MAHADEVAPPA MAHESH, MS, PhD
NICHOLAS DETORIE, PhD

Incorporating Radiation Dose Assessments Into the ACR Appropriateness Criteria®

Beth A. Schueler, PhD

In 2006, the ACR convened a group of radiologists, medical physicists, industry and regulatory agency representatives, and a patient advocate to address issues related to the risks of radiation exposure in medical imaging. This group, the Blue Ribbon Panel on Radiation Dose in Medicine, developed a series of recommendations aimed at optimizing radiologic image quality and radiation dose and preventing the inappropriate use of procedures involving ionizing radiation [1]. Several of their recommendations relate to educating referring physicians about radiation exposure risk. One recommendation in particular calls for the incorporation of radiation dose information into the ACR Appropriateness Criteria, a guide for the selection of proper imaging procedures for particular medical conditions. In response to this recommendation, relative radiation level (RRL) designations were added to the Appropriateness Criteria in September 2007. These designations indicate which imaging procedures expose patients to radiation and the relative magnitude of that exposure. By adding RRL designations, referring physicians using the Appropriateness Criteria will not only be advised of the appropriate imaging procedure for medical conditions but will also be steered toward procedures that minimize radiation dose to their patients.

The RRL designations included in the ACR Appropriateness Criteria are based on the imaging procedures' effective dose ranges. Effective dose is a quantity equal to the weighted sum of the doses to various body organs and tissues in which the weighting factors depend on the relative sensitivity to radiation-induced cancer or hereditary effects for those organs or tissues [2]. The quantity provides a measure of relative radiation detriment from different types of exposure or exposure involving different parts of the body. Although "effective dose" was defined for the assessment of the radiation risk of a worker population in general terms for radiation protection purposes, it can be used to approximately compare risk for different types of imaging procedures. To accomplish this, the RRL designations use effective dose ranges to classify imaging procedures into broad categories [3]. It is necessary to use broad categories because of the many and complex technical and individual variables involved, making the exact dose to any patient essentially impossible to calculate accurately. These ranges are specified in Table 1. A similar approach was used by the Royal College of Radiologists [4] in its imaging guidelines publication.

The assignment of RRL levels to each ACR Appropriateness Criteria imaging procedure was conducted by a group of medical physicists and a radiologist with expertise in applicable imaging modalities. This group reviewed current literature on radiation dose estimates for specific procedures, including regulatory surveys and publications in peer-reviewed journals [5-10]. When the group determined that publications or clinical experience indicated that there was a range of effective dose values for a particular procedure, the RRL was conservatively assigned to the highest level.

Because for most imaging procedures, radiation dose levels increase with patient size, RRL designations

Table 1. Relative radiation level designations and common example examinations for each classification

Relative Radiation Level	Effective Dose Estimate Range (mSv)	Example Examinations
None	0	Ultrasound, MRI
Minimal	<0.1	Chest radiography, hand radiography
Low	0.1-1	Spine radiography, pelvis radiography
Medium	1-10	Abdomen CT, barium enema, nuclear medicine bone scan
High	10-100	Abdomen CT without and with contrast, whole-body PET/CT

Note: CT = computed tomography; MRI = magnetic resonance imaging; PET = positron emission tomography.

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Table 2. Example ACR Appropriateness Criteria guideline for right lower quadrant pain, variant 1: fever, leukocytosis, and classic clinical presentation for appendicitis in adults

Radiologic Procedure	Appropriateness Criteria Rating	RRL
CT abdomen and pelvis with contrast	8	High
CT abdomen and pelvis without contrast	7	High
Ultrasound abdomen RLQ	6	None
Ultrasound pelvis	5	None
X-ray abdomen	5	Medium
MRI abdomen and pelvis with or without contrast	4	None
Contrast enema	3	Medium
Nuclear medicine WBC scan abdomen pelvis	3	Medium

Note: Appropriateness Criteria scale: 1 = least appropriate; 9 = most appropriate. CT = computed tomography; MRI = magnetic resonance imaging; RLQ = right lower quadrant; RRL = relative radiation level; WBC = white blood cell.

are based on the dose that would be received by an average-sized adult. For ACR Appropriateness Criteria developed specifically for the pediatric population, RRL assignments were made with consideration of a child's increased radiation-induced cancer mortality risk compared with that of an adult [2]. Because of children's smaller size, the radiation levels required for imaging examinations of children are generally, but not always, lower than those for adults. Particularly for CT examinations, radiation doses may not be lower for children unless reduced technique protocols are implemented for pediatric imaging by facilities. As a result, RRLs for pediatric computed tomographic procedures were assigned to the higher RRL.

Although the overall risk for cancer induction from a diagnostic imaging procedure involving ionizing radiation is small, the risk is not zero. Therefore, it is important to minimize patient radiation exposure and to guide ordering physicians to avoid ordering unnecessary examinations. Any exposure that accompanies an imaging examination should be justified on the basis of the benefit to the patient. The RRL assignments will continue to be reviewed periodically and updated as clinical practice evolves and new radiation dose information becomes available. An example of appropriateness rankings and RRL designations for a selected medical condition is shown in Table 2.

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Beth A. Schueler, PhD, Department of Radiology Mayo Clinic, Rochester 200 First Street SW, Rochester, MN 55905; schueler.beth@mayo.edu.