Follow-up of the effects of interventions on lumbar spine radiographs and CTs

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Authors: H. Oikarinen¹, P. Tahvonen², O. Tervonen¹; ¹Oulu/FI, ²Rovaniemi/FI  
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Aims and objectives

Global radiation doses to the public have increased by 20% since the beginning of the 20th century [1]. An increase has been seen particularly in the use of CT causing a major proportion of the ionizing radiation from medical sources. However, numerically, most of the examinations using ionizing radiation are radiographs [2]. It has been estimated that about 20-50% of radiological examinations are inappropriate. Hence, concerns have been highlighted about the effectiveness of the implementation of justification. Although the risk to a single individual is small, increased doses may result in long-term public health problems. Especially radiation-induced lifetime risk of cancer mortality is higher at younger age until approximately the age of 35 years [3-5]. Referral guidelines for imaging have been published in several countries [6-8]. There are various interventions designed to improve guideline implementation and enhance justification. Change is thought to be possible when well-focused, combined interventions are used [9-11].

Painful disorders related to the back and neck is major causes of work disability in developed countries [12]. In the case of low back pain, spine radiographs are of limited value and do not improve clinical outcome unless there are rare clinical red flags present suggesting serious pathology. Furthermore, when advanced imaging for lumbar spine is needed, MRI instead of CT is often recommended. The radiation dose of a lumbar spine radiograph is among the highest for conventional radiographs being equivalent to about 70 thorax pa x-rays, while the dose of radiation from lumbar CT is equivalent to about 300 thorax x-rays. In these examinations, radiation is also delivered to the area of radiation-sensitive organs [6].

A previous survey of CTs of the lumbar spine done on young patients in our hospital had revealed problems in justification [13]. An internal audit had also shown unjustified lumbar spine radiographs. The aim of this study was to find out and follow up the effects of various interventions on the number and justification of the lumbar spine radiographs and CTs done on patients under 35 years.
Methods and materials

The study was performed in the Department of Diagnostic Radiology of Oulu University Hospital, Oulu, Finland and approved by the institutional review board at Oulu University.

Interventions:

Since 2006, various interventions to improve justification were implemented in the hospital. The referral criteria for imaging recommended by the European Commission (EU) in Finnish were available online. The printed version was distributed into different areas of the radiology department in 2006. Indications of spine radiographs based on these criteria were also provided in Finnish by e-mail for the referring practitioners and the staff of the radiology department. An institutional recommendation to prefer MRI instead of CT for the lumbar spine, except in trauma, was also released. These guidelines continued to be available on the hospital intranet.

Furthermore, since 2006, four different 3-h educational lectures were provided each year for the staff of the radiology department and the referring practitioners. The sessions were also repeated. The lectures consisted of legislation on radiation protection, justification, the risks and doses of radiation, the indications of different radiological examinations, and specific topics, e.g. orthopaedic and paediatric imaging. These sessions were part of official education, but attendance was voluntary. Info pocket cards on radiation protection were also provided in 2006. They consisted of information on radiation, justification, and doses of different examinations including lumbar spine examinations. The MRI capacity in the hospital was increased by a 1.5-T system (in addition to two 1.5-T and one 0.23-T MRI systems).

Analysis:

The numbers of radiographs and CTs of the lumbar spine done on patients under the age of 35 years in the years 2005, 2007, 2008 and 2009 were assessed. A retrospective analysis of justification concerning radiographs of the lumbar spine done on patients of this age group in 2005 was performed. Justification of radiographs in 2007, 2008 and 2009 after interventions was also analysed. Furthermore, justification of lumbar spine CTs in 2005, 2007, 2008 and 2009 was assessed. The results concerning CTs in 2005 and 2009 have been published before [9,13].
Lumbar spine radiographs were picked up from three different units of the radiology department since the patient profiles in these units were different. Unit 1 mainly received patients from the surgery clinic, while unit 2 and unit 3 received patients from various clinics, the latter also from the paediatric clinic. Lumbar spine radiographs, 20 per unit each year (except 13 in unit 2 in 2009 as there were no more examinations available), were consecutively extracted from the electronic patient files starting from the beginning of each year. Lumbar spine CTs, 30 each year (except 27 in 2009 as there were no more examinations available), were extracted consecutively. The referrals and corresponding patient files were analysed by an experienced radiologist to assess justification. Another radiologist went through the information collected to give a second opinion. If necessary, consensus was used. The EU referral criteria were used as a reference.

**Statistical methods:**

Frequency distributions and cross-tabulations were used to describe the data. The total numbers of examinations were compared between different years using chi-square goodness of fit test separately for lumbar spine radiographs and CTs. The proportions of justified examinations were compared between different years and units using Pearson’s chi-square test. P-value < 0.05 was considered as significant. IBM SPSS Statistics version 22 was used to conduct the statistical analyses.
Results

The total numbers of both lumbar spine radiographs and lumbar spine CTs were significantly higher in 2005 compared to the other years (p < 0.001) Table 1 on page 6. The decrease from 2005 to 2007 was already significant (p < 0.001), and the level remained unchanged during the years 2008 and 2009 in both groups.

There was a significant difference in the degree of justification of lumbar spine radiographs between units 1, 2 and 3 in 2005 (p=0.003) and in 2007 (p=0.044) Table 2 on page 6. The proportion of justified lumbar spine radiographs was highest, 95%, in unit 1 in 2005, and there was no significant change during the follow-up in that unit. The level of justification was poorer in unit 2 in 2005, 65%, and there was no significant improvement during the follow-up. The proportion of justified lumbar spine radiographs was lowest in unit 3 in 2005, 45%, but the level of justification improved significantly (p=0.001).

The proportion of justified lumbar spine CTs was low in 2005 (23%) compared to the other years (p < 0.001) Table 3 on page 7. The improvement from 2005 to 2007 was already significant (p=0.004) and the degree remained unchanged during the following years.
Table 1: The total number of lumbar spine radiographs and lumbar spine CTs performed on patients under 35 years in different years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Lumbar Spine Radiographs (n)</th>
<th>Lumbar Spine CTs (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>453</td>
<td>132</td>
</tr>
<tr>
<td>2007</td>
<td>303</td>
<td>37</td>
</tr>
<tr>
<td>2008</td>
<td>302</td>
<td>38</td>
</tr>
<tr>
<td>2009</td>
<td>284</td>
<td>27</td>
</tr>
</tbody>
</table>
Table 2: The proportion of justified lumbar spine radiographs performed on patients under 35 years in the three units of the department in different years. The number of cases analysed is 20 each year in all the units except in unit 2 in 2009, as only 13 cases were available.

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**Table 3:** The proportion of justified lumbar spine CTs performed on patients under 35 years in different years. The number of cases analysed is 30 each year except in 2009, as only 27 cases were available.

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Conclusion

In this study, the total numbers of both lumbar spine radiographs and CTs done on patients under 35 years decreased significantly from 2005 to 2007 after the interventions, and the levels remained unchanged in the follow-up. In all age groups in our hospital, the number of lumbar spine radiographs also decreased by about 60% from 2005 to 2009, but in Finland overall, it remained unchanged from 2005 to 2008. The corresponding decrease in the number of lumbar CTs in our hospital from 2005 to 2009 was comparable to this study; in Finland as a whole, there was a decrease of about 20% from 2005 to 2008. In contrast, the total number of CTs increased between 2005 and 2009 both in our hospital and in Finland.

The level of justification related to the radiographs was unexpectedly low in two units in 2005. The best level, 95%, in unit 1 remained unchanged in the follow-up. This may be associated with a more homogeneous patient profile, as the patients in this unit were mainly referred from the surgery clinic. The other two units received patients from different specialities and may have had more unselected patients. There was no significant change from the level of 65% in unit 2, which may also reflect the complexity of the justification process. Nonmedical aspects may have an effect on the request, and radiographers should be encouraged to consult a radiologist in connection with an unclear referral. In unit 3 the level of justification was initially poor, 45%, but improved significantly. This unit was mainly performing radiographs of children and, hence, the staff may have been more prepared for the interventions related to justification. It is also to be noted that the samples from 2007 and 2008 included more children than adults, which may have affected the results. However, the sample from 2009 with a good level of justification included nine adult patients. In some other studies, guideline implementation with or without education has reduced spine radiograph referrals by about 20%, and in one study by about 80%, but these studies do not include information on the level of justification [14-16]. In our study, we also analysed both the referrals and the corresponding patient files and conducted a 3-year follow-up.

The low level of justification of CTs of the lumbar spine improved significantly already in 2007 and the level remained unchanged. There are only few other published studies on the justification of CT examinations, while other studies on the effect of traditional interventions on the justification of CTs are lacking [9,13,17-20].

In conclusion, a combination of interventions - guidelines, education and increased MRI capacity - can achieve a sustained reduction in the number of unnecessary lumbar spine radiographs and CTs in young patients. The effect of the interventions on the justification
of examinations performed is variable in different units, but sustained improvement is possible.
Personal information

Heljä Oikarinen, MD, PhD
Department of Diagnostic Radiology
Oulu University Hospital
Oulu, Finland
helja.oikarinen@ppshp.fi

Pirita Tahvonen, MD
Department of Diagnostic Radiology
Lapland Central Hospital
Rovaniemi, Finland

Osmo Tervonen, MD, PhD
Department of Diagnostic Radiology
Oulu University Hospital
Oulu, Finland
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http://www.acr.org/Quality-Safety/Appropriateness-Criteria


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