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Clinically Unjustified Diagnostic Imaging – a Worrisome Tendency in Today's Medical Practice

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Summary

Background: The purpose of the study was to evaluate the percentage of unjustified examinations among all the CT and MRI studies performed by two radiology departments and to determine the types of examinations which are most commonly carried out unnecessarily.

Material/Methods: Three radiologists assessed the justification of CT and MRI examinations performed during a period of 14 days based on the referrals. The radiologists assessed 799 referrals for CT scans (847 examinations of a particular part of the body) and 269 MRI referrals (269 examinations). The criteria for justification were: medical expertise and the guidelines. During the first stage radiologists divided the examinations into 3 groups: justified, unjustified and the examinations of questionable justification. The second step was to determine the reasons why the studies were considered as unjustified or of questionable justification.

Results: 73 of 1116 examinations (6.54%) were considered to be unjustified or of a questionable justification. There were 59 CT scans (59/847=6.97%) and 14 MRI studies (14/269=5.20%). The most common reasons to consider them as unjustified or of questionable justification were: inadequate method of diagnostic imaging chosen as a first-line tool and lacking or insufficient clinical details.

Conclusions: In our investigation 6.54% of both CT and MRI examinations were considered as unjustified or of questionable justification, which is lower than described in other studies (from 7% to 26%). The assessment was based only on referrals, therefore a total share of these examinations is likely to be higher.

MeSH Keywords: Magnetic Resonance Imaging • Referral and Consultation • Tomography, Spiral Computed

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Background

In the last several years there has been a dynamic development and an increase in accessibility to respective diagnostic imaging methods, which has a great influence on rapid and correct disease diagnosis. However, at the same time new diagnostic possibilities can result in too wide application of diagnostic imaging and inadequate choice of method in diagnosing a certain disease. This may result in unjustified 'overperforming' of examinations and some of them are probably performed without appropriate medical justification. What is more, an increase in accessibility to diagnostic imaging methods does not necessarily lead to shortening of waiting time to the planned examination. In such a situation the positive effects of better access to examinations, such as higher rate of disease detection, can be nullified by delayed diagnosis.

The problem of unjustified and excessive use of diagnostic imaging methods is brought up in the international

bibliography and it is most often described as *"unwarranted, inappropriate, unnecessary, unjustified"* [1–4]. The problem is serious, as the incorrect management of diagnostic imaging methods results in biological effects of the examinations, an increase in time to diagnosis and an increase in the number of diagnostic errors – too large number of diagnostic conclusions results in diverging from the correct final diagnosis. Negative economic effects of unjustified diagnostic imaging examinations are also significant.

Purpose of study

The purpose of the study was to evaluate the percentage of unjustified CT and MR examinations performed in the given period of time in the Department of Diagnostic Radiology, Central Clinical Hospital of the Ministry of the Interior in Warsaw and in the Department of Radiology and Diagnostic Imaging, Medical Centre for Postgraduate Education, Professor Adam Gruca's Clinical Hospital in Otwock, and to determine the types of examinations which are most commonly carried out unnecessarily.

Material and Methods

Material

A retrospective analysis was performed, with the review of all referrals for CT examinations (a total number of 799) and MR examinations (269) performed in the Department of Diagnostic Radiology, Central Clinical Hospital of the Ministry of the Interior in Warsaw and in the Department of Radiology and Diagnostic Imaging, Medical Centre for Postgraduate Education, Professor Adam Gruca's Clinical Hospital in Otwock during a period of fourteen consecutive days in January 2015.

Among 799 referrals for CT examinations the following were present:
- 353 referrals for head examinations (with or without cervical spine),
- 169 referrals for abdominal examinations (with or without pelvis),
- 102 referrals for chest examinations,
- 48 referrals for chest and abdominal examinations,
- 8 referrals for head, chest and abdominal examinations (in trauma-scan protocol),
- 119 referrals for examinations of other body regions, including musculoskeletal system;

As a result, the following were performed:
- 361 head CT examinations,
- 217 abdominal CT examinations,
- 150 chest CT examinations,
- 119 other CT examinations;

A total number of 847 CT examinations of particular body regions were performed.

Among 269 referrals for MR examinations the following were present:
- 81 referrals for head examinations,
- 127 referrals for spine examinations,
- 49 referrals for musculoskeletal system (excluding spine) examinations,
- 9 referrals for abdominal or biliary system, or pelvic examinations,
- 3 referrals for examinations of other body regions.

The number of referrals for MR examinations equaled the number of performed examinations.

Methods

Three radiologists with an average of 27 years' work experience assessed the justification of the performed examinations based on the referrals. The justification criteria were as follows: medical knowledge of the radiologist coupled with work experience, and European guidelines [5]. In the first stage of the analysis the examinations were assessed and divided into the following groups: justified, unjustified and of questionable justification. Next, a percentage of the examinations considered as unjustified or of questionable justification, as assessed by at least two radiologists, was calculated, both among all the examinations and among the examinations of particular body regions.

In the second stage each of the radiologists was to determine the reasons why a respective examination was regarded as unjustified or of questionable justification. This was associated with choosing one of the following answers:
- a different diagnostic imaging method was recommended as a first-line tool in this case;
- the referral included too few clinical details or did not include presumptive clinical diagnosis;
- too large scope of examination was chosen with reference to the diagnosis;
- too little scope of examination was chosen with reference to the diagnosis;
- the examination was ordered without contrast medium administration, however, contrast administration was recommended in this case in order to fully interpret the examination and there were no contraindications for its administration;
- a follow-up examination was unwarranted (e.g. performed to early/often);
- other explanation – personal comment of the radiologist.

Results

The detailed results of the first stage of the analysis were presented in Table 1.

A total number of 73 out of 1116 examinations (6.54%) were considered as unjustified or of questionable justification by at least two radiologists. Among CT examinations it was 59 out of 847 (6.97%) and among MR examinations it was 14 out of 269 (5.20%). Among CT examinations the highest rate was in the abdominal CT group (8.29%), and among MR examinations – in the head MR group (9.88%).

Among those 73 examinations, which were regarded as unjustified or of questionable justification, a total number of 26 (35.62%) were performed as emergency examinations: 16 head CT examinations, 8 abdominal CT examinations and 2 spine MR examinations.

Table 1. The number of respective examinations considered to be unjustified or of questionable justification.

Type of examination and examined region (total number of examinations)	The number of examinations considered to be unjustified by three radiologists	The number of examinations considered to be unjustified by two radiologists and of questionable justification by one radiologist	The number of examinations considered to be unjustified by one radiologist and of questionable justification by two radiologists	The number of examinations considered to be of questionable justification by three radiologists	The number of examinations considered to be of questionable justification by two radiologists	Total
Head CT examinations (361)	9	3	4	7	3	26 (26/361=7.20%)
Abdominal CT examinations (217)	2	2	4	7	3	18 (18/217=8.29%)
Chest CT examinations (150)	4	–	1	2	1	8 (8/150=5.33%)
Other CT examinations (119)	1	1	1	4	–	7 (7/119=5.88%)
Head MR examinations (81)	1	–	–	4	3	8 (8/81=9.88%)
Spine MR examinations (127)	1	1	–	3	–	5 (5/127=3.94%)
MR examinations of the musculoskeletal system (excluding spine) (49)	–	1	–	–	–	1 (1/49=2.04%)
Abdominal/biliary system/pelvic MR examination (9)	–	–	–	–	–	0
Other MR examinations (3)	–	–	–	–	–	0

The results of the second stage of the analysis, in which the radiologists determined the reasons why these examinations were considered as unjustified or of questionable justification, were presented in Table 2.

Figure 1 presents the percentage distribution of the reasons chosen by the radiologists. The whole (100%) comprises 73 examinations regarded as unjustified or of questionable justification.

The most common (48%) reason for considering the examination to be unjustified or of questionable justification was too few clinical details in the referral. It was also the most frequent reason chosen by the radiologists in the head CT examination group – too sparse clinical data did not fully explained the purpose of performing the examination (e.g. 'fever'); in case of five referrals no clinical details were given. It applied mainly to the emergency examinations. An inadequately chosen diagnostic imaging method was also a frequent reason in the head CT examination group (e.g. referral for a head non-CE CT examination in a patient with headache, visual disturbances and hyperprolactinemia, or a head CT examination in a patient with torticollis). Two main reasons for attributing the abdominal CT examination to one of two mentioned groups were also: lacking clinical details and the choice of an inadequate diagnostic imaging method (e.g. ordering a CT examination in case of suspicion of *megacolon toxicum* without performing an abdominal X-ray first, or ordering a pelvic CT examination in case of the following referral: 'status post rectal polyp removal, assessment of local status'). An inadequately chosen diagnostic imaging method was also the most frequent reason among the chest CT examinations (e.g. in case of suspicion of pneumothorax in a patient who already had several X-ray examinations performed within the last few days and no pneumothorax was present there, and the referral contained no clinical reasons for performing a CT examination). Unwarranted follow-up examinations were frequent in the head MR examination group (e.g. a third follow-up examination performed year after year in a 74-year-old patient with diagnosed meningioma, 4×5×10 mm in size, with calcifications).

Discussion

In our investigation 6.54% of CT and MR examinations were considered as unjustified or of questionable justification, which is a lower value than described in other studies (from 7% to 26%) [1,2]. The analysis was limited to the assessment of the justification of the performed examination only based of the referrals, however, there are probably numerous cases of unwarranted examinations which are caused by other reasons associated with other diagnostic imaging stages and therefore cannot be revealed only through the analysis of the referrals. Thus, we should assume that the real percentage of these examinations is higher than presented. One of the areas associated with unnecessary performing of diagnostic imaging examinations, which included more cases than in the performed analysis (26 out of 73 examinations – 35.62%), are certainly emergency examinations.

Table 2. Reasons for which the examination was considered as unjustified or of questionable justification.

Reasons for which the examination was considered as unjustified or of questionable justification	Number of examinations								
	Head CT examination	Abdominal CT examination	Chest CT examination	Other CT examination	Head MR examination	Spine MR examination	MSK MR examination	Abdominal MR examination	Other MR examination
A different diagnostic imaging method was recommended as a first-line tool	5	6	4	2	3	1	–	–	–
The referral included too few clinical details/did not include presumptive clinical diagnosis	12	9	3	4	3	3	1	–	–
Too large/small scope of the examination	4	–	–	–	–	–	–	–	–
The examination was ordered without contrast medium administration, however, contrast administration was recommended in this case	4	3	–	1	–	–	–	–	–
An unwarranted (including performed too early/often) follow-up examination	1	–	1	–	2	1	–	–	–
Other explanation – personal comment of the radiologist	–	–	–	–	–	–	–	–	–

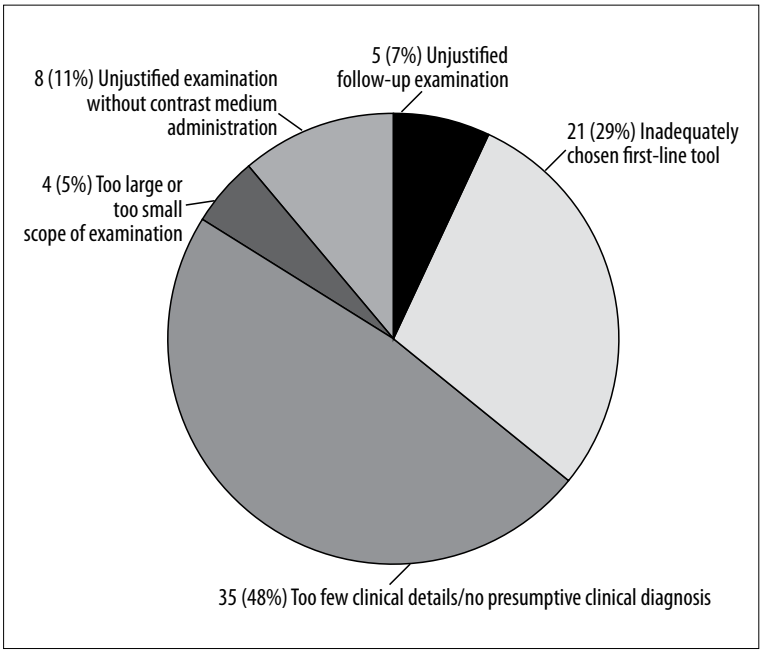

Figure 1. The percentage distribution of the reasons chosen by the radiologists.

The next limitation of the performed analysis was a difficulty in unequivocal interpretation of the clinical details from the referral. Quite often the referrals included a few symptoms or laboratory test results, from which it was not clear what is the suspected diagnosis of the referring physician and what are his/her expectations about the examination. This also resulted in slightly different interpretation and assessment of individual examinations by the evaluating radiologists.

When trying to answer the question if a given imaging examination is justified and well used, several different points can be taken into account. An examination can be regarded as unused when it does not contribute to the diagnostic pathway (e.g. due to inadequately chosen imaging method), or when its results do not affect further clinical decisions. These are also the examinations ordered based on a very general presumptive diagnosis; they are performed very commonly, but often do not show any

pathology, because of the qualification of too broad patient profile (e.g. ultrasonography examination in case of vomiting), or show pathology that cannot be unequivocally and correctly interpreted due to lack of precise clinical details in the referral. The examinations that need to be repeated, e.g. due to inadequately chosen parameters or protocol, are also considered as unused. Lastly, these are also the examinations which need to be repeated because they were performed in another medical centre, but the patient received neither the result, nor the recorded study. The unjustified examinations are incompatible with the guidelines. This group includes also the examinations that allow to make a correct diagnosis, but do not have to be performed as they can be successfully replaced by other methods – less invasive, more available or cheaper. The follow-up examinations which are performed too often, especially those with use of ionizing radiation, are also regarded as unjustified.

There are numerous studies which evaluate quantitative or qualitative analysis of unjustified and unused examinations, including different points mentioned above.

Unjustified examinations which are incompatible with the guidelines

Lehnert et al. analysed the appropriateness of performing CT and MR examinations based on their compatibility with *evidence-based guidelines* and deemed 26% of them to be unjustified [1]. Oikarinen et al. [2] demonstrated in their study that almost 7% of MR examinations are unjustified. After the authors excluded from the analysis head MR examinations in children (all of them were considered as justified), more than 8% of the remaining examinations were regarded as unjustified. Bekiesińska-Figatowska [3] estimates, based on the analysis of the referrals, that the percentage of unjustified (incompatible with the guidelines) MR examinations in our country is much higher than presented in the study mentioned above (Oikarinen et al.).

Not using previous examinations and repeating examinations

It is a serious problem in Poland, as in our country there is no common system for healthcare entities, which would allow the exchange of medical information, storage and mutual sharing of the patient data. Lammers et al. demonstrated that in the chosen emergency departments in the United States the repeated examinations (within a period of 30 days) comprised 14.7% of CT examinations, 20.7% of ultrasonography examinations and 19.5% of chest X-ray examinations. In hospitals which belonged to the network connected with medical information exchange system, the rate of repeated diagnostic imaging examinations was significantly lower than in the hospitals which were not connected with such a system [6].

Unused and unjustified examinations and their clinical implications

A justified examination is characterized by the fact that its result affects further therapeutic decisions. Busch in his study from 2013 concerning optimalization in diagnostic imaging remarks that the process of optimalization in the recent years has been centred upon the quality, effectiveness and efficacy of single examinations [4]. The author emphasizes that the effectiveness of the examination in relation to the clinical results is important, and diagnostic imaging examinations which do not contribute to clinical management are an unnecessary burden for the patient [4]. Lehnert et al. demonstrated that in 58% of the patients who underwent a diagnostic imaging examination according to the guidelines, there were positive results of therapeutic management observed. At the same time in case of the examinations which were incompatible with the guidelines, only in 24% of patients such effects were observed [1].

Unjustified examinations and ionizing radiation exposure

Inconsiderate and unwarranted performing of diagnostic imaging examinations with use of ionizing radiation is associated with unnecessary exposure of the patients to negative biological effects of this radiation. Oikarinen et al. demonstrated that among all the CT examinations performed in the patients below the age of 35 years, 77% of the lumbar spine examinations, 36% of the head examinations, 37% of the abdominal examinations, 20% of the paranasal sinuses examinations and 3% of the cervical spine examinations were unwarranted [7]. According to the authors, most of these examinations could be replaced by MR examinations. Brenner believes that at least 25% of CT examinations can be replaced by another imaging method or even completely discarded [8].

Biological effects of ionizing radiation affect predominantly young patients. Fenton at al. concluded that there is an overperforming of CT examinations in children – as much as 1422 out of 1653 children with trauma had a CT examination performed (a total number of 2361 examinations), 54% of which were described as normal. The most surprising observations concern the abdominal CT examinations - among the children in whom there was a pathological finding revealed in the examination, only 5% were examined surgically [9]. In children - if possible - one should perform the examinations which have the least negative biological effects possible, such as ultrasonography or MR examination. When it comes to the examinations following abdominal trauma, a comprehensive analysis performed by Zhou et al. showed that ultrasonography examinations have a high sensitivity, specificity and accuracy – 91.9%, 96.9% and 96.6%, respectively, in comparison with CT examination, diagnostic peritoneal lavage, repeated ultrasonography examination, cystography, surgery and clinical observation [10].

Diagnostic imaging examination as a part of diagnostic pathway

An effective performing and use of diagnostic imaging examinations should be a part of an entire efficient diagnostic and therapeutic process, which brings as much benefits as possible. Busch in his study emphasizes that in order to decrease the number of unjustified examinations, an entire diagnostic pathway should be optimalized, not only single examinations [1]. According to the author, such an approach will result in positive effects in clinical aspect and in terms of equipment and economy [1].

Conclusions

An excessive and unjustified use of diagnostic imaging methods is a problem whose scale is hard to assess, as its causes are present at different stages of medical diagnostics. In order to decrease the number of unwarranted diagnostic imaging examinations (and as a result to shorten the waiting time to perform the examination, to decrease the ionizing radiation exposure to the patients, and to decrease the costs of the examinations), an activity on several stages and centred on many diagnostic elements is needed. This is associated with improving skills of the radiologists, electroradiology technicians and physicians, so they can expertly use the respective diagnostic imaging methods. The management according to the procedures and guidelines is a condition of proper administration of diagnostic imaging methods. On the 10th November 2015 Minister of Health issued an announcement concerning declaration of the list of sample radiological procedures in the field of radiology – diagnostic imaging and interventional radiology. It is recommended that the guidelines concerning MR and US use will be introduced as well. An efficient system of medical information exchange between healthcare centres would be of additional convenience.

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