Routine Quality Assurance “Cookbook”

This “Cookbook” is a companion guide to the AIUM Routine Quality Assurance (QA) for Diagnostic Ultrasound Equipment document, which outlines the basic QA requirements for AIUM-accredited practices.

The Guide may be used as a brief step-by-step manual indicating when designated personnel should perform each procedure. Click on each step for additional information and illustrations.

**Designated Personnel**

1. Sonographer, Physician, or other Qualified Ultrasound System User
2. Housekeeping
3. Environmental, Health and Safety
4. Physicist, Engineer

**Guide**

Introduction .......................................................................................................................... 3

Section A: Cleanliness & Safety .......................................................................................... 4

Immediately: .......................................................................................................................... 4

  Clean any spill of bodily fluids or hazardous materials. 1,2,3 .................................................. 4

At the end of each exam: ........................................................................................................ 4

  Clean gel from transducers and ultrasound machine control panels. 1 .................................... 4

Daily: ...................................................................................................................................... 4

  Check transducer cables for damage. 1 ................................................................................. 4

  Check transducer for cracks, separations, and discolorations. 1 ............................................ 4

  Clean monitors and inspect for cracks. 1 ............................................................................... 4

  Check for any damage to power cords or PACS connections. 1 ........................................... 4

  Identify and report improper operation of switches or knobs on machine console. 1 ............. 4

  Identify and report any burned-out indicator lights. 1 .......................................................... 4

  Clean rooms for dust, dirt, and infection control. 2 .............................................................. 4

Weekly: .................................................................................................................................. 4

  Clean dust from machine console air filters. 1 ....................................................................... 4

  Check machine for dents and other damage. 1 ...................................................................... 4
Routine Quality Assurance “Cookbook”

Monthly:......................................................................................................................................................... 4

Thoroughly clean ultrasound machine console and other equipment in the exam room. 

Section B: Image Display & Performance ............................................................................................................ 5

Daily: .................................................................................................................................................................. 5

During routine scanning, visually assess images for vertical shadows and streaks caused by dead elements in the transducer. 

Annually: .......................................................................................................................................................... 5

Check brightness and contrast controls. 

Assess monitors, gray scale setup. 

Assess cables, housing, and transmitting surfaces of each transducer. 

Assess transducer uniformity for each transducer. 

Assess maximum depth of visualization for each transducer. 

Assess distance measurement accuracy for each transducer. 

Recommended but not mandatory: 

Evaluate target resolution for each transducer.
Introduction

What is the purpose of the AIUM Routine Quality Assurance Program?  
The purpose of a quality assurance (QA) program in medical ultrasound is to ensure that the equipment and clinical practices of a facility are safe, and that the information obtained from a clinical ultrasound procedure is as accurate as can be determined.

Who is this document intended for?  
The QA procedures outlined in this document address the QA requirements in the clinic as set forth by the American Institute of Ultrasound in Medicine (AIUM) Ultrasound Practice Accreditation Council. This document is intended to assist clinical ultrasound personnel who are setting up and maintaining an equipment QA program for their facilities. Sonographers, physicians, or other technical staff, including medical physicists and biomedical engineers, can carry out these procedures easily. (See “Designated Personnel,” p. 3.)

The AIUM recommends that clinical facilities appoint an individual to be responsible for the program. A sonographer, physician, or other qualified staff member may be designated to organize and run the program. If a medical physicist or biomedical engineer is available, this individual could organize and maintain the program, preferably in partnership with a designated QA sonographer.

What is the Equipment Manufacturer’s Role?  
The ultrasound equipment manufacturer provides valuable resources for QA. Most provide a list of recommended QA procedures in the operator’s manual for each machine. This list should be consulted when designing a clinical QA program. The operator’s manual provided by the manufacturer usually contains valuable information on equipment operation, and safety and cleaning methods, including recommendations for disinfecting ultrasound probes.

Some ultrasound systems can be tested online, for example, through Internet or telephone connections to the manufacturer’s facility, and this type of testing can be a valuable part of a routine QA program.

What types of equipment and operating modes are covered?  
QA procedures listed in this manual are for ultrasound machines operating in a gray scale imaging mode. However, because recommended tests emphasize the performance and integrity of the transducer, the test results apply to a limited degree to Doppler and color flow performance as well for machines that operate in these modes.

The AIUM Routine Quality Assurance Program Requirements address two practice components:

- **Section A: Cleanliness and Safety** lists routine checks and procedures carried out on a regular basis by the sonographer to ensure cleanliness and safety of scanning equipment.
- **Section B: Image Display and Performance** includes basic practical procedures to identify some malfunctions and to make sure the equipment operates consistently at its expected level of performance.

- When equipment physical or operational irregularities are observed, notify the individual responsible for your QA program for follow-up according to program protocols.
**Designated Personnel**

1. Sonographer, Physician, or other Qualified Ultrasound System User
2. Housekeeping
3. Environmental, Health and Safety
4. Physicist, Engineer

## Section A: Cleanliness & Safety

<table>
<thead>
<tr>
<th><strong>Immediately:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean any spill of bodily fluids or hazardous materials.</td>
<td>1,2,3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>At the end of each exam:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean gel from transducers and ultrasound machine control panels.</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Daily:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Check transducer cables for damage.</td>
<td>1</td>
</tr>
<tr>
<td>Check transducer for cracks, separations, and discolorations.</td>
<td>1</td>
</tr>
<tr>
<td>Clean monitors and inspect for cracks.</td>
<td>1</td>
</tr>
<tr>
<td>Check for any damage to power cords or PACS connections.</td>
<td>1</td>
</tr>
<tr>
<td>Identify and report improper operation of switches or knobs on machine console.</td>
<td>1</td>
</tr>
<tr>
<td>Identify and report any burned-out indicator lights.</td>
<td>1</td>
</tr>
<tr>
<td>Clean rooms for dust, dirt, and infection control.</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Weekly:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean dust from machine console air filters.</td>
<td>1</td>
</tr>
<tr>
<td>Check machine for dents and other damage.</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Monthly:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoroughly clean ultrasound machine console and other equipment in the exam room.</td>
<td>1</td>
</tr>
</tbody>
</table>
## Section B: Image Display & Performance

### Daily:

During routine scanning, visually assess images for vertical shadows and streaks caused by dead elements in the transducer.  

### Annually:

Check brightness and contrast controls.  

1. Confirm machine monitor settings are at calibration points used for setting up hard copy and/or workstations.

Assess monitors, gray scale setup.  

*Materials: Stored gray bar or Society of Motion Picture & Television Engineers (SMPTE) pattern in the ultrasound scanner.*

### Evaluate:

1. Display the gray bar pattern stored in the ultrasound machine. If no gray bar pattern is found, use the gray bar display on B-mode images.
2. Verify that all gray transitions are visible on the system monitor.
3. Send this image to the PACS network; verify that these same gray level transitions are viewed on the PACS monitor(s).
Assess cables, housing, and transmitting surfaces of each transducer.\(^1,\!^4\)
1. Confirm there are no cracks, separations, or discolorations.

Assess transducer uniformity for each transducer.\(^1,\!^4\)

Materials: Phantom

Adjust system settings:
1. Disable spatial compound imaging (cross beam; sonoCT; Sie Clear; etc)
   \textit{Note: See system users’ manual for instructions on disabling.}
2. Apply a shallow depth setting to provide good spatial detail up close to the transducer.
3. Use a single transmit focal depth.
4. Adjust sensitivity (output; gain; dynamic range) to produce an image having uniform gray level.
5. Use maximum persistence (frame averaging) settings.

Evaluate:
1. Scan a uniform region of the phantom. Be sure the transducer is fully coupled with no gaps, etc.
2. Look for shadows emanating from the transducer surface.

Rate the transducer 1 - 4 (see Rating Criteria, below).
\(\Rightarrow\) \textit{Transducers rated “1” or “2”:} Still operational
\(\Rightarrow\) \textit{Transducers rated “3”:} Place on a “Replace when possible” list, and use with caution.
\(\Rightarrow\) \textit{Transducers rated “4”:} Immediately remove from service.
RATING CRITERIA

1. No nonuniformities

2. 1-2 minor nonuniformities
3. 3 minor nonuniformities OR 1 major flaw

4. More than 3 minor nonuniformities OR 2 or more major flaws
Assess maximum depth of visualization for each transducer.\textsuperscript{1,4}

\textit{Materials:} Phantom containing material that has acoustic properties mimicking soft tissue.

\textit{Adjust system settings:}
1. Increase the power output to 100\% (maximum output).
2. For multi-frequency transducers, use a mid-frequency setting; eg, for a transducer that provides imaging at 2.5, 4.5, and 5 MHz, choose 3.5 MHz.
   \textbf{⇒} IMPORTANT: Use the same frequency for subsequent testing.
3. Place the transmit focus (or multiple focal zones) as deeply as possible to maximize visualization of image texture (resulting from the microscopic scatterers in the phantom).
4. Increase the system gain to the level where electronic noise is just barely perceptible.

\textit{Evaluate:}
5. Scan a region of the phantom, and freeze an image.
6. Use the electronic calipers to estimate the maximum distance over which you can visualize the background texture pattern.
   \textbf{⇒} Call this measurement the maximum depth of penetration.
   \textbf{⇒} Use this number to compare performance from one QA session to the next.

\textit{Set up to estimate the maximum depth of penetration for a curvilinear array transducer. The value is 14.68 cm. Caliper positions are used to estimate the maximum depth of penetration.}

\textit{Set up for a linear array transducer. The value is 4.55 cm.}
Assess distance measurement accuracy for each transducer: 1,4

Materials: Phantom containing material that has acoustic properties mimicking soft tissue.

Evaluate:
1. Scan a phantom, viewing a column of targets with the transducer positioned to image the column of targets near the center of the displayed field.
2. Place digital calipers to measure “leading edge” to leading edge distance between 2 targets.
3. Compare measured distance with known separation.
4. Repeat for horizontal measurement accuracy, imaging targets with known horizontal spacing.
5. Place digital calipers to measure from the center to the center of 2 of these targets.
6. Compare measured distance with known separation.

Vertical distance measurement checks. The known distance between targets is 2 cm, and the readout agrees very well with this expected distance.

Horizontal distance measurement accuracy checks. The known distance is 3 cm, and the readout is well within acceptable limits.
## Recommended but not mandatory:

<table>
<thead>
<tr>
<th>Evaluate target resolution for each transducer.(^{1,4})</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Materials:</em> Phantom choice is at the discretion of the facility.</td>
</tr>
</tbody>
</table>

**Evaluate:**  
Scan a phantom containing focal targets, such as simulated cysts or low-contrast objects.  
Evaluate target resolution.