VIEWPOINT

Curbing Unnecessary and Wasted Diagnostic Imaging

Ohad Oren, MD
Department of Hematology and Oncology, Mayo Clinic, Rochester, Minnesota.

Electron Kebebew, MD
Department of Surgery, Stanford Cancer Institute, Stanford University School of Medicine, Stanford, California.

John P. A. Ioannidis, MD, DSc
Stanford Prevention Research Center, Stanford University, Stanford, California; and Meta-Research Innovation Center at Stanford (METRICS), Stanford University, Stanford, California.

Despite modest effects from initiatives such as the Choosing Wisely campaign, unnecessary diagnostic imaging remains a substantial problem in the United States.[1-3] Significant between-country differences probably reflect largely wasted overuse. The United States occupies top usage ranks, with population rates of annual computed tomography (CT) scans (245 per 1000 people) and magnetic resonance imaging (MRI) scans (118 per 1000 people)[2] that are 5 and 3 times higher than those of Finland, respectively. With aggressive testing, the yield of useful information increases only slightly. Further, some diagnostic tests generate the detection of mostly incidental findings ("incidentalomas") with the frequency proportional to the excess of testing performed.

Radiographic incidentalomas, defined as abnormalities that did not serve as the native reason for the performance of the test, are very common.[4] These findings have major financial and health consequences, including further wasted efforts for unnecessary diagnosis and treatment and patient anxiety.[5] Much of the focus to date has been on the management of incidentalomas rather than their adverse consequences. These adverse consequences are difficult to capture in their entirety because unnecessary diagnostic hints may complicate much of the future care of a patient in unpredictable ways. Well-orchestrated strategies are needed that can reduce unnecessary diagnostic imaging. A fundamental question is whether these strategies work and how best to determine whether they do without compromising patient well-being.

> Overuse of imaging equates to haphazard screening of individuals for disease.

One set of strategies may involve education of physicians most likely to order tests. Medical school, residency, and continuing medical education can sensitize physicians about diagnostic waste. Clinicians can be educated to routinely answer the following questions before ordering any radiographic test: Is it necessary? What are the consequences of performing the test? What are the alternative options (and their associated benefits and risks)? What is the likely outcome with no further workup?

Interventions studied to date include implementation of appropriate use criteria, provision of educational support, and use of "rule-out" imaging criteria with corresponding reductions in the unnecessary use of imaging tests.[6,7] However, these investigations typically used before-and-after analyses and were not randomized trials. A rare randomized clinical trial (RCT) introduced an educational intervention that focused on appropriate use criteria for the outpatient ordering of transthoracic echocardiography among 196 physicians.[8] The result was a nominally significant but small reduction (10.1% in the control group vs 8.8% in the intervention group) in the proportion of ordered tests that clearly lacked benefit. However, additional important patient outcomes, such as patient experience and costs, were not assessed. More RCTs are needed.

Another possible approach is to educate the general public. Healthy individuals and patients can be counselled that imaging studies have associated risks not only due to radiation and intravenous contrast, but also can lead to the detection of incidental findings. Flowcharts and diagrams can be created to demonstrate the possible scenarios and the likely cascade of tests that may be required, along with the risks and benefits of each step. One problem that arises with such educational material is that some of the key benefit and risk estimates of a diagnostic workup are based on limited data with high imprecision and potential bias. In addition, the effectiveness of various campaigns to sensitize patients about the risks of wasted imaging is unknown. No RCTs are currently available on the effect of patient-level interventions. Several before-and-after studies of behavioral interventions have shown possibly promising results, eg, among patients with irritable bowel syndrome, reassurance, exercise instruction, and guided imagery were associated with lower use of imaging.[9]

General campaigns aimed at the public or all patients with a given disease may be less effective than efforts that target point of care, when each specific patient needs to decide whether to have an imaging test performed. Instead of the current typical pretest conversation, which generally involves a clinician simply notifying the patient that imaging is ordered, a shared decision-making process requires comprehension of the likely gains vs the potential detrimental effects of testing, including the detection and investigation of unrelated findings. An informed consent process of that kind may improve transparency and reduce confusion regarding follow-up and treatment options. However, paradoxically, exposure of patients to more information and more medical jargon may tilt them toward choosing to do more rather than less. This may be an even greater concern if physicians discuss not only the tests that they deem are possibly useful, but all test options. It is unknown what threshold of perceived utility should be used by a physician before opening a conversation with a patient on whether a test should be performed.

Corresponding Author: John P. A. Ioannidis, MD, DSc, Stanford Prevention Research Center, 1265 Welch Rd, MSOB X306, Stanford, CA 94305 (jioannid@stanford.edu).

Effective interventions may need to occur concurrently at multiple points in the system and involve both clinicians and patients. These interventions also need to address outcomes that reflect patient safety and harms. For instance, displaying the price of tests to physicians may decrease cost but not the volume of testing, and that might not improve patient safety.[8,10] There is also some evidence that interventions that address both physicians and patients (or their families for pediatric patients) may be more effective than interventions that are directed only toward physicians or only toward patients.[9]

Another possibility is to capitalize on advances in imaging technology so that the quality and focus of the image are adjusted to the level of clinical suspicion. Practically speaking, lowering the imaging sensitivity of nontarget tissues may result in more target-site focus and less distraction by unrelated findings. For instance, a CT scan of the chest ordered in an attempt to rule out pulmonary embolism could be modified to have only medium resolution for skeletal tissues and breast (in female patients) and high resolution for the pulmonary vessels. As a result, pulmonary nodules, abnormal marrow signals, and breast irregularities will be less likely to be detected.

A similar idea involves the visual projection of only the radiographic fields relevant to the clinical question. Anatomical sites outside the region of clinical concern ("low-yield territories") would be imaged but shadowed on the final film. For example, CT performed due to strong clinical concern for nephrolithiasis would not include imaging of the liver or the spleen and could allow the radiologist to specifically address only the clinical concern of renal stones. It might be argued that a limited radiographic image is equivalent to a partial physical examination and that a restricted field jeopardizes the ability to make accurate unifying diagnosis. This may be true for complicated cases. However, in most clinical imaging performed for patients free of multiorgan disease and cancer and suspicion thereof and who present with straightforward, readily explainable symptoms concerning a limited number of clinical entities, a resolution-modified and field-focused approach may minimize incidentalomas without loss of useful information. Although this approach would not reduce the number of initial tests, it could potentially prevent the cascade of tests that follow an incidental finding. Dealing with how this focus may affect the malpractice climate would also be necessary.

Other ideas involve more systematic changes to the ordering, distribution, and reimbursement of imaging tests. The cost of nonindicated imaging could be significantly increased and low-value studies could be associated with higher out-of-pocket expenses. As an extreme situation, the use of certain test modalities in particular clinical scenarios could be prohibited or markedly limited (ie, brain MRI in patients with stable chronic migraine headache).

Alternatively, the use of certain modalities could be restricted to cases approved by radiology specialists, similar to the use of some high-potency antibiotics requiring approval by infectious disease specialists. With marked improvements in the sensitivity and specificity of automated reading of images, radiologists will be needed less to interpret some imaging tests. The specialty of diagnostic radiology may thus need to change focus: instead of training radiologists primarily to read images, they may need to be trained as gatekeepers who mostly regulate or are consulted about what tests should be ordered and, even more so, which ones should not be ordered. This would require embedding radiologists more routinely as consultants in clinical encounters that contemplate ordering imaging tests. Gatekeeper mechanisms will have to be cautiously evaluated to balance the need for accessible imaging with the harms mediated by the overuse of tests.

Overuse of imaging equates to haphazard screening of individuals for disease. There is virtually no evidence that screening of this kind improves overall population health. Advanced imaging tests, such as CT scans and MRI scans, were never subjected to RCTs when they were introduced and rightly so because they were seen as revolutionarily innovative, useful informational advances. However, while information can be useful, too much information can create numerous problems. Proper studies, in particular RCTs, should be supported to examine how to curb unnecessary and wasted imaging. Public funders as well as reimbursors of medical care should consider seriously supporting such trials because they would stand to benefit enormously from the findings of rigorous studies of the utility of diagnostic imaging.

ARTICLE INFORMATION

Published Online: January 7, 2019. doi:10.1001/jama.2018.20295

Conflict of Interest Disclosures: None reported.

REFERENCES

1. Smith-Bindman R, Miglioretti DL, Johnson E, et al. Use of diagnostic imaging studies and associated radiation exposure for patients enrolled in large integrated health care systems, 1996-2010. *JAMA*. 2012;307(22):2400-2409. doi:10.1001/jama.2012.5960

2. Papanicolas I, Woskie LR, Jha AK. Health care spending in the United States and other high-income countries. *JAMA*. 2018;319(10):1024-1039. doi:10.1001/jama.2018.1150

3. Levinson W, Born K, Wolfson D. Choosing Wisely Campaigns: a work in progress. *JAMA*. 2018;319(19):1975-1976. doi:10.1001/jama.2018.2202

4. O'Sullivan JW, Muntinga T, Grigg S, Ioannidis JPA. Prevalence and outcomes of incidental imaging findings: umbrella review. *BMJ*. 2018;361:k2387. doi:10.1136/bmj.k2387

5. Adams SJ, Rakheja R, Bryce R, Babyn PS. Incidence and economic impact of incidental findings on 18F-FDG PET/CT Imaging. *Can Assoc Radiol J*. 2018;69(1):63-70. doi:10.1016/j.carj.2017.08.001

6. Webster NJ, Moore N, Stewart F. Reducing unnecessary head computed tomography in mild traumatic brain injury. *Adv Emerg Nurs J*. 2017;39(4):300-308. doi:10.1097/TME.0000000000000169

7. Wang KY, Yen CJ, Chen M, et al. Reducing inappropriate lumbar spine MRI for low back pain: radiology support, communication and alignment network. *J Am Coll Radiol*. 2018;15(1 pt A):116-122. doi:10.1016/j.jacr.2017.08.005

8. Bhatia RS, Ivers NM, Yin XC, et al. Improving the appropriate use of transthoracic echocardiography: The Echo WISELY trial. *J Am Coll Cardiol*. 2017;70(9):1135-1144. doi:10.1016/j.jacc.2017.06.065

9. Hiscock H, Neely RJ, Warren H, Soon J, Georgiou A. Reducing unnecessary imaging and pathology tests: a systematic review. *Pediatrics*. 2018;141(2):e20172862. doi:10.1542/peds.2017-2862

10. Silvestri MT, Bongiovanni TR, Glover JG, Gross CP. Impact of price display on provider ordering: A systematic review. *J Hosp Med*. 2016;11(1):65-76. doi:10.1002/jhm.2500