Diagnostic Imaging Dilemmas

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Disclosures

- None

Objectives

- Using a case based scenario, at the end of this session, the learner will be able to discuss the best imaging techniques for:
  - Minor head trauma
  - Neck injuries
  - Abdominal pain
  - Suspected pulmonary embolism

Frontmatter

- Vast increase in use of diagnostic imaging
  - CT scan use tripled between 1996 & 2010
  - MRI use quadrupled
- Concerns about $$
- Radiation exposure risks
- Pitfalls in diagnosis
  - Misreads
  - False + & -

Decision Support?

- Advent of widespread HER's has brought clinical decision support
- Data mixed
  - Some show decrease in # of tests ordered, others don't
- Clinical policies from multiple specialty societies
- ACR Appropriateness Criteria

ACR Appropriateness Criteria

- Evidence based guidelines for imaging use
- Updated frequently when new evidence arrives
- Sometimes in conflict with other specialty societies
- www.acr.org/appropriateness-criteria

Radiation Risk

- Rads, rems, grays, sieverts……
- Most risk is based on extrapolation
- Disconnect between physicians and radiation physicists

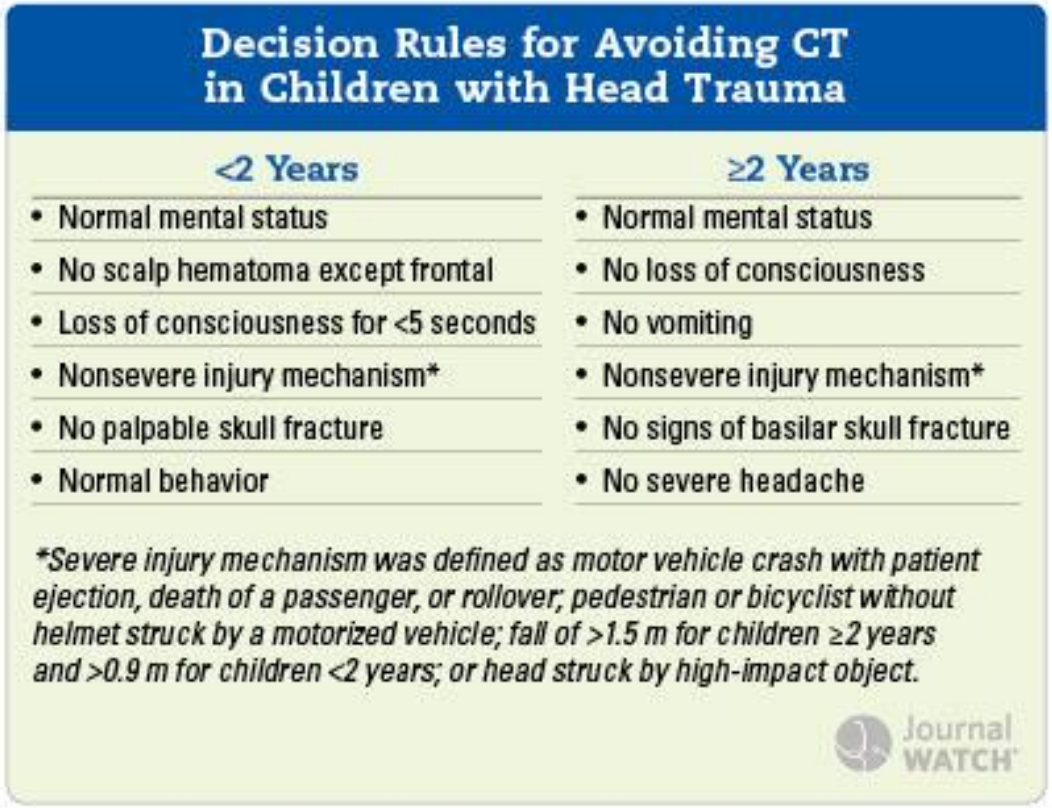
Case 1

- An 18 month old is brought in by his parents after a fall at home
- He has a left frontal goose egg and an otherwise normal exam
- No LOC, vomiting, or behavior changes
- What imaging does he need?

Case 1

- CT Head
- Skull Xrays
- Nothing

PECARN



Decision Rules for Avoiding CT in Children with Head Trauma

<2 Years	≥2 Years
• Normal mental status	• Normal mental status
• No scalp hematoma except frontal	• No loss of consciousness
• Loss of consciousness for <5 seconds	• No vomiting
• Nonsevere injury mechanism*	• Nonsevere injury mechanism*
• No palpable skull fracture	• No signs of basilar skull fracture
• Normal behavior	• No severe headache

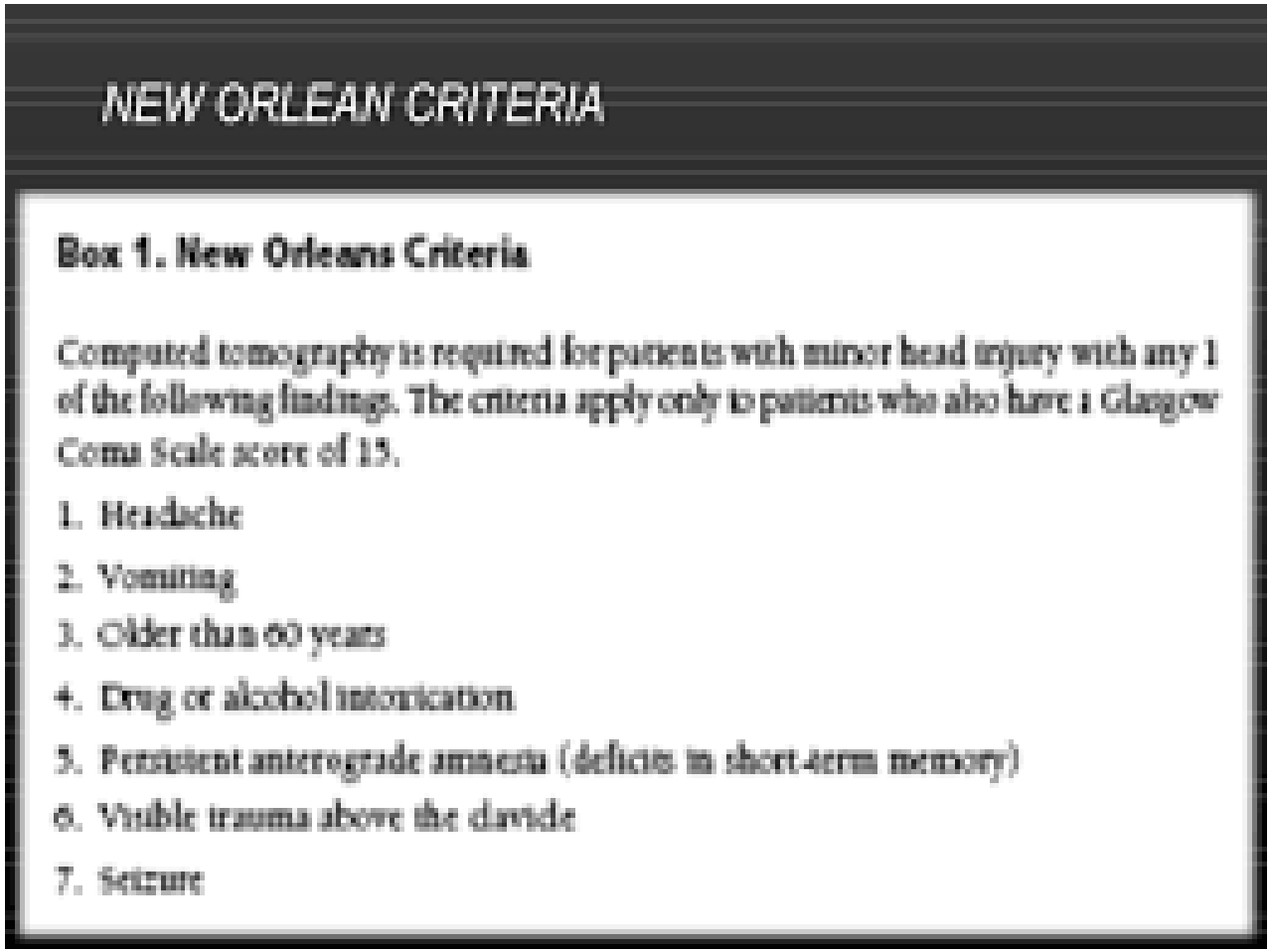
**Severe injury mechanism was defined as motor vehicle crash with patient ejection, death of a passenger, or rollover; pedestrian or bicyclist without helmet struck by a motorized vehicle; fall of >1.5 m for children ≥2 years and >0.9 m for children <2 years; or head struck by high-impact object.*

Journal WATCH

Case 1a

- Now you have a 59 year old male patient arriving by EMS
- He was found face down on a sidewalk
- He smells strongly of ethanol
- He has a small abrasion above his left eye
- He moves everything symmetrically but doesn’t follow commands
- No other trauma noted

New Orleans Rule



"Regardless of what your wife says, you do have a backbone and I have the X-ray to prove it."

Case 2

- You have a 30 yo male pt with sudden onset right flank pain
- He appears uncomfortable, is vomiting, and has hematuria
- His abdomen is nontender
- What is the best study?

Case 2

- CT scan of the abdomen w/o contrast
- Kidney US
- IVP
- Nothing

Case 2

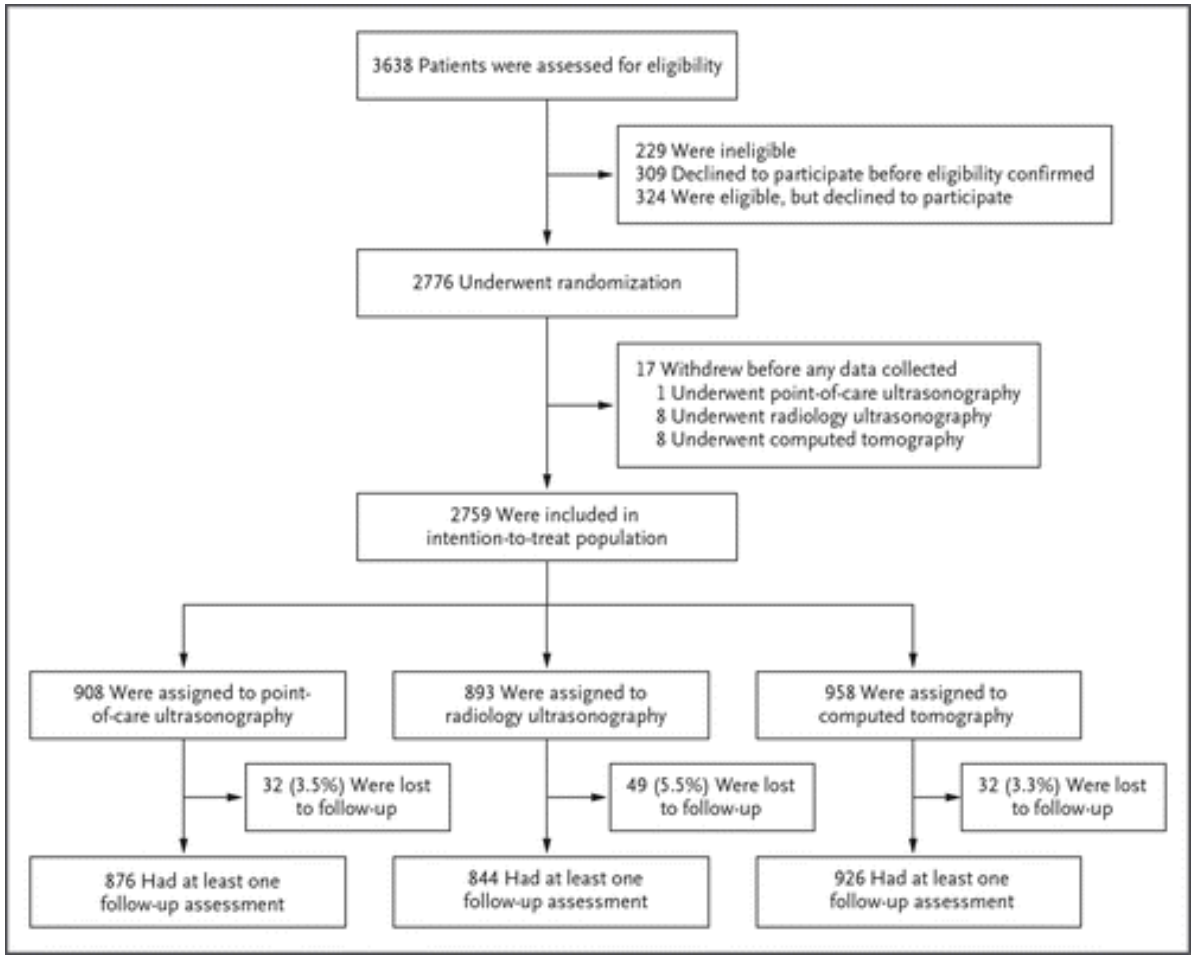
The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Ultrasonography versus Computed Tomography for Suspected Nephrolithiasis

R. Smith-Bindman, C. Aubin, J. Bailitz, R.N. Bengiamin, C.A. Camargo, Jr., J. Corbo, A.J. Dean, R.B. Goldstein, R.T. Griffey, G.D. Jay, T.L. Kang, D.R. Kriesel, O.J. Ma, M. Mallin, W. Manson, J. Melnikow, D.L. Miglioretti, S.K. Miller, L.D. Mills, J.R. Miner, M. Moghadassi, V.E. Noble, G.M. Press, M.L. Stoller, V.E. Valencia, J. Wang, R.C. Wang, and S.R. Cummings

US vs CT for Stones



Case 2a

- You have a 75 yo female patient with diffuse abd pain & vomiting
- He has a hx of afib, CAD & HTN
- Her coumadin was recently stopped due to multiple falls
- Her abdomen is diffusely tender with involuntary guarding
- What is the best imaging study?

Case 2a

- Ultrasound
- CT abd/pelvis with IV contrast only
- CT abd/pelvis with IV & PO contrast
- Angiography

ACR Appropriateness Criteria

Appropriateness Designation	Score	AHA/ACC Rec.	Level of Evidence	Additional Published Characteristics Appropriate Imaging Tests
Appropriate	9	I	A – B	• Wide spectrum of patients studied
	8	IIa	C	• No **patient selection** bias (consecutive)
	7	IIb		• All patient image results **verified** ("gold standard" or prognosis)
Uncertain	6	IIb	B - C	• Blinded **interpretation**
	5			• **Reproducible** acquisition and interpretat
	4			
Inappropriate	3	III	C	
	2		A - B	
	1			

ACR Appropriateness Criteria

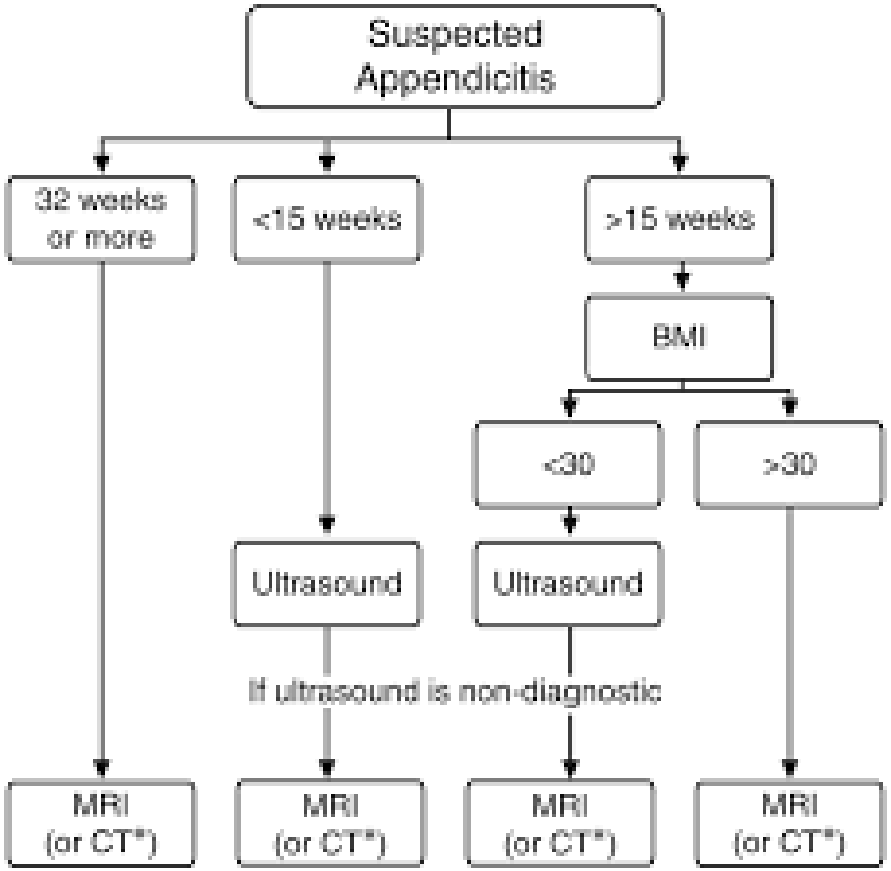
Table 1. Variant 1: Acute mesenteric ischemia

Radiologic procedure	Rating	Comments
CTA abdomen with contrast	9	Fast noninvasive study that also evaluates other causes of abdominal pain.
Arteriography abdomen	8	Allows diagnosis and treatment with a single procedure.
X-ray abdomen	7	Initial study for patients with acute abdominal pain.
MRA abdomen without and with contrast	7	Longer when compared to CT. Limited in distal thrombosis/embolism or nonocclusive mesenteric ischemia. See statement regarding contrast in text under "Anticipated Exceptions."
US abdomen	6	High sensitivity and specificity for venous occlusion, and can assess other causes of abdominal pain.
MRA abdomen without contrast	3	Lower sensitivity and specificity than MRA that incorporates contrast.

Case 2b

- A 28 yo 27 week pregnant f pt presents with RLQ pain x 24 h
- She is tender in her R mid and lower abd
- She ahs nausea, anorexia, no fevers
- Her FHT are in the 160's
- She has a WBC count of 16000
- What is the bets imaging study?

Imaging for Appendicitis in Pregnancy



Case 3

- A 24 yo, 32 weeks pregnant f pt presents with pleuritic chest pain and acute dyspnea
- She has had an otherwise uncomplicated pregnancy
- She is tachycardic with symmetric lower extremity edema, a sat of 94%, and a clear CXR
- What imaging study should be done next?

What About Radiation in Pregnancy?

Table 1. Fetal absorbed doses from selected procedures*

X-Ray Examinations	Fetal Absorbed Dose (mGy)
Cervical spine (AP, lat)	<0.001
Chest X Ray (PA, lat)	0.002
Thoracic Spine X Ray (AP, lat)	0.003
Abdomen X Ray (AP)	1–3
Lumbar Spine X Ray (AP, lat)	1
Limited IVP	6
Barium Enema	7
CT Examinations†	**Fetal Absorbed Dose (mGy)**
CT Head	0
CT Pulmonary Angiogram	0.2
CT Abdomen	4
CT Abdomen Pelvis	25
CT KUB	10
Background for 9 months of pregnancy†	**0.5 - 1**

What About Radiation in Pregnancy?

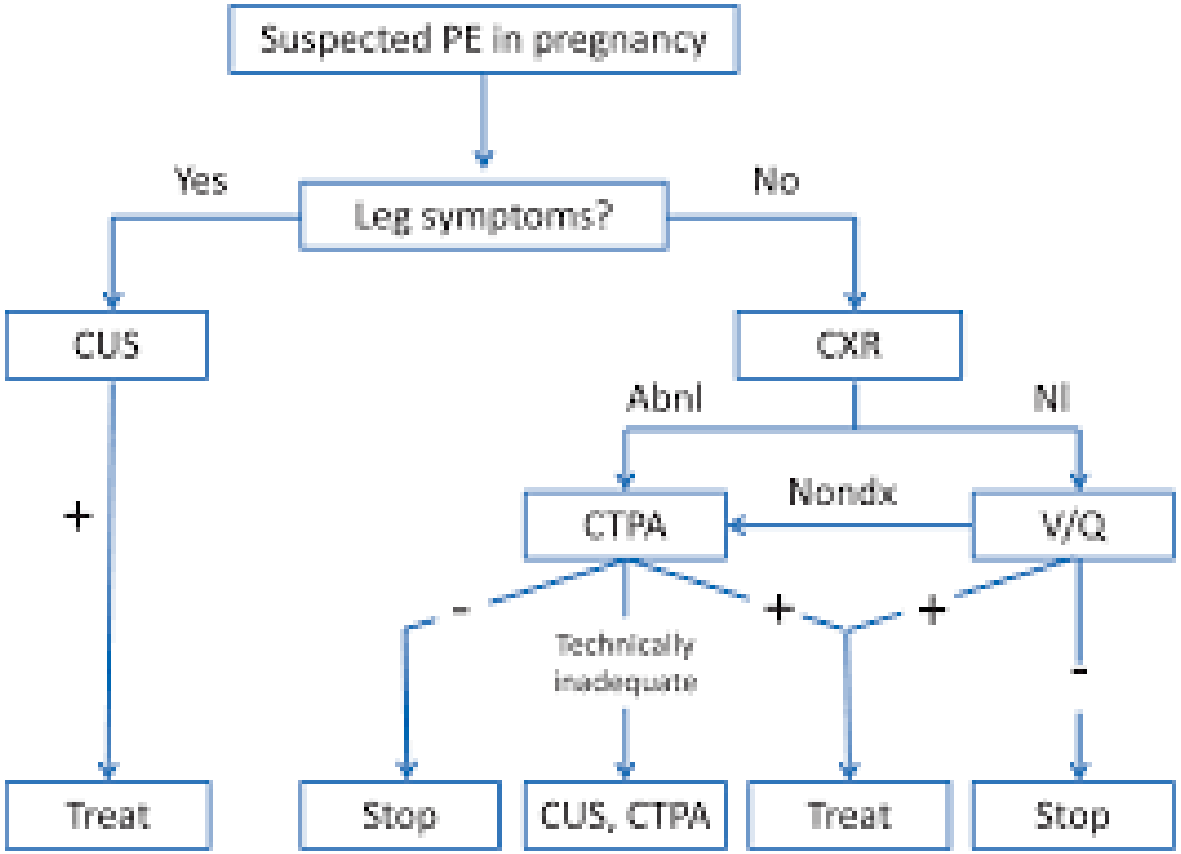
Table 4. Effects of Ionizing Radiation on Conceptus

PREGNANCY PHASE	WEEKS POST CONCEPTION	RADIATION EXPOSURE	POSSIBLE CONCEPTUS HEALTH EFFECTS
Pre-implantation	0 to 2 weeks	Diagnostic exposure (less than 100 mGy [10 rad])	Embryo implantation failure; embryo death by cytogenic damage
		Greater than 100 mGy (10 rad)	Lethality
Organogenesis	2 to 7/8 weeks	Less than 50 mGy (5 rad)	No increase of significant congenital malformations above background incidence
		Greater than 100 mGy to 150 mGy (10 rad to 15 rad)	Malformations due to cell killing; growth retardation; cataracts; skeletal anomalies; central nervous system abnormalities: microcephaly, mental retardation (risk of severe mental retardation is not increased over background levels)
Fetal Development			
Early	8/9 weeks to 15 weeks	Less than 50 mGy (5 rad)	Cancer is the only detectable health risk
		50 mGy to 500 mGy (5 rad to 50 rad)	Dose dependent growth retardation; IQ reduction
		Greater than 500 mGy (50 rad)	Increased risk of growth retardation/spontaneous abortion; major malformation; IQ reduction; severe mental retardation
Mid	16 weeks to 25 weeks	Less than 50 mGy (5 rad)	Cancer is the only detectable health risk
		50 mGy to 500 mGy (5 rad to 50 rad)	Not likely to produce health risk except cancer
		Greater than 500 mGy (50 rad)	Increase in major malformations and spontaneous abortions; dose dependent growth retardation; IQ reduction; severe mental retardation
Late	26 weeks to delivery	Less than 500 mGy (50 rad)	Cancer is the only detectable health risk
		Greater than 500 mGy (50 rad)	Dose dependent neonatal death and spontaneous abortion; major functional anomalies or malformations unlikely

Sources: Centers for Disease Control and Prevention. Prenatal radiation exposure: a fact sheet for physicians. [emergency preparedness & response fact sheet online]. 2005 Mar 23 [cited 2008 Jan 21]. Available from Internet: http://www.bt.cdc.gov/radiation/prenatalphysician.asp; De Santis M, Di Gianantonio E, Straface G, et al. Ionizing radiation in pregnancy and teratogenesis: a review of literature. ***Reprod Toxicol*** 2005 Sep-Oct;20(3):323-9; International Atomic Energy Agency. Radiologic protection of patients: pregnancy and radiation in diagnostic radiology. [online]. [cited 2008 Jan 21]. Available from Internet: http://rpop.iaea.org/RPoP/RPoP/Content/SpecialGroups/1_PregnantWomen/PregnancyAndRadiology.htm; International Commission on Radiological Protection. Radiation and your patient: a guide for medical practitioners. ***Ann IRCP*** 2001;31(4):5-31; International Commission on Radiological Protection (ICRP). ***Biological effects after prenatal irradiation (embryo and fetus)***. ICRP Publication No. 90. Kidlington, Oxford (United Kingdom): Elsevier; 2003; Lowe SA. Diagnostic radiography in pregnancy: risks and reality. ***Aust N Z J Obstet Gynaecol*** 2004 Jun;44(3):191-6; Timins JK. Radiation during pregnancy. ***N J Med*** 2001 Jun;98(6):29-33; Toppenberg KS, Hill DA, Miller DP. Safety of radiographic imaging during pregnancy. Am Fam Physician [online]. 1999 Apr 1 [cited 2008 Jan 21]. Available from Internet: http://www.aafp.org/afp/990401ap/1813.html.

For sources associated with specific values, contact the ***Pennsylvania Patient Safety Advisory*** staff.

Imaging Options for Suspected PE



Case 3

- A 35 yo m pt is brought in after a motor vehicle collision
- He is intoxicated but alert and can describe the accident well
- He has mild tenderness to his cervical paraspinal muscles but no stepoff or point tenderness to the spine
- What imaging does he need?

Case 3

- Cervical spine XR
- CT cervical spine
- MR cervical spine
- Nothing

NEXUS

Table 2. NEXUS Criteria For Radiographic Evaluation Of The Cervical Spine Following Blunt Trauma[81]

1. Midline cervical tenderness
2. Focal neurologic deficits
3. Altered level of consciousness
4. Evidence of intoxication
5. Painful distracting injury

Table 4. Canadian Criteria For Detecting Clinically Important Cervical Spine Injury[46]

High Risk Factors	• Age > 65 • Fall > 1 meter • Axial loading injury • High speed MVC/ rollover/ejection • Motorized recreational vehicle or bike collision • Presence of paresthesias

Low Risk Factors	• Simple rear-end MVC
	  • Not pushed into oncoming traffic
	  • Not hit by large bus or truck
	  • No rollover
	  • Not hit by high-speed vehicle
	• Sitting position in the ED
	• Ambulatory anytime
	• Delayed onset of neck pain
	• No midline cervical tenderness

CT or Xray?

- Ct largely replacing XR at trauma centers
  - Last EAST guidelines recommend CT as first line
- XR may miss up to 25% of clinically significant spinal injuries
- XR only recommended for low risk neuro intact patients
- C spine fx may be associated with blunt cervical vascular injury

Conclusions

- Multiple data sources to help make imaging recommendation
- If in doubt ask your radiologist
- Take home points
  - CT similar radiation to fetus as VQ
  - US or MRI best initial imaging for suspected appy in pregnancy
  - CT replacing plain films for c spine injury

Questions?

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