Clinical Audit in a Pediatric Radiology Department

The establishment of Diagnostic Reference Levels (DRLs) is a first step in clinical auditing of radiology departments. Comparison of local and European DRLs can prompt re-evaluation/optimization of procedures.

This article describes a practical example of such a clinical audit in a Portuguese pediatric radiology department.

The worldwide use of ionizing radiation for medical use has increased considerably over the last few years [1]. Recent studies indicate that the dose a patient receives can vary considerably from one healthcare unit to another, even for the same type of examination, suggesting that there is a considerable margin for optimization and dose reduction [2–4]. This is all the more important in pediatrics, given that children are ten times more vulnerable to the effects of radiation than adults. Dose reduction should be a matter of concern in all radiology but especially in pediatrics [5].

Dose values should be reviewed periodically to ensure adequate radiological protection according to clinical audit Directive 97/43 EURATOM [6].

PEDiatric CLINICAl AUDIT

A clinical audit is defined as a process based on a structured review of radiological practices, procedures and results carried out in order to promote standards of good medical radiological practices [7]. The overall aim is the improvement of the quality and outcome of patient care. The audit process is established to ensure that all facilities and professionals are in accordance with European Directives. Guidelines for the carrying out of a clinical audit are given in the Radiation Protection report no.159 [6].

Conducting clinical audits of the ionizing radiation used for medical purposes is mandatory in the EU, although the audit frequency and detailed methods may differ from Member State to Member State. The quantification of dose is done by the establishment of local Diagnostic Reference Levels (DRLs). Establishment of DRLs is a basic step in the audit process.

The first directive of the Patient Radiation Protection document, 84/466 EURATOM, states that quality criteria must be tailored to pediatric patients, because of their higher radiosensitivity and life expectancy [8]. Female children are more radiosensitive compared with males of the same age [9]. The justification of making the radiological examination in the first place, the use of standardised techniques and procedures as well as the optimization of the protective measures are all important factors to ensure the optimization of dose with the overall objective of micronizing the potential risks without any loss in diagnostic accuracy. Therefore, it is always essential to balance the benefits of a procedure against the possibility of inducing damage or harming the patient, although this can be difficult to quantify [10]. Exposure in pediatric imaging depends on several factors such as age, gender, body mass index, antero-posterior and lateral diameters, the cooperation of the children themselves, as well as the technology and equipment being used and the selection of the exposure parameters.

This pioneer study in Portugal aimed to promote a radiological clinical audit and demonstrate that optimization and radiological protection assume a major role in pediatrics.

METHODOLOGY

The study took place at the Pediatric Hospital of Coimbra, Portugal. The frequency of radiological examinations and local DRLs were analyzed and compared with recommendations and international literature.

A retrospective data analysis of dose reports and Digital Imaging and Communication in Medicine (DICOM) headers available in Picture Archiving and Communication System (PACS) was performed for the two most common procedures per modality (radiography, Computed Tomography (CT) and fluoroscopy).

Children who had radiological examinations in 2012 were categorized according to age into several groups, namely 0, 5, 10 and 15 year old (+/− 1 month). For each age group and procedure ten dose files were collected as well as information on the patient gender, age and type of radiological examination. Exposure parameters were collected as well as the appropriate dose descriptors for the modality used. These were the Dose Area Product (DAP) expressed in Gy.cm² for radiography and fluoroscopy. For CT, the CT Dose Volume Index (CTDvol) expressed in mGy and Dose Length Product (DLP) expressed in mGy.cm were also used.
RESULTS

The most common procedures were selected and local DRLs were established for these procedures in the following age groups:

- 0 year: chest radiography, head CT and micturating cystourethrography (MCU);
- 5 years: chest radiography, pelvis radiography, head CT and chest CT;
- 10 years: chest radiography, pelvis radiography and head CT;
- 15 years: chest radiography, head CT and chest CT.

The results showed a large variation and inconsistency in the selection of exposure parameters according to patient age/size.

Table 1 shows the comparison of the locally established DRLs with other European pediatric studies.

It can be seen that the majority of the local DRLs for chest and pelvis radiography and the MCU examination are similar to other European studies. The locally established DRLs for chest CT were in general much lower than those in other European studies whereas, for head CT, the local DRLs were in general much higher than the other European DRLs.

A multidisciplinary team was assembled to analyze the results of these dose values and the underlying practices. In particular the dose values for CT suggested that there was a high potential for optimization of procedures and suggested the need to revise protocols. The adjustment of the exposure parameters, as a function of age categorisation, could have a great impact on dose value with minimal impact on image noise.

Our pediatric hospital participated in a collaboration for the calculation of Portuguese national CT DRLs [15] and decided to participate in experimental tests for CT optimization [16]. The results of these studies prompted an upgrade of the CT software to include a combination of tube current and tube voltage modulation. This enabled a mean dose reduction of 43% for head CT examinations [17].

CONCLUSION

This study was carried out in 2012 according to the recommendations and guidelines of Radiation Protection report no.159, which describes how to implement a structured audit in a Radiology Department in compliance with the most recent guidelines from International Atomic Energy Agency (IAEA) [1].

The carrying out of clinical audits is imperative to ensure both the safety of patients and diagnostic accuracy. The establishment of DRLs is the first step in an audit and is the best way to guarantee self-assessment and continuous improvement of radiology practices. The results of our audit highlighted the need for optimization of procedures and also to alert radiographers and radiologists and encourage them to participate in experimental and clinical studies in order to promote dose reduction in their pediatric patients.

REFERENCES

5. Strauss K et al. Image quality: Ten steps you can take to optimize image quality and lower CT dose for pediatric patients. AJR Am J Roentgenol. 2010;201:156-868

TABLE 1. Comparison of locally established DRLs with other European pediatric studies.

<table>
<thead>
<tr>
<th>Body Region</th>
<th>Dose Descriptor</th>
<th>Age (years)</th>
<th>This Study</th>
<th>UK 2005</th>
<th>IT 2004</th>
<th>DDM2 2012</th>
<th>Austria</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCU</td>
<td>DAP (mGy·cm²)</td>
<td>0</td>
<td>104</td>
<td>400</td>
<td>-</td>
<td>300</td>
<td>-</td>
</tr>
<tr>
<td>Chest</td>
<td>DAP (mGy·cm²)</td>
<td>0</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CT DRL</td>
<td>DAP (mGy·cm²)</td>
<td>5</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Head CT</td>
<td>DAP (mGy·cm²)</td>
<td>0</td>
<td>699</td>
<td>270</td>
<td>-</td>
<td>270</td>
<td>-</td>
</tr>
<tr>
<td>Chest CT</td>
<td>DAP (mGy·cm²)</td>
<td>5</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

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