Currently, more than 63% of articles submitted to *Radiology* are from outside of the United States. When authors are non-English speakers, review and editing of these articles is often difficult because the authors' meaning can be obscured by issues of language and semantics. We try to address the scientific content to the best of our ability. During the revision process, when we suggest changes in the manuscript, we track changes in written documents and ask authors to ensure that their meaning has been maintained. In the case of the article "Biliary Atresia: Color Doppler US Findings in Neonates and Infants," two main issues arose that Dr Krishna and colleagues mention in their letter, at least one of which was not recognized by the authors as changing their intended meaning, likely due to problems with translation from English to their native language.

This letter raises several important issues for our authors.

First, we encourage authors submitting works to *Radiology* who are nonnative English speakers to have someone familiar with their work who is a native English speaker carefully check their final draft and revisions. Second, all authors should carefully check revisions suggested by the editor and copy editors for accuracy. Third, we encourage our readers to let us know of any errors in Letters to the Editor so that corrections can be appropriately addressed.

$CTDI_{vol}$, DLP, and Effective Dose Are Excellent Measures for Use in CT Quality Improvement

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Editor:

McCollough and colleagues, in their recent editorial in the May 2011 issue of *Radiology* (1), have dismissed volume computed tomography (CT) dose index ($CTDI_{vol}$) and dose-length product (DLP) as useful measures of patient radiation dose, arguing that they do not measure the dose the patient absorbs. However, these indexes quantify the radiation dose to which a patient is exposed and thus dictate the dose absorbed by the patient. Although absorbed doses vary by patient size, they are primarily determined by the doses that come out of the machine and the region imaged. These types of readily available and controllable measures are critically needed to understand and improve the safety of imaging. Although these measures may vary by as much as twofold across patient size for the same type of examination to get images of similar quality, we found 10- to 100-fold differences in DLP for CT scans obtained for the same clinical indication among thousands of examinations we have reviewed, reflecting far more variation than could possibly occur owing to patient size. In fact, after accounting for patient weight and body mass index, a profound—and unacceptable—variation in these measures remained. Most of the variation in dose is due to variation in the adoption of multiphase protocols, larger scanning regions, or higher dose settings without awareness of the resulting dose burden these choices create. Thus, without even considering patient weight, we could greatly improve how we are conducting CT simply by assessing $CTDI_{vol}$ and DLP.

The authors also dismiss the use of effective dose (1), which can be calculated from DLP by using age- and sex-specific conversion factors, or more complicated methods that take into account patient size, arguing that it is too imprecise. Effective dose is a useful measure for identifying patients who receive unnecessarily high doses, tracking doses over time, and assessing facility performance and is easy to understand because it puts doses from scans of different body regions on an equitable scale. Furthermore, it is a useful measure for epidemiologic studies, where standard statistical methods exist for analyzing imprecise variables and can account for effect modification according to patient size, sex, and region imaged.

No measurement we use in medicine or research is perfect. The important question is whether a particular measurement is useful given its limitations. In this case, the answer is a resounding yes. $CTDI_{vol}$, DLP, and effective dose are excellent measures of radiation dose from CT and could be used immediately to improve the safety of CT by identifying when doses may be higher than necessary and standardizing how we conduct CT examinations.

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Reference

1. McCollough CH, Leng S, Yu L, Cody DD, Boone JM, McNitt-Gray MF. CT dose index and patient dose: they are *not* the same thing. Radiology 2011;259(2):311–316.

Response

From
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We respectfully disagree with the assertion by Drs Smith-Bindman and Miglioretti that we have dismissed $CTDI_{vol}$ and DLP as useful tools; they are incredibly valuable measures of scanner output and the first-line tools for dose management in CT (1). They are not, however, measures of patient dose. The quantities used to describe amounts of radiation are all precisely defined in international standards (2–4), as are quantities used to reflect risk (3,5). In CT, these are all related to scanner output and, hence, correlated with $CTDI_{vol}$. However, each is fundamentally different. The use of precisely defined quantities in a manner that is inconsistent with their meaning, and without accounting for factors affecting their values, can lead to misleading conclusions.

For example, in a recent safety audit, we observed a factor of 8 difference in $CTDI_{vol}$ (5–40 mGy) between patients having the same examination, a single-phase abdomen and pelvis CT examination, for similar clinical indications. On the surface this would appear to be an inappropriate difference in "dose." However, these patients were significantly different in size (5 feet 8 inches tall male patient weighing 110 lb vs 4 feet 10 inches tall female patient weighing 177 lb), and examination of the CT radiographs and cross-sectional images demonstrated that the attenuation through the pelvis was much greater in the second patient, justifying at least a factor of 8 increase in scanner output.

Image Gently (6,7) and the U.S. Food and Drug Administration (8) correctly stress that patient size must always be considered when prescribing scanner output. Between a neonate and obese patient, at least a factor of 50 in scanner output ($CTDI_{vol}$) is required to obtain comparable image quality. In addition, differences in patient height between babies and adults lead to even greater differences in DLP. Finally, differences in patient history and examination indication can often explain why one patient received two scan phases and another only one scan phase.

Although we agree that reviews of protocols and patient cases may reveal systematic overuse of multiphase protocols, larger scanning regions, or higher-dose settings, we disagree that this can be done by simply reviewing CTDI and DLP values, which do not account for patient size and clinical factors. It is essential to record and account for patient and examination variables to determine if observed variations in dose indexes are or are not appropriate. $CTDI_{vol}$ and DLP are essential parts of that process, but of themselves are insufficient metrics.

With respect to effective dose, however, it has no place in quality management processes. The International Commission on Radiation Protection, which developed the concept of effective dose and defines the manner in which it is calculated (3,5,9), states unequivocally that it is not to be calculated for any individual patient, nor is it to be used for individual risk estimation or for epidemiologic purposes. Effective dose was developed for occupational radiation safety, and its values are derived from factors that average risk over all ages and both sexes. Its application in the field of medicine is tenuous at best (10). We all want to use CT effectively and safely for the benefit of patient care. But oversimplifying complex issues and metrics does not serve the best interest of the patient. Only by understanding precisely what these quantities mean and how they are to be used can we ensure that patient safety decisions are made based on accurate data.

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References

1. McCollough CH, Leng S, Yu L, Cody DD, Boone JM, McNitt-Gray MF. CT dose index and patient dose: they are *not* the same thing. Radiology 2011;259(2):311–316.
2. International Commission on Radiation Units and Measurements. Patient dosimetry for x-rays used in medical imaging. Report 74. Bethesda, Md: International Commission on Radiation Units and Measurements, 2005.
3. International Commission on Radiation Units and Measurements. Fundamental quantities and units for ionizing radiation. Report 60. Bethesda, Md: International Commission on Radiation Units and Measurements, 1998.
4. International Electrotechnical Commission. Medical electrical equipment. Part 2-44: particular requirements for the safety of x-ray equipment for computed tomography. IEC publication no. 60601-2-44. 3rd ed. Geneva, Switzerland: International Electrotechnical Commission, 2012.
5. The 2007 Recommendations of the International Commission on Radiological Protection. ICRP publication no. 103. Ann ICRP 2007;37(2-4):1–332.
6. Goske MJ, Phillips RR, Mandel K, McLinden D, Racadio JM, Hall S. Image gently: a web-based practice quality improvement program in CT safety for children. AJR Am J Roentgenol 2010;194(5):1177–1182.
7. Strauss KJ, Goske MJ, Kaste SC, et al. Image gently: ten steps you can take to optimize image quality and lower CT dose for pediatric patients. AJR Am J Roentgenol 2010;194(4):868–873.
8. Food and Drug Administration. FDA public health notification: reducing radiation risk from computed tomography for pediatric and small adult patients. Pediatr Radiol 2002; 32(4):314–316.
9. International Commission on Radiological Protection. Recommendations of the International Commission on Radiological Protection. ICRP report no. 26. Oxford, England: International Commission on Radiological Protection, 1977.
10. Martin CJ. Effective dose: how should it be applied to medical exposures? Br J Radiol 2007;80(956):639–647.

Satisfaction of Search in Radiographic Modalities

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