On the Same Page—Physicist and Radiologist Perspectives on Protocol Management and Review

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Abstract

To sustain compliance with accreditation requirements of the ACR, Joint Commission, and state-specific statutes and regulatory requirements, a CT protocol review committee requires a structure for systematic analysis of protocols. Safe and reproducible practice of CT in a complex environment requires that physician supervision processes and protocols be precisely and clearly presented. This article discusses necessary components for data structure, and a description of an IT-based approach for protocol review based on experiences at 2 academic centers, 3 community hospitals, 1 cancer center, and 2 outpatient clinics.

Key Words: Protocol review, protocol optimization, data mining, radiation safety

J Am Coll Radiol 2015;12:808-814.

BACKGROUND

The task of creating tools for managing and reviewing protocols requires a thorough understanding of each individual scanner's nuanced protocol parameter offerings. Required features of protocol management and review solutions are delineated later. The organization of protocol by examination type, body type, and additional relevant facets of a protocol, such as dose level, is needed. Protocol review involves checking protocols for unauthorized changes and acquisition parameters, by following specific guidelines defined by the user. The volume and multidimensionality of the data suggest that an IT solution is needed. Necessary features for protocol management and review solutions, with special attention to less frequently considered technical protocol parameters, are delineated in the following sections.

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TPS reports receiving equipment from a grant from GE HealthCare, and research support from Siemens HealthCare AG USA, and that he supplies CT protocols to GE HealthCare under a licensing agreement.

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PROTOCOL DOCUMENTATION AND MANAGEMENT

Broadly, protocol documentation should include information related to: patient preparation, including feeding status, enteric contrast type, rate, and timing; patient handling, including clothing, patient position, and respiratory commands; intravenous contrast parameters; and intravenous gauge [1,2]. Table 1 lists patient setup and contrast protocol parameters, with sample values. To maintain safe practice, specification of acceptable ranges of deviation from these "standing-orders" for drugs by technologists, on a per patient basis, is required.

The technical component of a protocol must contain prescription of the localizer, method of contrast timing, main acquisition events, and the number and type of image reconstructions. We elaborate on these scanner-based components in this paper. The destination for post-processed images, PACS archiving, and billing should be included within protocol documentation. The document should include graphical representation and specific example images for most of the categories, such as scan range, choice of monitoring location, and complicated reformat planes.

METHOD OF DATA ENTRY

The first requirement for protocol management and review is a solution that will allow the user to easily create and store electronic copies of protocols tailored to each

1546-1440/15/$36.00 ■ http://dx.doi.org/10.1016/j.jacr.2015.03.042

Table 1. Protocol parameters relating to patient preparation and contrast administration

Clinical Protocol Element	Example Values
Feeding status	No fast, nothing by mouth, clear liquids
Clothing	No metal
Enteric (oral) contrast	None, water, 5 ml Iohexol 300 (Omnipaque) in 200 ml of water
Enteric contrast instructions	Target dose: 1 liter positive oral contrast in 200-ml doses at 15-min intervals with the final dose given on the scan table
Laboratory tests	EGFR, creatinine
Prescan patient prep	Clamp Foley catheter before scanning
IV contrast	None, load 100 mL of Iohexol 300 (Omnipaque) and 100 ml of normal saline, 170 mL of Iopamidol (Isovue 370) and 140 mL of normal saline.
IV contrast injection parameters	None, 75 ml of Iohexol 300 at 4 mL/sec followed by a 50-ml saline chase at 4 mL/sec
Patient positioning	Arm extended over the head with the elbow as close to iso-center as possible; angle the gantry so the scanning plane is parallel to the line connecting the infraorbital rim with the opisthion.
Breathing instructions	Hold breath during scan; coach patient to scan lungs on expiration, coach patient to scan lungs on inspiration.
Scan timing (not related to bolus tracking)	None; wait 7 min before scanning delayed trauma phase. Wait 12 min before scanning delayed cholangiocarcinoma phase.

Note: The inclusion of example images is necessary to guide proper technologist "positioning" and "scan timing." For example, a photograph of bolsters being used to position feet for MSK scanning and a sample axial image of the main pulmonary artery in a chest CT angiography pulmonary embolus study would be included. EGFR = estimated glomular filtration rate; IV = intravenous; MSK, musculoskeletal.

CT scanner in its install base. This task may be automated, as all modern scanners allow for direct export of most protocol parameters into formats readable by most spreadsheet editing software. Unfortunately, some parameters (eg, automatic exposure control position, reconstruction information) are not included in these exports and must be obtained via alternate means, typically through visual interrogation of the scanner settings and manual data entry.

A less desirable option entails manual entry of data into a protocol entry tool; however, this approach would require a protocol entry tool that can continuously evolve as scan parameters and methodologies for prescription of radiation become more personalized and patient centered. An interesting, but infrequently used, third option is to capture protocol information directly from examinations by querying the DICOM header, capturing protocols that were actually used to scan patients. This method has the added benefit of verification of compliance with the scanner protocols, through capture of parameters of executed protocols.

DIFFERENCES IN CT TECHNOLOGY REQUIRE DETAILED PROTOCOL DOCUMENTATION

Protocol acquisition documentation should include more than simply the basic technical scan parameters, such as kV, mA, rotation, and pitch. One comprehensive source from which information should be included in protocol documentation is provided by the American Association of Physicists in Medicine (AAPM), in their publication *AAPM CT Lexicon* [3]. Use of this standard will provide uniform display of the protocol format. The ideal protocol documentation should display multiple scanner protocols side-by-side, as depicted in the *AAPM CT Lexicon,* with similar protocol parameters listed on the same row. Rather than relist all of the scan parameters from that report, we list the rationale for including several that are important to image quality and dose.

It is important that all of the parameters in the AAPM CT Lexicon, and those discussed in the current paper, be listed for every series and/or phase of a protocol in which they are unique. Routine practice at our institutions is to create $\geq$3 different sets of images from a single CT acquisition, each with distinct reconstruction and presentation options. With so many images, precise capture of details about naming and archiving is imperative, especially when an institution generates these images from different scanner platforms. In our experience, proper documentation leads to protocol harmonization that, in the long run, benefits patient care by producing comparable descriptors, thereby facilitating comparison with prior studies.

LOCALIZER RADIOGRAPHS

Detailed CT localizer radiograph documentation includes the number, projection angle and order, and acquisition parameter. Each of these parameters plays a role in how the automatic exposure control system operates [4,5]. These