Symptoms and signs of chronic kidney disease (CKD)
Definition of CKD in children

Chronic kidney disease (CKD) is defined as:
"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 glomerular filtration rate (GFR), as defined by a GFR of less than 60 mL/min per 1.73 m²" (1)

National Kidney Foundation’s Kidney Disease Outcomes Quality Initiative (NKF-K/DOQI) stages of chronic kidney disease

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>GFR (mL/min/1.73m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kidney damage with normal/increased GFR</td>
<td>&gt;90</td>
</tr>
<tr>
<td>2</td>
<td>Kidney damage with mild decrease in GFR</td>
<td>60–89</td>
</tr>
<tr>
<td>3</td>
<td>Moderate decrease in GFR</td>
<td>30–59</td>
</tr>
<tr>
<td>4</td>
<td>Severe decrease in GFR</td>
<td>15–29</td>
</tr>
<tr>
<td>5</td>
<td>Kidney failure</td>
<td>&lt;15 or dialysis</td>
</tr>
</tbody>
</table>

Epidemiology and prevalence of CKD

- CKD is a common disorder of varying severity
- Merits attention of general practitioners and also needs public health approach for
  - Prevention
  - Recognition / early detection
  - Management
- CKD should not only be recognised as “life threatening disorder “ affecting a few children who need the care a nephrologist
Epidemiology of CKD

- There is limited information on the epidemiology of CKD in the paediatric population.

- Most epidemiological information on CKD originates from data available on end-stage renal disease = when treatment with renal replacement therapy becomes necessary.
### Studies on the epidemiology of CKD stages 2–5 in Europe

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Number of cases</td>
<td>1,197</td>
<td>143</td>
<td>605</td>
<td>118</td>
<td>127</td>
<td>282</td>
</tr>
<tr>
<td>Inclusion criteria</td>
<td>0–19 years GFR&lt;75</td>
<td>0–19 years CKD 3–5</td>
<td>0–17 years CKD 2–5</td>
<td>0.5–15 years GFR&lt;30 or SCr&gt;120 (&lt;3 years), &gt;150 (3–9 years), &gt;180 (&gt;10 years)</td>
<td>0–15 years SCr&gt;133 (&lt;2 years) or 175 (&gt;2 years)</td>
<td>0–18 years GFR&lt;75</td>
</tr>
<tr>
<td>Pediatric population covered (millions)</td>
<td>16.8</td>
<td>2.4</td>
<td>11.3</td>
<td>1.7</td>
<td>0.5 (Lorraine)</td>
<td>24.0</td>
</tr>
<tr>
<td>Incidence (pmarp)</td>
<td>12.1</td>
<td>11.9</td>
<td>8.7</td>
<td>7.7</td>
<td>10.5</td>
<td>11.9</td>
</tr>
<tr>
<td>Prevalence (pmarp)</td>
<td>74.7</td>
<td>56</td>
<td>71.1</td>
<td>59</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>Male/female ratio</td>
<td>2.0</td>
<td>1.3</td>
<td>1.9</td>
<td>1.6</td>
<td>1.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Age at diagnosis (years)</td>
<td>6.9 (mean)</td>
<td>3.0 (median)</td>
<td>3.9 (mean)</td>
<td>3.3 and 11.3 in congenital and acquired disorders (median)</td>
<td>6.3 and 10.6 in congenital and acquired disorders (median)</td>
<td>8.0 (mean)</td>
</tr>
<tr>
<td>GFR or CKD stages at diagnosis</td>
<td>GFR 42 (mean)</td>
<td>CKD 3: 67% CKD 4: 19% CKD 5: 14%</td>
<td>GFR 52 (mean) CKD 2–3: 82% CKD 4–5: 18%</td>
<td>Pre-RRT: 57%</td>
<td>Pre-RRT: 76%</td>
<td>CKD 2–3: 38% CKD 4: 30% CKD 5: 32%</td>
</tr>
</tbody>
</table>

Prevalence according to age

The North American Pediatric Renal Transplant Cooperative Study (NAPRTCS) (3) chronic renal insufficiency (CRI) database: 5651 patients aged 2-17 years with an estimated GFR < 75 mL/min per 1.73 m²

- 0-1 years: 19%
- 2-5 years: 33%
- 6-12 years: 17%
- >12 years: 31%

Treatment prospects of CKD

- Associated with high morbidity, mortality and high medical expenditures

- Limited resources – few patients will qualify for renal replacement therapy

- Early detection and optimal management can
  - Prevent development of complications
  - Delay the need for dialysis / transplantation
  - Prevent premature death
Origins of adult kidney disease

- Prenatal factors may have an impact on organogenesis and determine CVS events, hypertension and the risk for CKD at adult age
- Adverse prenatal factors e.g. hypertension, smoking, maternal infection/diabetes → IUGR
- LBW is associated with ↑ risk of CKD and with ↑ rate of progression of established renal disease

Progression of CKD

• Initial insult → hyperfiltration of remaining glomeruli

• self-perpetuating vicious circle of fibrosis → progressive renal scarring, involving all structures of kidney

• Proteinuria develops or worsens in all forms of CKD as renal function ↓
Detection of CKD

- Serum creatinine poor marker of renal function
- >60% of kidney function may be lost while S-creat may remain in normal range
- S-creatinine correlates with muscle bulk, age, gender → falsely low in children with malnutrition
- Main manifestation: development of proteinuria and hypertension
Diagnosis of kidney disease in children

- Symptoms and signs associated with either acute or chronic renal conditions often appear to be unrelated to the kidney
- Advanced renal impairment often remains undetected because of the “functional reserve” of kidneys
- Children with advanced renal failure may have only mild ↑ S-urea and creatinine – thus diagnosis overlooked
Complaints “unrelated” to kidney

- Poor growth from infancy throughout childhood
- Gastrointestinal complaints – vomiting / constipation
- Swelling / pruritis - treated for allergy
- Pale - investigated for anaemia
- Bone disease – treated by physiotherapist / orthopod
- Cardiomegaly - referred to cardiologist
- Shortness of breath “pneumonia”
- “Convulsions / coma
Golden rules to diagnose kidney disease

To increase diagnostic yield of kidney disease (allowing diagnosis in > 90% of cases):

– Obtain a comprehensive medical and family history
– Do thorough physical examination, including growth standards and measure blood pressure
– Do urine dipstick test
• History
  – Antenatal and perinatal history
  – Current problem
  – Growth and development
  – Previous illnesses, investigations & hospitalisation
• Family history – with particular reference to
  – Conditions associated with inherited kidney diseases e.g. deafness
  – Congenital abnormalities of UGT
  – Hypertension
  – Relatives with chronic kidney or cardiovascular disease
Symptoms & signs of underlying kidney disease

- Poor growth
  - Stunting > wasting (Waterloo criteria)
  - Crossing growth standard lines
- Feeding problems: poor appetite, vomiting
- Polydipsia with specific preference for cold water/ice
- Constipation
Clinical examination

• Age taken into consideration
• General examination – in neonate look for
  – Dysmorphic features
  – Features of recognizable syndromes
  – Potter facies
    • Flat facial profile, beaked nose, small chin
    • Low set ears
    • Contractures / hip dislocation / club feet
• Respiratory distress
  – Pulmonary hypoplasia
  – Spontaneous pneumothorax
Clinical examination

• General examination – growth parameters
• JACCOL and DDD
• Vitals
• Systematic examination including
  – Skin, integument (nails and hair)
  – Musculoskeletal system
  – Abdomen, genitalia
  – All systems to be examined completely
Measure height /length

Height is measured erect from the age of 3 years

Length is measured supine from birth – 3 yrs
In older child with CKD, stunting is more common than wasting.
Growth chart depicting growth failure
General Examination

Look for:

- Dehydration in absence of excessive extrarenal fluid losses
- Circulation; peripheral pulses
- Fever (recurring without identified site of infection)
- Anaemia
- Nails: leuconychia / porcelain nails
- Oedema
- Jaundice (± haemolysis / ± liver disease)
Peri-orbital oedema

> In mornings after getting up

Often treated for “allergy”
Pitting peripheral oedema -
Underlying nephrotic syndrome
Oedema

Differentiate between generalised and localised oedema

Here: oedema is localised over dorsal aspects of the feet
Nephrotic syndrome

Anasarka =

Generalised oedema plus fluid collections in body spaces, e.g. pleural and peritoneal cavities
Neonate with

- Abdominal distention
- Fullness in the flanks
- Percussion is necessary to differentiate between fluid, solid organ/mass and air
Abdominal distension
Resonant to percussion
No shifting dullness
Constipation due to polyuria
Dysmorphic Features

Turner Syndrome

- Stunted girl
- Skeletal deformity
- Webbed neck
- Wide spaced nipples
Potter Sequence

- Caused by compression of foetus due to oligohydramnios
- Abnormal facies
- Pulmonary hypoplasia
Prune Belly Syndrome

- Absence of abdominal muscles
- Cryptorchidism
- Dilated urinary tract
  - obstructed or
  - non-obstructed
Measuring the blood pressure
## 95th Percentiles of Blood Pressure for Boys for Age & Height Percentiles

<table>
<thead>
<tr>
<th>Age</th>
<th>Systolic Blood Pressure by Percentile of Height, mmHg+</th>
<th>Diastolic Blood Pressure by Percentile of Height, mmHg+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5% 10% 25% 50% 75% 90% 95%</td>
<td>5% 10% 25% 50% 75% 90% 95%</td>
</tr>
<tr>
<td>1</td>
<td>98 99 101 103 104 107 106</td>
<td>54 54 55 56 57 58 58</td>
</tr>
<tr>
<td>2</td>
<td>101 102 104 106 108 108 110</td>
<td>59 59 60 61 62 63 63</td>
</tr>
<tr>
<td>3</td>
<td>104 105 107 109 110 109 113</td>
<td>63 63 64 65 66 67 67</td>
</tr>
<tr>
<td>4</td>
<td>106 107 109 111 112 111 115</td>
<td>66 67 68 69 70 71 71</td>
</tr>
<tr>
<td>5</td>
<td>108 109 110 112 114 112 116</td>
<td>69 70 71 72 73 74 74</td>
</tr>
<tr>
<td>6</td>
<td>109 110 112 114 115 114 117</td>
<td>72 72 73 74 75 76 76</td>
</tr>
<tr>
<td>7</td>
<td><strong>110</strong> 111 113 115 117 115 119</td>
<td><strong>74</strong> 74 71 76 77 78 78</td>
</tr>
<tr>
<td>8</td>
<td>111 112 114 116 118 117 120</td>
<td>75 76 72 78 79 79 80</td>
</tr>
<tr>
<td>9</td>
<td>113 114 116 118 119 119 121</td>
<td>76 77 74 79 80 81 81</td>
</tr>
</tbody>
</table>
Examine eyes and ears

Including fundoscopy

Acquired and inherited kidney disease often associated with ear or eye pathology

- Night blindness due to Retinitis Pigmentosa
- Retinal degeneration

Juvenile Nephronophthysis
Keratoconus is associated with Alport Syndrome
Impaired eye sight and painful eyes

Corneal opacities in cystinosis
Eye signs associated with kidney disease

- Cataracts – congenital Rubella / CMV / Iatrogenic
- Leucocoria = white pupil (retinoblastoma) or aniridia – both associated with nephroblastoma (Wilm’s tumour)
- Coloboma in UGT abnormalities (mutation of EYA gene)
- Hypertension – hypertensive retinopathy
- Retinopathy: inherited kidney diseases
Skin abnormalities commonly associated with renal disease e.g.

Impetigo in boy with acute post streptococcal glomerulonephritis
Purpura in a patient with Henoch Schönlein Purpura (HSP)
Skin manifestations associated with collagen vascular disease e.g. in SLE / PAN

- Vasculitis
- Purpura
- Erythema nodosum
Skin Manifestations of SLE

Butterfly rash
Skin Manifestations of SLE

Increased nailbed capillaries
- Tuberous sclerosis
- Adenoma sebaceum
- Angiomyolipoma in kidneys
Musculoskeletal System

Rickets in children >2 years ≠ nutritional problem = usually due to renal tubulopathy

Features
  - Skeletal deformities
  - Bone pain
  - Spontaneous fractures
  - Weakness/delayed motor milestones
  - Assess hearing
  - Check eyes
Tetany in a child with renal rickets
Renal rickets
Bossing
Chest deformities
Hypotonia
Tetany
References