Guideline for repeat imaging studies: nationwide result of pilot project for application of the guideline

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Aims and objectives

As the technical advances of imaging modalities such as computed tomography (CT) has made diagnosis more accurate and less invasive, the use of diagnostic imaging has rapidly increased, imaging costs have grown as well (1). In Korea, the number of high-tech imaging devices has been increasing: from 240 of CT and 51 of MRI in 1995 to 1,768 of CT and 956 of MRI in 2010 (2).

In Korea, the nation-led healthcare insurance service has been given to the whole nation with low-cost policy. It is positive that the whole national people can easily use high-cost medical services including MRI, but several demerits appear: especially overuse of medical imaging using radiation. Consequently, the KSR and Health Insurance Review and Assessment Service (HIRA) took a project, making guidelines for repeated CT examinations in the study for the appropriate management method regarding high-tech radiologic examination in 2014, in order to prevent unnecessary exposure to the radiation by frequent CT examination and to recommend repeated evaluations based on the medical necessity and evidence-based rationale (3). Repeated CT examination is an important cause of increased use of radiation exposure in tertiary hospitals, and guidance should be made for reasonable use of radiation.

The purpose of study is to investigate whether the frequency and distribution of the repeated CT would be changed after application of the guideline.
Methods and materials

This study was performed in 17 regional distributed institutes. The patients who brought with a previous imaging study including CT scans of various body parts to the pilot institutes for 1 month before publication of the guideline were investigated, and the rate of repeat CT of the same body part in the referred hospital within 1 month was assessed. We considered region of referred hospital, referring hospital volume, and causes of repeat CT as variables.

Table 1. Table contents for Repeated CT Examination (3)

I. Introduction
1. Objectives of the Guideline
2. Contributing Authors and Development of the Guideline
3. Utilization of Repeat CT Guideline

II. Definition of Repeats CT

III. General Guideline for CT Examination

IV. Anatomical CT Examination and Repeat CT Guideline
1. Chest CT for Lung Cancer Evaluation
2. General Abdominal CT
3. Abdominal CT for Hematuria Evaluation
4. Heart CT
5. Spine and Pelvis CT
6. General Brain CT

V. Pediatric CT Examination Guideline

VI. References

Table 2. One example of Guidelines for repeat CT exams of anatomical part: General Abdominal CT (3)
Necessary Supplementary CT

1. In case of making an accurate diagnosis, dynamic contrast-enhanced abdominal CT is necessary

   e. g.) A. Diagnosis of newly detected liver lesion

   - Detection of liver lesion during the process of acute abdomen diagnosis among the high-risk patients pool (chronic hepatitis, alcohol consumption, other liver disease, follow-up of every surgical resection of malignant tumor)

   B. Suspicion of intestinal ischemia or necrosis (supplementary and repeat CT)

   C. Suspicion of intestinal internal bleeding

   D. Suspicion of pancreatic cancer

   E. Suspicion of abdominal vessel injury after sustaining external trauma

2. Case of additional pre-contrast CT evaluation for making an accurate diagnosis

   e. g. ) Diagnosis of gall bladder lesion and cholelithiasis

3. Case of additional 3D reconstruction

   e. g. ) A. Suspicion of colon diseases that require contrast-enhanced CT such as colon polyps

   B. In order to evaluate the vessel infiltration or vessel anatomy via contrast-enhanced CT before the surgery

Acceptable Duplicate CT

1. Radiologists are not able to read or interpret the images because of the poor quality of the image resolution.

   e. g. ) A. Severe Motion Artifact

   - Motion artifact due to patient's movement

   - Motion artifact due to the defective device

   B. Image slice thickness exceeds 8 mm

   C. Occurrence of Inter-slice gap
D. Inappropriate contrast-enhanced CT examination during the necessary contrast-enhanced examination.

2. Inadequate inclusion of the area of interest

3. In the process of diagnosing during the emergency case of acute abdomen or severe abdominal trauma, while radiologists are absent due to the hospital policy or not in the clinical shift hour, which makes difficult for corresponding physicians to make a correct decision in diagnosis and treatment plan.

Follow-up CT

1. When complications or persistent symptoms arise, even after the treatment

2. When physicians determine that the clinical course of the patients has changed

3. When benefits of taking the cross-section image after a surgery or procedure may help the patients in evaluating the current condition are recognized.

Table 3. Survey items

<table>
<thead>
<tr>
<th>Items</th>
<th>Institution</th>
<th>Size of Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Patient</td>
<td>Age, Sex</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>Referring department</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Items</th>
<th>Institution</th>
<th>Size of Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>General information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Items</th>
<th>Examination information</th>
<th>Size of Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior imaging</td>
<td>Body part, size of institution, cause of exam</td>
<td></td>
</tr>
<tr>
<td>Repeat imaging</td>
<td>Body part, reason for repeat examination</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>Comparison of prior imaging and repeat imaging protocol</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Classification for repeat imaging (3, 4)

<table>
<thead>
<tr>
<th>Code</th>
<th>Definition</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>A subsequent examination which either confirms or refutes the presence of a questionable</td>
<td>High value added supplementary imaging</td>
</tr>
</tbody>
</table>
finding identified on prior examination or better characterizes a known abnormality or indeterminate finding.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>Suboptimal imaging quality</td>
<td>Permissible</td>
</tr>
<tr>
<td>D2</td>
<td>Insufficient scan range</td>
<td>duplicative imaging</td>
</tr>
<tr>
<td>F1</td>
<td>Suspected surgical or intervention complication with poor improvement of symptoms</td>
<td>Follow-up imaging</td>
</tr>
<tr>
<td>F2</td>
<td>Change in patient status determined by physician</td>
<td></td>
</tr>
<tr>
<td>F3</td>
<td>Other follow up (when CT follow up is thought to be of definite value to the patient)</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td>No reason</td>
<td>Unnecessary/unneeded exam</td>
</tr>
<tr>
<td>X</td>
<td>A patient encounter that occurs for an entirely different purpose.</td>
<td>Unrelated</td>
</tr>
</tbody>
</table>
Results

A total of investigated examination was 7,238 cases before publication and 7,030 cases after publication, and 1,209 (17%) and 1,357 (19%) cases were repeat CT, respectively. However, in the hospitals exposed to the guideline beforehand, the rate of repeat CT significantly decreased from 15% to 12% (p=0.03). There are differences among the regional distribution of referred hospital and referring hospital volume, and the repeat rate in the medium-sized hospital was highest (21% vs 12% in large hospital and 12.1% in clinic). According to the causes of repeat, F and S groups were the first and second most causes both before and after publication (52% and 23% before publication; 52% and 21% after publication). D group was relatively small (4%).

Fig. 1: Figure 1. Rate of repeat CT before and after implementation of guideline. The hospitals (red box) exposed to the guideline beforehand, the rate of repeat CT significantly decreased from 15% to 12% (p=0.03).

References: Radiology, The Catholic University of Korea, Seoul St. Mary’s Hospital - Seoul/KR

There are differences among the regional distribution of referred hospital and referring hospital volume, and the repeat rate in the medium-sized hospital was highest (21% vs 12% in large hospital and 12.1% in clinic).
According to the causes of repeat, F and S groups were the first and second most causes both before and after publication (52% and 23% before publication; 52% and 21% after publication). D group was relatively small (6%).

**Fig. 2:** Figure 2. In terms of classification of repeat CT, "follow-up imaging" was the most common reason for repeat imaging regardless of body part (51%), followed by "high value added supplementary imaging" (28%), "unnecessary/unneeded exam" (10%), and "permissible duplicative imaging" (6 %).

**References:** Radiology, The Catholic University of Korea, Seoul St. Mary's Hospital - Seoul/KR
**Fig. 3:** Figure 3. Classification of repeat imaging (%) by referring hospital type. The graph shows higher D (permissible duplicative imaging) and S (high value added supplementary imaging) for clinics, suggesting that clinics have poor image quality and/or suboptimal protocols compared with general and university hospitals.

**References:** Radiology, The Catholic University of Korea, Seoul St. Mary's Hospital - Seoul/KR

**Fig. 4:** Figure 4. Classification of repeat imaging (%) by referring body part. The graph shows high D for abdominal imaging, possibly due to the need for different protocols such as dynamic liver, pancreas, and adrenal protocols.

**References:** Radiology, The Catholic University of Korea, Seoul St. Mary's Hospital - Seoul/KR
Fig. 5: Figure 5. Classification of repeat imaging (%) by CT type. The graph shows that CT machines with less than 4 channels have a high D and S, suggesting CT machines with less than 4 channels have poor image quality.

**References:** Radiology, The Catholic University of Korea, Seoul St. Mary’s Hospital - Seoul/KR
Conclusion

Among them, unrelated imaging, follow-up imaging, and necessary supplementary imaging are accepted as reasonable and valid; however, duplicate imaging and unnecessary supplementary imaging are difficult to consider as the repeats. Especially, intentional duplicate imaging such as permissible duplicate imaging is conducted when the initial imaging has a default and unintentional duplicate imaging and unnecessary supplementary imaging are unnecessary measures in re-evaluation process.

About 18% of the CT studies performed at referring hospital was repeated within 1 month, and the most of the repeat examination was proved to follow-up or supplementary exams. Although the rate of repeat CT did not change after publication, there is a room for decrease the repeat rate after disseminating the guideline.
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References