

PARTNERS IN SOLUTION

IMAGING/DIAGNOSTIC QA SOFTWARE

Tuesday July 14, 3:30 pm - 5:30 pm

Yu Liu

Medical College of Wisconsin, Milwaukee, WI

Steve Dyer: "AutoQA Plus - Catphan QA"

QA Benchmark, LLC, Frederick, MD

Kenneth Ruchala: "RapidCHECK Software for Diagnostic"

Sun Nuclear Corporation, Madison, WI

Brian Cote: "Necessity of monitor quality control and total management with QA software"

EIZO, Inc., Cypress, CA



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IMAGING/DIAGNOSTIC QA SOFTWARE

Thursday July 16, 1:00 pm-3:00 pm

Yu Liu

Medical College of Wisconsin, Milwaukee, WI

Erik Wikstrom "Ocean – RTI's QA Software – How can it improve Workflow?"

RTI Group North America

Felix Schofer "QA solutions for cone beam and computed tomography QA"

QUART GmbH

Matt Whitaker "Interfacility and machine image quality analysis using a cloud-based system"

Image Owl, Inc.



Learning Objectives

- Understand various accreditation organizations' imaging physics QA requirements
- Learn commercially available QA software analysis tools



Introduction

- Importance of Quality Assurance (QA)
- QA requirements for Diagnostic Medical Physics
- QA Tasks: Diagnostic Medical Physics
- Solutions From Vendors (Tue & Thurs)
- Questions and Answers



Importance of Quality Assurance for Diagnostic Medical Physics

- Quality and safety improvement for patient care and safety
- Mammography Quality Standards Act (MQSA)(1992)
- Medicare Improvements for Patients and Providers Act (MIPPA)(2008)



QA requirements for Diagnostic Medical Physics

- The Joint Commission (TJC)
- American College of Radiology Accreditation (ACR)
- Intersocietal Accreditation Commission (IAC)
- ACR-AAPM-SIIM Technical Standard for Electronic Practice of Medical Imaging



Diagnostic Imaging Modalities Requiring Physics QA- TJC

- X-ray radiography/Fluoroscopy
- Computed Tomography
- Magnetic Resonance Imaging
- Nuclear Medicine/Positron Emission Tomography (PET)



Diagnostic Imaging Modalities Requiring Physics QA- ACR

- Computed Tomography
- Magnetic Resonance Imaging
- Nuclear Medicine/SPECT/Positron Emission Tomography (PET)
- Digital mammography
- Ultrasound



Diagnostic Imaging Modalities Requiring Physics QA- IAC

- Computed Tomography
- Magnetic Resonance Imaging
- Nuclear Medicine/Positron Emission Tomography (PET)



X-ray Radiography/Fluoroscopy QA

- kVp accuracy and consistency
- Exposure vs. kVp and mAs
- HVL
- Timer accuracy
- Light field vs. radiation field
- Dose rate
- Maximum dose rate



Computed Tomography/CBCT QA

- ACR Computed Tomography Quality Control Manual 2017
- AAPM TG-233 Report: Performance Evaluation of Computed Tomography Systems (2019)
- AAPM TG-200 Report: The Design and Use of the ICRU/AAPM CT Radiation Dosimetry Phantom: An Implementation of AAPM Report 111 (2020)
- AAPM TG-111 Report: Comprehensive Methodology for the Evaluation of Radiation Dose in X-Ray Computed Tomography (2010)



ACR Computed Tomography QA

- CTDIvol measurements
- CT number (HU) uniformity
- CT number (HU) accuracy
- Image slice thickness
- High contrast resolution
- Distance measurement accuracy
- Low contrast performance and Contrast-to-Noise Ratio (CNR)
- Laser alignment accuracy/scan localizer accuracy
- Artifact evaluation
- Acquisition display monitor

Medical Physicist CT Survey Report

This report summarizes the results of tests performed in accordance with the American College of Radiology CT QC Manual.

Facility Name _____	Unit ID _____
Address 1 _____	Manufacturer _____
Address 2 _____	Model _____
City, State, ZIP _____	Serial Number _____
	Date of Manufacture _____

CTAP # (if applicable) _____

Medical Physicist Signature _____

Survey Date _____
Report Date _____

Medical Physicist Tests	Pass/Fail	Technologist QC Evaluation	Pass/Fail/NA
Review of CT Protocols	<input type="checkbox"/>	Water CT Number and SD (Daily)	<input type="checkbox"/>
Scout Prescription Accuracy	<input type="checkbox"/>	Artifact Evaluation (Daily)	<input type="checkbox"/>
Alignment Light Accuracy	<input type="checkbox"/>	Wet Laser QC (Weekly)	<input type="checkbox"/>
Table Travel Accuracy	<input type="checkbox"/>	Visual Checklist (Monthly)	<input type="checkbox"/>
Radiation Beam Width	<input type="checkbox"/>	Dry Laser QC (Monthly)	<input type="checkbox"/>
Low-Contrast Performance	<input type="checkbox"/>	Acquisition Display QC (Monthly)	<input type="checkbox"/>
Spatial Resolution	<input type="checkbox"/>		<input type="checkbox"/>
CT Number Accuracy	<input type="checkbox"/>		<input type="checkbox"/>
Artifact Evaluation	<input type="checkbox"/>		<input type="checkbox"/>
Dosimetry	<input type="checkbox"/>		<input type="checkbox"/>
CT Number Uniformity	<input type="checkbox"/>		<input type="checkbox"/>
Acquisition Display Calibration	<input type="checkbox"/>		<input type="checkbox"/>

Comments



Magnetic Resonance Imaging Physics QA

- ACR Magnetic Resonance Imaging Quality Control Manual (2015)
- AAPM Report No.100: Acceptance Testing and Quality Assurance Procedures for Magnetic Resonance Imaging Facilities (2010)



ACR Magnetic Resonance Imaging QA

- Image uniformity
- Geometric accuracy
- High contrast spatial resolution
- Low contrast detectability
- Slice position accuracy
- Slice thickness accuracy
- Laser alignment accuracy/scan localizer accuracy
- Artifact evaluation
- Display monitor
- RF coil and other testing

MRI Equipment Evaluation Summary

Site: _____ Report Date: _____
System MRAP#: _____ Survey Date: _____
System BMRAP#: _____
MRI System Manufacturer: _____ Model: _____
Medical Physicist/MRI Scientist: _____
Signature: _____

Equipment Evaluation Tests		Pass/Fail/NA
1.	Setup and Table Position Accuracy	
2.	Center Frequency	
3.	Transmitter Gain or Attenuation	
4.	Geometric Accuracy Measurements*	
5.	High-Contrast Spatial Resolution*	
6.	Low-Contrast Detectability*	
7.	Artifact Evaluation	
8.	Film Printer Quality Control (if applicable)	
9.	Visual Checklist	
10.	Magnetic Field Homogeneity	
	Method of Testing	
11.	Slice-Position Accuracy*	
12.	Slice-Thickness Accuracy*	
13.	Radiofrequency Coil Checks	
	Were all clinically used coils evaluated? (Yes/No)	
	Was the breast coil evaluated? (Yes/No/NA)	
	a. SNR	
	b. Volume Coil Percent Image Uniformity (PIU)	
	c. Percent Signal Ghosting (PSG)	
14.	Soft-Copy (Monitor) Quality Control	
15.	MR Safety Program Assessment	
	* tests that can be performed by scanning the ACR MRI Phantom	

Evaluation of Site's Technologist QC Program		Pass/ Fail
1.	Setup and Table Position Accuracy (weekly)	
2.	Center Frequency (weekly)	
3.	Transmitter Gain or Attenuation (weekly)	
4.	Geometric Accuracy Measurements (weekly)	
5.	High-Contrast Spatial Resolution (weekly)	
6.	Low-Contrast Detectability (weekly)	
7.	Artifact Evaluation (weekly)	
8.	Film Printer Quality Control (if applicable) (weekly)	
9.	Visual Checklist (weekly)	

Medical Physicist's or MRI Scientist's Recommendations for Quality Improvement



Nuclear Medicine/SPECT Physics QA

- AAPM TG-177 Report: Acceptance Testing and Annual Physics Survey Recommendations for Gamma Camera, SPECT, and SPECT/CT Systems (2019)



ACR Nuclear Medicine/SPECT QA

- Energy resolution
- Count rate parameters
- Intrinsic/System image uniformity
- Intrinsic/System spatial resolution
- High contrast spatial resolution
- Low contrast detectability
- Image uniformity
- Artifact evaluation
- Display monitor
- Misc.

NM Equipment Evaluation Summary	
System: _____	Report Date: _____
Address: _____	System NMAP# - Unit #: _____
System Manufacturer: _____	Survey Date: _____
Physicist Signature: _____	Model: _____ Medical Physicist: _____
Equipment Evaluation Tests	
1 Intrinsic uniformity	Pass/Fail/NA
2 System Uniformity with all commonly used collimators	
3 Intrinsic or System Spatial Resolution	
4 System Sensitivity (count rate/unit activity)	
5 Relative Sensitivity	
6 Energy Resolution	
7 Count Rate Parameters	
8 Image Uniformity	
9 Monitor/Formatter Evaluation	
10 System Interlocks	
11 Monitor Evaluation	
12 Overall System Performance for SPECT Systems	
a. Uniformity	
b. Resolution	
Contrast	
13 System interlocks	
Evaluation of Technologist QC Program	
1 Daily Uniformity Check	Pass/Fail
2 Daily CT check (SPECT/CT systems)	
3 Weekly Bar Phantom	
4 Semi-annual (quarterly preferred) SPECT ACR phantom	Date
5 Uniformity Calibration	
6 Center-of-Rotation/Head Alignment (SPECT Systems)	
7 Dose Calibrator Tests	
a. Accuracy	
b. Linearity	
c. Constancy	
Medical Physicist's Recommendations for Quality Improvement and Comments on Testing Procedures	





Positron Emission Tomography Physics QA

- AAPM TG-126 Report: PET/CT Acceptance Testing and Quality Assurance (2019)



ACR Positron Emission Tomography QA

- Spatial resolution
- Phantom image quality
- Image uniformity
- Accuracy of CT#
- Monitor evaluation
- Sensitivity
- Count rate performance
- Image co-registration
- Accuracy standard uptake value (SUV)

PET Equipment Evaluation Summary

System: _____ Report Date: _____
 Address: _____
 System PETAP# - Unit #: _____ Survey Date: _____
 PET System Manufacturer: _____ Model: _____
 Medical Physicist: _____
 Signature: _____

Equipment Evaluation Tests

* Optional ** Not required for PET/MR systems


	Pass/Fail/NA
1. Spatial Resolution	
2. Count Rate Performance (count rate versus activity), including count loss correction *	
3. Sensitivity	
4. Image Uniformity	
5. Image Quality Phantom	
6. Accuracy of CT#	
7. Accuracy of standard uptake value (SUV) measurement	
8. Image Co-registration	
9. Monitor Evaluation	
10. Safety Evaluation	
Mechanical	
Electrical	

Evaluation of Site's Technologist QC Program

	Pass/ Fail
1. Daily PET Detector Check	
2. Daily CT Check	
3. Semi-annual (quarterly preferred) PET ACR Phantom	
4. Dose Calibrator Tests	
a. Accuracy	
b. Geometry	
c. Linearity	
d. Constancy	

Date	Pass/ Fail

Medical Physicist's Recommendations for Quality Improvement and Comments on Testing Procedures



Digital Mammography/Digital Breast Tomosynthesis (DBT)

- Mammography Quality Standard Act (MQSA)
- ACR Mammography Quality Control Manual (1999)
- 2018 ACR Digital Mammography Quality Control Manual, Rev. 2 (May 2020)



ACR Digital Mammography/DBT QA

- Phantom image quality
- DBT Z resolution
- Spatial Resolution
- DBT volume coverage
- Automatic exposure control system performance
- Average Glandular Dose
- Acquisition workstation monitor
- Radiologist workstation monitor

Medical Physicist's ACR DM QC Test Summary

Facility Name _____ MAP ID Unit# _____
 Address _____ Room ID _____
 _____ Report Date _____
 _____ Survey Date _____

X-Ray Unit Manufacturer _____ Model _____
 Control Panel Serial # _____ Manufacture Date _____ Installation Date _____

DM Unit Type: Digital radiography (DR) Computed radiography (CR) Digital Breast Tomosynthesis (DBT)
 Unit Use: Diagnostic and screening mammography Diagnostic only Screening only
 Survey Type: Mammography equipment evaluation (MEE) - Full MEE - Partial Annual survey
 Equipment Tested: DM unit AW monitor RW monitor Viewbox Printer Other: _____
 Oversight Level: Medical physicist on-site Medical physicist oversight

Quality Control Manual Used for Survey and Facility QC: _____ 2018 ACR Digital Mammography QC Manual (with 2D and DBT QC)

Medical Physicist _____ Signature _____

QC Test Results

Test	Pass/Fail**			
	2D**	2D Add-on DBT	DBT	CA
Medical Physicist Tests				
1. Mammography Equipment Evaluation - MQSA Req.				
2. ACR DM Phantom Image Quality				
3. DBT Z Resolution				
4. Spatial Resolution				
5. DBT Volume Coverage				
6. Automatic Exposure Control System Performance				
7. Average Glandular Dose				
8. Unit Checklist				
9. Computed Radiography (if applicable)				
10. Acquisition Workstation Monitor QC				
11. Radiologist Workstation Monitor QC				
12. Film Printer QC (if applicable)				
13. Evaluation of Site's Technologist QC Program				
14. Evaluation of Display Device Technologist QC Program				
15. Manufacturer Calibrations (if applicable)				
16. Confirmation Assessment				
MEE/Troubleshooting - Beam Quality (HVL) Assessment				
MEE/Troubleshooting - kVp Accuracy and Reproducibility				
Troubleshooting - Ghost Image Evaluation				
Troubleshooting - Viewbox Luminance				
Technologist QC Evaluation				
1. ACR DM Phantom Image Quality				
2. Computed Radiography Cassette Erasure (if applicable)				
3. Compression Thickness Indicator				
4. Visual Checklist				
5. Acquisition Workstation Monitor QC				
6. Radiologist Workstation Monitor QC				
7. Film Printer QC (if applicable)				
8. Viewbox Cleanliness (if applicable)				
9. Facility QC Review				
10. Compression Force				
11. Manufacturer Calibration (if applicable)				
Optional - Repeat Analysis				

Your Phantom Results - 2D
 Fiber (± 2.0) _____
 Speck grp (± 3.0) _____
 Mass (± 2.0) _____
 AGD (± 3.0 mGy) _____

Your Phantom Results - DBT
 Fiber (± 2.0) _____
 Speck grp (± 3.0) _____
 Mass (± 2.0) _____
 AGD (± 3.0 mGy) _____

** "Pass" means all components of test passed; "Fail" means any or all components fail; if "CA" checked, see Corrective Action Summary
 ** or DBT acquisition only



ACR Ultrasound Physics QA

- Image uniformity
- Geometric accuracy
- System sensitivity
- Contrast resolution
- Spatial resolution
- Artifact evaluation
- Display monitor
- Misc.

Ultrasound/Breast Ultrasound Equipment Annual Survey Summary

Facility Name:		
UAP/BUAP #:	Unit #:	Report Date:
Serial Number:		Survey Date:
System Manufacturer:		Model:
Medical Physicist (or designee):		
Signature:		

Equipment Evaluation Tests

Test	Pass/Fail	Comments
1. Physical and Mechanical Inspection		
2. Image Uniformity and Artifact Survey		
3. Geometric Accuracy (Optional)		
4. System Sensitivity		
5. Scanner Electronic Image Display Performance		
6. Primary Interpretation Display Performance (Optional)		
7. Contrast Resolution (Optional)		
8. Spatial Resolution (Optional)		

Were all clinically used transducers tested? YES NO

Overall comments:

You must submit either this summary form, a similar form containing the same date, or the entire, most recent Annual System Performance Evaluation report.



Imaging Modalities Requiring Display Monitor QA

- Digital Mammography/DBT (MQSA)
- Computed Tomography
- Magnetic Resonance Imaging
- Nuclear Medicine/SPECT/PET
- Ultrasound



Display Monitor QA

- AAPM TG-18 report: Assessment of Display Performance for Medical Imaging Systems (2005)
- ACR-AAPM-SIIM Technical Standard for Electronic Practice of Medical Imaging (2017)
- AAPM TG-270 report: Display Quality Assurance (2019)



Display Monitor QA

- Ambient lighting
- Display Luminance and Grayscale Display Function (GSDF)
- Display color
- Luminance uniformity
- Display noise
- Temporal performance
- Spatial resolution
- SMPTE , TG-18, TG-270 and test patterns



Imaging/Diagnostic QA Software

- Some QA procedures are labor extensive without QA software
- Performance trend analysis may not be possible without QA software
- Other workflow and efficiency limitations without QA software

