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OUTCOME OF CONTINUOUS AMBULATORY PERITONEAL DIALYSIS IN PATIENT WITH ACUTE KIDNEY INJURY

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ABSTRACT

Introduction: Though peritoneal dialysis has several limitations, it is still used in acute kidney injury (AKI) patients as an alternative method of renal replacement therapy (RRT) especially in low socioeconomic countries. **Materials and method:** This prospective observational study included thirty patients diagnosed as AKI fulfilling the indication for initiation of dialysis. Peritoneal access was established through flexible Tenckhoff catheter for continuous ambulatory peritoneal dialysis (CAPD) and 6-8 exchanges were done in 24 hours. **Results:** Among 30 patients in this study mean age was (mean±SD) 49.93±14.42 years, seven (23.33%) patients were hemodynamically unstable. The cause of AKI was drug induced in 6(20.7%), hypovolemia/ATN in 6(20.0%), sepsis in 5(16.7%), heart failure in 2(6.7%) and 11(36.7%) had multiple causes. In initial presentation mean serum creatinine was 683.42 µmol/L, and the number of session required for stabilization of serum creatinine were 7.5±1.43, sessions required for correction of hyperkalemia and metabolic acidosis were 2.15±0.69 and 2.5±0.76 respectively. The delivered Kt/V urea was 1.95±0.14 weekly. Six (20.0%) patients had peritonitis, five (16.7%) had peri catheter leakage. Among 30 patients, three patients (10%) had died, sixteen (59.3%) had recovery of renal function and rest did not recover renal function. **Conclusion:** CAPD was effective for correction of metabolic and electrolyte imbalance leading to adequate and gradual reduction of serum creatinine within an acceptable time limit with favorable outcome and minimal complications.

KEYWORDS: Acute kidney injury, continuous ambulatory peritoneal dialysis, Tenckhoff catheter.

INTRODUCTION

Acute kidney injury (AKI) is a syndrome characterized by a sudden deterioration in renal function (over several hours to several weeks) resulting in failure of kidney to excrete nitrogenous waste product and to maintain fluid and electrolyte homeostasis.[1] AKI requiring renal replacement therapy (commonly designated AKI-D) occurs in approximately 1% to 2% of hospitalized patients and in 6% to 7% of critically ill patients.[2] Severe or life threatening AKI demands a form of renal replacement therapy (RRT) that is initiated or commenced to return the parameters of the body's internal milieu to normal. The mode of RRT preferred should be effective and fast enough to relieve the patient from uremia without hampering the body's renal and cardiovascular physiology.

There is still debate regarding the best dialysis method and dose for AKI.[3] Continuous Renal Replacement Therapy (CRRT) has become the most commonly used dialysis method for AKI around the world, especially in developed countries but its cost make it grossly inappropriate for majority of developing countries. Though intermittent hemodialysis is commonly practiced

in our country it is not suitable for patients who are hemodynamically unstable, having anginal pain, bleeding risk or heparin allergy and heart failure. Each session of dialysis carries the risk for developing hypotension, cardiac arrhythmia, chest pain, muscle cramps, vomiting and Dialysis Disequilibrium Syndrome (DDS). Intermittent Peritoneal Dialysis (IPD) is still used by the resource poor countries because of easy availability, comparatively low cost and easy administration but it allows only intermittent clearance for duration not more than 24-48 hours and uses a narrow lumen rigid catheter with high chance of infection and leakage. Continuous ambulatory peritoneal dialysis (CAPD) has many potential advantages. It is technically simple with minimal infrastructure requirements using a flexible Tenckhoff catheter which overcomes most demerits of IPD catheter and is considered gold standard for peritoneal access. Here solute removal is gradual with less potential risk for disequilibrium syndrome. Since no extracorporeal circulation is required, there is relatively good hemodynamic tolerance, local renal hemodynamics and residual renal function all may be better preserved. As the peritoneal membrane has pores large enough to allow clearance of toxic cytokines in sepsis, it may provide a significant advantage over conventional hemodialysis and hemofiltration. There is also less chance of leakage and incidence of peritonitis has greatly reduced. So interest in using CAPD to manage AKI patients has been increasing.

Continuous peritoneal dialysis and daily hemodialysis are both effective for treating AKI patients and are similar with regard to survival rate, recovery of kidney function and metabolic control.[4] Because solute clearance is lower with peritoneal dialysis than hemodialysis, there has been concern that peritoneal dialysis cannot control uremia in AKI patients.[3] In the last ten years, some studies in literature have reported efficient fluid removal and metabolic control in patients on continuous peritoneal dialysis.[4,5,6] The objective of this study was to assess the effectiveness of CAPD as a form of renal replacement therapy in AKI and to observe the outcome and mechanical complications.

METHODOLOGY

This was a prospective observational study carried out in the Department of Nephrology, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh from January 2015 to September 2016.Patients with clinical and laboratory criteria of AKI (According to AKIN criteria) and had indication for RRT were included in this study. Indications for commencing dialysis were symptomatic uremia, hyperkalemia (serum potassium > 6.5 mmol/l), severe metabolic acidosis (pH <7.15), fluid overload, oliguria (urine output <0.3 ml/kg for 24 hours). Patients unwilling to give consent,age below 18 years, chronic kidney disease (CKD) stage 4 and 5, urinary tract obstruction, pregnancy**,** recent abdominal surgery (<1 month)**,** pre renal AKI, rapidly progressive glomerulonephritis (RPGN) were excluded.

After evaluation by history, physical examination and laboratory investigations, patients who were diagnosed as AKI and had indication of RRT (as mentioned previously) were counseled and selected for CAPD. Peritoneal dialysis (PD) catheter (double-cuffed swan neck coiled tip catheter) were inserted under local anesthesia percutaneously& secured by purse string sutures around the deep cuff. Peritoneal dialysis was started as quickly as possible within 24 hours.

A CAPD session was defined as 24 hours of dialysis. Compositions of dialysate fluid were: Na 132 mEq/L, Ca, 3.5 mEq/L, Cl 96 mEq/L; Mg 0.5 mEq/L, Lactate 40 mEq/L; 1.5% glucose. Initially PD was performed manually by 1000 ml dialysate with 1.5 hourly exchanges then gradually increases the dwell volume to next day 2000 ml 3 hourly exchanges with average 6-8 exchange per 24 hours. All patients stayed in supine position with minimal ambulation during first 3 days. In patients with fluid overload, hypertonic fluid (2.5% or 4.25%) was used. Delivered dose of peritoneal dialysis was determined by formula for Kt/V urea, where K = volume of dialysate drained multiplied by dialysate/plasma concentration, t = duration of dialysis, V = volume of distribution of urea (Total Body Water ~ 0.5 [female] or 0.6 [male] multiplied by body weight.) Blood samples were collected at the beginning of each dialysis session for serum creatinine; serum electrolytes and ABG analysis were done. Dialysate fluid (10 ml) was taken for measurement of urea from each bag. When peritonitis was suspected dialysate fluid was taken and sent for cytology and culture sensitivity.

CAPD was withheld when any of the following situations arose:

- Dialysis was discontinued temporarily for spacing or observation in case of Partial recovery or stabilization of renal function as defined below:
  - Restoration of diuresis (gradually increase to more than 1000 mL urine in 24 hours),
  - A progressive fall in serum creatinine (<353 µmol/L),
- Change of dialysis method (i.e. hemodialysis),
- The death of the patient,
- Absence of recovery of renal functions after 30 days.

When renal function was stabilized, PD was stopped temporarily and the patient was followed up for further recovery (i.e. spontaneous decline in serum creatinine, gradually increasing urine output). Patients with no recovery of renal function were kept on dialysis and with stabilized renal function were followed up for at least two weeks before removal of Tenckhoff catheter. At the time of discharge they were advised to come for follow-up at the end of 1st, 2nd and 3rd month and at each visit they were assessed for recovery of renal function. And

then the patients were labeled as renal recovery or no recovery.

Data collection, processing and analysis

The result was presented as mean±SD or median, according to normality characteristics of each variable with 5% ($p<0.05$) significance level. To compare parametric variables paired t-test was used. Data was analyzed using Statistical Package for Social Science (SPSS) v 22.0 (Chicago, IL) software.

RESULTS

Table I: Baseline characteristics of the AKI patients at the time of enrollment (n=30).

Variables	Values
Age (years)	49.93±14.42
Male sex	20/30 (66.7%)
Weight (kg)	62.4±4.61
Blood pressure (mmHg):	
SBP Mean±SD	112.0±22.7
DBP Mean±SD	64.8±12.1
Hemodynamically unstable	7/30(23.3%)
At onset of dialysis: Serum creatinine (µmol/L)	683.4±68.4
Mean Urine output (ml)	383.6 ml
Etiology of AKI:	
Drug induced	6/30 (20.0%)
Hypovolemia	6/30(20.0%)
Sepsis	5/30(16.67%)
Heart failure	2/30(6.7%)
Mixed/multiple	11/30(36.7%)
Co-morbid conditions:	
DM	11/30(36.7%)
HTN	9/30(30.0%)
CKD	9/30(30%)
IHD	9/30(30.0%)
CVD	3/30(10.0%)
Indication for the initiation of dialysis:	
Symptomatic uremia	26 (86.7%)
Hyperkalemia	13 (43.3%)
Fluid overload	7 (23.3%)
Oliguria	14 (46.7%)
Severe metabolic acidosis	8 (26.7%)

Results were expressed as mean±SD and number (percentage) as applicable.

Table I shows the basic characteristic of the patients at the time of enrolment. Mean age of the patients was 49.93 years. Male was 66.7% and female 33.3%. Weight was 62.4±4.61 kg (mean±SD). Mean SBP was 112.0 mm Hg and DBP 64.8 mm Hg. Seven patients were hemodynamically unstable. Mean urine volume was 383.6 ml in 24 hours. The cause of AKI was drug induced in 6(20.0%) patients, hypovolemia/ATN in 6(20.0%) patients, sepsis in 5(16.67%) patients, heart failure in 2(6.7%) patients and 11(36.7%) had multiple causes. The co-morbidities were as follows: 11(36.7%) patients had DM, 9(30%) HTN, 9(30%) CKD, 9(30%) IHD and 3(10%) patients had CVD. Majority of the patients had uremic symptoms 26(86.7%), followed by in descending order oliguria 14(46.7%), hyperkalemia (>6.5 mmol/L) 13(43.3%), fluid overload 7(23.3%) and metabolic acidosis 8(26.7%) cases.

Table II: Serum creatinine, potassium and bicarbonate at the beginning and after each session of continuous ambulatory peritoneal dialysis (n=30).

Variables	Sessions										P value	Data were analyzed by Paired t-test, p value <0.05 was taken as significant
	0 (n=30)	1 (n=30)	2 (n=30)	3 (n=30)	4 (n=30)	5 (n=30)	6 (n=30)	7 (n=30)	8 (n=30)	9 (n=30)	10 (n=30)	
S.Creatinine (µmol/L)	683.4	664.2	641.6	609.9	562.4	514.8	483.5	443.9	405.2	375.4	342.6	**<0.001**
S.Bicarbonate (mmol/L)	17.4	19.7	21.1	21.1	22.2	22.5	23.4	24.5	24.8	25.7	24.5	**<0.001**
S.Potassium (mmol/L)	5.7	4.9	4.7	4.7	4-4	4.3	4.4	4.2	4.4	4.3	4.2	**<0.001**
Ultrafiltration (ml/24hrs)	-	1109.3	1432.5	1432.5	1478.2	1396.7	1457.4	1423.5	1340	1285.7	1316.4	-

Table II: shows each post CAPD session serum creatinine, bicarbonate and potassium. First (pre dialysis) values were significantly different compared to post dialysis values (after last session of CAPD) for each patient.

Table III: Outcome of CAPD in AKI patients treated with CAPD.

Session required for correction	**S. Creatinine**	**7.5 ± 1.43**
	S. Urea	7.3 ± 1.12
	S. Potassium	2.15 ± 0.69
	Severe metabolic acidosis	2.50 ± 0.76
Complications	Peritonitis	6/30 (20%)
	Pericatheter leakage	5/30(16.7%)
Outcome	No recovery of renal function	11/27 (40.7%)
	Recovery of renal function	16/27 (59.3%)
Death	3/30 (10%)	
Weekly Kt/V urea	1.95 ± 0.14	

Table III shows number of CAPD session required to reduce serum creatinine, urea, potassium and severe.

Table IV: Follow up of AKI patient treated with CAPD.

Time	**S. Creatinine µmol/L**	
	Recovery	**No recovery**
At the end of 4 week	282.4	632.3
At the end of 8 week	260.7	686.6
At the end of 12 week	230.6	672.8

Table IV reveals recovery of the renal function estimated by serum creatinine level at the end of 4, 8 and 12 weeks.

DISCUSSION

This prospective observational study was carried out in Department of Nephrology; BSMMU with an aim to observe the outcome of CAPD in AKI. In all study patients peritoneal access was established through flexible Tenckhoff catheter for CAPD. Thirty four patients fulfilling the indication for initiation of dialysis were enrolled in the study. Four patients were excluded from due to death of two patients within 24 hours after initiation of dialysis and two patients developed catheter related mechanical problem (poor outflow). Finally 30 patients remained for evaluation. To assess the outcome, total number of CAPD sessions required for initial stabilization of serum creatinine and normalization of serum potassium, serum bicarbonate and pH were observed. At the same time complications related to CAPD, extent of renal function recovery and survival rate was also observed at the end of 3rd month.

In this study, patients required 6 to 10 sessions of CAPD for stabilization of serum creatinine and with the average number of sessions required being 7.5±1.43 (mean±SD). Gabriel et al,[4] conducted a prospective study on 30 AKI patients who underwent continuous peritoneal dialysis. In their study serum creatinine became stabilized after 4 sessions. Similar outcomes were observed in studies conducted by Daniel Ponce et al.[7] Phuet al,[8] and Bazari,[9] reported that acedemia could not controlled by IPD because if diaphragm mobilization was impaired by PD and causing increase intra-abdominal pressure and pulmonary ventilation and compliance. In our study, sessions required for correction of hyperkalemia & metabolic acidosis were 2.1±0.69 and 2.5±0.76 (mean±SD). A prospective study on 204 AKI patients who received continuous peritoneal dialysis conducted by Ponce et al.[7] where exchanges were given by a cycler. In their study, serum potassium was normalized after one session, pH and bicarbonate after the second session. Similar outcomes were observed in studies of Gabriel et al.[6] In this study comparatively more sessions were required for achieving targeted serum creatinine, serum potassium and pH. The reason might be due to relatively less volume of fluid used and automated cyclers being unavailable in our country. Other studies described earlier used automated cycler with more volume of fluid and more exchanges.

Chitaliaet al.[5] compared two modalities for treating AKI in moderately catabolic patients in a crossover study. Patients either received manual PD or automated tidal PD. Manual PD achieved a weekly Kt/V urea of 1.8 and tidal PD a weekly Kt/V urea of 2.43 and 86 of the 87 patients recovered renal function. The ISPD guidelines, peritoneal dialysis for acute kidney injury 2014, recommended that a weekly Kt/V urea of 2.1 may be acceptable. Chionh et al.[10] done a study and detailed review suggested that by inference from data from extracorporeal blood therapies, a targeted dose of a weekly Kt/V urea of 2.1 with peritoneal dialysis may represent a reasonable dose to guide and help plan appropriate therapy. In our study the delivered weekly Kt/V urea was 1.95±0.14 (mean±SD).

Infection occurred in 6(20.0%) patients in the form of peritonitis and the organisms were *Pseudomonas auriginosa*, *Eecherischia coli* and *Staphylococcus aureus*. There was no exit site or tunnel infection. In the study of Gabriel et al.[4] 12% patients had peritonitis. Chitaliaet al.[5] showed peritonitis to occur in up to 12% of cases and frequently developed within first 48 hours of therapy. Similar results were observed by Ponce et al.[7] and Phu et al.[11] During this study pericatheter leakage occurred in 5(16.7%) patients. Ponce et al.[7] studied 204 patients on acute PD and found a mechanical complication rate of 7.3%.

Among thirty patients, fourteen recovered renal function and fifteen had to continue CAPD during discharge and one expired. The patients who continued dialysis after discharge, two recovered renal function later and two died. The outcome at the end of study period 10% died,

59.3% had recovered renal function and rest did not recovered.

A work by Gabriel et al.[4] including over 30 patients who underwent CAPD observed that 23% recovered, 13% remained on dialysis and 57% died. A study by Ponce et al,[7] on 150 AKI patients who had undergone CAPD showed that 57.3% died, 23% recovered renal function and 6.6% remain on dialysis on hospital discharge. Compared to this study mortality rate was lower in our study. This may be due to fact that among the patients they had included in their study, 65% were hemodynamically unstable, majority (54%) of their patients had sepsis and 77% were on mechanical ventilation, but in our study only 10% patients had sepsis, 23.3% had low blood pressure and none of them were on mechanical ventilation. As this was a single center study in a short period of time, all the results were not consistent with similar studies. Considering the limitations of this study, it may be recommended that further large scale multi center randomized controlled trials of larger duration including comparison of continuous ambulatory peritoneal dialysis with different other modalities of renal replacement therapy may be done in AKI patients.

CONCLUSION

Continuous ambulatory peritoneal dialysis was effective in correction of metabolic and electrolyte imbalance resulting in adequate and gradual reduction of serum creatinine and urea within an acceptable time span with favorable outcome and minimal complications. Thus it can be used as an alternative to other form of RRT in AKI.

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