Introduction

- Non diagnostic and suboptimal breast MRI studies waste time and money, and can cause both radiologist and patient dissatisfaction.
- Any study which could not be read was considered defective.
- Over a period of 2 months, 66 studies were performed.
- 17% of studies (11 studies) were defective and could not be read.
- Of these, 6% (4 studies) were so severe, that a repeat study was necessary (patient callback).
- Using LEAN principles, we developed a quality assurance program to decrease this defect rate.
Key Stakeholders investigated defects

- Key Stakeholders
  - MRI operational manager RT(R)(MR)(M)
  - Breast MRI section head MD, MS
- Stakeholders
  - All Radiologists who read Breast MRI's
- Pareto Chart tallied frequency of each defect

Pareto Chart to Identify Defects

Most common defect: 3D processing
Many defects were one-time only
Fishbone Diagram

- Used in Root Cause Analysis.
- Identified all contributing causes to problem.
- Characterized defects by common themes or responsibilities.

Breast MRI Study Defects which cause Failure

Documentation
- No LMP
- No chart note
- No reason for order
- No current sx (lump/pain)

Equipment
- Wrong magnet
- Wrong RF coil
- No marker on lump/pain
- RF coil/positioning

Artifacts
- Fold-over suppression
- Motion artifact
- Poor fat sat
- RF coil/positioning

3D Post Processing
- Study not sent/processed 3D
- Prior not sent/processed 3D
- Angio map not sent to PACS
- Snapshots not sent to PACS

At the Scanner/QC
- No Orthogonal reconstruction
- No MIPS

Defective Breast MRI Study

Most causes of defects were Technologists’ responsibility
Proposed Technologist Re-education

- As most of the identified causes of defects were the technologists' responsibility, technologist re-education was proposed.

- The MRI Accreditation Requirements for Technologists by the ACR was used as a reference.

ACR requires tech to perform 50 Breast MRI studies /2 yrs
Technologist Selection and Certification

- The breast MRI volume at our main facility maximally supported 15 technologists.
- 15 technologists were selected by the stakeholders to undergo the certification process (3 techs were dropped based on volume).
- The certification process included:
  - Key stakeholders created a checklist (of output variables) which defined a quality study.
  - Key stakeholders reviewed 5 random studies performed by each tech against checklist.
  - At least 1 of the 5 studies must be from each of the 2 different magnet vendors.
- If all 5 studies passed the entire checklist, the technologist was certified.
- If any study had a defect in any output variable, the technologist was on probation and had to complete an additional 5 studies defect-free under the supervision of a “Super-tech”
“Super-Techs”

- 4-5 certified technologists who showed interest and demonstrated skill as subjectively assessed by the key stakeholders were designated as Super-techs.
- At least one Super-tech was present on each shift.
- Super-tech responsibilities:
  - Supervised any technologist on probation on their shift.
  - Were available to answer any questions from certified technologists.

Elimination of Waste

- A Value Stream Map was created to identify opportunities to decrease wasted effort.
- The LEAN term for waste is “Muda”.
- All stakeholders (all reading radiologists) agreed to the Muda classification of any activity prior to its elimination.
**Breast MRI QI Value Stream Mapping**

<table>
<thead>
<tr>
<th>Patient</th>
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<tbody>
<tr>
<td>Order</td>
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<tr>
<td>RIS control sheet</td>
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<tr>
<td>Symptom summary sheet</td>
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<tr>
<td>Progress note (tech)</td>
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<tr>
<td>Labs</td>
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<tr>
<td>MRI screening form</td>
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<tr>
<td>MD Chart note</td>
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<tr>
<td>Report of prior mammograms</td>
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<table>
<thead>
<tr>
<th>Imaging</th>
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<tbody>
<tr>
<td>Axial T1 TSE</td>
</tr>
<tr>
<td>Axial STIR</td>
</tr>
<tr>
<td>Sagittal T1</td>
</tr>
<tr>
<td>3D GRE pre-contrast</td>
</tr>
<tr>
<td>3D GRE post-contrast x5</td>
</tr>
<tr>
<td>Subtraction images</td>
</tr>
<tr>
<td>Sagittal reformat</td>
</tr>
<tr>
<td>Localizer</td>
</tr>
<tr>
<td>Axial T2 TSE</td>
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<table>
<thead>
<tr>
<th>3D Processing</th>
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<tbody>
<tr>
<td>Registration</td>
</tr>
<tr>
<td>Angiogenesis maps</td>
</tr>
<tr>
<td>MIPS</td>
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<tr>
<td>Breast Detection mask</td>
</tr>
</tbody>
</table>

Grey boxes were opportunities to decrease Muda

- **VA** (Value-Added)
- **BNVA** (Business Non-Value-Added)
- **NVA** (Non-Value-Added)

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**Muda**

- **Documentation.** With our new EHR, some information was newly readily available. Scanning a document with the same information was redundant.
  - MD Chart note
  - Prior mammogram report

- **MRI Pulse sequence.** Minimizing number of pulse sequences reduced scan time, thereby decreasing risk of patient motion.
  - T2 TSE was eliminated after optimizing STIR and T1 TSE
Post Technologist Certification Breast MRI

- All stakeholders (reading radiologists) were active participants.
- They flagged a study with a defect as either “Hold-do not read” or “Read-with subsequent quality review”.
- The Operational Manager was responsible for resolving any “Hold” issue within 2 hours (e.g. obtaining necessary documents, processing study on 3D software, implementing patient call-back procedure).
- The Operational Manager performed the “quality review” of the other flagged studies on a regular basis.

Technologist Breast MRI Checklist

- A checklist was created by the key stakeholders for the technologists to keep by and use at the MRI console (Figure 2)
Technologist Breast MRI Checklist

- Mark area of lump or pain
- If patient is barrel chested or large breasted: switch to sentinelle table
- Breast MRI form must be completed by patient (need LMP)
- Check GFR/labs
- Follow appropriate Breast MRI protocol per ECMS guidelines
- Confirm positioning: Axillary tail, inframammary fold, breast not touching bottom
- Confirm phase encoding is Right to Left on axial images and Superior to Inferior on sagittal images
- Confirm good quality “fat sat” (do not inject if the fat sat is poor) and no artifacts
- Do subtractions
- On Philips scanner, do sagittal reformat on phase 1 post contrast scan.
- Send images to PACS, and then to CAD stream all at once
- Verify images are on PACS (sort the dynamic scan!)
- Verify Cad processed exam properly (GE has axial and coronal reformats, Philips needs sagittal and coronal reformats)
- Load prior studies to CAD
- Confirm all clinical documents are scanned, progress report, outside study reports and images are loaded to PACs.

Results

5 months after initiation of the technologist (re)training we measured the number of studies with defects (could not be read):

<table>
<thead>
<tr>
<th></th>
<th>Pre-intervention</th>
<th>Post-intervention</th>
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<tbody>
<tr>
<td>Total # studies</td>
<td>66</td>
<td>42</td>
</tr>
<tr>
<td># studies w/defect</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td># studies w/severe defect</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>
Results

- Percentage of quality issues and rate of patient callback was calculated over a 2 month period after intervention (January-February 2015).
- A total of 42 studies were performed.
- Overall defect rate decreased from 17% to 2.4%. Using the Chi-square contingency table, the p value was calculated to be less than 0.02 (p<0.02) which is statistically significant.
- Severe defect rate (patient must be re-imaged) decreased from 6.1% to 0%. Due to the small number of severe defects, it is difficult to assess the statistical significance.

Summary

- Identified key stakeholders (and all stakeholders)
- Identified and tallied defects (Pareto Chart)
- Categorized the defects (Fishbone Diagram)
- Identified who is responsible for the defects (technologists)
- Created technologist re-education and certification program
  - Identified maximal number of techs that could be supported by MRI volume
  - Created a checklist that defined a quality study
  - Certified techs based on checklist review of their studies on both magnets
  - Identified Super-techs
- Identified and eliminated waste (Value Stream Map identified Muda)
- Measured defect rate after intervention, decreased from 17% to 2%
- Future plans: Repeat every 1-2 years
References