Extracardiac Findings on Cardiac Computed Tomography
A Radiologist’s Perspective

Kevin M. Johnson, MD
New Haven, Connecticut

There has been debate in the cardiology literature as to how to handle unexpected noncardiac findings on cardiac computed tomography examinations. From the perspective of a radiologist, all structures on the presented images should be assessed. The interpreter needs to carefully winnow the findings down to potentially important ones. Then the question becomes what to do next. Cardiologists who take primary responsibility for cardiac computed tomography examinations must be able to recognize noncardiac findings that require immediate action. Although infrequent, their clinical impact can be substantial. False-positive results will occur; minimizing these depends on knowledge of common trivial findings, normal variants, and customary workup and follow-up recommendations. This implies experience in interpreting structures outside the heart. Therefore, help from an experienced and decisive radiologist should maximize sensitivity for significant lesions while minimizing the number of false-positive diagnoses. (J Am Coll Cardiol 2010;55:1566–8) © 2010 by the American College of Cardiology Foundation

Computed tomography (CT) is an extremely powerful way to peer inside a patient’s body, and unexpected findings are a fact of life. A dilemma is created when we discover something for which we are not looking, but as physicians, we face what William James called a “forced option” (1): We must either do something or elect deliberately not to do something in every instance.

Most such findings are harmless, but mixed in with a few that are not. The physician needs to spot these dangers scattered across a largely benign landscape. There has been debate in the cardiology literature as to how to do this in cardiac CT—should the large field of view (FOV) images be reviewed? Must the lung windows be read? Positions have been taken on each side (2,3).

If a cardiologist elects not to interpret the structures outside the heart and great vessels, the other findings remain on the archived images indefinitely and are subject to later discovery. The problem then becomes defending a “miss” in a setting in which other practitioners (radiologists) use a different standard of care. The prospect of having radiologists narrow their interpretation habits instead is dim indeed. This reality must be weighed by the nonradiologist interpreter.

Whatever approach is used, false-positive findings will occur. Whether they are “too many” depends on how they are dealt with. If one recommends many biopsies or short-interval follow-ups, then costs can rapidly escalate out of control. But although false-positive results are bad, false-negative results can be worse. False-positive findings harm largely to the extent that they are taken more seriously than they should be. False-negative findings can have dire consequences.

A definitive cost-benefit analysis is needed to resolve the question of whether the benefits of true-positive findings offset the costs of false-positive findings. Costs of incidental findings on cardiac CT in 699 patients were recently studied by MacHaalany et al. (4). The total cost of further diagnostic steps was $119 per patient on average, with the median closer to $62 (because 1 complication of a lung biopsy accounted for approximately one-half of all costs). This expense can be compared with the cost of the scan, which ranges from ~$100 for calcium scoring up to ~$600 to $1,000 for a coronary CT angiogram. Crucially, the authors did not remark on the benefits in the 14 patients in whom clinically important findings resulted. The cost was $5,931 per diagnosis of 5 cases of pulmonary emboli, 1 case of pneumonia, 6 cases of cancers, 1 case of unsuspected aortic dissection, and 1 case of a ruptured breast implant. Therefore, their study was not a cost-benefit analysis.

The trick is not to create new problems with your readings. To this end, one must apply certain tests to each finding in question: is this is a normal variant? If so, ignore it. Is it a trivial benign entity? If so, discard it. Is it abnormal but clinically unimportant? If so, then mention it and move...
on. In all other cases, the important question becomes what should be done next?

**Question of Action**

Our thinking about noncardiac findings on cardiac examinations can be usefully organized around the question of action, that is, making a judgment for each finding as to whether it merits therapy, prompt further workup, later follow-up, or no further action. Findings fall into 2 broad categories: those that must be addressed immediately and those that can wait. The latter can be further subdivided into those that can wait for a short time such as a day or 2 and the rest.

I propose that cardiologists need to recognize noncardiac findings that require immediate attention and can leave the rest to be overread by a radiologist at a (slightly) later date. As it happens, essentially all the former lie within the smaller FOV, although all are not visible with the mediastinal windows.

**FOV**

A cardiac CT examination is typically reconstructed with a small FOV to encompass the heart, but of necessity the entire transverse dimension of the chest has been scanned and the images are available for review on the scanner, if not always transferred to the reading station. Whether the large FOV needs to be routinely reviewed on cardiac CT studies has been a point of contention. I will not attempt to resolve the dispute here except to say that there are a number of other instances in radiology in which this is not the usual procedure (e.g., CT of the spine, sinuses, and hips).

An experienced radiologist takes several minutes to page through the large FOV image stack, once in the mediastinal windows, once in the lung windows, and once in bone windows, with attention to the periphery outside the smaller FOV. The smaller FOV is then viewed in the mediastinal windows for assessment of the heart.

A crucial point is that although radiologists may not always look at the large FOV images, good practice dictates that they look at all parts of all images actually presented to them for reading. For example, neuroradiologists are responsible for detecting abnormalities in the portion of the retroperitoneum included on standard lumbar CT images, even though they are not given and do not review the large FOV images.

If only the small FOV is interpreted, the lung windows must be included if pneumothorax and pneumonias are to be detected. If the small FOV reveals abnormalities in the periphery, review of the large FOV dataset, if still available, can be helpful in understanding the nature of the findings.

**Approach to the Images**

I think of the anatomy in terms of gross anatomic structures: make the findings for each structure, then mentally “dissect” them for reading. For example, neuroradiologists are responsible for detecting abnormalities in the portion of the retroperitoneum included on standard lumbar CT images, even though they are not given and do not review the large FOV.

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**Table 1 Recommendations for Follow-Up and Management of Nodules <8 mm Detected Incidentally at Nonscreening Computed Tomography**

<table>
<thead>
<tr>
<th>Nodule Size (mm)*</th>
<th>Low-Risk Patient†</th>
<th>High-Risk Patient</th>
</tr>
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<tbody>
<tr>
<td>≤4</td>
<td>No follow-up needed§</td>
<td>Follow-up CT at 12 months: if unchanged, no further follow-up.</td>
</tr>
<tr>
<td>&gt;4–6</td>
<td>Follow-up CT at 12 months: if unchanged, no further follow-up.</td>
<td>Initial follow-up CT at 6–12 months, then at 18–24 months if no change.</td>
</tr>
<tr>
<td>&lt;6–8</td>
<td>Initial follow-up CT at 6–12 months, then at 18–24 months if no change.</td>
<td>Initial follow-up CT at 3–6 months, then at 9–12 months if no change.</td>
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<tr>
<td>≥8</td>
<td>Follow-up CT at approximately 3, 9, and 24 months, dynamic contrast-enhanced CT, PET, and/or biopsy.</td>
<td>Same as for low-risk patient.</td>
</tr>
</tbody>
</table>

Newly detected indeterminate nodule in persons 35 years of age or older. *Average of length and width. †Minimal or no history of smoking and of other known risk factors. §History of smoking or of other known risk factors. ¶The risk of malignancy in this category (≤1%) is substantially less than in a baseline CT scan of an asymptomatic smoker. [Honsold (ground-glass) or partly solid nodules may require longer follow-up to exclude indolent adenocarcinoma. This table was redrawn, with permission, from MacMahon et al. (5).] CT = computed tomography; PET = positron emission tomography.
action is needed. This is where the medical history can be useful. There is a widespread misconception on the part of nonradiologists that history deleteriously biases the reading. Bias is indeed introduced and is a crucial element in selecting the correct examination, using the correct protocol, and reading the images with maximal accuracy. Clinicians do not usually examine their patients without first obtaining the history; optimal radiologic care also sometimes requires one. An example is the incidental discovery of pulmonary nodules; recommendations for further action differ depending on the smoking and other history. The Fleischner Society has produced useful pulmonary nodule guidelines (5) (Table 1).

After winnowing out the anatomic variants, the trivial abnormalities, and the abnormal but clinically unimportant findings, each of the remaining findings must have an action plan associated with it. When the diagnosis is definitive (e.g., pneumothorax or pulmonary embolus), the plan is therapeutic rather than diagnostic. Otherwise, the choices come down to recommending further imaging or other diagnostic workup (most notably biopsy) or later follow-up. Findings that require immediate actions are listed in Table 2, along with important but less urgent findings.

Experience and judgment are most important to avoid unnecessary workup. For cardiologists interpreting cardiac CT, an alliance with a radiologist can help greatly in this task. Sometimes the best course of action is no action, but the less experienced the observer is, the less comfortable he or she is likely to be with this course.

Conclusions

If a cardiologist is to take primary responsibility for the cardiac CT examination, he or she must be able to recognize findings that require immediate action, whether these are in the heart or not. Time will tell to what extent cardiac CT becomes the domain of the radiologist or the cardiologist. In any case, responsibility for the remainder of the clinically important findings also falls on the primary interpreter unless and until it is passed along to a colleague with complementary skills.

Reprint requests and correspondence: Dr. Kevin M. Johnson, Department of Diagnostic Radiology, Yale University School of Medicine, 17 Hillhouse Avenue, New Haven, Connecticut 06520. E-mail: kevin.johnson@yale.edu.

REFERENCES


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