The guideline scope extends to both specialist renal units and shared care centres, including those where children are seen by non-specialist paediatricians. This guideline provides guidance on the monitoring of growth in children and young people with CKD. Where this monitoring indicates growth concerns, clinicians should manage and refer cases according to their local or regional paediatric endocrine referral pathways.

Background: Growth retardation is well documented in children with CKD, even in children with mild-moderate chronic renal insufficiency. Short stature is associated with increased morbidity and mortality. A combination of regular anthropometric measurements, clinical assessment of growth and a nutritional assessment is an essential part of treatment in these children.

The guideline rationale is that growth is documented in a proportion of those receiving renal replacement therapy (published in the UK Renal Registry report), leaving scope for improved monitoring for identification of growth failure in children at an earlier stage of CKD.

Evidence indicates that growth hormone (rhGH) therapy achieves a better final height outcome when commenced at a younger age and at a lesser severity of CKD (eg stage 3 rather than end stage 4-5).

When there are linear growth concerns, the initial step remains identification and treatment of nutritional deficiencies and metabolic abnormalities. Then recombinant human growth hormone (rhGH) should be considered if there is growth failure despite the treatment of nutritional deficiencies and metabolic abnormalities.

Growth hormone treatment for children with growth failure associated with Chronic Renal Insufficiency (also known as CKD) is approved by the National Institute of Health and Clinical Excellence (NICE). Treatment with somatropin should always be initiated and monitored by a paediatrician with specialist expertise in managing growth hormone disorders. Growth hormone prescribing is beyond the remit of this guideline whose purpose is to enhance early detection of growth problems and facilitate onward referral.

Evidence base: There is no direct gold standard evidence or specific UK or European consensus guidelines for monitoring the growth of children with moderate to severe renal disease. This document therefore aims to define minimum standards for measuring and monitoring growth in children with CKD, based on local expert opinion, international committee reports, and indirectly supportive peer-reviewed clinical trials and reviews. Multiple measures are necessary to give a broad and reliable picture of
growth and nutrition, and the frequency of measurement will depend on the child’s age and stage of CKD (see page2). Children displaying growth delay or unstable medical or nutritional status will require more frequent monitoring\textsuperscript{10}, as will those with more complex social or medical problems.

There are other international guidelines on growth monitoring in children with CKD (US and Australia\textsuperscript{10,13}). This guideline is the second version of a UK guideline for growth monitoring in this population group of children with CKD.

**The evidence base** for this guideline was reviewed using the following search strategy: MeSH terms for Kidney and kidney disease were combined with MeSH terms for Children and Growth and Nutrition assessment on 10.06.2015. The Cochrane database was also searched for articles with the search terms ‘kidney’, ‘children’ and ‘growth’.

**Grading of Recommendations:** The modified GRADE system was used to define the strength of recommendation and level of evidence supporting this guideline\textsuperscript{11}. This highlighted two features: there was consistent evidence that growth monitoring is required in CKD, with the benefits of this clearly outweighing any risks (1B). However the frequency of measurement we recommend provides significant benefits in our opinion but has a weak evidence base due to a general lack of studies in this area(1D).

**This guideline is endorsed by** The British Society for Paediatric Endocrinology and Diabetes (BSPED), The British Association for Paediatric Nephrology (BAPN) and The Paediatric Renal Interest Nutrition Group (PRING).

<p>| Stages of Chronic Kidney Disease (CKD) \textsuperscript{14} |
|---------------------------------|---------------------------------|---------------------------------|</p>
<table>
<thead>
<tr>
<th><strong>Stage</strong></th>
<th><em><em>GFR</em> (ml/min/1.73m\textsuperscript{2})</em>*</th>
<th><strong>Description</strong></th>
<th><strong>Management</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt; 90</td>
<td>Normal Renal Function (but urinalysis, structural abnormalities or genetic factors indicate renal disease)</td>
<td>Observation and control of blood pressure</td>
</tr>
<tr>
<td>2</td>
<td>60-89</td>
<td>Mildly reduced renal function (Stage 2 CKD should not be diagnosed on GFR alone - but urinalysis, structural abnormalities or genetic factors indicate renal disease)</td>
<td>Observation, control of blood pressure and cardiovascular risk factors</td>
</tr>
<tr>
<td>3a</td>
<td>45-59</td>
<td>Moderate decrease in renal function, with or without other evidence of kidney damage</td>
<td>Observation, control of blood pressure and cardiovascular risk factors</td>
</tr>
<tr>
<td>3b</td>
<td>30-44</td>
<td>Moderate decrease in renal function, with or without other evidence of kidney damage</td>
<td>Observation, control of blood pressure and cardiovascular risk factors</td>
</tr>
<tr>
<td>4</td>
<td>15-29</td>
<td>Severely reduced renal function</td>
<td>Planning for end-stage renal failure</td>
</tr>
<tr>
<td>5</td>
<td>&lt;15</td>
<td>Very severe (end-stage) renal failure</td>
<td>Transplant / Dialysis</td>
</tr>
</tbody>
</table>

*GFR: Glomerular Filtration Rate values normalised to an average surface area (size) of 1.73m\textsuperscript{2}
Notes on Growth Monitoring (measuring and plotting)
The table on the following page outlines the detail of the required growth monitoring with frequency of measurement and plotting at various ages and according to CKD stage (CKD stage defined on previous page).

Staff should be competent in measuring and plotting and use appropriate growth charts. The Royal College of Paediatrics and Child Health provides education and training information for healthcare professionals. Along with currently available UK-WHO growth charts, training guides can be found at www.rcpch.ac.uk/growthcharts.15 Items to note are:

- Measure infants nude and older children in light clothing and without shoes.
- Use corrected age up to 1 year for patients born 32-37 weeks gestation. Use corrected age up to 2 years for patients born earlier than 32 weeks gestation.
- Measurements should be plotted on UK WHO 0-4 (2009) and UK 2-18 (2013) growth charts
- Or if there are clinical concerns requiring close growth monitoring, the following are useful:
  b) Childhood and puberty close monitoring (CPCM) growth charts UK 2-20yr (2013) (These are available but not yet widely adopted, and include puberty phase specific centile lines.

Notes regarding onward referral
The guideline focuses on the monitoring of growth. This guideline does not quote absolute referral criteria. This is consistent with current RCPCH Growth Monitoring Guidelines, as there is no evidence based criteria as to what cut-off constitutes poor growth in all children.

Within the renal arena, there are differing thresholds in three nations recommendations (US takes height less than or equal to 2nd centile as the cut-off 10, Australia uses 25th centile 12, whilst NICE UK outlines to consider GH in CRI for “growth failure”16, a term which is not quantified in that guideline). These highlight the lack of firm evidence base.

The importance is for the clinician to accurately monitor and chart a child’s growth to enable the clinician to identify whether the growth is optimal or not and for the clinician to consider next steps.

This guideline's pragmatic suggestion is for the clinician to consider paediatric endocrine referral if:

- growth is slowing (crossing height centiles or height velocity < 25th centile)
- or child’s height centile is beneath the mid-parental height range.

Consideration should be given to undertaking a bone age Xray where there are growth concerns. (Evidence review does not substantiate routine bone age Xrays where there are not growth concerns).
<table>
<thead>
<tr>
<th>GFR ml/min 1.73m²</th>
<th>CKD Stage</th>
<th>MEASUREMENT</th>
<th>FREQUENCY OF MEASUREMENT</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 90</td>
<td>Stage 1</td>
<td>Normal childhood growth monitoring</td>
<td>Royal College of Paediatrics &amp; Child Health (RCPCH) guideline (Page 2)</td>
<td>Measure, document and plot on growth chart (Page 2)</td>
</tr>
<tr>
<td>60-89</td>
<td>Stage 2</td>
<td>Length/height and weight</td>
<td>Annually¹⁰</td>
<td>Measure, document and plot on growth chart</td>
</tr>
<tr>
<td>GFR ml/min 1.73m²</td>
<td>CKD Stage 3-5</td>
<td>MEASUREMENT</td>
<td>FREQUENCY OF MEASUREMENT (minimum recommended)</td>
<td>ACTION</td>
</tr>
<tr>
<td>≤ 59</td>
<td></td>
<td>Weight (Euvolaemic i.e normal fluid status) 4,7,13,10,17</td>
<td>Measure every clinic visit but for growth purposes required: Every month if aged &lt; 6 months Every 2 months if 6-12 months Every 3 months if &gt;1 yr</td>
<td>Measure, document and plot on growth chart</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Head circumference⁴,10,16</td>
<td>Every 2 months if &lt; 1 yr Every 3 months if 1-2 yrs</td>
<td>Measure, document and plot on standard head circumference curve on growth chart.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Length/Height⁴,7,10,14,16</td>
<td>Every 2 months if 0-1 yr Every 3 months if &gt; 1 yr</td>
<td>Measure supine length if &lt;2 years on validated length mat i.e. rollametre or kiddimetre. Measure standing height if &gt;2 years on wall-mounted stadiometer⁴. Document and plot on growth chart. Sitting height, knee height or total leg length can be used as height proxies¹⁸,19.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assess Pubertal Stage</td>
<td>Annually if ≥ 12 years. i.e. during the older half of the normal age range of onset of puberty in girls 8-13 years, boys 9-14 years.</td>
<td>Consider whether growth and development progress is as expected or whether concern of pubertal delay. Consider using CPCM Chart if concerns assess six monthly.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Body Mass Index (BMI)⁴,7,9,10,19</td>
<td>Only applicable if &gt; 2 years, then do so every 6 months⁴,20</td>
<td>Calculate and plot on growth chart (UK 2-18 yrs) against chronological age ²¹</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parental heights</td>
<td>At commencement of growth monitoring.</td>
<td>Calculate Mid-parental height using information on growth chart. Document in notes and on growth chart</td>
</tr>
</tbody>
</table>

All these items for Children with greater severity CKD i.e. Stages 3 – 5.
References


15. UK-WHO Growth Charts. Royal College of Paediatrics and Child Health . Website at http//:www.rcpch.ac.uk/growthcharts


21. Cole, T. Personal communication 2010