Multifaceted Approach to CT Dose Reduction for "Rule-Out Aortic Dissection"

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Background

- Acute Aortic Syndromes
  - Aortic Dissection
  - Intramural hematoma
  - Penetrating atherosclerotic ulcer
  - Aortic rupture
- Incidence reported 5-30 / 1 million per year

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Acute Aortic Syndromes

- Mortality
  - 20% before hospitalization
  - 20% during hospital admission
  - 20% over the next 10 years
- Difficulty in clinical diagnosis
  - Signs and symptoms lack sensitivity and specificity for AAS
  - Correctly suspected in only 15-43% of cases

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Research Background

- IRB approved retrospective review of all patients referred for evaluation of AAS within the Montefiore Medical Center enterprise from 1/1/06 – 8/1/10
- Analysis focused on clinical and radiographic parameters associated with AAS
- Models of proposed clinical algorithms suggested and performance evaluated

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Research Background

- Based on retrospective data available, clinical algorithms for appropriate imaging were developed
- Performance of these proposed models was calculated

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Original Contribution

Preliminary development of a clinical decision rule for acute aortic syndromes☆,☆☆

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ABSTRACT

Objective: Patients with suspected acute aortic syndromes (AAS) often undergo computed tomography (CT) with negative results. We sought clinical and diagnostic criteria to identify low-risk patients, an initial step in developing a clinical decision rule.
Methods: We retrospectively identified all adults presenting to our emergency department (ED) from January 1, 2006, to August 1, 2010, who underwent CT angiography for suspected AAS without prior trauma or AAS. A total of 1465 patients met inclusion criteria; a retrospective case-controlled review (ratio 1:4) was conducted. Cases were diagnosed with aortic dissection, intramural hematoma, penetrating atherosclerotic ulcer, or ruptured aneurysm.
Results: Of the patients who underwent CT, 2.7% (40/1465) had an AAS; 2 additional cases were diagnosed after admission (ED miss rate, 5% [2/42]). Patients with AAS were significantly older than controls (66 vs 59 years; $P = .008$). Risk factors included abnormal chest radiograph (sensitivity, 75% [26/33]; specificity, 82% [113/137]) and acute chest pain (sensitivity, 83% [29/35]; specificity, 71% [111/157]). None of the 19 patients with resolved pain upon ED presentation had AAS. These data support a 2-step rule: first screen for ongoing pain; if present, screen for acute chest pain or an abnormal chest radiograph. This approach achieves a 54% (84/155) reduction in CT usage with a sensitivity for AAS of 96% (95% confidence interval, 89%-100%), negative predictive value of 99.8% (99.4%-100%), and a false-negative rate of 1.7% (1/84).
Conclusions: Our results demonstrate a need to safely identify patients at low risk for AAS who can forgo CT. We developed a preliminary 2-step clinical decision rule, which requires validation.

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Research Background: Results

- Internal audit of CT use for indication of AAS illuminated a system wide problem:
  - Large population radiation burden
  - Multiphase CT protocol
  - Overall, low incidence of AAS in those imaged
  - Poor and inconsistent clinical predictors utilized by referring ED staff

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Purpose:

- To describe a multifaceted approach to CT dose reduction for patients suspected of having AAS at a large inner-city academic medical center
- Highlight themes and aspects of these successful efforts that can be extrapolated to other clinical scenarios and other imaging settings

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Methods:

- 6 key elements of this effort:
  - CT Technical parameters
  - Radiation dose archive
  - Multiphase imaging optimization
  - Unification of imaging protocol across multiple imaging sites
  - Development of clinical predictors of AAS
  - Collaboration with referring clinicians in development of powerful research database

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Methods:

- Composite results of these multiple efforts evaluated
  - Overall CT radiation dose
  - Consistency of CT dose archive
  - Referral patterns and audit of appropriate indications
  - Audit of overall positive rate as surrogate for appropriateness
  - Availability of essential clinical data for research

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Modification 1:
CT Technical Parameters

- Standardized voltage settings for all "CT Aortic Dissection" cases reduced to 100 kVp

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Modification 2: Dose Recording

- Institution of Department wide requirement for Dose Report inclusion in PACS with each study

Accession Number: 16238916 Oct 01 2014
Patient ID: 02710787 LightSpeed VCT
Exam Description: CT Aortic Dissection

Dose Report

Series	Type	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy-cm)	Phantom cm
1	Scout	-	-	-	-
2	Helical	I129.250-I319.250	5.83	148.57	Body 32
200	Axial	I313.000-I313.000	7.20	3.60	Body 32
4	Helical	I52.250-I681.000	9.03	625.87	Body 32
			Total Exam DLP:	778.04	

1/1

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Modification 3: Multiphase Scanning Reduction

- Previous standard protocol included pre-contrast imaging of chest and abdomen for detection of intramural hematoma
- Standard protocol altered to pre-contrast imaging of the thorax only

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Modification 4:
Protocol Uniformity

- Montefiore Medical Center represents an integrated health care network of 6 hospitals and 3 full time ERs
- Medical Center has continued to expand with new hospitals and new affiliations with other local entities
- Emergency Department volume consistently within top 5 nationally

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- Greater than 275,000 ED visits /year
- Greater than 48,000 CT exams / year

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Modification 4: Protocol Uniformity

- Recognition of heterogeneous imaging protocols that existed across hospital enterprise
- Unified protocol with standard study name "CT Aortic Dissection"

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Modification 5: Referring Physician Collaboration

- Research and audit using an interdisciplinary approach with active involvement of our primary referral base, ED physicians
- Development and publication of clinical algorithm based on retrospective data
- Collaborative initiative yielded a focused effort on optimizing patient selection

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Modification 6:
Prospective Data Accrual

- Order Entry for new imaging study allowed for *a priori* development of unique interface to require all relevant research data to be entered prospectively

- Effective tool for prospective research reliant on clinical records and for validation of proposed clinical algorithm

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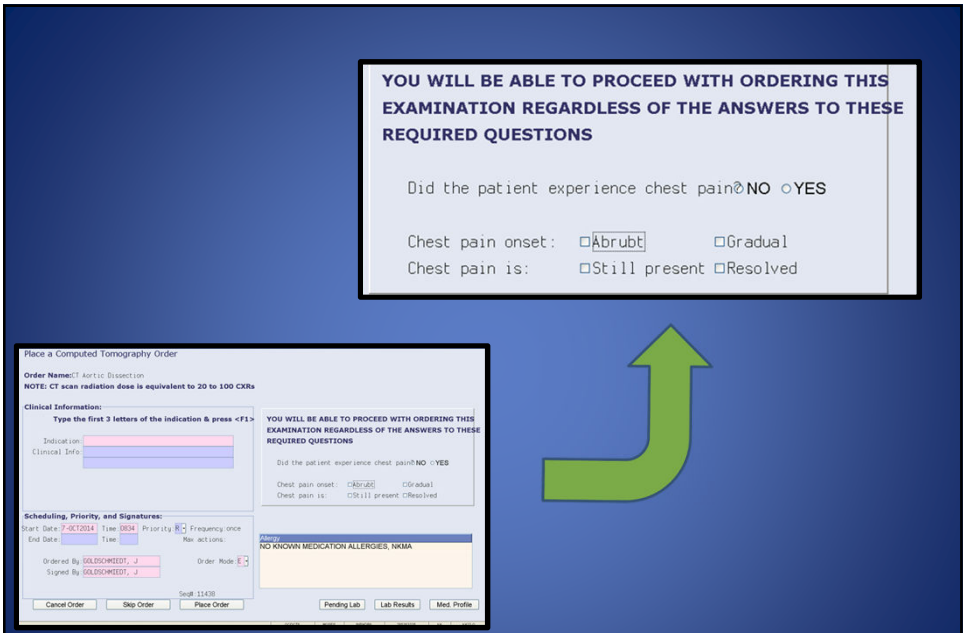

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Results:

- 6 months of data accrual (8/13-1/14)
  - 192 cases of "CT Aortic Dissection" performed
- Comparison made to published institutional data which predated this multifaceted approach

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	Control	Study Population	
Cases (N=)	1465	192	
Mean Effective Dose	43 ± 20 mSv	13 ± 6 mSv	p = 0.0001
Incidence rate	2.7 %	4.3 %	p = 0.14
Dose Recorded	61%	100%	p < 0.05

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Results:

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Technical Modifications

- Optimized voltage
- Limitation of multiphase acquisition
- Resulted in 70% reduction in Effective Dose

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Elimination of unnecessary scans

- Trend to increased incidence in the imaged population implies more appropriate patient selection
- Elimination of pre-contrast abdominal imaging

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Attention to Quality Improvement Processes

- Standardized technique across large enterprise
- Consistent archive of radiation dose
- Uniform exam title allows for easy and focused audit

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Inter-Departmental Collaboration

- Development of clinical algorithm
- Assist in implementation of optimization techniques
- Builds rapport and respect for colleagues across multiple specialties
- Collaborative research opportunities

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Discussion I:

- Complexity contributes to many challenges in the Radiology community
- Solutions must address various components that contribute to practice optimization

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Discussion II:

- Often, the solutions to these complex challenges require alterations both in radiology practice and clinical interactions
- Involvement of clinical services facilitates effective problem solving, increases the likelihood of successful implementation and contributes to robust clinical research

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Discussion III:

- The Radiology community serves a crucial role in stewardship in Quality Assurance measures and leading interdisciplinary problem solving

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Thank You

Goal:
Successful
radiation
reduction

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