Weekly testing of CR reader and AEC calibration using a commercial CR quality tool

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Motivation: Patient dose and repetitive performance

- Two of the quantities in a CR room that require regular stability monitoring are:
  - AEC chamber calibration (delivered dose to image receptor)
  - CR reader exposure index calibration
- Goal: to measure variations in performance metrics, and integrate monitoring into our CR QC program
- Key integration metrics:
  - Can be performed by technologists in a short amount of time
  - Reproducible and quantitative results to indicate whether performance has changed enough to require action

The commercial CR quality tool

QA Radchex
Diagnostic Imaging
Specialists Corp.,
St. Malo MB

- Size and shape matches a 10x12 inch CR cassette
- Responds to X-ray exposure in same way as CR imaging phosphor
- Displays response in units of CRLU (CR light units), where 1 CRLU corresponds to approximately 0.1 mR (depending on beam quality and scatter)

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Test 1 of 2: CR reader calibration

- Outline: apply a known dose to a CR cassette, and verify the exposure index reported by the CR reader is stable over time

1. Place QC tool on tabletop underneath the included copper filter
2. Using a standard kVp (80), adjust mAs and SID until QC tool reads 14.1 ± 0.2 CRLU
3. Apply the same exposure to a dedicated QC CR cassette, with copper filter
4. Read the CR cassette and record the exposure index

- Repeat weekly, monitoring exposure index values

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Test 2 of 2: AEC chamber calibration

- Outline: measure the dose delivered to the detector when using the AEC with a standard protocol, and verify that this is stable over time

1. Insert QC tool into bucky, place copper filter in front of bucky
2. Use standard SID for the bucky
3. Take one exposure using 80 kVp, all 3 AEC chambers, no density adjustment
4. Record CRLU from the QC tool (and mAs from the console)

- Repeat weekly, monitoring CRLU values

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QC program

- Started at one hospital in 2009
- Now expanded to seven hospitals in our region
  - 15 CR readers (Fujifilm and Carestream)
  - 13 rooms, each with wall and table bucky
- QC tool provided to each hospital
- Weekly test results are recorded in spreadsheets and stored via Microsoft SharePoint
- Data accessed remotely by quality control staff via SharePoint

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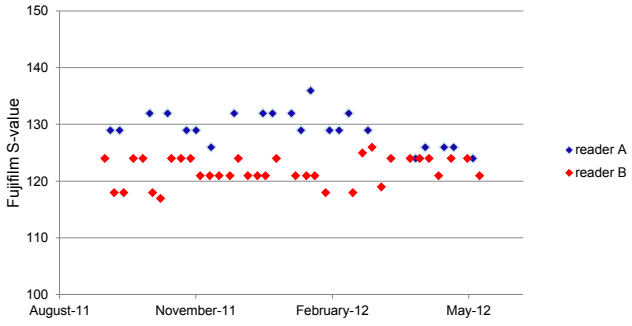
Results

- Time commitment: 15 minutes to test one room plus one reader
- Compliance varies by site: not all recorded data every week
- Most CR reader and AEC results are stable
  - but values do vary from week to week. The amount of variation differs between units.
- Occasionally get outlier values: unusually high or low values which do not reoccur the next week
  - Less than ten in the last year of data, over all rooms and readers

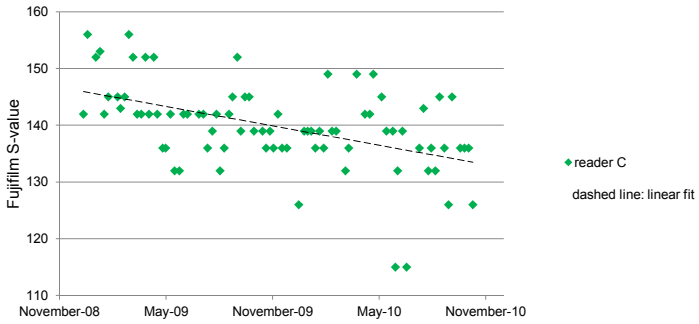
Example: Two typical CR readers



- The mean S-values differ by about 5% (some difference in calibration is expected)
- Both stable over selected time period, with some week-to-week variation
  - Standard deviation (σ) in S-values is 3.0 for reader A, 2.4 for reader B

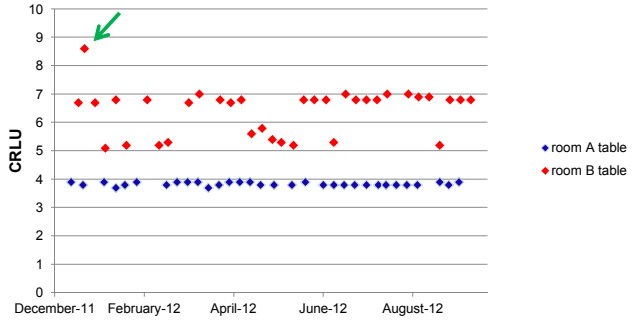
- Over a 1 year period, S-value σ's between 3 and 12 were seen on Fujifilm readers
- EI-value σ's between 15 and 32 were seen on Carestream readers

Example: CR reader drift



This reader showed larger variability, and a gradual downward trend in S-values over a two-year period

Example: AEC for two typical buckys



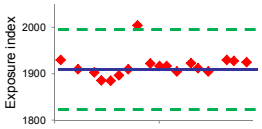
- Both stable, but one has considerably larger week-to-week variation
- One high value (8.6 CRLU) does not reoccur and is considered an outlier

Other results

- CR reader or AEC recalibrations can cause one-time jumps in measured values
  - Some observed jumps possibly due to unrecorded calibrations by biomedical service staff
- Some outliers possibly due to improper setup or technique
- CR readers at one hospital initially showed large drifts and variability in S-values. This was found to be due to calibration values not being updated correctly after servicing.

Next step: monitoring

- Monitor results for unexpected changes:
  - Define a baseline EI (S-value) for each reader, and a baseline CRLU value for each bucky



  - Based on variations seen in data, define a tolerance range around baseline of ±20% for S-value (±80 EI), ±20% for AEC CRLU
  - If a result is outside tolerance range, technologist repeats test
    - after a second failure, notify service and medical physics to investigate further
- Review results after 6 months and consider tolerance ranges, false negative failures and testing frequency

Other points

- Wide initial tolerance ranges (±20%) have been chosen to reduce reporting of outlier points, but narrower tolerances will be considered after monitoring program is running
- Important to keep records of reader and AEC recalibrations, to account for jumps in the data
  - New baseline should be performed after recalibration
- Could also monitor tube output by recording console mAs during the AEC test

Conclusions

- This testing method is practical for monitoring CR reader and AEC for unexpected changes or drifts in calibration
- Data has been recorded from 15 readers and 13 rooms, covering one to three years
- Most units are stable most of the time, but some instances of changes and instability have been observed
- Can consider reducing testing frequency to biweekly or monthly