Chronic Kidney Disease in the Neonate

Joshua J. Zaritsky, MD, PhD[a,*], Bradley A. Warady, MD[b]

KEYWORDS

• Chronic kidney disease • Neonate • Dialysis • Nutrition

KEY POINTS

- The definition of chronic kidney disease (CKD) in neonates differs from that of children older than 2 years. In addition, kidney function during the neonatal period is characterized as normal, moderately reduced, or severely reduced, based on the age-adjusted glomerular filtration rate (GFR).
- Nutritional management is a key component of the care provided to the neonate with CKD. Optimal nutrition is mandatory if the best possible outcomes in terms of height, weight, and brain development are to be achieved by the neonate or young infant experiencing impaired kidney function.
- Historically, the morbidity and mortality rates of neonates with CKD have been poor, with the presence of nonrenal disease being the most important predictor of mortality. Over the last decade, however, there has been steady improvement in patient survival, even in those patients initiated on chronic dialysis as neonates.

DEFINING CKD IN THE NEONATE

Although the diagnosis of chronic kidney disease (CKD) is applicable to patients of all ages, its definition in neonates has some clear distinctions from that made in older children and adults. Specifically, the criterion established by KDOQI (Kidney Disease Outcomes Quality Initiative)[1] and expanded by KDIGO (Kidney Disease: Improving Global Outcomes)[2] that the duration of kidney disease be longer than 3 months does not apply to neonates. Instead, it is recognized that many of the developmental renal abnormalities that can account for decreased kidney function (see the next section) have lifelong consequences. Thus, it is possible to classify many children as having CKD within the first few days of life.

The diagnosis of CKD in the neonatal period is typically made a priori after a renal ultrasonogram, first performed in the prenatal period and repeated soon after birth,

Disclosures: None.
[a] Department of Pediatrics, Nemours/A.I. duPont Hospital for Children, 1600 Rockland Road, Wilmington, DE 19803, USA; [b] Department of Pediatrics, Children's Mercy Hospital, 2401 Gillham Road, Kansas City, MO 64108, USA
* Corresponding author.
E-mail address: Joshua.zaritsky@nemours.org

Clin Perinatol 41 (2014) 503–515
http://dx.doi.org/10.1016/j.clp.2014.05.002 **perinatology.theclinics.com**
0095-5108/14/$ – see front matter

reveals disorganized renal architecture or a significant urologic abnormality accompanied by abnormal kidney function; this is in stark contrast to adult CKD, which is usually the result of an episode of acute kidney injury (AKI) or a long-standing metabolic (ie, diabetes) or cardiovascular (ie, hypertension) condition. Clearly some neonates who suffer AKI shortly after birth as a result of perinatal asphyxia, hypoxia, sepsis, or hypovolemia will also go on to have long-standing kidney damage and CKD, although the time period that passes before the diagnosis can be made remains variable.[3]

It is important to recognize that the additional diagnostic criterion for CKD as per KDOQI of a glomerular filtration rate (GFR) of less than 60 mL/min/1.73 m^2 does not apply until age greater than 2 years when the body surface area–adjusted GFR is comparable with values achieved by older children and adults. The normal GFR in the newborn period is significantly less than 60 mL/min/1.73 m^2, and increases rapidly owing to enhancement of renal perfusion via a combination of increased mean arterial pressure accompanied by a decrease in renal vascular resistance.[4] Increases in glomerular size and capillary permeability coupled with a redistribution of intrarenal blow flow to more superficial cortical nephrons also contribute to the characteristic increase in GFR that occurs throughout the neonatal period and early infancy.[5]

Thus, the definition of normal kidney function in the neonatal period (and conversely CKD) must take into account age-appropriate values of GFR. There are several published references for normative GFR values in both preterm infants[6,7] and neonates[4,8,9] (**Table 1**). GFR approximation is often made based on serum creatinine levels via a GFR-estimating equation for clinical care. At present the updated Schwarz equation, derived using iohexol clearance and enzymatically measured creatinine, appears to be the most robust,[10] although none of the data that formed the basis for this equation were derived from neonates. In addition, estimated GFRs cannot be used in the setting of AKI when the serum creatinine is rapidly changing.

Given these limitations, attempting to classify a neonate based on the traditional 5 KDOQI stages of CKD is potentially misleading and, therefore, not recommended.

Table 1
Glomerular filtration rate (GFR) in healthy infants as assessed by inulin clearance

Age	Mean GFR ± SD (mL/min/1.73 m^2)
Preterm babies	
1–3 d	14.0 ± 5
1–7 d	18.7 ± 5.5
4–8 d	44.3 ± 9.3
3–13 d	47.8 ± 10.7
8–14 d	35.4 ± 13.4
1.5–4 mo	67.4 ± 16.6
Term babies	
1–3 d	20.8 ± 5.0
3–4 d	39.0 ± 15.1
4–14 d	36.8 ± 7.2
6–14 d	54.6 ± 7.6
15–19 d	46.9 ± 12.5
1–3 mo	85.3 ± 35.1

Abbreviation: SD, standard deviation.

Adapted from Schwartz GJ, Furth SL. Glomerular filtration rate measurement and estimation in chronic kidney disease. Pediatr Nephrol 2007;22(11):1840.