

# Neuroimaging

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Assistant Professor and MRI Director  
Neuroradiology  
OHSU

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## Acknowledgements

- Many of the slides in this presentation are from James C. Anderson MD at OHSU.

## No Disclosures

## Objectives

- Review of Neuroradiology and imaging modalities
- Discussion of ordering and appropriateness criteria
- Discussion of interpretations and reports
- Review of issues related to:
  - Radiation
  - MRI
  - Contrast
  - Advanced Imaging

## Neuroradiology

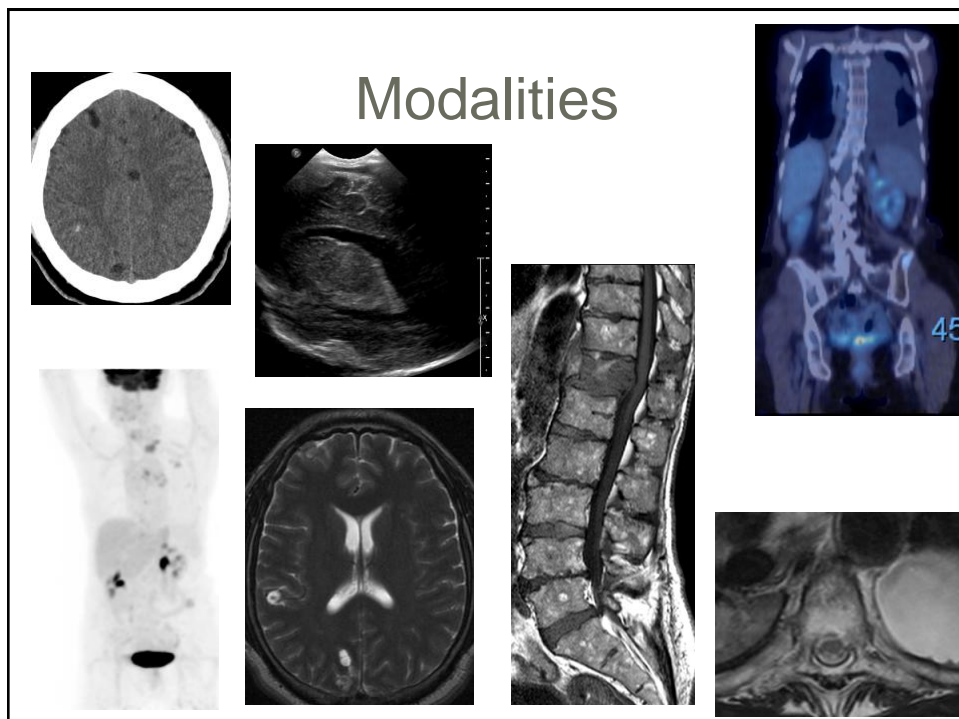
- Subspecialty of Diagnostic Radiology
  - Internship Year
  - Radiology Residency (4 years)
  - Neuroradiology fellowship (1-2 years)
  - Potential additional interventional training
  - Ongoing Maintenance of Certification with requalification every 10 years

## Neuroradiology

- Training in use and interpretation of CT, MRI, plain films, neurosonography, and nuclear radiology related to the brain, spine and spinal cord, head, neck, and organs of special sense in adults and children
- Angiography training

# Neuroradiology

- Radiology groups tend to fall into 3 categories:
  - Small groups of general radiologists who may or may not have subspecialty fellowship training but have minimal (<25%) continued exposure to the subspecialty
  - Groups of radiologists that partially sub-specialize, i.e. the neuroradiology trained radiologist may do NR, body, and MSK imaging but not mammography, ultrasound etc.
  - Fully sub-specialized groups. i.e. Neuroradiologist will do 80 – 100% sub-specialty practice.

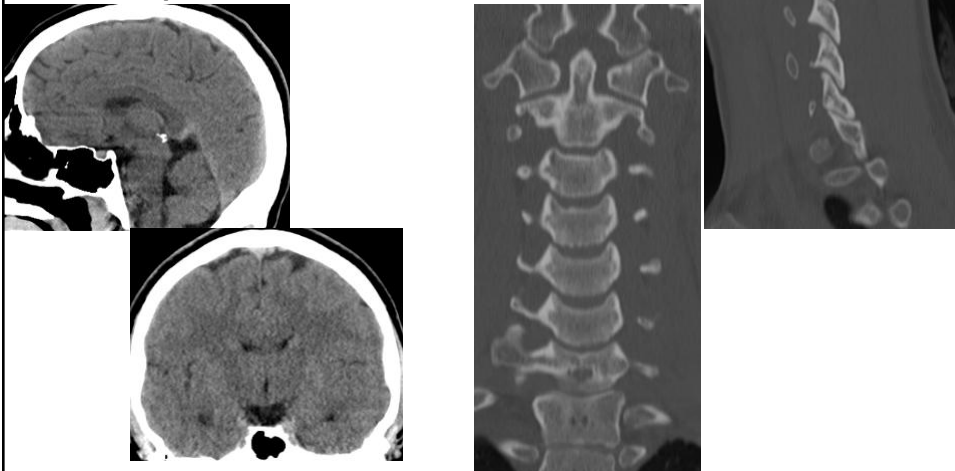


## Modalities

- CT
- MRI
- Nuclear Medicine
- Ultrasound
- Angiography
- Plain Films

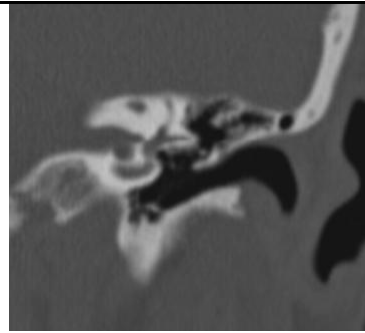
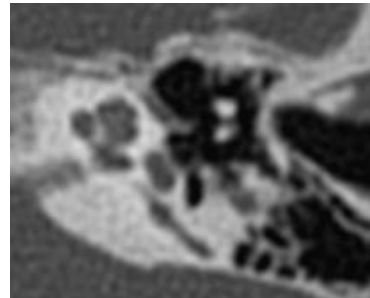
## CT

- Spiral/helical scans
- Multiplane reconstructions



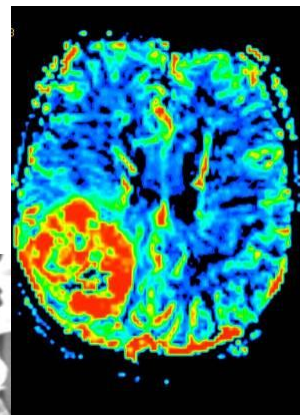
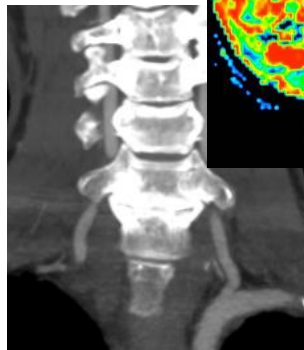
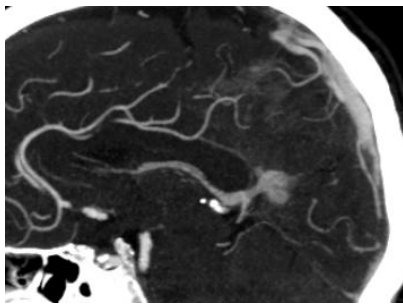
## CT

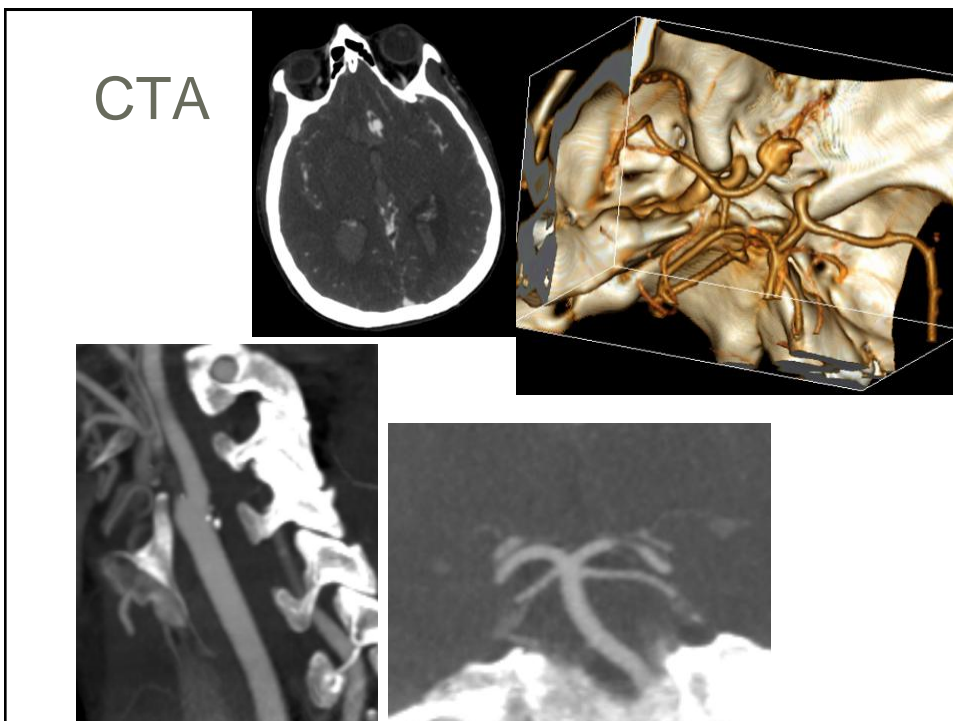
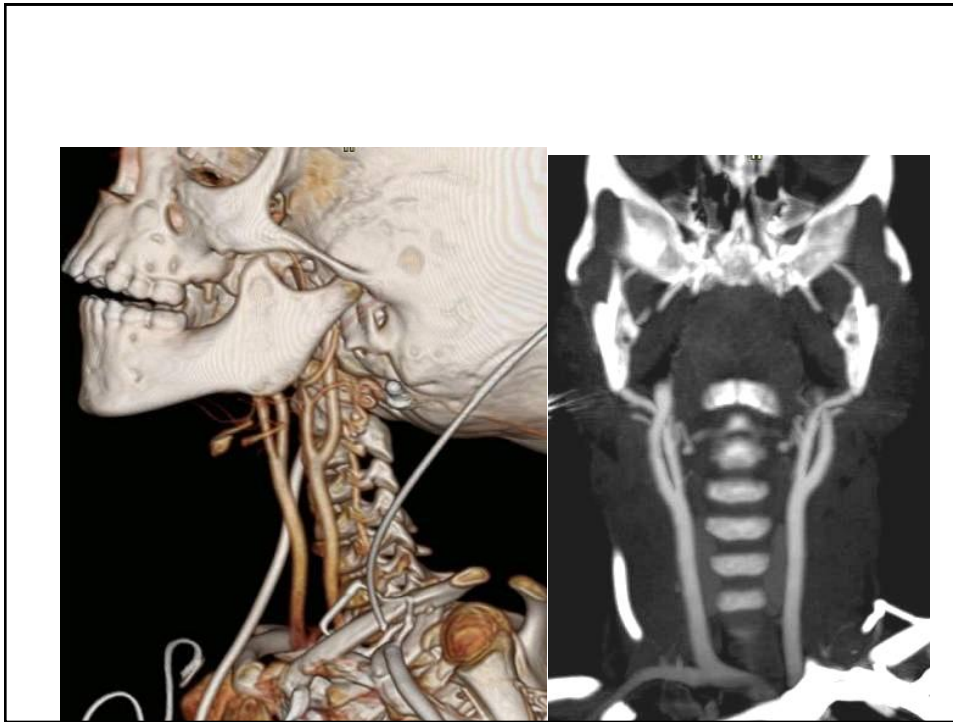
- Sub-millimeter resolution



## “Advanced” CT

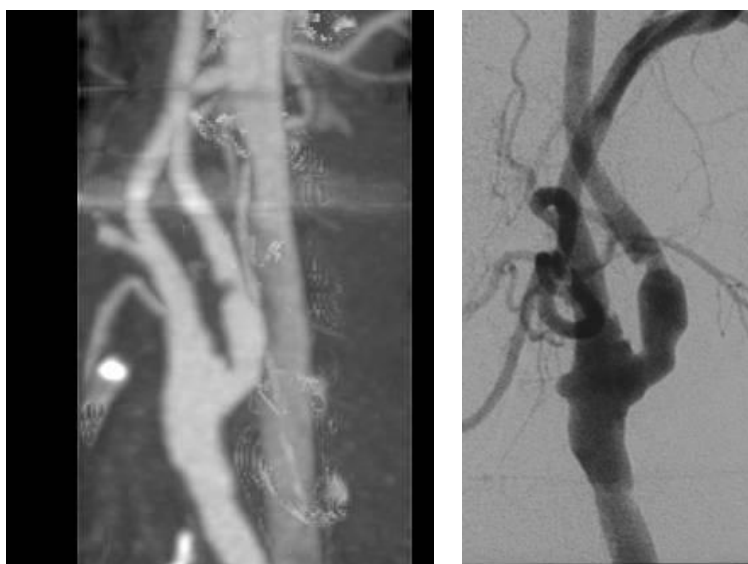
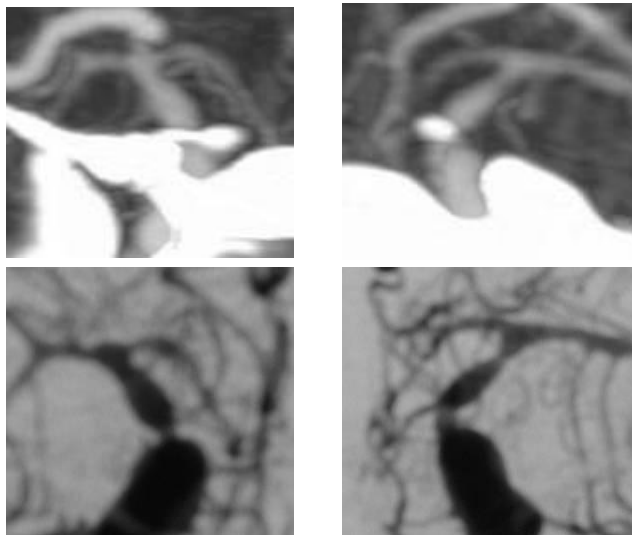
- CTA (CT Angiography)
- CTV (CT Venography)
- pCT (perfusion CT)

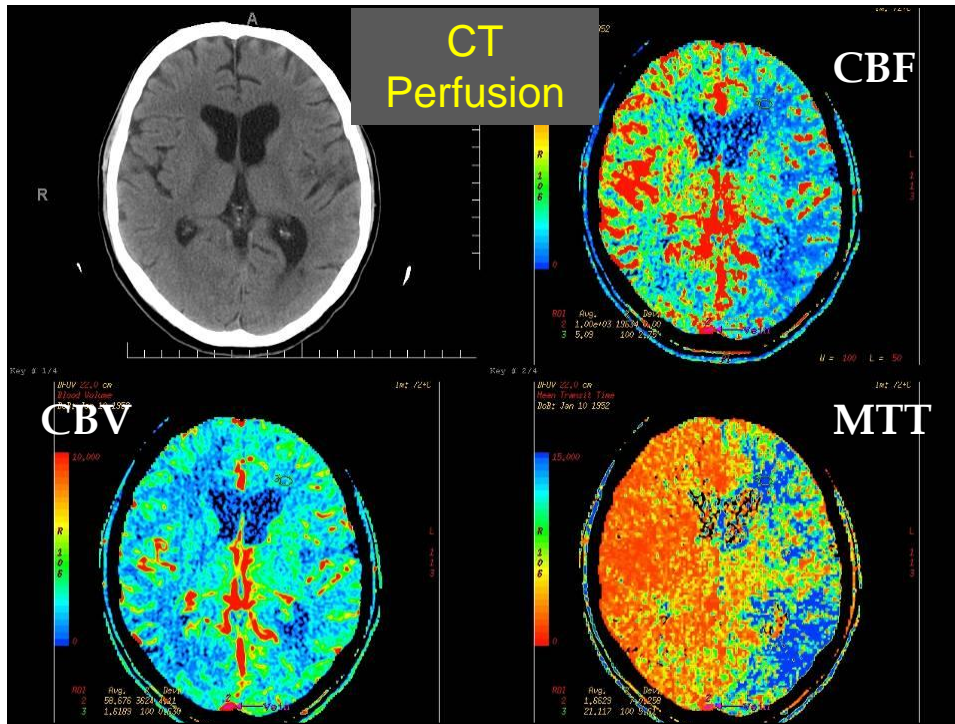






## CTA vs. Angiography





## MRI

- “screening” vs. directed imaging
- Magnet strength
- Advanced sequences and imaging

## MRI - Procedure

- MRI configurations
  - Open
  - Wide bore
  - Standard bore
- Magnet strengths
  - Low field (<1.5T)
  - 1.5 T
  - 3.0 T

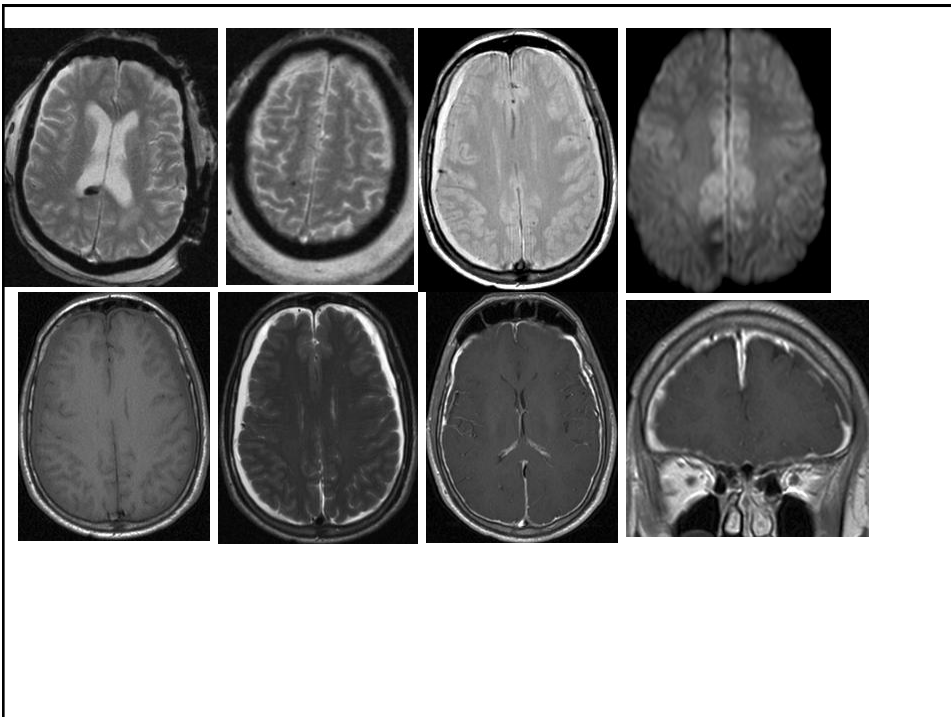


- Head coils
- Noise – headphones
- Must screen for metal
- No x-rays or ionizing radiation
- IV access if contrast
- 30 min – 1 hour



# MRI

- Basic sequences
  - T1, T2, FLAIR, T2\*(GRE), DWI
  - Post-Contrast sequences

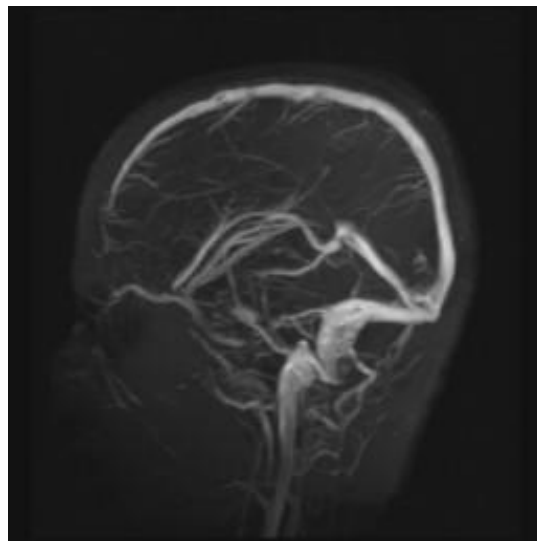


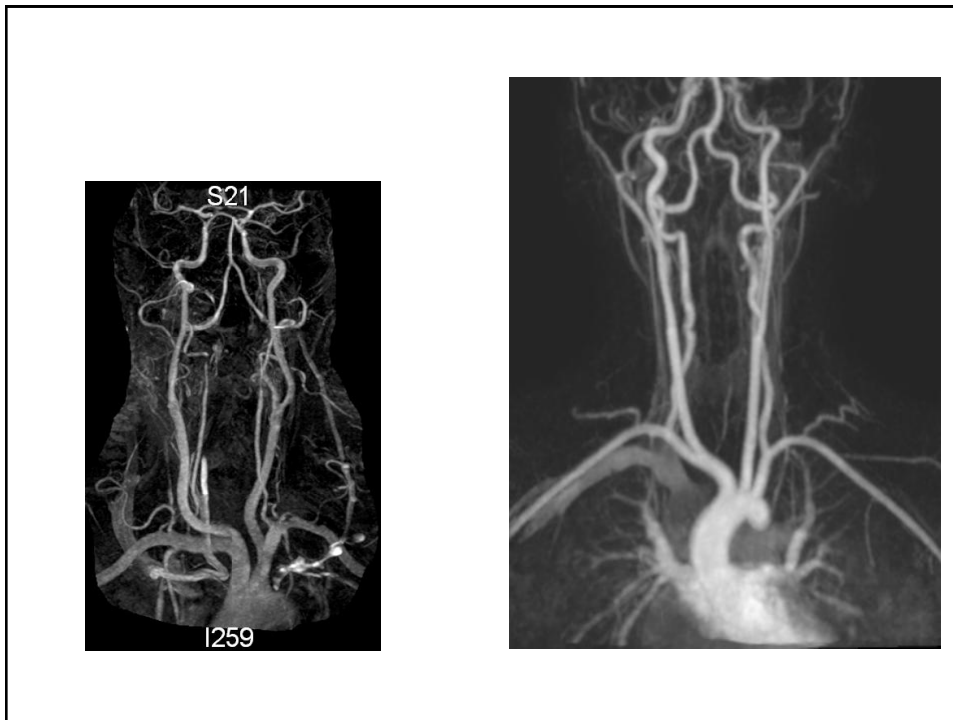
## MRI Vascular Sequences

- MRA
  - Head done without contrast
  - Neck done with and without contrast
- MRV
  - Head done with and/or without contrast



## MRV

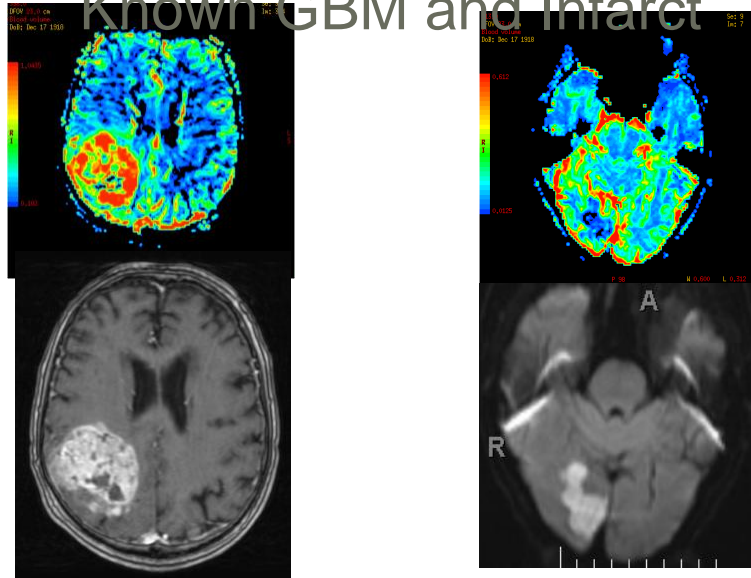




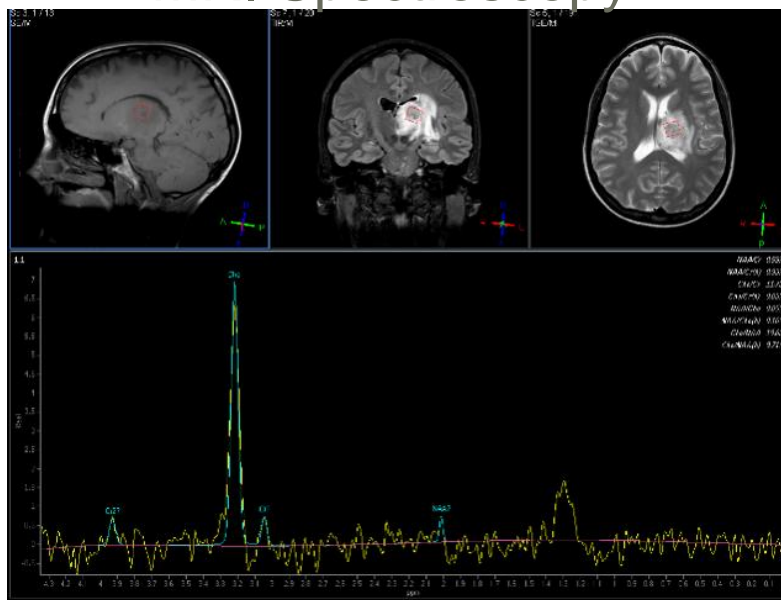
## Advanced MR Imaging

- MR perfusion
- MRS (MR spectroscopy)
- DTI (diffusion tensor imaging)/tractography
- fMRI (functional MRI)

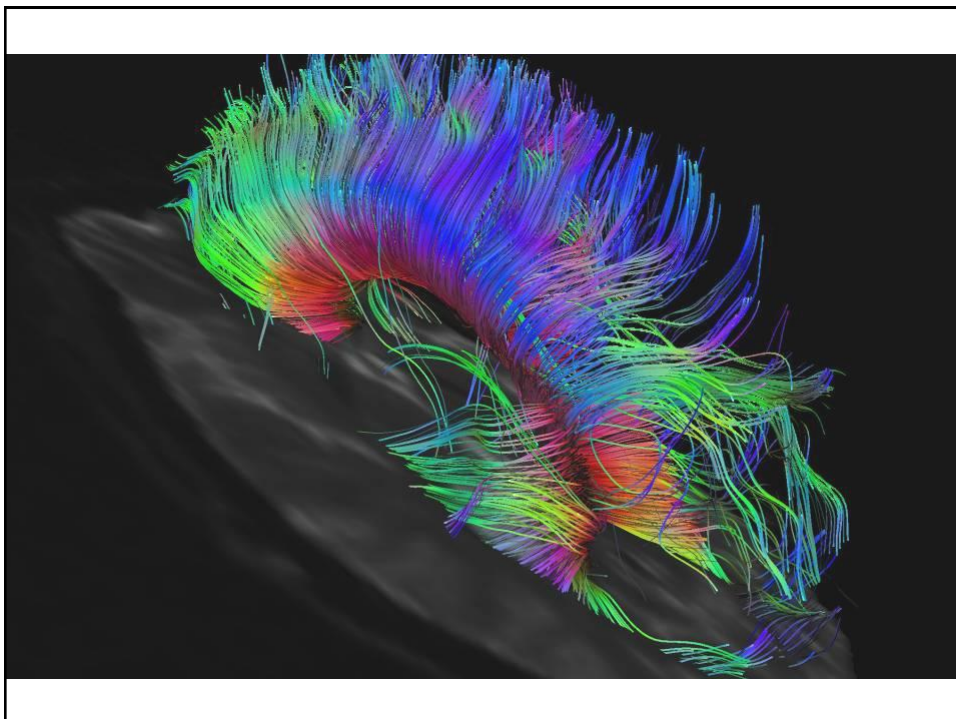
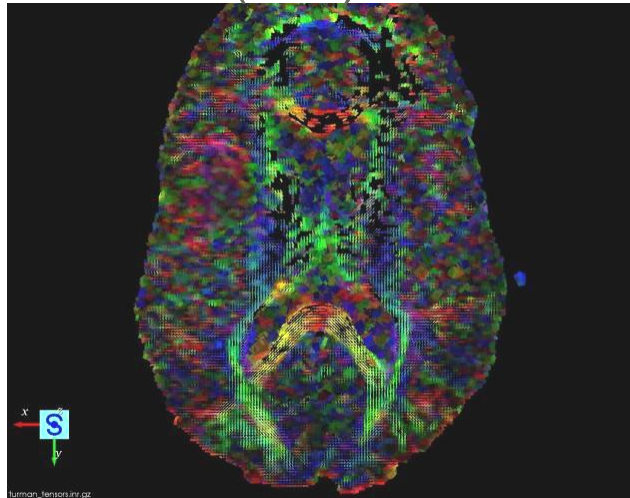
# MRI Perfusion: Known GBM and Infarct



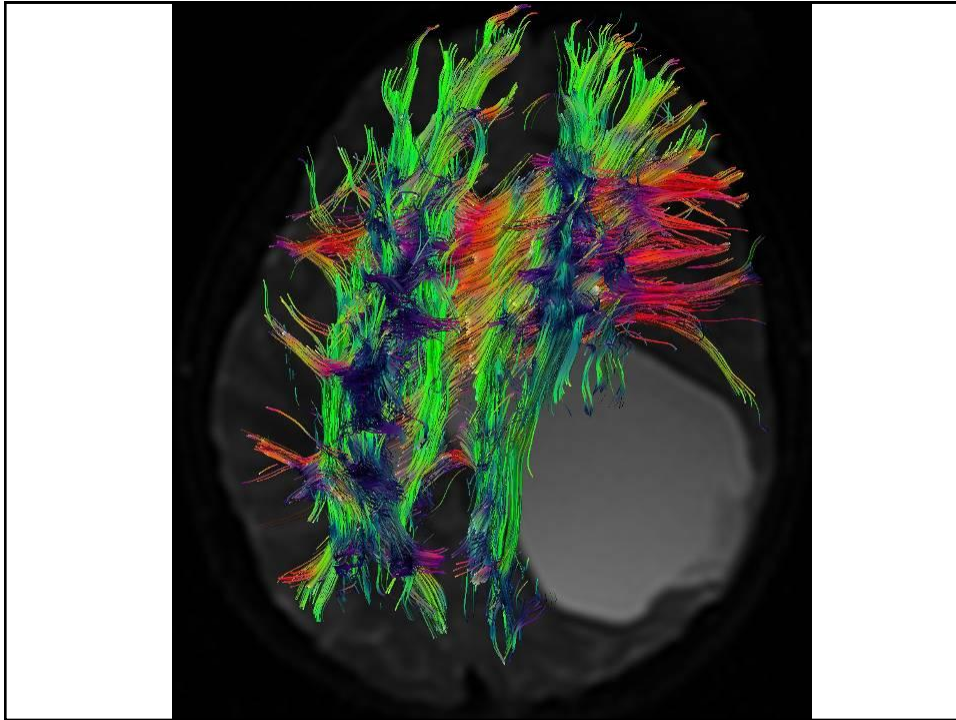
# MRI Spectroscopy



## Diffusion Tensor Imaging (DTI)



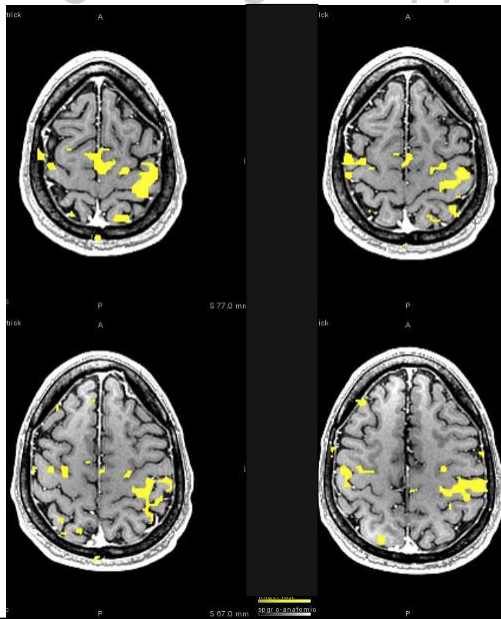




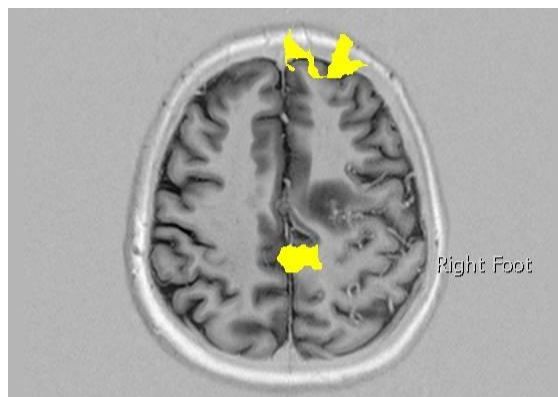
## Functional MRI

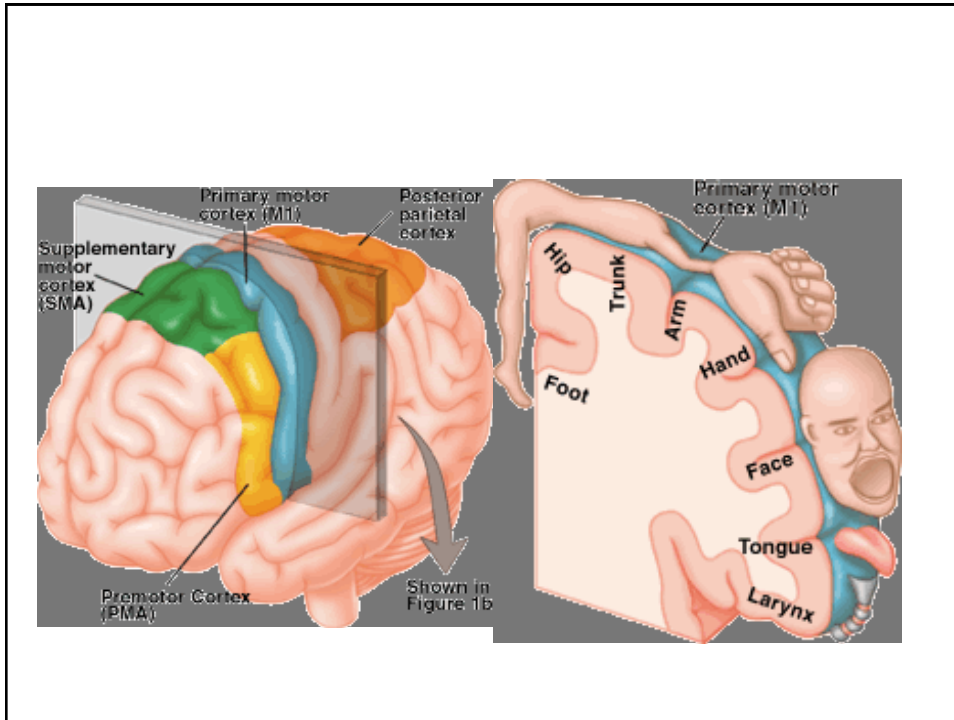
- Through changes in brain perfusion to active areas of cortex, we can indirectly measure brain activity during a task.

## Right Finger Tapping

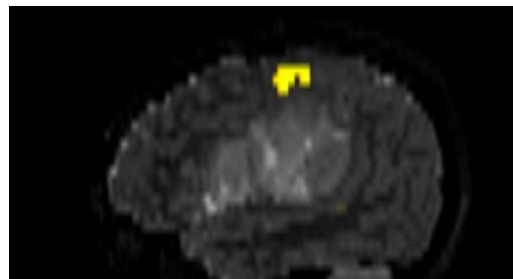


## Right foot/ ankle

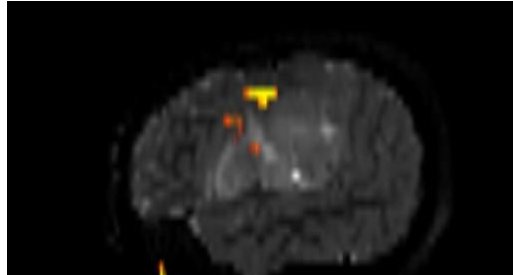




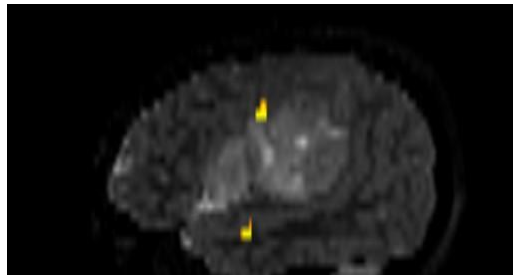
## Finger Tapping



## Fish Lips



## Smacking Tongue



## Language Evaluation

- Language tests are designed to test two components of language.
  1. Word Generation
  2. Comprehension
- Most right handed individuals are left dominant meaning that the left half of the brain has the language areas. Some people are bilateral, and some are right sided.

## Verb Generation Instructions:

### Verb Generate Task

When you see ##### just rest:  
do not think at any word or sentence.

When you see a noun (an object word):  
think of a verb (action word) that you can associate with it.

#### Examples:

<u>See</u>		<u>Think</u>
Clothes	→	Wash
Cards	→	Play
Horse	→	Ride

Think the words silently to yourself do not say them out loud.  
Do not move your mouth or your lips

Try to keep still.

## Verb Generation Practice

Get Ready. The letters come  
fast...

- Slides automatically advance every 3 seconds.

####

Ball

####

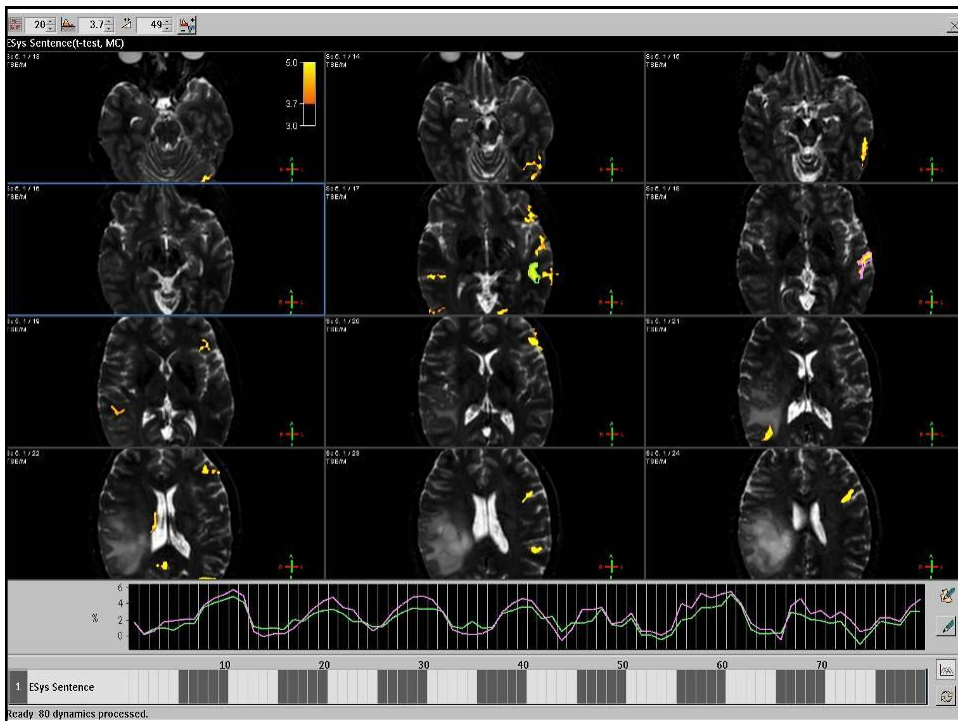
Apple



####

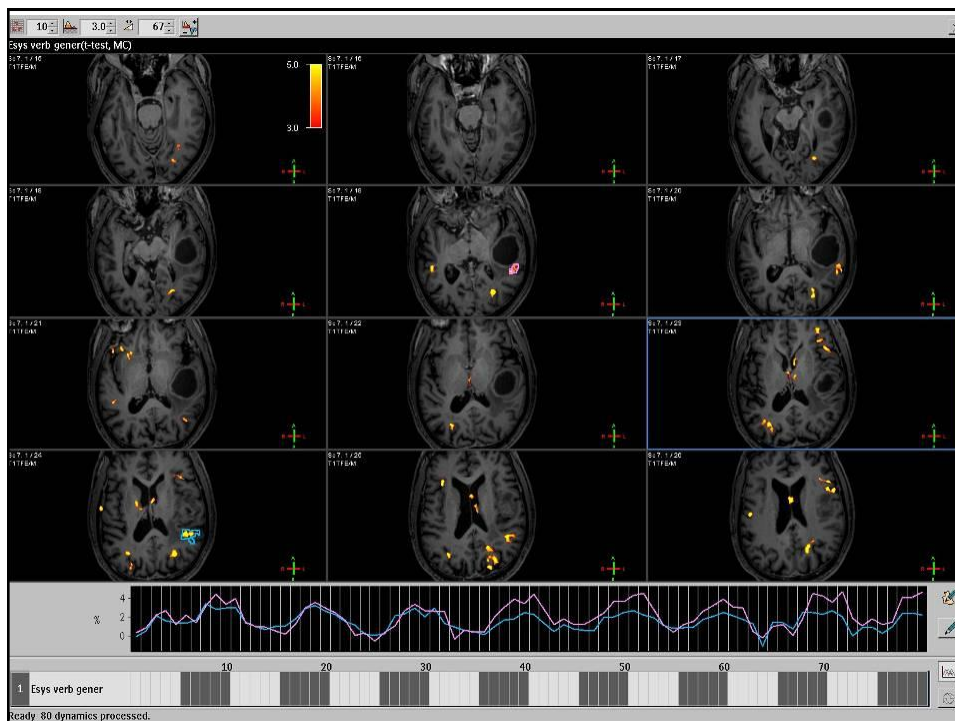
Car

# The Result



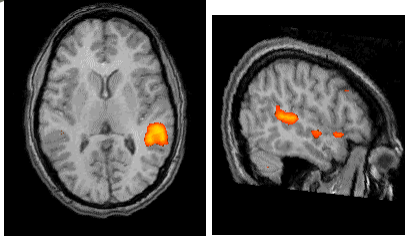
## Intra-operative Correlation

- Surgeons will perform an awake craniotomy if indicated and evaluate language during resection.

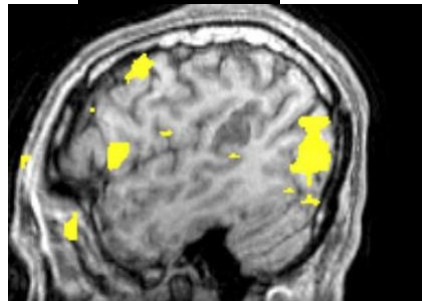


## Language Evaluation

- Wernicke's Area

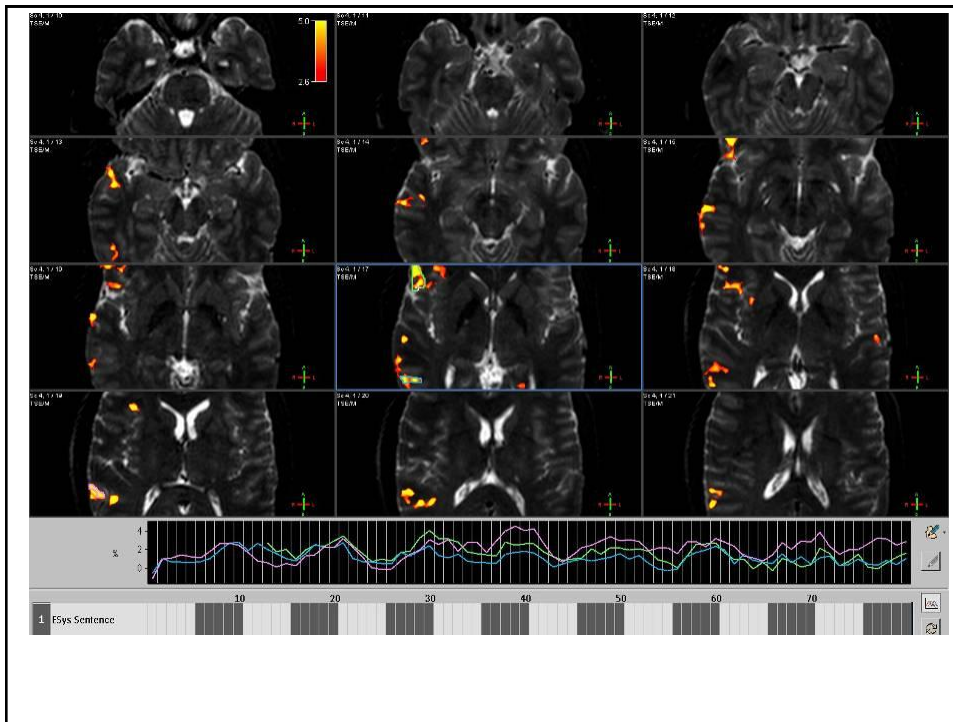


- Broca's Area

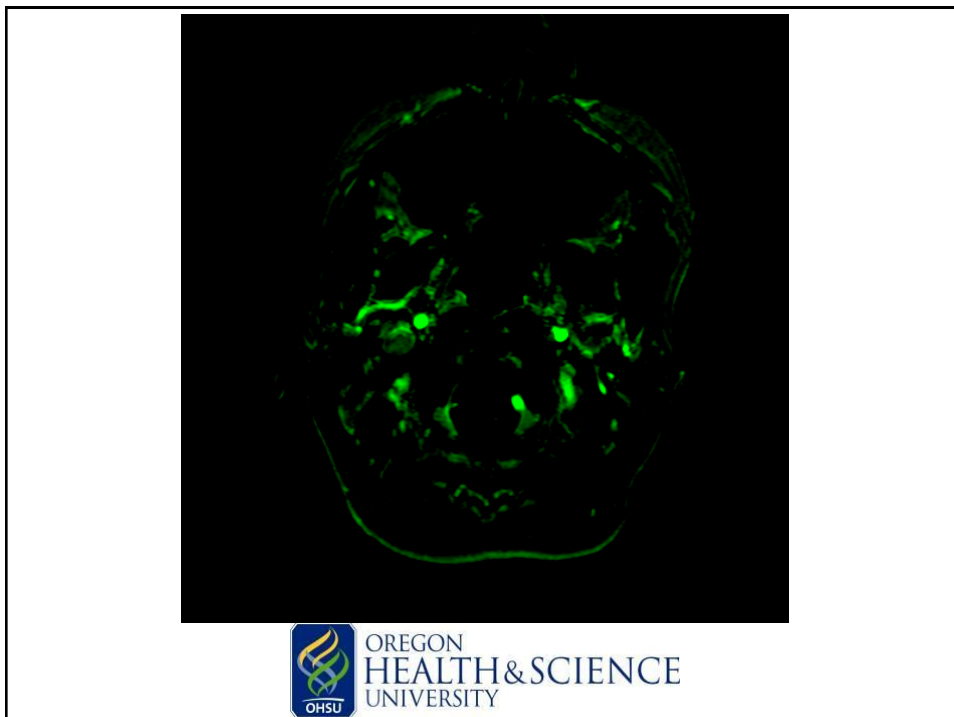
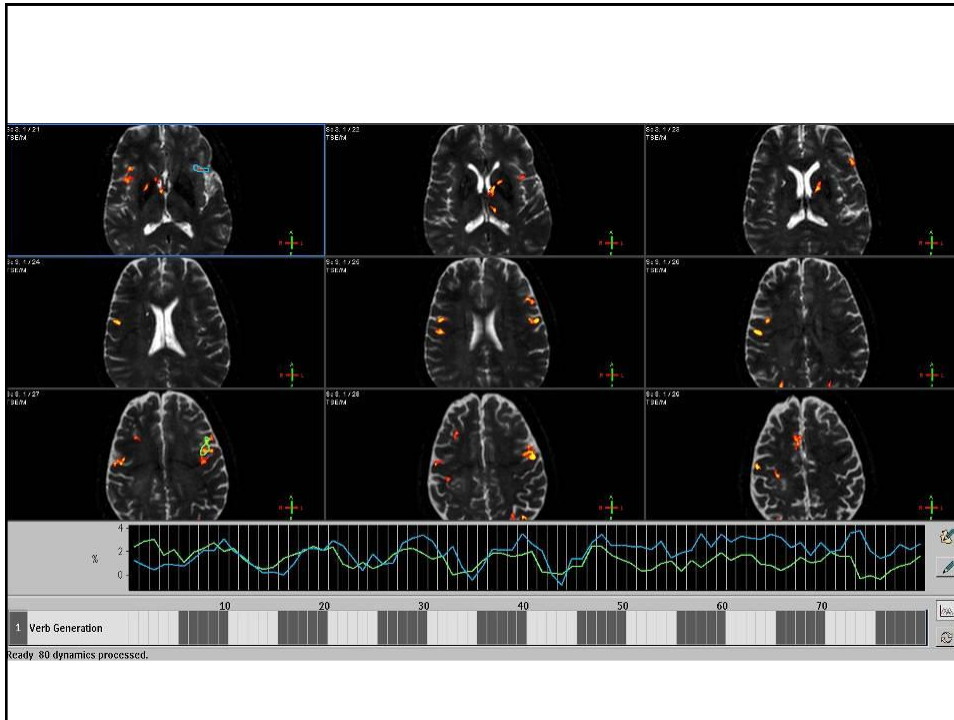


## Case Example

- Patient was left handed, then mother decided he should use right hand at age 5 for school. Been right-handed ever since.



## Case example “The Duck Fan”



We are not able to read your mind yet  
...but we can see  
when and where you are thinking.



## Ordering

- Nationally – little standardization in terminology for studies
  - CT brain – CT head
  - Neck vs. cervical spine
  - Back vs. spine

## Ordering

- Imaging center (institution) variations in “protocols”
  - Orders
  - Billing codes
  - Protocols
  - Scans or sequences

## Ordering

- Variations in availability of patient information
  - History on order
  - History from patient
  - Access to electronic medical record



## The Myth of “I don’t want the history”



## Ordering Help

- Discuss with radiologist
- Discuss with imaging center/hospital
- American College of Radiology

# ACR Appropriateness Criteria

- ACR Appropriateness Criteria (<http://acsearch.acr.org/>)
  - On-line access
  - Mobile apps
- Helpful (not perfect)
- Informative

**www.acr.org**

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RADIOLOGY  
QUALITY IS OUR IMAGE

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## ACR Appropriateness Criteria®

The ACR Appropriateness Criteria® are evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition. By employing these guidelines, providers enhance quality of care and contribute to the most efficacious use of radiology.

The guidelines are developed by expert panels in diagnostic imaging, interventional radiology, and radiation oncology. Each panel includes leaders in radiology and other specialties. There are more than 175 topics with over 850 variants in the March 2011 version.

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[Anytime, Anywhere™ Application for Mobile Devices](#)

In collaboration with Skyscape, the ACR has developed the Anytime, Anywhere™ application for handheld mobile devices as an alternative solution to radiology benefit management companies or computerized physician order entry systems that do not contain the ACR Appropriateness Criteria® guidance. This application provides instant, point-of-care access to all of the ACR Appropriateness Criteria®, which can be directly downloaded to the iPhone, BlackBerry, Palm, or other PDAs, smart phones or mobile devices. The content includes topics from expert panels in breast, cardiac, gastrointestinal, musculoskeletal, neurologic, thoracic, urologic, pediatric, vascular, and women's imaging, as well as interventional radiology and radiation oncology.

**Diagnostic Imaging Topics**

Topics with an asterisks (\*) include pediatric imaging recommendations.

**Breast Imaging**

**Cardiac Imaging**

**Gastrointestinal Imaging**

**Musculoskeletal Imaging**

**Neurologic Imaging**


- Ataxia\*
- Cerebrovascular Disease (Revised)
- Cranial Neuropathy
- Dementia and Movement Disorders (Rev):
- Focal Neurologic Deficit
- Head Trauma\*
- Headache
- Low Back Pain
- Myelopathy
- Neck Mass/Adenopathy\*
- Neuroendocrine Imaging
- Orbits, Vision and Visual Loss\*
- Plexopathy
- Seizures and Epilepsy (Revised)
- Sinonasal Disease
- Suspected Spine Trauma\*
- Vertigo and Hearing Loss

\*This topic also includes pediatric imaging.


**Pediatric Imaging**

**Thoracic Imaging**

Clinical Condition:		Dementia and Movement Disorders	
Variant 1:		Probable Alzheimer's disease.	
Radiologic Procedure	Rating	Comments	RRL*
MRI head without contrast	8		○
MRI head without and with contrast	7	See statement regarding contrast in text under "Anticipated Exceptions."	○
CT head without contrast	6		☼☼☼
FDG-PET head	6	For problem solving.	☼☼☼☼
Tc-99m HMPAO SPECT head	5	For problem solving.	☼☼☼☼
CT head without and with contrast	4		☼☼☼
MR spectroscopy head	4		○
MRI functional (fMRI) head	2	For research purposes.	○
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level
Variant 2:		Possible Alzheimer's disease.	
Radiologic Procedure	Rating	Comments	RRL*
MRI head without contrast	8		○
MRI head without and with contrast	7	See statement regarding contrast in text under "Anticipated Exceptions."	○
FDG-PET head	7	For problem solving.	☼☼☼☼
CT head without contrast	6		☼☼☼
Tc-99m HMPAO SPECT head	6	For problem solving.	☼☼☼☼
CT head without and with contrast	5		☼☼☼
MR spectroscopy head	4		○
MRI functional (fMRI) head	2		○
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level



**ACR**  
Appropriateness Criteria®



New Search    Redefine Search    ACR Appropriateness Criteria HOME    ACR Home

**Overview: Searching for Clinical Conditions**

This search engine allows you to search for terms found within the ACR Appropriateness Criteria® (ACR AC) documents so you can more easily find the clinical conditions you are interested in reviewing.

When searching for clinical conditions, you may wish to use the medical term and the common term. For example, searching for "shortness of breath" OR "dyspnea" may save you a step in your searching and ensure a more complete listing of the topics.

**Select Category**

Select All

Diagnostic/Interventional Topics Only

Radiation Oncology Topics Only

any of these words\*

And

all of these words\*

\*Words and Phrases must be separated by a comma


**Instructions:**

- Select the CATEGORY
- TYPE the word or words for which you want to search the ACR AC documents.

any of these words is for "OR" statements  
e.g., acute ataxia, stroke - "acute ataxia" OR "stroke"

all of these words is for "AND" statements  
e.g., acute ataxia, stroke - "acute ataxia" AND "stroke"

If you decide to use both boxes in your search, the two statements will be joined by "and".



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### Clinical Conditions Search Results

Search Results for:  
("headache") 8 Topics found.

Topic	Panel	Results
<a href="#">Headache</a>	Neurologic	headache (71)
<a href="#">Headache — Child</a>	Pediatric	headache (61)
<a href="#">Ataxia</a>	Neurologic	headache (2)
<a href="#">Focal Neurologic Deficit</a>	Neurologic	headache (2)
<a href="#">Sinusitis — Child</a>	Pediatric	headache (2)
<a href="#">Head Trauma</a>	Neurologic	headache (1)
<a href="#">Multiple Brain Metastases</a>	RO-BRAIN Metastases	headache (1)
<a href="#">Neuroendocrine Imaging</a>	Neurologic	headache (1)

### American College of Radiology ACR Appropriateness Criteria®

**Clinical Condition:** Headache

**Variants:** Chronic headache. No new features.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without and with contrast	4	See statement regarding contrast in text under "Anticipated Exceptions."	○
MRI head without contrast	4		○
CT head without contrast	4		☼☼☼
CT head without and with contrast	4		☼☼☼
MRA head with or without contrast	2		○
Arteriography cervicocerebral	2		☼☼☼
CTA head with contrast	2		☼☼☼

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate      \*Relative Radiation Level

**Variants:** Chronic headache with new features.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without and with contrast	8	See statement regarding contrast in text under "Anticipated Exceptions."	○
MRI head without contrast	7		○
CT head without contrast	5	If new features highly suggestive of intracranial hemorrhage, see variant 3. If MRI unavailable or contraindicated.	☼☼☼
MRA head with or without contrast	5	Selected cases when vascular disease suspected. See statement regarding contrast in text under "Anticipated"	○

<b>Clinical Condition:</b>		<b>Headache</b>	
<b>Variant 3:</b>		<b>Sudden onset of severe headache ("Worst headache of one's life", "thunderclap headache").</b>	
<b>Radiologic Procedure</b>	<b>Rating</b>	<b>Comments</b>	<b>RRL*</b>
CT head without contrast	9		***
CTA head with contrast	8	Usage of CT vs MRI depends on local preference and availability.	***
MRA head with or without contrast	8	Usage of CT vs MRI depends on local preference and availability. See statement regarding contrast in text under "Anticipated Exceptions."	O
Arteriography cervicocerebral	7		***
MRI head without contrast	7	May be helpful after CT depending on CT findings.	O
MRI head without and with contrast	6	May be helpful after CT depending on CT findings. See statement regarding contrast in text under "Anticipated Exceptions."	O
CT head without and with contrast	6		***
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>
<b>Variant 4:</b>		<b>Sudden onset of unilateral headache, or suspected carotid or vertebral dissection or ipsilateral Horner's syndrome.</b>	
<b>Radiologic Procedure</b>	<b>Rating</b>	<b>Comments</b>	<b>RRL*</b>
CTA head and neck with contrast	8	Usage of CT versus MRI depends on local preference and availability.	***
MRA head and neck with or without contrast	8	Usage of CT versus MRI depends on local preference and availability. See statement regarding contrast in text under "Anticipated Exceptions."	O
MRI head without and with contrast	8	With diffusion-weighted sequences. See statement regarding contrast in text under "Anticipated Exceptions."	O
MRI head without contrast	8	With diffusion-weighted sequences.	O
CT head without contrast	7		***
Arteriography cervicocerebral	7		***
CT head without and with contrast	6		***
US carotid duplex	3		O

### HEADACHE

Expert Panel on Neurologic Imaging: John E. Jordan, MD<sup>1</sup>; Franz J. Wippold II, MD<sup>2</sup>; Rebecca S. Cornelius, MD<sup>3</sup>; Sepideh Amin-Hanjani, MD<sup>4</sup>; James A. Brunberg, MD<sup>5</sup>; Patricia C. Davis, MD<sup>6</sup>; Robert L. De La Paz, MD<sup>7</sup>; Pr. Didier Dormond<sup>8</sup>; Isabelle Germano, MD<sup>9</sup>; Linda Gray, MD<sup>10</sup>; Suresh Kumar Mukherji, MD<sup>11</sup>; David J. Seidenwurm, MD<sup>12</sup>; Michael A. Sloan, MD, MS<sup>13</sup>; Patrick A. Turski, MD<sup>14</sup>; Robert D. Zimmerman, MD<sup>15</sup>; Greg J. Zipfel, MD<sup>16</sup>

#### Summary of Literature Review

Headache is one of the most frequent ailments of the human race. Studies of the prevalence of headache of any kind in populations have estimated frequencies of 11%-48% in children [1,2] and 6%-71% in adults [3,4]. As with migraine, age, gender, and case definition may largely account for this variance [5]. However, a higher prevalence of headache has been found by surveys in Europe and North America [6,7] than by those of Asian and South American countries [4,8]. A survey of the Canadian population showed that only about 20% of people there are headache free [9]. Prevalence of migraine shows a clear-cut gender difference, as well as genetic factors, affecting about 15%-18% of women and 6% of men [5,10,11]. It occurs most commonly in men and women 25-55 years of age. Muscle contraction or tension accounts for most of the nonmigraine headaches encountered in population surveys.

By comparison, the frequency of pathology that can present with headache is rather low. The yearly incidence of brain tumors in the United States is 46 per 100,000. For subarachnoid hemorrhage, the yearly incidence is nine per 100,000. Arteriovenous malformations (AVMs) are about one-tenth as frequent as saccular aneurysms. Only a subset of these patients presents with isolated headache. In a retrospective review of the presentation of 111 brain tumors, headaches were a symptom in 48%,

equally for primary and metastatic brain tumors [12]. Headaches were similar to tension type in 77%, migraine type in 9%, and other types in 14%. The typical headache was bifrontal but worse ipsilaterally, and was the worst symptom in only 45% of patients. Other studies have found a higher frequency, but sometimes the headache preceded the diagnosis of brain tumor by several years, bringing up the possibility of an association with this common complaint, rather than causality [13,14]. In children with brain tumors, headache was present in 62%, more often with infratentorial tumors [15]. Because tumors are rare and only about half of them present with headache, it becomes apparent that if all patients with headache undergo imaging procedures, a large proportion of the studies will be negative [13].

Several studies have confirmed the low yield of imaging procedures in individuals presenting with isolated headache—that is, headache unaccompanied by other neurological findings [16,17]. Most of them are retrospective reviews. The patients were referred for imaging because the referring physician suspected pathology detectable by imaging or the patients requested the study to be certain that they did not have a brain tumor. A prospective review of 293 computed tomography (CT) scans ordered in an ambulatory family practice setting disclosed that most of them were ordered because the clinician suspected that a tumor (49%) or a subarachnoid hemorrhage (SAH) (9%) might be present. Fifty-nine (17%) were ordered because of patient expectation or medico-legal concerns [18].

#### Computed Tomography and Magnetic Resonance Imaging

Studies before 1991 on the yield of CT or magnetic resonance imaging (MRI) in patients with headache but normal neurological examination were reviewed by Frisberg [19]. The scans examined in most of the larger studies were performed with first-generation CT equipment. In addition, Frisberg included three more studies in his excellent meta-analysis [20-22]. Of 897 studies in patients with migraine, only four were positive, three for a tumor and one for an AVM, giving a 0.4% yield of potentially treatable lesions. In patients with unspecified headache, 1,825 scans yielded a total of 43 lesions (21 tumors, 8 hydrocephalus, 6 AVMs, 5 subdural hematomas, and 3 aneurysms), for a 2.4% yield of

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<sup>5</sup>University of California Davis Medical Center, Sacramento, California.  
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<sup>8</sup>Hôpital de la Salpêtrière, Assistance-Publique-Hôpitaux de Paris, France.

## Reports



## Reports – CONSUMER'S OPINIONS

- Referring physician opinions about radiology report
  - Want reports to be complete including pertinent negatives
  - Want reports to be in consistent formats
  - Feel that reports in their institutions fall far short of these goals
  - These studies are all rather dated (5-15 years old) but the results are still valid today

## Structured Reporting

- Variable results from research
  - More complete v. less complete
  - Accepted v. disliked
- Other issues
  - Transcribed
  - Voice recognition
  - Templates
  - Standard language/terminology

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### Clinical History:

Reason for exam, including medical necessity:

### Imaging Technique

Image acquisition parameters

Contrast materials and other medications administered

Radiation dose Comparison

Date and type of previous exams reviewed, if applicable

### Observations (Findings)

Extra axial spaces:

Hemorrhage:

Ventricular system:

Basal cisterns:

Cerebral parenchyma:

Midline shift

Cerebellum:

Brainstem:

### Other:

Vascular system:

Visualized Paranasal sinuses

Visualized Orbits

Visualized upper cervical spine

Sella and skull base:

### Summary (or Impression)

An itemized list of key observations, including any recommendations.

CT BRAIN WITHOUT CONTRAST, [Order Observation Time]

INDICATION: [Clinical Information]

COMPARISON: [None]

TECHNIQUE: Axial CT images of the brain from skull base to vertex, including portions of the face and sinuses, were obtained without contrast. Supplemental 2D reformatted images were generated and reviewed as needed.

ADDITIONAL TECHNIQUE: [<None>]

FINDINGS:

Soft tissues: [Unremarkable]

Skull/Skull base: [No fractures, deformities, or destructive lesions. Sella is normal. Mastoids and middle ears are clear.]

Face/Orbits: [No fractures, deformities, or masses in the visualized portions.]

Sinuses: [Visualized portions are clear.]

Brain: [No significant cerebral abnormality. Specifically, no evidence of hemorrhage, hydrocephalus, tumor, vascular lesion, acute infarction, or intracranial injury.]

Additional Comments: [None]

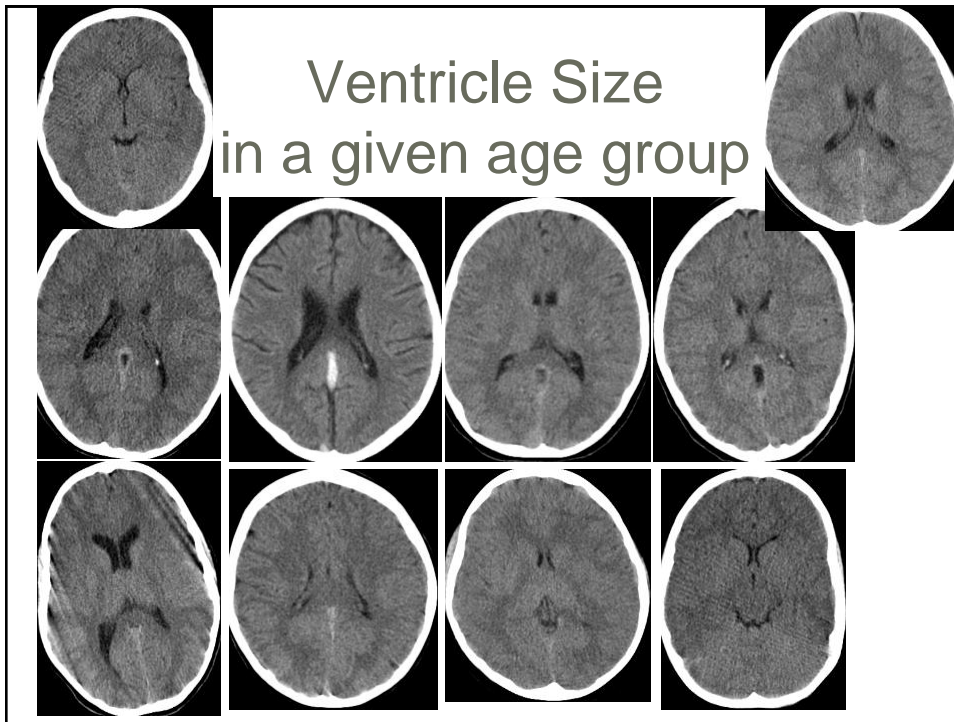
IMPRESSION:

[Normal noncontrast CT of the brain].

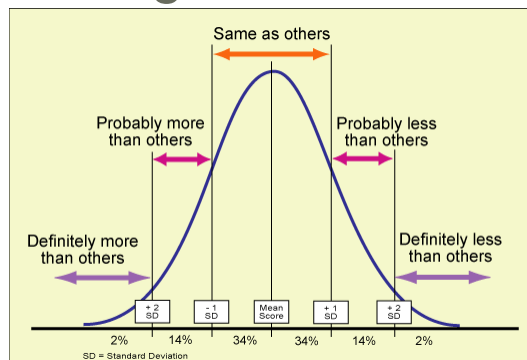
## Reports

- “negative” or “normal” reports
  - Within the limitation of the study
    - Artifact, motion, resolution
  - Scan ability
    - i.e. acute infarct on CT
  - Conspicuity of pathology
    - i.e. marrow abnormality on T2WI
  - Range of normal

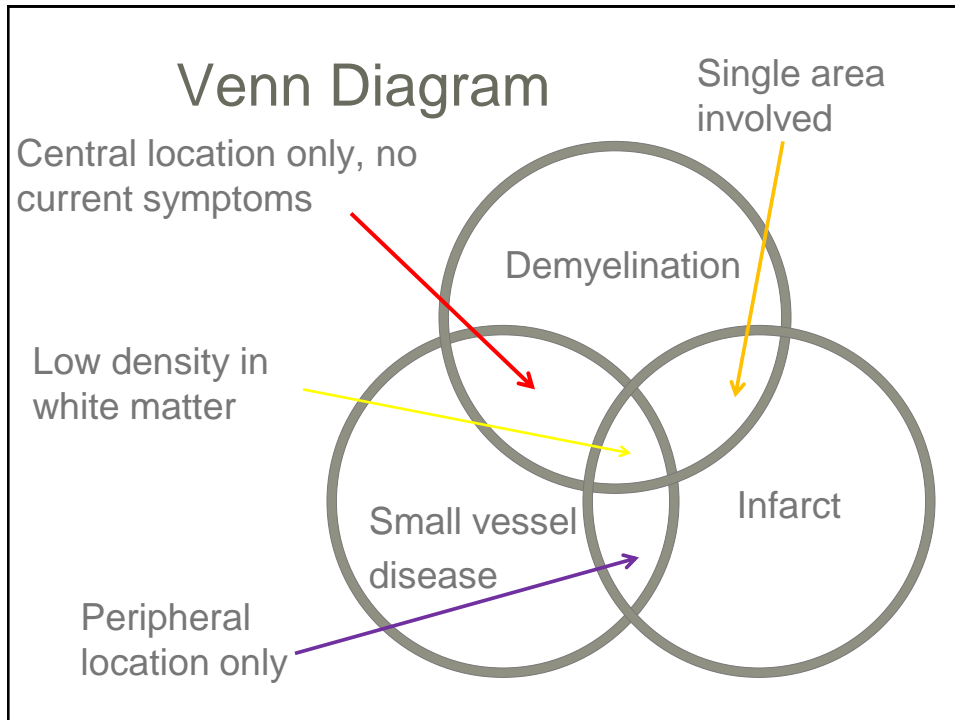




## Range of Normal



- Some findings are distributed in a Bell curve distribution.



## Part 4: Assorted Issues

- Radiation
- Contrast
- Symptom specific imaging

## Radiation

- Primary issues:
  - Attention to dose issues for individual scan protocols
  - Appropriate use of imaging modalities to reduce dose to individual patients and population
  - Attention to individual cumulative dose
  - Attention to those at greatest risk
  - Radiation risk v. benefit

## Radiation

- Attention to dose issues for individual scan protocols
  - Radiology and Imaging Center issue
  - Monitor and maintain quality and dose
  - Reporting of dose

## Radiation

- Appropriate use of imaging modalities to reduce dose to individual patients and population
  - Clinical appropriateness for scans
  - Understanding abilities of various modalities
  - Adjusting scans based on clinical need

## “Screening” studies

- “screening” sinus
- Whole body low dose CT for myeloma
- “Quick Brain” MRI for hydrocephalus

## Radiation

- Attention to individual cumulative dose
  - Awareness and reporting of multiple exams

## Radiation

- Attention to those at greatest risk
  - Children
  - Women
  - Estimated 15 – 20 year time to develop cancer

## Contrast

- CT
  - Iodinated
- MR
  - Gadolinium based
  - Iron based

## Contrast - Allergy

- Low incidence with LOCM (0.2% - 0.7%)
- Myths:
  - Shellfish
  - Dairy products
- Facts:
  - Significant allergies, asthma
  - Prior reaction to contrast
  - Risk v. benefit

## Contrast - CT

- Reactions
  - Mild – nausea, vomiting, urticarial reaction, pain at injection site, feeling of warmth/flushing
  - Moderate – vasovagal, symptomatic urticaria, mild bronchospasm, tachycardia, mild hypotension
  - Severe – respiratory distress, cardiac arrest, profound vasovagal, laryngeal edema, seizure, severe hypotension

## Contrast - CT

- Renal
  - Risk related to:
    - Degree of pre-existing renal disease
    - Hydration
- Risk Factors
  - Highest risk: combination of diabetes and renal insufficiency
  - Others: dehydration, cardiovascular disease and use of diuretics, advanced (<70) age, multiple myeloma (HOcm), hypertension, hyperuricemia.

## Contrast - MR

- Allergy - Reaction
- No nephrotoxicity at approved dosages
- Nephrogenic Systemic Fibrosis

## Contrast - MR

- Reactions:
  - Very low allergic type reactions (0.004% - 0.7%)
  - Severe reactions are exceedingly rare (0.001%– 0.01%)
  - No cross-reactivity to iodinated contrast media
  - Risks:
    - asthma and various other allergies
    - Prior reaction to gadolinium agent



## Nephrogenic systemic fibrosis NSF

- Initially noted in end stage chronic kidney disease
- In 2006, association with gadolinium-based contrast administration in patients with renal disease
- Mechanism still under investigation
- Highest risk in patients with eGFR  $<30\text{ml/min}/1.73\text{m}^2$

## When is contrast needed?

- If you are thinking of a CT with contrast, you might as well get an MRI.
  - Usually the only time a CT with contrast is really helpful, is when a patient can't have an MRI!
- MRI with contrast:
  - Tumors
  - Infections

## Neuroradiology Protocols

- We review all orders.
- We select the best protocol for the indication.
- The more information we get in the indication, the better we can determine the optimal exam protocol.
- We need to know what you are concerned about, or what you are evaluating.

## Symptom Specific Imaging and Neuroradiology Protocols.

- Traumatic Brain Injury
- Memory impairment
- “Altered Mental Status”
- Epilepsy
- Acute Stroke
- Multiple Sclerosis
- Pituitary
- Temporal bone/IAC
- Trigeminal Nerve

Most other indications will get our routine brain imaging w or w/wo contrast

## Traumatic Brain Injury

- Routine brain imaging protocols usually include the blood sensitive sequences
  - GRE or Gradient Recalled Echo
  - SWI or susceptibility weighted imaging
  - Contrast not needed.
  
- Protocol is used mainly for documentation.

## Memory Impairment

**Clinical Condition:**

**Head Trauma**

**Variant 5:**

**Subacute or chronic closed head injury with cognitive and/or neurologic deficit(s).**

Radiologic Procedure	Rating	Comments	RRL*
MRI head without contrast	8		O
CT head without contrast	6		☼☼☼
Tc-99m HMPAO SPECT head	4	For selected cases.	☼☼☼☼
FDG-PET head	4	For selected cases.	☼☼☼☼
MRA head and neck without contrast	4	For selected cases.	O
MRA head and neck without and with contrast	4	For selected cases. See statement regarding contrast in text under "Anticipated Exceptions."	O
CTA head and neck with contrast	4	For selected cases.	☼☼☼
MRI head without and with contrast	3		O
CT head without and with contrast	2		☼☼☼
X-ray and/or CT cervical spine without contrast	2	Assuming there are no spinal neurologic deficits. See ACR Appropriateness Criteria® on "Suspected Spine Trauma".	☼☼☼
X-ray head	2		☼
MRI functional (fMRI) head	2		O
US transcranial with Doppler	1		O

## Altered Mental Status

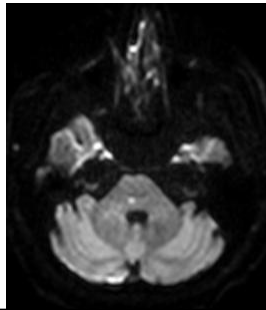
- CT and MRI have a role.
- CT is a screening exam for bleeds or masses
- MRI is more frequently diagnostic if CT is negative or inconclusive.

## Epilepsy

- First Time Seizure v. Known Epilepsy
- 3T
- Slice thickness is thinner.
- Scan plane is perpendicular to temporal lobes.
- In VA population, contrast is useful to exclude underlying masses.

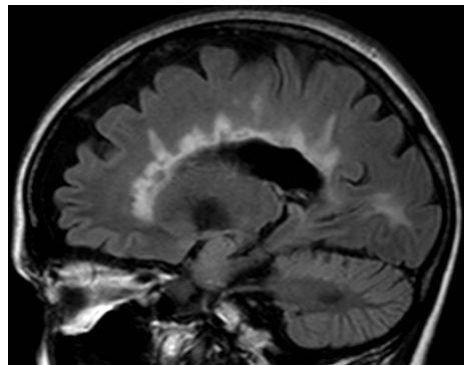
## Acute Stroke

- CT v. MR
- MRI only v. MRI/MRA
- Screen or evaluate for treatment



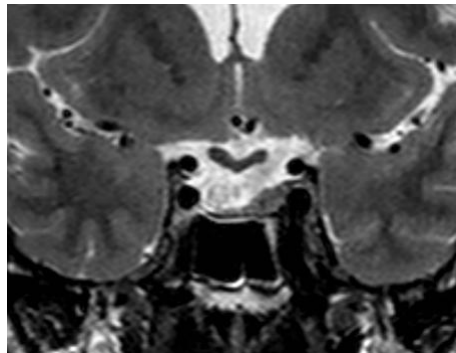
## Multiple Sclerosis

- Initial diagnosis v. follow-up
- Contrast is optional
- 3D Sequences are the future



## Pituitary

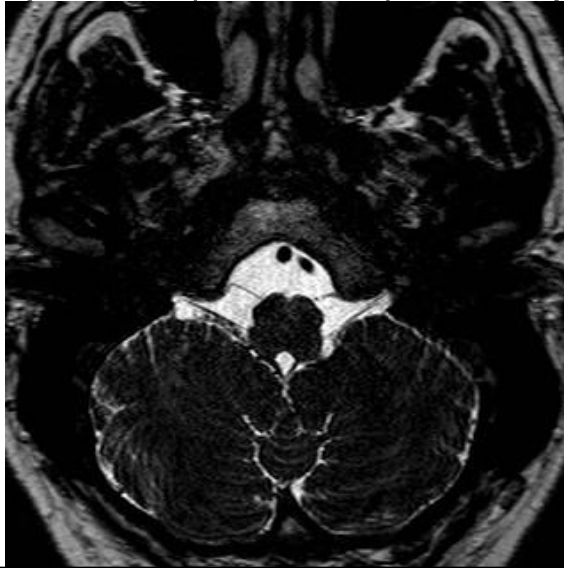
- Pre-test probability
- Screening v. surgical planning
- Dynamic imaging
- Imaging is focused on sella.



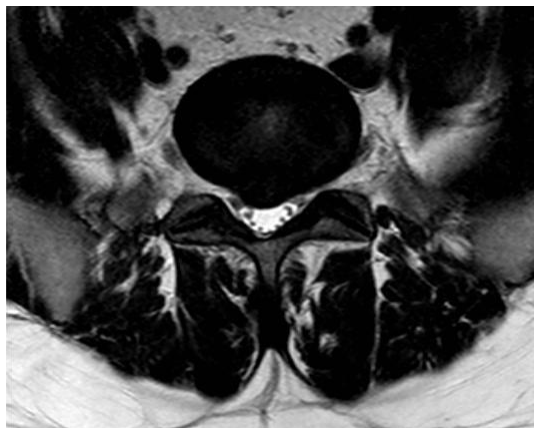
## Temporal Bone

- CT v. MR
- Screen for acoustic schwannoma v. comprehensive exam
- Hi-resolution T2 sequence
- Hi-resolution post contrast images.

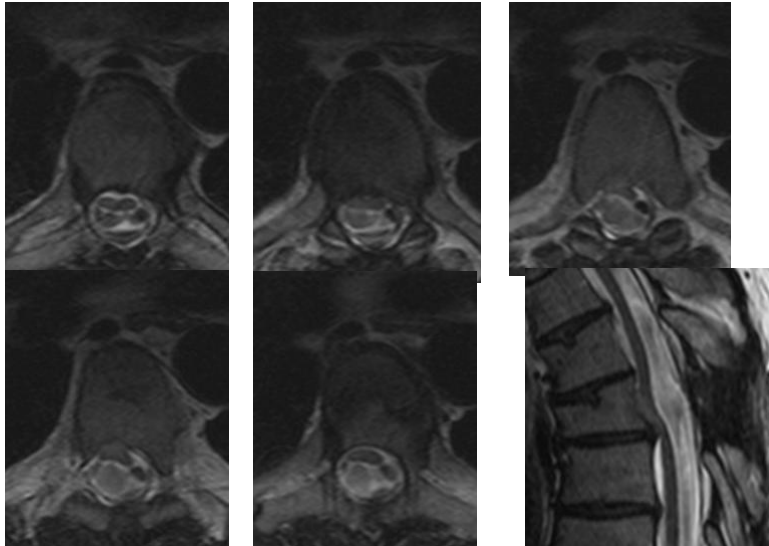
## High Resolution T2 Images (BFFE, Fiesta, CISS)



## Spine Imaging



## Spine Imaging



## Summary

- Neuroradiology is a specialized but diverse field with some highly advanced applications.
- Guides for the “best test” for an indication are available ([www.acr.org](http://www.acr.org)), or you can discuss with the radiologist.
- The more information you give us in the order, the more likely we are to select the best protocol for an indication.



# Questions?

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