interventional procedures. CT examinations accounted for
19% of studies and 76% of total CED; within that group, ab-
dominal/pelvic examinations accounted for 43.1% of the
procedures, 73.2% of the CT radiation exposure, and 55.6% of
total CED. A total of 7.6% interventional procedures generated
8.1% CED, and 8.2% nuclear medicine procedures resulted in
7.6% CED.

Assumed risk factors for this study were derived from anal-
yses of mortality data based on Japanese atomic bomb survi-
vors exposed to radiation doses typical of two or three CT scans
in adults, using a linear no-threshold model (LNT), which is
not adjusted for factors such as rate of exposure or genetic
repair. Although leading international scientific bodies believe
that the use of the LNT model for estimating low-dose radia-
tion risk is appropriate, many scientists contend that it is not
supported by data at doses less than approximately 100 mil-
isievert or at long-term dose rate up to at least 200 millisievert
per year.2–5 However, the LNT model is still considered the
most appropriate and conservative for the purposes of radia-
tion protection.6

The authors cite studies by various authors to support their
thesis that dialysis patients receive higher radiation doses than
other chronically ill patients, further referencing the American
College of Radiology white paper on radiation dose favoring more
explicit tracking of CT-related exposures, including identifying
exposures for specific populations, such as hemodialysis patients.
The authors conclude that a significant number of non-notable
findings or negative results present an imperative to rethink jus-
tification for repetitive CT examinations. Huda6 recommended
that nonionizing alternatives should be considered and that the
benefits should clearly exceed the risks of radiation exposure be-
fore CT examinations are performed. Furthermore, as diagnostic
facilities implement measures to reduce radiation exposure, a re-
duction in the number of CT examinations should be accompa-
nied by reduced exposures per examination when possible.

This study is an example of what is often seen in patient care
settings where individuals of varying clinical experience order di-
agnostic imaging procedures. De Mauri et al.1 do not specify
whether attending physicians, fellows, or residents ordered the
studies; whether there were consultations with imaging special-
ists; or how benefits versus radiation risks for the imaging pro-
dcedures were defined. In general, certain types of procedures are
often overused because they are relatively easy to perform and a
large amount of information is provided very quickly. The partic-
ular example described here, that of CT scans, can produce sub-
stantial cumulative doses of radiation when used multiple times.

The conservative approach to addressing the issue of cumula-
tive radiation dose necessitates defining groups of patients who
would be considered high risk for exposure to ionizing radiation.
This group would likely include children because the potential for
radiation-induced cancer is more likely over their lifetimes than in
older patients. In circumstances in which clinical management
appropriately requires multiple imaging procedures, careful
monitoring of the cumulative radiation dose should be done and
should be part of the patient’s record so that careful consider-
ations of further exposure can be properly documented during the course of treatment. Of fundamental importance is that the radiation-producing tests should provide a substantial clinical advantage to the patient that helps in the management of the disease. This has been a primary tenet of imaging procedures for many years and is particularly important in high-risk groups, such as dialysis and transplant patients.

In addition to recording cumulative dose information and making it available to the ordering physician, it is prudent to have an imaging expert, such as a radiologist or a nuclear medicine physician, provide suitable recommendations for alternative types of studies. Review of ordered studies on any class of patients but especially on those identified as high risk for radiation exposure should be done by someone who understands the utility of an imaging procedure. This person, then, is in the position to recommend alternative but equally suitable studies that operate without ionizing radiation yet provide images of comparable value. Examples of alternative imaging modalities are diagnostic ultrasound and magnetic resonance imaging. Both of these imaging modalities provide exceptional images of various parts of the body that might otherwise be imaged using ionizing radiation.

When exposure to ionizing radiation is believed to provide best information, several practical measures can reduce radiation exposure. The best possible protocol should be used, applying only minimal radiation to produce the desired image. Imaging protocols using inappropriately high levels of radiation should be eliminated or modified. In fluoroscopy, pulsed acquisition, last image hold, and other approaches using variable x-ray beam filtering can optimize the image while reducing patient dose. CT dosing should follow a predetermined protocol that is accepted as being appropriate for the type of study requested. CT examinations can take advantage of tube current control, iterative reconstruction, and careful collimation to reduce entrance exposures. The American College of Radiology publishes guidelines for many studies that can help standardize these imaging procedures. In the case of studies performed with radioisotopes, guidelines provided by the Medical Internal Radiation Dose Committee of the Society of Nuclear Medicine should be followed to minimize dose while ensuring good-quality images. Careful calculation of isotope requirements, new designs for collimation, and longer acquisition times can lessen patient doses in nuclear medicine studies.

Recommendations from the U.S. Food and Drug Administration will likely lead to requirements for equipment to monitor, record, and alarm when doses for a protocol are beyond the specified thresholds. Whatever the type of study, doses should be carefully monitored during the procedure and recorded for easy reference on follow-up by incorporation of this information into the patient’s medical record. Undoubtedly, some of these needs will require the modification of computer software that controls imaging systems and changes to database systems that record patient data so that cumulative dose can be made available for the medical record.

The Society of Nuclear Medicine, the American College of Radiology, the American Association of Physicists in Medicine, the Radiologic Society of North America, the Society for Pediatric Radiology, and the American Society of Radiologic Technologists are among the groups that are highly concerned with radiation dose and proper use of radiation for imaging. Some have banded together to develop informational awareness programs such as the Image Gently program for pediatric imaging (www.pedrad.org/associations/5364/ig/) and the Image Wisely program for adult imaging (www.imagewisely.org). The objective of these web sites is to encourage practitioners to avoid unnecessary ionizing radiation and to use the lowest radiation dose for necessary optimal studies. Such programs provide advice and recommendations on ways to provide top-quality images with minimal delivered dose.

Radiation appropriately used and calibrated provides great benefit to patients needing diagnostic images. However, proper knowledge of procedures, dosage, effects, alternatives, and expected results is imperative to avoid potential overuse. One must remember that the objective of imaging is to maximize patient benefit while minimizing the potential burden of further disease as a result of the procedure.

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DISCLOSURES

None.

REFERENCES

2. Scott BR: Stochastic thresholds: A novel explanation for nonlinear dose response. Presented at the BELLE Conference Amherst, MA, June 6, 2005

See related article, “Estimated Radiation Exposure from Medical Imaging in Hemodialysis Patients,” on pages 571–578.