Clinically unjustified imaging diagnostics - a worrying tendency in today's medical practice

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Aims and objectives

In the last several years, a dynamic development of organ imaging methods and a significant increase in their availability can be observed. This creates a risk of a too wide use of diagnostic imaging and may result in unjustified excessive performance of examinations, some of which are undoubtedly performed without a proper medical substantiation. The problem is serious, because mismanagement of diagnostic imaging methods, in addition to a biological impact of the examinations and a delay in the diagnosis, increases the amount of diagnostic errors. Negative economic consequences are also important.

The aim of this study was to assess the percentage of unjustified examinations among all CT and MRI scans performed in two selected Diagnostic Imaging Departments as well as to identify the most common reasons for regarding examinations as unjustified. Another objective was to compare the data obtained with the results published by other authors [1,2,3].
Methods and materials

Materials

All referrals for the CT scans (799) and MRI scans (269) performed during fourteen consecutive days of January 2015 in the Department of Diagnostic Radiology at the Central Clinical Hospital of the Ministry of the Interior in Warsaw and in the Department of Radiology and Diagnostic Imaging at the Medical Centre for Postgraduate Education, Professor Adam Gruca’s Clinical Hospital in Otwock were analysed retrospectively.

The 799 referrals for CT scans included:

- 353 referrals for examinations of the head (with or without the cervical spine),
- 169 referrals for examinations of the abdominal cavity (with or without the pelvis),
- 102 referrals for examinations of the chest,
- 48 referrals for examinations of the abdominal cavity and the chest,
- 8 referrals for examinations of the head, chest and abdominal cavity (in the Trauma-scan protocol),
- 119 referrals for examinations of other areas, including the musculoskeletal system.

Thus, there were performed:

- 361 CT scans of the head,
- 217 CT scans of the abdominal cavity,
- 150 CT scans of the chest,
- 119 CT scans of other areas;

In total, 847 CT scans of individual body parts were performed.

The 269 referrals for MRI scans included:

- 81 referrals for examinations of the head,
- 127 referrals for examinations of the spine,
- 49 referrals for examinations of the musculoskeletal system except for examinations of the spine,
- 9 referrals for examinations of the abdominal cavity, bile ducts or pelvis,
- 3 referrals for examinations of other areas.

The number of referrals for MRI scans corresponds to the number of the examinations performed.

Methods

Three radiologists, having 27 years of professional experience on average, based on the referrals assessed the justness of the performed examinations. The criteria of the justness included own medical knowledge of the evaluators supported by their professional experience and European guidelines [4]. The first stage of the analysis was the evaluation of the examinations and their division into justified, unjustified and questionable ones. Then there was calculated the percentage of examinations that have been recognized by at least 2 evaluators as unjustified or questionable among all the examinations and among the examinations of particular areas.

The second stage consisted in the determination by individual evaluators why they regarded a given examination as unjustified or questionable by selecting one of the following responses:

- at a given diagnosis, another method of diagnostic imaging was recommended first;
- the referral included insufficient clinical data or did not include the initial diagnosis;
- too large scope of the examination was selected;
- too small scope of the examination was selected;
- the examination was ordered without the contrast agent, while for the full assessment of the examination it was advisable to administer such an agent and there were no contraindications to this;
- it was an unjustified follow-up examination (e.g. performed too often);
- other justification - own comment of the evaluator.
Results

This study shows that 73 (6.54%) of all 1116 examinations were recognized by at least two evaluators as unjustified or questionable, which included 59 of 847 (6.97%) CT scans and 14 of 269 (5.20%) MRI scans. Detailed results are shown in Table 1.

Table 1 on page 6

Table 2 presents the results of the second stage of the analysis, which consisted in the determination by individual evaluators why they recognized the examination as unjustified or questionable.

Table 2 on page 6

Figure 1 shows the percentage distribution of substantiations provided by evaluators.

Fig. 1 on page 6

Table 3 presents some examples of unjustified referrals.

Table 3 on page 7

Out of these 73 unjustified or questionable examinations, 26 (35.62%) were performed as urgent procedures - they included 16 CT scans of the head, 8 CT scans of the abdominal cavity and 2 MRI scans of the spine.
### Table 1: The number of examinations regarded as unjustified or questionable.

<table>
<thead>
<tr>
<th>Type of examination</th>
<th>Number of examinations regarded as unjustified by 3 evaluators</th>
<th>Number of examinations regarded as unjustified by 2 evaluators and as questionable by 1 evaluator</th>
<th>Number of examinations regarded as unjustified by 1 evaluator and as questionable by 2 evaluators</th>
<th>Number of examinations regarded as questionable by 3 evaluators</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT scans of the head (361)</td>
<td>9</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>26 (26/361=7.20%)</td>
</tr>
<tr>
<td>CT scans of the abdominal cave (217)</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>7</td>
<td>18 (18/217=8.29%)</td>
</tr>
<tr>
<td>CT scans of the chest (150)</td>
<td>4</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>8 (8/150=5.33%)</td>
</tr>
<tr>
<td>CT scans of the other areas (119)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>7 (7/119=5.88%)</td>
</tr>
<tr>
<td>MR scans of the head (81)</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>MR scans of the spine (127)</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>5 (5/127=3.94%)</td>
</tr>
<tr>
<td>MR scans of the musculoskeletal system (60)</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1 (1/60=1.67%)</td>
</tr>
<tr>
<td>MR scans of the abdominal cavity, bile ducts or pelvis (9)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>MRI scans of the other areas (3)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
</tbody>
</table>

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### Table 2: The reasons why the examination was regarded as unjustified or questionable.

<table>
<thead>
<tr>
<th>The reasons why the examination was regarded as unjustified or questionable</th>
<th>Number of examinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT scans of the head (9)</td>
<td>5</td>
</tr>
<tr>
<td>CT scans of the abdominal cave (12)</td>
<td>6</td>
</tr>
<tr>
<td>CT scans of the chest (4)</td>
<td>4</td>
</tr>
<tr>
<td>CT scans of the other areas (3)</td>
<td>2</td>
</tr>
<tr>
<td>MR scans of the head (1)</td>
<td>3</td>
</tr>
<tr>
<td>MR scans of the spine (1)</td>
<td>1</td>
</tr>
<tr>
<td>MR scans of the musculoskeletal system (1)</td>
<td>3</td>
</tr>
<tr>
<td>MR scans of the abdominal cavity, bile ducts or pelvis (1)</td>
<td>1</td>
</tr>
<tr>
<td>another method of diagnostic imaging was recommended first</td>
<td>5</td>
</tr>
<tr>
<td>the referral included insufficient clinical data or did not include the initial diagnosis</td>
<td>12</td>
</tr>
<tr>
<td>too large/small scope of the examination was selected</td>
<td>4</td>
</tr>
<tr>
<td>the examination was ordered without the contrast agent, while it was advisable to administer such an agent</td>
<td>4</td>
</tr>
<tr>
<td>unjustified follow-up examination (e.g. performed too often);</td>
<td>1</td>
</tr>
<tr>
<td>other justification — own comment of the evaluator.</td>
<td>-</td>
</tr>
</tbody>
</table>

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Fig. 1: The percentage distribution of substantiations provided by evaluators.

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<table>
<thead>
<tr>
<th>Type of examination</th>
<th>Clinical data provided in the referral</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT scan of the head</td>
<td>&quot;Fever to be diagnosed&quot;</td>
<td>Scarce clinical data (no data about previous examinations)</td>
</tr>
<tr>
<td>CT scan of the head</td>
<td>&quot;Torticollis&quot;</td>
<td>Inadequate method and scope of the examination</td>
</tr>
<tr>
<td>CT scan of the abdominal cave</td>
<td>&quot;Suspected megacolon toxicum&quot;</td>
<td>Inadequate method</td>
</tr>
<tr>
<td>CT scan of the pelvis</td>
<td>&quot;State after the a rectal polypectomy, assessment of the local condition&quot;</td>
<td>Scarce clinical data</td>
</tr>
<tr>
<td>CT scan of the chest</td>
<td>&quot;Suspected pneumothorax&quot;</td>
<td>Inappropriate method (in X-ray examinations no pneumothorax was found in previous days and no clinical grounds to perform a CT scan were specified in the referral.</td>
</tr>
<tr>
<td>MRI scan of the head</td>
<td>&quot;Meningioma – follow-up&quot;</td>
<td>Too frequent follow-up examinations (the third follow-up examination year after year in 74 year old patient, meningioma 4x5x10mm, with calcifications)</td>
</tr>
</tbody>
</table>

Table 3: Examples of unjustified referrals.

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Conclusion

The obtained percentage of the CT and MRI scans regarded as unjustified and questionable (6.54%) is slightly lower than that indicated in the literature (from 7% to 26%) [1,2]. Such discrepancies arise not only from differences in the material and methodology, but also from a different approach to an unjustified examination which can be interpreted in various aspects.

Lehnert et al analysed the suitability of CT and MRI scans based on their compliance with the guidelines and they recognized 26% of them as unjustified [1]. Oikarinen et al[2] showed that almost 7% of MRI scans were unjustified. After excluding from the statistics the MRI scans of the head in children (all were recognized as justified), more than 8% of the remaining examinations were recognized as unjustified. Bekiesińska-Figatowska [3], based on an analysis of referrals, estimates that the percentage of unjustified (non-compliant with the guidelines) MRI scans in Poland is much higher than that indicated in the aforementioned study by Oikarinen et al.

The purposefulness and justness of performing imaging examinations can be assessed with reference to the impact of the examination on the further proceeding with the patient. A justified examination is an examination, the outcome of which will affect the further clinical proceeding. Otherwise it is an unnecessary burden for the patient. Lehnert et al. showed that in the group of patients, for whom examinations were performed in line with the guidelines, in 58% of them positive effects of further therapeutic measures were observed, while in the group of patients, for whom the examinations were not performed in line with the guidelines, only in 24% of them such effects were found [1].

Referring to the goals of our study, we have shown that among the CT scans the highest percentage of unjustified/questionable examinations was found in the group of examinations of the abdominal cavity (8.29%), while among the MRI scans - in the group of examinations of the head (9.88%). In our analysis, the two most commonly occurring causes of recognizing an examination as unjustified or questionable were the lack of or insufficient clinical data (35 of 73 examinations) and a poor choice of the imaging method selected as the first (21 examinations). The fact that the performance of imaging examinations that use ionizing radiation is often unjustified and not well-thought out, especially in the case of young people, is very disturbing considering the adverse biological effects. Oikarinen et al. showed that among all CT scans performed in people under 35 years of age, 77% of examinations of the lumbar spine, 36% of examinations of the head, 37% of examinations of abdomen, 20% of examinations of nasal sinuses and 3% of examinations of the cervical spine were unjustified [5]. According to the authors, most of these examinations could be replaced with MRI scans. Brenner considers that at least 25% of the CT scans can be replaced by an examination that uses a different modality or even be completely given up [6]. Fenton et al. [7] report in their study that out of 1653 children after trauma, as many as 1422 had a CT scan
performed (2361 scans in total), of which 54% were described as correct. The most surprising are findings that concern CT scans of the abdominal cavity - among the children, in whom abnormalities were found in this examination, only 5% were examined surgically [7]. As regards the examinations after injuries of the abdominal cavity, a broad retrospective analysis performed by Zhou et al. showed that the ultrasound examinations had a high sensitivity, specificity and accuracy (respectively 91.9%, 96.9% and 96.6%) as compared with CT scans, diagnostic peritoneal lavage, repeated ultrasound examination, cystography, surgery or clinical observation [8].

It is worth mentioning here the problem of unnecessarily repeated examinations. Lammers showed that in the selected emergency departments in the United States, the examinations that were repeated (within 30 days) accounted for 14.7% of the CT scans, 20.7% of the ultrasound scans and 19.5% of X-ray images of the chest. At the same time, in hospitals belonging to the network connected to the medical information exchange system, the number of repetitions of imaging examinations was significantly lower than that in hospitals not belonging to the aforementioned system [9].

Our analysis was limited to evaluating the justness of performing the examinations solely on the basis of referrals, but probably there is a lot of cases of unjustified examinations, the causes of which lie in other stages of medical diagnostics and cannot be identified by an analysis of referrals only. It must therefore be assumed that the actual percentage of these examinations is higher than indicated by us. One of the areas of the unjustified use of imaging examinations, in which there were more such cases than in our analysis (26 of 73 examinations - 35.62%), is the performance of examinations as urgent procedures.

Another limitation of our analysis was the difficulty of an unambiguous interpretation of the clinical data included in the referral. It often happened that the referrals included a number of symptoms or results of laboratory tests, from which it did not result explicitly which disease was suspected by the referring physicians and what they expected from the imaging examination. This factor had also an impact on a slightly different interpretation and evaluation of individual examinations by the radiologists who performed the analysis presented here.

To sum up, the excessive and unjustified use of diagnostic imaging methods is a problem whose scale is difficult to estimate, since its causes lie at various stages of medical diagnostics and there are different aspects of the unjustified, excessive use of imaging methods. A justified examination is an examination, the outcome of which will affect the further clinical proceeding with the patient. Reckless use of imaging methods that use ionizing radiation is an unnecessary burden for the patient.