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Role of Acute Peritoneal Dialysis in AKI Patients: A Retrospective Analysis

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Abstract

Background: Despite being a simplified and universally available intervention, acute peritoneal dialysis (PD) procedure is underutilized in treatment of acute kidney injury (AKI) patients. At places where facilities of hemodialysis are limited or not available; PD may provide a useful and equally effective alternative renal replacement therapy. ***Methods:*** A retrospective analysis of all acute PD sessions performed by the authors during last 11 years was done. Demographic profile of patients, various complications reported, and patient outcome was studied. ***Results:*** During study period, a total of 3042 Acute PD sessions were performed in 2629 patients. The mean numbers of PD cycles were 39.2±15.1 (range; 12- 48 cycles) with total PD fluid volume of 79.2±14.8 (range; 24-111 litre) used per session. Poor outflow was the most common complication observed (n-318, 10.4%), while peritonitis was observed in 268 (8.8%) cases. Serious complications of organ perforation by PD catheter were observed in only 04 (0.13%) cases. Mean Urea reduction ratio were 46.2% and 60.8%, at 24 hours and at end of sessions, respectively. ***Conclusion:*** Acute PD is an efficient and cost-effective renal replacement modality in AKI patients with acceptable complication rates. In resource poor settings, it provides a viable alternative to hemodialysis.

Keywords: ***Acute kidney injury, Hemodialysis, Peritoneal dialysis, Peritonitis, Developing country.***

Introduction

The incidence of acute kidney injury (AKI) has increased over the past few decades, and constitutes an important cause of hospital admissions, and mortality [1]. In developed world AKI is mostly hospital acquired entity, while in developing countries AKI is mainly caused by community-acquired diseases [2,3]. Acute kidney injury (AKI) is also ominous complication noted in critically ill patients, admitted at Intensive Care Units. The reported incidence of AKI in ICUs varies from 30 to 70% [4-6]. Occurrence of AKI in these patients is associated with increased morbidity and mortality [4]. Peritoneal dialysis (PD) was the first renal replacement modality used for AKI patients [7]. Till 90s, Acute PD was most common, and most of times only renal replacement modality available for AKI patients, but wide-spread availability of hemodialysis gradually replaced acute PD in treatment of AKI, especially in developed world [8,9]. However, hemodialysis is expensive and technically challenging in resource-limited settings. In majority of ICUs in developing countries provision of bedside Hemodialysis is not available, and patients have to be transported to dialysis units for hemodialysis. Shifting of such critically ill patients who are on mechanical ventilators, or are on inotropic support is risky since these patients may become hemo-dynamically unstable during transportation. Acute PD is still frequently used in developing countries because of its simplicity, lower cost and minimal need for infrastructure [10]. In this study, we report our experience of acute PD session performed during last 11 years.

Methods

It was a retrospective cross-sectional study. All acute PD sessions performed by authors during study period of September 2013 till October 2024, were analyzed.

Inclusion criteria: All adult patients (age >18 yrs) with severe AKI, who underwent Acute PD during study period.

Exclusion criteria: All Pediatric cases, Cases of chronic kidney disease.

Definition of AKI: Acute kidney injury was defined according to acute kidney injury network (AKIN) criteria [11]. Occurrence of AKI was considered when serum creatinine increased by more than 0.3 mg/dL from baseline value, within last 48 hours, or when urine output was less than 0.5 mL/kg per hour for more than 6 continuous hours. Indications of dialysis included uremic encephalopathy, uremia, refractory hyperkalemia and other electrolyte imbalance, refractory metabolic acidosis, and oligo-anuria with life-threatening fluid over load [12].

Peritoneal Dialysis Procedure: Semi-rigid acute PD Catheter made of PVC was inserted bedside under local anaesthesia, after creation of artificial ascites. Maintaining strict aseptic conditions, the catheter was placed per-cutaneously with the help of a trocar, and connected to the PD set with bags containing PD fluid. After insertion of PD catheter, dialysis exchanges were started immediately. The dwell-exchange duration was 01 hour. For average built adults, 2 L of 1.5% dextrose PD solution was prescribed, while in larger built patients 2.5 L dwell volume was prescribed. Extra 25% Dextrose was added to make final concentration of 4.25%, whenever rapid ultra filtration was needed.

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Heparin (1000 units per exchange) was added to maintain catheter patency. To prevent hypokalemia, injection potassium chloride (4 mmol/L) was added to the PD fluid after the 6-8th cycle. Blood urea and serum creatinine were measured a beginning of session, at 24 hours, and after completion of session, to assess clearance. Acute peritonitis was suspected whenever there was cloudy outflow or signs and symptoms of peritonitis were present [13]. Each suspected case of peritonitis was confirmed by fluid culture. The maximum duration of each session was 48 hours, after which, the PD catheter was removed. A new catheter was inserted after a minimum gap of 48 hours from previous session, if patient needed further dialysis.

Results

During study period, 3042 sessions of acute PD were performed in 2619 adult AKI patients. The baseline clinical and biochemical parameters are shown in table 1. Male predominance (57.2%) was observed in study population, while mean age of study population was 42.9±11.2 years with wide range of 18 to 91 years. Infections (with- or without septic shock) were the leading cause of AKI (35.4%), while hypovolemia (19.2%), and malaria (14.5%) were other important causes of AKI. Similar etiology of community acquired AKI are reported from other studies from developing world[1,14-16].

Hypertension (34.1%) and diabetes mellitus (29.5%) were the most common co-morbidities, observed in study population. A large proportion of study patients were critically ill, as evident by need for inotropic support (23.4%), and use of mechanical ventilation (17.5% cases). Transportation of such critically ill patients to dialysis units is a daunting task, hence acute PD could be useful renal replacement therapy (RRT) in such scenario. The mean numbers of PD cycles were 39.2±15.1 (range; 12- 48 cycles) with total PD fluid volume of 79.2±14.8 (range; 24-111 litre) used per session.

Table 2 summarizes the various complications encountered during acute PD procedure in study population. Poor Outflow mainly due to catheter malposition and fibrin clot deposition, was the most common complication (n=318, 10.4%) noted in present study. In 79 cases the catheter had to be removed, while in rest of the patients it was successfully managed with catheter repositioning. These patients with PD failure were then shifted to hemodialysis. Hemorrhagic outflow (n=299, 9.8%) was mild and spontaneously cleared in few sessions, in none of the case it caused PD failure. Acute peritonitis developed in 268 (8.8%) sessions during course of acute PD. It was managed with intraperitoneal ceftriaxone (1 gram/exchange) and acute PD session was continued to its desired duration. However in 31 cases, the clinical condition worsened leading to premature termination of PD cycles. Peri-catheter leak was observed in 102 (3.3%) cases, it was successfully managed with temporary stoppage of PD for few hours and tight purse string suturing around the catheter. Serious complications in the form of bowel or bladder perforation were observed in only 04 (0.13%) patients. In all these patients the PD process was stopped, catheter was removed and patients were shifted to hemodialysis. We were able to salvage all these 04 cases with broadspectrum i.v. antibiotics.

Mean blood urea levels were 229.3±72.1 mg/dl at baseline. While it declined to 123.3±49.2, and 89.8±31.3 mg/dl after 24 hours and at end of session; thus, denoting a urea reduction ratio of 46.2% at 24 hours, and 60.8% at end of therapy, respectively. Thus, the clearance achieved in present study was adequate, and was in concordance with available literature [9,17,18]. Baseline mean serum creatinine levels were 8.3±2.9 mg/dl, while levels declined to 5.9±1.9 mg/dl (29 % fall) and 4.6±2.2 mg /dl (44.6 % fall) after 24 hours, and at end of session, respectively. The clearance was not extrapolated in terms of Kt/V since V couldn't be estimated due to lack of body weight data in most of the cases. Mortality rate of 31.4 % (n=822) was observed in present study, results are comparable to studies around the world [1,3].

Table 1: Baseline demographic and laboratory characteristics of the patients (n=2619).

Variable	N (%) or Mean (range)
Male	1498 (57.2%)
Female	1121(42.8%)
Age (years)	42.9±11.2 (18-91)
Cause of AKI (N)	
Sepsis	928 (35.4%)
Hypovolemia/blood loss	503 (19.2%)
Malarial AKI	377(14.5%)
Obstructive uropathy	306 (11.7%)
Acute glomerulonephritis	176 (6.7%)
Myeloma AKI	119 (4.5%)
Drug induced	108 (4.1%)
Snake bite	102 (3.9%)
Co-morbidity (n)	
Hypertension	893 (34.1%)
Diabetes	772 (29.5%)
Use of inotropic support	612 (23.4%)
Use of Mechanical ventilator	459 (17.5%)
Cerebro-vascular accidents (CVA)	249 (9.5%)
Malignancy	202 (7.7%)
Hemoglobin (mg/dl)	9.1±4.3 (5.7-16.9)
Blood urea (mg/dl)	229.3±72.1 (102-397)
Serum creatinine (mg/dl)	8.3±2.9 (3.5-22.4)
Serum sodium (meq/L)	131.8±8.9 (109-161)
Serum potassium (meq/L)	4.6±1.6 (2.2-9.1)
Serum bicarbonate level (meq/L)	14.6±7.2 (3.2-28.3)
Serum Calcium (meq/L)	8.5±2.1 (5.2-15.8)
No of PD cycles*	39.2±15.1 (12- 48)
Total dialysate volumes (L)*	79.2±14.8 (24-111)

* n= 3042 (total no of PD sessions performed).

Table 2: Distribution of complications of Peritoneal dialysis procedure in study population (n=3042 sessions)

Variable	Number (percentage)
Poor outflow	318 (10.4%)
Hemorrhagic outflow	299 (9.8%)
Peritonitis	268 (8.8%)
Peri-catheter leak	102 (3.3%)
Bowel perforation	03 (0.1 %)
Bladder perforation	01 (0.03%)

Discussion

Acute kidney injury is relatively common occurrence, affecting approximately 5 to 8% of all hospitalized patients, while a higher prevalence of 30-70% is observed in patients in ICUs [1,4,6]. Clinical spectrum of AKI differs in developed and developing countries. In developed world, AKI is usually seen in elderly patients with multiple co-morbid conditions, and is part of multi-organ dysfunction with high mortality rate. In contrast, AKI in developing countries is mainly community acquired, and diarrhea, infections, insect bites, and pregnancy related problems being important causes in these cases [1,5,19,20].

Peritoneal dialysis was the first successful renal replacement modality for patients with AKI. Till 90s, acute PD was widely accepted for AKI treatment in India, but its practice progressively declined in favor of Hemodialysis [21,22]. Concern regarding inability to provide adequate clearance in hyper catabolic AKI cases further dampened its use in management of AKI [23,24]. Currently, PD is underutilized for management of AKI, both in India and around the world [22]. However, hemodialysis is expensive, technically

challenging, and not readily available in resource-limited settings. Moreover, PD itself has certain advantages. Being technically simple procedure, it does not require highly trained staff or a complex apparatus, and can be easily initiated. It is much cheaper in comparison to hemodialysis set-up, which is quite useful in developing countries. Unlike extracorporeal renal replacement therapies like intermittent hemodialysis or continuous renal replacement therapy (CRRT), PD precludes the need for vascular access and subsequent risks of catheter related blood stream infection (CRBSI) and venous thrombosis [9,10]. PD procedure doesn't require systemic anticoagulation, thus mitigating bleeding risk in critically ill patients. Additionally, PD may be preferable in critically ill patients with hypercoagulable states in whom the extracorporeal renal replacement therapies might be interrupted due to repeated circuit clotting [18]. Peritoneal dialysis can be used both as continuous or intermittent therapy and, due to slow rate of fluid and solute removal; it is suitable in hemodynamic unstable critically ill patients [25]. Fortunately, interest in PD in management of AKI patients has revived in recent years [26].

Recent randomized controlled trials have compared outcome of AKI patient randomized to either PD or extra-corporeal therapy (intermittent hemodialysis or CRRT). Expectedly, the delivered dialysis dose was lower in the PD group in comparison to HD. However the primary outcome parameters like the median ICU stay, recovery of kidney function, and mortality were similar in both groups, thus confirming non-inferiority of PD to blood based dialysis modalities [27-29].

The International Society for Peritoneal Dialysis has published updated guidelines for PD treatment for AKI, affirming PD as an acceptable form of RRT in patients with AKI in all settings [30]. These advantages of PD should be weighed against certain limitations; such as risk of peritonitis, occurrence of obligatory protein loss, need for an intact peritoneal cavity and overall lower effectiveness. Because the daily clearances of solutes are lower with PD than with daily hemodialysis, there has been concern that PD cannot control the uremia seen in acutely ill hyper catabolic AKI patients. However, many small size studies have reported adequate clearance and comparable outcome in critically ill AKI patient with use of PD [18,31]. Due to scarcity of data, there is a pressing need to re-evaluate the role of PD in AKI cases.

This study aimed to measure clearance and safety outcome of acute PD sessions performed by us during last 11 years. We used commercially available PD solutions and disposable catheters under aseptic conditions with standardized monitoring of vital functions and biochemical parameters. Technique success rate was excellent and, in all patients, acute PD could be initiated easily, while only 79 cases (2.6%) had to be shifted to HD due to catheter being non-functional. In accordance to literature, our study reiterate the fact that acute PD can be initiated anywhere with minimal infrastructure and negligible training. Thus, it could be very useful and lifesaving modality in poor countries, where modern medical facilities are almost non-existent [22,32-34]. Complication profile was also very favorable in our study. The most common complications noted, was poor outflow of peritoneal dialysate (n-318; 10.4%) due to catheter mal-position and fibrin clot deposition, which was easily fixed by re-positioning of the catheter. The commercially available semi-rigid acute PD catheter doesn't has any securing mechanism, hence it easily rotate when patient body position is changed. Our experience suggests that this problem may be mitigated by slight change in catheter design, with provision of side-hinges which may be sutured to skin.

Mechanical and infectious PD complications are major obstacles in providing adequate clearance in AKI patients. The incidence of early peritonitis following PD initiation for AKI treatment has ranged between 12% to 15% [22,32,33]. The risk factors for peritonitis in acute PD include use of rigid catheters, manual exchanges, higher dextrose concentration of PD solutions, and longer duration of PD sessions [26]. Moreover, the classical signs of peritonitis might be masked in critically ill patients, thus delaying diagnosis [30]. The rate of peritonitis was much lower (n-268; 8.8%) in comparison to reported literature [22,26,32]. Due to short duration of PD session (<48 hours), it was successfully managed in all but 31 cases, with use of antibiotics. In contrary, the available literature suggests less success rate in treatment of acute peritonitis in acute PD [32,33]. But these studies used single cuff silicon catheter and duration of acute PD was much longer (7 to 10 days).

The peri-catheter leak is of particular concern in acute PD. Unlike elective PD initiation where 2 weeks of healing time is allowed, the PD catheter is typically used immediately post insertion in acute-PD, resulting in higher risks of peri-catheter leaks [26]. Leak risks can result from patient factors (i.e., diabetes, obesity chronic steroid use) and modified by PD catheter insertion technique [34]. Lower initial dwell volumes (20 ml/kg) and performing PD in supine position may decrease the risks of peri-catheter leaks, due to reduced intra- abdominal pressure [34]. The incidence of peri-catheter leakage was minimal in our study (n-102; 3.3%) in comparison to reported rates of 10-12% [22,35]. This was another advantage of use of semi rigid catheter since its insertion causes minimal trauma. Serious complications like bowel or bladder perforation were noted 04 cases, all of which were successfully managed and patients survived. So, the present study reports favorable safety profile of acute PD in AKI cases. With respect to the efficacy of PD in our study, both blood urea and serum creatinine values decreased significantly at 24 hours and at end of session, indicating efficient purification. Urea reduction ratio of 60.8% was observed with single PD session, which is comparable to conventional hemodialysis session [36].

This study has certain limitations. First, Because of its retrospective design, the selection bias can't be eliminated. It is plausible to conclude that PD was preferred over hemodialysis in those patients who were sicker and hence couldn't be shifted to dialysis unit. This bias could affect the urea reduction ratio and mortality rate in present study. Second, Clearance rate in terms of Kt/V couldn't be estimated in present study due to unavailability of weight parameter in most of the PD prescription charts.

Conclusion

In conclusion, this study suggests that acute PD can be successfully done in patients with AKI. The adequacy achieved with single session of PD is comparable to Hemodialysis. With proper training of staff, the risk of peritonitis may be reduced significantly. Due to simplicity of procedure, and cost effectiveness, use of acute PD should be encouraged in critically ill AKI patients.

Abbreviations

AKI: Acute kidney injury
CRRT: Contentious renal replacement therapy
HD: Hemodialysis
i.v.: Intravenous
ICU: Intensive care unit
PD: Peritoneal dialysis
PVC: Poly-vinyl chloride
RRT: renal replacement therapy
V: Volume

Declarations

Ethics approval and consent to participate

Written informed consent was not needed due to retrospective nature of study involving data analysis only, from four institutes where author worked during last 11 years. Ethics committee approval was not required.

Consent for publication

I on behalf of all co-authors, hereby give my consent for publication of the manuscript in your esteemed journal.

Availability of supportive data

If needed, we give consent to provide supplementary Data.

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Conflict of interest

None

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None

Author's contributions

Author 1 was clinical incharge of all cases, and was responsible for diagnosis and clinical management of the cases.
Both authors contributed in data collection, literature search, preparation of manuscript, and editing of the final version of manuscript.

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