# Setting Up a Unified Database for Multi-vendor Reject Analysis

Kevin Little, PhD



## Background

- Rejected acquisitions: images of patient anatomy that are discarded by the technologist without being presented to the radiologist
  - No diagnostic value
  - Contribute to unnecessary patient dose
- Should be monitored as part of a radiography quality control program
- AAPM Task Group 151 recommended reject rates of 6-10% for adult patients[1]

[1]A. K. Jones, et. al., "Ongoing quality control in digital radiography: Report of AAPM Imaging Physics Committee Task Group 151," *Med. Phys.* **42**, 6658-6670 (2015).



## Background

- What about repeats?
  - It may be useful to track images of the same anatomy that are repeated
  - Since images are sent to the radiologist, there is at least marginal value
  - It's much simpler to track rejects from the information available at the modality

## Background

- Why monitor reject rates at all when dose is so low?
  - The dose for any one image is relatively low
  - May reveal quality information that you're not necessarily looking for
  - Reject rates that are too low may indicate that radiologists are accepting low-quality images



## Background

- Multiple manufacturers and models
- Widely different data and reporting formats
- Difficult to analyze as provided for whole department
- Wanted data to be accessed and available for analysis by physicists, managers, lead technologists, and radiologists
- A unified database with an interactive dashboard interface



## Steps for a unified database using logs

- Export reject and exposure logs from individual units
- Upload data to a secure server
- Check for data fidelity
- Load data into database or analytics service (Power BI, etc.)
- Match accession numbers and technologists using RIS data
- Apply reject reason mapping
- Apply anatomy/view mapping
- Analyze data using an interactive online portal or other method

## Export reject and exposure logs

- Each model has a unique export procedure
- Almost all systems currently require “sneakernet”—someone needs to physically go to each unit and export data to a USB drive
- In some cases, data can be exported directly a to mapped network drive (e.g. Canon), but often network firewalls will prevent this
- USB drives need to be hardware-encrypted



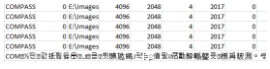
## Upload data to a secure server

- Need the data logs in a central, secure location
- Many models do not include unit-identifying information, requiring the person uploading the data to place the log file in the correct folder for identification
- This can lead to misidentification if data is uploaded to the incorrect folder



## Check for data fidelity

- Often exported files will be corrupted or incomplete



- Incorrect data types can cause problems in the database
- Unforeseen problems will pop up
- I’ve used both Python and PowerBI to check data fidelity

## Load data into a database or analytics service

- Each vendor will have different file formats for their reject and acquisition logs.
- Some vendors have a single acquisition log that also indicates rejects, and others have separate reject and acquisition logs, sometimes without linking information.
- Automation/scripting is necessary to avoid the time-consuming process of loading data into databases using a GUI.



## Option 1: Load data into a database

- Databases and data warehouses allow large data sets to be stored without loading the entire data set into memory
- SQL, Oracle, Pandas with Dask, etc.
- Python can directly interface with these databases through available packages (e.g. sqlalchemy, pandas, pymssql)
- If servers or licenses are not available, some software can be run locally (e.g. SQLite)
- Work with your informatics or business intelligence staff if possible



## Option 2: Use business analytics service

- I am currently switching to Microsoft Power BI instead of a traditional database or data warehouse.
- Power BI is able to massage data from many different sources (CSV, Excel, SQL, other databases).
- I developed in days of time what previously took weeks of time.
- Talk to those in your department that do business analytics and see if you can share a platform.
- If using a departmental/hospital service, data can be made easily accessible to other users.

## Match accession numbers and technologists using RIS data

- Information on the technologist level can be very useful
- Some systems have reliable user data (use log in or ID)
- Using self-identification at the reject prompt led to errors
- Some data logs did not include accession numbers (just date/time), so data had to be matched using another source (PACS)



## Apply reject reason mapping

| | DR System 1 | DR System 2 | DR System 3 | CR System 1 |
|---|---|---|---|---|
| **Incorrect Technique** | Incorrect Technique Selected<br>Noisy Image(s) | Exposure Factors | Technique | Exposure Malfunction<br>Over exposure<br>Under exposure<br>Exposure Error - User Defined Error |
| **Positioning/ Collimation** | Patient Positioning<br>Incorrect Collimation<br>Missing or Incorrect View Markers | Positioning | Clipped Anatomy<br>Positioning Error | Anatomy Cut-off<br>Marker missing (typed in category)<br>Obstructed View<br>Rotation<br>Tube or Grid Centering<br>Positioning - User Defined Error |
| **Artifacts** | Image Artifacts<br>Patient Jewelry or Clothing | Artifacts | Artifact | |
| **Patient Motion** | Patient Motion | Patient Motion | Motion | Motion |
| **Other** | Incorrect Anatomy Selected<br>Incomplete Acquisition<br>OTHER (typed response) | | Other Reason<br>Duplicate | Patient ID - Incorrect Study/ Side<br>Patient ID - User Defined Error |

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## Apply reject reason mapping

DICOM has defined
"Rejected for Quality Reasons"

| Coding Scheme Designator | Code Value | Code Meaning |
|---|---|---|
| DCM | 111207 | Image artifact(s) |
| DCM | 111208 | Grid artifact(s) |
| DCM | 111209 | Positioning |
| DCM | 111210 | Motion blur |
| DCM | 111211 | Under exposed |
| DCM | 111212 | Over exposed |
| DCM | 111213 | No image |
| DCM | 111214 | Detector artifact(s) |
| DCM | 111215 | Artifact(s) other than grid or detector artifact |
| DCM | 111216 | Mechanical failure |
| DCM | 111217 | Electrical failure |
| DCM | 111218 | Software failure |
| DCM | 111219 | Inappropriate image processing |
| DCM | 111220 | Other failure |
| DCM | 111221 | Unknown failure |
| DCM | 113026 | Double exposure |

## Apply reject reason mapping

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- Industry standard reject reasons is one of the goals of TG-305

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## Apply anatomy/view mapping

- Each manufacturer also uses various descriptions for anatomy
- Map varying anatomy/view descriptions to general unified descriptions:
  - abdomen
  - chest
  - lower extremity
  - upper extremity
  - head
  - neck
  - pelvis
  - shoulder
  - spine
  - anterior-posterior (AP)
  - decubitus (DECUB)
  - lateral (LAT)
  - oblique (OBL)
  - posterior-anterior (PA)
  - supine
  - other



## Display interactive data

- Want to be able to "slice and dice" data to gain insights
- Your department's informatics or business intelligence groups may already have a dashboard platform
- Examples: Tableau, Power BI, Plotly Dash

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## Display interactive data

- Counting rules are required to ensure multiple records for a single acquisition are not duplicated
  - Dual-energy acquisitions on the CR Chest unit would appear as up to four entries in the acquisition log
  - Multiple entries appeared for some dual-energy and pasting acquisitions on the DR Stationary units’ logs

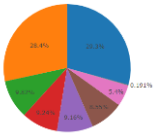


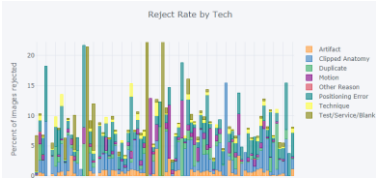
## Lessons learned

- A centralized database and dashboard can take a long time to set up in a multi-vendor environment
- Differences in vendors’ reporting formats make unification difficult
- Raw data may not be high quality
  - May not include reliable technologist identification
  - Reject reasons may not be appropriate

## Lessons learned

- Other, Test, Duplicate, etc. are not helpful when they are used for clinical rejects






## Lessons learned

- Cooperation within the team is vital
  - Informatics/BI, Management, Technologists, Medical Physicists, Radiologists
- Starting a conversation with all the members of the team can identify quality issues not directly related to rejects
- Rejected images (when available) can be helpful, but can be difficult to obtain and tie to the database



## AAPM Task Group 305

- "Task Group on Development of Standards for Vendor-Neutral Reject Analysis in Radiography"
- How can the data be standardized to make analysis simpler?
- What information is vital to the process?
- What are good ways to get the data from the modality to a centralized location?

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