causes of AKI.(23) The leading cause of ATN in the current study was sepsis, accounting for 32.4% of the total study group. Sepsis accounted for approximately 50% of cases in a Cape Town–based audit,(14) whilst in India sepsis accounted for 33.3% of AKI.(26)

AKI may often complicate pregnancy, particularly in developing nations. Pregnancy-associated kidney injury accounted for 24 patients (7.4%) of our cohort. This included eclampsia (2 patients), pre-eclampsia (18 patients), abruptio placentae (3 patients) and post-partum haemorrhage (1 patient). About 67% of all pregnancy-induced AKI (16 patients) were HIV-negative. The rates of AKI in pregnancy in centres in India range from 11% to 14.5%.(21) The pregnancy-related AKI rate of 7.4% in the current study is substantially lower when compared to previous audits in South Africa in the early nineties, which showed that pregnancy-related AKI accounted for 16% of all AKI requiring dialysis.(9) Improved antenatal

---

**Table 1**: Clinical data of HIV-positive patients.

<table>
<thead>
<tr>
<th>Clinical data</th>
<th>HIV + (Total = 83)</th>
<th>HIV − (Total = 221)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>39 ± 11</td>
<td>40 ± 13</td>
</tr>
<tr>
<td>CD4 count (cells/μl)</td>
<td>153 (4–621)</td>
<td></td>
</tr>
<tr>
<td>Hepatitis B-positive</td>
<td>3 (4%)</td>
<td></td>
</tr>
<tr>
<td>Hepatitis C-positive</td>
<td>1 (1%)</td>
<td></td>
</tr>
<tr>
<td>On ARVS</td>
<td>16 (19%)</td>
<td></td>
</tr>
<tr>
<td>Not on ARVS</td>
<td>51 (62%)</td>
<td></td>
</tr>
<tr>
<td>Unknown ARV status</td>
<td>16 (19%)</td>
<td></td>
</tr>
<tr>
<td>Pre-dialysis blood urea level (mmol/l)</td>
<td>43 ± 21</td>
<td></td>
</tr>
<tr>
<td>Pre-dialysis serum creatinine (μmol/l)</td>
<td>1053 ± 581</td>
<td></td>
</tr>
</tbody>
</table>

---

**Table 2**: Demographic data and causes of acute kidney injury in HIV-positive and HIV-negative patients.

<table>
<thead>
<tr>
<th></th>
<th>HIV + (Total = 83)</th>
<th>HIV − (Total = 221)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>39 ± 11</td>
<td>40 ± 13</td>
</tr>
<tr>
<td>Gender (M/F, %)</td>
<td>49/51</td>
<td>57/43</td>
</tr>
<tr>
<td>Decompensated kidney disease</td>
<td>7 (8.4)</td>
<td>116 (52.5)</td>
</tr>
<tr>
<td>ATN</td>
<td>53 (63.9)</td>
<td>63 (28.5)</td>
</tr>
<tr>
<td>HIV-related kidney disease</td>
<td>44 (53)</td>
<td>0</td>
</tr>
<tr>
<td>Glomerulonephritis</td>
<td>2 (2.4)</td>
<td>21 (9.5)</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>7 (8.4)</td>
<td>16 (7.2)</td>
</tr>
<tr>
<td>Malaria</td>
<td>13 (15.7)</td>
<td>5 (2.2)</td>
</tr>
<tr>
<td>Obstructive uropathy</td>
<td>0</td>
<td>12 (5.4)</td>
</tr>
<tr>
<td>Malignancy</td>
<td>4 (4.8)</td>
<td>6 (2.7)</td>
</tr>
<tr>
<td>Other</td>
<td>4 (4.8)</td>
<td>7 (3.2)</td>
</tr>
<tr>
<td>Rhabdomylosis</td>
<td>1 (1.2)</td>
<td>5 (2.2)</td>
</tr>
<tr>
<td>Malignant hypertension</td>
<td>0</td>
<td>10 (4.5)</td>
</tr>
<tr>
<td>Hypotensive</td>
<td>3 (3.6)</td>
<td>6 (2.7)</td>
</tr>
<tr>
<td>Drugs</td>
<td>4 (4.8)</td>
<td>5 (2.2)</td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>6 (2.7)</td>
</tr>
<tr>
<td>Severe metabolic acidosis</td>
<td>0</td>
<td>3 (1.4)</td>
</tr>
<tr>
<td>HUS</td>
<td>1 (1.2)</td>
<td>0</td>
</tr>
</tbody>
</table>
screening, quicker delivery of patients with red flag features and better obstetrical intervention may be responsible for this reduction in frequency over the last 20 years.

HIV positivity was present in 83 patients (26%) of our cohort. The mean age of this group was 39 ± 11 years which is similar to a Johannesburg study, which reported a mean age of 38 ± 9 years in HIV-positive patients presenting with AKI.(10) There were no gender differences within the HIV-positive group. The mean CD4 count for all patients with HIV was 153 cells/mm³ with a range of 4–621 cells/mm³. These findings are also similar to the Johannesburg study which found a median CD4 count of 135 cells/mm³.(10) Hepatitis B and C co-infection occurred in a very small number (4%) of HIV-positive patients. HIV unknown status was noted in 20 patients.

HIV-positive patients most frequently had kidney injury secondary to ATN. This occurred in 53 patients (63%) of HIV-positive patients, similar to the study by Vachiat et al. who reported that sepsis accounted for 62% of the AKI in HIV-positive patients compared to 43% in the HIV-negative group.(10)

Renal recovery was similar in HIV-positive (30/36%) and HIV-negative patients (58/26%). This is similar to that reported from the Cape Town study, where the recovery rate was 33%. However, HIV-negative patients had a significantly lower mortality, as compared to the HIV-positive patients. This is similar to findings elsewhere in the world, with mortality rates ranging between 26% and 43%. (13,14,27) Vachiat et al. showed a mortality rate of 44% but showed no statistical difference in outcome between HIV-positive and HIV-negative patients that were dialysed.

**LIMITATIONS**

Due to the retrospective nature of the study, data such as the hepatitis serology and ARV status were not available in all cases. ATN was defined according to the primary clinician diagnosing the event; no renal biopsy or biochemical or urinary indices for ATN were available for review and the diagnosis was based on clinical grounds and some biochemical recovery after dialysis. The lack of biopsy diagnosis may be a major limitation, particularly when assessing the ‘HIV-related kidney disease’ group. The exclusion of patients admitted to ICU may have skewed the outcomes of this study. A repeat serum creatinine was not available for assessment at a 3-month interval from initiation of dialysis and hence cannot truly reflect the definition of AKI according to the RIFLE criteria.(28)

**CONCLUSIONS**

This study has shown that the leading causes of AKI requiring acute dialysis at a large urban public hospital in South Africa include decompensated chronic kidney disease, ATN, pregnancy-induced kidney injury, malaria, HIV-related kidney injury and GN. This is very similar to that found in other developing nations. ATN due to sepsis was one of the leading causes in both HIV-positive and HIV-negative patients with a high mortality rate in both groups. HIV-positive patients had a higher renal recovery rate compared to their HIV-negative counterparts; however, mortality was overall higher in HIV-positive patients. Higher CD4 counts were associated with an overall improved outcome.

**REFERENCES**