A Dose Management Online System for quality assurance in an emergency radiology facility

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Background/introduction

As part of optimization principle in medical exposures, Euratom Directive highlights the importance of Quality Assurance (QA) programmes and assessment of patient doses in diagnostic radiology. Within QA framework, patient dosimetry plays a crucial role since it may represent an indicator to evaluate the optimization of protection in a radiology department.

Computed tomography (CT) is nowadays widely used in radiology because of its fast performance and high quality diagnostic images. Nevertheless, radiation doses associated with CT examinations are relatively high, so the dose optimization to patients is a priority while maintaining the diagnostic image quality. This is achieved by means of modulation technology, reconstructions algorithms and scanning parameters. Additionally, a systematic monitoring of the radiological examinations and tracking of patient doses represent an effective method for that purpose. The introduction, during last years, of automated dose tracking software, has facilitated monitoring and recording the scanning information of every CT examination. With regard of patient safety, these systems allow to set alarm levels for the detection and analysis of unusual doses in individual patients.

The aim of this study is to evaluate the CT dose data from a dose management online system, for reporting and managing unusual patient doses as a critical aspect of the radiology department QA programme, in order to set improvement actions.
Description of activity and work performed

Material

The study has been performed at the Radiology and Emergency radiology Departments of a University Hospital. A total of 16119 CT studies performed during one year have been included. These studies were performed at a Siemens Somatom Sensation 64 unit, placed in Radiology Department, and at a Siemens Somatom Sensation 40 unit placed in the Emergency Department. The dose data and other study parameters are automatically exported to DoseWatch, software developed by General Electric (GE®) for monitoring the radiation dose to patients. This software is connected to different devices at the department, providing every CT study data and allowing to statistically analyse them.

Doses are evaluated in terms of the Dose Length Product value (DLP), dosimetric quantity which gives an estimation of the total absorbed dose received by the patient during the whole scan (measured in mGy·cm). DLP values are estimated by the CT units from the scan parameters and exported to DoseWatch. DoseWatch allows to establish dose alarm levels in order to track unusual DLP values easily. These levels can be specified by the user. At the Department, the alarm level was set at 2 times the 75th percentile of the values collected from all the CT units, for each type of study. Doses from 18 different types of studies were analysed. CT scanning parameters such as CT surview and time of acquisitions performed were also taken into consideration in order to discard from the analysis extreme values of DLP.

Results

The data collected revealed that 3% of total examinations overcame the alarm level, and the totality of them were performed at the Emergency facility unit, where the professionals rotate frequently. The studies with higher proportion of alarms were Stroke Code CT, Angiography CT and Aorta CT (Table 1). The studies which proportion of mean DLP values from alarms/no alarms is Thorax CT (factor, f, mean DLP_{alarms}/DLP_{No alarms} = 5.92) followed by Angiography CT, Thorax/Abdomen CT, Abdomen CT and Brain CT (f=2.83, 2.69, 2.67, 2.59 respectively) (Figure 1).

A number of acquisitions with small DLP values were observed indicating unfinished exposures, representing the 0.2% of the studies.
These results may be due to the complexity of some studies or even patient size. From the analysis performed, it was observed that certain medical findings during the patient scan required more series to be made and the final study would correspond to a different categorization. In terms of Brain CT studies, 5% of the examinations in the Emergency facility which were not identified by the system as alarms reflected indeed DLP values above 2000 mGy·cm. The relatively high DLP values together with the fact that those examinations have a great number of imaging series, reveal that they really fall into the Stroke Code CT category instead of Brain CT.

These results have revealed the need to inform the technologists about the need to check the correct categorization of the study before being saved and closed. In this regard, some education sessions for physicians and technologists of the department have been performed, in order to improve quality criteria.
<table>
<thead>
<tr>
<th>Study</th>
<th>Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain CT</td>
<td>4%</td>
</tr>
<tr>
<td>Stroke Code</td>
<td>27%</td>
</tr>
<tr>
<td>Abdomen CT</td>
<td>7%</td>
</tr>
<tr>
<td>Angiography CT</td>
<td>24%</td>
</tr>
<tr>
<td>Pulmonary arteries CT</td>
<td>10%</td>
</tr>
<tr>
<td>Thorax CT</td>
<td>7%</td>
</tr>
<tr>
<td>Aorta CT</td>
<td>21%</td>
</tr>
<tr>
<td>Spine/Thorax/Abdomen CT</td>
<td>16%</td>
</tr>
<tr>
<td>Thorax/Abdomen CT</td>
<td>11%</td>
</tr>
<tr>
<td>Face/Neck CT</td>
<td>8%</td>
</tr>
</tbody>
</table>

**Table 1:** Alarms percentage for each study

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Fig. 1: Mean DLP values from alarms and no alarms for the most frequent studies performed at both Radiology and Emergency Departments.

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Conclusion and recommendations

The use of dose management system for data monitoring allowed a fast reviewing of the examination doses.

The use of, not only Diagnostic Reference Levels (DRLs) but also alarm levels for optimizations purposes allows to easily detect unusual doses or even overexposures.

Education and training efforts have to be made in order to improve CT protocols and categorization of studies in Emergency Department as part of the QA programme.
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