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ORIGINAL ARTICLE

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Renal failure in Nigerian children: factors limiting access to dialysis

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Abstract A 5-year clinical and laboratory study of Nigerian children with renal failure (RF) was performed to determine the factors that limited their access to dialysis treatment and what could be done to improve access. There were 48 boys and 33 girls (aged 20 days to 15 years). Of 81 RF patients, 55 were eligible for dialysis; 33 indicated ability to afford dialysis, but only 6 were dialyzed, thus giving a dialysis access rate of 10.90% (6/55). Ability to bear dialysis cost/dialysis accessibility ratio was 5.5:1 (33/6). Factors that limited access to dialysis treatment in our patients included financial restrictions from parents (33%), no parental consent for dialysis (6%), lack or failure of dialysis equipment (45%), shortage of dialysis personnel (6%), reluctance of renal staff to dialyze (6%), and late presentation in hospital (4%). More deaths were recorded among undialyzed than dialyzed patients ($P<0.01$); similarly, undialyzed patients had more deaths compared with RF patients who required no dialysis ($P<0.025$). Since most of our patients could not be dialyzed owing to a range of factors, preventive nephrology is advocated to reduce the morbidity and mortality from RF due to preventable diseases.

Keywords Dialysis access · Auditing of factors · Preventive nephrology

Introduction

Renal replacement therapy (RRT) is readily available and accessible to most children with renal failure (RF) in developed countries [1, 2]. In Nigeria, however, it remains inaccessible to a large number of children with acute renal failure (ARF), preterminal chronic renal failure (CRF), and end-stage renal disease (ESRD) [3, 4]. Consequently, in this country many patients who need dialysis treatment are managed only by conservative measures. This has significantly contributed to the high mortality of children with RF in Nigeria [4, 5].

The objectives of this study were to determine the factors limiting ready access of Nigerian children with RF to dialysis in our nephrology unit, and to suggest ways for improving this situation.

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Materials and methods

Clinical and laboratory data of Nigerian children admitted to our hospital for RF from January 1995 through December 1999 were prospectively recorded on a standard data form and analyzed. Relevant clinical data, which included age, gender, socioeconomic status of parents as determined by Oyedeji (modified) for Nigerians [6], ability to afford dialysis treatment, and the reasons for not dialyzing those who required dialysis treatment, were evaluated. In addition, the plasma urea and creatinine levels at the start of dialysis and the duration of dialysis treatment were recorded. Furthermore, information on death and on the mode of discharge (regularly discharged or discharged against medical advice) was obtained. Follow-up data of regularly discharged patients were also analyzed. Laboratory and clinical data were used to classify the patients into ARF, preterminal CRF, and ESRD and to determine eligibility for dialysis.

The following definitions were used to arrive at the above classification:

(a) ARF was defined as sudden onset of (1) reduction in urine volume to <300 ml/m^2 per day in children [7] or <0.6 ml/kg per hour in neonates [8], (2) increase in plasma urea and/or creatinine levels, associated (or not) with fluid or electrolyte imbalance, and/or (3) fractional sodium excretion >1% in a previously healthy child. Renal Burkitt lymphoma (*n*=9), post-streptococcal acute glomerulonephritis (*n*=6), nephrotic syndrome (*n*=6), and hemolytic uremic syndrome (*n*=1) were the primary renal diseases in the ARF patients; *Plasmodium falciparum* malaria (*n*=17), Gram-negative septicemia (*n*=10), gastroenteritis (*n*=5), severe intravascular hemolysis due to glucose-6-phosphate dehydrogenase deficiency (*n*=4), and posterior urethral valves (*n*=2) were the secondary causes of ARF.

(b) Preterminal CRF was defined as a progressive decline in creatinine clearance to <60–10 ml/min per 1.73 m^2 or a rise in plasma creatinine level to >120–500 μmol/l over a period of at least 6 months. The primary renal diseases were chronic glomerulonephritis (n=10) and chronic pyelonephritis (n=3); posterior urethral valves were a secondary cause in 1 patient.

(c) ESRD was defined as a condition in a CRF patient leading to a creatinine clearance <10 ml/min per 1.73 m^2 or a rise in plasma creatinine to a level >500 μmol/l. Chronic glomerulonephritis (n=6) and rapidly progressive glomerulonephritis (n=1) were the primary diseases. The diagnosis of the primary renal diseases in both CRF and ESRD patients was confirmed histopathologically from either percutaneous renal biopsy or autopsy specimens.

Creatinine clearance was determined from plasma and 24-h urine creatinine values, and where that was not possible, the Schwartz formula [9] was used.

The eligibility criteria for dialysis treatment of ARF were as follows:

– Clinical criteria
(a) Severe drug-resistant hypertension in a severely ill oligoanuric patient
(b) Acute pulmonary edema, congestive cardiac failure, and fluid overload
(c) Need for blood transfusion for symptomatic anemia with hematocrit level <15%
(d) Clinical manifestations of uremia, i.e., anorexia, nausea, vomiting, gastritis, bleeding diathesis, pericarditis, convulsions, deteriorating sensorium, or coma

– Biochemical criteria
(a) Urea >25 mmol/l
(b) Creatinine >300–500 μmol/l and >500 μmol/l for patients below and above 5 years of age, respectively
(c) Bicarbonate <15 mmol/l
(d) Potassium >6.5 mmol/l
(e) Phosphate >1.7 mmol/l

Clinical criteria, urea >25 mmol/l, metabolic acidosis, and plasma potassium >6.5 mmol/l, were the major reasons for considering dialysis in our patients.

CRF and ESRD patients were considered for dialysis treatment only when creatinine clearance fell below 10 ml/min per 1.73 m^2 or plasma creatinine was $\geq$700 μmol/l; however, when they presented acutely with uremia, severe hypertension, fluid overload, or pulmonary edema, they were considered for emergency acute dialysis.

Center description

Our nephrology unit (established in 1994) is an arm of the Department of Pediatrics that serves a population of 1,235,592 children (<16 years of age) of Osun State of Nigeria. The unit has seven beds, five nurses, and three doctors. It is supported by a hemodialysis (HD) unit; the latter has two beds, two Gambro AK-10 HD machines (Sweden), and five dialysis nurses. Both pediatric and adult patients are dialyzed in the HD unit.

Hemodialysis

Dialyzers were selected based on their urea clearance (not >3 ml/min per kg) and priming volume. Gambro Lundia AB IC1L and IC1 N (Sweden) cuprophan membrane plate dialyzers were used. The priming volume, ultrafiltration coefficient, and urea clearance (at a blood flow rate of 150 ml/min) of the IC1L dialyzer were 32 ml, 1.0 ml/h per mmHg, and 56 ml/min, respectively. Values for similar parameters for the IC1 N dialyzer were 43 ml, 1.5 ml/h per mmHg, and 91 ml/min, respectively. Pediatric blood lines (60 ml, 75 ml) were used, and where indicated an adult blood line (150 ml) was also used. The extracorporeal circuit volume was kept below 10% of each patient's blood volume (80 ml/kg). The femoral vein was routinely catheterized using a biluminal 9FG catheter. The blood flow rate (Q_B) was initially set at 50 ml/min and then gradually increased until the entire blood circuit was filled with blood; Q_B was thereafter set at the desired level, ranging between 125 and 200 ml/min. The dialyzate flow rate was maintained at 500 ml/min. An acetate-based dialysis solution was routinely used. Anticoagulation was achieved with a loading dose of intravenous (IV) heparin, 50 IU/kg per hour, followed by hourly maintenance dose, 25 IU/kg IV.

The ultrafiltrate volume was usually <5% of the patient's body weight. Patients were initially dialyzed for 2 h and subsequently for 4–6 h. Since all our patients presented acutely, dialysis was performed daily until satisfactory biochemical and/or clinical response was achieved.

Peritoneal dialysis

Acute intermittent manual peritoneal dialysis was carried out by the bedside of each patient. The urinary bladder was emptied and the peritoneal cavity was prefilled with 600–800 ml/m^2 of prewarmed potassium-free 1.5% peritoneal dialysate; this was to prevent bowel perforation during percutaneous intra-abdominal introduction of the semi-rigid McGraw Trocath cannula. The latter was aseptically introduced into the peritoneal cavity, 3 cm below the umbilicus (in the midline) after prior local anesthesia with 1% xylocaine. Mild sedation was achieved with intramuscular diazepam, 0.2 mg/kg, and promethazine, 0.5–1 mg/kg. The cannula was carefully maneuvered into the rectovesical pouch and dialysis commenced after ensuring free flow of dialysate. In each case, dialysis was initially started with 800 ml/m^2 of prewarmed 1.5% or 2.5% peritoneal dialysate to prevent leakage and tissue tracking; dialysate volume was, however, gradually increased to 1,200 ml/m^2 over the next 72 h. Each dialysis cycle lasted 1 h, i.e., 15 min for dialysate inflow, 30 min for intra-abdominal dwell, and 15 min for outflow. At least 10–12 cycles of dialysis were performed daily. Anticoagulation was maintained within the dialysis circuit by adding 500 IU of heparin into each liter of dialysate bag until bloody effluent was clear. Effluent was cultured daily for early detection of infection.

Statistical analysis

Chi-squared (X^2) and Fisher's exact tests were used as appropriate to determine the statistically significant difference between the outcome of management in dialyzed and undialyzed patients. Values of P<0.05 were considered statistically significant.

Results

Table 1 shows the age and sex distribution of 81 children managed for RF; the incidence of each RF type is also shown. Of 81 RF patients, 55 (68%) satisfied the eligibility criteria for dialysis, but only 6 underwent dialysis treatment (3 ARF, 2 preterminal CRF, and 1 ESRD). All patients with CRF and ESRD presented acutely. Of the 6 patients, 2 were treated by peritoneal dialysis and 4 by HD. Of the remaining 49 patients regarded as eligible for dialysis, 16 (33%) could not be offered this treatment because of financial constraints from the parents; the rest could not be dialyzed because of other factors indicated in Table 2. Among the latter, lack or failure of different parts of the dialysis equipment was predominant (45%). Table 3 relates the socioeconomic status of our patients to their ability to afford dialysis. The parents of 33 patients indicated that they were able to pay

Table 1 Age, sex distribution, and annual incidence of types of renal failure (*ARF* acute renal failure, *CRF* chronic renal failure, *ESRD* end-stage renal disease, *pmcp* per million children population)

Renal failure	Patient number	Mean age±SD (years)	Sex		Annual incidence (pmcp/year)
			Male	Female	
ARF	60 (74%)	6.3±4.4 (0.05–15)	35	25	10
Preterminal CRF	14 (17%)	11.4±3 (5–15)	8	6	2.3
ESRD	7 (9%)	11.6±2.6 (8–15)	6	1	1.13

Table 2 Factors limiting access to dialysis treatment in Ile-Ife, Nigeria

Dialysis determinants				n (%)
A	Financial restrictions from parents			16 (33)
B	No parental consent for dialysis because no subsequent possibility of transplantation			3 (6)
C	Lack or failure of dialysis equipment			22 (45)
	(1)	Hemodialysis		
		β	Breakdown of hemodialysis machine	2
		β	No hemodialysis machine available	2
		β	Electric power failure	1
		β	Lack of pediatric dialyzer	5
		β	No suitable blood lines	3
		β	No vascular catheters available	2
		β	No guide wire available	1
	(2)	Peritoneal dialysis		
		β	No suitable peritoneal dialysate	5
		β	No peritoneal catheter available	1
D	Shortage of dialysis personnel (nurses)			3 (6)
E	Reluctance of renal staff to dialyze			3 (6)
F	Late presentation in hospital			2 (4)

Table 3 Relationship between socioeconomic class and ability to bear dialysis cost

Socioeconomic class	Dialysis eligible (*n*=55)	Can afford dialysis (*n*=33)[b]		Cannot afford dialysis (*n*=16)
		Dialyzed (*n*=6)	Not dialyzed (*n*=27)	
Upper	5	2	3	–
Middle	18	3	15	–
Lower	32[a]	1	9	16
Upper class				
Class I	Holders of university degree(s); directors, chief executives, very senior professionals and managers, large scale businessmen or farmers; income/month ≥N55,000.00			
Middle class				
Grade II	Holders of university degree or higher national diploma; senior managers and professionals, very senior public servants, college principals, medium scale businessmen or farmers; income/month N40,000.00–N54,000.00			
Class III	Holders of national certificate in education or equivalent certificate; college teachers, senior public servants, confidential secretaries; income/month N25,000.00–N39,000.00			
Lower class				
Class IV	Holders of secondary school certificate or its equivalent; primary school teachers, junior public servants, small scale businessmen, artisans, drivers; income/month N10,000.00–N24,000.00			
Class V	Holders of primary school certificate or illiterate; unemployed, petty traders, subsistence farmers, messengers, cleaners, gatemen, gardeners, bus conductors; income per month <N10,000.00			

[a] 6 of 32 patients were denied access to dialysis due to lack of parental consent as well as reluctance of renal staff to dialyze CRF/ESRD children

[b] Ability to pay for dialysis does not guarantee access to dialysis in our unit

for dialysis, but only 6 were dialyzed due to different limiting factors.

The mean plasma urea and creatinine levels of 55 patients who were eligible for dialysis were 34.76±8.01 (25–58.8) mmol/l and 1,090.51±515.1 (213–2,254) μmol/l, respectively. Clinical, predialysis plasma urea, and creatinine data of dialyzed patients are shown in Table 4.

The outcome of our patients is shown in Table 5. More deaths were recorded in the hospital among those who were eligible for dialysis but actually did not receive this treatment compared with those who underwent dialysis treatment ($P<0.01$). There was also a higher mortality in the group eligible for dialysis ($n=29$) compared with those who were not eligible ($n=10$) ($P<0.025$). Most of the ARF

Table 4 Clinical, predialysis plasma urea, and creatinine data of dialyzed patients

Patient number	Age (years)	Sex	Weight (kg)	Diagnosis and indications for dialysis	Acute peritoneal dialysis		Acute hemodialysis	Predialysis plasma		Outcome
					Number of exchanges per day	Number of days on dialysis	Dialysis sessions per week	Urea (mmol/l)	Creatinine (μmol/l)	
1	5	M	16	Preterminal CRF: uremic encephalopathy, bleeding, acidosis, hypertension	13–18[a]	5	–	40	1,130	Alive
2	6	M	21	ARF: pulmonary edema, uremia, severe hypertension	10–15[b]	3	–	38	1,242	Alive
3	12	M	33	ESRD: Uremia, fluid overload, hyperkalemia, severe hypertension	–	–	1	44	1,405	Died
4	4	M	17	ARF: congestive heart failure, uremia	–	–	2	33	900	Alive
5	14	M	38	Preterminal CRF: uremia, acidosis, hyperkalemia, hypertension	–	–	5	55	1,842	Alive
6	4	M	18	ARF: uremic pericarditis, acidosis, bleeding diathesis	–	–	2	32	1,050	Alive

[a] 53 l of dialysis solution were used
[b] 33.2 l of dialysis solution were used

Table 5 Outcome of renal failure in Nigerian children

Diagnosis	Eligible for dialysis[a]				Not eligible for dialysis[b]		Discharged against medical advice
	Dialyzed and survived	Dialyzed but died	Not dialyzed but survived	Not dialyzed and died	Survived	Died	
ARF	3	0	7	21	15	10	4
Preterminal CRF	2	0	3	4	0	0	5
ESRD	0	1	1	3	0	0	2
Total	5	1	11	28	15	10	11

[a] 10 were discharged against medical advice
[b] 1 patient was discharged against medical advice

patients who were eligible for dialysis could not be dialyzed due to financial constraints, lack or failure of dialysis equipment, late presentation, and shortage of renal personnel. Uremic complications, disseminated intravascular consumptive coagulopathy, uncontrollable severe hypertension, and pulmonary edema were the causes of death in 28 patients who were eligible for dialysis but were not dialyzed. Furthermore, the 10 deaths recorded among those not eligible for dialysis were due to associated co-morbidities such as kwashiorkor, severe anemia, nosocomial septicemia, and tumor lysis syndrome in 7 of 9 patients with renal Burkitt lymphoma.

Of 25 ARF survivors, 13 failed to honor their follow-up clinic appointments after they were regularly discharged from the hospital; however, the mean follow-up period was 4.25±2.52 (1.5–9) months for the remaining 12 patients. While 1 of 5 preterminal CRF survivors failed to honor the follow-up clinic appointment, the remaining 4 were followed for a mean period of 15.63±7.4 (7.5–25) months. The only survivor among the ESRD patients was lost to follow-ups after 8 months of regular clinic attendance. In total, 11 patients were discharged against medical advice and were therefore lost to follow-up.

Discussion

Data on the incidence of RF in Nigerian pediatric patients are few [3, 4]. An earlier study puts the incidence of ARF and CRF at 8 and 6 new cases per year, respectively [4]; these are similar to our present data on ARF and CRF. The incidence of ESRD has been reported to be 7.5 new cases per million children population (pmcp) per year [3]. Our ESRD incidence of 1.13 new cases pmcp/year is seven times lower than the latter. Since ours is the only pediatric nephrology unit in the Osun State of Nigeria, with a population of 1,235,592 children (under 16 years of age), the total number of RF children seen in this study was rather small. The fact that our unit is still relatively new and a number of cases might not have been referred from the peripheral hospitals may be a factor. The strong preference of our largely illiterate population who live in rural communities for traditional medicine and spiritualists could also have accounted for the small number of RF cases seen; many patients might also have been managed at home with herbal remedies due to financial constraints. Aggressive health education and improvement in our literacy level should reverse this trend.

Dialysis eligibility criteria in some African countries like Ghana [10] and Morocco [11] included deteriorating clinical status, fluid overload, rapidly rising urea or plasma urea level ≥33 mmol/l, severe hyperkalemia, and hypernatremia. Our dialysis eligibility criteria are similar to the latter. Based on the above criteria, 62% and 100% of Ghanaian and Moroccan children, respectively, who were eligible for dialysis were dialyzed. Our data, however, show that 89.10% of our RF patients did not have access to dialysis treatment. Our 10.90% dialysis access rate is disturbingly low when compared with figures from Ghana and Morocco. Access to dialysis is equally poor in other pediatric centers in Nigeria [3, 4].

The ability to bear dialysis cost/dialysis accessibility ratio of 5.5:1 in this study indicates that the dialysis answer to the rapidly deteriorating clinical status and renal function of RF children may not be guaranteed in all cases who can afford it; this is due to a number of non-financial constraints (Table 2). These non-financial factors were responsible for our failure to dialyze 27 of 33 patients who maintained they were able to afford it.

Prohibitive costs of dialysis (N10,000.00 Nigerian naira or U.S. $ 105.26 US dollars/HD session) (33%) and lack or failure of dialysis equipment (45%) were the major impediments to dialysis in this study; they were also major threats to survival of the patients, especially those with ARF who constituted 74% of the RF cases; 21 of 28 deaths (75%) from among those eligible for dialysis but who were not dialyzed were in fact due to ARF. Data from developed countries showed that the prognosis of ARF could be better if those requiring dialysis treatment are promptly dialyzed. A study from Germany revealed a 73% survival rate for dialyzed ARF cases whose major causes were hemolytic uremic syndrome, cardiac surgery, and septicemia with multiorgan failure [12]. Similarly, a 100% survival rate was achieved among dialyzed ARF cases in a particular study from Japan; ARF in the Japanese patients was mainly due to hemolytic uremic syndrome, tubulointerstitial nephritis, and glomerular diseases of varying etiologies, and cortical necrosis [13]. Given the etiology of ARF in this study, it is obvious that the majority of the recorded deaths could have been prevented if dialysis treatment had been given to those who required it. Local production and distribution of expensive peritoneal dialysis and HD equipment that is presently obtained from manufacturers at high prices abroad could improve this situation.

The renal staff in our center (doctors and nurses) is hesitant to apply dialysis procedures to children because of the heavy financial burden chronic dialysis programs impose on the parents; the latter often sell valuables to offset dialysis bills and other healthcare debts to the detriment of other siblings. Current questions that remain open are, how many dialysis sessions or peritoneal dialysate bags would they afford before being financially bankrupt or is dialysis therapy of any value, if there is no chance for subsequent renal transplantation (Table 2)? Denial of (long-term) dialysis treatment has also been reported from developed countries, but for different reasons; some of these reasons included growth retardation [14] and co-morbid congenital neurological disorders [15].

Poverty precluded dialysis therapy in at least a third of our patients; it is a major factor limiting access to renal healthcare in Nigeria [16, 17] and also a recognized cause of discharge against medical advice [18, 19].

Healthcare delivery in Nigeria is largely funded by the government. The yearly budgetary allocation to health in this country is usually very low, corresponding often to less than the 5% of the minimum recommended by the World Health Organization for developing countries. The high costs for dialysis treatment in our center are reflected by this poor funding. A well-designed health insurance scheme run by private insurance companies, that should improve healthcare funding and delivery to a large number of Nigerian people, has been advocated [20]. In the United States, a federal legislative act in 1973 entitled every citizen, irrespective of age, to obtain Medicare reimbursement for RRT, including children [14]. Similarly, in Japan all dialysis patients are covered by either social insurance or welfare aid so that no patient, irrespective of social status, is charged more than U.S. $ 83/month for treatment [21]. In contrast, an ESRD patient in our unit on regular HD 3 times/week would presently pay U.S. $ 1,263/month, i.e., 15 times the amount required in Japan! To cut the costs for dialysis treatment, reuse of dialyzers was proposed [21]. Although this appears to be an attractive option, the dialyzer reuse system is a controversial issue because of its negative influence on morbidity and mortality [22].

The results presented here demonstrate the urgent need to improve RRT facilities for children in Nigeria, staff strength, and to significantly reduce the cost of dialyzing children, so that more patients can have access to dialysis. Since dialysis is a very expensive treatment, it imposes heavy financial burdens, and is beyond the reach of most families of our patients. At present the initiation and maintenance of dialysis therapy in a Nigerian child with ARF or CRF is frustrating and problematic due to the lack of facilities due to economic constraints. It was proposed that an inexpensive option to improve renal health in developing countries would be the extension of preventive nephrology that would no doubt reduce morbidity and mortality from RF due to preventable diseases [16]. Kidney disorders subject to preventive measures in Nigerian children include acute glomerulonephritis due to β-hemolytic streptococcal infection, hemolytic uremic syndrome, nephrotic syndrome due to *Plasmodium malariae*, and non-renal causes of ARF such as gastroenteritis, septicemia, *P falciparum* infection, and intravascular hemolysis due to glucose-6-phosphate dehydrogenase deficiency [5, 23, 24, 25]. Early and strict management of these and other preventable conditions would significantly reduce the incidence of ARF and ultimately reduce the demand for RRT facilities. Improvement in the general health of the population through provision of piped water, proper sewage disposal, maintenance of a high standard of environmental hygiene, and effective vector control would equally assist in preventing ARF.

Considering our present situation, it may be sensible to (1) restrict dialysis treatment to ARF and selected cases of CRF, (2) to introduce stricter dialysis criteria such as dialyzing only when azotemia and hyperkalemia become symptomatic, and in CRF, when creatinine clearance is $\leq$5 ml/min per 1.73 m^2, (3) to use the less expensive and less technically demanding peritoneal dialysis instead of the expensive HD. Equally important are improved training of personnel and cooperation with other nephrology centers in Nigeria and other African countries so that common problems can be jointly addressed.

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