Too many errors in the initial interpretation of pediatric skeletal radiographs
- development of a tailored training program

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Introduction
Diagnostic errors in interpretation of skeletal radiography may create unnecessary morbidity, patient uncertainty and costs. In the pediatric emergency department trauma radiographs are often primarily interpreted by physicians in training not by experienced radiologists resulting in higher error rates [1,2].

We present our strategy to reduce the number of diagnostic errors in the initial interpretation of pediatric skeletal radiography in the emergency department.

Methods
From October 2014 to June 2015 data of all trauma patients with initially misdiagnosed skeletal radiographs was prospectively collected in a large pediatric referral hospital. We documented site of injury, initial diagnosis and corrected diagnosis as well as clinical significance and therapeutic consequences of diagnostic errors.

Based on these findings we developed a tailored training program.

Results
In 12% of 2316 trauma patients aged from one to seventeen years skeletal radiographs were misdiagnosed. In 112 cases junior doctors, in 7 cases residents and in 6 cases pediatric surgery consultants had diagnostic errors that were corrected the next day. 42 patients were diagnosed false negative (missed fracture) and 63 false positive (overdiagnosis). The error rates of specific anatomic regions are listed in table 1. The most frequently missed fracture was supracondylar elbow fracture (n=12). No morbidity resulted from delay of correct diagnosis.

After definition and analysis of diagnostic errors we developed an image-oriented learning tool. An Internet based research revealed that existing tools only partly covered our problematic issues.

Our target group consists of junior doctors staying for three to six month at our department of pediatric surgery. The intended outcome is a reduction of diagnostic errors in initial interpretation of pediatric skeletal radiography.

We chose a case based, image-oriented, quiz type module. According to the results of our study we focused on elbow, wrist and finger radiographs. 80 pediatric skeletal radiographies from our study were selected for the module. Of these 12 x rays presented normal findings. The radiography plus a short medical history is presented and the correct diagnosis has to be entered. For competition purposes we added a high score documenting the number of correct diagnosed radiographies. Besides training of correct radiography interpretation we addressed the following issues with multiple-choice questions: What kind of radiography is needed? What findings do I suspect? What if the imaging is normal?

After an introducing lecture on pediatric traumatology, junior doctors are given access to the learning tool and encouraged to use it regularly.

To evaluate the success of our efforts, we plan to repeat our study from October 2016 to June 2017.

Conclusion
Precise problem analysis allows development of a tailored learning program. A quiz-type learning tool seems to be ideally suited to practice correct interpretation of skeletal radiography.

Table 1 Error rate in selected regions

<table>
<thead>
<tr>
<th>Region</th>
<th>Missed fracture</th>
<th>False positives</th>
<th>Overdiagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elbow</td>
<td>42</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Wrist</td>
<td>10</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Metacarpus</td>
<td></td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Knee</td>
<td>19</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ankle</td>
<td>15</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Metatarsus</td>
<td></td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Finger</td>
<td>14</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Wrist</td>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>82</td>
<td>63</td>
<td>63</td>
</tr>
</tbody>
</table>

References
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Results: In 125 of 2316 trauma patients aged from one to seventeen years skeletal radiographs were misdiagnosed. In 112 cases junior doctors, in 7 cases residents and in 6 cases pediatric surgery consultants had diagnostic errors that were corrected the next day. 62 patients were diagnosed false negative (missed fracture) and 63 false positive (overdiagnosis). The error rates of specific anatomic regions are listed in table 1. The most frequently missed fracture was supracondylar elbow fracture (n=12). No morbidity resulted from delay of correct diagnosis.

<table>
<thead>
<tr>
<th>Radiographs</th>
<th>Misdiagnosis</th>
<th>Error rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elbow</td>
<td>166</td>
<td>20</td>
</tr>
<tr>
<td>Wrists</td>
<td>302</td>
<td>25</td>
</tr>
<tr>
<td>Fingers</td>
<td>762</td>
<td>35</td>
</tr>
<tr>
<td>Metacarpus</td>
<td>142</td>
<td>6</td>
</tr>
<tr>
<td>Toes</td>
<td>228</td>
<td>8</td>
</tr>
<tr>
<td>Knee</td>
<td>196</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 1: Error rate in selected regions from October 2014 to June 2015

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**References:**
