CT Protocol Optimization

The Role of "Auto QA" and "Exam QA"

DEPARTMENT OF
RADIOLOGY
University of Wisconsin
School of Medicine and Public Health

CT PROTOCOL MANAGEMENT
The UW / GE Adventure

Our protocol management project began with an effort to:

- Decrease Radiation dose.
- Decrease contrast dose.
- Standardize image quality, across the fleet.
- Create improved scanning parameters for specific disease states.

Abdominal Imaging Protocols - 23

- Chest/Abd and/or Pelvis
- Chest/Abd and/or Pelvis High Image Quality CA F/U
- Abdomen and/or Pelvis and/or Bony Pelvis

- Trauma – Chest/Abd and/or Pelvis
- Trauma – Chest
- Trauma – Abdomen/Pelvis & Penetrating Abdominal Trauma
- CT Cystogram

- Liver – Biphasic
- Liver – Triphasic
- Liver – HCC

- Pancreas – Neoplasm/Screening
- Pancreas – Neoplasm Pre-Op CTA

- Renal – Flank Pain / Limited Kidney
- Renal – CT Urography
- Renal – Kidney Tumor
- Renal – Urothelial Tumor follow-up
- Renal – Donor

- Abdomen – Adrenal Gland
- Abdomen/Pelvis – R/O Hernia
- Abdomen/Pelvis – Pre IVC Filter Removal
- Abdomen/Pelvis – CT Colonography
- Abdomen/Pelvis – Small Bowel Enterography
- Abdomen/Pelvis – Active Bleeder

- CTA – Obscure GI Bleed
- CTA – Mesenteric Ischemia

105 total unique clinical protocols

- Abdominal Imaging - 23
- Neuro Imaging - 21
- Pediatric – 11
  - Low Dose version
- Pediatric – 11
  - Higher Image Quality version
- Musculoskeletal - 16
- Cardiovascular - 18
- Chest - 5

Quality Policy:

The UW CT Protocol Optimization Team is committed to continually reducing patient radiation dose while optimizing the clinical utility of CT scans. We will use technical knowledge, industry standards, and customer requirements to develop, validate, and deliver scanning protocols of the highest quality.

Project Overview:

The UW CT Protocol Optimization Team is working to reduce patient radiation while continually improving the clinical utility of CT scans.

Their process for this involves using the knowledge and abilities of faculty and residents of the UW Madison Radiology Department to aid in the optimization of CT protocols. Information will be gathered through an automated QA process, through which the radiologists rate the quality of CT images as either “good” or “bad.”

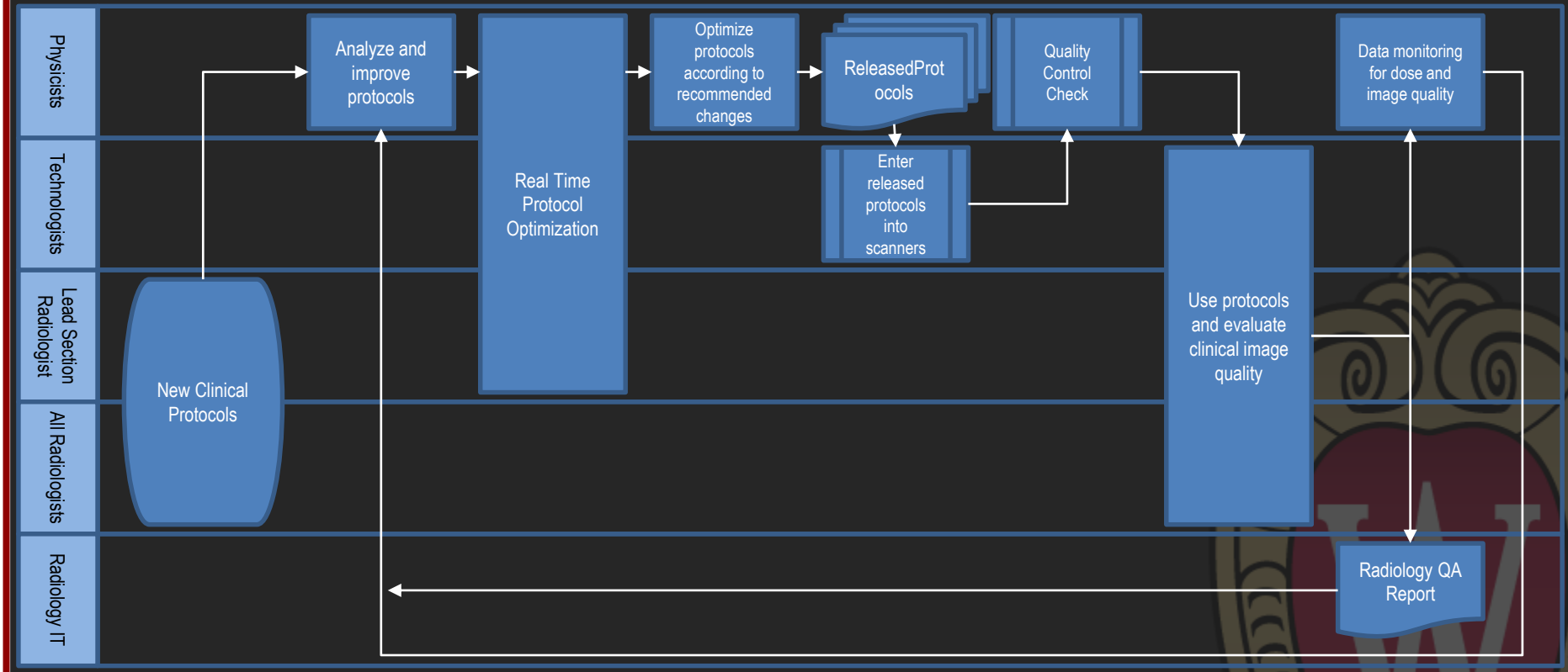
When “bad” images are identified, the team takes action to understand the underlying cause of the issue, correct the deficiency, and provide you with a more robust diagnostic tool.

Scope:

To-date, we have provided protocols to GE Healthcare for the following CT scanner platforms: Revolution EVO 64ch with ASiR, Revolution EVO 32ch with ASiR, Revolution EVO 64ch with ASiR-V, LightSpeed VCT, Revolution Discovery CT/Discovery CT750 HD, Optima CT580W, Discovery IQ PET/CT (Optima 540), Revolution CT (256) and Revolution CT ES (128).

This optimization process covers the following sections within the Department of Radiology: Abdominal, Cardiovascular, Musculoskeletal, Neuroradiology, Pediatric, and Thoracic.

ISO 9001:2008: UW Quality process map



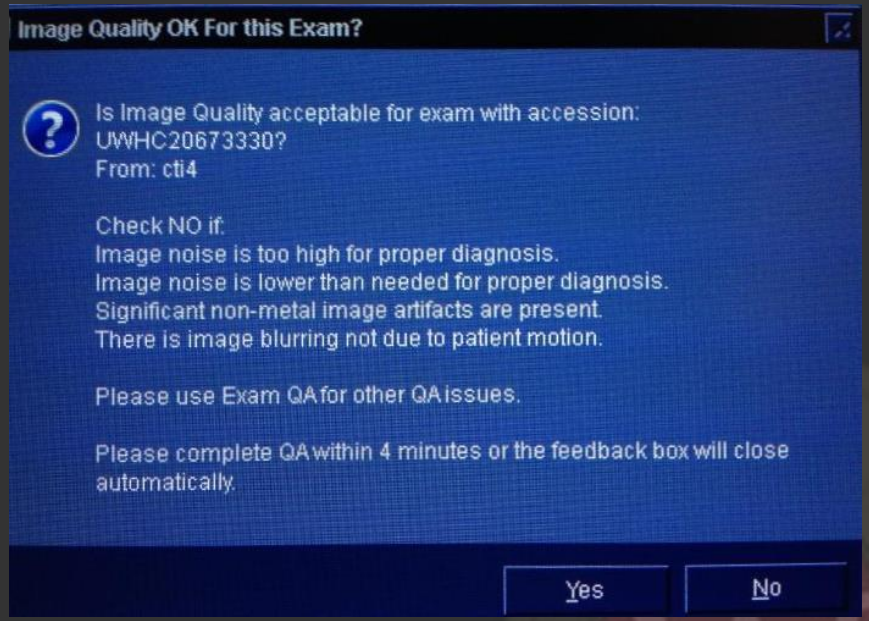
F Ranallo, TP Szczykutowicz, M Pozniak, and R Bruce "An overview of a CT protocol optimization process at a major university hospital medical center; including details on physics support, IT support, and a radiologist based quality assurance program" Medical Physics. 40:6 2013

Szczykutowicz, Timothy P., et al. "Compliance with AAPM Practice Guideline 1. a: CT Protocol Management and Review—from the perspective of a university hospital." *Journal of Applied Clinical Medical Physics* 16.2 (2015).

Auto QA

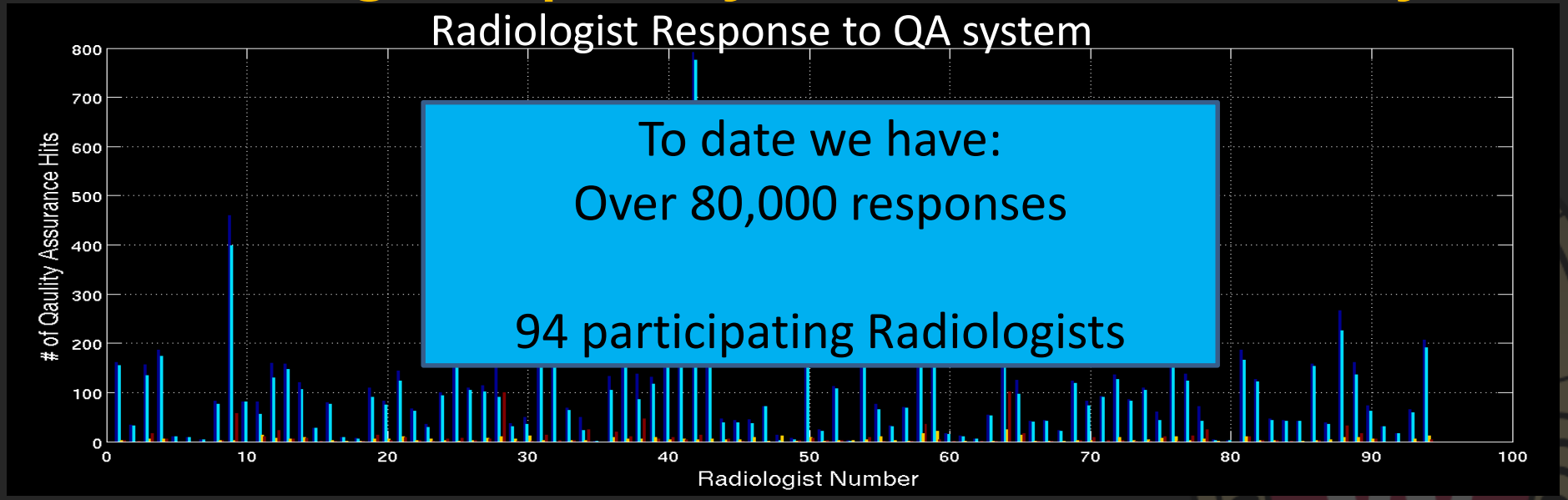
Our primary tool for collecting data on the CT protocols is “Auto QA”.

When a reviewing physician opens a completed CT study, he/she receives a PACS system prompt to comment on image quality.



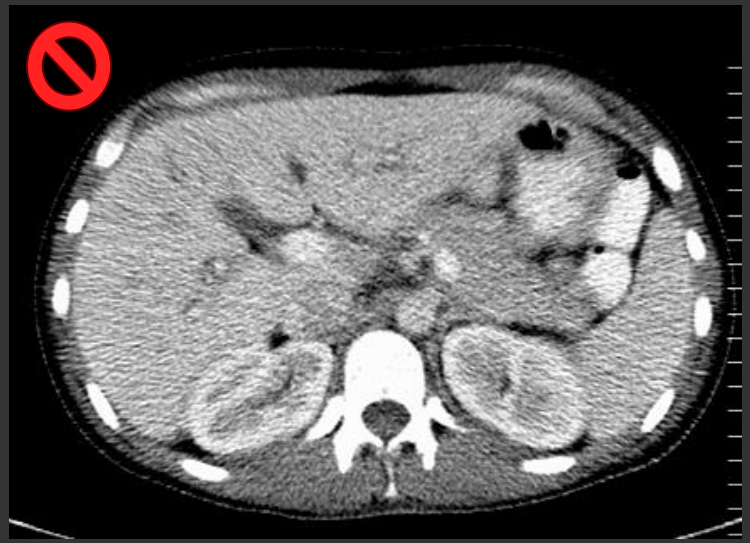
All radiologists need to activate this module for their user name (instructions included herein), and should be participating in the process.

IT tools:
Radiologist quality assurance analysis



TP Szczykutowicz, F N Ranallo, W W Peppler, R J Bruce, and M A Pozniak “MDCT protocol optimization using an automated IT solution provided size specific patient doses, automatic tube current modulation information, and radiologist feed-back. RSNA 2013 S405AB-08

Example: Image Noise Too High



A routine abdomen/pelvis exam with contrast: the image at left displays too much noise, while the image on the right has an acceptable degree of granularity in the liver.

Example: Image Noise Lower Than Necessary

A routine abdomen pelvis exam with contrast. On the bottom is an image with too little noise for a routine abdomen pelvis, while the image on the top has an acceptable noise level for this exam type.

Example: Image Noise Lower Than Necessary

A routine abdomen pelvis exam with contrast. On the top is an image with too little noise for a routine abdomen pelvis, while the image on the bottom has an acceptable noise level for this exam type.

Note: The top image was actually from a trauma abdomen pelvis exam. The UW trauma abdomen pelvis protocol is used to reconstruct images of the spine for the neuro section to read. These images require lower noise than the routine abdomen images and therefore while the image quality may appear “too good” to a body radiologist, it will be “just right” for the reconstructions of the spine for a neuroradiologist. You must be aware of all of the uses of a given study in order to accurately rate image quality.

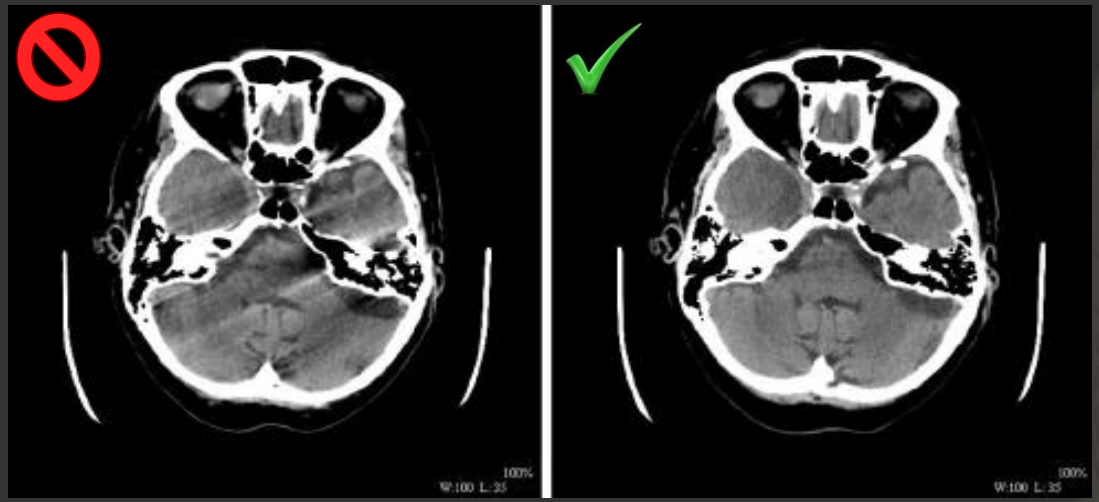
Example: Significant Non-Metal Image Artifacts

Hsieh, Jiang. "Computed tomography: principles, design, artifacts, and recent advances." SPIE, 2009.

Example of photon starvation artifact through the shoulders. Note: no metal is present in this case. The KV or mA are simply set too low → this is a protocol problem!

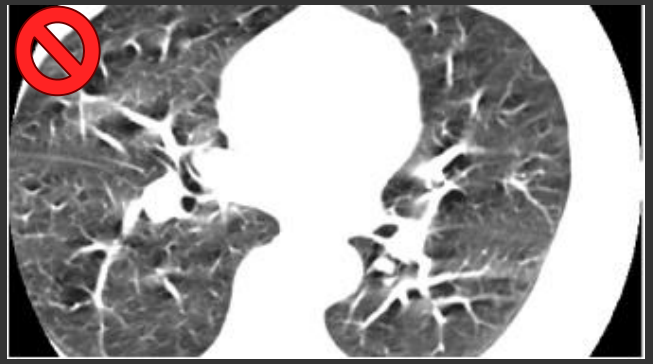
Example: Image Blurring due to Patient Motion

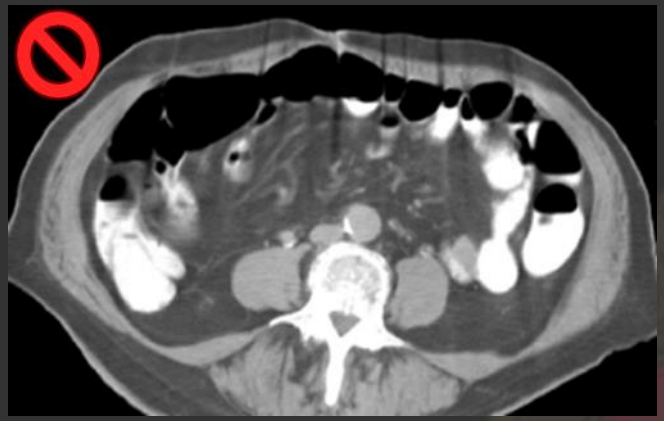
Patient motion caused by too long a scan time is also a protocol problem of this type. Distinguishing the difference between a patient voluntarily moving and involuntary motion during a relatively long scan time can be difficult. If in doubt, mark patient motion issues with a “No” response.



Hsieh, Jiang. "Computed tomography: principles, design, artifacts, and recent advances." SPIE, 2009.

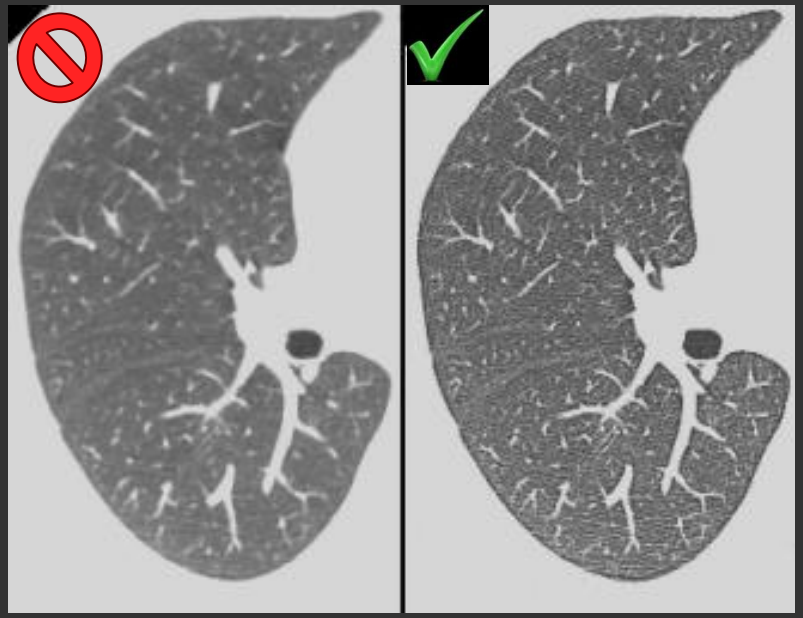
Example: Image Blurring due to Patient Motion





Hsieh, Jiang. "Computed tomography: principles, design, artifacts, and recent advances." SPIE, 2009.

Example: Image Blurring not From Patient Motion



Hsieh, Jiang. "Computed tomography: principles, design, artifacts, and recent advances." SPIE, 2009.

Example of a lung reconstruction using a standard algorithm (left) and a lung algorithm (right). The image on the right is sharper. The reconstruction algorithm is displayed by PACS. If the algorithm matches the protocol, but you still find the image lacking in resolution, please respond “No” using “Auto QA”. If the image was reconstructed with an incorrect algorithm, please use “Exam QA”.

Remember: Each series of a protocol will often have different levels of sharpness due to algorithm and slice thickness differences.

Distinguishing Between “Auto QA” and “Exam QA”

“Auto QA” is used to address how well a protocol is working. Issues which fall into the aforementioned categories are caused by an un-optimized protocol, and should be addressed within the “Auto QA” System.

Issues which are not related to how well a protocol is performing should be logged using “Exam QA”. The next few slides detail degradations of image quality NOT caused by un-optimized protocol settings.

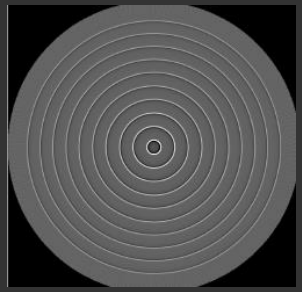
Exam QA

Exam QA is used for “other QA issues,” or things which are not directly related to the protocols:

- Patient mispositioning
- CT scanner defect (ring, bull’s eye, streak, or typhoon artifacts)
- Change of protocol at time of scan
- Incorrect patient size selection
- Contrast timing or administration
- Patient motion
- Metal or bone artifacts
- Very obese patient
- Problem with reformats (CT tech error)

Example: Artifacts That Should be Logged With Exam QA

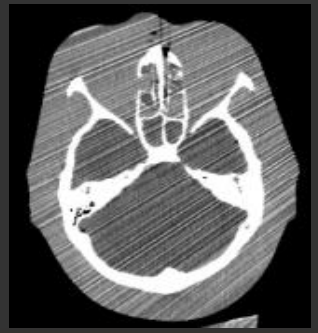
Detector Problems

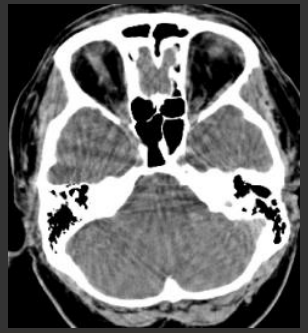


Left: Detector response error for a single view angle

Right: Ring artifacts

Tube Problems





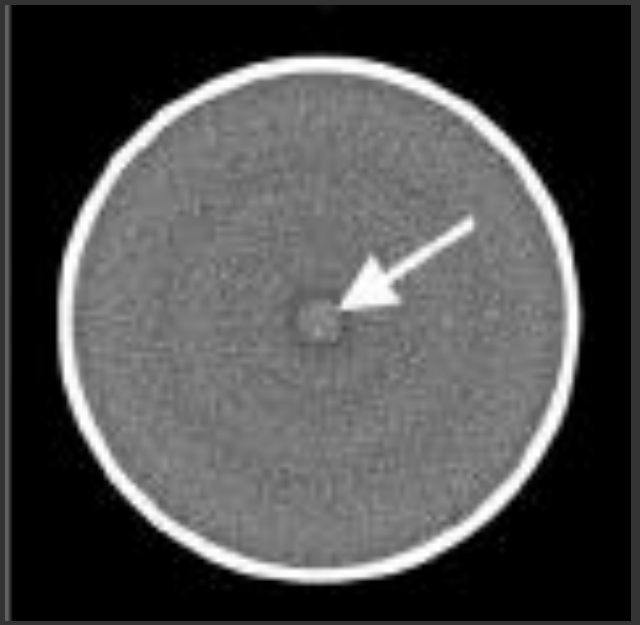
Left: Tube arcing

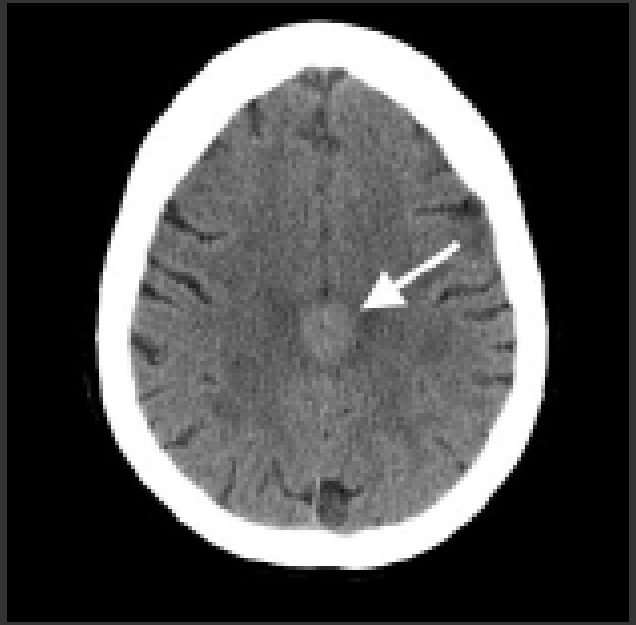
Right: Tube wobble

Hsieh, Jiang. "Computed tomography: principles, design, artifacts, and recent advances." SPIE, 2009.

Example: Artifacts That Should be Logged With Exam QA

Ring artifacts that can mimic disease or anatomy

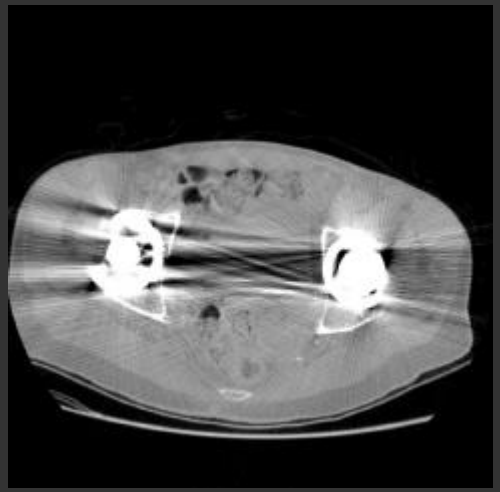




If you see (or suspect) this type of artifact, notify the CT Tech and/or Medical Physics immediately.

Cody, Dianna D., Donna M. Stevens, and Lawrence E. Ginsberg. "Multi–Detector Row CT Artifacts That Mimic Disease1." Radiology 236.3 (2005): 756-761.

Example: Artifacts That Should be Logged With Exam QA



Artifact caused by metal (Ti) implants.

Hsieh, Jiang. "Computed tomography: principles, design, artifacts, and recent advances." SPIE, 2009.

Truncation Artifacts:

These can be caused by improper placement of the patient within the scanner (top-right), but sometimes this type of artifact cannot be avoided as some patients cannot raise their arms over their heads, or some patients are simply too large (bottom-right) to fit within the scanning field of view.

What is Done With the Information?

The responses are compiled by protocol and scanner.

"No" responses from the "Auto QA" system are INDIVIDUALLY reviewed by the medical physics staff, and then gone over with each section head to determine when protocol changes would be beneficial.

Protocol-related items identified in the "Exam QA" system receive the same treatment.

"Other QA Issues" identified in the "Exam QA" system which are not protocol related are forwarded to the appropriate department personnel for follow-up.

Why Use the System?

Without a robust feedback system, some CT protocols may go for long periods of time without beneficial changes being made.

This system gives every radiologist ownership in our protocols; everyone is involved in their design and optimization.

Responsibilities

All Radiologists and Radiology Residents should have “Auto QA” activated for their user name. (instructions included herein).

All Radiologists and Radiology Residents should participate in the “Auto QA” system while they read exams. This process will take less than one minute.

Attending Physicians should discuss image quality and dosing concerns with Radiology Residents as part of the Read Out process.

It is the responsibility of attending physicians to correct resident mis-categorized “Yes” responses to the “Auto QA” system. This is accomplished using the “Exam QA” system.

Any Radiologist or Radiology Resident with questions regarding image quality or dose should direct them to Frank Ranallo (Ranallo@wisc.edu) from Medical Physics or Tim Szczykutowicz (tszczykutowicz@uwhealth.org) from Radiology.

Responsibilities (cont.)

A Clinical Section CT Lead Radiologist has been established for each functional area:

- Abdominal: Meg Lubner
- Chest: Jeff Kanne
- Cardiovascular: Scott Nagle
- Community Division: Robert Bour
- MSK: Keegan Markhardt
- Neuro: Greg Avey
- Pediatric: Jonathan Swanson

Clinical Section CT Leads will go over “No” responses with the Medical Physics team to discuss possible protocol changes, as well as sign off on any change made to a protocol in his/her section.

They will also receive reports detailing participation rates within their section, and enforce cooperation with the “Auto QA” data collection system.

Set Up

Users must activate “Auto QA” on PACS. This is done by going to “Preferences” and checking the “Auto QA” box.

If you need help completing this <u>one-time</u> activation, you can contact one of the following people:

- **Richard Bruce**
- **Jason Pulling**
- **Tim Szczykutowicz**
- **Gary Wendt**