Renal Replacement Therapy in Neonates

Ahmad Kaddourah, MD, MS, Stuart L. Goldstein, MD*

KEYWORDS

• Acute kidney injury • Continuous renal replacement therapy • Peritoneal dialysis • Hyperammonemia • Neonates

KEY POINTS

- Dialysis is an effective therapy for treating neonates with acute kidney injury and hyperammonemia.
- Peritoneal dialysis is the most common modality for treating acute kidney injury in neonates, although continuous renal replacement therapy is an increasingly utilized alternative.
- Early initiation of dialysis may improve outcomes in neonates with kidney failure and volume overload.
- Hyperammonemia requires rapid intervention with dialysis to decrease neurologic toxicity.

Video of PD catheter accompanies this article at http://www.perinatology.theclinics.com/

INTRODUCTION

Recent advances in the technology and safety of renal replacement therapy (RRT) have changed the practice of pediatric nephrologists significantly in the last 2 decades. In the 1990s, only 53% of pediatric nephrologists offered RRT for infants younger than 1 year of age, and only 41% offered RRT to infants younger than 1 month of age.[1] In 2011, initiation of dialysis in the first year of life represented up to 9.4% of all children who required maintenance dialysis according to the North American Pediatric Renal Trials and Collaborative Studies (NAPRTCS) report. This initiation rate was the highest of any year in the first 18 years of life.[2] Providing RRT is the expected standard of care for newborns when it is indicated. This article reviews the available acute RRT options for neonates to treat acute kidney injury (AKI) and inborn errors of metabolism

Dr Kaddourah was sponsored in the Cincinnati Children's Hospital Pediatric Acute Care Nephrology and Dialysis Fellowship by an unrestricted educational grant from Gambro Renal Products.

Center for Acute Care Nephrology, Cincinnati Children's Hospital Medical Center (CCHMC), MLC 7022, 3333 Burnet Avenue, Cincinnati, OH 45229-3039, USA
* Corresponding authors.
E-mail address: stuart.goldstein@cchmc.org

Clin Perinatol 41 (2014) 517–527
http://dx.doi.org/10.1016/j.clp.2014.05.003 perinatology.theclinics.com
0095-5108/14/$ – see front matter

with hyperammonemia. RRT for chronic end-stage renal disease is beyond the scope of this review.

RRT FOR AKI

AKI is one of the most important independent risk factors for mortality in hospitalized children[3,4] and adults.[5–7] The AKI incidence rate is high in neonatal intensive care units (NICUs) among specific populations such as very low-birth weight infants (18%),[8] neonates undergoing cardiopulmonary bypass (23%–52%),[9,10] and neonates receiving extracorporeal membrane oxygenation (ECMO) (71%).[11] Unfortunately, although AKI has been recognized as an important mortality risk factor, the current universal clinical practice is limited to treating the complications of AKI rather than preventing it. Trials to study the effect of different medications such as fenoldopam[12,13] and rasburicase[14] to prevent AKI have had equivocal results. With the current lack of effective pharmacologic approaches to treat or prevent AKI, RRT is the main intervention to manage its consequences. The common modalities of RRT in the NICU to support neonates with AKI include acute peritoneal dialysis (PD), continuous renal replacement therapy (CRRT), and intermittent hemodialysis (HD). There are no randomized clinical trials to favor one modality; hence, the choice of modality is based on patient condition, physician expertise, and institutional resources.[15]

Acute PD for AKI in Neonates

Unlike older children, in whom CRRT has become the preferred modality for the management of AKI,[16–18] acute PD is the most common modality of RRT provided to neonates. The principal advantages of PD are the relatively easy technique in terms of surgical insertion of a PD catheter and lack of need for vascular access and an extracorporeal blood circuit, which represent the most challenging technical problems for HD and CRRT, especially for low birth-weight neonates.

The requirements for effective PD are a functioning PD catheter, an intact peritoneal membrane, which represents the filter for dialysis, dialysis fluids, and connecting tubing and drainage bags.

PD access

In acute situations, where the clinical scenario requires only a temporary need of dialysis for clearance or volume overload, most neonates receive a temporary peritoneal catheter placed in the true pelvis. There are many commercially available temporary catheters including Tenckhoff (Quinton peritoneal catheters; Kendall Co, Mansfield, MA, USA), Mac-Loc multipurpose drainage (Cook Inc, Bloomington, IN, USA) and Teflon rigid (Cook Inc, Bloomington, IN, USA) catheters, with equivocal evidence of superiority of one over the others.[19] Although these temporary catheters have a higher risk of leak and dialysis failure compared with permanent tunneled PD catheters, they are usually effective and thus recommended as the initial approach.

PD fluids

The dialysis fluid is generally composed of an osmotic agent, a buffer, and electrolytes. These components can be modified to affect blood purification (ie, clearance) and fluid removal (ie, ultrafiltration). **Table 1** shows the components' concentration ranges of the standard commercially available PD fluids.

Osmotic agents Dextrose monohydrate (the bioavailable D-form of glucose) is the conventional osmotic agent used in dialysis fluids. The supraphysiologic concentrations (1500–4250 mg/dL) of dextrose create an osmotic gradient via the peritoneal