



A Presentation System for Just-in-Time Learning in Radiology



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Why “Just-in-Time”?

Education

Knowledge when
you can't use it

Decision support

Information when
you're too busy to
learn anything

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FOLLOW THE MONEY
By SCOTT HENSLEY



Doctors' Continuing Education Needs Prescription for Change
April 19, 2004 5:52 p.m.

Heart-attack patients get the same quality of care whether or not their doctor has taken continuing-education classes.

This disappointing finding from a study to be published in a few months suggests the \$1.6 billion system for educating doctors after they graduate from medical school isn't cutting it. The system has also been characterized as too influenced by drug makers, whose funding has swayed the curriculum.

Most states require doctors to keep up with current practice through a minimum number of hours of accredited continuing medical education, or CME, in order to renew their

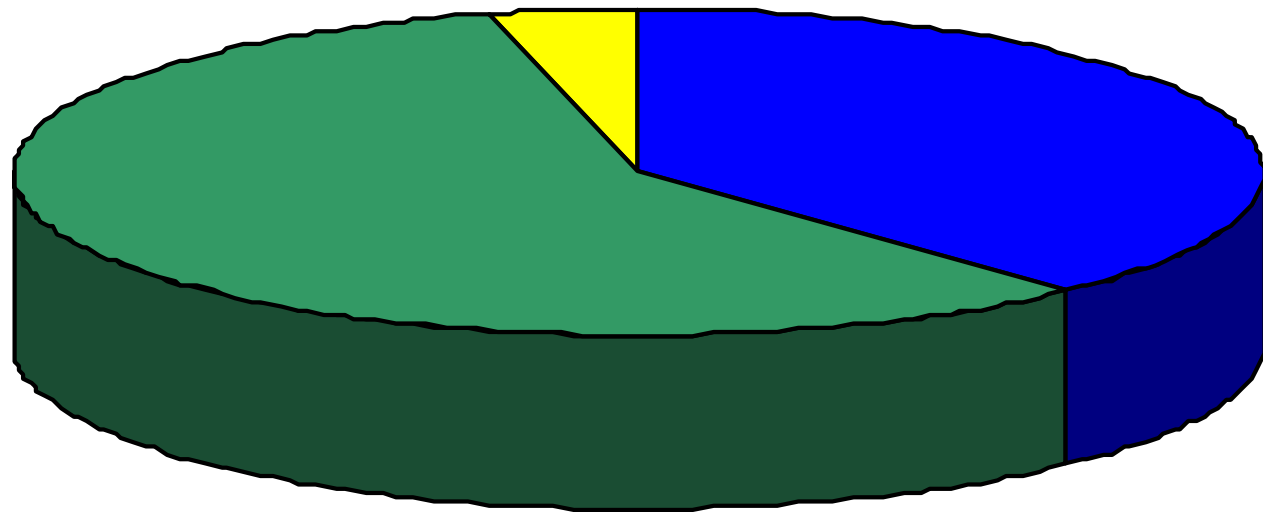
19 April 2004



“Just-in-Time” Learning

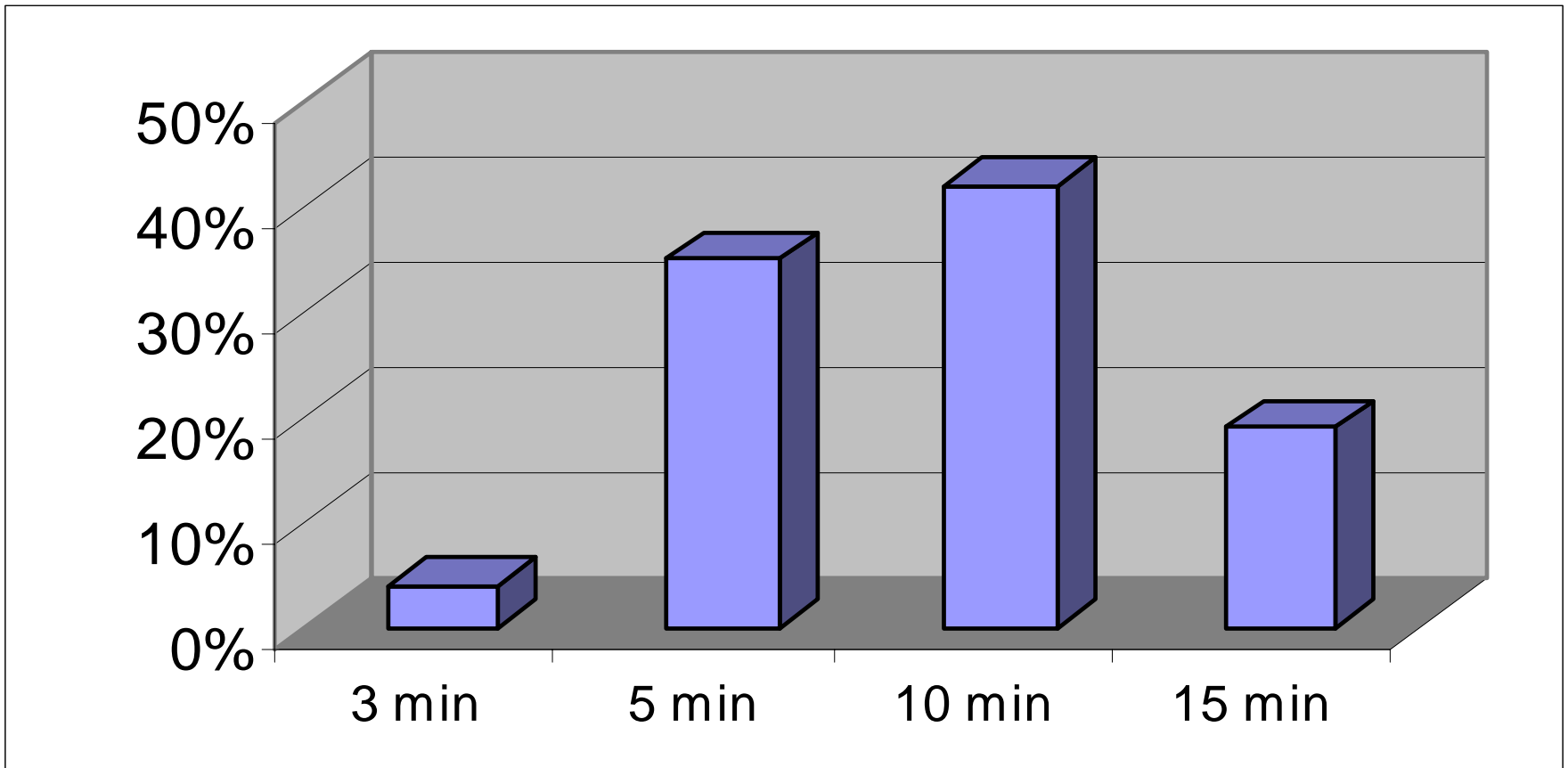
- “Situated learning”
 - Integrate learning into the setting where knowledge is used
 - Supported by educational theory and empirical evidence
- Embed learning and self-assessment into the radiologist’s daily workflow using RIS and PACS

Just-in-Time Learning



- I definitely would use it
- I would try it, and might use it if I liked it
- Unsure
- I probably would not use it
- I would not use it

Brief Learning Modules



Kahn et al., JDI 2006 (in press)



Introducing TEMPO

- Brief educational modules
- Targeted education
 - Clinical context
 - Imaging procedure
 - Body part(s)
 - Radiologist's educational needs, preferences, and level of expertise
- Self-assessment questions



Materials

- 74 *AJR* articles
 - With kind permission from ARRS
- Extracted data from *AJR* Online
 - 400 article sections
 - 1,594 figures
 - 1,422 references
 - 26 tables

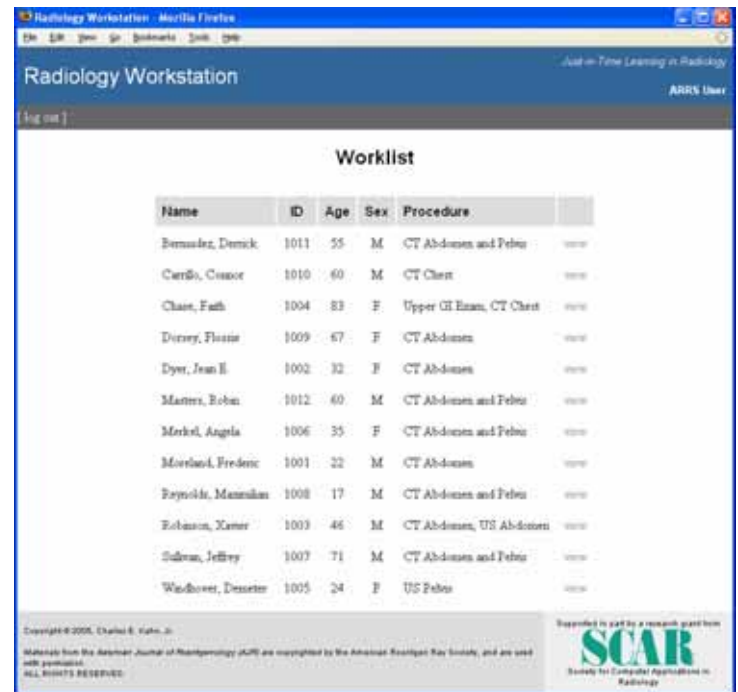


Methods

- 34 learning modules
 - Learning objectives
 - Multiple-choice test items
 - 0.1 – 0.5 CME hours
- TEMPO learning management system
 - Web services to identify clinical context

Radiology Workstation

- Simulates PACS
 - Web-based
 - Individual user sign-on
- Radiologist worklist
 - 10 cases
 - body CT / US
- Web services link to TEMPO



The screenshot displays a web-based interface for a Radiology Workstation. The title bar indicates 'Radiology Workstation - Mozilla Firefox'. The main content area is titled 'Radiology Workstation' and includes a 'Worklist' section. The worklist is presented as a table with the following data:

Name	ID	Age	Sex	Procedure
Bernandez, Derrick	1011	55	M	CT Abdomen and Pelvis
Carroll, Connor	1010	60	M	CT Chest
Chant, Faith	1004	83	F	Upper GI Exam, CT Chest
Dorsey, Flame	1009	67	F	CT Abdomen
Dyer, Jean E.	1002	32	F	CT Abdomen
Martens, Robin	1012	60	M	CT Abdomen and Pelvis
Merkel, Angela	1006	35	F	CT Abdomen and Pelvis
Morland, Frederic	1001	22	M	CT Abdomen
Fajnicki, Marianne	1008	17	M	CT Abdomen and Pelvis
Johnson, Carter	1003	46	M	CT Abdomen, US Abdomen
Sullivan, Jeffrey	1007	71	M	CT Abdomen and Pelvis
Wardover, Debra	1005	24	F	US Pelvis

At the bottom of the interface, there is a copyright notice: 'Copyright © 2005, Charles E. Kahn, Jr.' and a logo for SCAR (Society for Computer Applications in Radiology).

Radiology Workstation

ARRS User

[log out]

Worklist

Name	ID	Age	Sex	Procedure	
Bermudez, Derrick	1011	55	M	CT Abdomen and Pelvis	view
Carrillo, Connor	1010	60	M	CT Chest	view
Chase, Faith	1004	83	F	Upper GI Exam; CT Chest	view
Dorsey, Flossie	1009	67	F	CT Abdomen	view
Dyer, Jean E.	1002	32	F	CT Abdomen	view
Masters, Robin	1012	60	M	CT Abdomen and Pelvis	view
Merkel, Angela	1006	35	F	CT Abdomen and Pelvis	view
Moreland, Frederic	1001	22	M	CT Abdomen	view
Reynolds, Maximilian	1008	17	M	CT Abdomen and Pelvis	view
Robinson, Xavier	1003	46	M	CT Abdomen; US Abdomen	view
Sullivan, Jeffrey	1007	71	M	CT Abdomen and Pelvis	view
Windhover, Demeter	1005	24	F	US Pelvis	view

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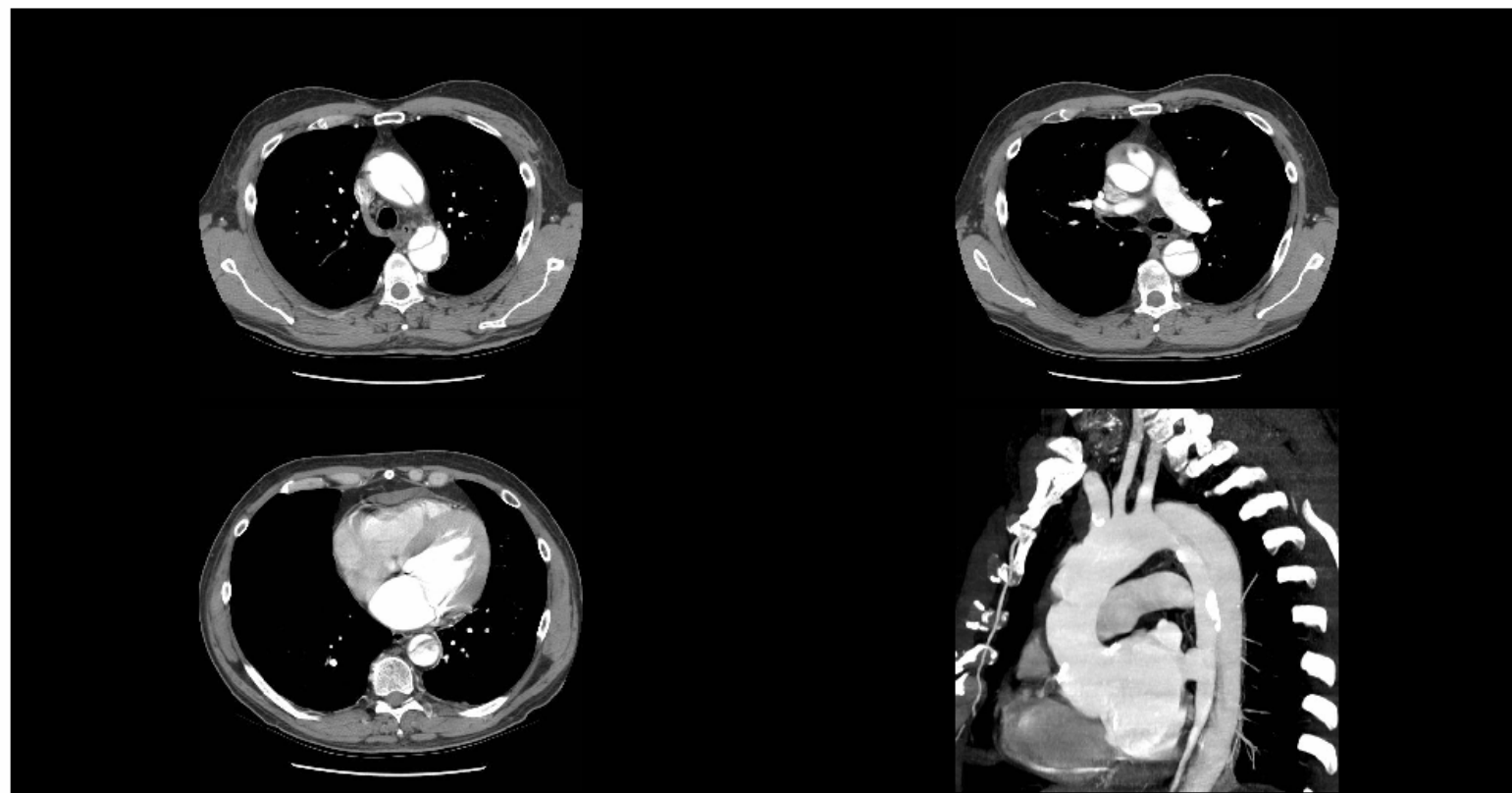
SCARSociety for Computer Applications in
Radiology

Radiology Workstation

ARRS User

[\[Worklist \]](#) [\[TEMPO Learning \]](#) [\[Log out \]](#)**#1010 Carrillo, Connor (60 M)****CT Chest**

Sudden back pain, extending to lower extremities.



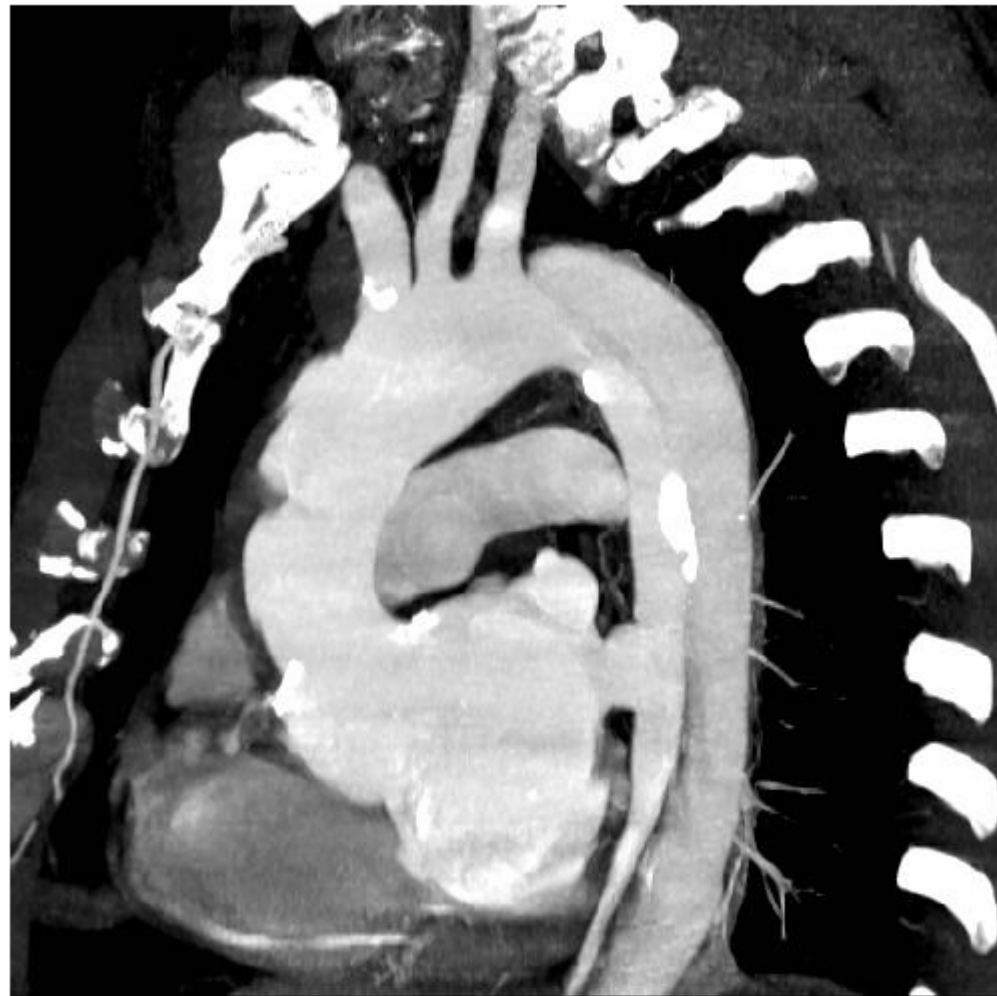
Click an image to view it at full size.

<http://arsenal.cs.uwm.edu> - tad1.jpg (JPEG Image, 512x512 pix...)



Done

<http://arsenal.cs.uwm.edu> - tad4.jpg (JPEG Image, 512x512 pix...)



Done



TEMPO Learning

- Linked from clinical case
- Context awareness
 - User ID
 - ICD-9 codes: exam indications
 - CPT-4 codes: imaging procedure
 - Free-text exam information



Learning Module Selection

- Ranks relevant modules
 - Shows title and CME credits
 - Excludes completed modules
- Entire list of modules can be viewed

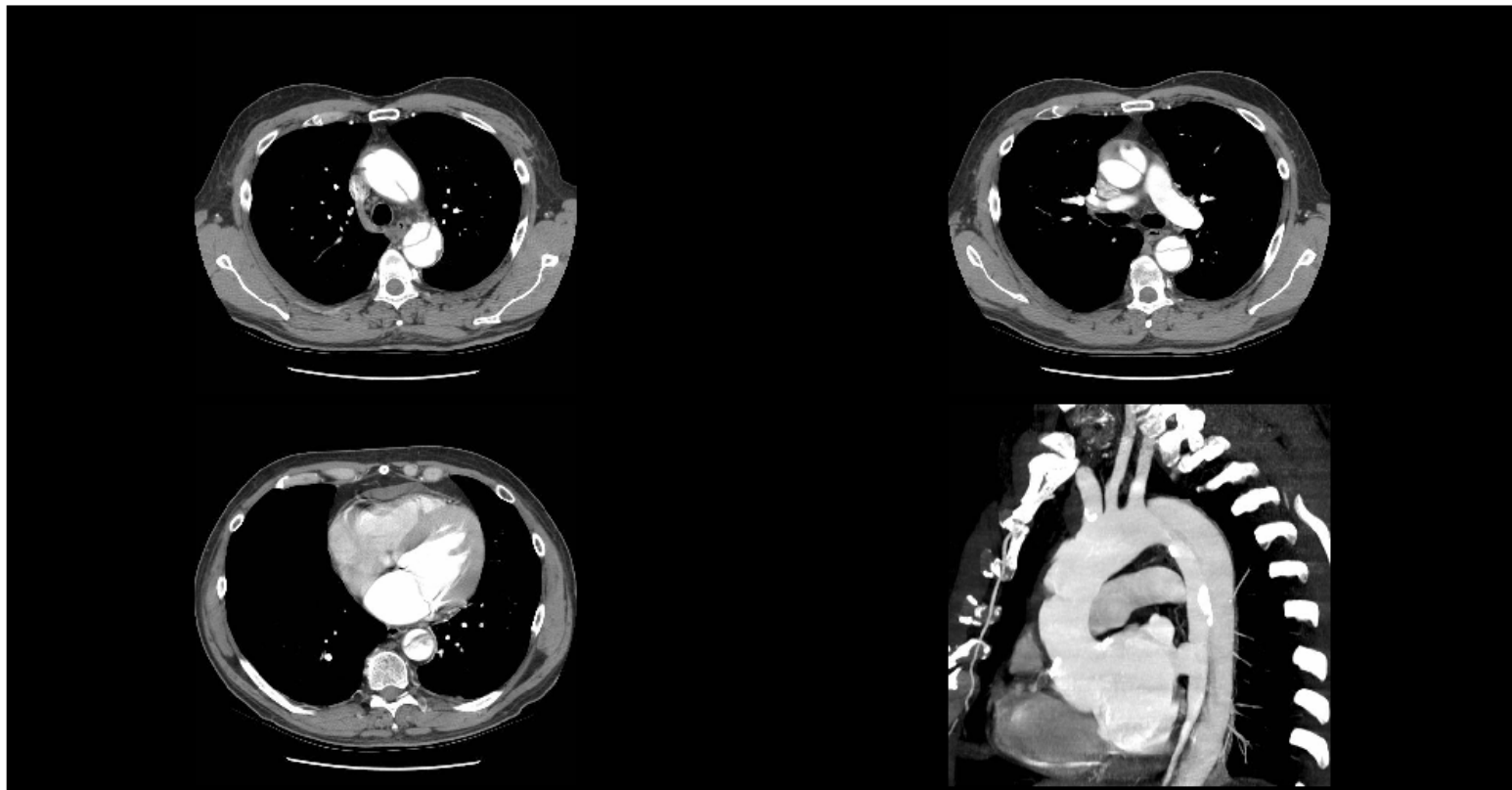
Radiology Workstation

[Worklist] [**TEMPO Learning**] [Log out]

#1010 Carrillo, Conn (60 M)

CT Chest

Sudden back pain, extending to lower extremities.



Click an image to view it at full size.

	Learning Module		CME Hours
●●●●●	Aortic Dissection		0.20
●●●●●	Pulmonary Vein Anomalies		0.40
●●●●●	Azygos System Anomalies		0.40
●●●●●	Superior Vena Cava Anomalies		0.20
●●●●	Traumatic Aortic Transection		0.20
●●	Hereditary Hemorrhagic Telangiectasia: (1) Lung		0.20
●	Aortic Intramural Hematoma and Penetrating Ulcer		0.30



[List all modules](#)

Aortic Dissection

Learning Objectives:

- ◆ Understand the mechanisms involved in the disruption of the aortic wall layers.
- ◆ Recognize the imaging characteristics of aortic dissection.

0.20 CME hours



Based on:

Pathogenesis in Acute Aortic Syndromes: Aortic Dissection, Intramural Hematoma, and Penetrating Atherosclerotic Aortic Ulcer

Katarzyna J. Macura, Frank M. Corl, Elliot K. Fishman and David A. Bluemke
AJR 2003; 181:309-316

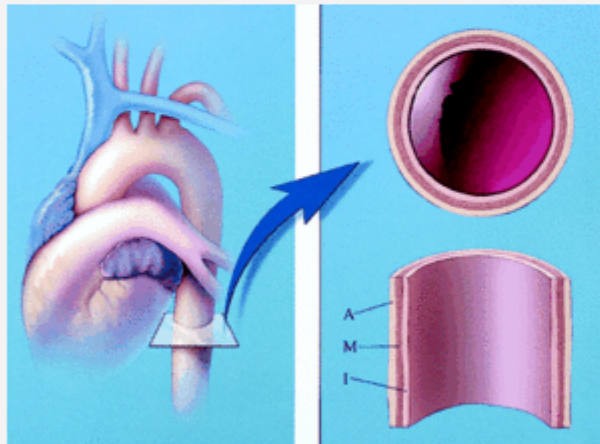
[Begin module](#)

[Select another module](#)

Aortic Dissection

Figure 1

Diagram shows three layers of normal aortic wall, from inner to outer: intima (I), media (M), and adventitia (A).



Acute aortic syndromes refer to the spectrum of aortic emergencies that include aortic dissection, intramural hematoma, penetrating atherosclerotic ulcer of the aorta, aortic aneurysm leak and rupture, and traumatic aortic transection. The aortic wall is composed of three layers (Fig. 1): the inner layer of intima, the middle layer of media, and the outer layer of adventitia. Multiple mechanisms are involved in the disruption of the aortic wall layers, leading to various acute aortic syndromes. This pictorial essay focuses on the distinction of a typical aortic dissection from an intramural hematoma and penetrating atherosclerotic ulcer.

A classic aortic dissection begins with a laceration of the aortic intima and inner layer of the aortic media, forming an entrance tear that allows entering blood to split the aortic media [1]. The splitting of the media is responsible for formation of a double-channel aorta, with an aortic dissection flap dividing the aortic lumen into true and false lumens (Figs. 2 and 3A, 3B). The intima and the inner part of the aortic media form the intimomedial flap. The flap tissue is composed mainly of aortic media delaminated from the aortic wall [2]. The outer portion of the aortic media and adventitia form the outer wall of the false channel. Reentrance tears are usually present in the intima, creating additional communication between the true and false lumens in the distal aorta. The true lumen is usually small with high-velocity flow, whereas the false lumen is larger with slower velocity, turbulent blood flow (Fig. 4A, 4B).

Aortic Dissection

References

1. Coady MA, Rizzo JA, Elefteriades JA. Pathologic variants of thoracic aortic dissections: penetrating atherosclerotic ulcers and intramural hematomas. *Cardiol Clin* 1999; 17:637-657
2. Vilacosta I, San Roman JA. Acute aortic syndrome. *Heart* 2001;85:365-368
3. Larson EW, Edwards WD. Risk factors for aortic dissection: a necropsy study of 161 cases. *Am J Cardiol* 1984; 53:849-855

Cystic medial necrosis associated with connective tissue disorders was once believed to contribute to degeneration of the aortic media leading to aortic dissection. However, a study showed that a minority of patients with aortic dissection exhibited medial degeneration [3]. In most patients, the primary event that allowed the blood to spread through the aortic media was the intimal tear. When present, degenerative changes within the media and the loss of the elastic tissue reduce the resistance of the aortic wall to hemodynamic stress, leading to subsequent dissection. Hypertension-related spontaneous rupture of the aortic vasa vasorum might lead to intramural hematoma and subsequently to intimal tear. Intramural hematoma precedes intimal rupture because hemorrhage of the vasa vasorum weakens the media, and the arterial pressure from blood flow in the aortic lumen subsequently favors the entrance of blood from the lumen into the aortic media [1]. Atherosclerosis was once thought to cause aortic dissection. However, there is an association between an atheroma and the location of dissection in only a small number of patients [1]. Dissection in the region of gross atherosclerosis is usually limited by neighboring fibrosis and calcification.

Mechanical forces contributing to aortic dissection include flexion forces of the vessel at fixed sites, the radial impact of the pressure pulse, and the shear stress of the blood. During the cardiac cycle, the heart and aorta produce rhythmic movements, allowing all but fixed segments to move. These fixed points of the aorta are exposed to the most significant flexion forces. Classic type A and B aortic dissections produce an intimal tear at the areas of greatest hydraulic stress: the right lateral wall of the ascending aorta



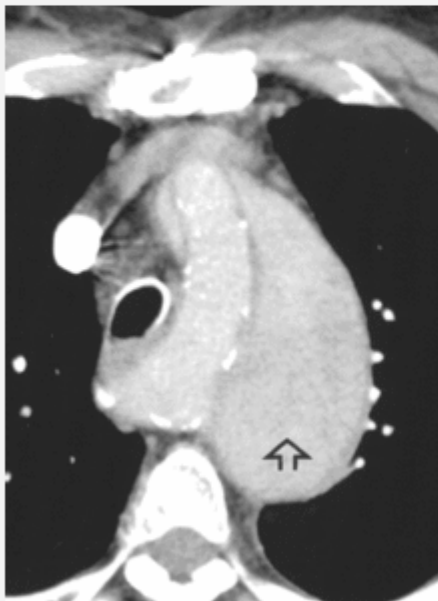
Self-Assessment

- Multiple-choice items
 - Immediate response
 - Explanations of right and wrong choices
- Choices pseudo-randomized
 - Based on user + item numbers
 - Each user sees a different order
 - Consistent ordering for each user

Aortic Dissection

Figure 5B

68-year-old man with aberrant right subclavian artery and horseshoe kidney.



Axial contrast-enhanced CT scan shows dissection involving aortic arch with calcifications within intimomedial flap and different attenuation of enhanced blood within true and false (arrow) lumens. Intimal tears leading to dissection

Which of the following CT findings is most specific for aortic dissection?

- Mediastinal hematoma
- Intimomedial flap within the aorta
- Abberant right subclavian artery
- Hypoperfusion of a kidney

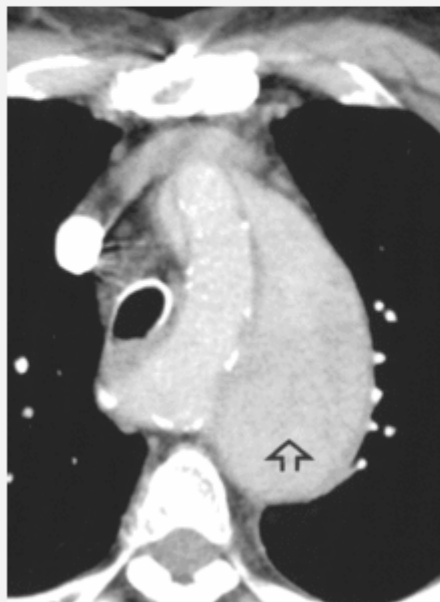
To receive your CME credits for this learning module, click below:

[Complete module](#)

Aortic Dissection

Figure 5B

68-year-old man with aberrant right subclavian artery and horseshoe kidney.



Axial contrast-enhanced CT scan shows dissection involving aortic arch with calcifications within intimomedial flap and different attenuation of enhanced blood within true and false (arrow) lumens. Intimal tears leading to dissection

Which of the following CT findings is most specific for aortic dissection?

- Mediastinal hematoma

This is highly suggestive of aortic injury, but may also occur in injury to other vessels or be a normal postoperative appearance.
- Intimomedial flap within the aorta

Yes. The flap divides the true and false lumens.
- Abberant right subclavian artery

No. This may simply be an anatomic variation. Intimal tears leading to dissection frequently form in areas of elevated hydraulic stress, such near aberrant vessel origins.
- Hypoperfusion of a kidney

This is an associated finding, but may also occur in chronic renal disease, renal artery stenosis, post-surgical, and/or infarct.

TEMPO » Aortic Dissection - Mozilla Firefox

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Just-in-Time Learning in Radiology

TEMPO

ARRS User

Aortic Dissection

You have completed 0.20 CME hours

Select another module 

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Done



Preliminary Evaluation

- System Usability Scale (SUS)
 - 10 Likert-scaled items
 - Score = 0 to 100
 - Usually 65 to 70
 - 17 radiology staff and residents
 - SUS score = 70.6 ± 8.2
- Learning modules relevant to case (88%)
- Optimal length of learning modules (94%)



Conclusions

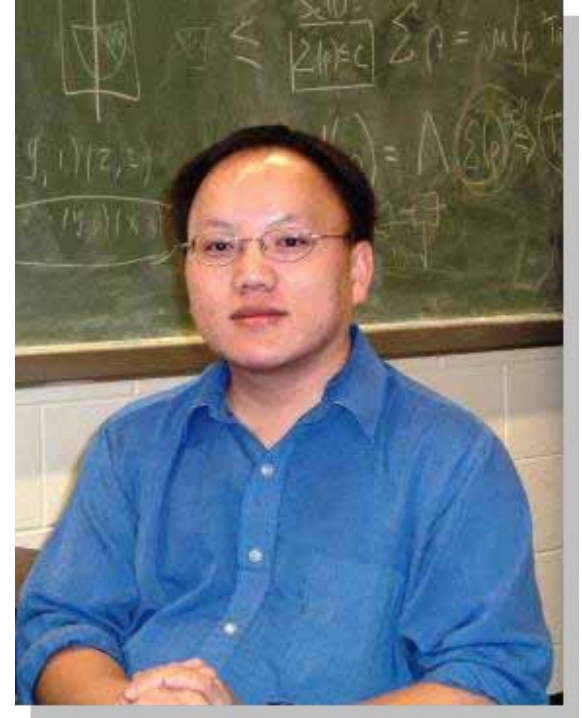
- Information technologies can embed education into clinical practice to create “just-in-time” learning
- Radiologists received TEMPO favorably, and are interested in JIT learning



Amadeu Santos, MD



Jayson Rock, MS



Cheng Thao, MS

Kevin Ehlers, MS

Paul Nagy, PhD

Heartfelt Thanks...



- Research grant



- License to use *AJR* articles



TEMPO

Demonstration

Friday 3:30 – 5:00 pm