Owing to increased diagnostic accuracy, availability and patient flow there has been a rapid surge in the utilisation of CT over the last few decades at the cost of being one of the largest sources of medical radiation exposure (1). In Switzerland alone, the number of CT examinations has increased by 142% from 1998 to 2008, and in 2008 CT was accountable for 68% of annual medical radiation exposure (2). Stochastic effects such as malignancies have recently been attributed to CT in children and young adults (3, 4).

The inherent risks associated with ionising radiation are a compelling argument for the radiological community to invest in CT dose reduction and uphold the ALARA (as low as reasonably achievable) principle. Various strategies for dose reduction have been suggested such as a rigorous review of indication, implementation of novel technologies, use of low-dose protocols and practical radiation protection by technicians (e.g. reduction of scan length). Although radiology departments spend considerable resources (e.g. time for evaluation and training, financial investment in state-of-the-art equipment) to improve patient safety in CT, the measurement of quality outcome through meaningful quantitative indicators such as CT dose metrics (e.g. CTDI, DLP, SSDE) have been widely neglected. A potential reason for this neglect is the very complex and time-consuming work required to manually collect doses from each CT performed at an institution. With the recent introduction of different dose management software, dose tracking can now be done in a comprehensive and fully automated method. The analysis of this valuable data offers radiologists, medical physicists and administrators an opportunity to monitor the actual dose distributions and helps in planning evidence-based future investments (e.g. continuous quality improvement programmes, technical developments).

The Clinic of Radiology and Nuclear Medicine at the University of Basel Hospital has been using dose management software (Radimetrics™, Bayer) since September 2013 and applying it for improvement programmes, technical developments).

At patient level
1. Tracking cumulative effective dose

The aim is to limit periodic CT scans in adolescents patients or patients with benign conditions, where alternative modalities such as ultrasound or MRI would suffice without affecting patient management. As shown in Figure 2, a common threshold level at a cumulative effective dose of 100 mSv. If a patient exceeds this dose, the information is passed on to our radiology information system (RIS) aiming at a stricter justification next time.

2. Identifying dose outliers

Early detection of systematic errors like unintentional selection of wrong technical parameters is possible. We have set up a threshold value for each CT protocol using CTDI and have chosen an arbitrary dose threshold level at 5 mSv above the national diagnostic reference levels (DRLs) as no current guidelines exist. If an outlier occurs then the dose management team is alerted by email.

At institutional level
1. Dose tracking

The dose management software tracks the dose from each CT examination and calculates the average dose for different CT protocols based on thousands of CT studies. This gives us an overview of CT doses in our institution (Table 1). Dose tracking is performed for our 20 most frequently performed CT protocols.

### Table 1: CT Dose statistics between 2012 and 2014 from the University of Basel Hospital assessed with a dose management software.

<table>
<thead>
<tr>
<th>Protocol Description</th>
<th>2012 Mean ED (mSv)</th>
<th>2013 Mean ED (mSv)</th>
<th>2014 Mean ED (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routine CT abdomen-pelvis</td>
<td>11.73</td>
<td>12.24</td>
<td>14.50</td>
</tr>
<tr>
<td>Routine CT abdomen-pelvis for urolithiasis</td>
<td>6.45</td>
<td>7.62</td>
<td>7.42</td>
</tr>
<tr>
<td>Total no. of CT scans</td>
<td>1,173</td>
<td>1,224</td>
<td>1,450</td>
</tr>
<tr>
<td>Mean ED (mSv)</td>
<td>9.6</td>
<td>9.6</td>
<td>8.1</td>
</tr>
<tr>
<td>Routine CT abdomen-pelvis</td>
<td>5.4</td>
<td>3.1</td>
<td>2.8</td>
</tr>
<tr>
<td>Total no. of CT scans</td>
<td>2014 three scanners were equipped with the same.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The introduction of dose management software has given us the opportunity to have an integrated view of our CT doses at patient and institutional levels with the ability to detect dose outliers early. In addition, such IT solutions for dose tracking are the basis for establishing a national dose index registry.

The goal of standardised CT doses is driving the Swiss Society of Radiology to build up a national CT dose registry in the future by using state-of-the-art dose management software for dose tracking.

### References