Implementation of the ACR DMQC Manual in a Large-Scale Enterprise

July 14, 2020
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Cleveland Clinic
Disclosures

• Member of the ACR Subcommittee on Breast X-ray Imaging Physics
• ACR Mammography Phantom Reviewer
Aims

• Share our experience
  - Our motivation for transitioning to the ACR Digital Mammography QC (DMQC) Manual
  - The steps that were involved in implementing a new QC program for a large and interconnected enterprise
  - “Lessons learned”
Resources

https://www.acraccreditation.org/resources/digital-mammography-qc-manual-resources

QUALITY CONTROL MANUAL
Revised 2nd Edition — May 2020

• QC Manual – UPDATED MAY 2020!!
• FAQ
• Physicist and Technologist Webinars
A multi-geographic enterprise

- 41 sites offering mammography services
  - 2 states (OH, FL)
A multi-geographic enterprise

- 41 sites
  - 23 Screening-only
  - 18 Scr+Diagnostic

- 42 Radiologist Workstations
  - Located at DIAGNOSTIC sites
71 FFDM Units

- DBT: 79%
- 2D Only: 21%

- Siemens: 86%
- Hologic: 13%
- GE: 1%
Management Trends

Subset of sites (~73%) fall under centralized management

~14k exams / month
(screening + diagnostic)
- Breast Imaging Radiologists rotate between diagnostic sites

- Screening exam acquired at a Breast Imaging facility can be read from ANY diagnostic site
Management Trends

• Single LIP is responsible for the programs at a large number of sites
  - 2 QC Supervisors responsible for preparing for and attending all MQSA inspections
    • Conduct quarterly QC reviews on behalf of LIP

• Some technologists travel between sites, must be familiar with the equipment and QC programs at each of those sites
Management Trends

• Highly integrated system
• QC program managed by a small group of people
• Need tools that:
  - Facilitate remote oversight
  - Automate standardized workflows
  - Streamline routine clerical activities
One QC manual to unite them all...

Standardization of mammography QC across all vendors and models
- ACR manuals are updated infrequently (unlike vendor QC manuals)
ModalityQC v.3 built off preexisting platform used for tracking inventory and physics surveys.
Our Motivation

• QC logs can be transitioned off of SharePoint and into ModalityQC (electronic QC software)
  - Real-time notification of failures
  - Tracking of service tickets
  - Automatic report generation for:
    • ACR
    • MQSA Inspections
    • Quarterly QC reviews for MQSA EQUIP (eventually…)

All-or-nothing

- Highly integrated system
  - Breast Imaging sites
    - Transitioning a single mammography unit necessitated transitioning all workstations
  - Benefit achieved by transitioning ALL sites
    - Large scope, high cost
      - Transition needed to be carefully considered and planned out
Transition Timeline

2019 Q2
- Cost-benefit analysis presented to administration
- Obtained approval to transition enterprise in 2020
Costs and Considerations

• Transitioning does not necessarily make sense for everyone

• Costs need to be detailed to administration:
  - Phantoms
  - Technologist Training
  - Software and/or Development (tools, templates, etc.)
Costs and Considerations

• Vendor will not necessarily provide QC training specific to the ACR QC Manual for new sites or installs
  - Who will conduct this training?
Costs and Considerations

First unit transitioned starts the ticking clock for all peripheral equipment:

- All workstations that read for than unit must be transitioned before the next regularly scheduled annual survey for that mammography unit

Gains/Impact

• **Time Savings**
  - Technologist
    • Streamlined routine QC
    • Dashboards and failure tracking
  - Lead Interpreting Physician
    • Electronic sign-off for quarterly reviews
  - Physicist
    • Minimal template management

Not about doing “less” ... About making it *easier* to do the *right thing better*
Tips

• Include your LIP and Mammography supervisors/administrators in conducting the cost-benefit analysis
  - Ensure you don’t miss anything
  - Knowing what the effort will involve (especially TIME) helps set expectations
2019 Q2
- Cost-benefit analysis presented to administration
- Obtained approval to transition enterprise in 2020

2019 Q3
- Develop beta version of ModalityQC v.3:
  - Online QC logs
  - Automatic reports
  - Physics testing template
Meeting with QC Supervisors

• Sat down with QC Supervisors before building out Modality QC v.3
  - Ultimately, this tool was for them and their techs
  - Opportunity for them to outline:
    • Wish-List
    • Biggest pain points
      • Keeping track of service tickets
      • Monitor QC
Objectives

• Ensure forms can be updated quickly, as necessary
• Make electronic QC logs simple to use and hard to screw up
• Make it easier to manage remote sites and know what’s going on:
  - How many units down?
  - How many service calls open?
QC Log Design

• Dynamic smart-form designer
  - Can be used to build and design forms for any modality
Option to deactivate form or fields that are not applicable

Customization at the item-level:
- Presets
- Tolerance criteria
- Headers/footers

### Mammo Weekly Phantom Image Quality (2D)

<table>
<thead>
<tr>
<th>Technique (2D)</th>
<th>Active</th>
<th>Preset Value</th>
<th>Min</th>
<th>Max</th>
<th>Baseline (center)</th>
<th>Max Change (data)</th>
<th>Update Baseline on PASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Filter</td>
<td>✔</td>
<td>1 Preset: []</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>kVp</td>
<td>✔</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mAs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Phantom Score (2D)

<table>
<thead>
<tr>
<th>Artifacts</th>
<th>Active</th>
<th>Pass/Fail - no pre-set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber Score</td>
<td>✔</td>
<td>2</td>
</tr>
<tr>
<td>Speck Group Score</td>
<td>✔</td>
<td>3</td>
</tr>
<tr>
<td>Mass Score</td>
<td>✔</td>
<td>2</td>
</tr>
</tbody>
</table>

**Form Header Note**

Procedure = MAM SCREENING W TOMO
(Perform exam in COMBO mode, score 2D image and)

**Form Footer Note**

Days To Complete QC Before Late Alert: 7

[Save]
Consolidated instructions for the technologist

Procedure = MAM SCREENING W TOMO
(Perform exam in COMBO mode, score 2D image and tomo slices in their respective logs)

View = RCC
Technique = OPDOSE (Prime ON for 2D, AEC Segmentation ON)
Paddle = 24x30 low-edge
Compression Force = 50 N
Contains the information of the “ACR Technique and Procedures Summary”
Technique (2D)

Target Filter: W/Rh

kVp: 28

mAs: 

Phantom Score (2D)

Artifacts: Pass, Fail

Fiber Score: - select -

min passing: 2

Speck Group Score: - select -

min passing: 3

Mass Score: - select -

min passing: 2

Scoring Diagram:

<table>
<thead>
<tr>
<th>Scoring</th>
<th>Full Point</th>
<th>Half Point</th>
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</thead>
<tbody>
<tr>
<td>Fibers</td>
<td>≥ 8 mm long</td>
<td>≥ 5 and &lt; 8 mm long</td>
</tr>
<tr>
<td>Specks</td>
<td>4 - 6 specks</td>
<td>2 - 3 specks</td>
</tr>
<tr>
<td>Masses</td>
<td>≥ ¾ border</td>
<td>≥ ½ &amp; ≤ ¾ border</td>
</tr>
</tbody>
</table>

Failures in phantom image quality MUST be corrected BEFORE clinical use.
Artifacts: Pass | Fail

Fiber Score: 0.5
min passing: 2

Speck Group Score: 3.0
min passing: 3

Mass Score: 1.0
min passing: 2

Alert: Failure detected!
Please select Action Taken (or correct data entry)

Summary of Failed Checks:
1. [Artifacts @ Fail]=[Fail]
2. [Fiber Score @ 0.5] under (2)
3. [Mass Score @ 1.0] under (2)

Action Taken Regarding Failed Checks:
- select -

Alert:
Comments are required when Quality Control checks fail or are outside the acceptable limits.

- select -
## Tracking Service

<table>
<thead>
<tr>
<th>Log Date</th>
<th>Unit Status</th>
<th>QC Result</th>
<th>Logged By</th>
<th>Logged Date</th>
<th>Comments</th>
<th>Fail Action</th>
<th>Site Review</th>
<th>MP Review</th>
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</thead>
<tbody>
<tr>
<td>2020-04-15</td>
<td>Active</td>
<td>Fail (Critical Item)</td>
<td>Hulme, Katie</td>
<td>2020-04-15 09:42</td>
<td>I called them&gt;&gt;&lt;Artifacts @ Fail&gt;=[Fail]; &gt;&gt;[Fiber Score @ 1.0] under (2);</td>
<td>Service Ordered</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Service Ordered**

- Service Work Order: [Enter Work Order]

- [Cancel] [Track Service]
# Tracking Service

## Modality-QC > MAMM > CCAC

### [2144] KTEST - Siemens Mammomat Inspiration (2D+DBT) @ AC2-1-145D

<table>
<thead>
<tr>
<th>QC Status</th>
<th>QC Check</th>
<th>Last QC</th>
<th>Last QC Result</th>
<th>Last Site Review</th>
<th>Last MP Review</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mammography Weekly Phantom Image Quality (2D)</td>
<td>2020/04/15</td>
<td>Fail (Critical Item)</td>
<td>2020/03/10</td>
<td>Review</td>
</tr>
<tr>
<td></td>
<td>Mammography Weekly Phantom Image Quality (DBT)</td>
<td>2020/02/10</td>
<td>Pass</td>
<td>2020/03/10</td>
<td>[never]</td>
</tr>
</tbody>
</table>

- **QC Team**
- **Export QC Data**
- **ACR Checklist**
- **Service Ordered**
- **NEW QC TEST**
# Tracking Service

**Modality-QC > Mammography > Lorain FHSC**

**[2595] RD1 - Siemens Mammomat Inspiration Prime (2D+DBT) @ LR2-141**

<table>
<thead>
<tr>
<th>Survey Date</th>
<th>Due Date</th>
<th>Survey Type</th>
<th>Done By</th>
<th>Survey Status</th>
<th>Result</th>
<th>Fail #</th>
<th>Pend.CA</th>
<th>Reviewer</th>
<th>Report</th>
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<tr>
<td>2021-01-24</td>
<td>2021-02-24</td>
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<td>Projected</td>
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<td>0</td>
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<tr>
<td>2020-04-29</td>
<td>2020-05-30</td>
<td>Service</td>
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<td>Completed</td>
<td>F-P3</td>
<td>1</td>
<td>0</td>
<td>Non-CCF/Service Engineer,</td>
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<td></td>
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<tr>
<td>2020-04-09</td>
<td>2020-05-22</td>
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<tr>
<td>2020-01-24</td>
<td>2020-03-10</td>
<td>Annual</td>
<td></td>
<td>Completed</td>
<td>P</td>
<td>0</td>
<td>0</td>
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<tr>
<td>2019-01-22</td>
<td>2019-01-22</td>
<td>Post-Repair (Approval Only)</td>
<td></td>
<td>Completed</td>
<td>P</td>
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<td>0</td>
<td>Hulme, Katie</td>
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<tr>
<td>2019-01-10</td>
<td>2019-11-27</td>
<td>Annual + Post-Repair</td>
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<td>Completed</td>
<td>P</td>
<td>0</td>
<td>0</td>
<td>Hulme, Katie</td>
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<tr>
<td>2018-09-27</td>
<td>2018-09-28</td>
<td>Acceptance</td>
<td></td>
<td>Completed</td>
<td>P</td>
<td>0</td>
<td>0</td>
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Survey Info

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<tbody>
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<td>Survey Date</td>
<td>04/29/2020</td>
</tr>
<tr>
<td>Status</td>
<td>Completed</td>
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<tr>
<td>Type</td>
<td>Service</td>
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<tr>
<td>Repair Type</td>
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<tr>
<td>Site</td>
<td>Lorain Family Health and Surgery Center</td>
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<td>Equipment Type</td>
<td>Mammography (2D+DBT)</td>
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<tr>
<td>Manufacturer</td>
<td>Siemens</td>
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<tr>
<td>Model</td>
<td>Mammomat Inspiration Prime (2D+DBT)</td>
</tr>
<tr>
<td>Bldg Code</td>
<td>LR2-141</td>
</tr>
<tr>
<td>SN</td>
<td>11011</td>
</tr>
<tr>
<td>CE #</td>
<td>226705</td>
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<td>Siemens</td>
<td>400-608449</td>
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Survey Report and Failures

<table>
<thead>
<tr>
<th>Survey Result</th>
<th>Fail - P3 (Non Urgent Scheduled Service)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Date</td>
<td>04/29/2020</td>
</tr>
<tr>
<td>Comments</td>
<td>Power Outage Unit will not come back up Service Ordered &gt;&gt; WO#3608415</td>
</tr>
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</table>

Survey Report:

- View Report

Survey Report:

<table>
<thead>
<tr>
<th>Failure Type</th>
<th>WO #</th>
<th>CA Documentation</th>
<th>Updated</th>
<th>Updated By</th>
<th>CA Done</th>
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<tr>
<td>Equipment Issue</td>
<td>Power Outage Unit will not come back up Service Ordered &gt;&gt; WO#3608415</td>
<td>3608415</td>
<td>Service Approval</td>
<td>4/30/2020 10:36:16 AM</td>
<td>WEBERR1</td>
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### Survey Info

<table>
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<tr>
<th>Survey Date:</th>
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<tbody>
<tr>
<td>Status:</td>
<td>Completed</td>
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<tr>
<td>Type:</td>
<td>Service</td>
</tr>
<tr>
<td>Repair Type:</td>
<td>Other</td>
</tr>
<tr>
<td>Additional Staff:</td>
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</table>

### Survey Report and Failures

<table>
<thead>
<tr>
<th>Survey Result:</th>
<th>Fail - P3 (Non Urgent Scheduled Service)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comments:</td>
<td>Power Outage Unit will not come back up Service Ordered &gt;&gt; WO# [3608415]</td>
</tr>
</tbody>
</table>

### Equipment Issue

<table>
<thead>
<tr>
<th>Failure Type</th>
<th>WO #</th>
<th>CA D</th>
</tr>
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<tbody>
<tr>
<td>Power Outage Unit will not come back up Service Ordered</td>
<td>3608415</td>
<td></td>
</tr>
</tbody>
</table>

### Corrective Action Log

**Facility**

**MAP ID:**

**ON or Equipment ID:**

**Date:**

**QC Test Name and # (if applicable):**

**Description:**

**Relevant Personnel Notified:**

**Personnel Name:**

**Date/Time of Call/Notification:**

**Describe Actions Taken:**

**Confirmation of Resolution:**

**Event resolved?**

**To Be Monitored**

**NA**

**Tech Signature**

**Date**
# Dashboards

## Modality-QC > Mammography > Dashboard

### Failures
- 0 Failures
- 0 Past Failures Pending Service Closure
- 0 QC Checks Due

## QC Completion Map

<table>
<thead>
<tr>
<th>QC Map</th>
<th>Lutheran LUHO-D5002 [352]</th>
<th>Lutheran LUHO-D1 [408]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly Review Workstation Monitor QC (Dual Display)</td>
<td><img src="image" alt="Completion Status" /></td>
<td><img src="image" alt="Completion Status" /></td>
</tr>
<tr>
<td>Mammo Weekly Phantom Image Quality (2D)</td>
<td><img src="image" alt="Completion Status" /></td>
<td><img src="image" alt="Completion Status" /></td>
</tr>
<tr>
<td>Mammo Weekly Phantom Image Quality (DBT)</td>
<td><img src="image" alt="Completion Status" /></td>
<td><img src="image" alt="Completion Status" /></td>
</tr>
<tr>
<td>Mammo Monthly Visual Checklist</td>
<td><img src="image" alt="Completion Status" /></td>
<td><img src="image" alt="Completion Status" /></td>
</tr>
<tr>
<td>Compression Thickness Indicator</td>
<td><img src="image" alt="Completion Status" /></td>
<td><img src="image" alt="Completion Status" /></td>
</tr>
<tr>
<td>Acquisition Workstation Monitor QC (Single Display)</td>
<td><img src="image" alt="Completion Status" /></td>
<td><img src="image" alt="Completion Status" /></td>
</tr>
<tr>
<td>Siemens Detector Flat-Field Calibration (Contact)</td>
<td><img src="image" alt="Completion Status" /></td>
<td><img src="image" alt="Completion Status" /></td>
</tr>
<tr>
<td>Siemens Detector Flat-Field Calibration (Mag)</td>
<td><img src="image" alt="Completion Status" /></td>
<td><img src="image" alt="Completion Status" /></td>
</tr>
<tr>
<td>Siemens Detector Flat-Field Calibration (Tomo)</td>
<td><img src="image" alt="Completion Status" /></td>
<td><img src="image" alt="Completion Status" /></td>
</tr>
<tr>
<td>Compression Force</td>
<td><img src="image" alt="Completion Status" /></td>
<td><img src="image" alt="Completion Status" /></td>
</tr>
</tbody>
</table>
Physics Template

• Changes made to ACR template to adapt it for internal use:
  - Imported inventory from SQL database to auto-populate “Facility, Unit and Test Equipment” page
  - Created look-up tables with the settings to use for each test based on Make/Model
Items of Clarification

• AEC settings for Phantom Image Quality (AEC Segmentation ON or OFF)?

Q. When performing the Phantom Image Quality test, what settings should be used to acquire the phantom image?

A. Some manufacturers have historically included in their QC manual phantom image quality test procedure a step to fix the AEC “sensor” position, or to fix automatic segmentation features, or fix kVp settings, in order to ensure the phantom image quality acquisitions are consistently performed. With ACR’s QC manual and the new, larger phantom, this accommodation is unnecessary. For facilities using the ACR manual, the phantom image quality test must be performed using the same image acquisition settings that are used in routine patient screening mammography exams.

2019 Q3
- Develop beta version of ModalityQC v.3:
  - Online QC logs
  - Automatic reports
  - Physics testing template

2019 Q4
- Beta test ModalityQC v.3 at MC
- Beta test Medical Physics annual testing on select units
- Annual Mammography QC Meeting

2019 Q2
- Cost-benefit analysis presented to administration
- Obtained approval to transition enterprise in 2020
Modality QC - Beta Testing

- 2 units + 2 workstation + 2 techs
  - Trained technologists on ACR QC and electronic QC logs
    - Conducted ACR QC in conjunction with manufacturer QC for 1 month
  - Purpose
    - Identify bugs in the software
    - Opportunity to develop training materials early and obtain technologist feedback
Annual Mammography QC Meeting

• Early December
• Attendees:
  - Lead QC techs and administrators from all CCF facilities
  - Physicists that perform mammography surveys
Annual Mammography QC Meeting

• Objectives:
  - Review programmatic changes for the new year, including:
    • ACR QC Manual Transition
      • Motivations
      • Roll-out schedule
      • Where and when to order the phantom
Annual Mammography QC Meeting

• Conducted hands-on ACR QC Training session for Phase 1 sites immediately following annual meeting
  - Dropped this for Phase 2 sites, on-site training the day of was found to be sufficient
2019 Q2
- Cost-benefit analysis presented to administration
- Obtained approval to transition enterprise in 2020

2019 Q3
- Develop beta version of ModalityQC v.3:
  - Online QC logs
  - Automatic reports
  - Physics testing template

2019 Q4
- Beta test ModalityQC v.3 at MC
- Beta test Medical Physics annual testing on select units
- Annual Mammography QC Meeting

2020 Q1
- Phase 1 of roll-out begins
Current Status

As of this presentation, have transitioned:
- 15/41 sites
- 24/71 units

~35%
Transitioning a Site

• Sites cannot transition to the ACR QC Manual until the physicist has conducted an annual survey of the digital mammography unit using the ACR DM QC manual and phantom (transition survey)
Single-Unit Sites

- Physics Testing - AM
- Technologist QC Training (1 hour) - PM
  - Conducted on-site immediately following physics testing
  - Perform and log all weekly, monthly, semi-annual QC
- Siemens: only tests NOT performed were the quarterly detector calibrations, date of last calibration was logged and recorded
Hands-On Training

- Q1 - All hands-on QC training conducted on-site by Medical Physics
- Q2 - QC Supervisors trained and hands-on QC training split between Medical Physics and QC Supervisors
Lessons Learned:

• Execution stage easier than the planning stage 😊

• None of the sites that have transitioned have had an MQSA inspection yet…
  - Physicist will attend the first few inspections as there will surely be some bumps!
Lessons Learned:

- Anticipate possible issues with ROI measurements for DBT and have a plan in place
  - Export your DICOM images or have the facility burn you a CD
  - Possible DICOM readers w/ ROI statistics:
    - Osirix
    - K-PACS
Lessons Learned

• Remind them to buy their phantom!
  - Divided sites up by quarter, sent reminder email the 2nd month of the preceding quarter

• Emphasize the purpose behind what is happening
  - If it is not in their best interest, you shouldn’t be doing it!

• Your confidence helps their confidence
Acknowledgements

• Vadim Kartuzov (our computer whiz)
• Grant Fong, MS
• Shelly Weber, RT
• Pat Murphy, RT
Cleveland Clinic

Every life deserves world class care.