Clinical Research

Five-year experience of continuous ambulatory peritoneal dialysis in children: a single center experience in a developing country

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ABSTRACT

BACKGROUND The pediatric peritoneal dialysis (PD) program in Cipto Mangunkusumo Hospital, Indonesia was started in 2014. However, there has been no published data on the patients' outcome. This study was aimed to report the characteristics and outcomes of a continuous ambulatory peritoneal dialysis (CAPD) program for children.

METHODS This retrospective study was conducted in Cipto Mangunkusumo Hospital as a national referral hospital. Data were collected from medical records of patients aged ≤18 years with end-stage renal disease who underwent CAPD in 2014–2019. The baseline characteristics, PD-related infection rate, as well as patient and technique survivals were analyzed.

RESULTS Out of 60 patients who underwent CAPD, 36 (60%) were boys on the age range of 4 months–18 years. The mean follow-up duration was 12 (95% confidence interval [CI] = 9.4–15.3) months. The number of PD-related infections increased along with the growing number of patients on CAPD. The peritonitis rate was 0.42 episodes per year at risk, and the most common etiology was alpha-hemolytic *Streptococcus* (5/24, [20.8%]). The 1- and 3-year technique survival rates were 60.3% (95% CI = 44.5–72.9) and 43.9% (95% CI = 23.2–62.9). The 1- and 3-year patient survival rates were 69.6% (95% CI = 52.5–81.5) and 58% (95% CI = 31.2–77.5).

CONCLUSIONS In this unit, CAPD could be performed in children as young as 4 months of age. The peritonitis rate was relatively low which was likely caused by skin-derived microorganisms. Both technique survival and patient survival were also relatively low.

KEYWORDS child, chronic kidney disease, continuous ambulatory peritoneal dialysis, peritonitis, survival

Peritoneal dialysis (PD) could be the primary choice of dialysis for children who live in a developing country like Indonesia. Apart from the fact that PD is more tolerable in infants and young children, PD is more cost-effective compared to hemodialysis (HD).[1,2] In Indonesia, the annual costs of HD per patient may reach 12,000 USD, while the cost of PD is approximately 6,000 USD. Moreover, PD has more simple requirements in terms of medical personnel and facilities compared to HD.[3] Therefore, the implementation of PD in developing countries can minimize the gap between demand and supply of renal replacement therapy (RRT) for children with end-stage renal disease (ESRD).

At Cipto Mangunkusumo Hospital, the first pediatric continuous ambulatory peritoneal dialysis (CAPD) program was performed in 2014 with a team consisting of 5 pediatric nephrologists and 7 dialysis nurses. Neither the PD-first policy nor PD-preferred policy has been adopted in Indonesia. Since CAPD program was initiated, there has been no report on the outcome of pediatric patients undergoing CAPD.

This study was aimed to describe the pediatric CAPD program in Cipto Mangunkusumo Hospital and to report the first five-year outcomes of the program.

METHODS

In this retrospective study, the inclusion criteria were all children aged ≤18 years with ESRD who underwent CAPD at Cipto Mangunkusumo Hospital from July 2014 to June 2019. The patients with CAPD who were not catheterized at the Cipto Mangunkusumo Hospital or was seen for CAPD follow-up in other centers were excluded, to avoid variety of microbiological pattern between different centers.

CAPD program was led by a pediatric nephrologist whose tasks were covering, monitoring, and administrating the PD unit. HD and PD were performed simultaneously at the pediatric dialysis unit. There was no special facility for PD training and exchange area. None of the 7 nurses who performed PD and HD simultaneously had any specialized training or duty for PD. No protocol had been developed for PD prescription and complication management. No program had been issued on continuous quality improvement with key performance indicator monitoring. No distinct curriculum had been established on the pre-dialysis educational program, formal PD training program, or patient retraining program. Home visits were not conducted.

The clinical data were obtained from the patients' medical records. The collected data included age, gender, primary disease, break-in period, blood test and peritoneal culture results, surgical procedure, preoperative antibiotic prophylaxis, infectious and non-infectious complications, and outcomes. The break-in period was the time between catheter insertion and PD initiation. The first period of follow-up comprised the time when PD fluid was infused into the peritoneal cavity and left to dwell within the abdomen for four to five hours per cycle. Patients were then followed-up every month until the end of the study, administrative censoring (permanently switched to HD, loss-to-follow-up, and withdrawal of treatment) or death. This study was conducted according to the principles of the declaration of Helsinki, and in accordance with the Medical Research Involving Human Subject Acts (WMO). This study was approved by the Ethical Committee of the Faculty of Medicine, Universitas Indonesia (No: 247/UN2.F1/ETIK/2019), and the consent was waived due to the nature of the retrospective study.

This study was designed to evaluate the growth of CAPD overtime; PD-related infection rates such as peritonitis, exit-site infection, and tunnel infection; the incidence of culture-negative peritonitis; as well as patient and technique survivals. Peritonitis was diagnosed when there were at least two of the following criteria: (1) The clinical symptoms were consistent with peritonitis, such as abdominal pain and/or cloudy dialysis effluent; (2) dialysis effluent white cell count of >0.1 × 10^9/l after a dwell time of at least two hours with >50% polymorphonuclear neutrophils; (3) a positive effluent culture of dialysis fluid.[4] Exit-site infection was defined as the presence of purulent discharge with or without skin erythema on the catheter-epidermal interface. Tunnel infection was considered when there was any inflammation feature along the catheter tunnel.[5] The time-to-first peritonitis was defined as a duration between PD initiation and the first episode of peritonitis.

Statistical analysis was performed using SPSS software, version 24 (IBM Corp, USA) and GraphPad Prism 8.0.1 (GraphPad Software, USA). Continuous variables were compared using *t*-test. Categorical data between groups were compared using chi-square test or Fisher's exact test if the assumption for chi-square was not met. Patients and technique survivals were analyzed using Kaplan-Meier methods. Technique survival was reported using 180-day as well as death-censored definitions.[6] In the technique survival analysis non-censored for death, technique failure was defined as a composite of death or transfer to hemodialysis for at least 180 days. Patients discontinuing PD for reasons other than technique failure (e.g. transfer to adult dialysis unit, return of renal function, and loss to follow-up) were censored. For the report of death-censored technique survival alone, death was also censored. A *p*-value of <0.05 was considered significant.

RESULTS

With the increasing number of CAPD patients with the highest growth in 2017, there was an increase in the number of CAPD drop-out cases (Figure 1). There were 60 patients aged 4 months to 18 years old who underwent CAPD at the Cipto Mangunkusumo Hospital in 2014–2019 (Table 1). The mean duration

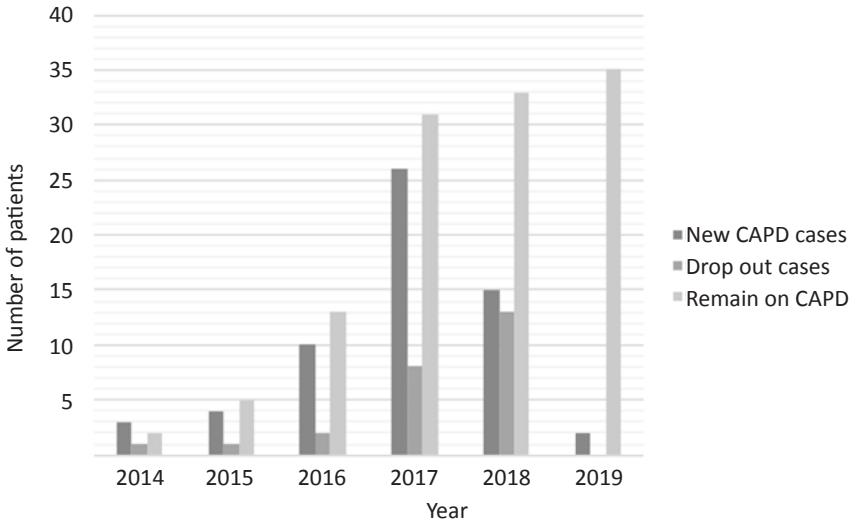

Figure 1. Trends in rates of PD cases over time. Drop-out cases are patients who had PD discontinued due to permanently switched to hemodialysis, loss-to-follow-up, or death. This data were obtained until 31st January 2019. PD=peritoneal dialysis; CAPD=continuous ambulatory peritoneal dialysis

Table 1. Patients' characteristics

Characteristics	n (%) (N = 60)
Age (years), mean (SD)	11.9 (3.8)
Male sex	36 (60.0)
Primary disease	
Cystic/hereditary/congenital	31 (51.7)
Glomerulonephritis	9 (15.0)
Interstitial nephritis	20 (33.3)
Break-in period (days), mean (range)	16 (12–20)
PD after HD	58 (96.7)
Omentectomy	16 (26.7)
Catheter orientation	
Lateral	49 (81.7)
Downward	11 (18.3)
Infectious complication (episodes per year)	
Peritonitis rate	0.42
Exit-site infection rate	0.27
Tunnel infection rate	0.05
Non-infectious complication (n = 26)	
Fluid overload	12 (46.1)
Hydrocele	6 (23.1)
Omental wrapping	4 (15.4)
Pleuroperitoneal fistula	2 (7.7)
Malposition	1 (3.8)
Umbilical hernia	1 (3.8)
Patients conditions at the end of follow-up	
Remain on PD	36 (58.3)
Death	13 (21.6)
Permanently switch to HD	6 (10.0)
Normalized kidney function	2 (3.3)
Transferred to adult PD	2 (3.3)
Lost to follow-up	1 (1.7)

PD=peritoneal dialysis; HD=hemodialysis

of follow-up was 12 months. Almost all patients (58 children, 96.7%) had previously undergone HD, and the mean period between HD initiation and PD was 8.4 months. No patient was using automated peritoneal dialysis machine since it was not available in Indonesia. The most common primary diagnosis underlying the ESRD was hypoplastic bilateral kidneys (Table 1). All patients utilized a straight double-cuff Tenchkoff catheter. Tenckhoff catheter was inserted by a pediatric urologist using the laparoscopic technique. Antibiotic prophylaxis before the surgery were cefotaxime (25/60, 41.7%), cefazolin (14/60, 23.3%), cefoperazone sulbactam (3/60, 5%), ceftriaxone (3/60, 5%), and ceftazidime (2/60, 3.3%), while 10/60 (16.7%) patients did not receive antibiotic prophylaxis. Omentectomy was at first performed in a total of 16 (26.7%) patients during Tenckhoff catheter insertion; however, the technique was discontinued starting February 2017 because of bleeding complications. Since February 2017, omentectomy was only performed in patients with a bulky omentum.

The mean break-in period was 16 days. The dialysis fluid used for all children in this study was Dianeal® (dextrose) dialysate (Baxter Healthcare SA, Singapore Branch). The dialysis fluid was replaced as often as four to five times daily with a dwell volume of 1,100 ml/m^2. The glucose concentration in PD fluid that had been used was 1.5%; the patients received a 2.5% concentration only under certain conditions, such as fluid overload. The total duration of CAPD in this study was 62.6 patient-years. Post-operative PD exit-site dressing was maintained for one to two weeks except when the dressing was overly wet,

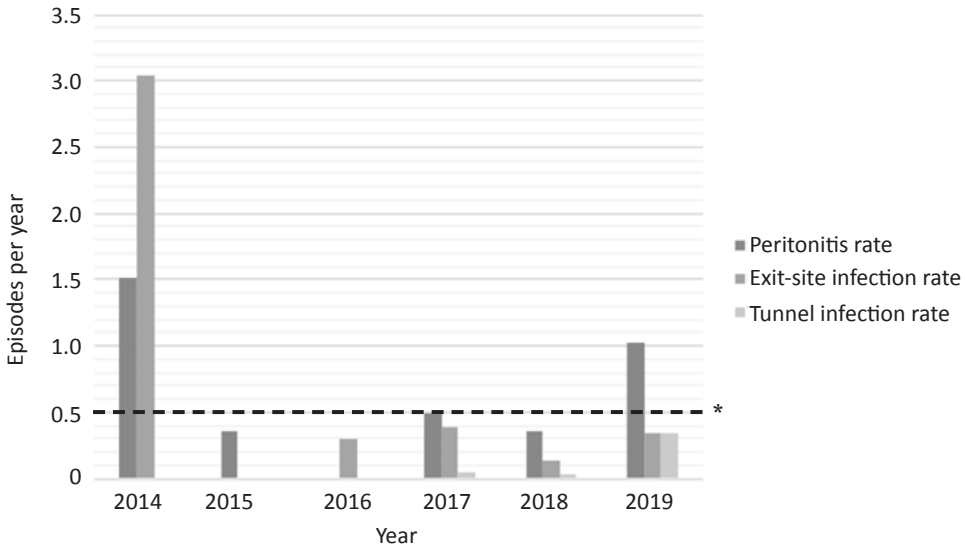

Figure 2. The incidence of peritoneal dialysis-related infection episodes is reported as episodes per year. This data were obtained until 31st January 2019. *Target from International Society of Peritoneal Dialysis 2016[4]

dirty, or with active bleeding. Gentamycin ointment was used on the exit site.

Twenty-six events of peritonitis occurred in a total of 18 patients, with a peritonitis risk rate of 0.42 episodes per year. Began with the high peritonitis rate of 1.52 episodes per year in 2014, the peritonitis incidence dropped in the following years before it rose significantly in 2019 (Figure 2). The mean time-to-first peritonitis was 6.6 months. Regarding the exit-site infection outcome, there were 17 episodes of exit-site infections in nine patients with the rate of 0.27 episodes per year. The highest exit-site infection incidence was in 2014, reaching 3.04 episodes per year. However, the exit-site infection incidence fell and remained less than 0.5 episodes per year for the remaining years (Figure 2). The mean time-to-first exit-site infection was 5.4 months. Three episodes of tunnel infections occurred in three patients with the rate of 0.05 episodes per year.

Of several variables that were assumed as risk factors (Table 2), we found that albumin may increase the risk of peritonitis with an odds ratio of 0.38 (95% CI = 0.16–0.96), p = 0.041. Of 26 peritonitis events, cultures were done in 24 patients. Cultures were not performed for two patients due to human error caused by the healthcare team performed fluid analysis only and started giving intraperitoneal antibiotic without any culture. The culture results showed that alpha-hemolytic *Streptococcus* was the most common cause of peritonitis (5/24, 20.8%). Culture-negative

Table 2. Factors affecting outcome of pediatric patients on peritoneal dialysis

Variables	Peritonitis, n (%) (N = 18)*	Non-peritonitis, n (%) (N = 42)	Survive, n (%) (N = 48)	Death, n (%) (N = 12)
Age (years), mean (SD)	12 (3.8)	11 (3.7)	11.7 (3.6)	12.6 (4.6)
Male sex	10 (55.6)	26 (61.9)	31 (64.6)	5 (41.7)
Lateral catheter orientation	17 (94.4)	32 (76.2)		
Antibiotics prophylaxis	14 (82.4)	35 (83.3)		
Exit-site infection	4 (22.2)	5 (11.9)		
Tunnel Infection	1 (5.6)	3 (7.1)		
Hypertension			39 (81.3)	12 (100.0)
Hb (g/l), mean (SD)	87 (16.0)	88 (18.0)	90 (14.0)†	79 (23.0)†
K^+ (mmol/l), mean (SD)	3.6 (0.8)	3.6 (0.8)	3.6 (0.8)	3.5 (0.8)
Albumin (g/l), mean (SD)	29 (6.8)‡	34 (6.8)‡	33 (7.0)	31 (7.0)

Hb=hemoglobin

*Peritonitis occurred in 14/48 (29.2%) patients who survived and 4/12 (33.3%) patients who did not survive (p = 0.74); †Significant factor contributing to patient survival (p = 0.04); ‡Significant factor contributing to peritonitis (p = 0.03). All continuous variables were analyzed using t-test. All categorical variables were analyzed using Fisher exact test except for gender

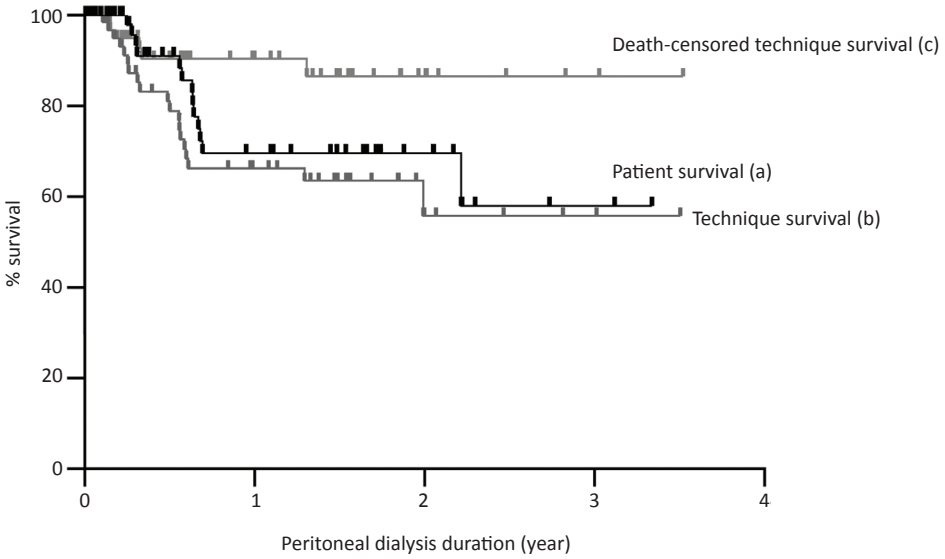

Figure 3. Kaplan–Meier plots show patient and technique survival of children undergoing continuous ambulatory peritoneal dialysis (CAPD) in Cipto Mangunkusumo Hospital in 2014–2019. No patients had follow-up duration beyond four years. (a) Survivals of patients. Kaplan–Meier endpoints were the end of the study, permanently switched to HD, loss to follow-up, treatment withdrawal, and death. The 1- and 3-year patient survival rates were 69.6% and 58%; (b) Technique survival 180 days describes the number of patients had never switched to HD for at least 180 days. For these analyses, death was considered as a technical failure and thus was not censored. The 1- and 3-year technique survival rates (180 days) were 62.6% and 51.1%; (c) For the analyses of death-censored technique survival 180 days, death was not considered as a technical failure, thus it was included in the analysis (censored). The 1- and 3-year death-censored technique survival (180 days) rates were 89.2% and 85%

peritonitis occurred in five cases. Twenty-five patients were screened for *Staphylococcus aureus* before PD catheter insertion, but none of them had the colonization.

The most common non-infectious complication of PD among all patients was fluid overload (12/60, 20%) (Table 1). At the end of the follow-up period, 36 of 60 patients (58.3%) were still undergoing CAPD. None of the patients underwent renal transplantation during the follow-up period. Among the 24 patients who dropped out, most patients died (13/24, 54.2%). The most common cause of death in these patients were cardiovascular etiologies (5/13, 38.5%) and was followed by sepsis (3/13, 23.1%), respiratory problems (2/13, 15.4%), cerebrovascular (2/13, 15.4%), and pleuroperitoneal fistula (1/13, 7.7%). Most patients had hypertension which was poorly controlled. The hemoglobin level of patients who died was lower than those who survived (Table 2). According to the universal health coverage (UHC) policy in our unit, erythropoietin stimulating agents (ESAs) and intravenous iron were limited to patients with hemoglobin less than 120 g/l and 100 g/l, respectively.

At Cipto Mangunkusumo Hospital, the 1- and 3-year patient survival rates were 69.6% (95% CI = 52.5–81.5) and 58% (95% CI = 31.2–77.5). The 1- and 3-year technique survival rates (180 days) were 62.6% (46.8–74.9) and 51.1% (30.1–68.7). There was one patient returned to PD after switched to HD for at least 30 days. All patients who switched to HD for at least 180 days discontinued PD permanently due to recurrent peritonitis (3/6, 50%), non-compliance (2/6, 33.3%), and non-cooperative caregiver (1/6, 16.7%). The 1- and 3-year death-censored technique survival rates (180 days) were 89.2% (95% CI = 75.8–95.4) and 85% (95% CI = 68.2–93.3) (Figure 3).

DISCUSSION

In the present study, the characteristics and outcomes of CAPD program for children in a single center in Indonesia were evaluated. From only 3 patients choosing CAPD as dialysis modality in 2014, the number of patients has grown to a total of 60 patients in the past five years. Patient satisfaction with CAPD might contribute to the substantial CAPD uptake especially in 2017 (Figure 1). Parents with babies and young children preferred PD over HD because PD could avoid the complications of HD access.[7] Moreover, CAPD patients had more flexible diet and fewer fluid restriction compared with HD patients.[8] They also had greater full-time school attendance rate compared to those on HD.[9] These positive CAPD experiences have

encouraged patients and caregivers in our unit to promote CAPD to other children with ESRD requiring dialysis.

Apart from the technical simplicity and tolerability, an economic factor likely drove the increase of PD uptake in Indonesia. The increasing burden of HD therapy in our unit urged the healthcare service providers to implement a more cost- and time-efficient dialysis modality for children. In Hong Kong and Thailand, PD first policy has been implemented since it was known to be cost-effective.[10,11] Although Indonesia has not applied PD first policy yet, an Indonesian study shows that the incremental cost-effectiveness ratio associated with one additional quality-adjusted life-year gained for implementing PD first policy in Indonesia is cheaper than implementing HD first policy (13,707 USD *versus* 14,707 USD).[12] Furthermore, the implementation of UHC in Indonesia was fruitful in improving access to pediatric RRT which is similar to Thailand. In Thailand, UHC could bear the cost burden of PD which is 7,300 USD/year, and that of HD is 12,100 USD/year.[13] At Cipto Mangunkusumo Hospital, the UHC covered 532 USD/month for PD cost including 120 bags Dianeal® and 120 MiniCap (Baxter Healthcare SA, Singapore), which was sufficient for one PD patient requirements per month. Meanwhile, compared to HD, the UHC only covered 843 USD per patients per month from the actual cost of 1,230 USD/month, which was inadequate. An analysis on budget impact of PD compared with conventional in-center HD in Malaysia suggested that there has been an increase of PD population from 8% in 2014 to 38% in 2018 resulted in 5-year cumulative savings 23.93 million RM for the Malaysian government.[14] Overall, reimbursement policies and government initiatives have been identified to successfully increase the PD uptake in Asia.[3]

In this center, the most common causes of ESRD were congenital anomalies of the kidney and urinary tract, similar to the International Pediatric PD Network (IPPN) report.[15] In our unit, chronic PD was successfully initiated in a baby as young as 4 months of age. However, this was considered late compared to other units. In the UK, for example, chronic PD can be initiated in an infant as young as 7 days.[16] Compared with the UK, in our unit almost all patients (96.7%) were referred late. Being presented acutely, emergent dialysis (initiation of HD <48 hours after hospital admission) was required. Obtaining parental consents to choose CAPD as the initial RRT were quite challenging as some parents were more familiar with HD since HD had been a popular option as an ESRD treatment in adults in Indonesia. Furthermore, PD was perceived to be more hassle compared to HD and required caregivers' daily discipline.

Peritonitis remains a serious complication of PD as it may directly contribute to the mortality in PD patients. Furthermore, peritonitis is the most important risk factor of PD technique failure. Therefore, International Society of Peritoneal Dialysis (ISPD) recommends every CAPD program to reduce the peritonitis incidence to be lower than 0.5 episodes per year at risk.[4] In our unit, the peritonitis rate was 0.42 episodes per year at risk, which is better than the target set by ISPD. Moreover, our peritonitis rate is comparable with that of high-income countries, which is approximately 0.47 episodes per year at risk.[17] This finding is somewhat surprising as the CAPD program in our unit has been suboptimal. However, the low peritonitis incidence was not consistent throughout the years. The high peritonitis rate in 2014 and 2019 could be explained by the occurrence of peritonitis events among a low number of patients undergoing CAPD in a short PD total duration (Figure 2). In 2014, repeated peritonitis occurred in one patient with poor wound healing due to systemic lupus erythematosus. It is also worth noting that poor PD training such as delegating the training to incompetent nurses and training to several caregivers from three different patients at the same time might explain the high peritonitis incidence.

Several risk factors for peritonitis have been identified such as exit-site infection or tunnel infection, single-cuffed catheter, low compliance, upward exit-site orientation, and touch contamination.[18] Regarding the PD catheter-related infections, there is no sufficient data to recommend the minimum target of the exit-site infection and tunnel infection rate as part of a continuous quality improvement program.[5] We assume the overall exit-site infection and tunnel infection rate in our unit was low, except for the exit-site infection rate in 2014. In this year, only three patients underwent CAPD within 8 months of total PD duration. Exit-site infection occurred twice in one of these patients who subsequently developed peritonitis and technique failure in the same year. Although we could not identify the exit-site infection and tunnel infection as peritonitis risk factors, the episodes in 2014 highlighted the important consequence of exit-site infection resulted

in PD discontinuation. Hypoalbuminemia was identified as a risk factor for peritonitis in our patients similar with a report from Prasad et al.[19] Hypoalbuminemia in CAPD patients can be caused by malnutrition, persistent proteinuria due to underlying glomerulonephritis, inflammation, and dialysate protein losses during PD.[20] In our population of PD patients, the cause of hypoalbuminemia has yet to be studied; however, it is assumed that the cause is the lack of protein intake.

PD fluid cultures were obtained for almost all patients with peritonitis with gram-positive bacteria as it was the most common cause. This culture results suggested that peritonitis was caused by skin-derived microorganisms. Poor hand hygiene might explain the bacterial contamination from the skin. Unfortunately, the route of infection in peritonitis could not be proved as it is beyond the scope of this study. Another interesting finding from the culture result was the high rate of negative culture in our unit. Negative culture was found similar to ISPD standard rate that is 20%.[21] Compared to the rate in low-middle income countries, which may reach 26% to 59%, the prevalence of negative culture in our unit was low.[17] The cause of negative culture worldwide among children undergoing dialysis is poorly understood.

Major technological and procedural advances in PD contribute to the excellent long-term PD outcomes worldwide nowadays. Data from IPPN suggest that the PD 5-year patient survival rate is more than 90% while the PD 5-year technique survival rate is approximately 80%.[17] The technique survival rate at our unit is lower than the data of 1-year (97%) and 3-year (84%) survival rates in Malaysia.[22] The 1- and 3-year death-censored technique survival rates were satisfactory (Figure 3). If mortality was being censored, recurrent peritonitis became the most common cause of technique failure in our unit, although peritonitis did not affect patient survival rate in our study (p = 0.78). All five patients with technique failure owing to peritonitis discontinued PD less than 6 months. This explains a relatively low 1- and 3-year technique survival rate in our unit which we considered likely due to inadequate PD training and absence of retraining. Six months following the initiation of PD is a crucial period for PD continuation since the mean time-to-first peritonitis was 6.6 months following the initiation of PD. Around this time, knowledge, patient compliance, and caregiver skill may have deteriorated. Dong and Chen[23] found that six months after PD initiation, 51.5% patients did not perform correct hand washing, 46.2% of patients did not check expiration date or bag leakage, and 11.25% of patients forgot to use their mask and cap. Therefore, we recommend a retraining program at least every six months to prevent PD-related infections.

Australia and New Zealand Dialysis and Transplant Registry (ANZDATA)[6] suggested to report technique failure using different definitions that would be able to predict the prognostic implication for further PD. In our unit, the patient's likelihood of returning to PD was higher for the patients who switched to HD for 30 days than 180 days. Meanwhile, reporting using censored- and non-censored for death definition enables us to understand the magnitude of mortality on the PD discontinuation. It was known that death contributed to the cessation of PD in almost half cases.[6] In our unit, death was found to be the most common cause of PD discontinuation, reaching approximately 21.7%, which is similar to a study by Kolesnyk et al.[24]

Unlike the technique survival, our patient survival was still relatively low. The 1- and 3-year patient survival rates of patients at Cipto Mangunkusumo Hospital were far lower compared to in developed countries. The 1- and 3-year survival in the USA were 97.8% and 95.9%, while in Italia were 96.5% and 91.6%, respectively.[7,25] Low GNI per capita (10,000 USD) is a risk factor of mortality in children on PD (hazard ratio = 0.70, 95% CI = 0.56–0.88).[17] However, GNI might not be the only factor contributing to the poor patient survival in our unit. Compared to countries with GNIs <12,000 USD, 1- and 3-year patient survival rates were approximately 94% and 80%.[17] The survival data on Asian children on PD is rare. In India, the one-year patient survival rate is higher than our center (94% *versus* 69.6%); however, the three-year patient survival rate is lower (48% *versus* 58%).[19]

Other several factors have been identified to contribute to mortality rate in PD children patients, such as: the first year on dialysis, prematurity, comorbidity, and hypoalbuminemia. Infection and cardiovascular problems are generally the two major causes of death in PD patients.[27] In this center, the high number of mortalities might be caused by the poor control of comorbidities. First, late referral to pediatric nephrologist caused a significant burden to the patients and unit. Most patients has had serious ESRD complications such as severe hypertension, poor cardiac function, and severe anemia. Poor adherence to multiple antihypertensive medications in patients

with resistant hypertension might also contribute to the poor outcome. Anemia was also poorly managed. The lowest mean hemoglobin level in both surviving and non-surviving patients was still <100 g/l. Poor hemoglobin control might be owing to the suboptimal ESAs and intravenous iron dosing because ESAs and intravenous iron were restricted to patients with hemoglobin <120 g/l and 100 g/l subsequently.

To our knowledge, our study is the first to describe the status of the pediatric CAPD program in Indonesia. A multicenter study with a longer follow-up duration is required to evaluate the long-term outcome of pediatric CAPD that is representative for Indonesia. Our study limitation is a retrospective study that is prone to information bias. Moreover, limited risk factors could be evaluated due to small sample size. The follow-up period duration in this study was also short; therefore, the five-year survival rate could not be measured. Consequently, the generalizability of this study may be limited to dialysis units with similar backgrounds.

Conclusions

Pediatric CAPD program performance should be evaluated regularly. In our first 5 years of CAPD program, the peritonitis rate was relatively low compared to International Society of Peritoneal Dialysis (ISPD) standard. The peritonitis was likely caused by skin-derived microorganisms. We recommend a retraining program every six months considering the poor adherence to the PD protocol that may contribute to the development of peritonitis. Maintaining the albumin level within the normal range is also important to prevent peritonitis. Anemia and hypertension management in children with ESRD are crucial to improve patient survival. Local policy should promote the optimal target of hemoglobin (110–120 g/l) and blood pressure (≤50th percentile for age, sex, and height) as has been recommended by the Kidney Disease Improving Global Outcomes to prevent cardiovascular complications.[28] Our technique survival and patient survival were still relatively low compared to International Pediatric PD Network (IPPN) report.

Conflict of Interest

The authors affirm no conflict of interest in this study.

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REFERENCES

1. Frishberg Y, Rinat C, Becker-Cohen R. Renal replacement therapy (dialysis and transplantation) in pediatric end-stage kidney disease. In: Brenner and Rector's The Kidney. 10th ed. Philadelphia: Elsevier; 2016. p. 2402–37.
2. Li PK, Cheung WL, Lui SL, Blagg C, Cass A, Hooi LS, et al. Increasing home-based dialysis therapies to tackle dialysis burden around the world: a position statement on dialysis economics from the 2nd Congress of the International Society for Hemodialysis. Nephrology. 2011;16(1):53–6.
3. Li PK, Chow KM, Van de Luijtgaarden MW, Johnson DW, Jager KJ, Mehrotra R, et al. Changes in the worldwide epidemiology of peritoneal dialysis. Nat Rev Nephrol. 2017;13(2):90–103.
4. Li PK, Szeto CC, Piraino B, de Arteaga J, Fan S, Figueiredo AE, et al. ISPD peritonitis recommendations: 2016 update on prevention and treatment. Perit Dial Int. 2016;36(5):481–508.
5. Szeto CC, Li PK, Johnson DW, Bernardini J, Dong J, Figueiredo AE, et al. ISPD catheter-related infection recommendations: 2017 update. Int Soc Perit Dial. 2017;37(2):141–54.
6. Lan PG, Clayton PA, Johnson DW, McDonald SP, Borlace M, Badve SV, et al. Duration of hemodialysis following peritoneal dialysis cessation in Australia and New Zealand: proposal for a standardized definition of technique failure. Perit Dial Int. 2016;36(6):623–30.
7. United States Renal Data System (USRDS). ESRD among children, adolescents, and young adults. In: Annual Data Report. Michigan; 2018. p. 463–500.
8. Fraser N, Hussain FK, Connell R, Shenoy MU. Chronic peritoneal dialysis in children. Int J Nephrol Renovasc Dis. 2015;8:125–37.
9. North American Pediatric Renal Trials and Collaborative Studies. 2011 Annual Dialysis Report [Internet]. Boston: NAPRTCS. 2011 [cited 2012 Aug 1] Available from: https://web.emmes.com/study/ped/annlrept/annualrept2011.pdf.
10. Choy AS, Li PK. Sustainability of the peritoneal dialysis-first policy in Hong Kong. Blood Purif. 2015;40(4):320–5.
11. Chuengsaman P, Kasemsup V. PD first policy: Thailand's response to the challenge of meeting the needs of patients with end-stage renal disease. Semin Nephrol. 2017;37(3):287–95.
12. Afiatin, Khoe LC, Kristin E, Masytoh LS, Herlinawaty E, Werayingyong P, et al. Economic evaluation of policy options for dialysis in end-stage renal disease patients under the universal health coverage in Indonesia. PLoS One. 2017;12(5):e0177436.
13. Treerutkuarkul A. Thailand: health care for all, at a price. Bull World Heal Organ. 2010;88(2):84–5.
14. Bavanandan S, Ahmad G, Teo AH, Chen L, Liu FX. Budget impact analysis of peritoneal dialysis versus conventional in-center hemodialysis in Malaysia. Value Heal Reg Issues. 2016;9:8–14.
15. Borzych-Duzalka D, Aki TF, Azocar M, White C, Harvey E, Mir S, et al. Peritoneal dialysis access revision in children: causes, interventions, and outcomes. Clin J Am Soc Nephrol. 2017;12(1):105–12.
16. Imani PD, Carpenter JL, Bell CS, Brandt ML, Braun MC, Swartz SJ. Peritoneal dialysis catheter outcomes in infants initiating peritoneal dialysis for end-stage renal disease. BMC Nephrol. 2018;19:231.
17. Schaefer F, Borzych-Duzalka D, Azocar M, Munarriz RL, Sever L, Aksu N, et al. Impact of global economic disparities on practices and outcomes of chronic peritoneal dialysis in children: insights from the International Pediatric Peritoneal Dialysis Network

Registry. Perit Dial Int. 2012;32(4):399–409.
18. Sethna CB, Bryant K, Munshi R, Warady BA, Richardson T, Lawlor J, et al. Risk factors for and outcomes of catheter-associated peritonitis in children: The SCOPE Collaborative. Clin J Am Soc Nephrol. 2016;11(9):1590–6.
19. Prasad N, Gulati S, Gupta A, Sharma RK, Kumar A, Kumar R, et al. Continuous peritoneal dialysis in children: a single-centre experience in a developing country. Pediatr Nephrol. 2006;21(3):403–7.
20. Sezer S, Ozdemir FN, Akman B, Arat Z, Anaforoglu I, Haberal M. Predictors of serum albumin level in patients receiving continuous ambulatory peritoneal dialysis. Adv Perit Dial. 2001;17:210–4.
21. Warady BA, Bakkaloglu S, Newland J, Cantwell M, Verrina E, Neu A, et al. Consensus guidelines for the prevention and treatment of catheter-related infections and peritonitis in pediatric patients receiving peritoneal dialysis: 2012 update. Perit Dial Int. 2012;32(Suppl 2):S32–86.
22. National Renal Registry (Malaysian Society of Nephrology). 24th Report of the Malaysian dialysis and transplant registry 2016 [Internet]. 2016 [cited 2019 May 31]. p. 166–75. Available from: https://www.msn.org.my/nrr/mdtr2016.jsp.
23. Dong J, Chen Y. Impact of the bag exchange procedure on risk of peritonitis. Perit Dial Int. 2010;30(4):440–7.
24. Kolesnyk I, Dekker FW, Boeschoten EW, Krediet RT. Time-dependent reasons for peritoneal dialysis technique failure and mortality. Perit Dial Int. 2010;30(2):170–7.
25. Verrina E, Edefonti A, Gianoglio B, Rinaldi S, Sorino P, Zacchello G, et al. A multicenter experience on patient and technique survival in children on chronic dialysis. Pediatr Nephrol. 2004;19(1):82–90.
26. The World Bank. GNI per capita, PPP (current international $) [Internet]. 2017 [cited 2019 May 31]. Available from: https://data.worldbank.org/indicator/NY.GNP.PCAP.PP.CD.
27. Chesnaye NC, Schaefer F, Groothoff JW, Bonthuis M, Reusz G, Heaf JG, et al. Mortality risk in European children with end-stage renal disease on dialysis. Kidney Int. 2016;89(6):1355–62.
28. KDIGO. KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease. Kidney Int Suppl. 2013;3:136–50.