

## CORRESPONDENCE



## Radiation Exposure from Medical Imaging Procedures

**TO THE EDITOR:** In the August 27 issue, the article by Fazel et al.<sup>1</sup> and the accompanying Perspective article by Lauer<sup>2</sup> create an opportunity for the medical community to learn more about the work of radiation protection professionals: medical physicists and diagnostic radiologists. Radiologists are the only physicians who receive substantive training in radiation biology and safety that is linked to their board certification. Radiologists are most knowledgeable in managing and minimizing radiation exposures associated with medical imaging, and they can recommend sonography and magnetic resonance imaging (MRI) as alternatives to ionizing imaging.<sup>3</sup> In a 2009 report,<sup>4</sup> the National Council on Radiation Protection and Measurements, which was chartered by Congress, provided a comprehensive analysis of medical and all other sources of ionizing radiation to which the American public was exposed. The medical community should work together across disciplines to use existing knowledge about radiation protection to ensure that imaging is warranted and optimized. When patients do need imaging, they should ask if the imaging center is accredited, the imaging personnel are credentialed, and the protocols used are weight-based and indication-based, to ensure quality.

Kimberly Elaine Applegate, M.D.

Emory University  
Atlanta, GA  
keapple@emory.edu

E. Stephen Amis, Jr., M.D.

Albert Einstein College of Medicine  
Bronx, NY

David A. Schauer, Sc.D.

National Council on Radiation Protection and Measurements  
Bethesda, MD

1. Fazel R, Krumholz HM, Wang Y, et al. Exposure to low-dose ionizing radiation from medical imaging procedures. *N Engl J Med* 2009;361:849-57.

2. Lauer MS. Elements of danger — the case of medical imaging. *N Engl J Med* 2009;361:841-3.
3. Amis ES Jr, Butler PF, Applegate KE, et al. American College of Radiology white paper on radiation dose in medicine. *J Am Coll Radiol* 2007;4:272-84.
4. Report no. 160. Ionizing radiation exposure of the population of the United States. Bethesda, MD: National Council on Radiation Protection and Measurements, 2009. (Accessed November 12, 2009, at <http://www.ncrppublications.org/Reports/160>.)

**TO THE EDITOR:** Fazel et al. used claims-based estimates of cumulative effective doses of medical radiation to calculate the annual effective doses for adults 18 to 64 years of age, and they corroborated a previous report of higher population-based rates of exposure as compared with 25 years ago.<sup>1</sup> However, only small segments of the population (18.6 and 1.9 enrollees per 1000 per year, respectively) received high and very high effective doses. In contrast, self-referral is widespread and should have been discussed, since 81.8% of the total effective dose was administered to outpatients, mostly in physicians' offices. Lauer stated, "most radiologic imaging tests offer net negative results." The truth is that, owing to computed tomography (CT), exploratory laparotomy in patients with undiagnosed abdominal pain and cerebral angiography to diagnose brain tumors are now practice relics such as trephination, bloodletting, and plumbage. A survey of 225

### THIS WEEK'S LETTERS

**2289 Radiation Exposure from Medical Imaging Procedures**

**2292 Uterine Fibroid Embolization**

**2294 A Woman with Fever, Rash, and Lymphadenopathy**

**2296 Emergence of Oseltamivir-Resistant Pandemic H1N1 Virus during Prophylaxis**

internists on the relative importance of 30 medical innovations culled from *JAMA* and the *Journal* yielded three imaging-related innovations among the top five: MRI and CT scanning (number 1), balloon angioplasty (number 3), and mammography (number 5).<sup>2</sup> Net negative results?

Gary Jay Becker, M.D.

Jennifer Bosma, Ph.D.

American Board of Radiology Foundation  
Tucson, AZ  
gbecker@theabr.org

William Hendee, Ph.D.

Medical College of Wisconsin  
Whitefish Bay, WI

1. Report no. 160. Ionizing radiation exposure of the population of the United States. Bethesda, MD: National Council on Radiation Protection and Measurements, 2009. (Accessed November 12, 2009, at <http://www.ncrppublications.org/Reports/160>.)
2. Fuchs VR, Sox HC Jr. Physicians' views of the relative importance of thirty medical innovations. *Health Aff (Millwood)* 2001;20(5):30-42.

**TO THE EDITOR:** Like many authors, Lauer's viewpoint rests on acceptance of the linear, no-threshold theory, which posits direct dose-response relationships between exposure to even small amounts of radiation and the development of solid cancers.<sup>1,2</sup> Data most often cited to provide support for this hypothesis come from surveys of survivors of the Hiroshima bombing. No studies have verified the linear, no-threshold assumptions about cancer associated with the low doses used in diagnostic imaging; instead, Hiroshima data are extrapolated down to the lowest doses. Large-population studies of low-dose occupational exposure have shown no radiation-related increases in deaths from cancer.<sup>3</sup> Nevertheless, the linear, no-threshold theory is invoked by scientific professionals and the media, causing fear about even routine medical imaging. We harm our patients and ourselves by making assumptions that are not adequately supported by data. The time is right to initiate long-term studies involving persons who have undergone imaging. Such studies could provide the data that would lead to a meaningful dialogue — one based on fact rather than conjecture.

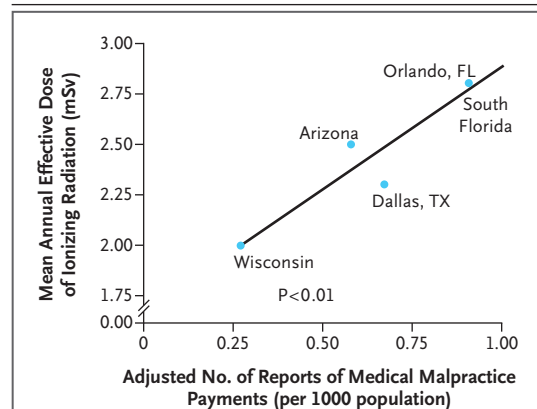
Reuben Saul Mezrich, M.D., Ph.D.

University of Maryland School of Medicine  
Baltimore, MD  
rmezrich@umm.edu

1. Brenner DJ, Hall EJ. Computed tomography — an increasing source of radiation exposure. *N Engl J Med* 2007;357:2277-84.

2. The Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation. Health risks from exposure to low levels of ionizing radiation: BEIR VII, phase 2. Washington, DC: National Academies Press, 2006.
3. Cardis E, Vrijheid M, Blettner M, et al. The 15-Country Collaborative Study of Cancer Risk among Radiation Workers in the Nuclear Industry: estimates of radiation-related cancer risks. *Radiat Res* 2007;167:396-416.

**TO THE EDITOR:** Fazel et al. do not comment on the variability among the five health care markets they studied: Arizona; Dallas; Orlando, Florida; South Florida; and Wisconsin. Crude pairwise t-tests show that these health care markets are distinct in their usage of radiation-based imaging. The importance of such a finding is that it may shed light on the underlying reasons for the overuse of radiologic procedures, which seems to be more extensive in Florida than Wisconsin, for example. More than 90% of surveyed physicians have reported practicing “defensive medicine,” and nearly half have reported “using imaging in clinically unnecessary circumstances.”<sup>1</sup> Baicker et al.<sup>2</sup> found that increasing malpractice payments (according to the state) correlate with increased Medicare spending on imaging ( $P < 0.01$ ). The simple plot in Figure 1 shows that malpractice reports per capita<sup>3</sup> (according to the state) correlate with the mean dose of radiation in the same five health care markets. Defensive medicine clearly fuels increasing health care costs, but could it cause cancer too?



**Figure 1. Relationship between Mean Doses of Ionizing Radiation from Imaging Procedures and Malpractice Reports in Five Health Care Markets.**

The mean annual effective doses of ionizing radiation from imaging procedures versus the adjusted number of per capita physicians' reports of medical malpractice payments are shown.

Vikram Budhraj, M.D.

Lincoln Medical and Mental Health Center  
Bronx, NY  
vikram.budhraj@gmail.com

1. Studdert DM, Mello MM, Sage WM, et al. Defensive medicine among high-risk specialist physicians in a volatile malpractice environment. *JAMA* 2005;293:2609-17.
2. Baicker K, Fisher ES, Chandra A. Malpractice liability costs and the practice of medicine in the Medicare program. *Health Aff (Millwood)* 2007;26:841-52.
3. Department of Health and Human Services. National Practitioner Data Bank 2006 annual report. Table 8. (Accessed November 12, 2009, at [http://www.npdb-hipdb.hrsa.gov/pubs/stats/2006\\_NPDB\\_Annual\\_Report.pdf](http://www.npdb-hipdb.hrsa.gov/pubs/stats/2006_NPDB_Annual_Report.pdf)).

**TO THE EDITOR:** In an otherwise thoughtful Perspective article, Lauer omits tort as a driving force in the ordering of unnecessary studies. Defensive medicine parallels evidence-based medicine as the standard of care in this country. Go to any busy emergency department and watch our youth being irradiated at a pace that is mind-boggling. Jim's physician knows that if he does not order the study, and Jim has a myocardial infarction, he will be asked why he did not order the study or send Jim to a cardiologist who would. In court, Lauer will not be on the jury of his peers.

It is untrue that "our medical system sees nothing wrong with Jim's care." Many physicians are appalled by the need to practice defensive medicine. However, increasing patient loads and the threat of lawsuits make it less risky to order a test than to explain why it is not needed. The United States leads the world in per capita imaging rates. It is the country with the highest malpractice liability. Nothing else explains the problem better.

B. Franklin Diamond, M.D.

Abington Memorial Hospital  
Abington, PA

**DR. FAZEL AND COLLEAGUES REPLY:** We agree with Applegate and colleagues that there is an urgent need for the medical community to promote radiation safety and to ensure that imaging is both justified and optimally performed. Radiologists and medical physicists will play a central role in this process, largely by developing strategies to reduce the doses of radiation in procedures without compromising diagnostic accuracy (i.e., optimization) and offering alternatives to imaging with ionizing radiation. However, ensuring that imaging is used appropriately (i.e., justification) will require the involvement of the broader medi-

cal community, with a focus on engaging the clinicians who most often decide when to pursue imaging and what type of imaging best fits the clinical context.

In response to Becker and colleagues: we acknowledged in our article that advances in imaging have expanded our capacity to help patients and have radically transformed medical care. However, this issue is distinct from concerns about whether physicians are ordering tests that are unlikely to provide benefit. Given the extent of radiation exposure that we found in this study population, it is critically important that we avoid imaging that is unlikely to provide a net clinical benefit.

Mezrich points out the limitations of the linear, no-threshold model. Although epidemiologic studies are consistent with this model, even at lower doses (<100 mSv),<sup>1,2</sup> we agree that these data are not definitive. We hope that studies such as ours promote further research to better define the biologic effects of low-dose radiation, given its considerable implications for the public's health.

Finally, we agree with Budhraj and Diamond that defensive medicine is probably one of the factors driving the increased use of imaging in the United States. However, its relative contribution remains unclear, particularly since the rapid rise in imaging over the past decade has occurred during a relatively stable period of malpractice litigation.<sup>3</sup> Other factors that are probably contributing to this trend include improved technology, widespread availability, favorable reimbursement, and a general shift in the culture of medicine in which imaging is increasingly used as a substitute for a thorough history and physical examination.

Reza Fazel, M.D.

Emory University School of Medicine  
Atlanta, GA  
rfazel@emory.edu

Harlan M. Krumholz, M.D., S.M.

Yale University School of Medicine  
New Haven, CT

Brahmajee K. Nallamothu, M.D., M.P.H.

University of Michigan Medical Center  
Ann Arbor, MI

1. Brenner DJ, Doll R, Goodhead DT, et al. Cancer risks attributable to low doses of ionizing radiation: assessing what we really know. *Proc Natl Acad Sci U S A* 2003;100:13761-6.
2. Little MP, Wakeford R, Tawn EJ, Bouffler SD, Berrington de Gonzalez A. Risks associated with low doses and low dose rates of ionizing radiation: why linearity may be (almost) the best we can do. *Radiology* 2009;251:6-12.

3. Department of Health and Human Services. National Practitioner Data Bank 2006 annual report. Figure 1. (Accessed November 12, 2009, at [http://www.npdb-hipdb.hrsa.gov/pubs/stats/2006\\_NPDB\\_Annual\\_Report.pdf](http://www.npdb-hipdb.hrsa.gov/pubs/stats/2006_NPDB_Annual_Report.pdf).)

**DR. LAUER REPLIES:** Applegate et al. argue that radiologists are most knowledgeable about the effects of ionizing radiation, and they call for stricter accreditation and credentialing standards. Although such efforts may well decrease radiation exposure in the population, they would not provide the high levels of evidence needed to ensure that the use of imaging tests leads to improved patient outcomes.

Becker and colleagues cite a survey of inter-nists as evidence that most imaging procedures yield value, and in doing so these newer procedures convert common old practices to “relics” such as bloodletting. Expert opinion, such as that derived from physician surveys, is the lowest form of clinical evidence.<sup>1</sup> Indeed, medical history is replete with examples of questionable practices that leading physicians promoted contrary to existing evidence.<sup>2</sup> Benjamin Rush and William Osler were strong supporters of bloodletting. More recently, despite expectations, CT scanning has failed to reduce the rate of false diagnoses among patients with suspected appendicitis.<sup>3</sup>

Citing the 15-Country Collaborative Study of Cancer Risk among Radiation Workers in the Nuclear Industry, Mezrich challenges purported associations between low-dose radiation exposure and harm. The study investigators analyzed the risk of death among 407,391 nuclear workers, and, in fact, found a significant association between the radiation dose and both all-cause and all-cancer mortality.<sup>4</sup> The observed rates of death exceeded expected rates even at cumulative doses as low as 5 to 50 mSv. The authors of the study concluded that their data were consistent with the conclusions of Biological Effects of Ionizing Radiation (BEIR) VII, which showed “a linear,

no-threshold dose–response relationship between exposure to ionizing radiation and the development of cancer in humans.”<sup>4</sup>

I wholeheartedly agree with Mezrich that “we harm our patients and ourselves by making assumptions . . . not adequately supported by data.” That is why it is essential to perform large-scale, randomized trials that will provide the data we and our patients need to make informed decisions. For example, the 50,000-patient National Lung Screening Trial (ClinicalTrials.gov number, NCT00047385) was designed to determine whether CT scanning reduces the rate of death from lung cancer among smokers.

Budhreja and Diamond suggest that most, if not all, overuse of imaging tests can be attributed to defensive medicine. Defensive practices may account for a small, but real, proportion of over-use.<sup>5</sup> However, other factors also are at play, including the practice culture, fee-for-service incentives, aggressive marketing, patient perceptions that overestimate the capabilities of modern technology, direct-to-consumer marketing, and third-party payments shielded from patient view.<sup>5</sup> Large-scale definitive trials may well help to align defensive with evidence-based medicine.

Michael S. Lauer, M.D.

National Heart, Lung, and Blood Institute  
Bethesda, MD

1. Tricoci P, Allen JM, Kramer JM, Califf RM, Smith SC Jr. Scientific evidence underlying the ACC/AHA clinical practice guidelines. *JAMA* 2009;301:831-41. [Erratum, *JAMA* 2009;301:1544.]
2. Haynes B, Haynes GA. ACP Journal Club: what does it take to put an ugly fact through the heart of a beautiful hypothesis? *Ann Intern Med* 2009;150:JC3-2-JC3-3.
3. Flum DR, Morris A, Koepsell T, Dellinger EP. Has misdiagnosis of appendicitis decreased over time? A population-based analysis. *JAMA* 2001;286:1748-53.
4. Cardis E, Vrijheid M, Blettner M, et al. The 15-Country Collaborative Study of Cancer Risk among Radiation Workers in the Nuclear Industry: estimates of radiation-related cancer risks. *Radiat Res* 2007;167:396-416.
5. Emanuel EJ, Fuchs VR. The perfect storm of overutilization. *JAMA* 2008;299:2789-91.

## Uterine Fibroid Embolization

**TO THE EDITOR:** In their article on uterine fibroid embolization (Aug. 13 issue),<sup>1</sup> Goodwin and Spies highlight few contraindications to the procedure; among them are “pregnancy, suspected cancer, active infection, or indeterminate endometrial or adnexal abnormalities.” They also cite

the U.K. Hysterectomy or Percutaneous Embolization for Uterine Leiomyomata (HOPEFUL) study, which showed a 2.6% incidence of septicemia after uterine fibroid embolization, with 1.1% of the women requiring emergency hysterectomy.<sup>2</sup>

Severe infection, often necessitating urgent