Q.A. Collectible

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Developing a Technique Chart for a CT System—Why is it Important?

Computerized tomography (CT) continues to contribute a large portion of the overall radiation exposure to patients in diagnostic radiology. A study at one major U.S. medical facility revealed that CT body exams produced 35 percent of the collective effective dose (CED) in diagnostic radiology.[1] With assistance and encouragement from the state inspector, facilities may find that they can reduce patient CT exposure substantially without investing anything more than a little time. Although new CT technology allows for improved imagery at lower patient dose, it should not be assumed that a *state-of-the-art* system minimizes dose—the system may be state-of-the-art, but may not be operated in an optimized or state-of-the-art manner.

CT is by far the most common type of digital imaging examination and much of the responsibility to keep patient dose as low as reasonably achievable, while maintaining image quality, falls on the equipment operator. While the ability to manipulate the image after the exposure is completed makes the system more versatile than screen-film procedures, it also increases the tendency to use one technique for a specific examination without regard to patient size or the body part being examined.

There are two types of detection systems in today s CT units: xenon and solid state. Of the two types, xenon detectors are the least efficient at absorbing the radiation that strikes them. Consequently, the average patient dose is usually higher for a xenon detector system. Xenon detectors also have a narrow dynamic range, which means they easily saturate, causing image deterioration or system shutdown, if patient dose is set too high.

The material used in the detectors of a solid state system varies (e.g., cadmium tungstate or gadolinium and yttrium phosphors) with manufacturer and unit age, but all of them are more efficient than xenon detectors at absorbing incoming photons. Solid state detectors are about 85 percent efficient at absorbing incoming photons, and have a wider dynamic range than xenon detectors. Therefore, the possibility of patients being exposed to more radiation than is necessary (and it going undetected) is increased.

All CT systems have the potential for excessive patient dose without degrading image quality. Furthermore, the more forgiving a system is, the greater the ability to lower patient dose without affecting image quality.

The setup process for each patient varies widely from one CT facility to another, based on equipment manufacturer, equipment age, and the options available on the CT scanner. Some newer

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systems have features that require the operator to enter the patient size, while others automatically set the appropriate kVp and mAs after the scout process is completed. **Many CT systems provide one starting technique for each type of scan and, if the CT operator does not manually reduce the technique, children and smaller adult patients are likely to be exposed to more radiation than is necessary for a quality examination.** A technique that works well for a large patient may be eight times higher in radiation dose than what is necessary for a smaller patient, and up to 20 times higher than what is needed during a pediatric examination.[1]

During a survey, field inspectors should:

Look for a technique chart that is based on **patient size or type of study** and ask the CT operator to explain the process they go through prior to scanning. If the technique factors do not vary with patient size, the inspector should ask if it is possible to alter the kVp or mAs. All systems should allow at least some variability in technique factors. **CT techniques should be adjusted based on patient size or type of study in the same way that they are adjusted for screen-film radiography.**

Check to see if they use the same technique factors for all areas of the body. A CT of the chest requires only a fraction (about 10 percent or less) of the radiation dose required for a CT scan of the abdomen.

Ask if they commonly overlap slices. If so, is it necessary?

Ask if there are instances when slices could be skipped without compromising the prescribed objective.

Ask if, during procedures normally calling for images with and without contrast, the images from the first scan are reviewed by the radiologist prior to collecting the images for the second scan to determine if the second scan is necessary. The referring physician should have the option of prescribing a non-enhanced (i.e., no contrast) CT scan. They may decide that the combined risk of additional radiation exposure and a potential adverse reaction to the contrast agent outweighs the benefit of a second scan with contrast.

A working technique chart based on patient size and body part can potentially reduce the patient dose and CT CED substantially. The radiologist and the CT technologist should work with the mAs settings for each projection until they determine which setting is just above the mAs that causes clinically unacceptable quantum mottle in the image. This will give them the optimized image-dose relationship. For example: a typical abdomen projection may be 130 kVp and 200 mAs, while a pediatric abdomen may only require 130 kVp and 50 mAs, or less. See Table.

CT Radiation Exposures*

For Various kVp and mAs Settings

kVp	mAs	Exposure Factors
140	400	1.0
140	200	~0.5
140	100	~0.25
120	400	0.54
120	200	0.27
120	100	0.13
80	400	0.16
80	200	0.08
80	100	0.04

***** This information was gathered on one CT unit and is intended to be used as an aid during discussions with CT operators on the advantages of using a technique based on patient size. Exposure factors and dose can vary considerably from one CT unit to another. The information in this chart does not necessarily apply to helical CT scanners. A survey of 105 CT units in 1995 revealed a range in multiple scan average dose (MSAD) of 2.3 to 10.9 R and 0.3 to 3.1 R for typical head and body scans, respectively.[2] Therefore, if the operator can reduce the mAs by 50 percent, while maintaining quality, the dose savings is significant.

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[1] Gray JE, Lower Radiation Exposure to Improve Patient Safety, Diagnostic Imaging, in press. (August and September, 1998 issues)

[2] Angelo DL & Winston JP, The Pennsylvania Computerized Tomography Study, 1995

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