

Use of signal to noise ratio for daily quality control of fluoroscopes used for interventional radiology procedures



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INTRODUCTION

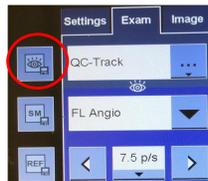
Complex fluoroscopically guided interventions (FGI's) are routine in many interventional radiology departments. Quality control (QC) is a necessary and appropriate activity to gauge the readiness of the fluoroscopes used in these procedures. We sought to identify a simple and reproducible metric to follow for daily QC, helping to ensure that the fluoroscope is ready to be used on FGI procedures.

AIM

To evaluate a daily image quality control regimen in a busy academic interventional radiology (IR) department using signal-to-noise (SNR) ratio from fluoroscopic (fluoro) loops.

METHODS

Daily QC was performed over a 5 month period on 6 Siemens fluoroscopes (2 Artis Zeego, 2 Axiom Artis and 2 Artis Q) using a 10"x10"x3" custom-built patient equivalent phantom consisting of polycarbonate, copper, and aluminum. The phantom was placed on the table in the same position each day, which consisted of setting a source-to-image distance of 100 cm, raising the table to a height so that the phantom just met the receptor, and centering the phantom under fluoro guidance. Each room was programmed to use the default "Normal" 7.5 pulses per second fluoro within a pre-configured exam for QA. After actuating fluoro several times to allow the filter selection to be reproducible, a fluoro loop was acquired for roughly 5 seconds and stored using the "Store Fluoro" function. Fluoro loops were then sent to a QC-Track (Atirix Medical Systems) server for automated processing. A 12 mm region of interest (ROI) was placed in a uniform region at the center of the phantom. SNR was computed in the ROI for each frame of the last 2 seconds of the fluoro loop. The SNR's for each of the last 15 frames were then averaged to yield a single mean SNR for the loop.



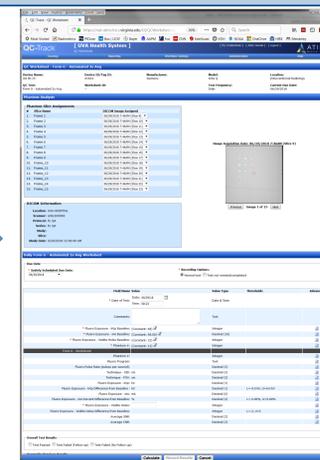
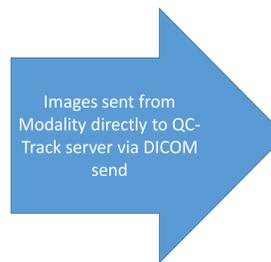
RIGHT: Picture of table side control panel showing selection of pre-configured non-clinical exam specifically for QC. The red circle indicates the button used to store the fluoro loop following 5 second depression of the fluoro foot pedal.

METHODS (CONT.)



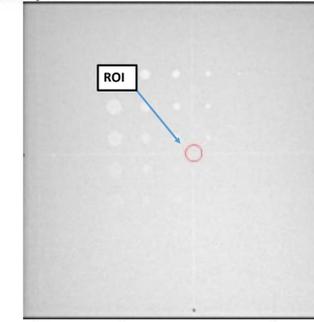
LEFT: Patient equivalent phantom, consisting of polycarbonate, copper, and aluminum layers. The attenuation of the phantom was used to drive the Automatic Dose Rate and Image Quality control (ADRIQ) to a level approximately equal to a 70 kg adult abdomen.

RIGHT: Phantom positioned directly on the table pad of a Siemens Artis Q. This configuration was easily reproduced in all 6 IR rooms.



LEFT: Stored fluoro loops automatically processed in QC-Track thin client. Each unit is identified by Station Name, assigned automatically in the database, and loop information catalogued for each day. The QA Tech logs-in to the application to record data and address any errors.

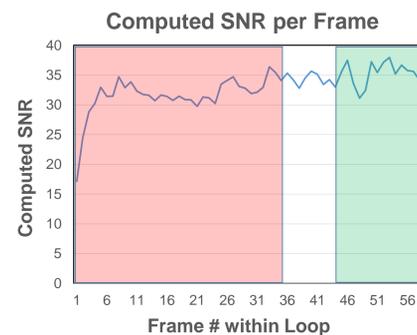
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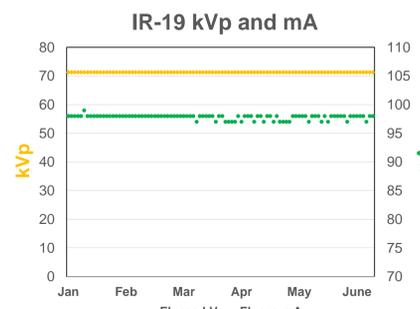
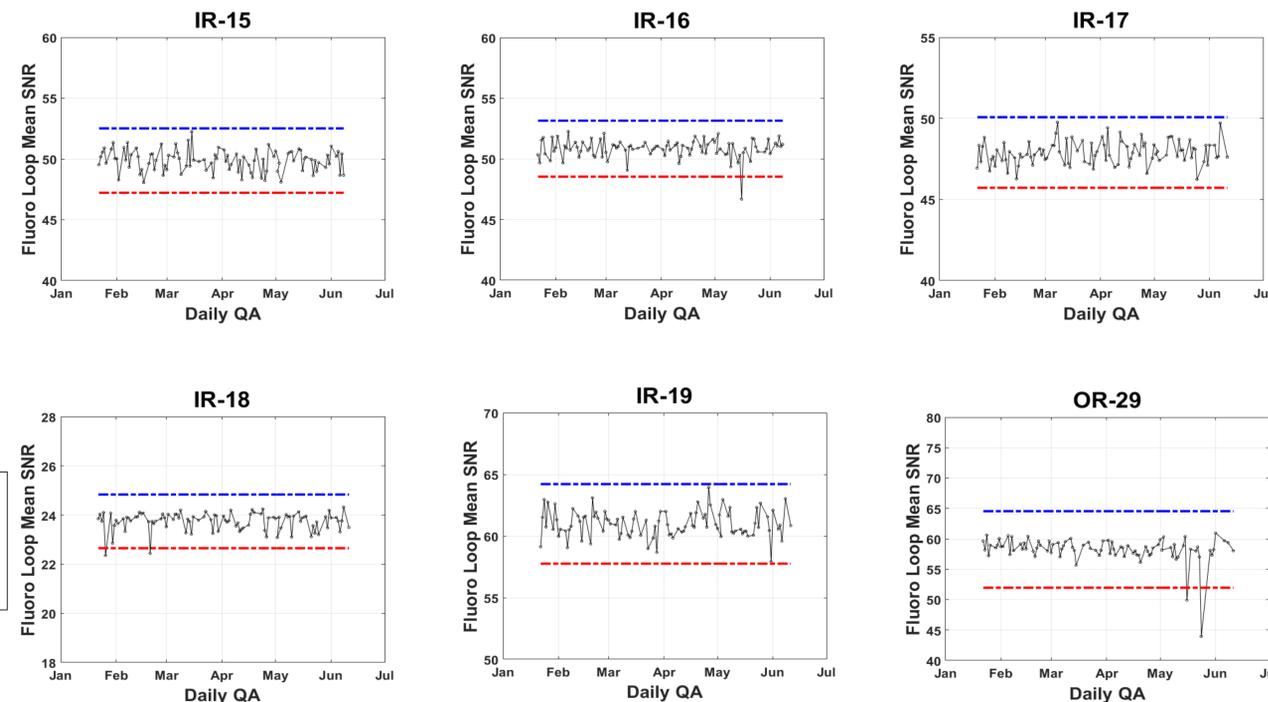
RIGHT: 1st image of 15 in a 2 second fluoro loop, showing the ROI used on all frames in the loop. SNR was calculated for all frames of the last 2 seconds of the fluoro loop and an average SNR was obtained for the loop for each day.

RESULTS

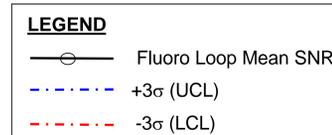
RIGHT: Plot showing the calculated SNR for a single trial run of an 8 second fluoro loop consisting of 59 frames. Instability in the SNR is observed (red shaded area) as the ADRIQ adjusts. The last 2 seconds of the fluoro loop (corresponding to 15 frames) is more stable (green shaded area). These frames were used for the mean SNR calculation each day.



RIGHT: Shewhart control charts* of the daily QC results showing the mean Fluoro Loop SNR for each room over a 5 month period. Using statistical process control logic, the red dashed lines indicate 3 standard deviations below the mean (Lower Control Limit, LCL), while the blue dashed lines indicate 3 standard deviations above the mean (Upper Control Limit, UCL). Only 5 recordings out of 568 (0.88%) fell outside of the control values for all 6 rooms.



LEFT: Plot showing the tabulated kVp (left Y-axis) and mA (right Y-axis) from the DICOM header for each QC run in room IR-19. Consistency in these two technique parameters, over the 5 month timeframe, was found. This trend was observed for all rooms.



*Koutras, MV, et al., Statistical Process Control using Shewhart Control Charts with supplementary Runs Rules, Methodol Comput Appl Probab (2007) 9:207-224.

CONCLUSIONS

Automated and observer-independent quality control of units used during fluoroscopically guided interventions was piloted for a busy IR department. Minimal technologist effort and change in workflow were needed to regularly monitor system performance and readiness of the system for the day. This data allows for room specific SNR thresholds to be established and used as a criterion for providing immediate feedback on whether the system is operating at an expected level.

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