Implementation of an Academic Medical Center CT Dose Reduction Program at a Newly Acquired Community Hospital

Kelly Cox, DO, Babatunde Olaiya, MD, Lauren Alexander, MD, Kush Singh, MD, Marc Benayoun, MD, PhD, Richard Duszak, MD, Sadhna B. Nandwana, MD

DESCRIPTION OF PROBLEM

Hospital mergers and acquisitions have accelerated in recent years, largely because of the Patient Protection and Affordable Care Act [1]. Despite the many advantages of consolidation, difficulties integrating protocols and guidelines across merged facilities are common. Challenges include incomplete clinical integration and resistance to change [2,3]. This may have substantial implications for patient safety and standardization, particularly in radiology departments.

Because of differences in technology, dosage and scan parameters across CT scanner models often demonstrate wide variability within and across CT imaging practices in health care facilities [4,5]. CT imaging protocols should be optimized and standardized to ensure that the lowest radiation dose is being safely delivered across all sites, which may be challenging during health care system consolidation.

Our academic medical center (AMC) recently acquired a large regional community hospital (CH), and our radiology department aggressively sought to bring the new facility into compliance with the rigorous dose reduction and monitoring programs already in place throughout the rest of the health care system. Those activities include participation in both the Partnership for Dose program (a multicenter National Institutes of Health–funded study analyzing our dose-tracking data for CT imaging) and the ACR Dose Index Registry® (which allows automatic tracking of CT doses and analysis of outlier doses and other discrepancies).

Our systemwide CT protocols are created at a subspecialty divisional level and reviewed by a departmental committee dedicated to CT quality and safety, with the goal of optimizing all CT protocols to ensure that clinical questions are answered while delivering the lowest radiation dose possible. Additional quality assurance mechanisms are in place to facilitate ongoing feedback and communication between technologists and radiologists. Other dose reduction techniques used include meticulous attention to automatic tube current modulation, peak tube current modulation, limiting scan range, and iterative reconstruction in each CT protocol [6,7].

In this report, we describe our experience in replacing prior CH abdominal and abdominopelvic CT protocols with the AMC's optimized protocols. We specifically focus on radiation dose changes and protocol integration issues.

WHAT WE DID

This institutional review board–approved, HIPAA-compliant analysis used quality improvement initiative data. We identified all abdominal or abdominopelvic CT scans performed on all three CT scanners at the CH for 1 month before the radiology departmental merger (December 2013). A similar search was conducted for all nine CT scanners across the AMC imaging facilities for the same month. Data collected included type of examination, number of contrast phases, individual phase volume CT dose index ($CTDI_{vol}$) and total $CTDI_{vol}$, tube current-time product, and tube voltage. The search was repeated 3 months later (March 2014) for the CH scanners after CT scan protocol standardization.

Premerger data from both CH and AMC scanners were analyzed to examine the differences in the number of contrast phases per examination, types of phases, and total $CTDI_{vol}$ before the merger. After the merger, the same parameters were examined and analyzed to explore the effects and extent of existing

1546-1440/16/$36.00 ■ http://dx.doi.org/10.1016/j.jacr.2016.03.021

AMC protocol implementation. Results were analyzed using χ^2 and independent-sample two-tailed t tests, with the significance level set at $P < .05$.

OUTCOMES

A total of 187, 159, and 153 patients underwent either abdominal or abdominopelvic CT at the AMC, the CH before the merger, and the CH after the merger, respectively. Similar numbers of noncontrast, contrast, and combined noncontrast and contrast CT examinations were performed at the CH and the AMC before the merger.

Ninety-four of 159 CT studies (59%) were performed with contrast at the CH compared with 91 of 187 (49%) at the AMC ($P = .052$). Of these CH studies, 93% consisted of a venous phase followed by a delayed phase, compared with none at the AMC ($P < .001$). In contrast, 87% at the AMC consisted of a single portal venous phase, compared with 5% at the CH ($P < .001$). The remainder of the CT studies with contrast at the AMC consisted of biphasic studies, defined as an arterial phase followed by a portal venous phase (12%) or a single arterial phase (1%), compared with none of either at the CH. The remaining 2% of CT studies with contrast at the CH consisted of various combinations of contrast-enhanced phases, including arterial/delayed and arterial/venous/delayed combinations (Table 1).

The percentages of studies performed as combined CT with and without contrast were 9% at the CH and 14% at the AMC ($P = .14$). Within this category, 71% of CH combined CT studies with and without contrast consisted of a noncontrast phase followed by portal venous and delayed phases. The remaining 29% consisted of a noncontrast followed by an arterial and a portal venous phase or noncontrast followed by arterial, portal venous, and delayed phases. At the AMC, 54% of combined CT studies with and without contrast consisted of a noncontrast phase followed by arterial and portal venous phases, 35% were noncontrast phase followed by a portal venous phase, and 11% were noncontrast followed by a delayed phase (Table 1). Similar numbers of noncontrast CT studies occurred at both the CH and the AMC. Specifically, 32% of examinations at the CH were noncontrast examinations, compared with 37% of the AMC CT studies ($P = .30$) (Table 1).

Regarding $CTDI_{vol}$ before the merger, the mean total value was significantly higher at 27.6 mGy for the CH compared with 19.3 mGy for the AMC ($P < .05$). Individual phases (noncontrast, arterial, venous, delayed) also had higher mean $CTDI_{vol}$ values at the CH.

Table 1. CT phase patterns across the AMC and CH before and after CT protocol implementation

	Facility					
	AMC		CH Before Implementation		CH After Implementation	
	n	%	n	%	n	%
CT noncontrast only						
Total	70	37	51	32	71	46
CT with contrast only						
Total	91	49	94	59	75	49
Arterial	1	1	0	0	2	3
Venous	79	87*	5	5	70	93
Arterial/venous	11	12	0	0	1	1
Arterial/delayed	0	0	1	<1	0	0
Venous/delayed	0	0	87	93*	2	3
Arterial/venous/delayed	0	0	1	<1	0	0
CT with and without contrast						
Total	26	14	14	9	7	5
Noncontrast/venous	9	35	0	0	3	43
Noncontrast/delayed	3	12	0	0	0	0
Noncontrast/arterial/venous	14	54	1	7	1	14
Noncontrast/venous/delayed	0	0	10	71	3	43
All four	0	0	3	21	0	0

Note: AMC = academic medical center; CH = community hospital.
*Statistically significant difference between AMC and CH before implementation ($P < .05$).