Original Article

The State of Paediatric Dialysis: Is the Story Different at Federal Medical Center, Asaba, South-South Nigeria?

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ABSTRACT

Introduction: Dialysis is a type of renal replacement therapy (RRT) employed to maintain the excretory function of a failed kidney. Hemodialysis is the most common form of dialysis offered worldwide and in Nigeria and in this analysis, we compared our experiences with previously published studies on pediatric dialysis. **Method:** A retrospective observational case series study of a prospective clinical database of children admitted into the pediatric ward of Federal Medical Center, Asaba, South-South Nigeria, who accessed hemodialysis during their management in the Pediatric nephrology unit, from November 2016 to October 2022 (6 years). **Results:** There were 78 patients admitted and managed by the nephrology unit during the study period, 37.2% required RRT, and 69.0% accessed it: of which 55% were females, 80% were adolescents, and 55% with Acute Kidney Injury (AKI). The median age at initiation of RRT was 12 years. Patients requiring hemodialysis (HD) for AKI were majorly those with nephrotic syndrome while most of those with chronic kidney disease (CKD) were of unknown etiology. All patients had multiple indications for HD but the most frequent was anuria. Patients with AKI were younger and pericardial effusion was a more common indication for HD in patients with CKD. The inpatient case fatality rate was 25% but the total including during the follow-up period was 50%. The presence of encephalopathy as an indication of HD was associated with an increased case fatality rate. **Conclusion:** Our RRT experience was comparable to other published works. The findings from this analysis underscore the need for nephro-prevention at all levels, as RRT is largely inaccessible and with fatal outcomes in our environment.

Key words: Haemodialysis, Kidney, Encephalopathy, Children, Dialysis, Nephrotic

Renal replacement therapy (RRT) is a modality of management for acute and chronic kidney diseases, instituted when there are life-threatening changes in fluid, electrolyte, and acid-base balance and patients can no longer maintain renal function with conservative management. [1]. Thus, it is indicated in both Acute Kidney Injury (AKI) and Chronic Kidney Disease (CKD). RRT includes renal transplantation and dialysis [1]. Dialysis replaces only the excretory function of the kidney and is generally grouped into peritoneal dialysis and hemodialysis [1]. Peritoneal dialysis (PD) is intracorporeal with a peritoneal membrane as a dialyzer while hemodialysis (HD) is extracorporeal that employs a dialysis machine and a dialyzer or artificial kidney [2]. In some cases of sudden or acute kidney failure, dialysis may only be needed for a short time (acute dialysis) until the kidney recovers its function [2].

It is also recommended that CKD patients who have an imminent need for maintenance dialysis at the time of initial assessment should receive acute dialysis based on features of uremia, protein-energy wasting, metabolic abnormalities, and/or volume overload recalcitrant to medical therapy [3]. Thus, children with both AKI and CKD can need for acute dialysis [4-8]. However, in CKD that has progressed to end-stage renal disease (ESRD), the kidneys usually do not recover and thus, dialysis is for life (chronic dialysis), until kidney transplantation is made available [2]. Chronic dialysis in Nigeria is still unrealizable, as many of the patients cannot afford it [4-6,9]. Hemodialysis is the most common form of RRT offered in many facilities worldwide and acute HD is the most commonly accessed modality of RRT for patients with AKI and ESRD in Nigeria [4-6,10,11].

In different parts of Nigeria, several children with AKI had acute dialysis during their management [5,6,10]. The common etiologies of AKI in these children were sepsis, gastroenteritis, malaria, primary renal disorder, acute glomerulonephritis (AGN), and hemolytic uraemic syndrome (HUS) [4-7,9-14]. Other studies documented metabolic disorders, congenital cardiopathy, tumor lysis syndrome, intoxication, and pigment nephropathy [5,7,13,14]. For children with ESRD stage of CKD, the common underlying etiology includes chronic glomerulonephritis (CGN), nephrotic syndrome, sickle cell anemia, and HIV infection [4-6]. There is a wide range of indications for acute dialysis as documented by several studies [4,5,11,14]] including azotemia, severe oliguria, and anuria, fluid retention (with peripheral and pulmonary edema, severe unresponsive hypertension, dyselectrolytemia, bleeding diathesis and neurologic abnormalities.

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The outcome of the children with AKI who had acute dialysis had varied responses ranging from full recovery, inpatient mortality, and progression to ESRD requiring chronic dialysis to undetermined due to loss of follow-up [6,7,11,14-17]. Pediatric patients with both AKI and CKD require RRT during their management. Several published works showed that pediatric acute dialysis experience is comparable across many facilities, with similar aetiologies and indications but varied outcomes. Here, at the pediatric department of Federal Medical Center (FMC) Asaba, we have a cohort of pediatric patients who underwent acute HD. In this analysis, we compared our experiences with previously published studies on pediatric dialysis, to find out if there is an urgent need for reevaluation of our management protocols to improve overall outcomes.

MATERIALS AND METHODS

It was a retrospective observational case series study of a prospective clinical database of children admitted into the pediatric ward of FMC Asaba, a tertiary facility located in Asaba, the capital of Delta State, with multidisciplinary departments including pediatrics, from November 2016 to October 2022 (6 years). All the children who accessed acute hemodialysis during their management by the Pediatric nephrology unit were recruited. Ethical approval was sought and obtained from the ethical committee at FMC Asaba. Informed consent was not obtained from the patients because this was a retrospective study of anonymized data not traceable to the subjects.

At enrollment into the pediatric nephrology unit, either through the clinic or admission from the emergency room, a proforma is opened for all the patients with nephropathy and later transcribed to an Excel clinical database, which was analyzed in this study. In the unit, we employ the KDIGO definitions for the diagnosis of AKI and CKD. AKI was defined as an increase in serum creatinine of 0.3mg/dl (>26.5µmol/L) within 48 hours or an increase in serum creatinine > 1.5 times the baseline, or urine volume <0.5ml/kg/hour for 6 hours [1]. Chronic kidney disease on the other hand was abnormalities of kidney structure or function, present for >3 months [3]. The indications for RRT as contained in the unit protocol and drafted from the KDIGO guidelines included features of uremia such as encephalopathy, bleeding diathesis, pericardial effusion, worsening azotemia accompanied by non-specific symptoms of anorexia, vomiting, nausea, diarrhea and/or lethargy [1,3].

Other indications are anuria with accompanying peripheral and pulmonary edema and hypertension recalcitrant to medical therapy and severe metabolic acidosis and dyselectrolytemia not responding to conservative management [1,3]. All those who had acute hemodialysis and who had their complete data extracted were analyzed. The data extracted from the patients' proforma were the age, gender, anthropometry, duration of illness before enrollment, diagnosis at enrollment, biochemical profiles (serum creatinine, blood urea, electrolytes), indications for acute hemodialysis, duration of hospital stay, and the management outcome including recovery, case fatality and follow up evaluation. Using age last birthday, the children were stratified into 2 different age groups: childhood age (<10 years) and adolescent age (10 to 18 years).

Statistical analysis

The data were entered into an Excel spreadsheet, later transferred to, and analyzed using IBM SPSS Statistics version 22.0 (IBM Corp., Armonk, NY, USA). Results were expressed in frequency tables. Chi-squared statistics were used to compare the clinical profile, indications for HD, and management outcomes between patients with AKI and CKD kidney disease categories who accessed acute HD. Independent Student's t-test was used to compare the mean and logistic regression was used to determine predictors of mortality among the patients. For any comparison of variables, p is significant at a value <0.05.

RESULTS

General characteristics of the study population who accessed haemodialysis.

The study flowchart

There were 78 patients admitted and managed by the nephrology unit during the study period. While 37.1% (29/78) required RRT, only 20 accessed it, with RRT access rate being 69.0% (20/29). The age range of the 20 patients who accessed RRT in the form of acute HD was 7-17 years, the median age at initiation of HD was 12 years and median duration of hospital stay was 11 days. 45% male of them were males and 80% were 10 years and above, **[Table 1].**

Table 1: General characteristics of the study population who accessed haemodialysis (n=20)

Parameters	Frequency	Percentage
Age <10 years	4	20
Male	9	45
Hypertension on admission	15	75
Aetiology of kidney disease for patients with acute kidney injury AKI n=11		
Nephrotic Syndrome	4	20
Acute poststreptococcal glomerulonephritis	2	10
Sepsis with **HAHCH	2	10
*G6PD deficiency with HAHCN	1	5
#RVD with severe malaria and AKI	1	5
Unknown aetiology	1	5
Aetiology of kidney disease for patients with chronic kidney disease CKD n=9		
Lupus nephritis	2	10
Sickle cell nephropathy	1	5
Unknown aetiology	6	30

*G6PD=Glucose-6-phosphate dehydrogenase. **HAHCN= haemolysis-associated haemoglobin cast nephropathy. #AKI= Acute kidney injury. ##RVD=Retroviral disease

All patients had multiple indications for HD but the most frequent was anuria. Most of the patients improved and the inpatient case fatality rate was 25%, **[Table 2].**

Factors that contributed to mortality in patients who accessed haemodialysis: The presence of encephalopathy as indication for HD was the only factor associated with increased mortality [p=0.015, odds ratio 95% CI: 16.00 (1.27–200.93)]. No other factor including age, gender, different

aetiologies, and other indications of HD seemed to have influenced the mortality in this study population.

Table 2: Indications and adequacy of haemodialysis among the patients n=20

Variables	Frequency	Percentage
Indication for haemodialysis		
Anuria	15	75
Encephalopathy	7	35
Worsening Azotaemia	6	30
Pericardial effusion	5	25
Recalcitrant volume overload	4	20
Uncontrolled hypertension	4	20
Severe metabolic acidosis	2	10
Bleeding diathesis	1	5
Adequacy of the haemodialysis sessions		
Delayed haemodialysis	12	60
Adequate haemodialysis	5	25
In patient outcome		
Improved	12	60
Discharged against medical advice	3	15
Died	5	25
Outcome on follow up		
Still stable	5	25
Lost to follow up	5	25
Overall no of death	10	50

Comparison of the mean biochemical profiles of patients with AKI and those with CKD who had haemodialysis: Children with CKD were older, had longer hospital stay with more HD sessions **(Table 3).**

Table 3: Comparison of the mean biochemical profile of patients with AKI and those with CKD who had haemodialysis.

Variables	AKI n=11	CKD n=9	p value
Mean age in years (SD)	10.2 (2.1)	15.2 (1.4)	<0.001
Mean weight on admission in kg (SD)	33.0 (7.5)	50.3 (12.7)	0.002
Mean height on admission in cm (SD)	133.0 (13.6)	157.8 (11.2)	0.001
Mean systolic blood pressure in mmHg (SD)	137.6 (50.6)	151.6 (27.1)	0.466
Mean diastolic blood pressure in mmHg (SD)	88.5 (33.9)	93.3 (12.2)	0.664
Mean duration of hospital stay in days (SD)	13 (8)	19 (19)	0.023
Mean peak serum sodium in mmols/L (SD)	133.2 (6.9)	133.5 (4.1)	0.194
Mean peak serum potassium in mmols/L (SD)	4.9 (1.0)	5.4 (1.2)	0.383
Mean peak urea level in mmols/L (SD)	41.9 (17.3)	61.3 (24.5)	0.283
Mean peak serum creatinine in mmols/L (SD)	695.5 (339.7)	984.8 (292.4)	0.752
Mean peak eGFR in mL/min/1.73 m^2 (SD)	12 (14)	6 (3)	0.059
Mean number of HD sessions (SD)	2 (1)	3 (2)	0.017

Comparison of clinical profile of patients with AKI and those with CKD who had haemodialysis: Per icardial effusion was a more common indication for HD in patients with CKD **(Table 4).**

Table 4: Comparison of clinical profile of patients with AKI and those with CKD who had haemodialysis.

Variables	AKI n=11	CKD n=9	p value
Male gender	7	2	0.092
Indication for haemodialysis			
Anuria	10	5	0.127
Uncontrolled hypertension	1	3	0.285
Recalcitrant volume overload	3	1	0.591
Pericardial effusion	0	5	0.008
Encephalopathy	4	3	1.000
Worsening Azotaemia	3	3	1.000
Outcome			
Improved on admission	7	5	1.000
Died on admission	3	2	1.000
Total no of death including follow up period	4	6	0.370

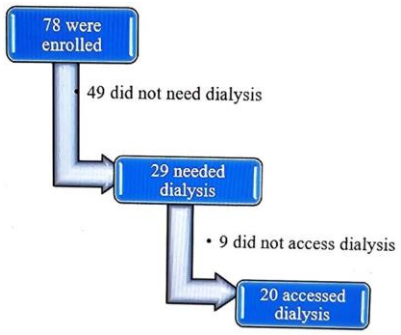

Figure 1: The Study Flow Chart

DISCUSSION

Patients who required RRT constituted 37.2% of all nephrology cases in the pediatrics department, with an RRT access rate of 69.0% and an inpatient case fatality rate of 25%. The RRT requirement rate in this study was similar to the findings previously documented in Nigeria by Odetunde et al [5], although with some degree of improvement in favor of the latter. It is still suboptimal when compared to the 100% access rate in other Nigerian studies [10,15]. Those who accessed acute HD in this index study had predominantly AKI etiology, similar to other studies in Nigeria [5,8], and in one of the pediatric intensive care units in Spain only 2.3% (3 cases) had CKD before RRT [7]. Contrastingly, a study in Kano Nigeria [6] documented more CKD cases probably because nephrotic syndrome cases requiring RRT were categorized under CKD, unlike the index study where they were in part of the AKI category.

RRT in patients with AKI: For patients with AKI, the common aetiologies were nephrotic syndrome with anuria and recalcitrant edema, post-streptococcal AGN, and

haemolysis-associated hemoglobin cast nephropathy (HAHCN) secondary to G6PD deficiency and sepsis. AKI is common in nephrotic syndrome [10,17] and was also documented as a cause of AKI in RRT patients [16]. The study in Kano Nigeria [6] observed AGN as the most common AKI etiology requiring RRT and AGN was a prominent cause also found in other studies. [9,15,16] Haemolysis-associated hemoglobin cast nephropathy was documented in other studies [5,14]. Sepsis was the most common cause of AKI in RRT patients as observed in some other studies in Nigeria [8,10,14-16] Ghana, [9] Pakistan [11], and Turkey [13] unlike in this index study where it constituted only 10% of cases and less prominent in other studies in Nigeria [5].

Other publications [5,11,15,16] documented acute gastroenteritis with severe dehydration as a notable cause of AKI requiring RRT. Although acute gastroenteritis (AGE) was the most common cause of AKI in the pediatric population in our facility [12], most of them resolved promptly with conservative management requiring no RRT, like Mbanefo et al [14] who documented no AGE etiology among those who had RRT. Severe malaria was identified as AKI etiology in only one patient who had RVD and was on antiretroviral therapy. Whether the anti-retroviral therapy had contributed to the AKI was not evaluated in this patient. However, in other studies [8,9,14-16], malaria was a prominent cause of AKI in RRT patients. Other common etiologies of AKI seen in patients who had RRT by other studies but not observed in the index study were hemolytic uraemic HUS [11,13,14,16], obstructive urolithiasis [5,9,11], toxic nephropathy [5,11,13,14], tumor lysis syndrome [5,7] and acute tubular necrosis [5,13].

RRT in patients with CKD: Most CKD patients wer e not diagnosed due to the unavailability and unaffordability of laboratory investigations. Sickle cell nephropathy is another etiology documented in the index study, similar to the findings in Ibadan, Nigeria [4]. Other common causes of CKD in RRT patients in other studies but not documented in the index study included steroid-resistant nephrotic syndrome in ESRD [4], congenital cardiopathy [4,7] congenital anomalies of the kidney and urinary tract (CAKUT) [5,9,16], chronic glomerulonephritis [4,6,8] and HIV-related renal failure [4,9].

Indications for and adequacy of RRT: All the patients in the index study had more than one indication for RRT but the most frequent indication was anuria, with varying degrees of volume overload evidenced by recalcitrant peripheral and symptomatic pulmonary edema mostly for the nephrotic syndrome patients. This was similarly the predominant indication for RRT documented by other studies [14], whereas some other studies noted it as one of the RRT indications [5,13,15]. Encephalopathy, in the form of seizures and altered levels of consciousness, was another common indication for RRT observed in the index study. This was also a common indication seen in other studies [14-16]. Comparably, other indications of RRT in this index study that were also documented by others include worsening azotemia [5,11,14-16], uncontrolled hypertension [15], bleeding diathesis [15,16], severe metabolic acidosis, [5,11,14-16] dyselectrolytemia [5,11,14-16].

Hemodialysis was grossly inadequate for the majority of the patients, and such was the finding in other studies in Nigeria [5], Ghana [9], and Pakistan [11]. Whereas in the index study, the inadequacy cut across patients with AKI as well as CKD, Callegari et al [9] found a similar trend in only those who needed to continue with RRT after the initial acute sessions. The reason for inadequate RRT was largely due to the out-of-pocket payment system in our facility due to a background of severe financial incapacitation, such as was documented by other studies [5,9,11]. Financial constraints contributed to the patients seeking voluntary discharge against medical advice after one or two HD sessions.

Outcome of management: The recover y rate was 60% which is within the range of 43-76% reported in Spain [7], Ghana [9], Pakistan [11], Turkey [13], and Nigeria [15]. The inpatient case fatality rate was 25%, comparable to other studies with similar populations comprising both AKI and CKD patients such as reported in Nigeria [6], and Ghana [9]. It is also comparable with findings among patients in pediatric intensive care units (PICU) as documented in Pakistan [11] and in Turkey [13]. Almarza et al [7] in Spain, however, reported a higher inpatient fatality rate of 44.5% among the PICU population, probably because about two-thirds of their study population had congenital cardiopathy. While among the population of AKI-only patients in Nigeria [14-16], who seemingly had adequate peritoneal dialysis, case fatality rate ranged between 5.5% and 41.2%, with Enugu in Eastern Nigeria recording lowest rate [14], as early presentation of their patients facilitated early RRT. Among CKD-only patients who accessed RRT, Nigeria recorded 59% [4], and expectedly so since there are no chronic dialysis programs yet in Nigeria. None of the aetiologies of kidney disease was significantly associated with mortality in this index study, in contrast to the study in Abuja [15], where 80% of mortality occurred in patients with sepsis. However, encephalopathy, as an indication for RRT, was associated with high mortality in the index study, while fluid overload, late presentation [6,9] female gender and peritoneal dialysis modality [11], need for inotropes [13] were documented in other studies. Age, gender, and etiology did not affect the outcome in the index report like the finding by Asinobi et al [4]. During the follow-up period, the case fatality rate increased to 50% as one additional death from AKI patients and 4 from CKD were recorded, some patients were lost to follow-up, and the rest maintained clinically stable. This trend was similarly observed by other studies [6,7,15], although the deaths recorded by Almarza et al in Spain [7] were not attributed to renal dysfunction.

Hemodialysis compared between the AKI and the CKD groups: When patients who accessed RRT wer e compared between the two kidney disease categories, those with AKI were younger and expectedly weighed less and shorter in height. Other studies [14-16] found AKI occurring in younger age groups too. Pericardial effusion was a significant indication for dialysis in patients with CKD when compared to the AKI group. Pericarditis is a notable uraemic symptom requiring dialysis in CKD patients [3]. Other studies [14-16] did not document pericardial effusion in their patients with AKI.

CONCLUSION

Our RRT experience was comparable to other published works. The access rate for acute hemodialysis was still suboptimal although over half of the patients who required it accessed it. The case fatality rate was high with encephalopathy featuring prominently as a poor prognostic factor. The findings from this analysis underscore the need for nephroprevention at all levels, as RRT is largely inaccessible and still with fatal outcomes in our environment. The regular

follow-up on the renal function status of all the children with AKI as designed by the proforma was grossly deficient due to financial constraints and loss to follow-up. There is a need for pediatric nephrologists to make these children visible to society and advocate for their inclusion in the policies that will ensure subsidization of their health care. With the ongoing effort to establish the National Renal Registry, this advocacy with both governmental and non-governmental organizations will likely pave the way for a better quality of life and medical care for children with nephropathy.

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