

# Organically Grown: Adventures in Primary Care Neuroradiology

Duke Spine Service  
2002-2024

Linda Gray, MD

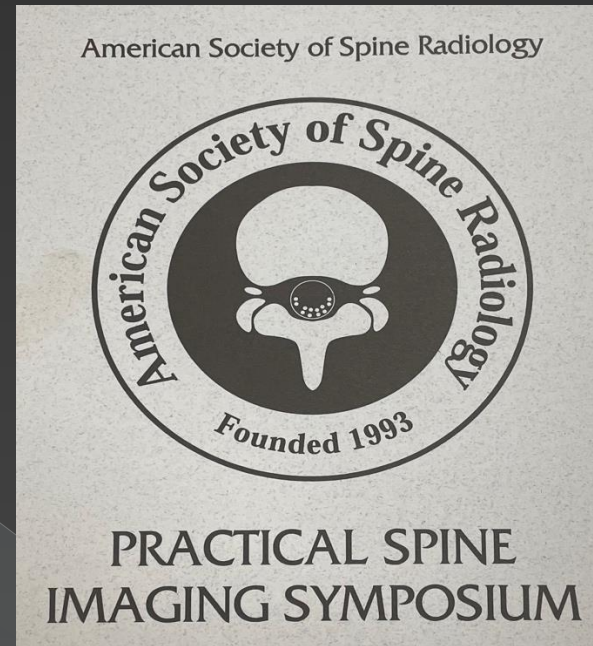
Associate Professor of Radiology  
Division of Neuroradiology



# 2002: Opportunity



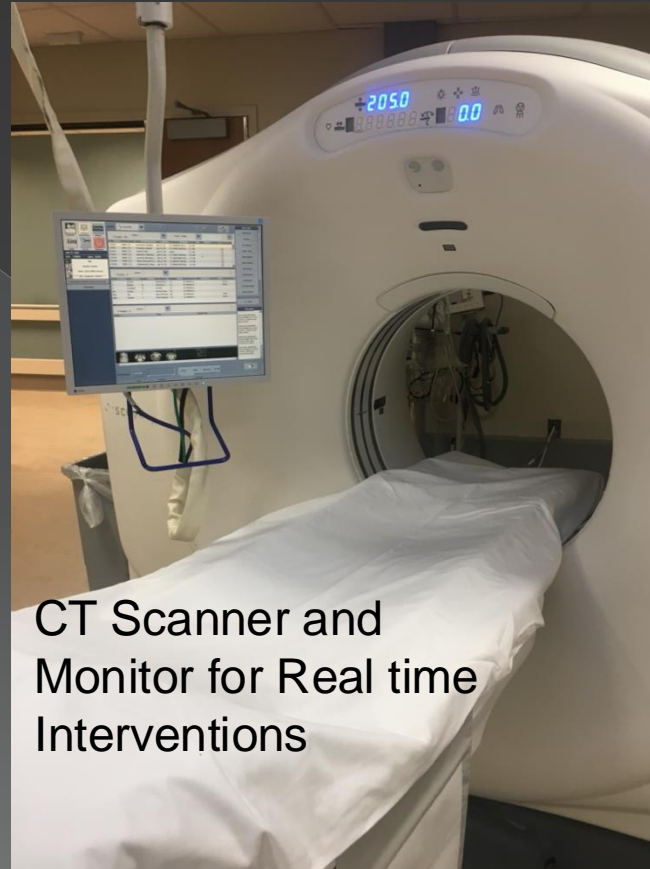
Request by  
Neurosurgery &  
Orthopedic Surgery for  
Pain Management  
Services



Attended ASSR  
Learn injectables  
We did not know to ask  
about credentialing

We started coloring outside the lines

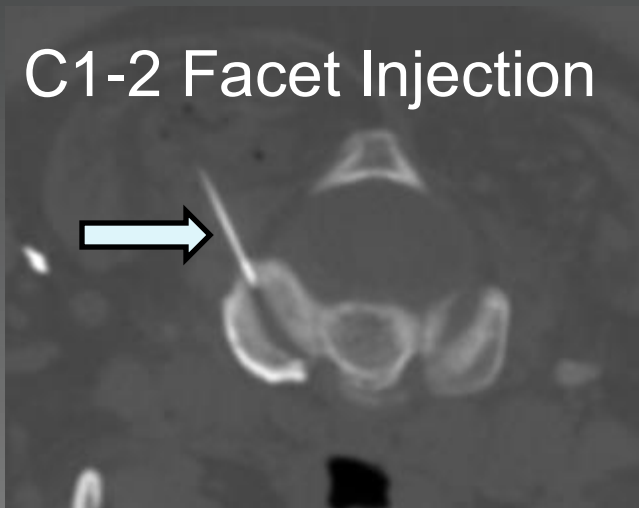
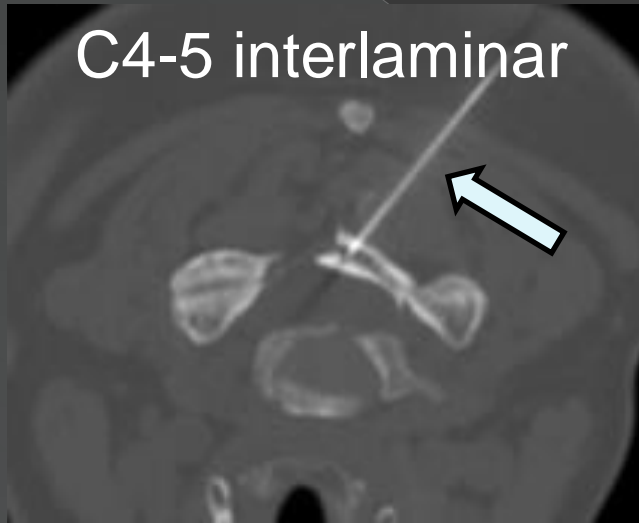
# Initiation of Pain Management Service: Decision- Fluoroscopy or CT Fluoroscopy ?



CT Scanner and  
Monitor for Real time  
Interventions

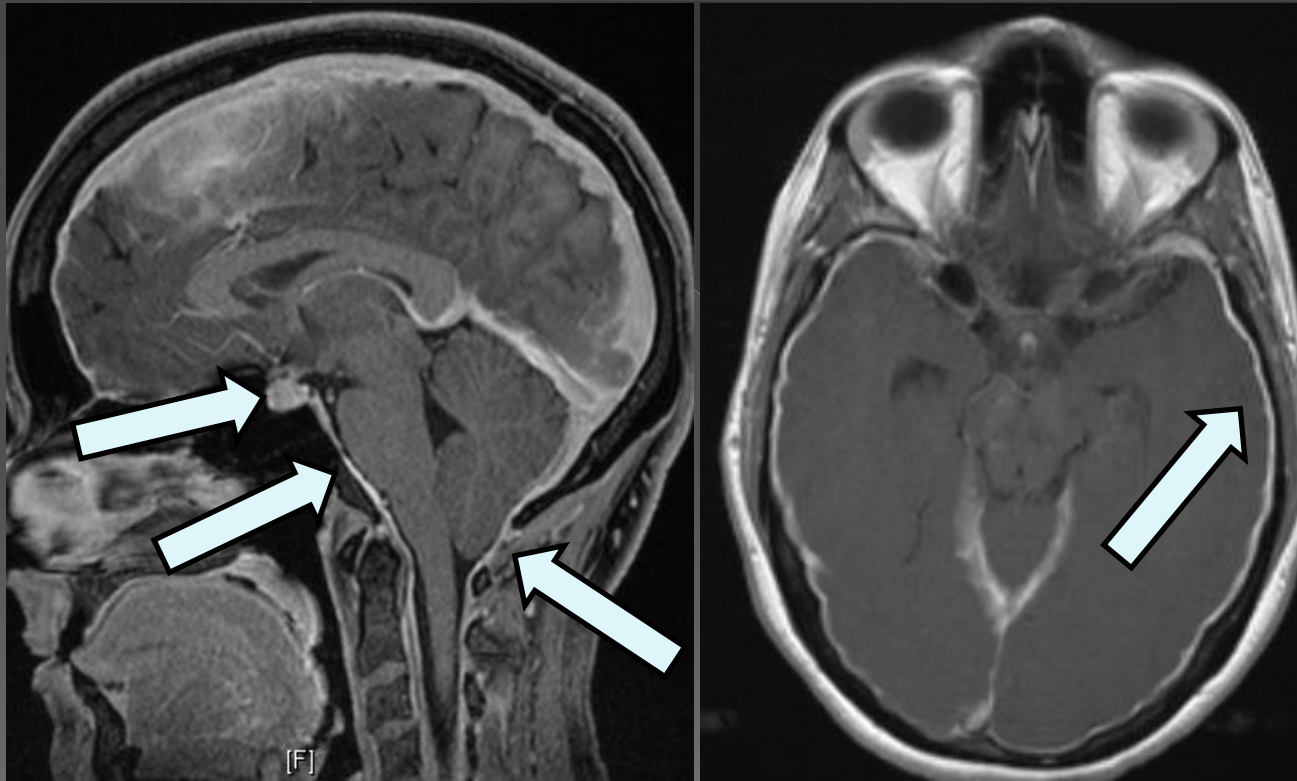
Initiation of CT fluoroscopy  
Enhancing precision & accuracy

# 22 g “Sharpshooters” in Diagnostics and Therapeutics



# 2006 1<sup>st</sup> Spinal CSF Leak Patient

37 yo female presents to the ED; severe chest & back pain after bending down to tie her child's shoes  
R/O MI & PE

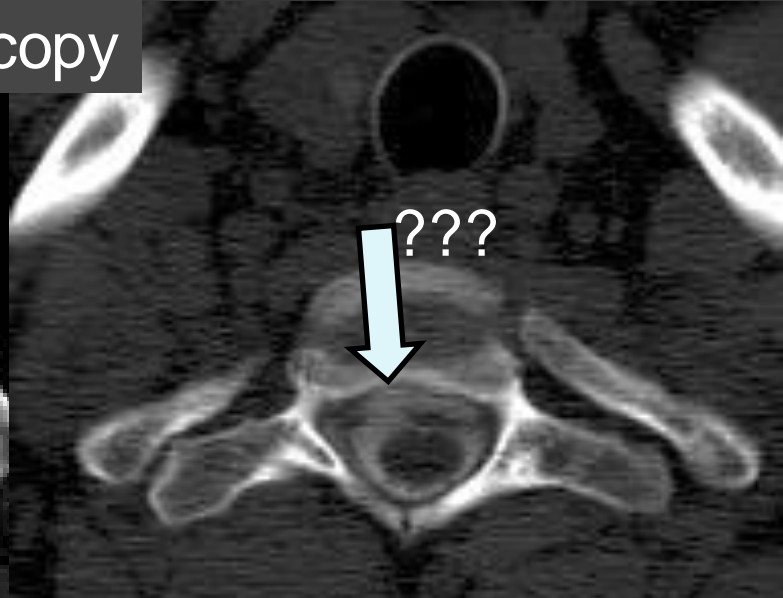
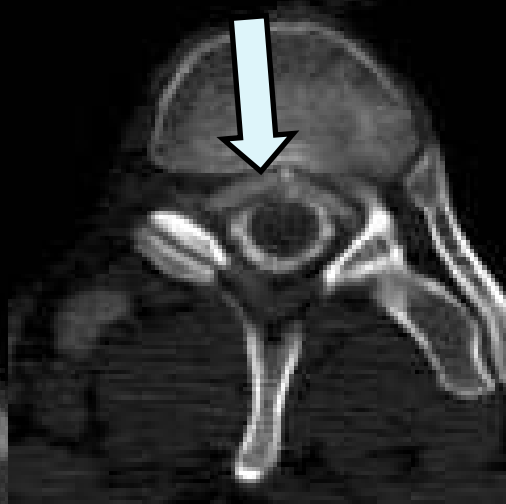


Obvious SIH

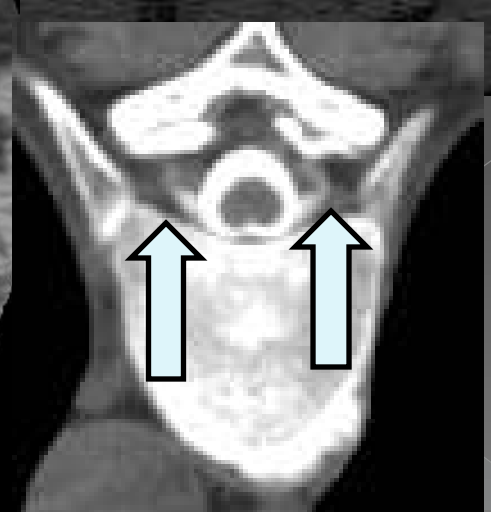
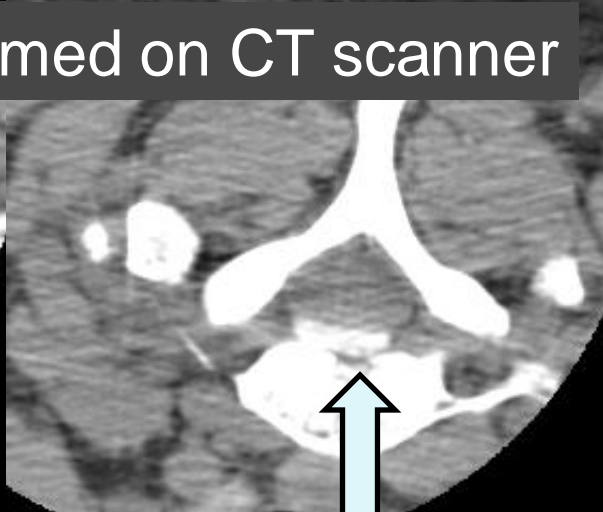
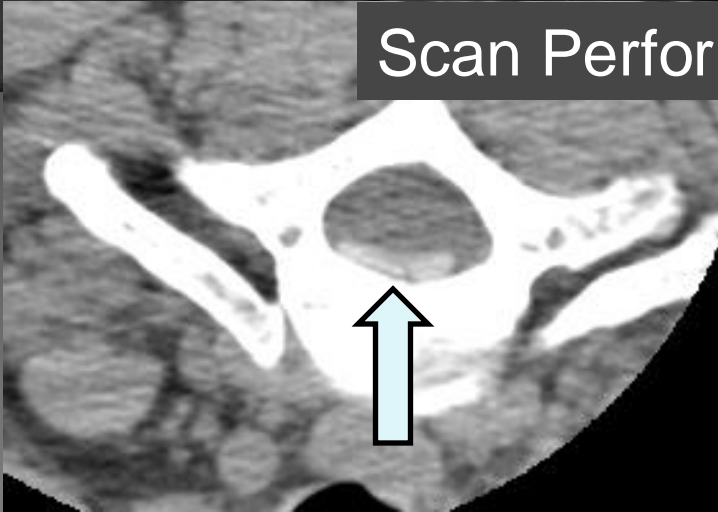
April 2006

Traditional Myelogram: injected in fluoroscopy & moved to CT

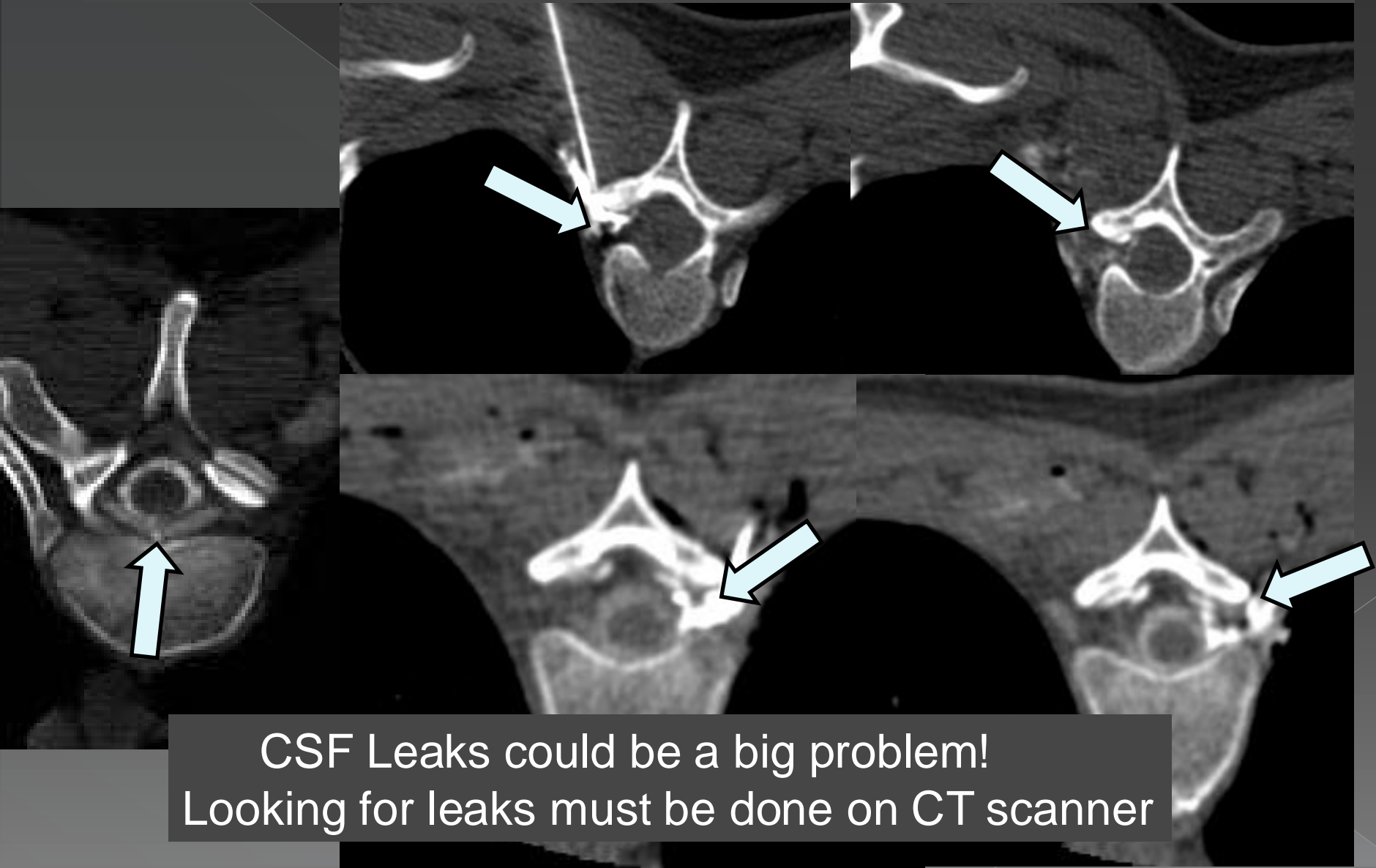
Scan started in fluoroscopy



Scan Performed on CT scanner



Patient had failed 3 nontargeted lumbar bloodpatches, Sx resolve with 5 targeted patches



CSF Leaks could be a big problem!  
Looking for leaks must be done on CT scanner

# Caring Empathetic & Sympathetic Staff Scheduling & Patient Questions



2007







Peter Kranz  
onboards 2009  
Post Duke  
Residency &  
Neurofellowship

Tried Collaborating with Neurology &  
Headache: 2010 Dinner meeting - “0” interest



Initiation of “Primary Care”  
Neuroradiology

# How to Manage an Interventional Neuroradiology Outpatient “Headache” Service?

Headache form

Cell Phone



**Duke Neuro**

Other pain:  
 Neck pain  
 Back pain  
 Chest pain  
 Pain all over

**SECTION 8: PREVIOUS EI**  
 Have you ever had an imaging?  
 CT scan of your head?  
 MRI scan of your head?  
 Lumbar puncture (spinal) (Clinical staff will enter oper

Have you ever seen for your  
 Neurologist  P  
 Allergy doctor  D  
 ENT doctor  C  
 Eye doctor  A

Do you have loose ligament  
**Connective Tissue Disord**  
 Have you been diagnosed v  
 Has anyone in the family b

**SECTION 9: HEADACH**  
 Have you taken caffeine or  
 If so, did this help?  
 Have you taken Topamax?  
 If so were your headaches

Have any Triptans helped  
 Have other migraine med  
 Any prior Bloodpatches?  
 If yes, when?  
 with improve

**Duke**

**If better when lying**  
 How long does it tak  
 How long does it tak  
 almost instantly l  
 better within 15 i  
 takes more than 1  
 How much better do )  
 completely  
 near complete  
 improved somew

**SECTION 6: DESCR**  
**BEFORE or during yo**  
 flashing lights, flick  
 numbness or weakn  
 other unusual feelin  
 If yes, please explai

**SECTION 7: ASSOCI**  
 (check all that apply)  
 nausea or vomiting  
 sensitive to light  
 sensitive to noise  
 sensitive to odors  
 worse with physica  
 other unusual feeling

**Other symptoms, eith**  
 Visual changes:  
 Blurred or double v  
 Changes in color vi  
 Other

Hearing changes:  
 muffled hearing  
 ringing/roaring in ea

Changes in smell  
 Changes in taste

**DukeRadiology**

Body Images fr  
 Draw the locatio

Name \_\_\_\_\_  
 Primary Care Physician/Neurologist (name/phone#) \_\_\_\_\_ D.O.B. \_\_\_\_\_

**SECTION 1: ONSET OF HEADACHES**  
 When did your current headache problem begin?  
 Have you had prior headaches of a different pattern?  
**If so, when did they begin?**  
 Any recent change in the pattern of your headaches?  yes  no  
 If yes, please describe: \_\_\_\_\_

**SECTION 2: HEADACHE FREQUENCY AND SEVERITY**  
 In the past 28 days, how many days was your headache?  
 severe (could not function)  
 moderate (hard to function)  
 mild (did not interfere with function)  
 no headache at all  
 Total = 28

**SECTION 3: IF HEADACHES ARE EVERY DAY**  
 When did every day headaches begin?  
 Did your headaches begin?  
 gradually, and become worse  
 suddenly, one day “out of the blue” and worst the first day  
 one day, “out of the blue,” and got worse over time  
 other: \_\_\_\_\_

**SECTION 4: LOCATION**  
 Headache location is (check all that applies):  
 always one-side and always the same side  
 always one-side, sometimes left or right  
 usually or mainly on one side  
 usually both sides or all over  
 mainly forehead

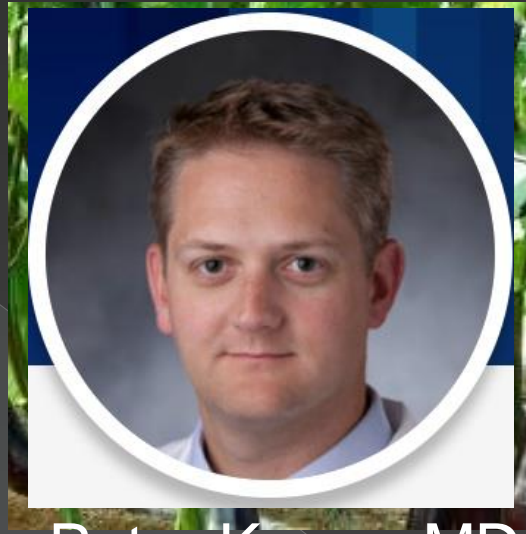
mainly side of head  
 mainly back of head or neck  
 upper back/between shoulder blades  
 includes face (below the eyes)/cheeks

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# Busier and Busier Service



Jeff Taylor, PA-C  
2007



Peter Kranz, MD  
2009



Tim Amrhein, MD  
2014



Mike Malinzak,  
MD 2017



Hope Weant  
NP 2018



Jay Willhite, MD  
2022



Jess Houk, MD  
2023

# Support Staff is Imperative

- CT technologists in scheduling, administrative assistant, nurse: Julie Fulcher and Trudy Wensell, Robin Yurchuck, Dana Jones, Donna Van Arnold, Emily Vano

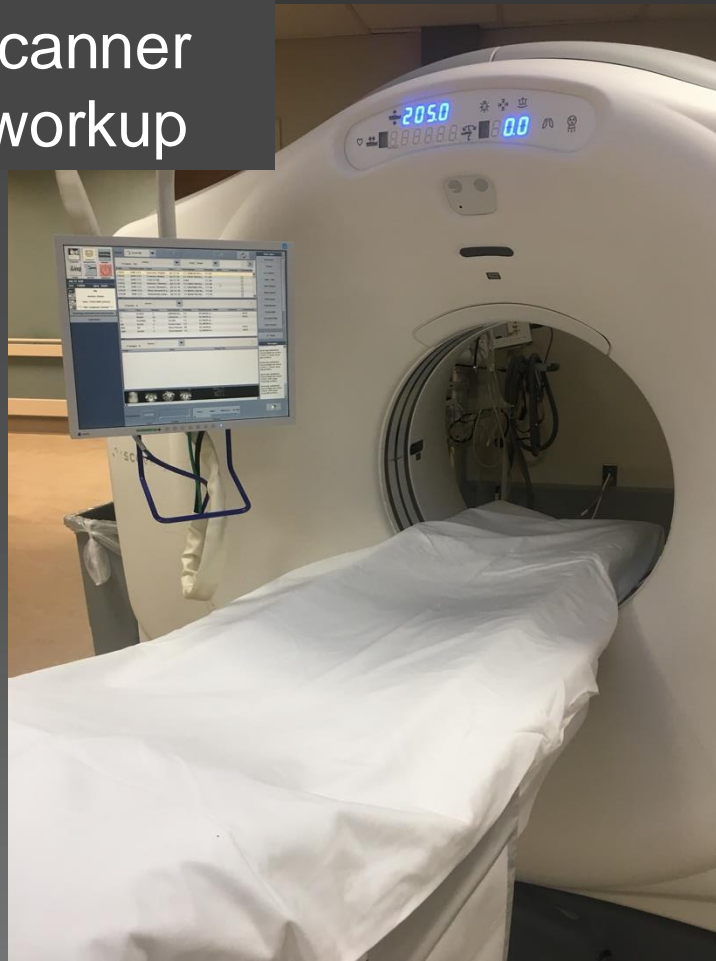


# Really??? “Neuroradiologist” diagnosing, guide-direct, implement & provide direct patient care?

- Internship – Medicine, Surgery, FP
- Some physicians seek radiology to avoid patient care
- Some physicians might seek radiology if they knew they could provide direct patient care
- Superior diagnosticians: imaging, minimally invasive biopsies & therapeutics
- Interventional – Spine, LPs, Angio/Myelos, H&N
- **“Own” the problem, don’t SCREW it up!**

Originally 1 CT fluoro unit dedicated to Neuro procedures  
now 2 fluoro units: inpatient and outpatient scanners  
How to get the resources? Build the need!!!

Inpatient scanner  
CSF leak workup



Outpatient scanner  
Pain injections

# Forefront of Evolution of Techniques

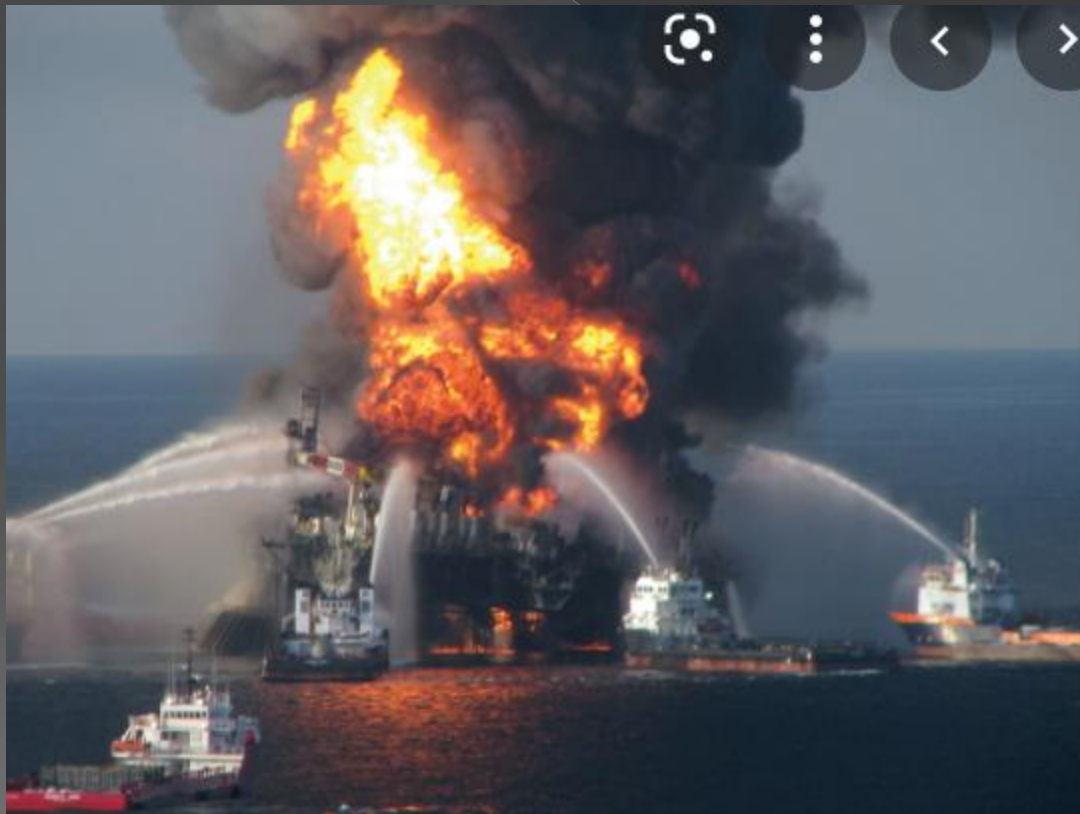
- LPs and pressure measurements
- Detection of Leaks
  - Dynamic / Ultrafast CT
  - Photon Counting CT
  - Fluoroscopic
  - DSM
  - MR
- Treatment of Leaks
  - Blood/Fibrin Glue
  - Surgery- ligation/clip, intradural, extradural
  - Embolization

# Forefront of Evolution of Techniques

- LPs and pressure measurements
- Detection of Leaks with myelography
  - Dynamic / Hyperdynamic
  - MR
  - Fluoroscopic
  - DSM
- Treatment of Leaks
  - Blood/Fibrin Glue
  - Surgery- ligation/strip, intradural, extradural
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April 20, 2010 Deepwater Horizon Gulf Oil Spill;  
measuring pressure of underwater oil reserve:  
? accurate pressure of CSF with smaller needle?  
call to Duke physics → Yes

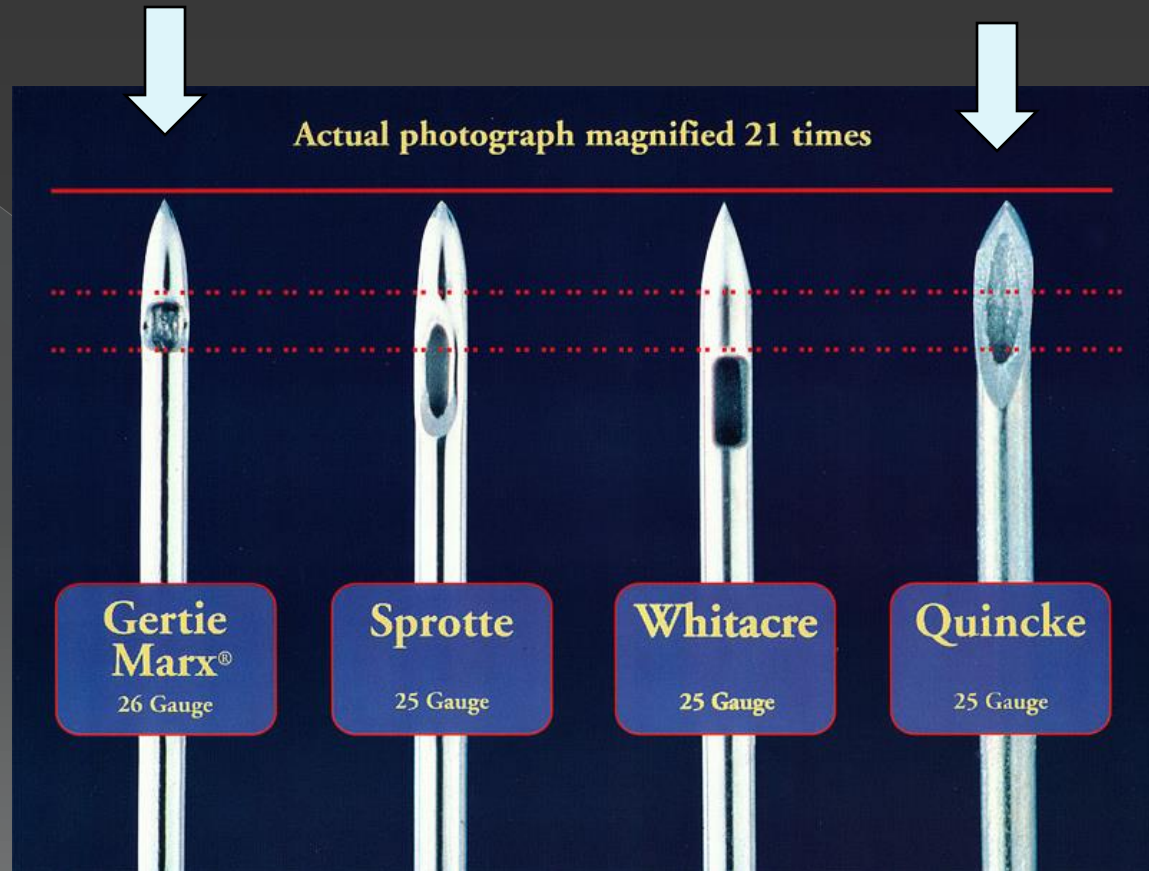


Connie Deline 6/2010



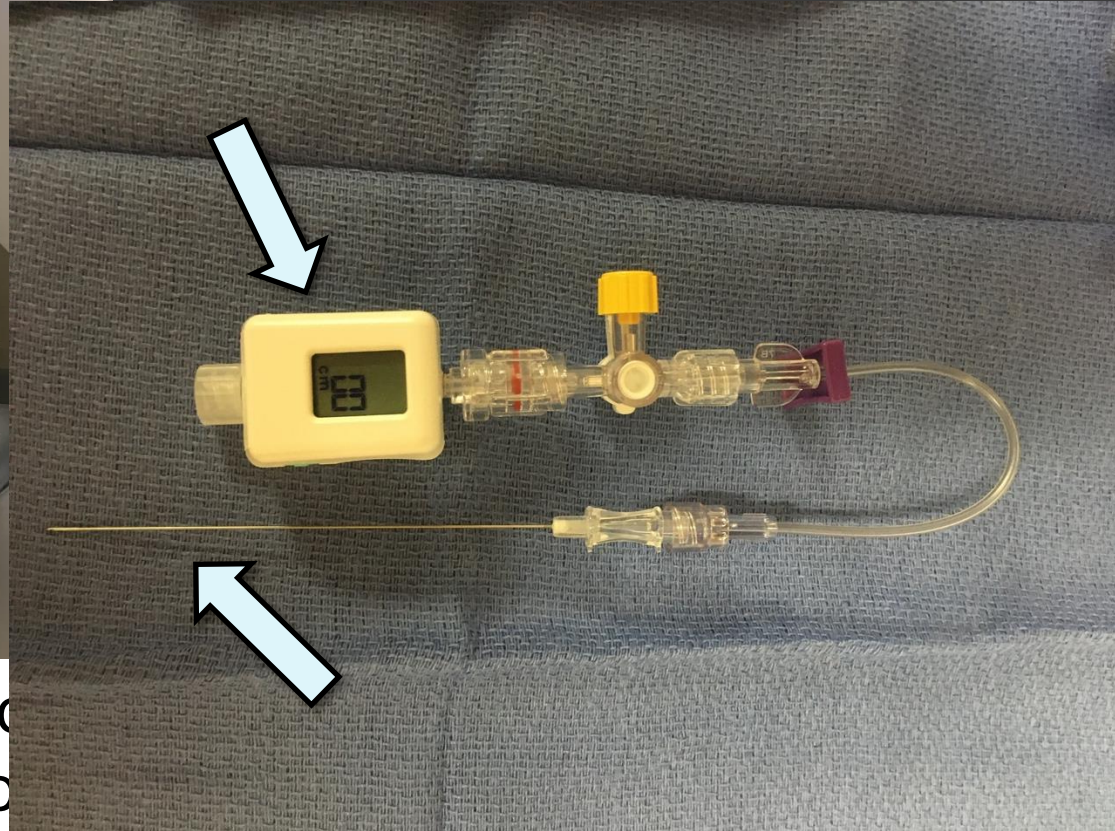
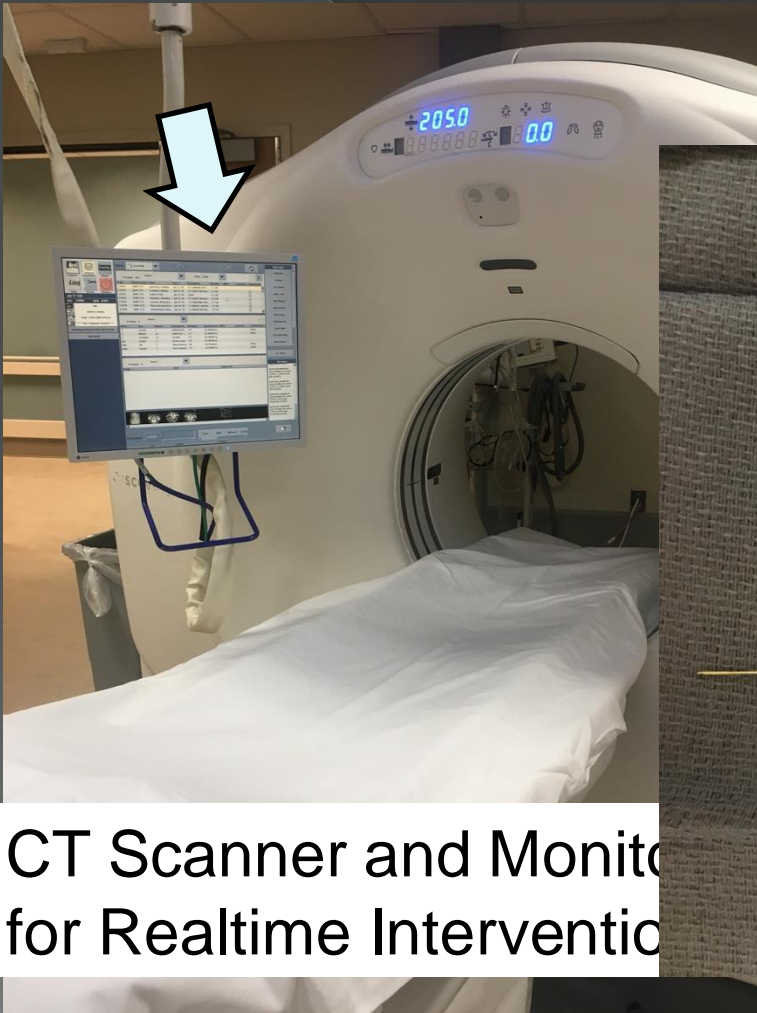
# 2010: Began using 24g Gertie Marx Needle internal diameter of 22g

- Small bore needle, blunt tip, 1/1000 chance of PLPH
- epidural space not contaminated by leaking of contrast from larger bore needle



# CT Fluoroscopic Guided LP & Myelogram

LP performed with 24g Gertie Marx (atraumatic) & digital Compass manometer



CT Scanner and Monitor for Realtime Intervention

# Forefront of Evolution of Techniques

- LPs and pressure measurements
- Increasing Tools for Leak Detection
  - Dynamic/ Hyperdynamic
  - Fluoroscopic
  - DSM
  - MR
  - Photon Counting CT
- Treatment of Leaks
  - Blood/Fibrin Glue
  - Surgery- ligation/strip, intradural, extradural
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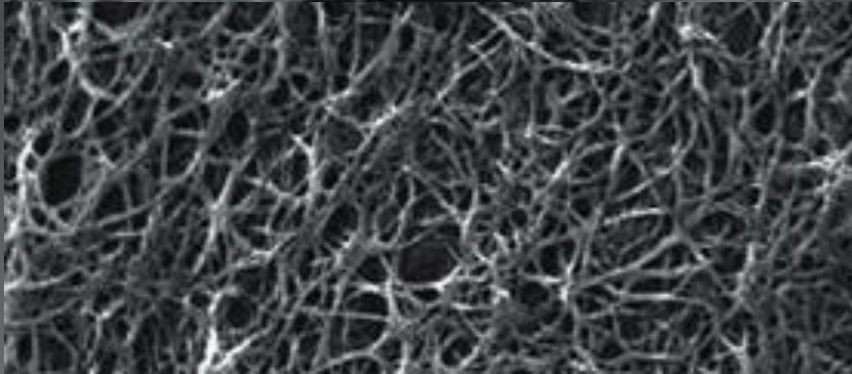
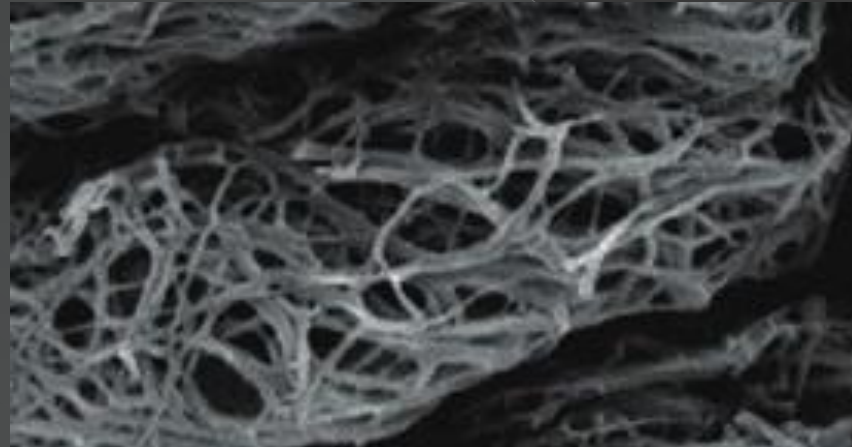
# Forefront of Evolution of Techniques

- LPs and pressure measurements
- Detection of Leaks with myelography
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# 2011 Fibrin Glue: Tisseel & Artiss

More adherent to dura than blood

Blood Clot



Fibrin Glue Clot- tighter matrix, slower to absorb, more adherent to dura

***Fibrinogen  
Factor VIII  
Fibronectin  
Aprotinin  
Plasminogen***

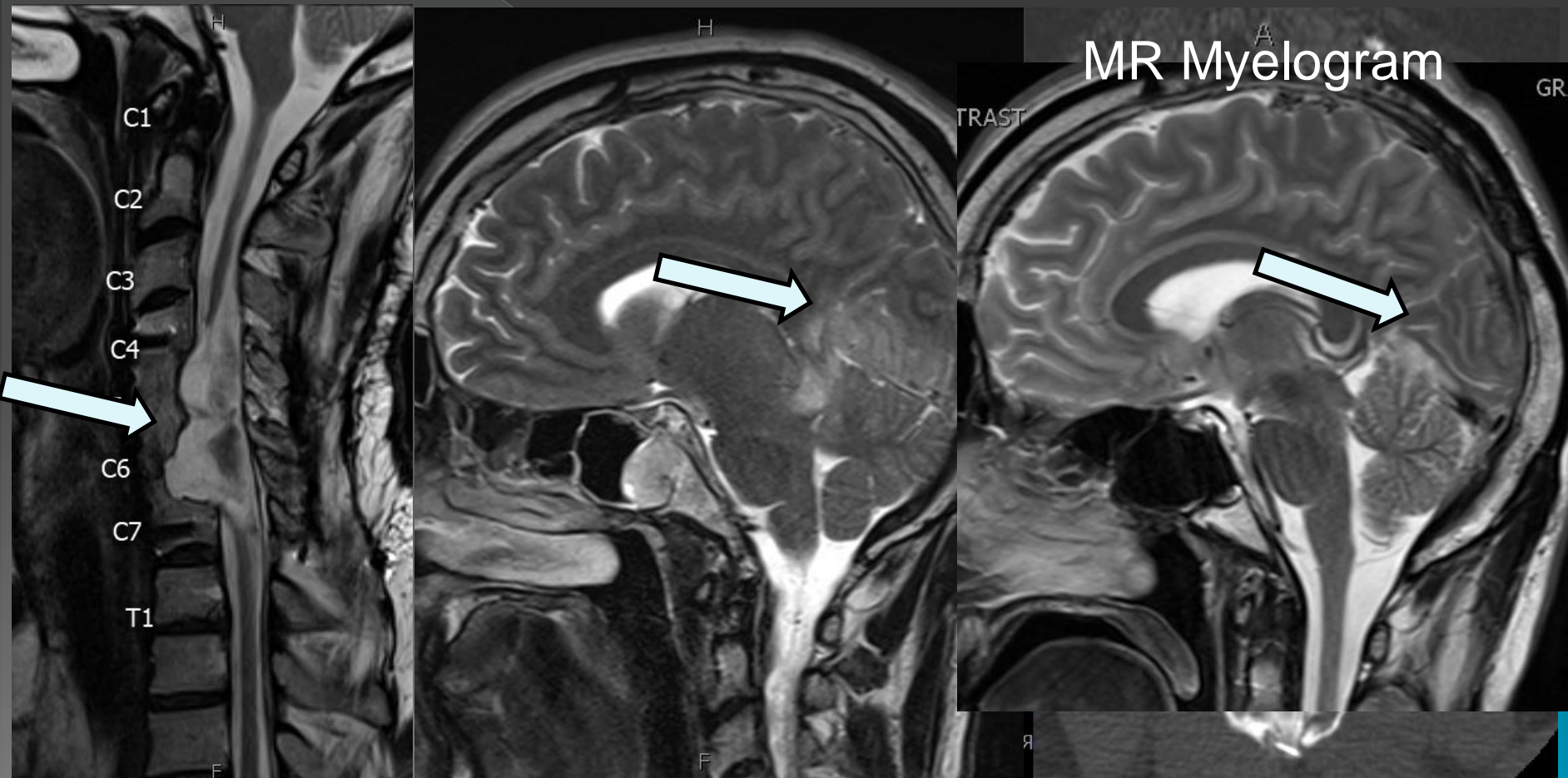
**+**

***Thrombin  
CaCl<sub>2</sub>***



***Fibrin monomers  
“glue”***

# When the Only Solution is: Percutaneous Treatment

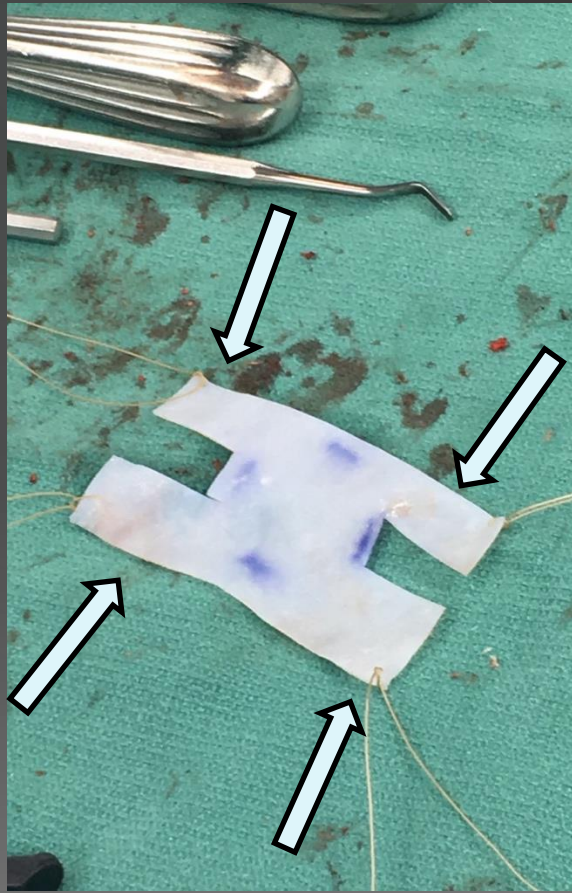


# Evolution of Techniques

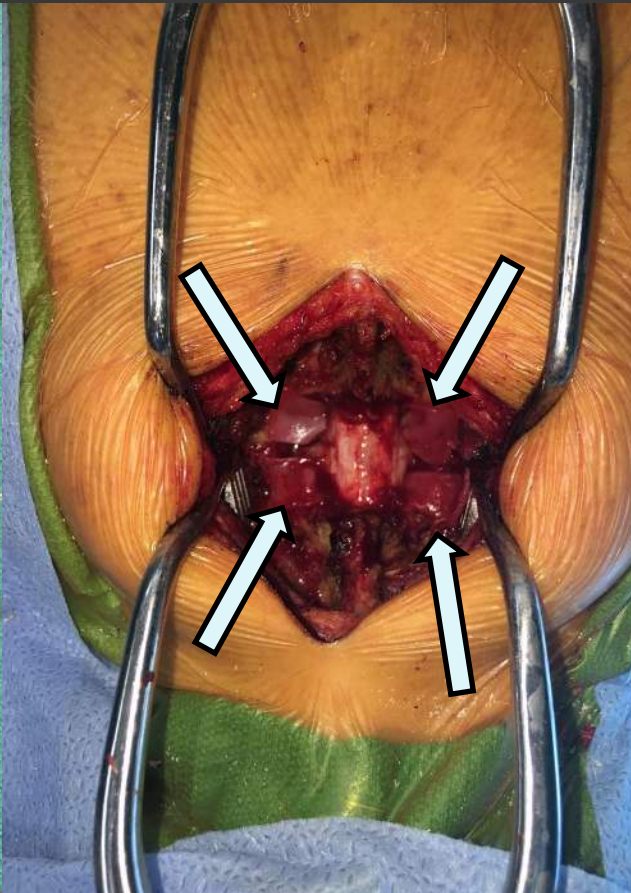
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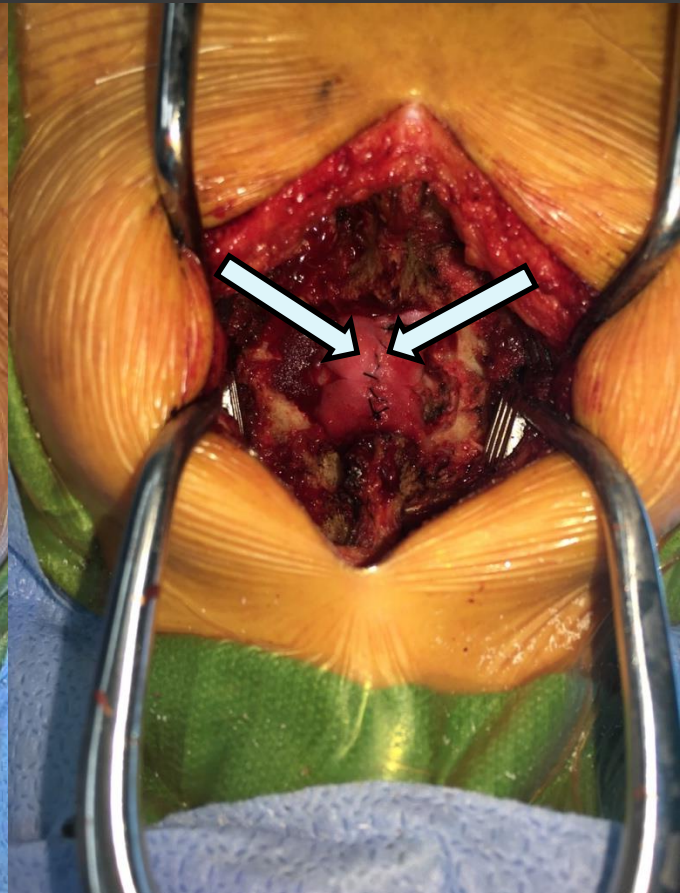
# Collaboration with Orthopedics - Extradural Surgery Sushi Wrap-Shave off discs and wrap dural leak



Collagen Wrap



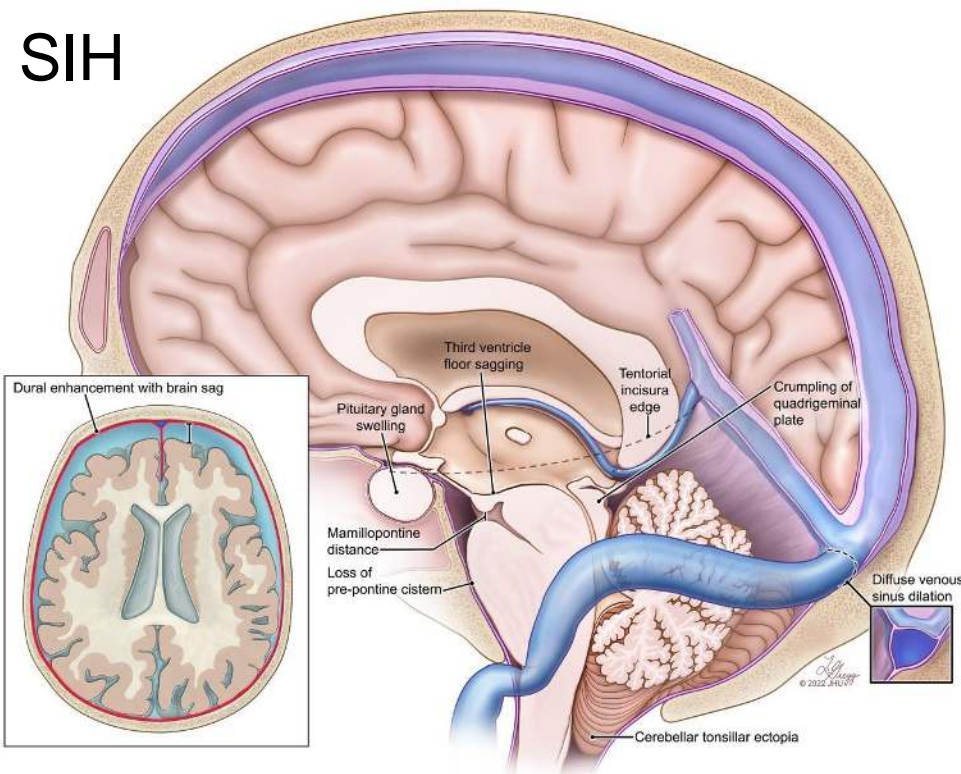
Feed wrap ventrally



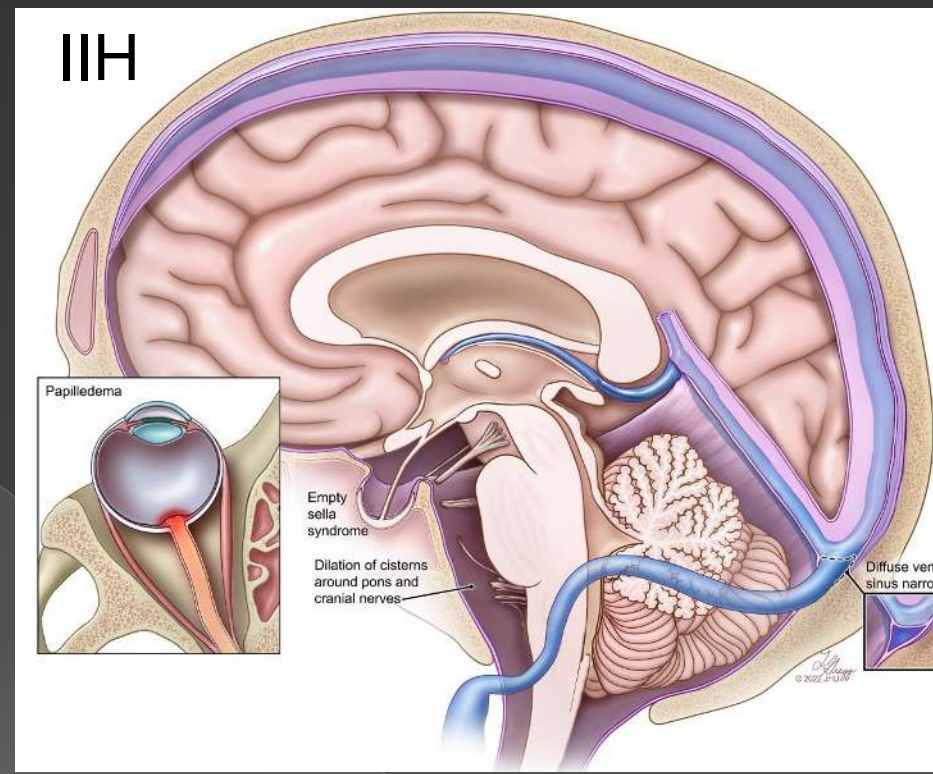
Suture to dorsal dura

# Concept of Continuum/Balance of CSF Pressure With SIH & IIH Disorders at the Extremes

SIH



IIH

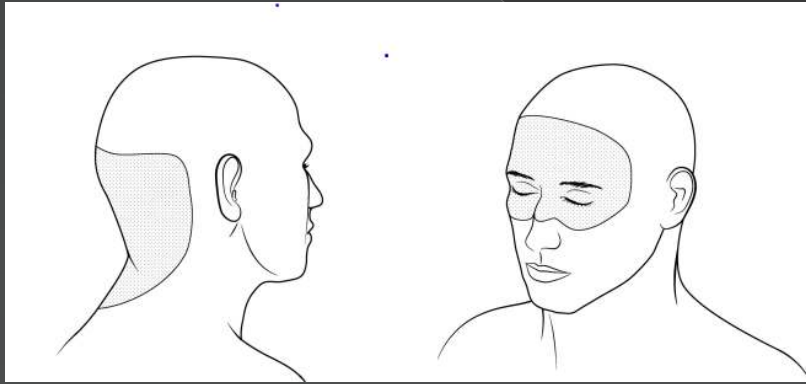


High Pressure  $\rightleftarrows$  Low Pressure

SIH

IIH

# Neuroradiologist as Prescribing Physician: Rebound High Pressure=IH Treatment



Post bloodpatch  
Surgery & Embolization  
Change in HA location and character

Acetazolamide  
Methazolamide  
Lasix, HCTZ,  
Triamterene

Ethacrynic acid  
Spironolactone

Repeat LPs, lumbar drain x 5 days  
Stents  
Shunts

Monitor  
K+  
Na+  
acidosis

# Delivering the Message if you are inspired, inspire others

**CSF Pressure Problems: an  
Underdiagnosed Cause of  
Headaches?**

Linda Gray, MD

Peter Kranz, MD

Peter Tanpitukpongse, MD

Jeffrey Taylor, PA-C

SENRS 2009

4<sup>th</sup> Annual Scientific Meeting of  
the 9/2014 Southern Headache  
Society Asheville, NC

AHS 11/2015

AHS Symposium 2018

Many lectures to Anyone interested and will listen



- ◎ 501c3 late 2014
- ◎ 1<sup>st</sup> medical advisory meeting 2015



Founder Connie Deline, MD



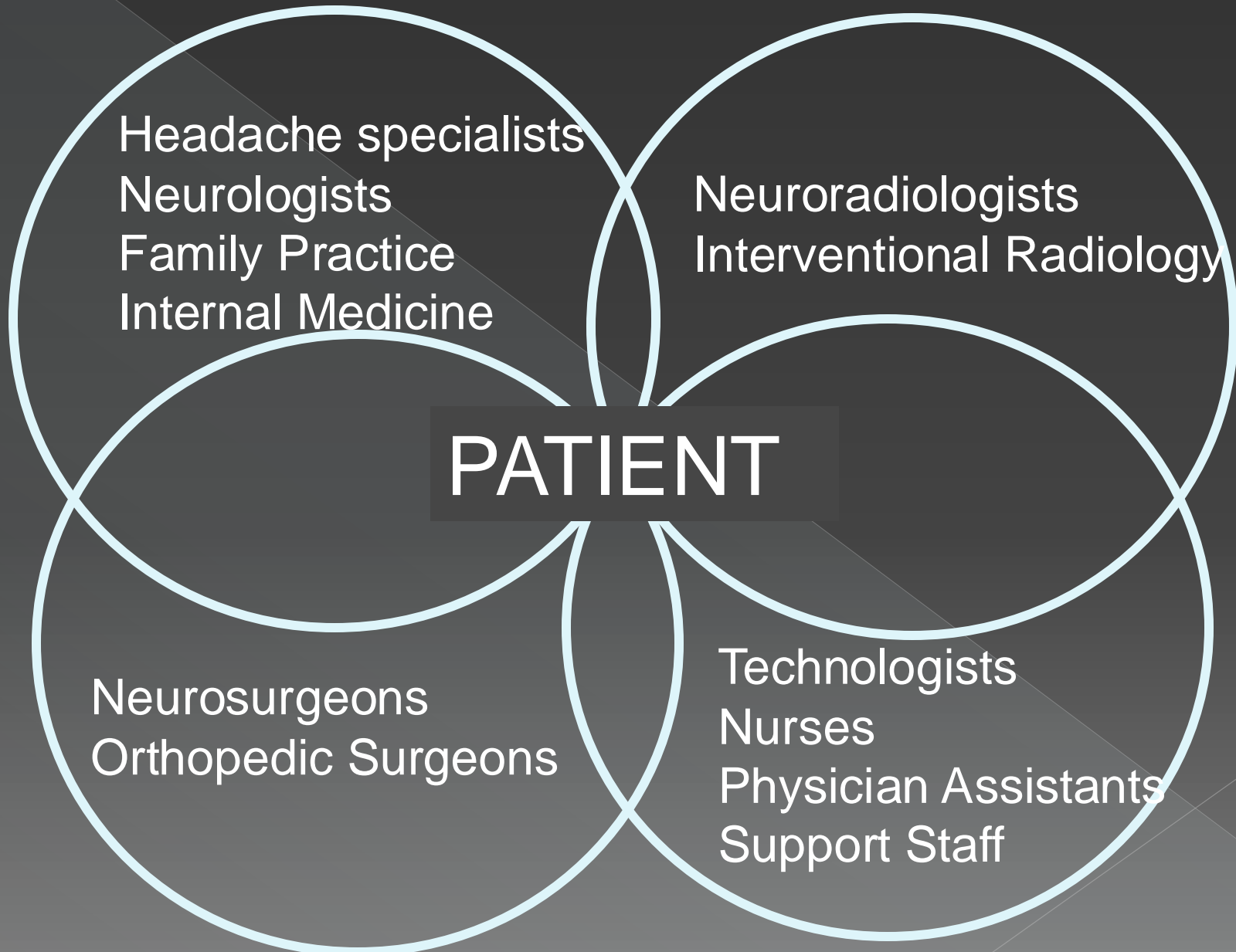
Andrea Buchanan



# Women in Radiology

- 18/220 F/M in medical school class
- Saw myself as a “person” in medicine & each of us brings something unique
- Endeavored to be at least as smart if not smarter than male counterparts
- Humility, avoid being intimidating
- Earn Respect from everyone including support staff, colleagues, referring physicians, patients

# It Takes Collaborative Team



Thank You