



Hello Kidney

Complications of Chronic Kidney Disease in Children

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Disclosures

I do not have any conflicts of interest to disclose

Chronic Kidney Disease

“Evidence of structural or functional kidney abnormalities (abnormal urinalysis, imaging studies, or histology) that persist for at least 3 months, with or without a decreased a glomerular filtration rate (GFR), as defined by a GFR defined of less than 60ml/min per 1.73m².”

Guideline KDOQI 2002

Incidences in Kidney Disease in Children

- ▶ US statistics: NAPRTCS 5,561 patients aged 2-17
 - age 0-1yr = 19%
 - age 2-5yrs= 33%
 - age 6-12yrs= 17%
 - >12 yrs= 31%
- ▶ International statistics: 18.5- 58.3 per million children
- ▶ Race, gender, age differences in incidences: rate of progression equal in both sexes, although obstructive uropathies are more common in males

NAPRTCS 2002

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Background

- ▶ By 2020, ~785K Americans will have ESRD
- ▶ Cost: \$28 billion/ year
- ▶ Due to importance of growth and neurocognitive development, children are more likely to be vulnerable to the effects of CKD than adults.

CKID Study Protocol 2009

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Risk Factors of CKD

- ▶ have diabetes
- ▶ have high blood pressure
- ▶ have a family history of chronic kidney disease
- ▶ are older
- ▶ belong to an ethnic group that has a high rate of diabetes or high blood pressure, such as African Americans, Hispanic Americans, Asian, Pacific Islanders and American Indians

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Normal GFR In Children

AGE, <i>Mo./MIN/1.73 M²</i>	Average <i>ML/MIN/1.73 M²</i>	Range
▶ 2-8 days	39	17-60
▶ 4-28 days	47	26-68
▶ 30-90 days	58	30-86
▶ 1-6 months	77	39-114
▶ 6-12 months	103	49-157
▶ 12-19 months	127	62-191
▶ 2-12 years	127	89-165

Reproduced with permission Heilbron DC, Holliday MA, al-Dahwi A, Kogan BA. Expressing glomerular filtration rate in children. *Pediatr Nephrol.* 1991; 5:5-11.

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Staging

- ▶ Stage I= normal GFR (>90) and persistent albuminemia
- ▶ Stage II= GFR 60-89 and persistent albuminemia
- ▶ Stage III= GFR 30-59
- ▶ Stage IV= GFR 15-29
- ▶ Stage V = GFR <15 or ESRD

Guideline: KDOQI 2008

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Etiology of CKD

Diagnosis	Incidences
Obstructive Uropathy	22%
Renal Dysplasia	18%
Glomerulonephritis	~10%
Focal Segmental Glomerulosclerosis	~9%
Reflux Nephropathy	8%

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Obstructive Uropathy/ Nephropathy

The image contains three diagrams illustrating urinary system anatomy and pathology. The left diagram shows a normal urinary system with labels for the collecting system, ureter, bladder, hydronephrosis (swelling of the kidney), and hydroureter (swelling of the ureter). The top right diagram shows a normal kidney with labels for the kidney, ureter, pelvis, and ureter. The bottom right diagram, titled 'Obstructed Kidney', shows 'Pathological dilatation (urine accumulation)' and 'Obstruction of the junction' between the kidney and ureter, with a label for the pelvis.

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Renal Dysplasia: Hypoplastic

- ▶ Hypoplastic Kidney: Abnormal small kidney that contain a reduced number of normally developed filtering elements

A black and white photograph showing a small, underdeveloped kidney (hypoplastic kidney) next to a normal-sized kidney for comparison.

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Dysplastic

- ▶ Dysplastic Kidney: Abnormal development of kidneys; may contain cysts

The image compares a 'Normal System' with a 'Multicystic Dysplastic Kidney (MCDK)'. The normal system shows two kidneys with a clear collecting system leading to the bladder. The MCDK system shows a kidney that is replaced by a cluster of cysts, with a distorted collecting system.

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Glomerulonephritis

- ▶ Glomerulonephritis describes the inflammation of the membrane tissue in the kidney that serves as a filter, separating wastes and extra fluid from the blood.
- ▶ aka: Nephritis, Nephrotic Syndrome
- ▶ Acute vs Chronic

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FSGS - Focal Segmental Glomerulosclerosis

- ▶ Focal” means that only some of kidneys’ glomeruli have been damaged, while some are still normal
- ▶ Glomerulo-” refers to the clusters of tiny blood vessels in the kidneys that filter waste from the blood.
- ▶ “Sclerosis” refers to scarring.

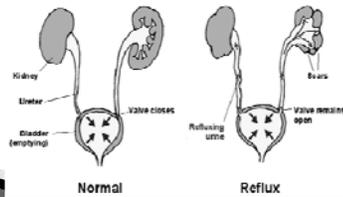
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Reflux Nephropathy

- ▶ aka: Vesicoureteral Reflux, Ureteral Reflux, Chronic Atrophic Pyelonephritis
- ▶ Urine backs up to the kidney; over time can cause scarring



Secondary Effects/ Complications

- ▶ Nutrition
- ▶ Growth
- ▶ Bones
- ▶ Cardiovascular Disease
- ▶ Anemia
- ▶ Neurodevelopment
- ▶ Psychosocial
- ▶ Pharmaceutical Agents

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Nutrition

- ▶ Feeding Disorders: anorexia, N/V, abnormal taste (G-Tubes)
- ▶ Protein: need protein intake, but not in excess
- ▶ Vitamins: Vit D, folate, Nephro QT, Renavite
- ▶ Calories: weight gain for growth
- ▶ Specialized Formula: PM 60/40, Suplena - low in phosphorous and potassium

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Growth

- ▶ The cause of delayed growth in children with kidney disease has been attributed to protein-calorie malnutrition, kidney losses of essential salts, increased tissue breakdown, metabolic acidosis, anemia, kidney related bone disease, and disturbances in the growth hormone-insulin-like growth factor-1 (IGF-1) axis.
- ▶ Adolescents (>13 years old) have less severe height deficits relative to infants (<24 months) and toddlers (2-5 years old). Infants are the worst off overall.
- ▶ Standardized growth charts and head circumference for monitoring growth
- ▶ Growth Hormone Injections

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Growth

- ▶ Children with STD score <-2.5 had two-fold higher risk of death compared to those initiating dialysis with STD score of >-2.5
- ▶ Increased hospital days per moth of dialysis
- ▶ Less likely to attend school
- ▶ Risk factor for increased morbidity and mortality in children with CKD

Furth 2002

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Factors that Contribute to CKD-related Growth Retardation

- ▶ Age of initiation of CKD
- ▶ Type of primary renal disease
- ▶ Concomitant acidosis
- ▶ Malnutrition from calorie deprivation
- ▶ Anemia
- ▶ Secondary hyperparathyroidism (with or without renal osteodystrophy)

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Bones

- ▶ Renal Osteodystrophy: combines features of secondary hyperparathyroidism, rickets, osteomalacia, and osteoporosis
- ▶ Secondary Hyperparathyroidism:
Range 11.8 – 94.8
- ▶ Dietary: low phosphorus foods
- ▶ Medication: Phosphorus Binders – Renvela, Renagel
- ▶ Vitamin D: Calcitriol (PO/ IV), Ergocalciferol
- ▶ Surgery: Parathyroidectomy

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Renal Osteodystrophy



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Cardiovascular Disease

- ▶ Cardiovascular mortality rate reported in children and young adults is almost 1000 times higher than general population group
- ▶ 33% of all deaths in children with ESRD were related to cardiovascular causes
- ▶ ECHO : Left Ventricular Hypertrophy, increased left atrial size, functional changes in systole and diastole, vascular calcifications

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Cardiovascular Disease: Hypertensive Target Organ Damage

- ▶ LVH and increased carotid artery stiffness
- ▶ Abnormalities in 24-hour BP profile
- ▶ Doppler Imaging of the ascending and abdominal aorta

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Anemia

- ▶ Causes: insufficient production of erythropoietin, diseased kidneys or iron deficiency
- ▶ Recombinant Human Erythropoietin: Epogen, Procrit
- ▶ Transfusions
- ▶ Infusions: Venofir, Ferrlecit 1.5 mg/kg per dose of elemental iron
- ▶ Oral Iron Supplements

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Neurodevelopment

Rotundo, et al and McGraw and Haka-Ikse, revealed findings of profound developmental delay in 60-85% of infants with severe renal insufficiency

Warady found that global developmental delay, delay in gross motor skills, overt hyponia, and impaired language development was reported in 20-65% of young infants and toddlers.

Hulstijn-Dirkmaat et al compared the development of 15 toddlers with CKD who were being conservatively managed with that of 16 children who were receiving dialysis therapy

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Neurodevelopment

- ▶ Older children show deficits in :
 1. IQ
 2. Memory
 3. Visual spatial skills
 4. Attention
 5. Executive Cognitive functions

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Factors that Influence Severity of Cognitive Deficits in CKD Kids

- ▶ Age of onset
- ▶ Duration of kidney failure
- ▶ Anemia
- ▶ Depression

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Psychosocial

- ▶ Development of independence is impeded
- ▶ Body Composition and Image
- ▶ Complications/ Frequent Hospitalizations
- ▶ Leads to adulthood: unemployment or lower quality employment
- ▶ Negative impact on siblings
- ▶ Multidisciplinary Approach

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Research

- ▶ **CKID:** Chronic Kidney Disease in Children Prospective Cohort Study – started in October 2003
- ▶ Study Aims :
 - To determine risk factors for progression of pediatric chronic kidney disease
 - To examine the impact of CKD on neurocognitive development
 - To examine the impact of CKD on risk factors for cardiovascular disease
 - To examine the impact of CKD on growth
- ▶ 50 Pediatric Nephrology Sites in North America and largest study in North America funded by National Institutes of Health (NIH)

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Research

- ▶ The North American Pediatric Renal Trials and Collaborative Studies (NAPTRCS) is a research effort organized in 1987. At the outset of the study, the operational objective of this was to obtain the voluntary participation of all renal transplant centers in North America in which (>4) pediatric patients received renal allografts annually. Scientific objectives include capture of information about current practice and trends in immunosuppressive therapy with an ultimate goal of improving care of pediatric renal allograft recipients in North America.
- ▶ In 1992, the study was expanded to include pediatric patients who receive maintenance hemodialysis or peritoneal dialysis therapy. In 1994, data collection began on patients with chronic kidney disease (CKD).

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Don't VOID the Renal System



Thank you for your attention.

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