Systematic analysis of chest radiographs and their dose exceedances
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How can we get better?

A. Steuwe, M. Groß, A. Ljimani, B. Valentin, G. Antoch

University Hospital Düsseldorf, Düsseldorf, Germany

The authors have no actual or potential conflict of interest in relation to this program/presentation.
Purpose

• Analyze dose exceedances in chest radiographs
• Increase the image quality
• Reduce the radiation exposure
• German diagnostic reference levels:
  – PA: 15 cGycm²
  – LAT: 40 cGycm²
Materials & Methods

- Study interval: 10/2021-11/2021
- Modality: Digital Diagnost 3.1 (Philips Healthcare, the Netherlands; installation 2014)
- Patient height & weight documented
- Dose management system Sectra DoseTrack™, Sectra (Sweden)
  - Dose area product (cGycm²)
  - Tube settings (potential (kV), tube current-time product (mAs))
  - Reason for dose exceedance
Analysis of dose exceedances

• Selected reasons for dose alerts
  – Obesity
  – Insufficient collimation
    • Unstable posture of patient
  – Dense pulmonary parenchyma
  – Low arm positioning
  – Metallic implants
  – Mixture of several factors
  – Others
Initial results

- 1354 radiographs in two months
- BMI 25.0-29.9 kg/m²: 29%
- BMI >30 kg/m²: 18%
- 24% alerts in total (p.a. (15%) and LL. (85%))

<table>
<thead>
<tr>
<th>Major reasons for dose exceedance (LL)</th>
<th>PA</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient collimation</td>
<td>28%</td>
<td>52%</td>
</tr>
<tr>
<td>Obesity</td>
<td>50%</td>
<td>25%</td>
</tr>
<tr>
<td>Combination of collimation and obesity</td>
<td>8%</td>
<td>2%</td>
</tr>
<tr>
<td>Arm positioning</td>
<td>4%</td>
<td>6%</td>
</tr>
<tr>
<td>Dense lung parenchyma</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>Not evaluable/no definite reason</td>
<td>4%</td>
<td>18%</td>
</tr>
</tbody>
</table>
Interventions

• Feedback to technicians and technicians-in-training
  – Why do we see dose exceedances?
  – Where do we see them?
  – (How) can they be prevented?

• Regular attendance of physicists at x-ray examination rooms
  – Analyze daily clinical practice and associated problems
  – Provide tips & tricks
  – Availability for questions and discussions
Interventions

• Involvement in dose-monitoring-system analysis
  – Increase awareness
  – Increase personal responsibility
  – Compare self acquired images and dose values to others

• Demonstrations of good and bad image examples in morning meetings
  – Are there general problems with the X-ray unit or its settings?
  – How to increase quality?
Effects from interventions

• Technicians and technicians-in-training are more aware of DRLs and dose values to be expected
  – Improved critical reflection on image quality and dose
• Feedback conversations between physicists, technicians and radiologists are a valuable tool
  – Useful suggestions for improvement
  – Important: Positive feedback for good acquisitions!
• Dose alerts due to insufficient collimation occur less frequently, however
  – Collimation in overweight and obese patients remains challenging
  – Lack of straight posture in elderly patients requires larger collimation
**Discussion**

- **German DRLs applicable for patients with a weight of 70 ± 3 kg**
  - Nearly 50% of the patients were overweight $\rightarrow$ higher dose necessary to maintain image quality
  - Proper collimation is more difficult in overweight patients

- **Varying and large technician teams $\rightarrow$ difficult to reach the whole team directly**

- **Additional step after first intervention: pre-set collimation was reduced to a smaller initial FOV (similar to p.a. acquisitions)**
  - Further improvement notable
Future directions

• Ongoing critical revision of x-ray image quality and doses

• More emphasis on patient breathing
  – Deep inhaling reduces lung density
    • Increased image quality of lung parenchyma
    • Reduces the automatically chosen tube current – time product

• Replacement of the x-ray unit in 2022
  – Old detectors are less sensitive than modern ones