Paediatric CT Practice - How safe is imaging in different countries?

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1. List of the facility’s CTDI and DLP for children from different age groups

Patients were selected randomly from the HIS, but care was taken only to include single region investigations. In all data patients were classified in the following age groups: Baby/Toddler: up to 3 years
Pre-School: 3 to <=6 years
School Age: 6 to <=10 years
Youngster: 10 to <=14 years
Adolescent: more than 14 years (max age 18 years and additional 7 pediatric oncologic follow-up patients between 20 to 26 years

Within some age groups there is no standard deviation (SDEV) listed, due to the limited number of patients and multi-organ scanning (e.g. chest CTA for sequestration) – those investigations were not included in dose analysis. Some CT machines always calculate CTDI and DLP for children based on a 6cm phantom, therefore these values were corrected in larger children (e.g. transversal diameter >= 24cm) by dividing CTDI and DLP by two.

Table 1: Age dependent dose values for head CT

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Regular Head CT Mean-CTDI</th>
<th>Regular Head CT SDEV-CTDI</th>
<th>Regular Head CT Mean-DLP</th>
<th>Regular Head CT SDEV-DLP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baby/Toddler</td>
<td>16.80</td>
<td>0.85</td>
<td>22.52</td>
<td>2.32</td>
</tr>
<tr>
<td>Pre-School</td>
<td>23.00</td>
<td>0.85</td>
<td>47.72</td>
<td>4.80</td>
</tr>
<tr>
<td>School Age</td>
<td>28.00</td>
<td>1.00</td>
<td>78.45</td>
<td>7.84</td>
</tr>
</tbody>
</table>

2. Information to indicate how radiation protection is promoted and practiced

Our Division of Pediatric Radiology does not run a webpage about our radiation protection strategy, but online resources from the division are available:
http://www.auntminnieeurope.com/index.aspx?sec=sup&sub=cto&pag=dis&ItemID=606029

3. How radiation protection during paediatric CT is practised in the facility

Due the availability of CT and MRI at our division, MRI imaging is used whenever possible, e.g. for non-traumatic, head injuries, inflammatory and neoplastic central nervous system diseases, hydrocephalus evaluation in ventriculo-peritoneal shunts, musculoskeletal diseases, cardiovascular assessment, abdominal/gastrointestinal questions, neurogenic diseases, and oncologic follow-up, except chest, to name just a few. CT scanning is used in trauma patients, complex cases and chest CT in oncologic follow-up. CT and MRI examinations are adapted to the institution, as well as clinical question - e.g. high contrast examinations (inner ear, airways, chest, CTA) and low-contrast examinations (brain, abdomen). All types of protocol are saved on the CT console and documentation can be found on the division’s intranet portal.

4. Assessment of the number of paediatric CT examinations that lack appropriateness

Due to the division’s meetings with clinical partners (e.g. daily interdisciplinary reporting at the ICU Units, regular weekly, interdisciplinary meetings) most patients are already discussed. The referral diagnosis for CT is checked by the attending paediatric radiologist and, in cooperation with radiographers, an appropriate protocol is selected or modified if necessary.

Those CT examinations with troublesome output (e.g. suboptimal enhancement after intravenous contrast injections, examinations with high noise content, unnecessary long scan range) are discussed in regular divisions meetings and a quality assurance programme exists.

5. Data on the percentage of dose reduction in CT of children

Patients are carefully placed (e.g. head in centre) and all positioning tools and goodies are used. All steps in the ‘imaging chain’ (Fig1) are optimised for children. Bismuth shielding (augmented by 2cm rubber foam between bismuth and skin in order to avoid artefacts) is combined with Z-modulation, which turned out to be the best option on our machine. Bismuth is used for the scan but not for the scout view. Tube down for scout view helps to reduce dose by 50% for thyroid and mammary gland. Scout view exposures settings are adapted to age. In babies, we use 80kV, between one and 14 years 100kV, and 120kV for all other ages. The mAs-settings are influenced by the above mentioned high/low contrast situation, as well as by tube modulation. Care is taken in small children, as a paucity of fat means there is less contrast and more noise - this fact is compensated for in the protocols.

6. How we manage dose in paediatric CT at Graz/Austria

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6.1. How we manage dose in paediatric CT at Graz/Austria

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7. Number of paediatric CT referrals that are reviewed by radiologists before giving appointments

For almost all indications there are age specific protocols on the CT machine and all investigations are planned and discussed in cooperation with radiologists and radiographers - both professions specialised in paediatric radiology. Due to the use of paediatric-adapted automated exposure control the machine keeps noise low, according the chosen parameter, constant in slim and obese patients. For IV contrast injection an Excel sheet has been developed, which calculates the amount of contrast medium, as well as the delay for almost all frequent clinical questions. Since 2011 the ‘Size-Specific Dose Estimates (SSDE) in Pediatric and Adult Body CT Examinations’ (AAPM Report 204) has been implemented too.

7.1. Number of paediatric CT referrals that are reviewed by radiologists before giving appointments

As already explained above, paediatric radiologists visit daily intensive care units and there are several meetings with clinical colleagues. Moreover, since paediatric radiologists perform all types of imaging in children, with the exception of nuclear medicine studies and some interventional procedures, patient problems and clinical questions are usually known to division staff.

All CT referrals are reviewed by the attending paediatric radiologist, including patient history and previous imaging results. If ultrasound, or MRI is the better modality to answer the clinical question then the patient is transferred to those modalities.

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