Learning Objectives

- Explore the desired goals of annual testing (not necessarily the same as the requirements of testing) and suggest ways to sell your services
- Review the genesis of MRI accreditation (primarily ACR but will touch on ICAMRL and the Joint Commission)
- Discuss methods to help you streamline your testing while covering all the bases.
Why is Quality Control Often Problematic?

- QC is part of most imaging operations but usually not promoted.
- Technologists often view QC as having minimal positive impact.
- Managers often view QC as lost scanning time and lost $.
- Payors have little impact at present because they don’t understand QC.
- QC can help imaging facilities achieve higher uptime by identifying problems before they become catastrophic.

Which is the FALSE statement?

1. Site managers often view QC and accreditation as lost scanner time and money.
2. Technologists often view QC as having a minimal impact on system performance.
3. QC is not a common part of most imaging operations.
4. QC can help sites improve uptime and scanner performance.
5. Payors can have a significant impact on the need for QC and accreditation.

Reference: Discussion per fourth slide.
How Testing Can Influence Quality

- **Cost Per Encounter**: QC should enhance efficiency (can’t be burdensome) and should help to ensure the MRI is available (improve uptime and throughput)
- **Risk To Patient/Personnel**: MR safety policies and procedures should protect patients and personnel (lower liability), MRI testing should help to identify broken or faulty components
- **Diagnostic Information Content**: Is the system running in an optimal fashion? Are the coils working well? Are the monitor and filming devices properly rendering images? Are the techs trained to notice any changes in technical performance? Are there any significant image artifacts?

Which is Usually NOT a Potential Patient Risk in the MRI Environment?

<table>
<thead>
<tr>
<th>Risk</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questionable RF Screen Room Integrity</td>
<td>19%</td>
</tr>
<tr>
<td>Broken RF Coil Cables</td>
<td>20%</td>
</tr>
<tr>
<td>Ferro-Magnetic Objects in the Scanroom</td>
<td>21%</td>
</tr>
<tr>
<td>Metal Particles in the Patient’s Eye</td>
<td>20%</td>
</tr>
<tr>
<td>Surgical Implants</td>
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2. Broken RF Coil Cables
3. Ferro-Magnetic Objects in the Scanroom
4. Metal Particles in the Patient’s Eye
5. Surgical Implants


Quality Improvement Incentives

- **CARROT**: Better throughput (more $ per hour), Enhanced reputation in the community, Pay for performance (P4P) initiatives, Accreditation (ACR, IAC, JC), etc.

- **STICK**: MIPPA per accreditation (ACR, IAC, JC), Pre-authorization/gate keeper organizations, Loss of reputation in local community, Potential litigation from errors, etc.

Positive Aspects of System Evaluation (Selling QC!)

- Scanners yield more consistent performance with appropriate service attention. QC provides a check on service.
- Referrers and payors have more confidence in the quality of MRI exams
- Opportunities exist for greater operational efficiency (better uptime performance)
- The program encourages a higher level of operator confidence and attention to system performance (improved knowledge base)
ACR requires accredited MRI sites to have weekly and annual MRI quality control programs that meet the minimal standards outlined in the ACR's Quality Control Manual.

ICAMRL requires annual testing and an on-site QC program.

JC requires testing of all medical equipment and management of safety risks in MRI.

ACR technical testing evaluates equipment and reviews local MRI safety policies/procedures annually. It also requires weekly on-site quality control and assesses the results annually.

These procedures can be adopted by sites utilizing either ICAMRL or JC accreditation.

The ACR MRI phantom is a relatively inexpensive device that provides a wide range of test data.

Suggestions for Optimal Testing

- Know the Equipment
- Know the Accreditation Rules
- Streamline Your Testing
- Sell Your Expertise as a Partner
KNOW THE EQUIPMENT

- Accreditation testing requires knowledge of MRI physics principles and familiarity with the devices examined. If you have not tested a particular model get help from someone who has. Don't try to fake it!
- You should be able to run the MRI scanner largely without assistance from techs or service. (Would you trust your car to a mechanic who couldn’t drive it?)
- Some vendors’ MRI units require special service software. Make connections with appropriate vendor reps as necessary.

KNOW THE RULES

- Each accreditation program has specific rules but they are not the same across programs.
- For ICAMRL and JC, the local MRI physics expert can recommend the details of the MRI technical program and the phantom to be used (voted in by the site’s MR Quality Control Committee)
- Ensure your testing covers all of the required ACR parameters. Failure to do so may delay your client’s accreditation until the report meets ACR’s standards.

What does ACR Require?

1. Background and weekly on-site QC testing:
   - Date of test and date of report
   - Location and type of MRI system with system ID
   - MRAP number
   - Tester's name and signature (tests must be done by the person writing the report)
   - Verification of Visual Checklist items (scan room RF integrity, MRI alignment lights and table functionality, magnetic fringe field warning signs, etc.)
   - Evaluation of previous year's weekly QC, visual checklist, and film densitometry (if camera is in use) with statement of action limits for future weekly testing
   - Review of site's brain T1 and T2 series with ACR phantom

2. Evaluation of ACR standard tests in the head coil (ACR sagittal, T1, and T2 tests):
   - Geometric distortion in all three orthogonal planes (sagittal and T1)
   - High contrast resolution in the phase and the frequency directions (T1 and T2)
   - Slice thickness accuracy (T1 and T2)
   - Slice location accuracy (T1 and T2)
   - Ghosting ratio (T1)
   - Low contrast object detectability (LCD disk spokes) (T1 and T2)
   - Image intensity uniformity (IIU) (T1 and T2)
   - Center Frequency (CF) and Transmit Gain (TG)

3. System magnetic field homogeneity:
   - Per vendor specifications with a description of the method (in the absence of vendor specifications see the ACR MRI QC Manual for suggested guidelines)

4. System monitor:
   - Maximum and minimum luminance in the four corners and the center, its uniformity, and evaluation of any significant artifacts
   - The appropriate high and low contrast resolution, spatial accuracy, and contrast setting per the SMPTE pattern grayscale distribution (95/100 and 5/0)

5. Film (if camera is in use):
   - Faithfully represents the SMPTE pattern shown on the system monitor, evaluation of any significant artifacts, and verify site densitometry readings for 0%, 10%, 40%, and 90%

6. Specialty coils:
   - Testing of all specialty coils used clinically (listed by model and serial number) with a description for each per test technique, phantom and set up used, results obtained, and Transmit Gain (TG) for each coil
   - For each volume coil the results must include SNR, ghosting ratio, image intensity uniformity, and artifact analysis
   - For each other coil (non volume) testing must include SNR and artifact analysis

7. Review of site’s MR Safety Policies and Procedures with suggestions for improvement
STREAMLINE YOUR TESTING

- Have all necessary equipment with you
- Verify the ACR phantom, other phantoms, and set-up equipment are at the site
- Have a defined test plan (makes testing more efficient and helps to avoid missing data)
- Recommend service conduct a PM prior to testing

You Don’t Have to Use ACR Forms

- As long as your test report includes all ACR requirements you can use your own format. Make PASS and FAIL very obvious and include a comment on the first page for every failure.

Site Responsibilities and Follow Up
Make Yourself Valuable as a Partner

- Encourage the local decision makers to embrace QC (explain carrot and stick)
- Make your testing as PAINLESS as possible (convenient schedule, LNT, remove bubbles in the phantom, etc.)
- While you are on site testing, offer to conduct an in-service to help local techs understand their weekly QC procedures and responsibilities
- Include a check the five technical MRI scans the site will submit for accreditation
- Respond to questions (via phone/email) and help with possible appeals should the site fail a portion of accreditation

Tips for Efficiency

- Start with the ACR phantom in the head coil and take all five required head studies, slice thickness, and the body coil test
- While one study is acquiring, you can analyze the data from the previous study and review the previous year’s QC.
- Then test each specialty coil (as indicated by the site)
- Finish with homogeneity, film, and monitor testing.
- IT’S NOT OUR JOB TO FIX IT!

Head Coil Studies

- ACR now requires acquisition of ALL FIVE technical scans submitted for accreditation as part of the annual testing
- ACR Sagittal Study
- ACR T1 Axial Study
- ACR T2 Axial Study
- SITE T1 Axial Study
- SITE T2 Axial Study
For all volume coils one must include analysis of SNR, ghosting ratio, and image intensity uniformity.

For non-volume coils one must conduct SNR and artifact analysis.

Don’t forget to include model number, serial number, and Transmit Gain.

You need only test those coils the site states it uses clinically.

Include a Description

There are a variety of methods to evaluate homogeneity. Use the one that works best for the type of equipment and the phantoms you have available. This may also depend on the access to service software that you have.
Phase Contrast Method

- Use GRE study and flood phantom (sphere is best)
- Select TE per the field strength (1.5T = 15.6ms, 3T = 7.8 ms, 0.5T = 47ms)
- Do Phase Reconstruction
- Each black to white transition equals 0.5ppm

Reviewing Site Records

- Check center frequency shift to ensure drift rate is within vendor specs.
- Check Transmit Gain variation (RF health)
- Check distances, resolution, and spokes data
- Provide Action Limits for CF, TG, geometric distortion, high contrast resolution, and spoke count (low contrast disks)
- Review MR Safety policies and procedures with suggestions for improvement

Other Tests

- Monitor: SMPTE pattern for 0% / 5% and 95% / 100%, geometric distortion, low contrast resolution, max and min luminance as well as uniformity. Look For Artifacts!
- Film: Does the film faithfully represent what is seen on the monitor? Check optical densities for 0%, 10%, 40%, and 90% SMPTE grayscales. Look For Artifacts and variations across the film (6 on 1)
Which is NOT part of the ACR Annual MRI Testing Program:

- Magnet Homogeneity Check
- RF Crosstalk Test
- Slice Thickness Test
- Examination of All Coils Used Clinically
- System Monitor Luminance Testing

Reference: Slide #18 and ACR MRI QC Manual

Which is NOT a Reason to View the SMPTE Pattern as Part of ACR Testing:

- ACR tells us to do it
- Check for proper high/low contrast resolution
- Check for proper grayscale distribution
- Check for artifacts in the monitor
- Check for proper monitor refresh rate
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5. Check for proper monitor refresh rate

Reference: Discussion during slide #30

How Can Proper MRI Testing and Weekly QC Affect Imaging Operations?

1. Decrease system availability
2. Improve diagnostic content
3. Exacerbate patient risk
4. Increase system downtime
5. Prevent timely vendor service

Reference: Discussion during slide #7
SUMMARY

- MRI QC and annual testing can benefit the site through enhanced uptime and optimal imaging performance.
- MRI physics services should be an integral AND PAINLESS part of the site’s quality control.
- Competent annual physics testing is the most important check on the quality of vendor service.
- *If your testing is not competent and painless please send me your client list.*

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- Thank you for your kind attention. I welcome your comments or questions. (bell3660@sbcglobal.net, 858-759-0150)