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# Counter-Point: Are We Really Ordering Too Many CT Scans?

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In a recent review published in the *New England Journal of Medicine*, DJ Brenner and EJ Hall, professors of Radiation Biology at Columbia University, analyzed the current trend to increased use of computed tomography (CT) scanning, the attendant radiation exposure, and the long-term potential for induction of fatal malignancies in the population.<sup>1</sup> This article was widely discussed in the popular press and on television news with headlines such as “Unnecessary CT scans exposing patients to excessive radiation: cancer cases could spike as a result,” “Doctors may risk overuse of CT scans,” and “The doctor says get a CT scan. Should you?”<sup>2-6</sup>

The original journal article and subsequent news coverage stated that one-third of CT scans are medically unnecessary, needlessly exposing millions of patients to high doses of radiation. However, the “evidence” on which this statement was based was insubstantial. In an ad hoc survey conducted during a panel discussion at a meeting of pediatric radiologists, a speaker mentioned that he felt 10% of CT scans were not medically necessary.<sup>7</sup> He then queried the audience, which responded that up to 30% were unnecessary. Aside from the fact that this was merely a casual inquiry, these are not the people making clinical decisions about patient care.

Emergency physicians (EPs) have, to some extent, been singled out with regard to this issue since we are responsible for ordering many CT studies. Dr. Brenner is quoted in *USA Today* as stating: “Virtually anyone who presents in the emergency room with pain in the belly or a chronic headache will automatically get a CT scan. Is that justified?” Dr. Fred Mettler, chief of Radiology at the New Mexico Veterans Administration Hospital, was quoted by MSNBC: “The pressure is greatest for ER doctors who ‘are in a bind ... they have all these patients stacked up’ and need to make quick decisions.” Again, it was not clinicians who made these statements, and they do not reflect the practice of high-quality emergency care.

EPs were also cited for being unaware of the magnitude of the radiation dose associated with CT scanning. In one survey, 91% of EPs did not believe that CT scans were associated with an increased risk of fatal cancer.<sup>8</sup> Clearly this misperception should be remedied, but its impact on clinical care is less certain.

In actuality, there is abundant evidence demonstrating the considerable benefit of CT in managing emergency department (ED) patients, substantially outweighing its risks. In fact, in some circumstances (e.g., patients with acute headache) we may not perform CT scans frequently enough. Nonetheless, the issue of radiation exposure with CT scanning is an important one and needs to be considered in clinical practice.

## Increasing CT Usage and Radiation Exposure

In their review, Drs. Brenner and Hall<sup>1</sup> describe the marked increase in the use of CT scanning, from three million scans in the U.S. in 1980, to 20 million in 1995, to over 60 million in 2005. Although the risk for an individual is small, in a few decades up to 2% of all cancers may be due to radiation exposure from CT scans, an increase from the current estimated rate of 0.4%. In addition, CT use is projected to increase even more in the future due to screening of asymptomatic patients, such as chest CT for lung cancer in smokers, virtual colonoscopy and cardiac/coronary artery scans. However, before any screening program is instituted, its benefit over the risks of radiation must clearly be established.

CT, particularly multidetector helical CT, is exceedingly “user-friendly” for the clinician, the patient and the radiologist. It is readily available, very fast, produces high-quality images, and is capable of detecting a wide array of illnesses. The typical CT radiation dose is 10 to 20 millisieverts (mSv), which is associated with a lifetime risk of fatal cancer of approximately one per 2,000 CT scans. The radiation exposure from three or four CT scans is roughly equivalent to that experienced by atomic bomb survivors in Japan who were located one to two miles from “ground zero.”<sup>9</sup> Although this startling figure has been questioned due to differences in the type and duration of radiation exposure,<sup>10</sup> it could well serve as a powerful argument to convince a patient to forgo a CT scan that the physician felt was truly unnecessary. Nonetheless, in EM practice, CT scans clearly provide potentially life-saving information for more than one in 2,000 patients.<sup>11</sup>

The radiation dose and risk of malignancy vary

substantially with age of the patient – from one in 10,000 for patients over age 40 years, to roughly one in 500 for a neonate.<sup>1,12</sup> Infants have a more than ten-fold greater risk than middle-aged adults due to their increased radiation sensitivity, smaller size, and longer life span, which provides a greater length of time for induction of malignancy. However, this calculation presumes that the same CT radiation settings are used in children as in adults. One major method to reduce radiation exposure in children is to reduce the radiation settings of the scanner based on the size of the patient. The earlier work of Dr. Brenner was instrumental in bringing attention to this issue.<sup>12-14</sup>

Drs. Brenner and Hall propose three ways to reduce CT radiation exposure in the population. The first is to reduce the radiation dose delivered by the scanner, a strategy especially important in children. CT dose reduction leads to increased image noise, but numerous studies have shown that image quality remains acceptable. Also, newer scanners employ automatic radiation exposure control. EPs should be cognizant of the equipment used in their institution and advocate that dose-reduction methods be used by radiologists, radiology technicians and CT scanner manufacturers.

The second measure to reduce radiation exposure is to use alternative imaging options whenever possible. These include ultrasonography and MRI, although the circumstances in which this approach would be useful are limited. In addition, the availability of MRI for ED patients is not widespread.

Their third suggestion is to reduce the number of CT scans ordered, limiting them to medically necessary situations, which the authors estimate could eliminate up to one-third of CT scans. However, their statement is unwarranted for most ED cases, and, if applied indiscriminately, the omission of CT could potentially be injurious to patients by causing diagnostic delay or misdiagnosis.

### **CT in Emergency Medicine**

The benefits of CT for a multiplicity of medical conditions, including traumatic injuries, neurological emergencies, abdominal pain, and certain thoracic disorders (pulmonary embolism and aortic dissection), are undisputed. At the same time, CT should not be used in place of a carefully performed history and physical examination. Indiscriminate use of CT, or any other diagnostic test, is a recipe for disaster. Such an approach would lead to over-ordering of CT scans, ordering the wrong CT protocol, erroneous use of CT results, and delaying necessary treatment in patients with serious conditions (e.g. ischemic bowel obstruction) while awaiting CT.

CT is now a staple in the diagnosis of appendicitis. It reduces the rate of negative laparotomy from an historical 15-20% to 4%,<sup>15</sup> reduces delays to surgery, and reduces the rate of misdiagnosis. CT is particularly useful when the diagnosis is uncertain based on clinical examination, although it can also be

beneficial in cases in which the diagnosis seems highly likely.

A recent prospective randomized trial of 152 patients with suspected appendicitis compared a strategy of mandatory CT in all patients to a selective approach based on clinical judgment.<sup>16</sup> Half the patients had appendicitis. The investigators found that the selective approach reduced CT scanning by one-third, but was associated with an increased rate of negative laparotomy (14% versus 2.6%), and an increased rate of perforation (18.4% versus 10.3%). The same investigators compared outcomes in three hospitals that had different rates of CT use in patients undergoing appendectomy.<sup>17</sup> The negative laparotomy rates varied significantly depending on the rates of CT utilization. CT utilization in the three hospitals was 87%, 66% and 13% and the negative laparotomy rate was, respectively, 2.5%, 17%, and 23%. A third study found that even among patients deemed by a surgeon to “definitely” have appendicitis, CT revealed that appendicitis was not present in a substantial number of cases (five of 18 cases, or 28%).<sup>18</sup>

When a less serious disorder is under consideration, alternative diagnostic strategies should be used. Renal colic is one example. It is not life-threatening and can be predicted with good clinical certainty, particularly when a patient has had prior documented episodes of renal colic. CT should be reserved for circumstances in which there is diagnostic uncertainty. CT is also useful when pain is refractory, and information about ureteral stone size and location would be therapeutically beneficial. An alternative diagnostic approach to a patient with high likelihood of renal colic would be ED discharge with instructions to the patient to strain his or her urine. Eventual retrieval of the stone confirms the diagnosis. A bedside renal ultrasound showing hydronephrosis might also be useful in supporting the clinical diagnosis of renal colic.

The cervical spine is an area where more widespread use of CT could lead to an unwarranted increase in radiation exposure. For high-risk patients (> 5% incidence of cervical spine injury), CT is a substantial advance. For low-risk patients who cannot be clinically cleared, conventional radiography is still used. However, the incidence of cervical spine injury in such patients is exceedingly low (0.2%).<sup>19</sup> Because many radiologists now prefer CT to radiography since it is more comprehensive and results in fewer missed injuries, there may be a tendency to recommend CT even though the patient is at very low risk of injury. Use of CT in the vast majority of these non-high-risk patients is not warranted.

For major trauma victims CT of the head, neck, abdomen, and, in many cases, chest is clearly beneficial despite its high radiation dose.<sup>20</sup> For minor trauma cases, CT is not needed when the clinician is confident there is no serious injury, and the patient can be observed for an appropriate period of time.

Finally, in patients with acute headache, data suggest that we may not be ordering CT scans frequently enough.

Subarachnoid hemorrhage (SAH) is the most consequential headache disorder because a small hemorrhage often precedes a major life-threatening bleed, which, when promptly diagnosed and treated, will prevent a subsequent major hemorrhage. Unfortunately, the initial "sentinel" headache is sometimes missed, with dire consequences. In a recent series of patients with SAH, 19% of those who were initially neurologically intact were missed during a preceding physician visit.<sup>21</sup> The most common reason by far the diagnosis was missed was that CT was not performed – in nearly 75% of missed cases. Misinterpretation of the CT or LP occurred in 15% of the missed cases, and failure to perform an LP when the CT was normal was responsible for fewer than 10%. A similar result was found in an earlier series.<sup>22</sup>

### SUMMARY

CT is a tremendous advance in managing a wide array of medical and surgical diseases and, despite its high radiation dose, should be used in many ED patients with potentially serious disorders. CT should not, however, be used indiscriminately or in lieu of a complete history and physical examination.

Measures to reduce radiation exposure to patients from CT should be instituted in accordance with Dr. Brenner's article. First and foremost, CT scanner radiation dose should be reduced as much as possible. While this is especially important in children, it should also be the goal in adults. Alternative diagnostic strategies should be employed whenever possible, including ultrasonography, MRI or watchful waiting, although this is only an option in some circumstances. Finally, ordering medically unnecessary CT scans should be avoided. However, in practice this must be done with caution so as not to risk harming the patient due to misdiagnosis or delayed diagnosis of a potentially serious disorder.

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