MR Accreditation: Basics and Beyond

Robert A. Pooley, Ph.D.
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Outline
• Basic Steps towards ACR MR Accreditation
• Basic Phantom Acquisition and Analysis
• Phantom Image Review
• On-going Quality Control
• Are You Prepared for an ACR Inspection?

Disclaimer
• The ACR pays me $$$ to review phantom images.

Steps Towards Accreditation
• Go to www.acr.org
• Click “Accreditation”
• Click “MRI”
• Read everything on these pages especially the “MRI Program Requirements”
• Apply for Accreditation
“Application for Accreditation is a 2-step process.”

- Step 1: Provide ACR with information regarding your practice
- Step 2: Submit data

Note

- An annual performance evaluation must be submitted to the ACR
- Surprisingly, the ACR receives many reports with
  - Required tests not performed
  - Corrective action not documented if the physicist/MR scientist failed any tests

Read “10 Things You Need to Know about CMS/MIPPA Accreditation Requirements”

- #1 Who needs to be accredited?
- The Medicare Improvements for Patients and Providers Act (MIPPA) calls for all providers of CT, MRI, breast MRI, nuclear medicine, and PET exams that bill under Part B of the Medicare Physician Fee Schedule to be accredited by Jan. 1, 2012, in order to receive payment for the technical component of these services. Currently, the CMS/MIPPA mandates apply to private outpatient facilities only, NOT to hospitals.

Basic Phantom Acquisition
Acquiring The Phantom Data

Phantom Tests

- Geometric accuracy
- High contrast spatial resolution
- Slice thickness accuracy
- Slice position accuracy
- Image intensity uniformity
- Percent signal ghosting
- Low contrast object detectability
Sagittal Localizer

Geometric Accuracy

Criteria: 148 ± 2 mm

Slice 1

Slice 5

Criteria: 190 ± 2 mm

High Contrast Spatial Resolution

Criteria: 1.0 mm
High Contrast Spatial Resolution

Slice Thickness Accuracy

Criteria: 5.0 ± 0.7 mm

Slice Thickness Accuracy

Criteria: slice thickness = 0.2 \times \frac{\text{top} \times \text{bottom}}{\text{top} + \text{bottom}}

Slice Position Accuracy
Slice Position Accuracy
Criteria: |bar length difference| < 5 mm

Image Intensity Uniformity
Slice 7
Criteria: PIU ≥ 87.5%

Image Intensity Uniformity
PIU: 100 x (1 - ((high - low)/(high + low)))

Percent Signal Ghosting
Slice 7
Criteria: ghosting ratio ≤ 0.025
ghosting ratio = |((T+B)-(L+R))/2 x large ROI|
Low Contrast Object Detectability

Slice 11
Criteria: 9 spokes

Low Contrast Object Detectability

Slice 8

When Bad Images Happen to Good People

Most Common Image Problems
- Ghosting
- Per cent image uniformity (PIU)
- Low contrast detectability (LCD)
- Geometric distortion
- Filter issues
Ghosting
Percent Image Uniformity

Ghosting - Cold Head Issue

ON
OFF
Low Contrast Detectability
Distortion Correction Issue
2D Distortion Correction ON

Applied "Undo 2D Distortion Correction" as post-processing

Courtesy Mayo Clinic Rochester

2D Distortion Correction OFF

"2D Distortion Correction" applied as post-processing

Edge Artifact

Courtesy Mayo Clinic Rochester
Quality Control Testing

• Regular
  • Weekly testing
  • One or two scanners

• Advanced
  • Daily testing
  • 20+ scanners at one institution
  • Could this be automated?
Weekly QC Data Sheet

What if you have 20 scanners?

- Complete ACR Phantom Testing on DAILY Basis for 20 Scanners with Automated Analysis and Interactive Real-Time Remote Monitoring!
- Dream or Reality?

Automated ACR Phantom Analysis

- It is Reality!
- Vision and prototype software by Joel Felmlee, Ph.D.,
- Clinical implementation by Kiaran McGee, Ph.D., et. al.,
- Slides courtesy of J. Felmlee, K McGee, Diana Lanners and Renee Jornsgard
- Unfortunately, this software is not yet available outside the institution

Materials & Methods
Application overview

Institutional MR Scanners

DICOM receiver and analysis workstation

Intranet Accessible User PC

Images automatically processed to extract 7 ACR QC metrics

Daily QC review and additional QC checks performed by technologists & physicists through accessible remote QC databases

Institutional SQL Databases

Communication between web server and database allows interactive data review and tolerance setting
Materials & Methods
Automated Analysis

Data Extracted from DICOM header

- Center frequency
- Transmit Gain/Attenuation

Metrics calculated directly from ACR Phantom images (and required by ACR)
- Geometric accuracy
- High-contrast spatial resolution
- Slice thickness
- Slice position
- Image intensity uniformity
- Percent signal ghosting
- Low-contrast object detectability
- Signal-to-noise ratio

Positioning the Phantom

- Raise the table every morning.
- Lower the table at the end of the day.

Landmark at the "Nose" crosshair.

Snug fit in platter.

Park position for head coil.

NX & NY Positioning

- Spirit Level will aid in positioning.
- Poor positioning will decrease SNR value and may result in a repeat exam. Image is angled 5°.
Series 1: Image 1 Sag. Scout

Control limits:
- S distance 148 mm +/− 2 mm
- Center Offset +/− 7 mm

Averaging 4 distances to test distortion. Center of phantom should match center of image.

Prescribing Series 2 Axials

*Make sure the 1st slice is centered at intersection of the bottom triangles!

Series 2: Image 1

ACR Phantom without the jig

Control limit:
At least 1.0 mm in both directions
Control Limit: 190 mm +/− 2 mm.
Series 2: Image 6

Series 2: Image 7

Series 2: Image 8

Series 2: Image 9
Series 2: Image 10

Series 2: Image 11

Then What???

- Review **ALL** phantom images
- End the exam
- Send the ACR Exam to the Analysis PC
- Go to the MRI QC website

Artifacts: Ghosting
Artifacts: Streaks/Smearing

“Auto ACR QC” website

ACR Profile QC website

Technologist Responsibilities

Blue: Images have not been sent to MITS PC

Yellow: Images received; awaiting tech review

Green: Questions answered and image analysis “Passed”

Red: Image analysis “Failed”. Rescan phantom w/ new Accession #.

This person is responsible for these questions.
1. Confirm the scanner
2. Answer three questions
3. Enter any necessary comments
4. Click on “Update”

Materials & Methods
Web Interfaces: Physics review of scanner QC data

Materials & Methods
Web Interfaces: Scanner main page & QC quick check

ACR On-site Survey
- Verify equipment information
- Check most recent physicist report
  - Confirm date within past year
  - Confirm that tests passed, or issues addressed
  - Check if recommendations were made
- Evaluate Site’s QC program
- Check documentation of scheduled maintenance
- Scan and analyze ACR phantom
Thank You