Effects of Acute Peritoneal Dialysis in Extremely-Low-Birth-Weight Infants: A Retrospective Cohort Study

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BMC Nephrology  BMC Series

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DOI:
10.21203/rs.2.17326/v1

SUBJECT AREAS
Urology & Nephrology

KEYWORDS
Acute kidney injury, Infants, Extremely low birth weight, Peritoneal dialysis, Hyperkalemia
Abstract
Background : Acute peritoneal dialysis (APD) is a first-line rescue therapy for neonatal acute kidney injury (AKI) refractory to conservative management, but its efficacy in preterm infants remains unclear. This study aimed to investigate the clinical outcomes of APD and APD efficiency in extremely-low-birth-weight (ELBW) infants. Methods : We reviewed the medical records of inborn ELBW infants who underwent APD in a tertiary center. We recorded perinatal characteristics, including the causes of AKI and clinical outcomes. Serial input and output data and laboratory parameters to assess ultrafiltration/dialysis efficiency were also obtained. Results : A total of 12 ELBW infants were included in the study. Mean gestational age and birth weight were 27.2 weeks and 706.5 g, respectively. Leading cause of AKI was sepsis (50%) followed by perinatal asphyxia. Mean age at the start of PD was 16.3 days. Mean ultrafiltration (UF) rate was 2.73 mL/kg/h. After a mean duration of 9.4 days, the mean reduction in serum BUN and Cr levels was 42.5% and 20.1%, respectively. Mean sodium level increased from 135.8 to 144.7 mg/mL, and mean potassium level decreased from 6.8 to 5.0 mg/mL. The most common complication was mechanical dysfunction of the catheter, including dialysate leakage via the insertion site (75%). Only two patients were successfully weaned off APD. The overall mortality rate was 92%. Conclusions : In ELBW infants with AKI, APD was an effective rescue therapy in terms of its ultrafiltration and dialysis efficiency, but not with respect to neonatal mortality. Indications for APD in ELBW infants should be individualized depending on the etiology of AKI.

Background
Although the precise incidence and prevalence rates of acute kidney injury (AKI) among newborns are unknown, it is commonly observed in the neonatal intensive care unit (NICU), with rates ranging from 8 to 24% [1]. Neonates with AKI have very high mortality rates, i.e., 4.5-78% [1-3]. AKI has a significant impact on the survival rate of preterm infants. Because the kidneys of extremely-low-birth-weight (ELBW; birth weight, <1000 g) infants are immature and susceptible to environmental insults, including infectious pathogens and nephrotoxic medications, the incidence rate of AKI among ELBW is high at about 56% [4, 5]. In ELBW infants, approximately 18% of cases of AKI occur as a result of renal hypoperfusion and ischemia [4, 6, 7].
Treatment of the metabolic complications of AKI includes appropriate management of fluids, electrolytes, acid-base balance, and appropriate nutrition [8, 9]. Despite non-dialytic management of AKI among newborns, major indications for initiating renal replacement therapy (RRT) include severe oliguria despite fluid therapy, diuretic administration, and inotropic support; refractory electrolyte imbalance; and worsening uremia [8-10]. Acute peritoneal dialysis (APD) is the most common form of RRT in young children, including neonates, because of the relative ease of access and technical simplicity [10-12]. A few studies have reported that APD is effective for the management of AKI and metabolic disturbances in neonates, including preterm infants [10, 13]. However, it has been used only occasionally in ELBW infants with AKI because of the unavailability of small-sized catheters and volume cyclers [14]. Only a few studies have investigated the implementation of APD in ELBW infants. Therefore, we aimed to evaluate the clinical characteristics and prognosis of ELBW infants who received APD treatment for AKI.

Methods

Study population

This study was a retrospective cohort study of ELBW infants born at Asan Medical Center Children’s Hospital, a tertiary academic center, who were admitted to the NICU between January 2008 and February 2018. Among them, 12 ELBW infants (seven male and five female infants) required PD for AKI. We defined AKI as any of the following criteria: increase in serum creatinine (Cr) level by ≥0.3 mg/dL (≥26.5 μmol/L) within 48 hours; increase in serum Cr level by ≥1.5 times that at baseline, which was known or presumed to have occurred within the prior 7 days; or urine volume of <0.5 mL/kg/h for 6 hours [15].

Indications for dialysis

We applied APD in ELBW infants with AKI, including anuria since birth or oliguria lasting over 48 hours; fluid overload, including pulmonary edema; refractory hyperkalemia; severe metabolic acidosis; and uremia. Furthermore, we considered the overall condition of the patients before and after dialysis and the prognosis in relation to the underlying diseases. Complications and outcomes were evaluated on the basis of clinical manifestations and results of biochemistry and serology studies, simple X-ray, and
echocardiography.

**Dialysis technique**

In all patients, we inserted the catheter for APD safely at their bedside based on unfavorable conditions for transfer to an operating room. Under sterile conditions with local anesthesia, a 20-gauge guide needle was inserted at the counter-McBurney point (the point over the left side of the abdomen that is one-third of the distance from the anterior superior iliac spine to the umbilicus) to inject 3-5 mL of sterile saline. We checked the insertion site of the catheter using abdominal sonography prior to puncture. As soon as the guide needle was inserted, we assessed the contents of the syringe to check for the presence of bowel injury. Thereafter, we inserted an intravenous (IV) cannula or a commercially available APD catheter with a guide wire for peritoneal access on the puncture site. The four types of catheters used were as follows: APD catheter (7.5, 8.5, and 9 Fr; Cook Inc., IN, USA), GamCath® catheter (8 Fr, dual lumens; Baxter, IL, USA), ARROW® central venous catheter (CVC) (4 Fr, dual lumens; Teleflex, NC, USA), and venous umbilical catheter (4 Fr; Vygon, Paris, France). Two to three side holes were manually created for the two types of vascular catheters, except for the APD catheter, during the procedure preparation. We evaluated the location of the catheter tip and determined the presence of other complications, including bowel perforation, using simple X-ray. The PD catheter tip was placed in the lower portion of the pelvis. APD was started immediately after insertion of the catheter.

Dialysis solutions (Hemosol or Physioneal; Baxter International, Deerfield, IL, USA) were used at standard hydrous dextrose concentrations of 2.5 and 4.25% with osmolalities of 396 and 485 mOsm/L, respectively. APD was started at a rate of 10 mL/kg, which was increased to 20-30 mL/kg at 60-120 min/cycle continuing for 24 hours. The initial APD cycle yielded an exchange inflow of 10 mL/kg for 10 minutes, a dwell time of 30 minutes, and a drain time of 20 minutes. We adjusted the dwell time and dextrose concentration of the dialysis fluids according to ultrafiltration (UF). UF refers to the difference between osmotically-induced ultrafiltration into the peritoneal cavity and fluid loss from the cavity during dialysis [16]. UF was defined as the difference (mL) between the applied dialysis fluid and the amount of dialysate, and net UF (mL/kg/h) was calculated using body weight and
dialysis time. The amount of fluid that can be removed can be increased by increasing either the APD dextrose concentration, amount of fluid in the peritoneum, or frequency of exchange. For input-dwell-output flow of the dialysis fluid, the ports of the three-way cannula connected to the APD catheter of the patients were operated manually by nurses at the appointed times. Gravity was used in the filling and draining processes. Automated PD is not available for ELBW infants because the minimum loading volume that supports the machine cannot be satisfied [17]. To discontinue APD, we determined weaning time based on increasing urine output, hemodynamic stability, and volume status.

Clinical data
We assessed the cause of AKI; indication and timing of APD; duration of APD (days); blood urea nitrogen (BUN), Cr, sodium, and potassium levels pre- and post-PD; urine output (mL/kg/h) pre- and post-APD; complications during APD; comorbidities; and causes of mortality. We also evaluated the use of nephrotoxic antibiotics (e.g., vancomycin, aminoglycoside, meropenem, and antifungal drugs), inotropes, and vasopressors before AKI diagnosis. Demographic characteristics, such as gestational age, birth weight, sex, history of multiple births, incidence rate of maternal preeclampsia, type of delivery, antenatal steroid use, Apgar scores at 1 and 5 minutes; presence of major morbidities such as respiratory distress syndrome, patent ductus arteriosus (PDA), bronchopulmonary dysplasia [18], significant neurological injury (SNI), necrotizing enterocolitis (NEC) [19], and late-onset sepsis (LOS), duration of hospital stay, and mortality rate were also assessed for each subject. Significant PDA was defined as a condition requiring pharmacological and/or surgical treatment to mitigate hemodynamic disturbance. SNI included intraventricular hemorrhage (IVH) grade ≥3 or periventricular leukomalacia. LOS was defined as bacterial infection confirmed by a positive blood or cerebrospinal fluid culture finding after postnatal day 3.

Results
Of 543 ELBW infants, 121 were diagnosed with AKI (Fig. 1). Twelve (seven male and five female infants) of these 121 infants were treated with APD. Their clinical characteristics and significant morbidities are shown in Table 1. Their mean gestational age and birth weight was 27.2 (±3.3) weeks and 706.5 (±220.5) g, respectively.
The most important cause of AKI was sepsis (50%) (Table 2). Two of the patients had AKI due to multiple organ dysfunction syndrome (MODS) after asphyxiation in the delivery room. Two other patients received APD for bilateral renal vein thrombosis. Ten of the enrolled patients were administered inotropes (e.g., dopamine, dobutamine, or epinephrine) and antibiotics (e.g., vancomycin, gentamicin, or meropenem) before the diagnosis of AKI (data not shown).

Mean age at the start of APD was 16.3 (±16.3) days (range, 1-43 days), except in two patients. The average duration of APD was 9.4 (±7.7) days (range, 5-14 days). The average percentage weight gain after APD initiation compared with that before AKI was 14.4% (range, 2-53%). Treatment with APD fluids (2.5 or 4.25%) was started at a rate of 10 mL/kg, which was increased to 20-30 mL/kg at 60-120 min/cycle continuing for 24 hours based on the effects of the dialysis. PD fluid concentration was increased from 2.5 to 4.25% in four patients because of insufficient drainage. PD fluid concentration was decreased from 4.25 to 2.5% in one patient because of hyperglycemia. Average UF rate was 2.73 (±1.35) mL/kg/h (Fig. 2).

To measure the effectiveness of dialysis, serum BUN, Cr, sodium, and potassium levels pre- and post-PD were analyzed in 10 patients (Fig. 3). The two remaining patients died before the evaluation. Average rate of reduction in serum BUN and Cr levels during dialysis was 42.5% (range, 12-64%) and 20.1% (range, 0-70%), respectively. Sodium level increased from 135.8 to 144.7 mg/mL, and potassium level decreased from 6.8 to 5.0 mg/mL after 9.3 (±4.4) days.

Four complications related to APD were observed in eight patients (67%). Main complications were mechanical dysfunction of the catheter, including leakage at the insertion site and catheter obstruction. The most common mechanical dysfunction was dialysate leakage at the insertion site (75%). Intraperitoneal hemorrhage at insertion or withdrawal of the catheter also occurred in three patients. Peritonitis needing intraperitoneal antibiotic administration was the only infectious complication recorded.

Despite dialysis, four patients died due to AKI-related hyperkalemia or metabolic acidosis. As soon as dialysis was performed, five other patients died because of MODS caused by sepsis, respiratory arrest, or congestive heart failure. One patient died of a pulmonary hemorrhage and another patient...
died due to deterioration of IVH regardless of dialysis.

With regard to UF, dialysis was discontinued when there was more fluid loss than osmotic ultrafiltration, because we considered this to indicate effective dialysis. Of the 12 patients, two patients were successfully weaned off dialysis after their renal function improved with a negative net UF. One of them died from hypoxic encephalopathy and coma 28 days after withdrawal of APD. The only survivor completely recovered his renal function as defined by normalization of serum BUN, Cr, and electrolyte levels; thus, he did not require long-term RRT. The mortality rate of the ELBW infants treated with APD was high (91.7%).

Discussion
In NICUs, use of dialysis in premature infants who are susceptible to AKI because of their immaturity or exposure to infection and toxins is gradually increasing [4, 5, 17]. However, to date, there is no guideline-based evidence regarding the indications and methods of RRT for premature infants. If renal failure does not resolve despite medical treatment, the timing and method of dialysis are selected on the basis of the decision of the primary care physician [8, 20, 21]. As a result, the prognosis of premature infants with AKI treated with RRT is poor. ELBW infants in particular are at very high risk for AKI, but few studies have suggested criteria for successful dialysis in ELBW infants with AKI. Although a recent study reported performance of APD in three ELBW infants, all infants received different types of peritoneal catheters and different technical methods were used [14]. Mortality of ELBW patients is generally high because these patients' organs are immature and failure of other organs often occurs [22]. Despite reports of application of hemodialysis (HD) in infants [23], HD may not be the neonatal treatment of choice for the following reasons: (1) the priming volumes for hemoperfusion filters are too large, requiring a minimum of 35 mL, making maintenance of the circulatory dynamics of premature infants difficult; (2) hemoperfusion filters require heparin to maintain patency; and (3) thrombocytopenia is a common complication of hemoperfusion. These factors can increase the risk of intracranial hemorrhage in neonates [20, 24]. In ELBW infants, who have unstable blood pressure and in whom obtaining vascular access is difficult, HD is hard to apply effectively.
Over the years, PD has become an effective and increasingly popular alternative to HD for the management of critically ill neonates, including premature infants [9, 25]. APD is relatively safe, technically simple, and cost-effective. It can also be applied in hemodynamically unstable premature infants [2, 8, 12, 25]. Catheter design, implantation site, and system configuration used to perform dialysis determine the effectiveness of APD in premature infants. However, the most common difficulty in APD is the introduction of a suitable peritoneal catheter for these patients. Obtaining catheter access for APD is more difficult in ELBW infants than in older neonates because of their small size and inelastic abdominal wall.

Permanent PD catheters (e.g., Tenckhoff catheters) with cuffs are very rigid and too long for the small intra-abdominal cavities of infants. They need to be tunneled under the skin. However, in ELBW infants, APD catheters can be inserted directly through the abdominal wall, without tunneling.

Temporary PD catheters are generally inserted along with IV catheters or commercially available peritoneal catheters [22]. Other alternatives are feeding tubes, suction catheters, neonatal chest drains, and Foley catheters [26-28]. In our study, although APD catheters were inserted in eight of the 12 patients, IV catheters (e.g., ARROW® CVC and venous umbilical catheters) were inserted initially in another four patients because of their low body weight. When using IV catheters, we manually created some side holes during the procedure. We expected these holes to have better permeability. Although these holes could have rough edges, which may cause bowel perforation or intraperitoneal hemorrhage, no such complications were observed in our study. PD worked effectively in two ELBW infants with smaller-sized catheters.

Complications associated with APD in premature infants include mechanical dysfunction, such as dialysate leakage and catheter obstruction requiring revision or reinsertion, intraperitoneal hemorrhage, and bowel perforation [17, 20, 29]. Peritoneal fluid leakage around the APD catheter and along the tunnel is a serious problem that can increase the risk of bacterial and fungal peritonitis [21, 30]. In this study, the complications observed in relation to APD were caused mainly by catheter-related dialysate leakage, which was resolved after adjustment of the dwell volume or reinsertion of the catheter on the other side. In a previous study, a tissue adhesive, i.e., commercially available
fibrin glue, was used at the insertion site [29]. Therefore, selection of an optimal catheter for APD is very important to minimize complications associated with APD access. In our study, the ability to discontinue APD in two patients was due to low leakage of the APD catheter, which affected net UF due to efficient APD action. A severe complication of APD is peritonitis, but only one patient in this study developed peritonitis. The use of prophylactic antibiotics should be carefully considered taking into account infection prevention versus generation of antibiotic-resistant bacteria [25, 28]. The efficacy of APD in ELBW infants is affected by many factors. In ELBW infants with hypotension, peripheral perfusion is insufficient for adequate exchange. If they develop sepsis, which increases vessel permeability, rapid solute removal and UF capacity reduction with gradient loss may occur [31].

Increasing the number of exchanges, administering large volumes of dialysate, or adjusting the concentration of glucose in dialysis fluids may help improve dialysis efficiency [32]. Although the number of exchanges may vary, approximately 24 exchanges per day are employed for APD. The number of exchanges is determined by the amount of fluid and solute removal required. A total of 20-40 cycles can be used; further, the procedure can be continued until the desired effect is obtained [32, 33]. The size of the peritoneal cavity, weight of the infant, presence of pulmonary or other diseases, and degree of uremic toxicity may influence the exchange volume [12, 34]. Additionally, it is rational to initiate APD using 2.5% dialysate solution to achieve better UF [12, 34]. Estimation of the peritoneal equilibration rate is necessary for optimal dialysis; however, practically frequent blood and dialysis fluid sampling is risky in ELBW infants. In our study, APD was started at the rate of 10 mL/kg, which was increased to 20-30 mL/kg at 60-120 min/cycle continuing for 24 hours.

In our study, the mortality rate of the ELBW infants treated with APD was high at 91.7%. In addition, most of the patients had findings compatible with disseminated intravascular coagulation features. In a previous study, the mortality rate was 79% in ELBW infants treated with APD; they were assumed to have died from underlying medical conditions and multi-organ failure rather than renal failure [20, 25]. In the current study, five ELBW infants had accompanying congenital heart disease and twin-to-twin transfusion. Initiation of dialysis may decrease urine output and intravascular volume, making
negative renal recovery an issue. This could aggravate underlying diseases, including congenital heart disease, which would increase the mortality rate of ELBW infants. However, a strength of this study is that it provides data on the effects of dialysis in ELBW infants with congenital heart disease or twin-to-twin transfusion; these effects have previously been monitored in only a few studies. Our study had some limitations. First, it was a retrospective study of a relatively small number of infants conducted at a single center; thus, the findings might not be generalizable to larger populations. Second, our data do not indicate whether the nutritional intake of ELBW infants causes high morbidity and mortality rates in maintenance dialysis. Lastly, we did not include premature infants with contraindications for APD, such as NEC, severe respiratory failure, and hemorrhagic tendency. Intrusion of the peritoneal cavity or placement of multiple abdominal drains may occur in infants with these contraindications. The available data from this and previous studies on treating ELBW infants with APD or HD for AKI suggest that alternatives to these techniques are required for the treatment of premature infants with AKI.

Conclusions
The use of APD should be carefully considered for the treatment of ELBW infants with AKI due to high mortality. Indications for APD in ELBW infants should be individualized depending on the etiology of AKI. It is important moving forward to generate guideline-based evidence regarding the indications and methods of PD in ELBW infants with AKI, determine the appropriate time to apply APD, and reduce complications and mortality rates related to PD.

Abbreviations
AKI, acute kidney injury; PD, peritoneal dialysis; ELBW, extremely-low-birth-weight; NICU, neonatal intensive care unit; RRT, renal replacement therapy; APD, acute peritoneal dialysis; Cr, creatinine; IV, intravenous; CVC, central venous catheter; UF, ultrafiltration; BUN, blood urea nitrogen; PDA, patent ductus arteriosus; SNI, significant neurological injury; NEC, necrotizing enterocolitis; LOS, late-onset sepsis; IVH, intraventricular hemorrhage; MODS, multiple organ dysfunction syndrome; HD, hemodialysis

Declarations

Ethics approval and consent to participate
The study protocol was approved by the Institutional Review Board and Ethics Committee of Asan Medical Center. This was retrospective study, so informed consent was waived.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed in the current study are available from the corresponding author on reasonable request.

Competing interests

The authors have no financial disclosures or potential conflicts of interest to declare.

Funding

No funding was received for this study.

Authors’ contributions

The authors contributed to the study as follows: study design, CYK, EJ; data collection, analysis, and interpretation, JN, CYK; manuscript composition and original draft writing: JN. CYK, EJ; and manuscript review, EJ, JHL, YSP, BSL, EAK, KSK. All authors have read and approved the final manuscript. JN and CYK are contributed equally to this work.

Acknowledgments

None.

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Tables
Table 1. Demographic characteristics of the enrolled subjects (n=12).

| Neonatal characteristics                  |        |
|-------------------------------------------|--------|
| Gestational age (weeks), mean ± SD        | 27.2±3.3 |
| Birth weight (g), mean ± SD               | 706.5±220.5 |
| Male sex, n (%)                           | 7 (58.3) |
| PROM, n (%)                               | 2 (16.7) |
| Cesarean section, n (%)                   | 10 (83.3) |
| Antenatal steroid use, n (%)              | 8 (66.7) |
| Apgar score at 1 min, median (range)      | 2.5 (0-7) |
| Apgar score at 5 min, median (range)      | 5.0 (1-8) |
| IUGR, n (%)                               | 9 (75) |
| RDS, n (%)                                | 11 (91.7) |
| Significant PDA, n (%)                    | 6 (50) |
| Moderate to severe BPD, n (%)             | 5 (41.7) |
| Postnatal steroid therapy, n (%)          | 2 (16.7) |
| Severe neurologic injury (IVH grade ≥3 or PVL), n (%) | 8 (66.7) |
| NEC (stage ≥2), n (%)                     | 0 (0) |
| ROP (stage ≥2), n (%)                     | 2 (16.7) |
| LOS, n (%)                                | 4 (33.3) |
| Hospital stay duration (days), mean ± SD  | 56.1±49.1 |
| Mortality, n (%)                          | 11 (91.7) |

SD, standard deviation; PROM, premature rupture of membranes; IUGR, intrauterine growth retardation; RDS, respiratory distress syndrome; PDA, patent ductus arteriosus; BPD, bronchopulmonary dysplasia; IVH, intraventricular hemorrhage; PVL, periventricular leukomalacia; NEC, necrotizing enterocolitis; ROP, retinopathy of prematurity; LOS, late-onset sepsis.

Table 2. Characteristics of peritoneal dialysis in the 12 ELBW infants with AKI.

| Patient's number | Cause of AKI | Type of peritoneal catheter | Dwelling time (minutes) | Urate (mL/kg/h) | Pre-/post-PD (mg/dL) | Pre-/post-PD (mg/dL) | Pre-/post-PD (mL/kg/h) | Outcome (Causes of mortality) |
|------------------|--------------|----------------------------|-------------------------|-----------------|--------------------|--------------------|------------------------|-------------------------------|
| 1                | Sepsis       | PD catheter (9 Fr)         | 30                      | 74 /6           | 147/1              | 4/7                | 15/5                   | Mortality (Sepsis; MODS)     |

15
| 2 | Y | 2 9 | MODS | 3 UV catheter (4 Fr) | 40 0 24 1. 124/65 1.7 6 | Peritonitis, intra peritoneal hemorrhage | Mortality (MODS) |
| 6 | + | 0 | | | 7 | |
| 4 | | | | | | |

| 3 | NA | 2 4 | Sepsis | 4 ARRO W catheter (4 Fr) | 20 6. 83 6. 2 134/45 10. 0.25/0.1 | Mortality (Hyperkalemia) |
| 5 | + | 2 | | | 3 5 | |
| 2 | | | | | | |

| 4 | NA | 2 5 | Sepsis | 2 6 ARRO W catheter (4 Fr) → PD catheter (8.5 Fr) | 35 1. 64 6. 1. 133/35 5.9 9.5 | Dialysate leak, catheter obstruction | Mortality (Hyperkalemia) |
| 4 | + | 4 | | | 5 8 | |
| 2 | | | | | | |

| 5 | NA | 2 7 | Sepsis | 4 PD catheter (8.5 Fr) | 30 3. 76 2. 125/43 4.5 2.9 | Dialysate leak age | Mortality (Sepsis; MODS, IVH) |
| 6 | + | 6 | | | 7 4 | |
| 6 | | | | | | |

| 6 | NA | 3 9 | MODS | 1 PD catheter (8.5 Fr) | 30 0. 27 1. 138/48 3.9 3.3 | Fetal hydrops | Mortality (Metabolic acidosis) |
| 1 | + | 0 | | | 9 0 | |
| 6 | | | | | | |

| 7 | NA | 3 9 | Sepsis | 2 0 PD catheter (8.5 Fr) | 40 4. 10 2. 130/46 6.5 7 | CoA | Mortality (Sepsis; MODS) |
| 5 | + | 6 | | | 5 7 | |
| 5 | | | | | | |

| 8 | NA | 2 5 | Pulmonary hemorrhage | 3 ARRO W catheter (4.0 Fr) | 45 6. 39 2. 134/53 8.1 4.5 | Dialysate leak age | Mortality (Pulmonary hemorrhage) |
| 6 | + | 6 | | | 5 5 | |
| 6 | | | | | | |

| 9 | NA | 2 4 | Bilateral renal vein thrombosis | 1 2 Bilateral renal vein thrombosis | 30 3. 94 2. 131/40 7.2 5.7 | Dialysate leak age | Mortality (Hyperkalemia) |
| 3 | + | 9 | | | 7 6 | |
| 6 | | | | | | |

| 10 | N | 2 8 | Bilateral renal vein thrombosis | 1 3 PD catheter (8.5 Fr) | 30 2. 98 2. 150/38 7.2 5. | Dialysate leak age, intra peritoneal hemorrhage | Mortality (Hypotensive shock; MODS) |
| 6 | + | 8 | | | 6 1 | |
| 3 | | | | | | |

| 11 | NA | 2 5 | Cardio | 3 PD | 40 1. 29 2. 132/1 7.3 0.1 | TTTS | Mortality |
| | | | | | | |
| 12 | Y |
|---|---|
| 7 | 9 genic shock |
| + | 6 |
| 2 | 4 Sepsis |
| 7 | 7 |
| + | 3 |
| 30 | / 1 |
| 70 | / 2 |
| 2.1 | / 6 |
| 2.92 | / 0.88 |
| 151/1 | 1.13/ 5.7 |
| Catheter obstruction |
| Survival |

ELBW, extremely-low-birth-weight; GA, gestational age; Bwt, body weight; AKI, acute kidney injury; PD, peritoneal dialysis; Fr, French; UF, ultrafiltration; BUN, blood urea nitrogen; Cr, creatinine; MODS, multiple organ dysfunction syndrome; NA, not available; Y, yes; TTTS, twin-to-twin transfusion syndrome; CoA, coarctation of aorta; PA, pulmonary atresia; IVS, intact ventricular septum; IVH, intraventricular hemorrhag

**Figures**

Figure 1

Prognosis of 543 ELBW infants. ELBW, extremely-low-birth-weight; AKI, acute kidney injury; PD, peritoneal dialysis.
Net ultrafiltration. UF was defined as the difference (mL) between the applied dialysis fluid and the amount of dialysate, and was calculated using body weight and dialysis time.

Average UF rate was 2.73 (±1.35) mL/kg/h. UF, ultrafiltration.
Figure 3

Serum BUN, Cr, sodium, and potassium levels pre- and post-PD. BUN, blood urea nitrogen; Cr, creatinine; Na+, sodium; K+, potassium.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

STROBE_checklist.pdf