Initial clinical experience: Reasons for rejects and remedial actions

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July 2019

Reject analysis in radiography

- Each radiograph that is not sent to the radiologists' workstation for review, constitutes unnecessary dose to the patient
- In the current digital environment, the radiologist does not know how many images were actually acquired, in addition to what he/she sees on PACS
- Unless reject analysis is performed in a rigorous manner, there is no way of knowing what an institution/a department/a clinical section's reject rate is

Clinical image QA: Technologist performance review

- Retrospective review* should assess quality of clinical images (positioning, etc), and also reject rate
- Minimize patient dose
- High reject rate can have negative impact on workflow
- Reject rate of zero is not a goal--technologists should recognize and reject radiographs that are not diagnostic

AAPM TG151 report (Ongoing QC in DR)

- Rejected image analysis integral part of QC
- Rejects inherent to projection radiography:
  - Patient positioning and alignment integral components of image quality
- 281,000,000 radiography exams in the US in 2016
- 14% of patient exposure due to repeated images*
- ALARA principle: as low as reasonably achievable
- Recommended reject rate: 8%


Screen-film radiography

- Reject analysis integral part of QC programs (Gray QC book)
- Financial incentive:
  - $5 of film
  - $5 retrieval of Ag from rejected film
- Films always available for reject analysis (cumbersome, not automated)

Screen-film radiography

Table 4.1: Percentage of objects by

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anomalous</td>
<td>20</td>
</tr>
<tr>
<td>Attenuation</td>
<td>15</td>
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<tr>
<td>Artifacts</td>
<td>5</td>
</tr>
<tr>
<td>Backlighting</td>
<td>4</td>
</tr>
<tr>
<td>Black Area</td>
<td>3</td>
</tr>
<tr>
<td>Blurred Image</td>
<td>2</td>
</tr>
<tr>
<td>Correct Image</td>
<td>1</td>
</tr>
<tr>
<td>Disturbed Image</td>
<td>1</td>
</tr>
<tr>
<td>Edge Distorsion</td>
<td>1</td>
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<tr>
<td>Film Movement</td>
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<tr>
<td>Noise</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
</tr>
<tr>
<td>Rejection</td>
<td>100</td>
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</tbody>
</table>

Digital Era: Reject analysis still necessary?

• Peer et al: Comparison of screen-film radiography and computed radiography (CR)
  - Reject data collected for two months
  - Screen-film: Reject rate 27.6%, main reason: exposure, others (technique related)
  - CR: Reject rate 2.3%, main reason: positioning
  - Nol et al (2006)*: Similar results

Reject rates

• Jones 2011: 8-10%
• Andersen 2012: 12%

Monitoring reject rates in a digital environment

• Radiography unit may not collect reject information
• Reject analysis might be software add-on $5
• Reject analysis software might interfere with clinical operation
• Information retrieval cumbersome (portables, busy environment)
• Multi-vendor environment:
  - Different data formats
  - Useful information not always readily retrievable

Clinical Experience

Clinical experience: Starting point

- Prior to 2014: Self-reporting of reject rates
- Reject analysis turned off (file storage problems due to limited hard drive space)
- Reject analysis optional on some DR systems, had to be purchased

Clinical experience

- 2014: Reject image information collected from radiography systems
  - Enabling reject feature
  - Data retrieval differs between vendors
  - Data formats
  - …
Reasons for Rejects

Overall

ARTIFACTS
INCOMPLETE
INCORRECT TECHNIQUE
PATIENT MOTION
POSITIONING/COLLIMATION
OTHER

Reasons for Rejects

Inpatient

ARTIFACTS
INCOMPLETE
INCORRECT TECHNIQUE
PATIENT MOTION
POSITIONING/COLLIMATION
OTHER

Reasons for Rejects

Inpatient/ED

ARTIFACTS
INCOMPLETE
INCORRECT TECHNIQUE
PATIENT MOTION
POSITIONING/COLLIMATION
OTHER
Reasons for Rejects

Inpatient  Outpatient B  Ohio State

POSITIONING/COLLIMATION  INCORRECT TECHNIQUE  ARTIFACTS  PATIENT MOTION  OTHER

Reasons for Rejects - Chest

Overall DR  Overall CR

POSITIONING/COLLIMATION  INCORRECT TECHNIQUE  ARTIFACTS  PATIENT MOTION  OTHER

Reasons for Rejects

Outpatient B 2017  Outpatient B 2015

2015: Mostly CR  2017: All DR

POSITIONING/COLLIMATION  INCORRECT TECHNIQUE  ARTIFACTS  PATIENT MOTION  OTHER
Clinical Experience: New equipment

Practice makes perfect

Practice makes perfect?
Designing Interventions

What causes the most rejects?

Reject rate by anatomy

Number of rejects by anatomy

Overall
What causes the most rejects?

Number of rejects by anatomy

Tailor intervention depending on inpatient/outpatient setting?

Interventions

Project introduction
- In-service to teach specifics
- Classification of reject categories
- Review reject rates
- When to reject (over/under exposure? DI?)
- Use technologists’ names rather than code for user names
- Encourage ownership/accountability of performed exam
- Develop image critique skills

Specific instructions
- Stop after two repeats and ask the lead of the area for advice.
- Do not reject images based upon DI numbers.
- Do not place repeated images in “unnecessary” image folder.
Interventions: Anatomy-specific training

- In-service for all technologists targeting specific procedures
  - Portable x-ray exams
  - Imaging wrists
  - Chest XRs
  - Lumbar spine
  - …

- Carrot & stick approach

Focus on Quality: Anatomy-specific training

- Manager 1
- Manager 2
- Manager 3

Lead tech designated RRA project leader

Imaging technical coordinator

New staff training
In-service

Randomly selected rejected images, one per reject reason category
Obtained corresponding "diagnostic image"
Review with radiologist and technologists
Pt Positioning, same techniques

Rejected

No need to repeat. Costophrenic angle is at edge of image, but not cut off.

120kVp 20mAs

Image Artifacts, same technique

Rejected

A snap in the image does not justify the extra dose for a repeat. Use judgement as to whether artifact is large enough or positioned such that it might interfere with diagnosis. The technologist should include a note acknowledging the presence of artifact.

120kVp 5mA

Jewelry on clothing, same technique

Rejected

A snap in the image does not justify the extra dose for a repeat. Use judgement as to whether artifact is large enough or positioned such that it might interfere with diagnosis. The technologist should include a note acknowledging the presence of artifact.

120kVp 8mA
Neve repeat because the image appears too light or dark. The radiologists will adjust display window and level settings.

120kVp, 25mAs
120kVp, 50mAs

A 20% increase in mAs does not justify the extra dose to the patient. This should not have been repeated.

TC114, Same Technique
120kVp, 8mAs
120kVp, 10mAs

This should not have been repeated.
In-service

Each "rejected" image was of diagnostic quality

• Teaching points:
  • If the image is not perfect, is it necessary to repeat?
  • Communication with radiologist: Use tech-note to indicate "imperfection"
  • Use judgement when (not to) repeat
Lessons learned

Interventions

Staff in-service: Focus on anatomic regions
- Example: Instructions for chest PA/lateral exams
- Invite radiologist
- Review reject rates for that anatomy
- May not result in a measureable reject rate reduction, but might improve image quality
Anatomy-specific training: Changes in reject rates?

Leadership/Ownership
- RRA Project leadership
  - Priority for management?
  - Needs to have a position of "authority". Either lead tech or create new position title.
  - Experienced technologist with strong communication and educational skills
  - Accessible, responsive
- Individual technologists' reject rates
  - White Gray strongly opposes tracking individual technologists' reject rates, leads/manager DO want this information
  - Ownership: Encourages technologists take pride in the quality of their radiographs, but also their (low) reject rate

Next steps
- Technologist-specific reject rate (GE X-ray quality app)
Acknowledgements

T. Kinsey
L. Liu
K. Haas
J. Spano-Rezpecki
F. Baker-Mallory
C. Froman
UCMC GMI technologists

Z. F. Lu
K. Little
A. Sanchez
Y. Zhang
E. Marshall
V. Mamyan
H. MacMahon