Team-Based Methods for Effectively Creating, Managing and Distributing CT Protocols

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Main teaching points

1. Protocols are the core of a CT imaging practice.
2. Protocol decisions must be made by a cross-section of work groups, consisting of at least a radiologist, technologist, and a medical physicist.
3. A protocol approval process is critical to maintain consistent and accurate protocols.
4. An efficient and timely protocol distribution system is essential.
5. A process for updating the protocols in the scanner is critical. Access to the programmed protocols should be very restricted.

Abstract

CT protocols, or scan instructions, are the core of every CT exam. The processes and parameters in the protocols impact all aspects of patient care associated the exam, as well as the diagnostic quality of the scan. This exhibit describes methods and principles for creating, maintaining, and distributing CT scan protocols, with an emphasis on the necessity of using a cross-sectional team of experts. The team-based approach consists of gathering input from all stakeholders in the exam, including radiologists, physicists, and technologists. Other individuals, such as nurses, should be consulted as necessary. Formal review and approval processes should be developed for new protocols and protocol modifications. Up-to-date protocols should be available to personnel at the scanner and processes should exist to ensure that the parameters programmed into the scanner match the written scan protocols.

Background

Approximately seven years ago our institution had 20 CT scanners, including four unique models all from a single manufacturer. The protocols were managed by six lead CT technologists and the printed protocols were kept in 3-ring binders—one at each scanner. The typical process for adding or modifying a protocol is described as follows. A change to a protocol was requested, typically by a radiologist, to one of the lead technologists. A request rate of 1-5 changes per week was typical and there was usually some urgency associated with the request. The technologist would then locate the original document file, which existed with approximately 450 document files in one (or more) of 10 different folders. The files were named according to whatever seemed appropriate, with no standard naming convention. Additionally, some protocols were specific to a radiologist, which added to the number of protocols. The change was made to the protocol and, if the change was significant, the filename was changed (adding another file to the collection). The final version was then printed, placed into a plastic sleeve, and delivered to each scanner to be placed in the protocol binder. The number of protocols, combined with the number of protocol binders, represented over 3000 pages of content. The number of protocols, and the de-centralized process of management, presented an unmanageable burden on the technologists. As a result, there were inconsistencies in the protocols, outdated versions, and duplicate files. Additionally, because of the time-consuming nature of updating the protocol binders at each scanner, the protocols at any given scanner typically contained a multitude of handwritten "updated information" in the form of post-it notes scattered throughout the collection. Clearly the practice had grown to a point where this protocol management system could not be maintained.

Framework to Address Protocol Issues

The issues associated with protocol management were recognized by CT leadership and a Protocol Review Group was formed to review the current processes and develop methods to address the shortcomings. The group sought input from radiologists, physicists, technologists, and nurses. The following six criteria are considered to be essential for our practice.

1. *CRITIQUED AND OPTIMIZED PROTOCOLS*

Reviewed by a cross-section of experts

- All content must be developed and critiqued by at least one radiologist, one physicist, and one lead technologist. Other individuals are consulted as necessary, including representatives from nursing, scheduling, billing, etc.
- All major protocol changes must be approved by the division chairperson or a designated liaison.
- Scan parameters for new protocols are developed using existing similar protocols and customizing for the particular imaging task. New protocols are initially performed on a case-by-case basis, with oversight by the proponent radiologist and, in some cases, in the presence of a physicist.

2. *MANAGEABLE FILE SYSTEM*

Minimize the number of electronic files

- Consolidate protocols for different scanner models into a single document.
- Eliminate radiologist-specific protocols.

Develop a file-naming convention and directory structure

- Directory structure: One folder for each division (abdominal, cardiac, musculoskeletal, neuro, research, thoracic, and vascular). Additional folders can be used for supplemental information, such as technique charts.
- File-naming convention: "Body part_exam type" (e.g., "Abdomen Pelvis_ Routine", "Liver_Bi-Phase")

Limit access to "master" files

- Directory access to the "master" protocol documents is limited to the protocol editors, including the lead technologists and physicists.

Other considerations

- Other methods of managing the files, such as custom software and databases were investigated. The group concluded that the effort to create such systems would be significant and that the systems might not be able to easily accommodate new scanner features and technologies.

3. *CLEAR AND CONCISE INSTRUCTIONS*

Minimize the possibility of misinterpretation

- Consistent and concise phrasing.
- Consistent layout and structure.
- Consistent formatting and color-coding.
- Consistent naming and numbering convention, with a one-to-one correspondence to the name or number in the scanner protocol list.
- Intuitive navigation to locate protocols.

4. *CONTENT FOR ALL INTERESTED PARTIES*

Technologists

- Patient positioning, complete scan parameters, billing, networking, scheduling information and any other information needed to complete the exam.

Nurses

- All contrast injection instructions.

Radiologists and Physicists

- Dose information, minimum available retrospective reconstructions, detector configurations, and base protocol (if applicable).

5. *FAST TURN-AROUND TIME (QUICKLY UPDATED)*
and
6. *ALWAYS AVAILABLE AT THE SCANNER*

- The necessity to quickly update and distribute the protocols essentially eliminates using printed versions, at least for an institutions with more than a few scanners. Therefore, electronic distribution is essential. The most straightforward implementation is to use a web-based system. A desktop or laptop computer can be located at the scanner console. A web-friendly format for the protocols, such as PDF, can be used to minimize the need for web authoring.

Process For Creating, Managing and Distributing CT Protocols

1. *Protocol Modification or Addition Requests*

Requests for new protocols or protocol changes are submitted to a dedicated internal e-mail address. The e-mail inbox is monitored by a designated lead technologist and requests are triaged appropriately. Technologists that receive direct requests are responsible for documenting the request. Every request must have a radiologist or physicist proponent. The addition of new scanner models requires a coordinated effort to adapt protocols in a manner that best utilizes the new scanner's capabilities.

2. *Making Changes to the Protocol Collection*

Step 1: Drafting. The lead technologist determines the preliminary team members to be involved in the protocol. The team members must include, at a minimum, the radiologist proponent, a medical physicist, and a lead technologist. Additionally, any other individuals that have expertise in any component of the protocol. This is especially true of protocols for research studies, where the principle investigator, study coordinator, and others may need to contribute information. The lead technologist drafts the protocol, typically using an existing protocol as a template. The draft is reviewed by all team members and may undergo several iterations. All protocols are created and archived as Microsoft Word documents and are eventually converted into PDF documents for final presentation.

Step 2: Approvals. When the protocol draft is completed and reviewed, approval is required from all team members. Final approval is required from the Division spokesperson or a designated liaison.

Step 3: Preparing for publication. After all approvals, the lead technologist converts the Word document into the PDF format. The file is saved in a separate directory of PDF files, which replicates the directory structure of the Word document collection. This matched directory structure assures that all hyperlinks will remain intact in the PDF versions. The technologist must also maintain the version history of each protocol. Version histories are stored as separate Word documents, one for each Division, and contain a summary of all changes to each protocol, including justification and authorization for the change. For major changes, such as the discontinuation of a scanner model, a copy of the current protocol is archived before the changes are made.

Step 4: Publishing the protocols. The protocols are published as a collection of inter-linked PDF files on an internal web site. A single link is provided from the Radiology webpage to the protocol "home" page. Once the user is on the protocol home page, all navigation is performed by clicking on hyperlinks within the protocol PDF documents (i.e., no web-authoring, beyond the single link to the protocol home page, is necessary). See Figures 1-3 for samples of the navigation pages and Figure 4 for a sample protocol. The protocol collection on the web is updated by using the internet File Transfer Protocol (FTP). A simple script, in conjunction with the MS Windows Scheduler application, automates this process, which is run daily. Additionally, the protocol collection can be updated manually.

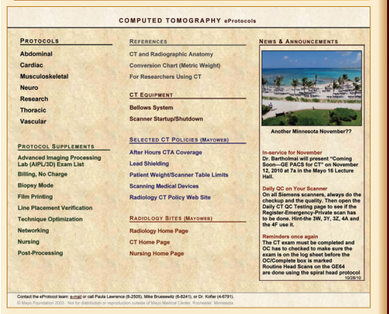
Step 5: Implementing protocol changes or additions. New protocols or protocols that have major changes are evaluated in a controlled environment, with the radiologist proponent present to provide feedback after each patient. The radiologists are encouraged to consult with their colleagues during the review process. If necessary, the protocol can be adjusted between cases.

Step 6: Finalizing the protocol. After the clinical utility of the protocol has been confirmed, the lead technologist is responsible for entering the scan parameters into the scanner, using the protocol name and number determined by the naming convention. By department policy, only the lead technologists are authorized to make changes to the stored protocols in the scanner.

3. *Communication*

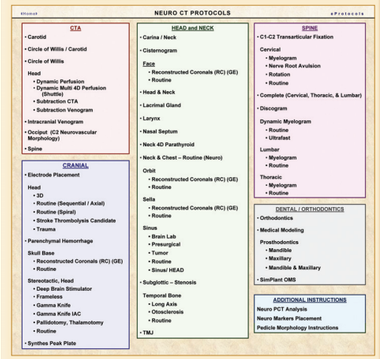
Periodic communication among the individuals who are responsible for the protocols is essential. Regularly scheduled monthly meetings among the physicists and lead technologists provide a forum for discussion of current protocol issues. Protocol issues are also discussed at Division meetings with the radiologists, physicists, and lead technologists.

Figure 1



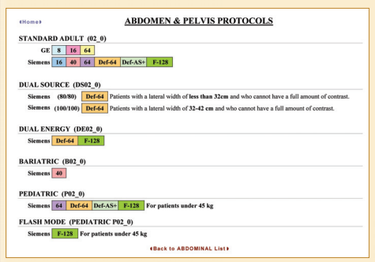
The CT ePROTOCOL Home Page. The protocols are categorized by CT Division, as listed in the upper-left corner of the page. Clicking on a Division name opens the Division navigation page. Below the protocol list are links to other instructional documents. The center column contains reference information and links to internal Radiology web sites regarding CT policies and procedures. The right-most column is for news and announcements and is updated as appropriate.

Figure 2



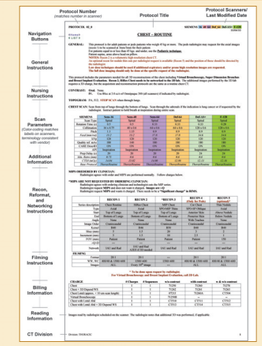
The navigation page for the Neuro Division. In this case, the protocols are subcategorized to simplify navigating the number of neuro protocols. Every protocol name that begins with a bullet (·) is a clickable link, which opens the protocol document and presents the scanner model list.

Figure 3



At the top of every protocol file is the scanner model or exam variation navigation page. Each color-coded box represents the protocol for a specific scanner model (and exam variation) and each is an active link that jumps to the appropriate location within the protocol file.

Figure 4



A sample protocol with the primary elements labeled. Some protocols include additional information, such as sample images and illustrations.

Summary

Protocols are the starting point for every CT scan performed at an imaging facility. Every aspect of the scan should be included in the written protocols, and input from individuals with expertise in each component of the exam should contribute to the protocols. This team approach is essential to providing the optimal service to the patient, from the first step into the scan room through interpretation of the images. Management and distribution of the protocol collection can be non-trivial, but are as important as the scan parameters. Hence, resources must be dedicated to these tasks and CT leadership and administration must actively support these activities.

Note: Representative "reasonable" protocols for various scans from several manufactures can be found on the AAPM website (**www.aapm.com**) by following the "CT Protocols" link in the left-hand column of the home page.