Initial clinical experience: Reasons for rejects and remedial actions

Ingrid Reiser, PhD DABR
Department of Radiology, The University of Chicago
July 2019

THE UNIVERSITY OF CHICAGO

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

*Chung JH et al, JACR **15** 1437-1422 (2018)

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%

* K.D. Rogers, I.P Matthews, and C.J. Roberts. Variation in Repeat Rates between 18 Radiology Departments. Brit J. Radiol. 60:463–468, 1987.

Screen-film radiography

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

Table 4.3. Percentage of rejects by category, St. Mary's Hospital—general radiology ~1983

	Rejects (%)
Positioning	30
Patient motion	3
Light films	14
Dark films	9
Black films	11
Tomo scouts	8
Static	—
Fog—darkroom	1
cassette	4
Mechanical	4
Good films	6
Miscellaneous	10

Technique: 42%

Gray JE, Winkler NT, Stears J, Frank ED. Quality control in diagnostic imaging. Chapter 4: Reject-Repeat Analysis Program. Gaithersburg, Maryland: Aspen; 1983.

Digital Era: Reject analysis still necessary?

Original article

Comparative reject analysis in conventional film-screen and digital storage phosphor radiography

- 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

*Nol et al. J Digit Imag 19 2006: pp 159-166 (2006)
**5. Peer et al. Eur Radiol 9, 1693-1696 (1999)

Reject rates

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

Jones AK et al. J Digit Imaging. 2011 Apr;24(2):243-55.
Andersen ER et al. Acta Radiol. 2012 Mar 1;53(2):174-8.

Monitoring reject rates in a digital environment

- Radiography unit may not collect reject information
- Reject analysis might be software add-on $$
- 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

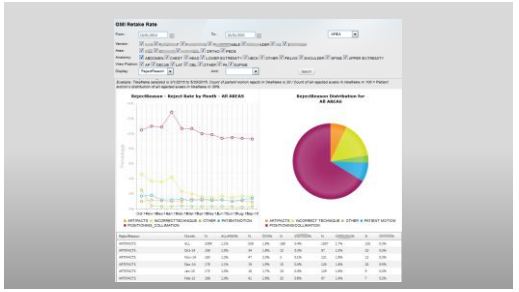
Clinical Experience

Clinical experience: Starting point

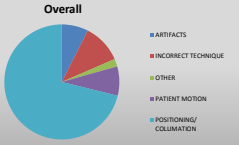
- Prior to 2014: Self-reporting of reject rates
- Reject analysis turned off (file storage problems due to limited hard drive space)
- Reject analysis optional on some DR systems, had to be purchased

Clinical experience

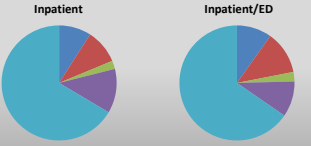
- 2014: Reject image information collected from radiography systems
  - Enabling reject feature
  - Data retrieval differs between vendors
  - Data formats
  - …

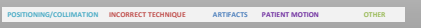


Reasons for Rejects

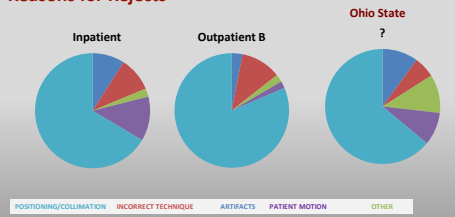


Reasons for Rejects

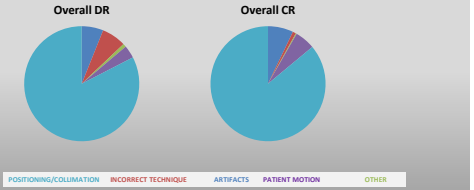




Reasons for Rejects

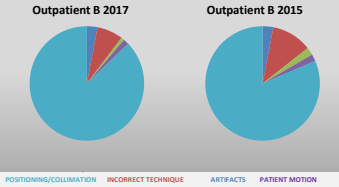


Reasons for Rejects - Chest



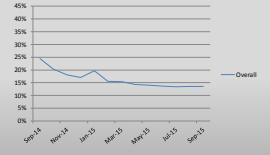
inpatient & outpatient, same time frame

Reasons for Rejects

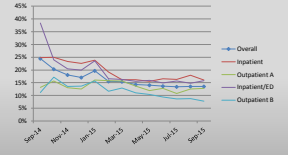


2015: Mostly CR
2017: All DR

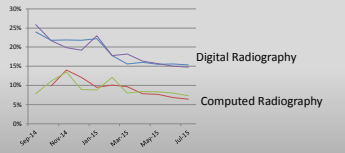
Reasons for rejects



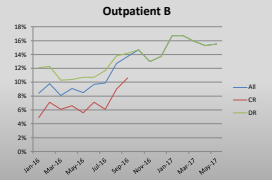
Rejects by clinical area



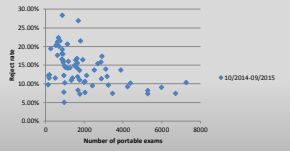
Rejects by equipment



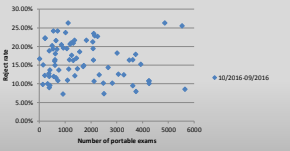
Clinical Experience: New equipment



Practice makes perfect

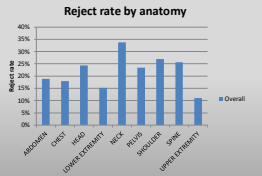


Practice makes perfect?

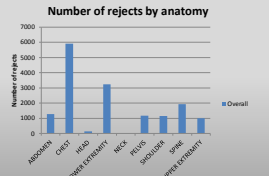


Designing Interventions

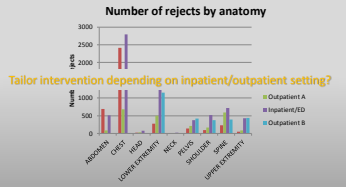
What causes the most rejects?



What causes the most rejects?



What causes the most rejects?



Tailor intervention depending on inpatient/outpatient setting?

Interventions

Project introduction

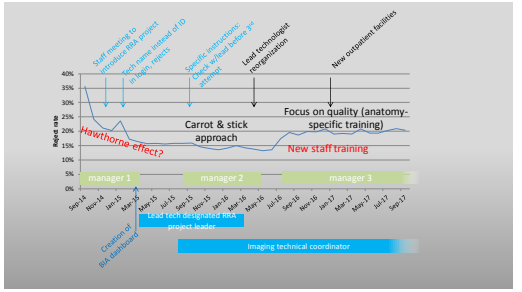
- In-service to teach specifics
  - Classification of reject categories
  - Review reject rates
  - When to reject (over/under exposure? DI?)
- Use technologists' names rather than code for user names
- Encourage ownership/accountability of performed exam
- Develop image critique skills

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 XR
  - Lumbar spine
  - …

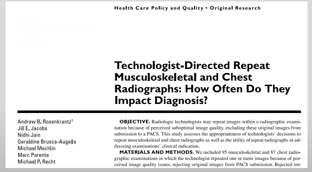



AuntMinnie.com

Study questions whether x-rays really need to be repeated

Radiologists' assessment of radiographs that were repeated

	Musculoskeletal radiographs	Chest radiographs
Agreed with reason for rejecting first image	84.7%	80.9%
Medical question could have been addressed without repeat image	77.0%	93.1%
Repeat image provided additional useful information	28.4%	3.4%



Health Care Policy and Quality • Original Research

Technologist-Directed Repeat Musculoskeletal and Chest Radiographs: How Often Do They Impact Diagnosis?

Andrew B. Rosenkrantz[1]
Jill E. Jacobs
Nidhi Jain
Geraldine Brusca-Augello
Michael Mechlin
Marc Parente
Michael P. Recht

OBJECTIVE. Radiologic technologists may repeat images within a radiographic examination because of perceived suboptimal image quality, excluding these original images from submission to a PACS. This study assesses the appropriateness of technologists' decisions to repeat musculoskeletal and chest radiographs as well as the utility of repeat radiographs in addressing examinations' clinical indication.

MATERIALS AND METHODS. We included 95 musculoskeletal and 87 chest radiographic examinations in which the technologist repeated one or more images because of perceived image quality issues, rejecting original images from PACS submission. Rejected im-

AJR 2017; 209:1–5

A. B. Rosenkrantz et al, *AJR* 2017; 209:1–5

In-service

Randomly selected rejected images, one per reject reason category

Obtained corresponding "diagnostic image"

Review with radiologist and technologists

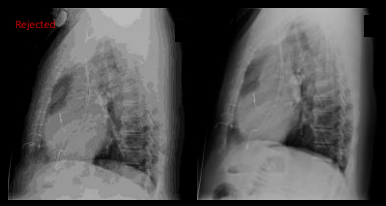
Pt Positioning, same technique

No need to repeat: Sternum is close to left edge, but entire lung is within image.

120kVp 16mAs

Pt Positioning, same techniques

Rejected

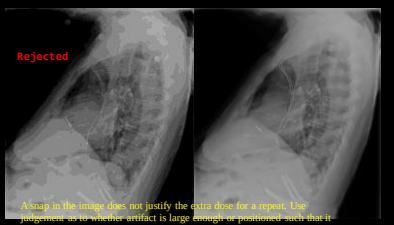


No need to repeat: Costophrenic angle is at edge of image, but not cut off.

120kVp 20mAs

Image Artifacts, same technique

Rejected

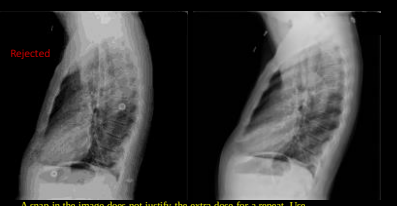


A snap in the image does not justify the extra dose for a repeat. Use judgement as to whether artifact is large enough or positioned such that it might interfere with diagnosis. The technologist should include a note acknowledging the presence of artifacts.

120 kVp, 5mAs

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 artifacts.

120kVp, 8mAs

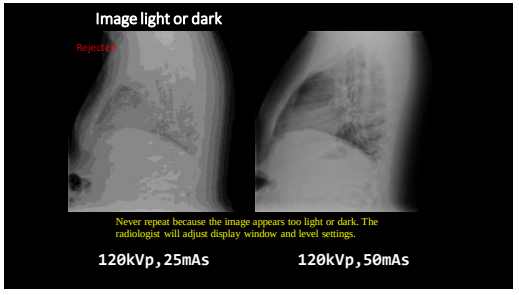
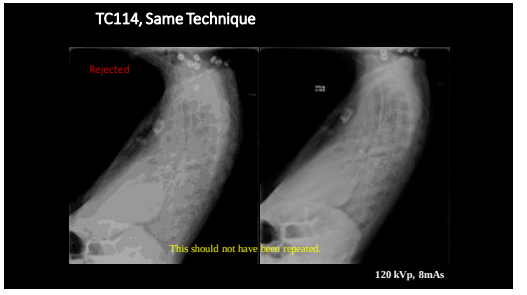
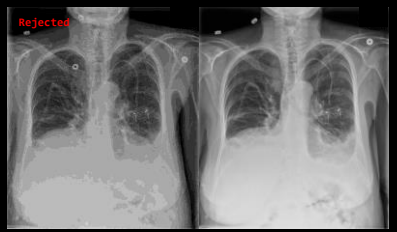


Image light or dark
Rejected
Never repeat because the image appears too light or dark. The radiologist will adjust display window and level settings.
120kVp,25mAs
120kVp,50mAs


Noisy Image
Rejected
A 20% increase in mAs does not justify the extra dose to the patient. This should not have been repeated.
120kVp, 8mAs
120kVp, 10mAs

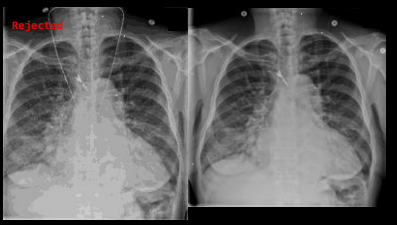

TC114, Same Technique
Rejected
This should not have been repeated.
120 kVp, 8mAs

CCD5550, Image Artifacts, Same Techniques



Patient Positioning

Patient Positioning, same techniques

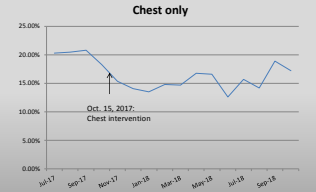


In-service

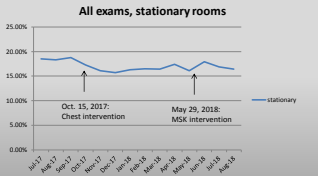
Each "rejected" image was of diagnostic quality

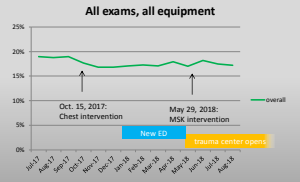
- Teaching points:
  - If the image is not perfect, is it necessary to repeat?
  - Communication with radiologist: Use tech-note to indicate "imperfection"
  - Use judgement when (not to) repeat

Impact?



MSK





Lessons learned

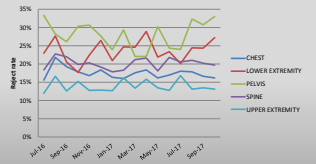
Interventions

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?



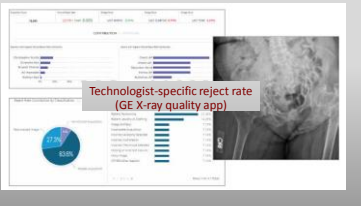
Difficult to measure impact of anatomic region-specific education

Likely helps improve quality of radiographs

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
  - While 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



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