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LESSONS FOR THE CLINICAL NEPHROLOGIST

Improvised, emergency peritoneal dialysis in children with acute kidney injury amid war in Tigray, Northern Ethiopia: two teaching cases

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Abbreviations

AKI	Acute kidney injury
ISPD	International Society of Peritoneal Dialysis
KRT	Kidney replacement therapy
NGT	Nasogastric tube
PD	Peritoneal dialysis
PIGN	Post-infectious glomerulonephritis
RPGN	Rapidly progressive glomerulonephritis

The cases

Case one

The first case regards a 4-year-old boy who presented with fever and vomiting lasting since 3 weeks. He was anuric for 5 days and had had seizures. On examination he was lethargic, with a pulse rate of 114 beats per minute, respiratory rate of 46 breaths per minute, and temperature of 38.5 °C. He had edema and respiratory acidosis. His hemoglobin and platelet counts were 6.5 g/dl and 35,000/mm^3, respectively. On peripheral blood smear, Giemsa stain Plasmodium falciparum species infecting red cells were detected. Microscopic urine analysis showed active urine sediment. Serum creatinine (SCr) was 9.2 mg/dl (Fig. 1). Abdominal sonography showed bilaterally enlarged and hyperechogenic kidneys. Blood culture revealed Escherichia coli which was sensitive to Ceftazidime.

Accordingly, he was diagnosed with severe and complicated malaria, encompassing stage III acute kidney injury (AKI), cerebral malaria, severe anemia, and gram-negative septicemia. He was treated with Vancomycin, Ceftazidime, and Artesunate. He was transfused with two units of whole blood. Peritoneal dialysis (PD) was started using a modified nasogastric tube ((NGT) with three extra side holes). Local anesthesia was given at the bedside using an aseptic technique, after which a small incision was made and the tube was inserted into the peritoneal cavity (Fig. 2). A PD solution of 2.5% dextrose was prepared by adding 62 ml of 40% dextrose to 1 l Ringer lactate (as 50% dextrose is not available in our setting). A PD solution of 1.5% dextrose was made by adding 37 ml of 40% dextrose to 1 l Ringer lactate. Potassium (4 mmol/l) was added to the PD solution when serum potassium was less than 4 mmol/l. Heparin (500 IU/l) was added to all emergency and extemporaneous PD solutions (Table 1). This preparation was modified from the international society for peritoneal dialysis (ISPD) guideline for peritoneal dialysis, updated in 2020 [11]. PD solution was made up by the attending Nephrologist who did the best to work under sterile conditions, immediately before use. Exchanges were performed manually by the attending resident. Initially, a 2.5% PD solution was used, then it was modified to 1.5%. Dwell time was initially 30 min, then every two hours thereafter, later changed to six sessions per day, based on the clinical response. His urine output increased from nil to 1.5 ml/kg/h and peritoneal dialysis was continued for 16 days. He developed mechanical obstruction on the 5th day of PD and the catheter was changed. After 25 days of hospital stay, he was discharged home with SCr of 0.5 mg/dl. On his last follow-up visit, clinical and laboratory parameters were stable (Fig. 1).

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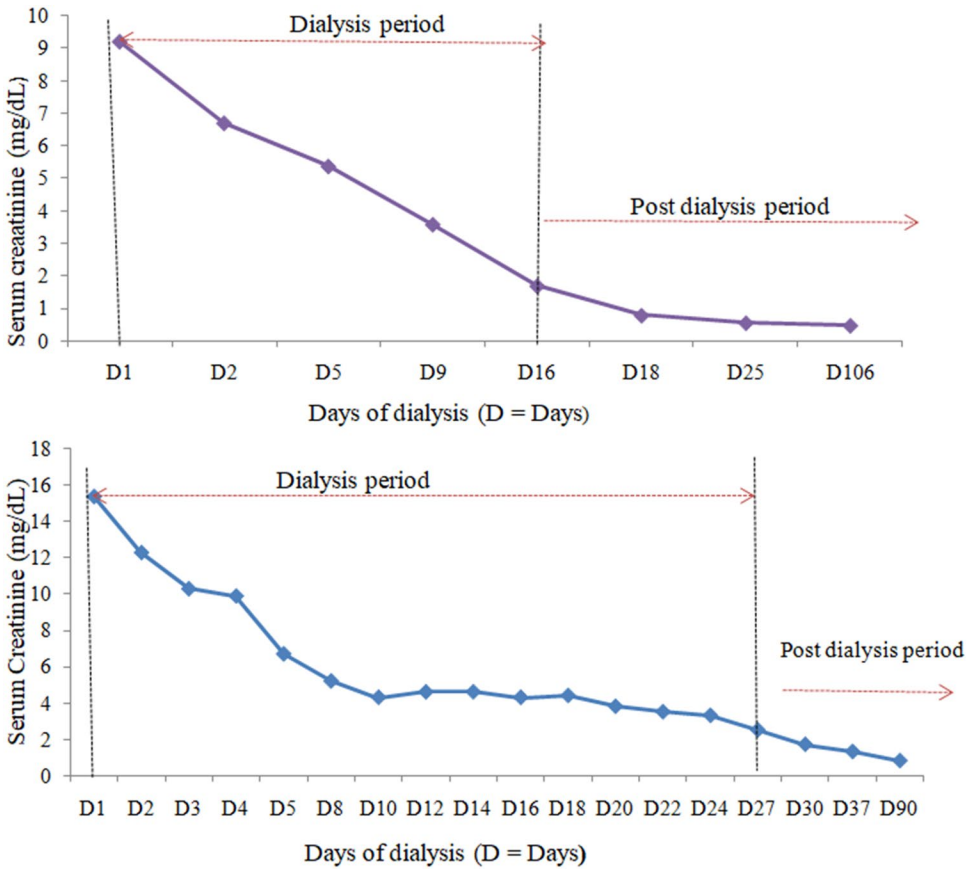

Fig. 1 Trends of serum creatinine for case 1 (top) and case 2 (bottom) during and post peritoneal dialysis period

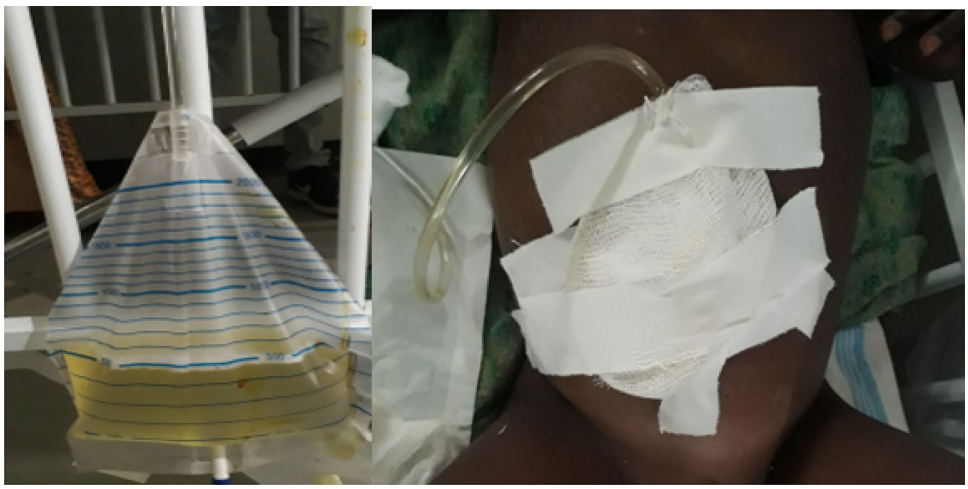

Fig. 2 Case one on improvised peritoneal dialysis catheter (right) and effluent drainage using urine bag (left)

Case two

A 13-year-old male diagnosed with rheumatic valvular heart disease 3 years earlier, presented with fever (38.5 °C), palpitations, and shortness of breath at rest ongoing for 1 week. He had an erythrocyte sedimentation rate of 134 mm/h and hemoglobin of 10.7 g/dl. Blood culture showed enterococci sensitive to ceftriaxone. Transthoracic echocardiography revealed severe mitral and aortic regurgitations with mild pulmonary hypertension, left ventricular ejection fraction of 71% and no vegetations. He was diagnosed with infective endocarditis according to modified Duke's criteria. Baseline serum creatinine at diagnosis of endocarditis was 0.5 mg/dl and microscopic urine analysis was normal. He was treated with Ceftriaxone and Gentamicin. However, on the 14th day of hospitalization, he developed fever and cough.

Table 1 Constituents of the 1.5% and 2.5% improvised peritoneal dialysis fluid (Modified from ISPD Guideline)

Constituents	1.5% Improvised PD[a] fluid	2.5% Improvised PD[a] fluid
Sodium (mmol/l)	127	127
Chlorine (mmol/l)	109	109
Lactate (mmol/l)	32	32
Potassium (mmol/l)	3.8	3.8
Calcium (mmol/l)	1.36	1.36
Glucose (g/dl)	1.45	2.5
Heparin (IU/l)	500	500
Osmolality (mOsm/l)	346	403

[a]*PD* peritoneal dialysis

Chest X-ray showed bilateral consolidations in the mid-lung zones. No microorganisms were identified on blood culture. A diagnosis of hospital-acquired pneumonia was made and the patient was treated with Vancomycin and Ceftazidime. After 6 weeks of inpatient treatment, he was discharged home.

However, on the fifth day post-discharge, he reported non-projectile vomiting and oliguria. At presentation, he was lethargic and his blood pressure was 130/90 mm. Severe wasting was noted and body mass index (BMI) (weight 28 kg) was 13.3 kg/m^2. He had conjunctival pallor and edema. Blood tests showed white blood cell count of 15,600 mm^{3}and SCr of 15.5 mg/dl (Fig. 1). Abdominal sonography revealed bilaterally enlarged and echogenic kidneys. Urinary sediment was active.

He was readmitted with a diagnosis of stage III AKI, likely secondary to post-infectious glomerulonephritis (PIGN). He had clinical features of Rapidly Progressive Glomerulonephritis (RPGN: progressive decrement of urine output to anuria and doubling of SCr over few weeks) though we had no kidney biopsy. Hypertension was controlled with Nifedipine. He was started on prednisolone 30 mg orally twice a day for one month which was then tapered over six months (Methylprednisolone was not available). A modified nasogastric tube was inserted into the peritoneal cavity and PD solution were prepared as described in the first case. Peritoneal dialysis was initiated with 1.5% solutions with a dwell time of two hours, then exchanges were performed every four hours, based on the clinical response (Fig. 2).

In his second week of hospitalization, he developed peritonitis (abdominal pain and cloudy effluent). Peritoneal fluid culture showed Acinetobacter species sensitive to ciprofloxacin. He was treated with ciprofloxacin orally for 21 days and he improved. He had severe hypoalbuminemia (serum albumin: 1.1 g/dl). He was oliguric till day fifteen of PD then diuresis progressively increased to 3.6 ml/kg/hr. PD was carried out for 27 days and he was discharged home in stable clinical conditions. On his last follow-up visit, he was clinically stable with SCr of 0.8 mg/dl.

Lessons for the clinical Nephrologist

Acute kidney injury (AKI) is associated with increased morbidity and mortality in children. Primary kidney disease, sepsis, severe malaria, diarrheal disease, and hemolytic uremic syndrome are the most common causes of AKI in developing countries [1–3]. In these countries, many children die from AKI, mainly due to a lack of facilities for kidney replacement therapy [2, 4]. Peritoneal dialysis is a better option for KRT for children in less developed countries because it is less expensive and does not need sophisticated infrastructures [5]. In a resource-limited setting, where standard catheters and fluids for PD are not available, they can be improvised from locally available materials, as shown in previous reports [2, 6–8]. The armed conflict in Tigray, northern Ethiopia, has lasted more than 18 months now and has resulted in enormous damage to the health care system including dialysis service in the region [9, 10]. Six months into the war, the use of improvised PD was the only option left to save the lives of children in need of dialysis. This article briefly discusses two cases of first-ever successfully improvised PD in children with AKI needing KRT in the war-torn Tigray region. Before this civil war, children who needed dialysis therapy were referred to Addis Ababa, the capital city of Ethiopia.

Standardized PD solutions and catheters are not always available in developing countries. This challenge leads to the use of improvised equipment in the management of critically ill children with AKI [2, 11]. In Ayder Hospital, Tigray's flagship health care institution, we had neither acute PD catheters nor standard PD solutions which necessitated improvised methods for the management of AKI. Both of the patients reported above developed stage III AKI, secondary to severe malaria and PIGN, respectively, requiring emergency dialysis. These two patients were successfully managed with acute PD using a modified nasogastric tube as a catheter and fortified Ringers lactate as a PD solution. Successful cases of improvised PD are well documented in previous literature [2, 6–8].

Delivering care to patients with AKI requiring dialysis is a leading challenge amid the war and blockade. A similar approach was taken by Pina et al. in 2010 in the combat zones of Afghanistan and Iraq [12].

In patients with cardiac impairment, like our second case, PD is a viable alternative to hemodialysis also because the

cardiovascular tolerance of PD is excellent [13]. The duration of dialysis in our cases was longer than in other similar reports [2, 13]. This may be due to the concomitant use of nephrotoxic drugs like Vancomycin and Gentamicin which might delay renal recovery. Moreover, the second patient had RPGN in which the recovery of renal function may be prolonged [14].

In the first case, the patient developed mechanical obstruction of the modified nasogastric tube on the fifth day of PD and thus it was replaced. Catheter blockage and leakage are common complications of improvised PD as compared to standard PD catheters [11]. Peritonitis, which is one of the major complications of improvised PD, developed in the second patient. Case two had also severe hypoalbuminemia (Serum albumin: 1.1 g/dl). Severe malnutrition compounded by the effect of longer duration on PD (27 days) might explain the hypoalbuminemia. These cases are the first successful experiences of improvised PD in Tigray, northern Ethiopia. This showed that pediatric AKI requiring KRT may benefit from careful utilization of an improvised catheter and PD solutions in a resource-limited setting, especially at times of crisis including war.

These can reduce the high morbidity and mortality associated with AKI in resource-limited settings, where standard materials are not available.

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Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Consent to publish The authors affirm that human research participants provided informed consent for the publication of the images in Fig. 2. The participant's next of kin have consented to the submission of the case report to the journal. Patient's next of kin signed informed consent regarding publishing their data and photographs.

Ethical approval There is no need for approval for ethical clearance of case reports according to the Institutional Review Board of Mekelle University, College of health science.

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