ORIGINAL ARTICLE

Paediatric acute peritoneal dialysis in southern Nigeria

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Accepted 2 October 2005**Background:** Acute peritoneal dialysis (APD) is the preferred treatment for isolated failure of the kidney. The authors reviewed children with acute renal failure (ARF) who had APD in Port Harcourt, Nigeria.**Results:** 221 patients, 147 boys and 74 girls (M: F, 1.99:1), mean (SD) age 5.4 (4.9) years had ARF. Dialysis was indicated in 112 cases. The main clinical indication being convulsion/uraemia 30 (26.8%). Only 27 patients (21 boys and 6 girls) had APD, giving an access rate of 24.1%. The commonest dialysis related complication was catheter malfunction 12 (44.4%). The mortality rate among the dialysed patients was 22.2%. Lack of dialysis and intractable hypertension significantly increased mortality ($\chi^2=7.13$, $p<0.01$) and ($\chi^2=14.9$, $p<0.001$) respectively.**Conclusion:** APD is effective in reducing mortality of children with ARF. However, there were low dialysis access rate and few complications.

Acute peritoneal dialysis (APD) provides a non-vascular form of renal replacement treatment in children with acute renal failure (ARF).^{1–3} It is beneficial in the control of volume overload states in patients with cardiovascular compromise, haemodynamically unstable, or patients in whom vascular access is problematic.^{1–3} It is also useful in treating acute haemorrhagic pancreatitis, hypothermia, or tumour lysis syndrome.^{1–4}

APD is the preferred treatment for isolated failure of the kidney in children of all ages including neonates.^{3–10} It is easier to perform, cheaper, and requires less sophisticated equipment than haemodialysis. Again it provides a better haemodynamic stability in children and avoids problems related to vascular access such as air emboli, thrombosis, infections, and haemorrhage.^{1–3, 7–11} There are no indications of the possible disadvantages of peritoneal dialysis (PD).

In developed countries facilities for APD are universally available and dialysis access rate is high.^{7–10} The situation is not the same in developing countries. We therefore reviewed children with ARF in Port Harcourt, Nigeria in whom dialysis was indicated to determine the common indications for dialysis, PD access rate, complications, and outcome.

METHODS

Patients and study design

The study was conducted at the University of Port Harcourt Teaching Hospital, Rivers State, Nigeria. Patients with the diagnosis of acute renal failure from January 1985 to December 2004, aged 0–16 years in whom APD were indicated were included in the study review. Patients' medical records were then retrospectively reviewed as recorded in the renal register. Demographic data for the 112 patients were summarised including age, sex, indications for dialysis, and access rate. Additionally, the investigations, complications related to APD, and outcome were evaluated.

ARF was defined as a rapid and progressive decline in renal function, manifesting as a rising plasma urea and creatinine concentrations, which is usually accompanied by oliguria (<1 ml/kg/h) or occasionally polyuria.

Hypertension was defined as systolic and/or diastolic pressure above the 95th centile for age.¹² Anaemia was regarded as packed cell volume or haemoglobin concentration below the reference range for age and sex.¹³

Eligibility criteria for dialysis included clinical features such as pulmonary oedema, intractable hypertension not

responsive to drugs, uraemic symptoms, and heart failure. The laboratory indications included hyperkalaemia (serum potassium >6.5 mmol/l), increased blood urea nitrogen $\geq$ 24 mmol/l, serum creatinine $\geq$ 300 μ mol/l in infants, and $\geq$ 500 μ mol/l in older children. The clinical and laboratory features appeared either in isolation or together.

APD was done manually in our centre with the patients responsible for providing the materials for dialysis. The dialysis solution used were 2.5% or 1.5% glucose, with the addition of 250 IU heparin/l and gentamycin 10 mg/l into each Dianeal fluid contained in a two litre plastic bag. The specialist nephrologist and the paediatrician in the renal unit inserted the entire acute peritoneal catheter under local anaesthesia. The left lateral border of the rectus muscle was the site of catheter insertion advanced to the right side of the pelvis. The bladder was catheterised before the insertion. The abdomen was filled initially with 10–20 ml/kg of dialysis solution and gradually increased to 30–40 ml/kg. The first exchange was drained immediately, and then subsequently increased to two hourly exchanges. An initial dwelling time of 30 minutes was permitted and then increased to two hours as the dialysis progressed. The vital signs (temperature, pulse, and blood pressure) were done at the beginning and at the end of each exchange. A PD data sheet was used for accurate recording of time, the volume of fluid delivered into the peritoneal cavity, the dwell time, volume out, and fluid balance. There are no trained nurses to assist in the dialysis of children and so only the doctors monitored the patients.

Peritonitis was suspected if they had abdominal pain, cloudy dialysate effluent, and fever. An exit site leak was considered if there was dialysate moisture around the PD catheter.¹

Patients were all receiving intravenous cephalosporin antibiotics during the period of dialysis. Conservative treatments were provided for other patients who could not afford dialysis or in whom dialysis was not indicated.

Statistical analysis was done using EpiInfo version 6. Patient demographic and clinical characteristics were analysed descriptively. Comparison of dialysis access rate based on sex and age were performed. Analyses assessing the factors influencing mortality were also done using χ^2 test. A p value ≤ 0.05 is considered significant.

Abbreviations: APD, acute peritoneal dialysis; ARF, acute renal failure; PD, peritoneal dialysis

Table 1 Frequency of dialysis indications in 112 patients

Indications	Frequency (%)
Clinical	
Convulsions/uraemia	30 (26.8)
Heart failure	24 (21.4)
Pulmonary oedema	23 (20.5)
Intractable hypertension	10 (8.9)
Laboratory	
Hyperkalaemia (≥ 6.5 mmol/l) not responsive to conservative management	23 (20.5)
Metabolic acidosis ($\text{HCO}_3^- < 15$ mmol/l)	36 (32.1)
Blood urea nitrogen (BUN) ≥ 24 mmol/l	63 (56.3)
Serum creatinine ≥ 300 $\mu\text{mol/l}$ in infants	36 (32.1)
Serum creatinine ≥ 500 $\mu\text{mol/l}$ in older children	45 (40.2)

RESULTS

Over the 19 year study period, 221 paediatric patients with the diagnosis of ARF were seen. They were 147 (66.5%) boys and 74 (33.5%) girls, with a male: female ratio of 1.99:1. Their mean (SD) age was 5.4 (4.9) years.

Of these dialysis was indicated in 112 (50.7%) patients, 80 (71.4%) boys and 32 (28.6%) girls. They were 48 (42.9%) infants, 19 (17%) >1 –5 years, 20 (17.9%) >5 –10 years, and 25 (22.3%) >10 years of age. Table 1 shows the frequency of dialysis indications in these patients. The most common clinical indication for dialysis in our study was uraemic symptoms with seizures in 30 (26.8%) patients, followed by heart failure in 24 (21.4%). Most of the clinical features were associated with raised serum urea of ≥ 24 mmol/l, serum creatinine ≥ 300 $\mu\text{mol/l}$ in infants, and ≥ 500 $\mu\text{mol/l}$ in older children. However, patients with intractable hypertension ((8 (7.1%)), convulsion (10 (8.9%)), hyperkalaemia (6 (5.4%)), and pulmonary oedema (8 (7.1%)) were eligible for dialysis without raised serum urea of ≥ 24 mmol/l and serum creatinine ≥ 300 $\mu\text{mol/l}$ in infants or ≥ 500 $\mu\text{mol/l}$ in older children.

Only 27 (24.1%) patients had APD because of financial difficulties and lack of dialysis materials in our centre. There were 21 (77.8%) boys, 8 (16.7%) infants, 9 (47.4%) >1 –5 years, 5 (25%) >5 –10 years, and 5 (20%) >10 years of age. Although more boys were dialysed, the difference was not significant ($\chi^2 = 0.95$, $p > 0.1$). Similarly, fewer infants were dialysed (8 v 19) in this study. One of them was a 6 day old neonate. The observed difference between the age groups was not significant ($\chi^2 = 3.17$, $p > 0.05$). One of the patients was positive for both HIV1 and 2. Anaemia with a mean (SD) packed cell volume of 20.5 (5.2)% was seen in 20 (74%) of the dialysed patients. Ten (50%) of them received blood transfusion, one had erythropoietin injections, while the rest had haematinics.

The mean (SD) serum urea and creatinine concentrations before dialysis were 38.8 (13.8) mmol/l and 795.2 (299.4) $\mu\text{mol/l}$ respectively. The duration of dialysis ranged from three to eight days with each patient having four to eight cycles in a day. The mean (SD) serum urea obtained after one to three days of PD was 11.9 (4.6) mmol/l and creatinine concentration measured three to five days after dialysis was 246 (89.1) $\mu\text{mol/l}$.

Few complications were recorded during the dialysis. Exit site leak occurred in two cases (7.4%) and catheter malfunction necessitating change in catheter occurred in 12 (44.4%) cases. One (3.7%) patient had purulent effluent around day 4 of the dialysis. A rapid exchange with no dwell time was done for about four hours, then half hourly dwell time. The culture of the effluent could not be done for financial reasons.

Forty eight (42.9%) of the dialysis eligible patients died during the study period. The mortality rate among the

dialysed patients was 22.2%. The lack of provision of dialysis and presence of intractable hypertension significantly increased mortality in this study ($\chi^2 = 7.13$, $p < 0.01$) and ($\chi^2 = 14.9$, $p < 0.001$) respectively. Among the dialysed patients the causes of death were recurrent anaemia (33.3%) and uraemia (66.7%).

DISCUSSION

The choice of modality of managing ARF depends on patient size, availability of vascular access, integrity of the peritoneal membrane and abdominal cavity, and perhaps most importantly, clinical experience and expertise.^{7–11} However, in most developing countries, as in our setting, there are no facilities for paediatric haemodialysis (PD), hence PD remains the only available option for management of ARF.

PD requires the creation of an access to the peritoneal cavity, which will permit the installation, and drainage of dialysate through repeated cycles.^{2–14–15} Such an access may be either acute or chronic. APD remained limited to the treatment of acute renal failure because of the need to acutely implant a catheter for each dialysis session. The development of chronically implanted catheters in the 1960s enabled PD to be used for long term dialysis therapy.^{14–16} More recently a telePD has been proposed to effect home monitoring of automated PD in paediatric patients receiving long term dialysis.¹⁵

APD was indicated in 112 (50.7%) patients with ARF in our study. This compared with 66 (53.7%) dialysis eligibility reported by Olowu *et al.*¹⁷ The decision to start dialysis should anticipate the natural history of ARF in paediatric settings.^{2–3–8} Previous studies have noted that most causes of ARF in Nigeria are pre-renal and some would respond to conservative management,^{17–18} unlike those in developed countries, which are intrinsic renal failure and are more likely to need dialysis.^{6–7–19}

This study reported more boys than girls with severe ARF needing dialysis. The higher incidence of urological abnormalities in boys has been noted to account for male preponderance in renal disorders both within and outside Nigeria.^{17–20–21} Also more infants were eligible for dialysis in our study. The increased metabolic rates and energy demands of young children result in earlier and more frequent dialysis.²

Indications for immediate dialysis in children with ARF include severe or persistent hyperkalaemia, intractable hypertension, congestive heart failure, pulmonary oedema from fluid overload, severe and persistent acidosis, and neurological complications of uraemia.^{2–3–8} In most cases the combination of clinical appearance, fluid overload, electrolyte imbalances, extreme increase of serum urea, and uncontrolled acidosis lead to a situation where dialysis becomes necessary. The most common clinical indication for dialysis in our study was uraemic symptoms with seizures.

PD has usually been the preferred treatment for isolated failure of the kidney in children and is universally available in developed countries.^{7–8} Unfortunately dialysis materials are not readily available in our hospital, and parents had to purchase the materials. Most of the populace who usually attend our hospital is poor and this accounted for low dialysis access rate of 24.1% in this study. Male sex preference, which is common in African setting, may have contributed to provision of dialysis materials by parents for their male children than the female children.

APD is usually performed manually but can be done with the assistance of a cyler.^{1–3} Automated cyclers are useful when a short exchange time (30–60 minutes) is required, with considerable savings in nursing time. We used manual type as there is no cyler in our hospital, and there is no

proper dialysis centre for children and no trained nurses to assist in PD.

Glucose is almost universally used as the osmotic agent in PD because it is non-toxic and readily metabolised once it passes into the blood. The selection of glucose concentration for dialysis would depend on the fluid balance of the patient.^{2 22 23} The glucose level in the PD fluid is expressed in glucose monohydrate (dextrose) (molecular weight 198), which is 10% greater than that of anhydrous glucose (molecular weight 180).¹¹ The dialysate solutions used in the study were 2.5% or 1.5% glucose depending on the type available at the immediate time of need. We used 1.5% when fluid loss was not required and sometimes 50% dextrose was added into 2.5% to make up a strong solution of 3.86% in patients who had pulmonary oedema to achieve fluid loss as we did not have haemofiltration. Other substances, including sorbitol, fructose, dextrans, and amino acids have not proved a viable alternative to glucose in dialysate.^{2 23 24} The use of sorbitol was associated with a comparatively high incidence of hyperosmolar coma. Amino acid based solutions are advocated in patients with malnutrition but it leads to worsen acidosis and increase urea load.²⁴

It is important to ensure that APD delivers adequate clearance to patients with ARF.^{1-3 11} Although, there are no guidelines as to what constitute adequate PD in a child with ARF, urea clearance can be used to determine adequacy of acute dialysis.¹⁻³ We did not measure urea clearance in our dialysed patients, but most had pronounced reduction in their serum urea and creatinine after dialysis.

The main dialysis related complication found in this study was catheter obstruction causing failure of dialysate to drain. This was thought to be from omentum and fibrin clots. None had exit site infection as the exit sites were covered with sterile gauze. The diagnosis of peritonitis is usually suggested by the presence of more than 100 cells/ml of white cell count or with a neutrophil count exceeding 50% of total, and a positive culture in the peritoneal fluid.² The incidence of peritonitis in children undergoing APD is reported to be up to 12%.¹ The routine use of intravenous cephalosporins during our dialysis as well as instillation of gentamycin into the dialysate may have contributed to low (3.7%) incidence of peritonitis in this study. However, the small number of dialysed patients in this study makes it difficult to draw a conclusive report on the actual incidence of dialysis related complications.

Although anaemia is a known feature of chronic renal failure, it was common in patients with ARF in our environment because of malnutrition and malaria. The use of erythropoietin and iron preparations has been advocated in children receiving long term PD to maintain a haemoglobin concentration of at least 11 g/l.²⁵ We rarely find erythropoietin in our hospital, and most of the time it is expensive, so we used blood transfusion in most patients except for a neonate who had erythropoietin.

Mortality data for children receiving acute dialysis are limited. Although dialysis reduced the mortality from ARF in this study, the mortality rate of 22.2% among dialysed patients in our study was higher than <10% reported in developed countries.² Recurrent anaemia was contributory to the death of a patient with HIV infection even after blood transfusion. In conclusion, APD is effective in the management of ARF in children. However, we have very low dialysis access rate in Nigeria because of poverty and lack of facilities for dialysis and the dialysis related complications are few.

There is therefore need to provide a dialysis centre for children at an affordable cost in Port Harcourt, Nigeria.

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