

EDITORIAL COMMENT

The Dilemma of Incidental Findings on Cardiac Computed Tomography*

Mark A. Hlatky, MD,†
Carlos Iribarren, MD, MPH, PhD‡
Stanford and Oakland, California

Nearby noncardiac structures are in the field of view whenever a patient undergoes cardiac computed tomography (CT) to measure coronary calcium or to perform a noninvasive coronary angiogram. The potential availability of this information creates a clinical dilemma, with experts weighing in on different sides. Some contend that a full interpretation of a cardiac CT scan should include a careful examination of noncardiac structures; in particular, most radiologists believe that every image should be interpreted completely (1). Others believe that examining noncardiac structures turns up too many incidental findings of uncertain clinical significance (“incidentalomas”), which leads to more harm than good because additional testing increases risk, cost, and patient anxiety (2,3). These experts caution that physicians should be guided by the principle of “first of all, do no harm.” This controversy over the approach to incidental findings resulting from advanced imaging procedures is not limited to cardiac CT, as similar vexing questions have been raised about brain, abdominal, and whole body imaging (2).

See page 1533

In any debate, it is important to separate solid facts from opinions and beliefs. Case series of cardiac CT examinations performed for a variety of indications (coronary calcium measurement, coronary CT angiography to evaluate chest pain) and using different techniques (electron beam CT or multidetector CT, small or large field of view, lung windows or not) have consistently reported that noncardiac incidental findings are remarkably common, ranging between roughly 20% and 60% of individuals (4). Most of these incidental findings had no proven clinical or prognostic significance, but a few have immediate clinical importance. In roughly 10% to 20% of

individuals, there are incidental noncardiac findings of uncertain significance that cause a recommendation to have follow-up with further tests and observation (5–11). The variation among studies in the proportion of “clinically significant” incidental findings is due, in part, to patient characteristics (e.g., older age and smoking history increase the likelihood of incidental findings), and in their definitions of “clinical significance” (4). Very few studies have followed patients to document subsequent clinical outcomes related to incidental findings.

The greatest concern is that an incidental finding on cardiac CT might represent an early lung cancer. Pulmonary nodules are quite common on CT scans, especially small nodules (<5 mm) when the lung fields have been examined in detail by an experienced radiologist. Since most pulmonary nodules are benign (12), the use of CT scans to screen for lung cancer is very controversial (13,14). Observational data have been interpreted by some investigators as showing CT screening for lung cancer to be highly effective (15), and by other investigators as showing that it has no effect on outcomes (16). A large randomized trial of CT screening for lung cancer is underway and will provide unbiased evidence on this important issue. In the meantime, the clinical guidelines of all major societies advise against the use of CT scans to screen for lung cancer.

If CT screening for lung cancer is widely regarded as unwarranted, should the lung fields on cardiac CT be searched for pulmonary nodules and other noncardiac findings? One argument is that since it is the standard of care to examine the noncardiac structures seen on a standard chest X-ray, it should be routine to examine noncardiac structures on a cardiac CT (1). This analogy is imperfect, however, because the lung fields on a chest X-ray are “in plain sight,” but on a cardiac CT scan, the field of view reviewed has to be enlarged and the settings manipulated to examine the lung fields fully. Another line of argument is that physicians have an obligation to extract the maximum information from any test. However, physicians are not obliged to extract all possible information from a blood, gene, or tissue sample, so should they be obliged to process imaging data to extract all possible information? In our view, the issue is not whether data can be collected, but whether the information it provides has clear value to the patient, as it is the physician’s duty to act in the patient’s best interest. This is an empirical question about the clinical outcomes of testing, and we need reliable data about the consequences, good and bad, of searching for incidental noncardiac findings on cardiac CT scans. Only recently have studies reported on subsequent medical testing and clinical outcomes of noncardiac incidental findings on cardiac CT.

In this issue of the *Journal*, MacHaalany et al. (17) report their 18-month follow-up of a cohort of 966 patients who underwent coronary CT angiography at a single center in Canada. They found 1 or more noncardiac incidental finding in 42% of the patients, but in only 12 patients (1%) were these findings judged to be “clinically significant.” A further 68

*Editorials published in the *Journal of the American College of Cardiology* reflect the views of the authors and do not necessarily represent the views of *JACC* or the American College of Cardiology.

†From the Stanford University School of Medicine, Stanford, California; and the ‡Division of Research, Kaiser Permanente of Northern California, Oakland, California.

patients (7%) had “indeterminate findings” requiring follow-up, 47 of whom had 1 or more noncalcified pulmonary nodule. Overall, the 80 patients with either a “significant” or “indeterminate” incidental finding had 87 follow-up CT scans, 9 biopsies, and assorted additional studies and consultations, leading to a cost of \$1,038 per patient for further evaluation (not including any treatment costs). One patient had a serious complication from a transthoracic biopsy that required hospitalization. On the benefit side of the balance, 3 lung cancers were found on follow-up CT scans (but none was seen on the initial CT scan!).

This mixed experience of MacHaalany et al. (17) is similar to that of other investigators. We found incidental noncardiac abnormalities in 190 (41%) of 459 healthy, asymptomatic subjects age 60 to 69 years undergoing cardiac CT as part of a research study to measure coronary calcium (18). Noncalcified pulmonary nodules in 81 individuals (18%) were followed up with an average of 1.3 additional chest CT scans over the subsequent 24 months (19). We found no lung cancers, and neither of the 2 nodules that increased in size on follow-up was shown to be malignant (19). Similarly, Onuma et al. (20) found noncardiac abnormalities in 292 (58%) of 503 patients undergoing coronary CT angiography for a variety of indications, 114 of whom (23%) required further follow-up. Over the subsequent 6 months, 75 patients had additional tests, including 24 CT scans. Two lung adenocarcinomas and 2 breast cancers were ultimately documented.

Implications

It is clear that noncardiac incidental findings on cardiac CT studies are very common and lead to additional diagnostic tests, increased risk from radiation exposure and biopsies, and definite costs. The potential benefits of these findings are small yet real, and the balance of risks, costs, and benefits is difficult to assess. It is likely that the value of examining noncardiac structures is less among asymptomatic individuals being evaluated for coronary calcium than it is among symptomatic patients undergoing coronary CT angiography, who may have a noncardiac source of their chest pain (9).

Since there is no professional consensus about the approach to reading cardiac CT scans for noncardiac findings, we suggest that the patient's concerns and preferences should be taken into consideration, as they would in any “close call.” The pros and cons of examining noncardiac structures could be presented fairly to the patient as part of the informed consent process. The patient should understand that incidental findings are common and usually of no clinical importance, but that there is roughly a 10% chance that they will need further follow-up tests to evaluate an incidental finding. There is a small chance (<1%) of finding an early cancer, but no proof that patients' survival would be improved, and most professional societies do not recommend screening for cancer with a chest CT. After being properly informed, the patient could then choose whether to “opt in” or “opt out” of having the noncardiac structures examined to search for incidental findings.

Reprint requests and correspondence: Dr. Mark A. Hlatky, Stanford University School of Medicine, HRP Redwood Building, Room 150, Stanford, California 94305. E-mail: hlatky@stanford.edu.

REFERENCES

1. Rumberger JA. Noncardiac abnormalities in diagnostic cardiac computed tomography. Within normal limits or we never looked! *J Am Coll Cardiol* 2006;48:407-8.
2. Stone JH. Incidentalomas—clinical correlation and translational science required. *N Engl J Med* 2006;354:2748-9.
3. Budoff MJ, Fischer H, Gopal A. Incidental findings with cardiac CT evaluation—should we read beyond the heart? *Catheter Cardiovasc Interv* 2006;68:965-73.
4. Jacobs PCA, Mali WPTM, Grobbee DE, van der Graaf Y. Prevalence of incidental findings in computed tomographic screening of the chest: a systematic review. *J Comput Assist Tomogr* 2008;32:214-21.
5. Aglan I, Jodocy D, Hiehs S, et al. Clinical relevance and scope of accidental extracoronary findings in coronary computed tomography angiography: a cardiac versus thoracic FOV study. *Eur J Radiol* 2009 Mar 4 [E-pub ahead of print].
6. Elgin EE, O'Malley PG, Feuerstein I, Taylor AJ. Frequency and severity of “incidentalomas” encountered during electron beam computed tomography for coronary calcium in middle-aged army personnel. *Am J Cardiol* 2002;90:543-5.
7. Horton KM, Post WS, Blumenthal RS, Fishman EK. Prevalence of significant noncardiac findings on electron-beam computed tomography coronary artery calcium screening examinations. *Circulation* 2002;106:532-4.
8. Hunold P, Schmermund A, Seibel RM, Grönemeyer DH, Erbel R. Prevalence and clinical significance of accidental findings in electron-beam tomographic scans for coronary artery calcification. *Eur Heart J* 2001;22:1748-58.
9. Koonce J, Schoepf JU, Nguyen SA, Northam MC, Ravenel JG. Extra-cardiac findings at cardiac CT: experience with 1,764 patients. *Eur Radiol* 2009;19:570-6.
10. Schragin JG, Weissfeld JL, Edmundowicz D, Stollo DC, Fuhrman CR. Non-cardiac findings on coronary electron beam computed tomography scanning. *J Thorac Imaging* 2004;19:82-6.
11. Lehman SJ, Abbara S, Cury RC, et al. Significance of cardiac computed tomography incidental findings in acute chest pain. *Am J Med* 2009;122:543-9.
12. Wilson DO, Weissfeld JL, Fuhrman CR, et al. The Pittsburgh Lung Screening Study (PLuSS). Outcomes within 3 years of a first computed tomography scan. *Am J Respir Crit Care Med* 2008;178:956-61.
13. Black WC, Baron JA. CT screening for lung cancer. Spiraling into confusion? *JAMA* 2007;297:995-7.
14. Marshall E. A bruising battle over lung scans. *Science* 2008;320:600-3.
15. The International Early Lung Cancer Action Program Investigators. Survival of patients with stage I lung cancer detected on CT screening. *N Engl J Med* 2006;355:1763-71.
16. Bach PB, Jett JR, Pastorino U, Tockman MS, Swensen SJ, Begg CB. Computed tomography screening and lung cancer outcomes. *JAMA* 2007;297:953-61.
17. MacHaalany J, Yam Y, Ruddy TD, et al. Potential clinical and economic consequences of noncardiac incidental findings on cardiac computed tomography. *J Am Coll Cardiol* 2009;54:1533-41.
18. Burt JR, Iribarren C, Fair JM, et al. Incidental findings on cardiac multidetector row computed tomography among healthy older adults. Prevalence and clinical correlates. *Arch Intern Med* 2008;168:756-61.
19. Iribarren C, Hlatky MA, Chandra M, et al. Incidental pulmonary nodules on cardiac computed tomography: prognosis and use. *Am J Med* 2008;121:989-96.
20. Onuma Y, Tanabe K, Nakazawa G, et al. Noncardiac findings in cardiac imaging with multidetector computed tomography. *J Am Coll Cardiol* 2006;48:402-6.

Key Words: incidental findings ■ cardiac CT ■ prognosis ■ noncardiac death ■ cancer.