

Electronic Records with Alerts for CT Technologist QC across Multiple Locations

Kevin J Little, PhD, Amy Leighty, BS, Xia Jiang, PhD, Xiangyu Yang, PhD, David E Hintenlang, PhD
Department of Radiology, Ohio State University Wexner Medical Center, Columbus, OH 43210

Introduction

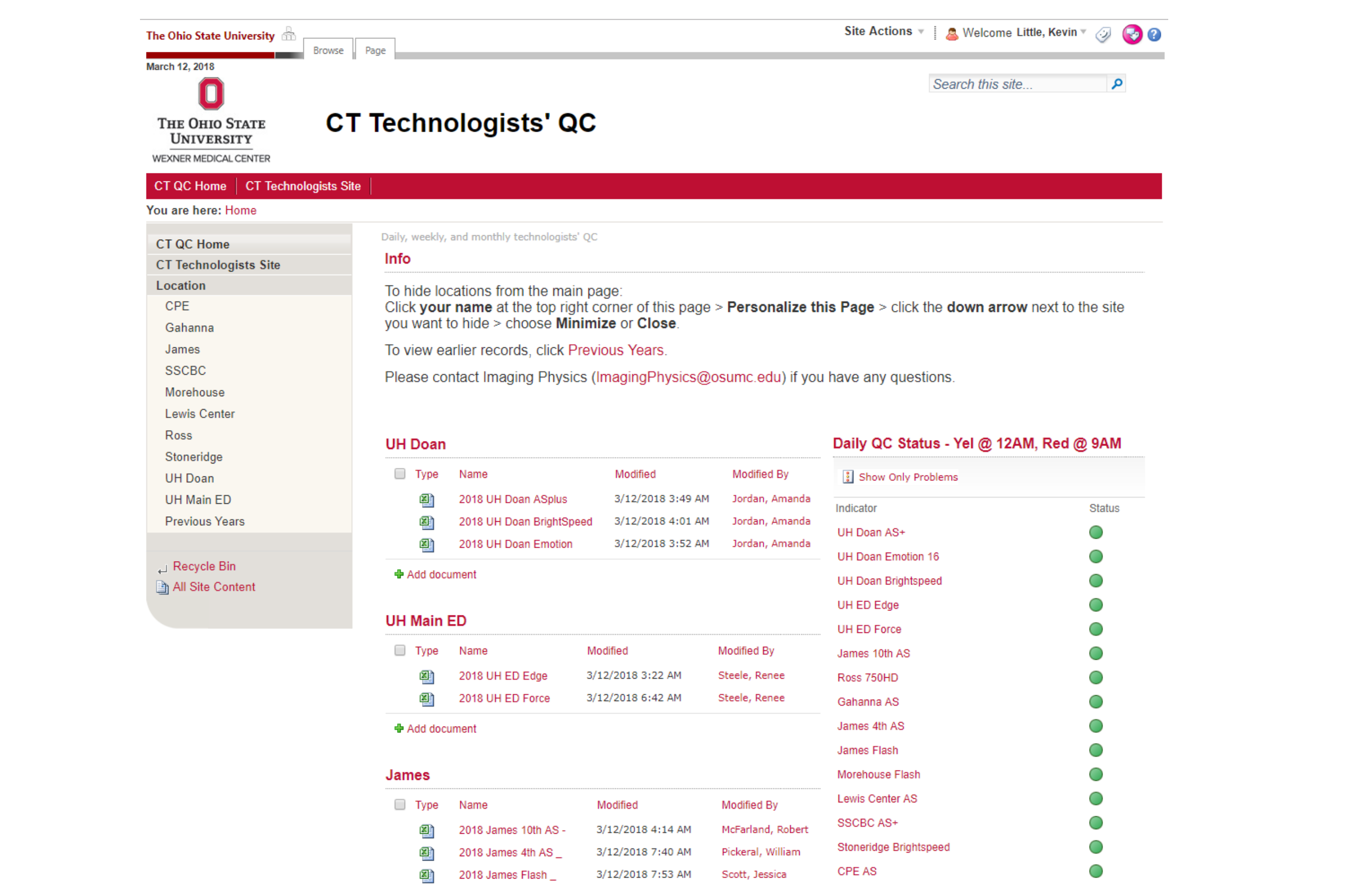
- Daily, weekly, and monthly technologists’ quality control (QC) tests have the potential to identify technical issues with a CT scanner before they affect clinical image quality or safety.
- Values outside their expected range are not always immediately recognized by the person performing the test.
- QC testing can be missed due to miscommunication or deviation from routines.
- If missed QC is not identified and reported according to site policy, this can lead to a citation by state regulators or accreditation agencies.
- Paper QC records are usually kept at the scanner, which can be inconvenient for a physicist or administrator to access in a multi-site system.
- While there is commercially available QC-related software and some groups have built fully automated in-house QC tools^{1,2}, our goal was to use readily-available software at our institution to streamline the recording and review of QC data as acquired by technologists.

Methods

- Daily, weekly, and monthly QC forms for the diagnostic CT scanners in our system were implemented with Microsoft Excel and hosted using our institution’s existing Microsoft SharePoint website.
- The QC site could be remotely accessed by technologists, administrators, and physicists across our multiple sites.
- Versioning with timestamps was used to track changes.
- Conditional formatting was used to identify QC values that were outside their expected range.
- A Python script was utilized to trigger timely email alerts for missing QC to a qualified medical physicist (QMP) and the respective system’s lead technologist for follow-up.
- A dashboard was created using Excel-based indicators in SharePoint to give an overview of the QC status of the enterprise.
- QC Technologists’ feedback was used to refine the system and to implement improvements, such as including guidance for performing QC directly on the form.

References:

¹J. Grimes, S. Leng, and C. McCollough, “A software tool for automated analysis of CT quality assurance phantoms,” *Med. Phys.* **41**, 558 (2014).
²P. Nowik, R. Bujila, G. Poludniowski, and A. Fransson, “Quality control of CT systems by automated monitoring of key performance indicators: A two-year study,” *J. Appl. Clin. Med. Phys.* **16**, 5469:254–265 (2015).



A screenshot of the QC website. The site is customizable for each user to show only applicable sites.

Technologist's Daily Quality Control									
OSUWMC CP Lewis Center Siemens Definition AS CTAP# 50804									
Siemens Daily QC Head Mode: Axial, 120 kV, 350 mA, 1 s rot, 12 x 1.2 mm coll, 4.8 mm recon, Homogeneity/Water HU Kernel, S80s, Noise Kernel: H30s									
Siemens Daily QC Body Mode: Axial, 120 kV, 420 mA, 0.5 s rot, 64 x 0.6 mm coll, 5 mm recon, Homogeneity/Water HU Kernel, S80f, Noise Kernel: B30f									
OSU Abdomen Helical: Hel, 120 kV, 210 mA, 0.5 s rot, 1.0 pitch, 128 x 0.6 mm coll, 3 mm recon, 210 mm FOV, Kernel: H4f									
OSU Daily Artifacts: Axial, 120 kV, 210 mA, 1 s rot, 128 x 0.6 mm coll, 0.6 mm recon, 210 mm FOV, Kernel: B30f									
Date	Initials	Siemens Noise		Siemens Homogeneity		Daily OSU Helical		Artifacts (Y = yes, N = no, if yes, describe)	Notes
		Head: Water SD (0.22 to 0.34 HU)	Body: Water SD Slice 2 (0.73 to 1.62 HU)	Head: Water SD Slice 2 (4 to 8 HU)	Body: Water HU Slice 2 (4 to 8 HU)	Center 400 mm ² Water HU (4 to 8 HU)	Center 400 mm ² Water SD (gathered data)		
3/1/2018	WW	3.59	4.08	0.14	-1.71	-3	6.5	N	
3/2/2018	NF	3.62	4.07	0.39	-0.31	-0.3	6	N	
3/3/2018									
3/4/2018									
3/5/2018	TR	3.57	3.99	0.29	-1.44	-0.7	6.1	N	
3/6/2018	TR	3.5	4.05	0.19	-1.72	0.2	6.5	N	
3/7/2018	TR	3.55	4.16	-0.69	-1.72	-0.3	6.6	N	
3/8/2018	WW	3.54	4.15	-1.6	-0.11	-0.1	6.9	N	
3/9/2018	WW	3.56	4.05	-1.23	-0.09	0.1	6.5	N	
3/10/2018									
3/11/2018									
3/12/2018	NF	3.56	4.15	-0.32	-0.93	-0.7	6.4	N	
3/13/2018	KL	3.45	4.4						
3/14/2018									

An example online form for daily QC. Values out of range appear in red, and required values that have not yet been entered appear in yellow.

Technologist's Weekly Quality Control									
OSUWMC Ross H154 GE Discovery CT750HD CTAP 53475									
GE Contr., Res., LCD, Noise, Uniform, QC Protocol									
Helical: 120 kV, 335 mA, 0.4 s rot, 0.516 pitch, 64 x 0.625 mm (40 mm) coll, 5 mm recon, Small Body, SFOV, 25 cm DFOV, Kernel: Standard if not indicated									
Date	Initials	Contrast Scale (Ser 1 Im 1)		High Contr Spatial Res (Ser 1 Im 1)		Low Contrast Detectability (Ser 7 Im 1)		Noise and Uniformity (Ser 1 Im 13)	
		Water Mean HU	Acrylic Mean HU	Difference	1.6 mm bars SD (0.10 to 0.14)	# groups visible bone kernel (act)	# groups visible std kernel (act)	Contrast (HU) @ 95% CL for 3 mm hole (6.5 HU)	Center HU Mean (110 to 132)
8/6/2017	ag	4.62	120.91	116.29	39.05	4	5	5.071	5.92
9/13/2017	ag	4.7	120.55	115.85	37.82	4	5	5.003	0.82
9/20/2017	ag	4.87	120.5	116.37	37.19	4	5	5.25	0.74
9/27/2017	ag	4.59	120.9	116.21	39.05	4	5	5.151	0.49
Position box cursor over target for pattern, and don't wait if big over the pattern. 2.0 mm									
2 cm (400 mm ²) ROI @ center 2 cm (400 mm ²) ROI @ 12 o'clock 2 cm (400 mm ²) ROI @ 3 o'clock									
Last Modified 3/5/2018 9:00 AM by Little, Kevin									

An example online form for weekly QC. Instructions for evaluating each QC test are provided for quick reference.

Results

- Email alerts allow missed QC tests to be corrected the same day instead of being discovered after their due date by a technologist or by a physicist’s periodic QC review.
- QC tests that are out of range are easily identified, and appropriate action can be taken.
- QC review by the QMP can be done remotely and more frequently in less time.
- Preparation for regulatory inspections of QC logs has been simplified.
- In two cases in the first six months of use, failing QC values (MTF) gave an early indication of tube failure.

Daily QC Status - Yel @ 12AM, Red @ 9AM		Weekly QC Status - Yel on Wed, Red on Fri	
☐ Show Only Problems		☐ Show Only Problems	
Indicator	Status	Indicator	Status
UH Doan AS+	●	UH Doan AS+	●
UH Doan Emotion 16	●	UH Doan Emotion 16	●
UH Doan Brightspeed	●	UH Doan Brightspeed	●
UH ED Edge	◆	UH ED Edge	●
UH ED Force	◆	UH ED Force	▲
James 10th AS	●	James 10th AS	●
Ross 750HD	●	Ross 750HD	●
Gahanna AS	●	Gahanna AS	●
James 4th AS	●	James 4th AS	●
James Flash	●	James Flash	●
Morehouse Flash	●	Morehouse Flash	●
Lewis Center AS	●	Lewis Center AS	▲
SSCBC AS+	●	SSCBC AS+	●
Stoneridge Brightspeed	●	Stoneridge Brightspeed	●
CPE AS	●	CPE AS	▲

A visual dashboard is available on the main page showing QC completion across the health system. Yellow indicates that a system is due for testing, and red indicates that a system is overdue.



Email alerts are sent to the imaging physics team and the appropriate lead technologist or manager when QC is missed or not fully completed.

Conclusions

Using software available at our institution, we implemented a QC system that improves efficiency for technologists, lead technologists, and the QMP by giving timely on-screen and email-based feedback remotely across multiple sites.