#### iMaging 5.0: Our Newest Radiology Operating System Unleashed

Kenneth L. Pierce, M.D.
Associate Professor
Stritch School of Medicine

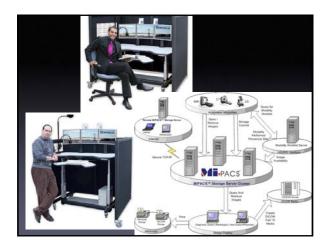
# iMaging 5.0: What's New?

- PACS
- Consultants
- Modalities
- Protocols
- HIPAA

#### **PACS**

- picture archiving and communication systems
- replaces hard-copy based means of managing medical images
- 'filmless'
- off-site viewing/interpretation
- data storage vs. fileroom

4	

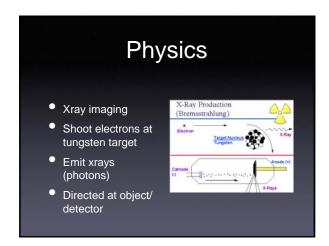


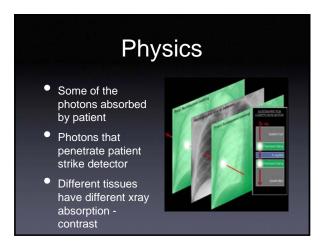
#### **PACS**

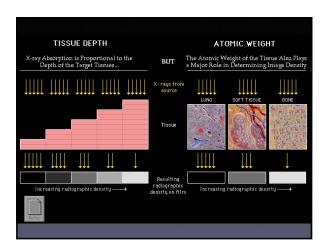
- Workstations in the main department
- 3MP resolution
- In OR
- Web-based browsers
- On PCs throughout hospital/clinics
- Available on home PC thru VPN
- CDs of studies are available in file room

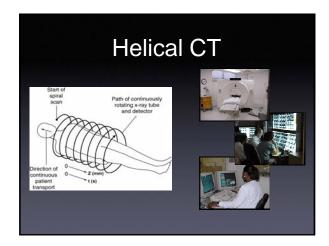
#### PACS vs Film

- Advantages/ Disadvantages
  - Storage
  - Access
  - Cost
  - Security









# MR Basics • Hydrogen proton imaging • Observe behavior of protons in magnet after application of RF signal • Unsurpassed contrast resolution, spatial resolution limited • Time consuming, costly • Contraindications?

# Ultrasound 1 to 10 MHz frequency/ 1.5mm wavelength speed determined by tissue different tissues(impedance)->different speed->reflection time for echo to travel back to probe used to calculate depth of tissue interface causing echo

## Doppler Ultrasound



- apparent change in frequency or wavelength of a wave that is perceived by an observer moving relative to the source of the waves
- rbc's move away or towards the transducer
- measuring frequency shift of a particular sample blood volume determines speed and direction

#### Nuclear Medicine

- uses unsealed radioactive substances in diagnosis and therapy
- differ from most other imaging modalities in that the tests show the function of the system being investigated as opposed to the anatomy
- majority of diagnostic tests involve formation of an image using gamma camera
- Most diagnostic radionuclides emit gamma

#### **Nuclear Medicine**

- The most commonly used radionuclides are:
  - technetium-99m
  - iodine-123 and 131
  - thallium-201
  - gallium-67
- PET metabolically active molecule (sugar)

—
—

#### **PET**

- positron emission tomography
- Oncology: (18F) fluorodeoxyglucose (FDG, FDG-PET) retained by tissues with high metabolic activity
- Neurology: radioactivity associated with brain activity
- Cardiology: "hibernating myocardium"

#### Interventional Radiology

- Vascular Diagnosis

  - ArteriographyVenographyLymphangiography
- Vascular Intervention
  - Angioplasty/stents Embolization

  - Filters
  - Chemoembo
- Venous access

- Non Vascular Intervention
  - Regional tumor therapy
  - Biopsy
  - Drainage
  - Biliary
- Urological

#### Radiologist as Consultant

- We're not 'technologists'
- Offer advice re:
  - Exam indication
  - Procedures
  - Interpretation
  - Conferences

-	

#### PROTOCOL

- ACR appropriateness criteria
- Available at acr.org
- Not perfect, but helpful
- Not followed

Clinical Condition:	Routing Admission and Pres	persons com mateigraphy	
Variant 1:	Asymptomatic; history and p	dysical unromarkable.	
Radiologie E Procedur		mess Commen	ės.
Routing admission cheet x-r			
Preoperative chest x-ray	2		
	Approprietasses Cr 1 2 3 6 5 6 1-Casel approprieta	Tech Sols 7 8 9 9-Med appropriate	
Variant 2:	Acute cardingulmonary find	ings by history or physical.	
Radiologic E Precedur		Common	n.
Routing admission chort x-		Cimit	
Prosperative chest x-ray			
	Approximate Ci	tteria Scalu 7 8 9 3-Mest appropriate	
Yariant.3:	Chronic cardiopulmonary di within 6 months available.	sense in the elderly (>65-year-old), p	revious CXR
Radiologie E			
Prosperative chest x-ray	e Rating	Common	ės
Routine admission chort x-r	sy 4		
	Appropriates CO		
Yariant 6:	1-Lent spropriets  Chronic cardiopulmonary di within 6 months nor available	9-Meet supreprints becase in the elderly ("45-year-old), p	revisus CXR
Radiologic E	xam Appropriate	10033	
Procedur Routine admission chest x-r		Common	ds
Prespensive chest x-ray	8	_	
	Agungelelesen C	Storie Nuelle	
	1 2 3 4 5 6 1-Cept appropriate	1 8 9 5-Med parenting	

Clinical Condition: Ro	opiratory Fallure	
Yariant 2: Pr	ellents receiving mechanical	ventilation.
Radiologic Exam Procedure	Appropriateness Rating	Comments
Pertable X-Ray Duily portable radiograph	,	
Follow-up for specific clinical conditions	9	
	Appropriational Criteri 1 2 3 4 5 6 7 part appropriate	Scale 8 9 9-Most appropriate
	00.000000	P Ann April 1988
Clinical Condition: Co	ompromised Respiratory Fu	enction
Yariant 3: Po	rients with endotracheal to	hes.
Radiologic Exam Procedure	Appropriateness Rating	Comments
Portable X-Ray	Parting	Constitution
Immediately after initial tube placement	,	
Subsequent routine for tube position	No Conspicus	
Follow-up for specific clinical indications	9	
	Appropriations Crists 1 2 3 4 5 6 7	. Fools
1-6.	on agreeists	P-Most appropriate
Yariant 6: Co	outine Cheet Radiographs intral venous pressure cath	rier insertion.
Radiologic Exam Procedure	Appropriateness Rating	Comments
Portable X-Hay		
Immediately following CVP insertion	9	
Follow-up for suspected clinical conditions		
Subsequent routine follow-up for cathotic position	2	
	Assertational Cities 1 2 3 4 5 6 7	is Scale

Clinical Condition: Cardiopoleon	ary Compromise	
Yariant 5: Swan-Ganz cat	heter.	
Radiologic Exam Procedure	Appropriateness Rating	Comments
Portable X-Ray		
Immediately after catheter insertion	9	
Fellow-up for clinical indications only	8	
Subsequent follow-up for eatheter position	2	
Appropriate	ngelatunus Critoria Scale 2 3 4 5 6 7 8 9 9-Mar	el appropriate
Clinical Condition: Potential Card <u>Yariant 6:</u> Nasogastric (N	iopulmonary Compros G) tube.	mise
Radiologic Exam Procedure	Appropriateness Rating	Comments
Portable X-Ray	8	Connecto
Immediately after initial small bore feeding tube or NG tube (before first feeding)		
Immediately after NG tube insertion intended for suction or gas release only	6	Non-feeding NG tube.
Subsequent follow-up for tube position	2	
	agriatomos Criteria Scale 2 3 4 3 6 7 8 9	
1 Sout appropriets	9-36e	et appropriete
Clinical Condition: Respiratory Co Yariant.7: Chest tube inse		
Radiologic Exam Procedure	Appropriateness Rating	Comments
Portable X-Ray Immediately following tube insertion	*	
Follow-up for specific clinical conditions only		
Subsequent follow-up of tube position	2	
	spriadonesa Criteria Scale	
Acon appropriate		d appropriate

	hest Pain ed pulmonary emboli	ism.
Radiologic Exam Procedure	Appropriateness Rating	Comments
Chest Film	9	Needed to correlate with V/Q scan and to help explain scan finding. Useful to exclude other conditions that may mimic symptoms.
Radionuclide V/Q Lung Sean	9	Generally accepted to be primary test to exclude diagnosis of PE. Quality of study & experience of reader are important.
Selective Pulmonary Angiography with Right Heart Catheterization	8	Indicated after an "intermediate" and "low" probability V/Q scans, yet still clinically suspiciou for PE, or a poor quality scan.
Spiral CT/CT Pulmonary Angiography	8	While widely used, there is still some concern regarding sensitivity for smaller and more peripheral emboli, and accuracy of negative scans.
Ultrasound DVT Study (Duplex Doppler Compression US for DVT)	6	Positive results would indicate need for anticoagulant therapy. Negative results would not rule out PE.
Cavography for Filter Placement	6	Recommended when IVC filter placement is planned or patency is in question. Not for routine evaluation of PE.
MR Angiography	5	May have similar utility to helical CT, particularly in patients who should not receive contrast. Limited availability of optimal technology and expertise.
Electron Beam Tomography (EBT)	4	Equipment generally not available. Diagnosis can be established by other modalities.
MRI	4	Large centrally located thrombi may be identified. Generally unnecessary for routine evaluation of suspected PE.
Conventional CT	3	Not generally useful, except for chronic major- vessel thromboembolic pulmonary hypertension.
Transesophageal US (TEE)	2	Of secondary value only; not for routine PE evaluation.
	Appropriateness Crite	

oggle Drawer Containing Th Content Views	umbnail And s	Comments
Criest Film	,	Plain films are needed to exclude other causes for chest pain.
Coronary Angiography	8	Necessary to define extent of stenosis, Usually done late in the work-up.
Transthoracic Echocardiography (TTE)	7	Indicated as a screening test to evaluate cardiac function. Inexpensive and portable.
Left Ventricular (LV) Angiography	7	Indicated to define ventricular function as part of the ischemia evaluation.
Radionuclide Myocardial Perfusion Scan	6	May be indicated to evaluate extent of ischemia. Usually done after initial screening tests suggest ischemia.
Radionuclide Ventriculogram	6	May be indicated to evaluate cardiac function.
Infarct Avid Imaging	5	May be indicated in questionable cases to confirm infarction.
Transesophageal Echocardiography (TEE)	4	May be indicated to evaluate cardiac function or to rule out aortic dissection.
Electron Beam CT/Multihead Ultrafast CT with Contrast	4	Probably not indicated except for quantitating ventricular function. Noncontrast images may be useful in screening for coronary calcification.
Magnetic Resonance Angiography (MRA)	4	
Conventional Computed Tomography with Contrast	3	Little indication except for documenting other sources of chest pain.
Magnetic Resonance Imaging (MRI)	3	Little indication except for screening for possible aertic dissection. May have some applicability in evaluating cardiac function.
MR Perfusion Studies	2	Research studies show some promise in evaluating infarction. Not extensively used clinically.
Position Emission Tomography (PET)	2	See comments on MR perfusion studies.

Radiologic Exam Procedure	Appropriateness Rating	Comments
Computed Tomography Angiography (CTA)	8	
Aortic Ultrasound (US)	8	The definitive screening modality but only measures aortic diameter accurately.
Computed Tomography (CT) with Contrast	8	Accurately defines aortic size and useful in defining extent. Relatively quick with acceptable cost.
Aortography	8	Most accurately defines extent and branch involvement but less accurate in defining diameter. Expensive.
Computed Tomography (CT) without Contrast	7	Useful even when contrast injection contraindicated. Screening helical CT is very rapid and accurate.
Abdominal Plain Films	5	Easily performed and inexpensive, but not accurate in estimating diameter of the aorta. Lateral is more accura- than the frontal plain film in estimating aortic diameter.
Magnetic Resonance Imaging (MRI)	6	Better than CT in defining extent but more expensive an time consuming. Can diagnose an inflammatory ancurysm.
Magnetic Resonance Angiography (MRA)	5	Can define branch involvement with reasonable accurace but is time consuming and expensive.
Peripheral Runoff Angiography	5	Important if there are signs or symptoms of peripheral vascular disease.
Abdominal Ultrasound (US)	4	May miss small aneurysm. Useful if aorta found normal on aortic US.
Aortic Duplex Ultrasound (US)	3	Useful only if signs or symptoms of peripheral vascular disease are present and angiography not planned.
Visceral Angiography	3	Rarely indicated. Risky in patients with large aneurysm
Intravenous Pyelogram (IVP)	2	Only indicated if additional information needed about the urinary tract.

Clinical Condition: Ac	ute Right Upper Quadrant Pain	
Variant 1: Fe	ver, elevated WBC, positive Murphy	sign.
Radiologic Exam Procedure	Appropriateness Rating	Comments
Ultrasound	8	
Cholescintigraphy	6	May use either nuclear medici exam or ultrasound exam.
Plain x-ray	4	
Computed tomography exam	4	
Contrast Studies		
Upper GI	4	
Barium enema	4	
I=Le	Appropriateness Criteria Scale 1 2 3 4 5 6 7 8 9 9-Most a	ppropriate
e'ariant 2: Fe	1 2 3 4 5 6 7 8 9 sist appropriate 9-Most a ver, elevated WBC, positive Murphy	
<u>variant 2:</u> Fe	1 2 3 4 5 6 7 8 9 set appropriate ver, elevated WBC, positive Murphy Appropriateness	sign, normal gallbladder ultraso
e'ariant 2: Fe	1 2 3 4 5 6 7 8 9 sist appropriate 9-Most a ver, elevated WBC, positive Murphy	
variant 2: Fe  Radiologic Exam  Procedure	1 2 3 4 5 6 7 8 9  sst appropriate  ver, elevated WBC, positive Murphy  Appropriateness Rating	sign, normal gallbladder ultraso
Fariant 2: Fe Radiologic Exam Procedure Cholescintigraphy	1 2 3 4 5 6 7 8 9 9-Most a ver, elevated WBC, positive Murphy Appropriateness Rating 8	sign, normal gallbladder ultrasc
Fariant 2: Fe Radiologic Exam Procedure Cholescintigraphy Computed tomography	1 2 3 4 5 6 7 8 9 9-Most a ver, elevated WBC, positive Murphy Appropriateness Rating 8 6	sign, normal gallbladder ultrasc
Radiologic Exam Procedure Cholescintigraphy Computed tomography Plain x-ray	1 2 3 4 5 6 7 8 9 9-Most a ver, elevated WBC, positive Murphy Appropriateness Rating 8 6	sign, normal gallbladder ultrasc
Radiologic Exam Procedure Cholescintigraphy Computed tomography Plain x-ray Contrast Studies	1 2 3 4 5 6 7 8 9 9-Most appropriate ver, elevated WBC, positive Murphy Appropriateness Rating 6 6 6 6	sign, normal gallbladder ultraso
Fariant 2: Fee Radiologic Exam Precedure Cholescintigraphy Computed tomography Plain x-ray Contrast Studie Upper G1 Barium coema Ultrasound	T 2 3 4 5 6 7 8 9 -Mont a properties ver, elevated WBC, positive Murphy Appropriateness Rating 8 6 6 6 3 3	sign, normal gallbladder ultraso
Radiologic Exam Procedure Cholescintigraphy Computed tomography Plain x-ray Contrast Studies Upper GI	T 2 3 4 5 6 7 8 9 -Mont a properties ver, elevated WBC, positive Murphy Appropriateness Rating 8 6 6 6 3 3	sign, normal gallbladder ultraso

Clinical Condition:	cute Right Upper Quadrant Pain	
Variant 3:	io fever, normal WBC.	
Radiologic Exam Procedure	Appropriateness Rating	Comments
Ultrasound	8	
Computed tomography exam	7	
Cholescintigraphy	6	
Contrast Studies		
Upper GI	6	
Barium enema	4	
Plain x-ray	4	
to t	1 2 3 4 5 6 7 8 9	et appropriate
		ost appropriate
	east appropriate 9-Me	
Variant 4: N	east appropriate 9-Me fo fever, normal WBC, ultrasound Appropriateness	shows only gallstones.
Variant 4:  Radiologic Exam  Procedure	east appropriate 9-Me to fever, normal WBC, ultrasound s Appropriateness Rating	shows only gallstones.
Variant 4: Nadiologic Exam Procedure Cholescintigraphy	cast appropriate 9-Me for fever, normal WBC, ultrasound to Appropriateness Rating 8	shows only gallstones.
Yariant 4:  Radiologic Exam Procedure Cholescintigraphy Computed tomography exam	cast appropriate 9-Me for fever, normal WBC, ultrasound to Appropriateness Rating 8	shows only gallstones.
Variant 4:  Radiologic Exam Procedure  Cholescintigraphy Computed tomography exam Contrast Studies	ost appropriate 9-Me fo fever, normal WBC, ultrasound Appropriateness Rating 8 6	shows only gallstones.
Radiologic Exam Procedure Cholescintigraphy Computed tomography exam Contrast Studies Upper GI	seast appropriate 9-Me so fever, normal WBC, ultrasound st Appropriateness Rating 8 6 6	shows only gallstones.

	ght Lower Quadrant I	rain presentation clinically for appendicitis.
Radiologic Exam	Appropriateness Rating	Comments
Plain X-ray Chest	4	
AP and upright abdomen	4	
Ultrasound RLQ graded compression	4	Imaging is rarely needed in this setting. If some contraindication exists for surgery or other potential complications or if there is anything atypical in the presentation, and imaging is needed, ultrasound or CT could be used for confirmation. Color Doppler can often be helpful in the ultrasound evaluation.
Pelvic/endovaginal	3	,
Computed Tomography Contrast enhanced CT	4	
Non-contrast (No oral or IV contrast)	2	
Nuclear Medicine WBC scanning	2	
Gallium	2	
Magnetic Resonance Imaging Abdomen with or without enhancement	2	
Barium Fluoroscopy Procedure Air-contrast barium enema	2	
Conventional small-bowel series	2	
Enteroclysis of the small bowel	2	
Single-contrast barium enema	No Consensus	
I-Least appr	Appropriateness Criteria 1 2 3 4 5 6 7 8	

Clinical Condition:	Suspected Abdominal Abso	ress
Variant 1:	Postoperative patient with	fever.
Radiologic Exam Procedure	Appropriateness Rating	Comments
Computed Tomography CT with IV contrast	8	
CT without IV contrast	6	IV contrast is preferred. However, if it is contraindicated, the study may still be of valu
Ultrasound	6	
Radiography Plain films	6	
UGI-small bowel follow	4	Appropriate if concern for anastomotic leak—should use water-soluble agent.
Contrast enema	4	Appropriate if concern for anastomotic leak—should use water-soluble agent.
Nuclear Medicine Gallium	4	
WBC (Te or In)	4	
Magnetic Resonance MRI without contrast	2	
MRI with contrast	2	
Interventional Angiography	2	
	Appropriateness Cri 1 2 3 4 5 6 1=Least appropriate	teria Scale 7 8 9 9=Most appropriate

Ilinical Condition:	Suspected Small Bowel Ob	truction
Variant 1:	No prior history of maligns	acy.
Radiologic Exam Procedure	Appropriateness Rating	Comments
Computed Tomography Abdomen & pelvis		
Plain X-ray Suring & spright abdomen		
Small bowel follow-through	- 6	
Small bowel enteroclysis	6	+
Ultrasound Abdomen sonogram	3	For experienced sonologists, may be an acceptable alternative means of diagnosis.
	Appropriate SC 12 3 4 5 6 Lent appropriate	7 S 9 9-Most appropriate
Abdomen evaluation  b  Entiant 2:  Radiologic Exam	Appropriateness Co.  1 2 3 4 5 6  Lent appropriate  Prior history of malignancy  Appropriateness	7 N 9 9-Most appropriate
Abdomen evaluation  Latiant2;  Radiologic Exam  Procedure	Appropriate Cr. 1 2 3 6 5 6 Lead appropriate Prior history of malignancy	7 S 9 9-Most appropriate
Abdomen evaluation  b  Entiant 2:  Radiologic Exam	Appropriateness Co.  1 2 3 4 5 6  Lent appropriate  Prior history of malignancy  Appropriateness	7 N 9 9-Most appropriate
Abdomen evaluation  Listiant 2:  Radiologic Exam Procedure Computed Tomography Abdomen & pelvis Plain X-ray	Appropriate  1 2 3 4 5 6  Lexi appropriate  Prior history of malignancy  Appropriateness  Rating	7 N 9 9-Most appropriate
Abdomen evaluation  Exerises, 2:  Redshingle Exam Executive Computed Tenongraphy Abdomen & pelvis Flain X-ray Supine & upright abdomen Supine & upright abdomen	Appropriateness C.C.  1 2 3 4 5 6  1 2 3 4 5 6  Prior history of malignancy  Appropriateness  Rating  S	7 N 9 9-Most appropriate
Abdomen evaluation  Listiant 2:  Radiologic Exam Procedure Computed Tomography Abdomen & pelvis Plain X-ray	Appropriate  Appropriate  Appropriate  Appropriate  Appropriate  Rating	7 N 9 9-Most appropriate
Abdomen evaluation  Extrinst.2:  Radiologic Exam Procedure Computed Tomography Abdomen & pelvis Flain X-ray Supine & upright abdomen Small bowel follow-derough	Anomycisteen Cri. 12 3 4 5 6 Lessi appropriate Prior history of malignancy Appropriateness Rating S S 6	7 N 9 9-Most appropriate
Abdomen cualuation  b  Carliant 2:  Radiologic Exam Procedure Campated Tomogrady Abdomen & pelvis Plan N-ray Sopies & oprigit abdomen Small bowel officior-drough Small bowel controllyin Chraswood	Anomycisteen Cri. 12 3 4 5 6 Lessi appropriate Prior history of malignancy Appropriateness Rating S S 6	7 N 9 9-Most appropriate
Abdomen evaluation  b  Entlant.2:  Rediologic Exam Procedure Computed Tomography Abdomen & pelvis Flain X-ray Segion & apright abdomen Small bowed fortow-drough Small bowed tomorrowlysis Small bowed contravelysis	Anomycisteen Cri. 1 3 4 5 6 Less appropriate Prior history of malignancy Appropriateness Rating S S 6 6	7 N 9 9-Most appropriate


Clinical Condition:	Acute Pancreutitis	
Variant 1:	Etiology unknown, first episode of	pancreatitis.
Radiologie Exas Procedure	m Appropriateness Rating	Comments
Ultravound		
IV contrast CT	8	
Gadolinium MRI	5	
MRCP	5	
Endoscopic ultrasound	5	If needed when initial studies do not determine etiology.
	Appropriate com Criteria ) 1 2 3 4 5 6 7 8 2 5 cost appropriate	
	T. Carrier Coloredo	Total Maria
Yariant 2:	Severe abdominal pain, elevated a admission; clinical score ponding,	mylase lipase, no fever or evidence of fluid loss
Radiologic Exar Procedure	m Appropriateness Rating	Comments
Radiologic Exam Procedure Ultrasound		Comments
Procedure	Rating	Comments
Ultrasound Procedure	Rating 8	Commends
Ultrasound IV contrast CT	8 8 8 5 5 5	
Ultrasound IV contrast CT Gudolinium MRI	Rating 8 8 5	
Precedure Ultrasound PV contrast CT Gudelinium MRI MRCP  Variant 3:	Refing  8  5  5  Assurations Cities 1  1 2 4 5 4 7 8  1-Lest appropriat  Sever abdominal pain, elevated as improvement or degradation (assu	huk 5-bles appropries  Mylass Epass, 48 hours later assuming as
Procedure Ultrasoud IV contrast CT Gadelinium MRI MRCP  Variant 3: Radiologic Exac	Refing  5  5  5  Assertations Chick 1-tent appropriate Serve addominal pain, electron (see	hold 5-Most agreemine mylase lipson, 48 hours later assuming no no no prior insights.
Precedure Ultracound IV contrast CT Gudelinium MRU MRCP  Xaciant_3;	Refing  8  5  5  Augustelesses Cilinia i 1 2 4 5 4 7 8  1-Lent appropriat  Severe abdominal pain, elevated as improvement or degradation (asso	huk 5-bles appropries  Mylass Epass, 48 hours later assuming as
Precidere Ultraseund IV contrast CT Gadelinium MRI MRCP  Xaciant.3:  Radiologic Exac	Refing  8  8  5  Assertations Cities in  5- Assertations Cities in  5- Assertation of Cities in  Five and a second of the cities in  Severe abdominal gain, elevated as  supervision of degradation (assert  Refing  Refing	hold 5-Most agreemine mylase lipson, 48 hours later assuming no no no prior insights.
Procedure Ultrasound IV commat CT Gadelinium MIU MICT  Variantl: Rediningle Exam Procedure Ultrasound	Relating  8  9  9  5  5  5  5  5  5  6  1-Lenst appropriate  Severe abdominal pains, elevated as improvement or degraduline (asset)  Severe abdominal pains, elevated as improvement or degraduline (asset)  Relating  Relating	hold 5-Most agreemine mylase lipson, 48 hours later assuming no no no prior insights.
Procedure Ultrascod IV connat CT Gadelinian MRI MRCP  Xatinat.ls  Radiologic Exac Procedure Ultrascod IV connat CT	Rating  8  9  5  Assertables and California 1-less convenients pain, clossed as long-recorded and format and long-recorded and format and long-recorded and Appropriation (asserts and Appropriation)  8  Appropriation (asserts and Appropriation)  8  Reting  8  8  8	hold 5-Most agreemine mylase lipson, 48 hours later assuming no no no prior insights.

	Metastases : test following detection of pr	
		imary tumor.
Radiologic Exam Procedure	Appropriateness Rating	Comments
CT Axial CT with dynamic bolus in PVP (>35gm of iodine)	8	
Helical CT in HAP and PVP	8	
Helical CT without contrast followed by HAP and PVP	6	
CT without Contrast	4	
CTAP or CTA	2	
MRI Spin-echo MRI then gradient-echo MRI with extracellular contrast media e.g. gadolinium chelates	6	
Spin-echo MRI without contrast	5	
MRI with reticulo-endothelial contrast e.g. Iron-oxide	5	
Ultrasound Abdominal Ultrasound	4	
Abdominal Ultrasound with color Doppler	4	
Intraoperative/Laparoscopic Ultrasound	2	
Nuclear Imaging Radionuclide liver scan with reticulo-endothelial agent	4	
Immunoscintigraphy	3	
Positron Emission Tomography	3	
Radionuclide liver scan with blood pool agent	2	
Somatostatin Receptor Imaging	2	
Hepatic Angiography with or without CTAP or CTA	2	
Hepatic Angiography with or without CTAP or CTA		

Clinical Condition:	Acute Onset Flank Pain	
Variant 1:	Suspicion of stone disease.	
Radiologic Exam Procedure	Appropriateness Rating	Comments
Intravenous urography (IVP)	8	Commence
Noncontrast helical CT	8	
Magnetic resonance imaging (MRI	) 4	
Renal ultrasound with intrarenal Doppler and KUB	6	Preferred exam in pregnant and allergic patients.
Plain abdominal film (KUB) alone	1	Most useful in patients with known stone disease.
	Appropriatenes 1 2 3 4 5	6789
	1=Least appropriate	9-Most appropriate

Appropriateness Rating 8 6	Comments
6	
8	
8	
6	
5	
8	
6	
5	
4	
5	
2	
	8 6 5 8 6 5 4

Radiologic Exam Procedure		
	Appropriateness Rating	Comments
Computed tomography CT	4	
CT + contrast	4	
CT angiography	2	
Magnetic resonance MRI	4	
MRI + contrast	4	
MRA	2	
Cathotor angiography	2	
Nuclear medicine SPECT	2	
	Appropriate Criteria Scale 1 2 3 4 5 6 7 8 9 -Leut appropriate  -Man	4 appropriate
Variant 2: So	dden ceast of severe beadache ("W udache").	Forst headache of one's life, thund
Radiologic Exam Procedure	Appropriateness Baring	Comments
Radiologic Exam Procedure Computed tomography CT	Appropriateness Rating	Comments
Procedure Computed tomography	Rating	Comments
Procedure Computed tomography CT	Rating 9	Comments
Procedure Computed innegraphy CT CT engingraphy Magnetic resonance	Rating 9 4	Comments
Procedure Computed immegraphy CT CT engingraphy Magnetic resonance MRI	9 4 6	Comments
Procedure Computed innegraphy CT CT engiography Magnetic resonance MRI MRA	9 4 6 6	Comments

	t Without Known Disc (PND)	ease Presenting With a Progressive Neurolog
Variant 3: PND in	an adult >40.	
Radiologic Exam Procedure	Appropriateness Rating	Comments
Magnetic resonance		
Unenhanced MR Enhanced MR (pro- and postcontrast)	8	
Double- triple-dose enhanced MR	2	
fMRI	No Consensus	Rapidly developing technologies that may provuseful for clinical problem solving.
MR spectroscopy	No Consensus	Rapidly developing technologies that may provuseful for clinical problem solving.
Computed tomography Unenhanced CT	6	If MR is not available.
Enhanced CT (pre- and postcontrast)	6	
Double-dose-delayed enhanced CT	2	
Vascular imaging MR angiography	4	
CT angiography	3	Relatively new modality with promising clinica utility.
Catheter Angiogram	2	
Ultrasound	3	
Nuclear Medicine PET	2	
SPECT	No Consensus	
	Appropriateness Criter	is Scale

Clinical Condition:	Acute Low Back Pain		
Variant 3:	Suspicion CA, infection.		
Radiologic Exam Procedure	Appropriateness Rating	Comments	
Plain MRI	8		
MRI + Gadolinium	7		
Plain Lumbar X-Rays	7		
Isotope Bone Scan	5		
CT	4		
Myelogram	2		
Myclogram/CT	2		
	Apprepriateness Crite		
Variant 4:	1 2 3 4 5 6 7  1-Least appropriate  Radiculopathy.	tia Scale 8 9 9-Most approgriate	
Radiologic Exam	1 2 3 4 5 6 7 1-Least approgriate  Radiculopathy.  Appropriateness	8 9 9-Most approgriate	
Radiologic Exam Procedure	Radiculopathy.  Appropriateness Rating	8 9	
Radiologic Exam Procedure Plain MRI	1 2 3 4 5 6 7  1-Least appropriate  Radiculopathy.  Appropriateness Rating  8	8 9 9-Most approgriate	
Radiologic Exam Procedure Plain MRI Myclogram/CT	1 2 3 4 5 6 7  1-Lent appropriate  Radiculopathy.  Appropriateness Rating  8  5	8 9 9-Most approgriate	
Radiologic Exam Procedure Plain MRI Myclogram/CT	1 2 3 4 5 6 7  1-Leat appropriate  Radiculopathy.  Appropriateness Rating  8  5  5  5	8 9 9-Most approgriate	
Radiologic Exam Procedure Plain MRI Myclogram CT CT MRI + Gadolinium	1 2 3 4 5 6 7  1-Lent appropriate  Radiculopathy.  Appropriateness Rating  8  5	8 9 9-Most approgriate	
Radiologic Exam Procedure  Plain MRI  Myelogram CT  CT  MRI + Gadolinium  Plain Lumbar X-Rays	1 2 3 4 5 6 7  1-Least appropriate Radiculopathy.  Appropriateness Rating 8 5 5 4 4	8 9 9-Most approgriate	
Radiologic Exam Plain MRI Myelogram CT CT MRI + Gadolinium Plain Lumbar X-Rays Isotope Bone Scan	1 2 3 4 5 6 7  T-Lent appropriate  Radiculopathy.  Appropriateness Rating  8  5  4	8 9 9-Most approgriate	
Radiologic Exam Procedure  Plain MRI  Myelogram CT  CT  MRI + Gadolinium  Plain Lumbar X-Rays	1 2 3 4 5 6 7	**-Non aggregation  Comments  Land Comments	

lerate or severe acute closed head i	
	injury, stable.
Appropriateness Rating	Comments
9	
8	
6	
4	
2	
2	
2	
2	
2	
2	
2	
2	
	Rating 9 9 8 6 4 2 2 2 2 2 2 2 2 2 2 2 2

	Clinical Condition: Head injury	with fracture
ariant 12:	Depressed skull fracture.	
Radiologic Exam Procedure	Appropriateness Rating	Comments
CT	9	
Skull plain film radiographs	8	
C-spine plain film radiographs	6	
MR	6	
MR with gadolinium	2	
MR with MRA	2	
CT with contrast	2	
Cerebral angiography	2	
SPECT	2	
PET	2	
Xenon-enhanced CT	2	
Transcranial Doppler	2	
	Appropriateness Criteria Scale 1 2 3 4 5 6 7 8 9	

		Onset Seizure
Variant 4:	Older than age 40.	
Radiologic Exam Procedure	Appropriateness Rating	Comments
Magnetic resonance		
MR plain	8	
MR with contrast	7	
fMR perfusion	2	
fMR spectroscopy	2	
fMR activation	2	
MR angiography	2	
Computed tomography		
CT plain	6	
CT with contrast	4	If no MRI is available. MRI preferred.
Functional SPECT	4	
PET	4	
MEG/MSI	2	
Ultrasound	2	
Interventional Angiography	2	
Gugagagay	Appropriateness Crite	eria Scale
	1 2 3 4 5 6 7 I=Least appropriate	

linical Condition:	Congestive Heart Failure	
ariant 1:	New CHF, suspected based on symp	otoms and physical examination.
Radiologic Exa Procedure	m Appropriateness Rating	Comments
Chest radiograph	9	
CT	2	CHF is readily diagnosed on CT obtained for other indications.
MRI	2	
		9-Most appropriate
'ariant 2:	1-Least appropriate Previous CHF, currently stable.	9-Most appropriate
ariant 2:  Radiologic Exa Procedure	1-Least appropriate Previous CHF, currently stable.	9-Most appropriate  Comments
Radiologic Exa Procedure	Previous CHF, currently stable.  MAD Appropriateness	9-Most appropriate
Radiologic Exa	Previous CHF, currently stable.  Mapropriateness Rating	9-Most appropriate
Radiologic Exa Procedure Chest radiograph	I-l. east appropriate  Previous CHF, currently stable,  m Appropriateness Rating 4 2 2 2	Comments  CHF is readily diagnosed on CT obtained for other indications.
Radiologic Exa Procedure hest radiograph	Previous CHF, currently stable.  m Appropriateness Rating 4 2	Comments  CHF is readily diagnosed on CT obtained for other indications.

	spected Physical Abuse, Child 2	Years or Less
Variant 1: N	o focal signs or symptoms.	
Radiologic Exam Procedure	Appropriateness Rating	Comments
Plain X-Ray - Skeletal survey	9	
Plain X-ray - Skull film	9	
MRI - Brain	5	May be done as an alternative to CT.
CT - Brain	5	May be done as an alternative to MRI.
Ultrasound - Abdomen	2	
Nuclear Medicine - Bone scan	No Consensus	Indicated when a clinical suspicion of abuse remains high and documentation is
	Appropriateness Criteria Scale 1 2 3 4 5 6 7 8 9	still necessary.
Yariant 2: H	d appropriate 5-	still necessary.
Yariant 2: H	a appropriate  Appropriateness	still recessary.  Most appropriate  Indiags, no neurologic abnormality.
Yariant2: H	appropriate 5	still necessary.  Most appropriate
Yariant 2: B Radiologic Exam Procedure	rad trauma by history, no focal fi	Still necessary.  Most appropriate ndings, no neurologic abnormality.  Comments
Yariant 2: B Radiologic Exam Procedure Piain X-Ray - Skeletal survey	a appropriate 9: 4 5 6 7 8 9  rad trauma by history, no focal fit  Appropriateness Rating 9	Most appropriate  Most appropriate  mdings, no neurologic abnormality.  Comments  This includes two views of the skull.
Nations 2: B Radiologic Exam Prioredure Plain X-Ray - Sacletal survey CT - Brain	rad trauma by history, no focal fi Appropriateness Rading 9	till necessary.  Most approprisis  melings, no neurologic abnormality.  Comments  This includes two views of the skull.  May be appropriate an alternative to MRI.
Yariant 2: H  Rediologic Exam Procedure Plain X-Ray - Sachetal survey CT - Beain MRI - Beain	Appropriate  Appropriates  Appropriates  Rating  5  5	till necessary.  Most approprisis  melings, no neurologic abnormality.  Comments  This includes two views of the skull.  May be appropriate an alternative to MRI.

Variant 1: Pr	remenopausal women.	
Radiologic Exam Procedure	Appropriateness Rating	Comments
Ultrasound Transabdominal	8	
Transvaginal	8	
Color Flow	6	
Doppler: PI/RI	6	
Computed Tomography	4	
Magnetic Resonance Imaging	4	
Plain Film of Abdomen/Pelvis	2	
Pregnancy Test	No Consensus	Differential diagnosis is different depending on the prognancy test results.
	Appropriateress	Fileria Scale
14	1 2 3 4 5	7.8.9
	Least appropriate	9-Most appropriate
Variant 2: Pe	ostmenopausal women.	9-Most appropriate
Variant 2: Pe	ostmenopausal women. Appropriateness	9-Most appropriate  Comments
Variant 2: Pe	ostmenopausal women.	
Radiologic Exam Procedure	ostmenopausal women. Appropriateness	
Kariant 2: Po Radiologic Exam Procedure Ultrasound	ostmenopausal women. Appropriateness Rating	
Variant 2: Pe Radielogic Exam Procedure Ultrasound Transabdominal	Appropriateness Rating	
Variant 2: Pe  Radiologic Exam Procedure  Ultrasound Transabdominal Transabdominal	Appropriateness Rating 8 8	
Radiologic Exam Procedure Ultrasound Transabdominal Transaginal Color Floor	Appropriateness Rating  8 8 6	
Variant 2: Pe Radiologic Exam Procedure  Ultrasound Transal-dominal Transal-dominal Color Flow Doppler: 19/181	Appropriateness Rating  8 8 6 6	
Variant 2: Pe  Radiologic Exam Procedure  Transal-dominal  Transveginal  Color Bose Doppler: PJ/RI  Computed Tomography	Appropriateness Rating  8 8 6 6 4	

Interventional I  Exciant 1: Suspected pulse		or Vena Cava Filter Placem traindication to anticoagula
Presentation/Signs/Symptoms	Appropriateness Rating	Comments
History Unsecured cerebral aneurysm after subarachnoid hemorrhage	8	
Recent intracerchral hemorrhage (within 2 weeks)	8	
Hematomyelia (within 2 weeks)	8	
Recent major hemorrhage	8	
Structural lesion with high risk of hemorrhage (e.g., varices, tamors with history of bleeding, etc.)	8	
Severe cardiovascular compromise from acute pulmonary embolus	8	
Status-post pulmonary embolectomy	8	
Elderly patient with unsteady guit or prone to falls	5	
Proexisting bleeding diathesis	5	
Uncontrolled hypertension	4	
Severe renal or liver disease	4	
Elderly patient with no other risk factors	4	
Cancer without history of prior bleeding	4	
Patient with advanced malignancy, multi- organ system failure, or other advanced systemic illness	4	
Patient less than 2 weeks after major surgery, deep biopsy, or major trauma	3	
Suspected septic embeli	No Conscisus	
Imaging Findings Filling defect identified on pulmonary angiography	8	
Ventilation-perfusion scan suggests embolus	5	Needs angio confirmation
High clinical suspicion of pulmonary embolus without imaging studies	2 printenes Criteria Scale	

### Risk Management

- Radiation safety
- Allergic reactions
- Medical emergencies and treatment issues
- Diagnostic issues
- Competency

1	ľ

#### **HIPAA**

- Health Insurance Portability and Accountability Act
- communications networks that link radiology information systems, billing software, and image transmission technology (PACS/teleradiology). hospital demographic downloads, electronic claims submission and remittance, and remote referring physician (reports and images) or patient access (billing records) to information via a web site.

#### **Contrast Reaction**

- not caused by iodine
- not related to shellfish
- not true allergy (no drug-antibody)
- mechanism remains unknown
- unpredictable
- dose independent
- prevalence 1-2% (0.04 0.22% severe)
- fatal 1 in 75,000

## Contrast Reaction - Premedication

- Prednisone 50 mg P.O, 13 hours before test
- Prednisone 50mg P.O, 7 hours before test
- Prednisone 50mg P.O, 1 hour before test plus Benadryl 50 mg P.O, 1 hour before test

-	

#### **Renal Toxicity**

- serum creatinine up more than 25% or > 0.5 mg%
- Risk Factors
  - 5 10 fold increase with pre-existing renal insufficiency (increased creatinine)
  - Dehydration
  - CHF
  - Age > 70
  - nephrotoxic drugs

#### **Renal Toxicity**

- direct relationship between serum creatinine and likelihood nephrotoxicity
- Hydrate 100 ml/hr Normal saline 4 hrs prior to procedure, continue for 24 hours
- Those on hemodialysis do not need extra seesions or dialysis immediately following contrast administration

#### **Renal Toxicity**

- Metformin (Glucophage)
  - oral diabetic agent
  - patients with renal insufficiency may develop lactic acidosis
  - withhold drug for 48 hrs after contrast administration in all patients taking this drug - restart if Cr back to baseline


### iMaging 5.0

- Ready for primetime
- Easily accessible
- Integrates well with clinical work
- Free iPod for every 3rd year student
  - See Dr Gruener after this lecture

	_