Original Article

Outcome of Peritoneal Dialysis in Children with Acute Kidney Injury

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ABSTRACT

Objective: To analyze the outcomes of PD in AKI cases among the pediatric population at a public sector tertiary care institute in Karachi, Pakistan.

Study Design: Longitudinal study

Place and Duration of Study: This study was conducted at the National Institute of Child Health, Karachi from May 2021 to March 2022.

Materials and Methods: Acute kidney injury was considered when creatinine clearance was decreased by 50% based on the modified pediatric RIFLE. During the study period, patients were observed for the development of catheter-related complications and mortality.

Results: A total of 160 patients with AKI underwent PD during the study. The mean age of patients was 14 (7 - 48) months and the majority of the patients were males (56.3%) at baseline mean serum creatinine, phosphate, calcium and sodium levels were 5.2 ± 0.23 mg/dL, 5.7 ± 1.9 mg/dL, 7.5±1.8mg/dL and 130±18.5 respectively. The most frequent cause of AKI was sepsis (26.9%). During the hospital stay, 97(60.6%) patients developed complications. The most frequent complication was peritonitis (23.8%) followed by catheter displacement (13.1%), catheter obstruction (10%), bleeding (8.1%), catheter leakage (4.4%), and exit site cellulitis (1.3%). In-hospital mortality was seen in 68(42.5%) patients. Frequency of PCKD (p=0.020), shock sign (p<0.001), febrile patients (p=0.021), sepsis (p=0.002), development of complications (p=0.004), peritonitis (p<0.001) and inotrope support (p<0.001) was significantly different among survivors and non-survivors. Serum creatinine (p=0.021) and phosphate (p=0.016) were significantly raised among non-survivors.

Conclusion: The present study demonstrated that the modality of peritoneal dialysis can be adopted in resource-limited settings. However, a multidisciplinary care model should be adopted for the prevention of complications associated with peritoneal dialysis catheters.

Key Words: Outcome, peritoneal dialysis, children, acute kidney injury, risk factors, complications

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INTRODUCTION

Acute kidney injury (AKI) is a sudden decrease in kidney excretory function which is indicated as a transformable rise in the blood concentration of creatinine and nitrogenous waste products, frequently with reduced urine output and kidney incapability for regulating fluid and electrolyte homeostasis [1].

Nearly 5% of all hospitalized patients and one-third of intensive care admissions develop AKIwhich frequently requires renal replacement therapy (RRT) [2]. Estimates suggest that 6% to 9% of AKI patients in the pediatric group need to undergo dialysis procedures [3].

The mortality rate is unacceptably higher in AKI episodes. It is estimated that 13.8% of pediatric patients with AKI suffer from mortality [4]. Moreover, the mortality rate of children is higher in regions where there is a crucial need for dialysis but not available [5]. Death in AKI episodes is also associated with underlying causes including cardiac issues, multiple organ failures and sepsis which worsen the prognosis but cases of isolated AKI strive for better survival [6]. Further risk factors such as hypotension, the necessity of mechanical ventilation and younger age have been found to be closely linked with poor outcomes regardless of the modality of dialysis [7].

Modalities that are frequently used for RRT include intermittent hemodialysis (IHD), continuous RRT (CRRT) and peritoneal dialysis (PD). There are multiple factors that influence the choice of modalities such as hemodynamic stability, past history of abdominal surgeries, size of the patient, presence of

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peritoneal defects and vascular accessibility [6]. Recently there is a rise in the preference for the utilization of continuous renal replacement therapy (CCRT) over PD for the pediatric population in the majority of the centers in developed countries [8]. However, in developing countries, PD is the choice of treatment owing to the fact of lower-cost burden and ease of initiation and the approach is appropriate for pediatric patients since they have greater peritoneal surface area [9].

Previously available literature reports the successful use of PD for management of AKI among all age ranges including neonates as well following open-heart surgeries, in cases of critical illness with multiple organ failure and successful PD use has been particularly observed in remote and poor infrastructure settings. The associated financial burden is three-five folds less than HD or CRRT due to which it remains the frequent modality for RRT in AKI cases in low-middle-income countries [10]. It is also a beneficial mode of management for newborns and babies with a bodyweight of less than a thousand grams and for infants in whom the achievement of vascular access is a challenging task for purpose of extracorporeal therapy [11].

There are a few limitations of PD such as the requirement of the intact peritoneal cavity and as a consequence, it is not indicated in children with a recent surgical history of abdominal surgery, cellulitis, hernia, paralytic ileus and peritonitis. The associated mechanical complication may be catheter displacement, leakage and obstruction. Some medical and surgical conditions such as bowel or bladder perforation are reported to be rarely occurring but frequently seen with the usage of rigid catheters [12].

Locally data on the appropriate treatment modality in AKI cases are inadequate and further, no modality of treatment has been proven to be superior to the other in AKI situations [9].

MATERIALS AND METHODS

This longitudinal study was conducted at the National Institute of Child Health, Karachi, Pakistan in the Pediatric Nephrology Department and Pediatric Intensive Care Unit from May 2021 to March 2022 after acquiring the ethical approval from the Institutional Review Board of the hospital. Patients of age 1 month to 12 years of any gender, diagnosed as AKI and requiring PD were included in the study following the gaining parental consent in writing. Patients presenting with urolithiasis and chronic ambulatory PD were excluded from the study.

Acute kidney injury was considered after observing a 50% decrease in creatinine clearance based on the modified pediatric RIFLE criteria [13]. A standard hospital protocol was followed for the management of AKI patients and the underlying conditions. Feeding was provided through a nasogastric tube in unconscious patients until they gained consciousness.

PD was performed in the pediatric nephrology department and pediatric intensive care unit through the insertion of a rigid catheter (Amecath) of appropriate size. Aseptic protocols were strictly followed and Infiltrated the abdominal cavity with 10-15 ml/kg of PD fluid to prevent visceral injury. A small incision was given and the catheter was inserted perpendicularly to the abdominal wall under local anesthesia or IV sedation in younger children at an infraumbilical position of 2cm just lateral and below the umbilicus. The stiletto was carefully taken off and the catheter was pushed towards the iliac fossa. A retaining knob is pushed to the abdominal wall. Dry gauze was placed. A fluid level of 5 - 10 mL/Kg was taken for initial cycles to assure smooth fluid drainage without any leakage. Afterward, fluid volume was given an increase of 10-20 mL/kg and 40-50 mL/kg for younger and older children respectively. For minimizing the risk of fluid leakage, a purse-string suture was subcutaneously applied at the entry site of the catheter into the peritoneal cavity. Catheters were immediately exchanged in case of leakage. The time duration of a single cycle was 45-60 minutes. The PD solution which was used, comprised 1.5%.

Peritonitis was considered when the patient had a fever (>100◦F) and abdomen pain as well as vomiting and cloudy purulent effusion along with WBC >100/ul in which neutrophils >50% or positive PD culture. Gut perforation was labeled when there was fecolith present in the PD fluid. Bowel perforation was labeled when there was glucose in urine DR.

The collected data was entered into SPSS version 21 for performing analysis of data. Categorical variables were summarized by means of frequencies and percentages. Numerical variables were first tested for the assumption of normality distribution with the Shapiro-Wilk test. Mean ± standard deviation was reported for Gaussian distributed variables whereas variables following non-Gaussian distribution were summarized as median with interquartile range (IQR). Chi-square or Fisher exact test was to make a comparison for categorical characteristics among survivors and non-survivors. An Independent t-test was applied for comparison of quantitative variables among alive and dead patients whereas the Mann-Whitney U test was applied for comparing non-normally distributed variables among the two groups. A two-tailed p-value ≤ 0.05 was taken as statistically significant.

RESULTS

A total of 160 patients with AKI underwent PD during the study period with a mean age of 14 (7 - 48) months. The majority of the study participants were males (n=90, 56.3%) and belonging to rural areas (n=111, 69.4%). 108 (67.5%), 44 (27.5%) and 8(5%) patients

were hypotensive, normal and hypertensive at baseline respectively. Patients presented with complaint of motion and vomiting (n=68, 42.5%) and dehydration (n=31, 19.4%). Almost all of the children were febrile at the time of presentation (n=152, 95%). Shock sign was present in more than half of the study participants (n=114, 71.3%). At baseline, mean serum creatinine, phosphate, calcium and sodium levels were 5.2 ± 0.23 mg/dL, 5.7 ± 1.9 mg/dL, 7.5±1.8mg/dL and 130±18.5 respectively.

Table No.1: Comparison of patients' socio-demographic and clinical features among survivors and non-survivors

Variables	Survivors	Non-survivors	p-value
Age (in years), median (IQR)	18(7 - 48)	12(5 - 48)	0.363
Hospital stay, median (IQR)	9.5 (7-13)	7(4 - 10)	**<0.001
PD duration, median (IQR)	4(3 - 5)	5(3 - 6)	0.093
Gender, male, n(%)	55(59.8)	35(51.5)	0.295
Motion and vomiting, n(%)	44(64.7)	24(35.3)	0.113
Dehydration, n(%)	16(51.6)	15(48.4)	0.460
Shock sign, n(%)	47(41.2)	67(58.8)	**<0.001
Febrile, n(%)	84(55.3)	68(44.7)	†*0.021
Inotrope support	40(40)	60(60)	**<0.001
Serum creatinine, mean ± SD	5.5±0.9	7.8±1.1	*0.021
Serum phosphate, mean ± SD	4.1±0.85	6.4±1.1	*0.016
Serum calcium, mean ± SD	5.1±2.1	8.2±0.95	0.053
Serum sodium, mean ± SD	133±17.5	128±15.5	0.144
Causes of AKI			
Sepsis, n(%)	16(37.2)	27(62.8)	**0.002
Renal calculi, n(%)	27(69.2)	12(30.8)	0.088
AGE, n(%)	11(73.3)	4(26.7)	0.193
PCKD, n(%)	12(85.7)	2(14.3)	*0.025
Hypoplastic, n(%)	8(66.7)	4(33.3)	0.560
Dysplastic, n(%)	4(40)	6(60)	†0.326
PUV, n(%)	4(40)	6(60)	†0.326
DKA, n(%)	3(60)	2(40)	†1.000
HUS, n(%)	3(75)	1(25)	†0.637
Drug induced, n(%)	2(66.7)	1(33.3)	†1.000
Dengue, n(%)	2(100)	0(0)	†0.508
Diphtheria, n(%)	1(50)	1(50)	†1.000
Complications, n(%)	47(48.5)	50(51.5)	*0.004
Peritonitis, n(%)	11(27.5)	29(72.5)	**<0.001
Catheter displacement, n(%)	12(57.1)	9(42.9)	0.972
Catheter obstruction, n(%)	11(68.8)	5(31.3)	0.337
Bleeding, n(%)	8(61.5)	5(38.5)	0.743
Catheter leakage, n(%)	5(71.4)	2(28.6)	†0.700
Exit site cellulitis, n(%)	0(0)	2(100)	†0.179

AKI: acute kidney injury, AGE: acute gastroenteritis, DKA: diabetic ketoacidosis, HUS: hemolytic uremic syndrome, PCKD: polycystic kidney disease
*Significant at p<0.05, **Significant at p<0.001

100(62.5%) patients were kept on inotrope support during their stay. A median hospital stays and PD duration was 8 (6 - 11) days and 4 (3 - 6) days respectively. Figure 1 presents the etiology of AKI injury. During the hospital stay, 97(60.6%) patients developed complications. The most frequent complication was peritonitis (n=40, 25%) followed by catheter displacement (n=21, 13.1%), catheter obstruction (n=16, 10%), bleeding (n=13, 8.1%) and catheter leakage (n=7, 4.4%).

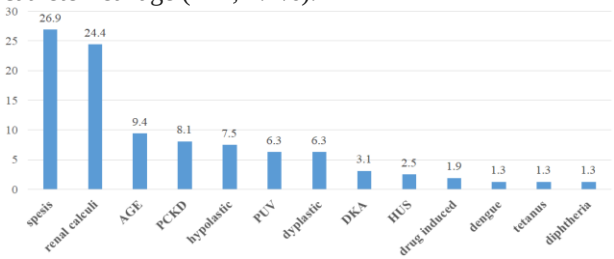

Figure No.1: Frequency of etiology of acute kidney injury

In-hospital mortality was seen in 68(42.5%) patients. Table 1 presents the comparison of patients' socio-demographic and clinical features among survivors and non-survivors. Hospital stay was significantly lower among non-survivors (p<0.001). Frequency of shock sign (p<0.001), febrile patients (p=0.021), sepsis (p=0.002), development of complications (p=0.004), peritonitis (p<0.001) and inotrope support (p<0.001) was significantly higher among non-survivors. Frequency of PCKD was significantly lower among non-survivors (p=0.020). Serum creatinine (p=0.021) and phosphate (p=0.016) was significantly raised among non-survivors.

DISCUSSION

There is evidence that the incidence of AKI is rising. Incidence varies from 30-to 50% particularly among infants and children undergoing cardiac surgical procedures [14]. Even the rate is higher in intubated children and among those on inotropes [15]. Inward settings, children receiving nephrotoxins and aminoglycosides are frequently affected with AKI during their hospital stay [16]. The modality for management should be based on patients' features, available resources, and capabilities [17]. PD usage is not encouraged in the Western world because of progress in CRRT. Gaiao et al [18] revealed in their survey that there was a difference of opinion among nephrologists regarding the usage of PD in developed and developing countries. The utilization of acute PD is restricted to low and middle-income countries primarily due to a lack of skillful technical manpower and fragile infrastructure for CRRT.

In this study median age of the patients was 14 (7 - 48) months. Relatively a higher mean age has been reported in the literature from other countries. Mean age of 45.6 ± 0.8months, 51.3 ± 44.3 months, 48.4 ± 50.4 months and 63.4 ± 6.3 months was reported from Africa [19], India [2] China [20], and Iran [21] respectively. It is quite

alarming to see that age at AKI diagnosis in our settings was quite smaller as compared to the age reported in other countries.

Causes leading to AKI differ based on the geographical settings. Mainly in the developed world, AKI settings shifted from primary glomerular disorders and hospital-acquired with frequent causes of critical illness, malignancy, post transplantation, nephrotoxins, and post-surgeries [22]. Whereas in developing countries causative factors remain sepsis, hemolytic uremic syndrome (HUS), and dehydration [23]. In the present study, the most frequent cause of AKI was sepsis and renal calculi. However, HUS was rare in our study. The findings are consistent with Mishra et al [2] who also reported that septicemia and HUS as the chief causes of AKI in their study. Esezobor et al [19] reported that sepsis was the cause of AKI in their study in more than one-third of the patients (40%). A Chinese study reported that more than half of the patients in their study had AKI due to renal causes (57.5%) and nearly a quarter had post-renal causes (25.7%) whereas prerenal causes were least (15%) [20]. Sepsis as the most frequent cause of AKI was also reported by Aroor et al [24].

Despite of series of advantages such as lesser hospital visits and enhanced preservation of remaining kidney function, PD has some disadvantages too. Patients are exposed to multiple complications because of the existence of prolonged catheters inside the peritoneal cavity and these complications may be of either infectious or non-infectious nature. peritonitis is an infectious complication whereas catheter obstruction, leakage, malfunctioning, scrotal swelling, and ultrafiltration failure are complications non-infectious nature [25]. These complications impact the performance of PD and often require immediate catheter revision. In the present study more than half of the study, participants were seen to acquire complications during their hospital stay with peritonitis being the most frequent complication followed by catheter displacement, catheter obstruction, and bleeding and catheter leakage. Duzalka et al [26] demonstrated catheter dysfunction as the most frequent complication of PD while peritonitis was the second most complication. Coccia et al [27] conducted a study to determine the clinical outcomes in children with AKI secondary to STEC-HUS treated with acute PD and reported that catheter malfunction (24%), peritonitis (19%), fluid leaks (11.5%), bleeding events (6%), and hyperglycemia (2%) were complication seen during the study.

The death rate of children in AKI cases is uneven and assumed to be mainly based on the severity of underlying diseases instead of kidney dysfunction only. Pediatric patients of AKI in whom AKI cause is limited kidney conditions like post-infectious glomerulonephritis reported to have a mortality rate of <1% while the death rate is higher in AKI cases as a consequence of multi-organ failure [28]. The in-hospital mortality rate in our study was 42.5% which is a consistent finding as previously available literature reports mortality rate ranges from 22.2-63.9% in AKI patients managed with PD [29, 30]. In the present study, the rate of mortality was significantly higher among patients developing peritonitis. Further baseline serum creatinine and phosphorous concentration were also significantly higher among expired patients, consistent with the findings reported in available literature [2].

The present study documents the experience of a single-center public sector institution in Karachi. Therefore, it is not wise to generalize these findings to the larger population. It is suggested to conduct a multi-center study to contribute to the literature in terms of generalizable findings from Pakistan with addressing all the shortcomings from clinical aspects of the current study.

CONCLUSION

The present study demonstrated that the modality of peritoneal dialysis can be adopted in resource-limited settings. However, a multidisciplinary care model should be adopted to prevent the complications associated with peritoneal dialysis.

Author's Contribution:

Concept & Design of Study:	Farjam Ahmed Zakai
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Revisiting Critically:	Farjam Ahmed Zakai, Mashal Khan
Final Approval of version:	Farjam Ahmed Zakai

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