

	EGD Scope			Colon Scope		ERCP Scope	EUS Scope	
	Diagnostic	Therapeutic	Double Channel	Adult	Pediatric		Radial	Linear
Name								
Number								
Diameter								
Working Channel								

Endoscopic Ultrasound (EUS)

- Books
 - Van Dam & Sivak
 - Bhutani & Deutsch
- Important Points
 - Bubble float right b/c pt on left lateral decubitus
- Indications
 - 1° cancer T/N staging (85% accuracy for lung, esophageal, gastric, pancreatic, rectal cancer)
 - 2° diagnosis of SMEL, stones, etc
 - 3° celiac neurolysis, pancreatic psuedocyst drainage, access otherwise inaccessible ducts, coil embolize gastric varices, treat bleeding pancreatic psuedoaneurysms, place fiducials, transduodenal/gastric GB drainage, assess anal sphincter integrity, abscess drainage, et al
- Malignancy
 - Malignant Mass Features: **hypoechoic, heterogeneous, poorly defined margins, anechoic areas represent necrosis**
 - Evidence of Vascular Invasion: loss of interface, irregular vascular wall, abutment, encasement, luminal narrowing, intravascular filling defects or occlusion, collaterals, invasion
 - If strong suspicion of cancer but FNA negative b/c paucicellular, necrotic, desmoplasia, etc then repeat in 3mo
 - Liver mets can be either hyper/hypoechoic lesions
 - Ascites is anechoic triangular shaped areas
 - Malignant LNs Features: more **hypoechoic** compared to surrounding tissue w/ loss of hyperechoic center occasionally center can be anechoic w/ necrosis), **>1cm** on short access, very **round** (not almond/oval/bean shaped aka "draping" meaning that surrounding structures define its shape not itself unlike cancer), **well-defined/sharp** (not poorly defined), **homogenous** (not heterogeneous)
 - If all then 80% likelihood malignant
 - Reactive LNs can look this way also therefore get FNA but remember that FNA can be false-positive b/c of the presence of luminal cancer cells therefore avoid traversing the primary tumor
 - Granulomatous dz can look like malignant LNs but often have a matted appearance
 - Splenule look like LNs around the tail of the pancreas
- General
 - Physics
 - Sound = vibrating air molecules are audible from 20-20k Hz (cycles/second), ultrasound is >2-18M Hz (increased Hz has better resolution but less penetration)
 - Wavelength (λ) = Velocity (c) / Frequency (f)
 - You can vary frequency but not velocity which is determined by the physical properties of the medium specifically density (ρ) and compressibility (K) where $c = 1/(\text{square root of } \rho \times K)$, as density increases compressibility decreases, Velocity (c) = Impedance (Z) / Density (ρ)
 - Wavelength tells you the resolution that you can see
 - General: 7.5MHz w/ 10cm penetration (5MHz w/ 15cm depth w/ less resolution vs 10MHz w/ 5cm depth w/ more resolution)
 - When US enters a substance it can either
 - Absorb/Attenuate (occurs when US is absorbed by the tissue and converted to heat)
 - Penetrate Deeper
 - Other
 - if uniform matter then
 - Reflect (occurs when US propagates from one medium to another that has a different impedance resulting in the wave bouncing back, if it goes to the transducer then it can be used to create an image)
 - Refract (occurs when US propagates across an interface at NOT a 90 degree angle, the US takes on a different angle, this leads to artifact)
 - if non-uniform matter then
 - Scatter (occurs when US interacts w/ different small components (collagen, fat globules, etc) in one medium that have different impedances, this is what gives a tissue different echotexture)
 - Artifact
 - Acoustic Enhancement (when sound goes thru tissue it is attenuated but when it goes thru **water** it is less attenuated so when it goes past water the signal is appears stronger aka enhanced)

- Acoustic Shadowing (opposite of enhancement, when sound goes thru something really **dense** aka high impedance like a gallstone all the signal is absorbed and none goes past it resulting no signal past the structure)
- Reverberation (when a single pulse undergoes multiple reflection back and forth from transducer to a reflector in the tissue until the signal has eventually attenuated away, seen as multiple white bands w/ equal spacing apart that decrease in intensity, occurs when passing thru **air**)
- Acoustic Mirror (flat bubble creates a mirror image of the transducer)
- Ring Down Artifact (tiny bubbles create white rays)
- Tangential Scanning (when you are assessing thickness of tissue and you are not pointing perpendicular then you will over estimate)
- Edge Artifact (when sound passes by a sharp edge it creates dark rays)
- Reflection (when the signal passes from one medium into another w/ a different impedance (eg. water-air interface) part of it reflects back creating a mirror image of the transducer on the other side of the interface)
- Complications
 - Cervical Perforation (0.05% which is rare but considerably more common than any other type of endoscopy and this is b/c the distal 4cm of the scope is rigid and wider)
 - FNA can result in infection, pancreatitis, tumor seeding, bile peritonitis, left adrenal gland hemorrhage
- Instrument
 - Acoustic Coupling w/ balloon/lumen filled w/ water (NB balloon can compress the wall making wall layer evaluation difficult)
 - Three Types
 - Radial/Diagnostic/Sector Array = 360° circumferential views at right angles to the shaft, straight or oblique view
 - Linear/Therapeutic/Convex Array = 120° linear view along line of scope, oblique visual view
 - Catheter based probes (can be passed thru regular endoscope)
 - Accessories
 - Fine Needle Aspiration (FNA) = cytologic dx of mass, cysts, LNs, pseudocyst drainage, duct access, Ascites fluid, celiac plexus block
 - Contraindications: INR >1.5, Plt <50k (ALWAYS CHECK)
 - Pre: antibiotics
 - Types
 - Solid Mass: 25G, no stylet, no suction to reduce bleeding
 - Cystic Mass: 22G, w/ stylet (pull out stylet 5mm to make needle sharp, then once in cyst push stylet in to remove material, then have nurse pull out stylet completely) w/ suction
 - Suspect Lymphoma: 19G, no stylet, primed w/ sterile NS, suction w/ sterile NS
 - Procedure: remove black cap, screw in FNA, adjust sheath ring, drop needle ring to 0, suck so that wall is next to scope, puncture mass, do x20 long passes (push in fast to shear off cells and pull out slowly to allow cells to be sucked into needle, always keep needle w/in lesion, stay in lesion and go at different angles, pull out needle, raise ring, pull out FNA, replace black cap)
 - FNA edge of large masses not middle b/c of likely necrosis
 - Always aspirate cysts COMPLETELY and only try to pass needle once b/c decreases r/o infection
 - Confirm lack of vascularity, never traverse tumor to reach LN b/c of r/o seeding
 - If lots of blood then reduce suction or use no suction
 - NEVER FNA mediastinal cyst but if you have to then completely drain it and give lots of antibiotics b/c of high r/o mediastinitis or considering referring to CTS for mediastinoscopy but remember that almost all are benign therefore just f/u
 - Make sure you see tip of needle during FNA to make sure you are not beyond the mass
 - Cyst Fluid (send to RedPath)
 - Collect two 0.5mL of fluid into the provided RedPath 2mL tubes
 - Don't stain or fix fluid
 - Send for: CEA, Amylase, Cytology, DNA Analysis (k-RAS point mutation and LOH)
 - There are two RedPath forms
 - Also Provide
 - Control (blood sample with 2mL Lavender Top EDTA or 2mL Yellow Top ACD)
 - Imaging (send all imaging documents)

- Solid Mass (send to MCD)
 - First Pass: cytology by smearing all specimen onto 2-6 slides both are air dried (some pathologist do DiffQuick w/o fixative and some do other stains requiring spraying with 95% ethanol fixative therefore just send air dried to pathology for quick read and let them determine what to do with them)
 - Second Pass: histology by injecting all specimen 10% formalin media which can then be used to make (a) a cell block which is created by creating a “tissue” by adding coagulation proteins to the specimen which is then fixed in formalin and wax is added allowing it to be sectioned into 8 thin 4-5micron slices (send to MCD) (b) solution for flow cytometry if you suspect lymphoma (send to MCD)
 - NB remove specimen using stylet or air
 - NB to go thru different parts of the mass bring needle back to right outside edge of mass and then change angle then go back in (it’s critical to go back out of mass but just to edge)
- Tru-Cut Biopsy (TCB) = histologic dx (rarely used, 19G, Cook Procore)
- Rendezvous (use a 19G FNA needle to pass wire)
- Fine Needle Injection (FNI) = injection chemo into a mass/cyst
- Celiac Plexus Block/Neurolysis (CPB/N)
 - Premedicate w/ Levaquin 500mg IV x1 and LR 500mL IV x1 over 2hrs
 - Linear scope w/ 22-gauge needle in gastric cardia to visualize the take-off of the celiac trunk and see the hypoechoic ganglion (sometimes not seen)
 - CPB: 2cc 40mg/cc triamcinolone + 8cc 0.5% bupivacaine w/ 5cc into right side and 5cc into left side
 - CPN: 10cc 98% dehydrated alcohol w/ into right side followed by 5cc of 0.5% bupivacaine (repeat for the left side) NB alcohol creates a hyperechoic blush
 - Always such back to ensure that you are not in a vessel first
 - NB always preload needle so that you don’t inject air or saline
 - Postmedicate w/ LR 500mL IV x1 over 2hrs b/c pts tend be hypotensive afterwards
 - Complications: paraplegia, bleeding, abscess, diarrhea (can be an issue for a few days afterwards), orthostatic hypotension
 - NB If injected in the right spot patient should hurt for a minute during injection but then feel immediately better in the recovery room
 - NB EUS guided is safer, more effective, longer lasting and cheaper than CT guided
 - NB nociceptive nerves leave the pancreas and enter the celiac plexus and then run with the L/R greater splanchnic nerves to cell bodies in dorsal root ganglion at T5-9
- “Duplex” (Imaging + Doppler)
 - Imaging: **B-mode**
 - White/Hyperechoic (Bone, Fat, Stone) – Light Grey/Hypoechoic (Tissue) – Dark Grey/Hypoechoic (Fluid, Vessels, Ducts, Cyst, Ascites) – Black/Anechoic (Air)
 - Doppler: **Continuous Wave, Pulsed Wave, Power Doppler** (not used anymore), **Color Doppler** (creates a red/blue two dimensional image over time, blue (away from transducer) and red (towards transducer) aka “BART” NB yellow indicates high velocity)
 - To determine duct vs vessel and can distinguish artery vs vein
 - Other: tissue elasticity, 3D rendering
- GI Tissue (WBWBW)
 - 1st Hyperechoic Superficial Mucosa → 2nd Hypoechoic Deep Mucosa/Muscularis Mucosa → 3rd Hyperechoic Submucosa (thickest) → 4th Hypoechoic Muscularis Propria (always abbreviated “MP”, this is the most important layer) → 5th Hyperechoic Adventitia/Serosa
 - When tumor abuts a sharp hyperechoic adventitia then 4th layer, abuts shaggy hyperechoic adventitia then 5th layer, grows past hyperechoic adventitia w/ loss of fat pad then extra organ invasion

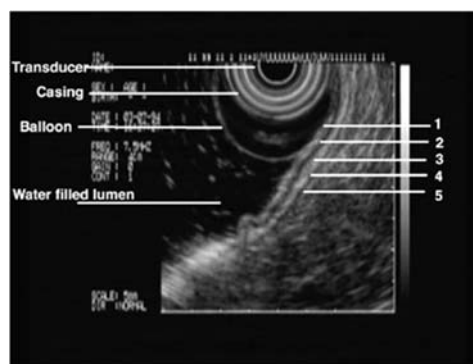
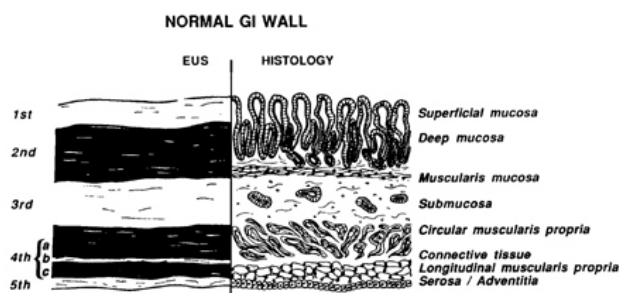


Figure 3: The five layers of gastrointestinal wall demonstrated at 7.5MHz scanning frequency. Layer 1: interface echo and superficial mucosa; layer 2: deep mucosa; layer 3: submucosa; layer 4: muscularis propria; layer 5: adventitia (or serosa with subserosal fat).

SubEpithelial Mass Lesions (SEMLs)

- Approach
 - 1st Rule out hypoechoic vessels w/ Doppler (eg. varix “bags of worms”, lymphangioma, hemangioma, etc)
 - 2nd Rule out anechoic cysts but sometimes they can be hypoechoic if gelatinous material
 - 3rd Rule out hypoechoic fluid collection (eg abscess)
 - 4th Determine if Mucosal vs Intramural vs Extramural
 - 5th Obtain Tissue
 - EGD: endoscopic appearance can be deceiving therefore one should never make Dx on endoscopic appearance alone (sometimes a lipoma is obvious), always do nl superficial Bx to rule out epithelial lesion but also do a tunnel jumbo forcep bx once EUS has been done
 - EUS: consider FNA for deep lesions
- DDx of Other Esophageal Stuff
 - Varices
 - Extension of pseudocysts
 - Duplication cysts if close to wall or bronchogenic cysts if away from wall
 - Posterior mediastinal tumors are usually neurogenic (schwannoma, neurilemoma, neurofibroma, ganglioneuroma, paraganglionoma and their malignant counterparts), LNs (lymphoma, TB, sarcoid, histo), bronchial tumor, mets, abscess
 - Anterior/lateral mediastinal tumors are usually lung cancer (EUS is good for dx, LNs, invasion into mediastinum, great vessels, vertebrae)
 - Contralateral LN involvement makes it surgical unoperable
 - Assess: LNs, Pleural Effusion, Left Liver Lobe and Left Adrenal Gland for lung cancer
 - Esophageal cancers (refer to esophagus notes for LNs, liver, etc to look at)

	EGD		EUS		
	Appearance	Location	Layer	Echogenicity	
Lipoma	Yellow, pillow/cushion sign	S=E	3 rd	hypEREchoic	
Brunner's Gland Hyperplasia		D	1 st = 2 nd = 3 rd	hypEREchoic	
Neural Tissue	No specific	X	3 rd = 4 th	hypEREchoic	DDx: schwannoma, neuroma, neurofibroma, glomus tumor
Inflammatory Fibroid Tumor	Ulcerated	E	3 rd = 4 th	hypEREchoic	
GIST	No specific	S>E	4 th > 2 nd	hypoechoic	look like leiomyomas therefore must FNA to distinguish Malignant if >1cm, heterogeneous, irregular margins, +LNs
Leiomyoma	No specific	S>E	4 th > 2 nd	hypoechoic	Malignant if more cystic, disrupts more layers, larger >3cm, +LNs, often found in gastric fundus
Carcinoid	No specific	R>S	2 nd = 3 rd	hypoechoic	
Granular Cell Tumor	No specific	E	2 nd = 3 rd	hypoechoic	
Fibrovascular Polyp		E	3 rd	hypoechoic	
Endometriosis	Normal	R	5 th	hypoechoic	Usually anterior side b/t rectum and uterus
Lymphoma/Mets	No specific	S>E	2 nd = 3 rd = 4 th	hypoechoic	
Pancreatic Rest	Umbilicated	S	3 rd > 4 th	hypoechoic	Small cystic structures
Gastropathy	Stomach is considered thick if >1cm (nl <5mm)	S		Normal just thickened	DDx: Gastritis, Menetrier's, ZES, et al NB gastric lymphoma and linitis plastica can appear as an infiltrating gastric lesion w/ nl overlying

					mucosa
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Endoscopic Retrograde Cholangiopancreatography (ERCP)

- Anytime you change from short to long position always go back into stomach never do it in the duodenum
- Glucagon 0.5mg IV and Robinul (glycopyrrolate) 0.1mg IV and hyoscyamine to decrease peristalsis
- When tech hands you cannula make sure it given to you in a draped U pattern
- MRCP: heavily T2 weighted MRI which makes water aka bile bright and everything else dark
- S/p Chole: <2yrs (retained cholesterol stone = firm stone) vs >2yrs (new brown stone = friable stone)
- Pre: look at radiology, need for abx Px, iodine contrast allergy surgically altered anatomy (refer to Chapter 24)
- Contraindications: recent AP, contrast dye anaphylaxis, psuedocyst, ascites, overlying residual barium from prior studies
- Post: diet, complications, meds, clinic f/u, imaging, labs
- ERCP in Pregnancy
 - Only main indications: biliary pancreatitis, cholelithiasis, cholangitis, bile duct injury
 - Perform during 2nd trimester if possible
 - Use lowest effective dose of anesthesia (avoid benzos, propofol is best)
 - Left lateral position is best (supine can cause “supine hypotension syndrome” via compression of IVC and aorta by gravid uterus and prone is just hard b/c of gravid uterus)
 - Place electrocautery pad in such a way that fetus is not in line b/t pad and sphincterotome
 - MFM consult to monitor fetal heart sounds
 - Mildly increased risk of spontaneous bile duct rupture
 - EUS to find stones etc
 - You can actually perform an ERCP w/o fluoro by cannulating and once wire passes easily then aspirating thru the cannula to determine if bile (yellow) or pancreatic (clear) fluid, once you found the bile duct do a shorter sphincterotomy and a short balloon sweep
 - Some have used cholangioscopy to visualize ducts w/o using fluoro
 - If fluoro is used then place lead UNDER pt’s belly and only use brief one second bursts of fluoro and avoid taking “hard copy” fluoro images, focus the beam as much as possible, goal total fluoro is <1min, place a radiation dosimeter to the ab wall overlying fetus
- ERCP in Children
 - Px abx are often given, general anesthesia, shield reproductive organs
 - maneuvers are harder, you work closer to papilla, tissue is very fragile leading to increased r/o false tracts
- Duct Anatomy (NB “proximal vs distal” is opposite for pancreas and biliary tree, liver (proximal) – duodenum (distal) vs pancreatic tail (distal) – duodenum (proximal))
 - CBD (7.5cm long, normal diameter depends on modality and where it is measured (distal CBD is wider vs proximal CBD is more narrow)
 - US/MRI 6-8mm (b/c it doesn’t incorporate the CBD wall)
 - CT 8-10mm (b/c it incorporates the CBD wall)
 - ERCP/PTC 8-10mm (b/c of contrast distension)
 - NB higher in older (add 1mm for every decade to the ULN after the age of 60yo)
 - NB s/p chole (add 1mm but not uniform for all pts, some don’t have dilation at all)
 - h/o biliary obstruction
 - intrahepatic dilation is seen as when the ducts run parallel to each other and measure >40% of intrahepatic portal vein
 - long term opiate use
 - paraneoplastic process of pulmonary adenocarcinoma
 - parts: supraduodenal vs retroduodenal vs pancreatic
 - DDX: cyst/diverticulum, accidentally included the cystic duct
 - cystic duct is often behind CBD thus image at LAO
 - similarly R/L hepatic ducts can be viewed at RAO
 - the way the cystic duct joins the CHD is highly variable
 - Often contrast fills just the left system b/c it is more dependent therefore to fill the right system you need to do an “occlusive cholangiogram” using a balloon catheter placed above cystic duct? and injecting contrast above balloon
 - Main Pancreatic Duct (PD) of Wirsung begins near the pancreatic tail and courses obliquely from anterior/tail to posterior/head (~20cm long, normal diameter: ~3-4mm (in head), ~2-3mm (in body), ~1-2mm (in tail)) PD runs therefore sometimes best to see PD via RAO/LAO, duct drains quickly unlike CBD
 - Accessory duct of Santorini, lies anterior to the CBD, drains into the minor papilla into the 2nd part of the duodenum, seen in 30% of pts w/ 70% being patent and of those ~90% have communications with the main duct
 - Biliary Anomalies
 - **Choledochal Cysts (refer)**
 - **Biliary Atresia (refer)**
 - **Anomalous Pancreatico-Biliary Unions/Ductal-Junctions (APBU/DJs)**
 - malformation of the confluence of pancreatic and bile ducts
 - bile and pancreatic juices flow freely b/t ducts
 - Types

- (1) bp: bile duct inserts into the pancreatic duct
 - (2) pb: pancreatic duct inserts into the bile duct
 - (3) Y: long common channel >15mm
 - Complications: choledochal cysts, gallbladder/CBD cancer, cholangitis, IARP, choledocholithiasis
 - Suspect when ERCP contrast injection results in simultaneous filling of both ducts
 - Given r/o cancer some consider cholecystectomy, resection of the CBD and hepaticojunostomy
 - Some just do sphincter ablation
- **Duct of Luschka** (accessory duct connecting R lobe of liver to GB resulting in a biliary leak if not recognized during routine cholecystectomy)
- **Aberrant Duct** (accessory connecting liver to CHD, CBD or Cystic Duct instead of thru the hepatic ducts)
- **Low/High Rising, Short, Ant/Post** (going ant or post to CBD and attaching to R side instead of L side of CBD)
- Cystic Duct**
 - Pancreatic Anomalies (refer to pancreatitis section)
- Side Viewing Duodenoscope
 - How to pass the scope?
 - Before make sure elevator is in/down to prevent it from catching tissue and then once in duodenum keep out/up so that when you pass guidewires, etc you can actually see them and they don't fly pass you unnoticed and cause a perforation and then when you are coming out bring elevator in/down to prevent it from catching again
 - Esophagus: if needed deflect slightly upward to view the esophagus ahead of you otherwise just keep the scope at neutral and observe for clear landmarks like Z-line
 - NB if difficulty then **lift R shoulder**
 - Stomach: at 40cm inflate air and drop the left hand and deflect tip down, as you advance wiggle the scope a little to facilitate passage, advance scope along the greater curvature while viewing the lesser curvature, advancing reveals the pylorus "setting"
 - NB suck out air as you leave stomach to reduce the amount of scope in stomach
 - NB if difficulty in the stomach then **flex R knee and rotate shoulders to L lateral decub position or turn the pt to their side**
 - Duodenum: once in the bulb go down and right to enter the 2nd part, as you advance the scope will remain in the "long position" (along the greater curvature), to shorten the scope to the "short position" (along the lesser curvature bringing the scope underneath the papilla "en face") perform four simultaneous maneuvers: (full right and lock + full up and lock + pull back + clockwise torque) and as you do this you will paradoxically advanced past the papilla and then with further pull back you start finally pulling back the scope to the papilla, once there don't turn the dials at all rather all movement should be down by moving the handle/shaft of the scope, in cannulation you want the duodenoscope to be in line w/ the vertical duodenal fold representing the intraduodenal segment
 - **NO BEND IN SCOPE ALWAYS KEEP IT AS STRAIGHT AS POSSIBLE TO MINIMIZE PERFORATION**
- Cannulation
 - NB
 - Billroth-II
 - Papilla is rotated 180 degrees therefore biliary cut is at 5 o'clock and pancreatic cut is at 7 o'clock
 - Periapillary/ampullary diverticulum
 - Why bad? distorts orifices even sometimes reversing them
 - Tx: use thin wires, try to evert diverticulum by using clips
 - Don't ever cut near base of diverticulum
 - Access
 - Major Papilla (CBD runs along roof while PD runs along floor)
 - CBD
 - Orifice: LUQ b/t 9-12 o'clock (endoscope should be below papilla)
 - Direction: upward and left along intraduodenal segment (hence the advantage of a sphincterotome which can be bowed to create the approach angle, once in place further advancement can be achieved by unbowing and pulling back the scope)
 - NB Periapillary Diverticula (seen in 7.6% of ERCPs, hard to achieve the right angle, sometimes easy, placing clips at edge to evert diverticulum, higher r/o perforation)
 - Sphincterotomy: 8-10-12mm at 11 o'clock
 - DDx of Bulge: choledochocoele, duodenal duplication cyst, impacted gallstone, papillitis, ampullary tumor, etc
 - Challenging Cannulation
 - Wire or Stent PD
 - Access Sphincterotomy
 - Rendezvous Approaches
 - PD
 - Orifice: mid-R b/t 1-5 o'clock (endoscope should be above papilla)
 - Direction: straight back and slightly right
 - NB PD is indicated by early branches, course to left and small diameter

- LAO view is best to see the entire PD
- Sphincterotomy: use an ultratapered catheter tip w/ narrow wires (0.018in) w/ soft/floppy tip to minimize trauma to the PD
 - Two types: (1) standard sphincterotomy or (2) needle knife over stent with stent guiding u as to the direction of the PD
 - Cut at 4-6-8mm at 1 o'clock
 - Generally place a stent afterwards
 - If a BS had already been done the PD is usually at the 5 o'clock
 - Indications: pancreatic SOD, CP w/ stenosis, to treat PD strictures/stone, transpapillary drainage of pseudocyst, ampullary adenoma, etc
- Minor Papilla
 - When? to diagnosis pancreas divisum, to Tx pancreas divisum w/ minor papilla sphincterotomy, etc
 - Pre: minor is very inconspicuous, given glucagon, the long position is sometimes needed to access but once accessed then change the scope into the short position, if hard to find then spray area w/ methylene blue + simethicone and then give secretin (SecreFlo (IU/kg) or a synthetic equivalent ChiRhoStim (0.2mcg/kg)) which stimulate pancreatic juices to flow thru minor papilla washing away the dye
 - Cannulation: use a highly tapered, short tipped (2-3mm), thin (3-4F) short cutting wire (20-25mm) catheter w/ a thin (0.018-0.021") soft tip wire and cut at the 11 o'clock position for 4mm, place a 3F 6cm Px stent
 - NB in incomplete divisum you can feed a guidewire thru the major which will eventually pass thru the minor (rendezvous technique)
 - NB pts w/ pancreas divisum often have a "satorinicle" in which the most distal end of the dorsal PD is dilated
- B-II/RYGB
 - Papilla is upside down and backwards therefore at 5 o'clock and runs down
- Catheter Type (taper w/ small wire vs blunt w/ large wire)
 - **Cannula** (only used if papilla had already been cut and you are going in real quick to just shoot some dye, only used by Dr. Hamilton, before placing curl up tip to create angle)
 - NB feed wire to tip and use wire to cannulate not the cannula itself
 - Wire Types (use 0.021-0.01" and angled for PD)
 - BS Jagwire 0.025/0.035, straight/angled, short/long, stiff/standard (most common, Hydra form is more flexible)
 - BS Glidewire 0.020/0.025/0.035, straight/angled, short/long, stiff/standard (flimsy for curvy ducts)
 - BS Dreamwire 0.035, straight/angled, short/long, stiff/standard (flimsy for curvy ducts)
 - BS Pathfinder 0.018 (firm but small therefore use in small tomes)
 - Cook Roadrunner 0.018 (for PD or tight strictures)
 - **Sphincterotome** (now the primary way of cannulating the papilla, it has a wire that runs through it with the last 2-3cm of wire exposed but then in the last 1cm the wire goes back in (as opposed to a precut sphincterotome in which the wire extends to the tip), can be used to bow the catheter and also cut thru the papilla using different currents (cutting (less pancreatitis) or auto-cut (less bleeding) or coagulation or blending), if you can't access then ampulla after a 3-5 times then resort to access sphincterotomes b/c the more manipulation the increased r/o pancreatitis)
 - Sphincterotome Types
 - Rapid Exchange
 - **BS Autotome 3.9-4.4-4.9F 20-30mm cutting wire w/ 0.025-0.035 wire**
 - most prefer the 30mm b/c you get better bowing
 - 3.9F uses a 0.025 wire and thus is better for small ampullas (but you need to change out wire to 0.035 to place stents) while the 4.4-4.9F uses a 0.035 which good for normal ampullas
 - Jagtome / Hydratome / Dreamtome is the same thing but preloaded with a Jagwire / Hydra Jagwire / Dreamwire
 - Long Wire
 - BS Truetome 3.9-4.4-4.9F 30mm w/ 0.025-0.035 wire
 - BS Ultratome 5.5F w/ 0.035 wire (Baylor, Stonetome is the same thing but has a balloon on it also)
 - Cook Ultrataper 4F w/ 0.020 wire 0.025 tight double lumen
- 11 o'clock cut: little wheel left, push into long position, CC torque, wire out of scope, little wire in papilla, cut intraduodenal segment, once done bow inside CBD and if good then it should slide out easily
- NB Bow wire a little and have it just touch tissue not bury into it b/c you want the heat to cut not the force of the wire itself b/c if you do then you will create a "zipper cut" aka cut up very fast
- NB cut along the intraduodenal segment and never beyond it
- NB rotatable sphincterotome

- NB bow inside CBD to assess adequacy of sphincterotomy
- NB always make sure you cut thru muscle
- **Access Sphincterotomes**
 - General
 - used to gain access after 3-5 attempts w/ conventional methods of cannulation have failed
 - unroof the ampulla by cutting its mucosal/submucosal layers layer by layer thereby exposing the ducts in the muscularis propria
 - pure cut: increase r/o bleed but decreased r/o stenosis vs pure coag: opposite therefore do blended current
 - preferred for B-II/RyGB (place a stent and cut along the stent to determine direction) and impacted stones (needle knife over stone)
 - to access CBD/PD start at ampullary orifice and cut up and left / straight and right (NB another approach is a "suprapapillary fistulotomy" in which you insert needle 1-3mm above ampullary orifice at the 11 o'clock position and cut downward towards the orifice to reveal the CBD)
 - only make a short cut ~5mm to find access then cannulate and do a formal sphincterotomy
 - do over a PD stent if you are able to place
 - maintain the same direction
 - maintain a clean incision
 - never cut past transverse duodenal fold
 - use glucagon to duodenal slow peristalsis
 - outside layer of duct is white while the inside layer of duct is salmon pink
 - always do a few practice swings to map out the path of cut
 - cut one superficial layer at a time (mucosa first, etc)
 - if oozing spray (not inject) 1:20k epi on the surface or use direct coag
 - if you can't see ducts you may need cut along the side
 - sometimes if you can find the PD but not the CBD then place a PD stent and use that to guide where to cut to find the CBD
 - high r/o complications, rarely done only in emergencies
 - Types
 - **pre-cut sphincterotomy** (similar to a sphincterotomy except that the wire extends to the tip)
 - **needle-knife sphincterotomy** (retractable straight wire that protrudes from tip)
 - Approach
 - start incision at the biliary orifice and extend cephalad opening up the orifice
 - start incision above biliary orifice and extend deep until the CBD is reached aka "fistulotomy"
 - start incision at pancreatic orifice and extend across septum to CBD aka "septotomy"
- **Rendezvous Approaches**
 - (1) IR obtains percutaneous biliary access thru gallbladder or peripheral intrahepatic duct, a guidewire is then fed in an antegrade fashion into the CBD thru the ampulla into the duodenum, during ERCP the guidewire is grasped w/ a snare pulled thru the accessory channel, standard cannula/sphincterotomes are then advanced over the wire
 - NB instead of a guidewire one can place a percutaneous drain
 - NB a wire can also be placed by surgeons during lap chole
 - CAN ONLY USE FOR RENDEZVOUS AFTER FOUR WEEKS BECAUSE THE TRACT HAS TO MATURE, IF ANY EARLIER THEN YOU RUN THE RISK OF LEAKING BILE/CONTRAST INTO PERITONEUM AS YOU DO ERCP
 - (2) use EUS to find CBD, place a FNA needle into duct, advance guidewire thru the FNA needle in antegrade fashion until it emerges from the ampulla
- Other Accessory
 - Strictures
 - 1st Balloon Dilation
 - 2 atm = 1 mm therefore to inflate to 6 mm you have to pump to 12 atm
 - 2nd Endoscopic Stenting
 - Controversy
 - TB>10 is known to be independent RFs for poor post-op outcome but decompression, even though effective at lowering TB, does NOT confer better post-op outcomes b/c stenting increases r/o peri-operative infections in addition to ERCP complications therefore if surgery is planned SOON then stenting is NOT recommended unless: (1) unresectable cancer, (2) there is clear evidence of acute infectious cholangitis or severe pruritus or (3) neoadjuvant chemoradiation is to be done before surgery (surgery must be delayed for at least 1-2wks, reduces liver damage from chemo)

- Pre-op stenting should be plastic NOT metal b/c metal makes subsequent surgery difficult
- there is rarely ever a need to relieve PD obstruction b/c the obstruction is usually chronic therefore pain is rarely a problem and exocrine insufficiency can be managed w/ replacement enzymes
- if duodenal obstruction then dilate duodenum first then stent biliary tract then stent duodenum
- Specifically for Type IV Hilar CCA (b/c they affect both the R and L system)
 - get a MRI/MRCP to assess which lobe of liver is more atrophic, during ERCP pass a guidewire w/o contrast into that system only, then feed a catheter across stricture into that system, then aspirate out bile to decompress, then inject contrast only there to create a unilateral cholangiogram, then place stent, there is no need to stent both sides as unilateral restoration of bile flow is sufficient (bilateral stenting can be done but technically challenging as you need two wires, either two metal stents side by side or one thru interices of other), importantly there is a r/o cholangitis if you inject contrast in unstented side that has retained contrast
 - if you do an ERCP and contrast extends to both systems then you have to stent both sides
- give antibiotics (refer below)
- first dilate then obtain tissue
 - ERCP
 - brush for cytology
 - biopsy for histology
 - brush/biopsy for FISH

- EUS
 - FNA for cytology (hard to do)
- If dx is unclear place
- Pig tail vs phalanges
- Vary in length/diameter/ends/material
- Use flimsy wire to get across stricture then exchange w/ stiff guidewire so that you can dilate, stent, etc
- Plastic is cheaper but require more ERCPs b/c of decreased patency therefore use in survival is expected to be short <3mo otherwise use covered SEMS
- Plastic

Types

Biliary

- Cook Cotton-Leung Biliary Stent
- Cook Zimmon Pigtail Biliary Stent
 - use if really dilated duct or incomplete stone removal
 - always mark the edge of the distal pigtail w/ a permanent marker before placement
- Cook Soehendra Tannenbaum Multiple Flap Biliary Stent 10F x 6,7,8,9,12cm

Pancreatic

- **High Risk PEP Prophylactic Stent: Cook Greenen Double Flapped (refer)**
- **Low Risk PEP Prophylactic Stent: Hobbs Freeman Single Pigtail (refer)**
- **Therapeutic Stent: Cook Johlin**
- Guidewire only if <8.5F but if ≥8.5F then need guiding introducer catheter over guide wire
- You can push stent w/ a pushing tube or sphincterotome
- Sphincterotomy is generally needed for anything ≥10F but do it regardless
- When measuring measure proximal extent of stricture to papilla and then add 2cm
- double pig tail to prevent upward/downward CBD migration or if multiple incompletely removed stones or infectious cholangitis
- remove w/ snares/baskets/forceps/Soehendra-stent-retriever
- patency rates vary from 2-6mo as they can become occluded w/ proteinaceous debris and bacterial biofilm, 3-11.5F
- If doing serial stents then start w/ x1 10F then x3 7F then x3 10F then x4 10F then x5 10F
- For pigtail stents mark the beginning of the pigtail to know when to stop putting in a stent in a duct
- For strictures change out every 2-3mo and each time add one more
- Patency (occlusion w/ debris/biofilm, 24 wks for >10F stents and 12wks for <10F stents, there is no link b/t patency and length of stent)

- There is no change in patency w/ the use of choleretic agents, aspirin, antibiotics
- Multiple plastic stents can be placed side by side
- Removal
 - Techniques that DO NOT maintain duct access w/ rat tooth forceps or snare
 - If stent migrated in
 - cannulate and feed guidewire w/in stent then pass Soehendra Stent Retriever over guidewire and abut end against distal of stent, rotate device anchoring it w/in the stent, pull out both retriever and stent
 - cannulate and feed guidewire w/in stent (or alongside but less ideal) then pass 4mm 2.5cm dilating (or extraction) balloon into stent (must be >10F) and inflate when w/in distal end of stent and then pull out both balloon and stent (or you can pass balloon above stent and pull it down but less ideal)
 - cannulate and feed guidewire w/in stent then pass a mini 5Fr snare partially opened into the CBD around distal end of stent and then close and pull
- Complications
 - Occlusion
 - Cholangitis
 - Cholecystitis (if cystic duct is covered)
 - Migration Into or Out (can cause perforation)
 - Pancreatitis if PD stent

• SEMS

- Types (8,10mm x 4,6,8,10cm, over 0.035" guidewire, most use 10mm x 6-8cm, use an 8mm if the stricture is very tight, before deployment the length is roughly double therefore 6cm = 12cm and after deployment usually the stent is not fully expanded therefore 6cm = 8cm)
 - Tight Interstices
 - BS Wallflex Covered/Uncovered (main one used, considered industry standard, 33% foreshortening, 7.5F delivery system)
 - W.L. Gore Viabil Covered (anti migratory anchoring fins at ends, pseudocyst drainage, 10F delivery system)
 - Open Interstices (only used if you want to place a stent thru a stent creating a "Y" configuration for hilar tumors otherwise rarely used)
 - Cook Zilver Uncovered
 - ConMed Flexxus Uncovered
- Covering
 - Uncovered (used for palliation of cancer): cannot be removed, lasts ~4mo
 - Good: no migration and no risk of blocking off ducts
 - Bad: higher r/o tissue ingrowth
 - NB if you are using it for a condition in which it will be removed (i.e. stricture b/c of patent cystic duct or crossing a hepatic duct) then take out ???
 - NB if inbedded and it needs to come out then use hot forceps and destroy the distal filaments allowing it to unravel/collapse
 - Covered (used for benign conditions): can be removed, lasts ~10mo
 - Good: lower r/o tissue ingrowth
 - Bad: migration (decreased by keeping 5mm ends uncovered) and higher risk of blocking off ducts eg. cystic duct = cholecystitis, L/R hepatic duct = cholangitis, PD = pancreatitis
- Other
 - all metal stents are MRI conditional meaning that you cannot perform an MRI until 4wks after placement
 - old ones are called Fixed Diameter Plastic Stent (FDPS) which easily become occluded and only up to 12F diameter FDPS can be passed
 - If occluded then (1) balloon sweep, (2) place another metal stent inside of it, (3) place a plastic stent, (4) thermal APC ablation of tissue
 - Expand over 48hrs therefore post-deployment dilation is not needed
 - Can be placed transpapillary or suprapapillary
 - Metal stents not be removed thru scope channel b/c sharp ends could damage scope
 - If impacted against the opposite duodenal wall then cut stent using APC
 - If migrated in then pass forceps thru CBD then thru interstices of stent then OPEN and pull out stent

- if stenting for palliative decompression then do metal if survival is <6mo and plastic if >6mo based on cost analysis studies
- NB nasobiliary/pancreatic drains are no longer used
- Complications: obstruction w/ cholangitis, proximal migration, duct perforation, if chronic then stricturing, mucosal hyperplasia vs tumor ingrowth
- 3rd Percutaneous drainage (done if altered GI anatomy like RYGB, complete biliary obstruction, failed ERCP, need to accurately examine the ducts proximal to the stricture)
 - (1) External Drainage: catheter is fed proximal to stricture and bile is drained externally through it
 - (2) Internal Drainage: catheter w/ holes is fed across stricture and ampulla w/ none left externally (kind of like an endoscopic stent)
 - (3) External-Internal Drainage: kind of like (2) but part of it is left externally (this is the best b/c it allows for natural bile flow, cholangiography, flushing if clogged, etc)
- 4th Surgical bypass w/ choledochoduodenostomy/jejunostomy
- Stone Extraction
 - General
 - Luminal Deformity: air (round, moves against gravity) vs stone (faceted, moves with gravity)
 - start w/ distal stone first, after stone removal inject cystic duct and GB (always comment in report) and if blocked the pt will need an earlier prophylactic cholecystectomy otherwise can be done w/in 2wks
 - use 50% contrast (half contrast and half water) so that you can see the stones better
 - Reverse trendelenburg (air goes up and stones go down)
 - 1st Open Sphincter
 - Sphincterotomy
 - Small (8mm) vs Avg (10mm) vs Long (12mm)
 - NB needle knife for impacted stones
 - Sphincteroplasty aka Endoscopic Papillary Balloon Dilation (EPBD) VERY HOT TOPIC RIGHT NOW!!!
 - Why good? decreased r/o acute (bleeding) and chronic (cholangitis, primary biliary stones) and preserves sphincter function
 - Why bad? increased r/o acute (pancreatitis therefore always place a PD stent)
 - Only good for small stones (<10mm) w/o acute cholangitis otherwise sphincterotomy
 - Good if pt has coagulopathy or need anticoagulation, altered anatomy esp B-II b/c unable to determine direction of sphincterotomy, perampullary diverticulum b/c if you do a sphincterotomy and they bleed they are very hard to Tx
 - Settings: use same balloons as those used for dilating strictures, 4-6-8-10-12-15mm x 2-4cm balloon (determine size based on diameter of CBD), 8atm pressure, stay inflated for 15-30sec
 - Some have tried a very small sphincterotomy before hand to guide dilation during balloon sphincteroplasty
 - 2nd ± Extraction
 - General
 - Be gentle w/ contrast and instruments to prevent pushing the stone into the intrahepatic ducts
 - Extraction Short Balloons (<1cm small stones) BS Balloon Extractor Pro XL 9-11.5/11.5-15/15-18mm
 - Has a port for contrast either below (if trying to see stone, stricture, etc) or above (if trying to see strictures, hilar tumor, etc)
 - you can actually inject contrast thru the guidewire port of a below port balloon allowing for contrast above or below
 - if you impact a stone then push it back w/ a forcep or extend the sphincterotomy or use a needle knife if a sphincterotomy has not been done
 - Olympus Extraction Baskets (1-2cm medium stones)
 - One size, plastic sheathed basket is passed above stone and then unsheathed, remove wire, jiggle basket backwards over stone, once stone is engaged the basket is closed but not too tightly to prevent wires from burying into the stone, pull back to remove
 - sometimes you can crush these stones using this basket, if it fails then the tip of the basket releases OR the basket impacts in the stone, in this case cut basket handle, remove the plastic sheath, remove scope and feed Soehendra lithotripter (14Fr metal sheath and crank) over basket wire to stone under fluoro, slowly wind the crank which closes the basket and crushes the stone against the metal sheath (if you crank quickly the wires of the basket will break b/c they are not technically lithotripter baskets)
 - NB new Soehendra lithotriptors have a 10F sheath and thus can be fed over the basket thru the scope
 - Lithotriptors (>2cm large stone)
 - Olympus Mechanical Lithotripter Baskets (different width sizes 1.5,2,2.5,3cm, unlike extraction baskets above they are stronger and have a built in metal sheath and crank,

- same principle as a basket but instead of just capturing and pulling out stone you are crushing it)
 - Intracorporeal aka Intraductal Laser Lithotripsy (ILL) or Intracorporeal aka Intraductal Electrohydraulic Lithotripsy (IEL) (use a mother/baby scope set up to visualize)
 - Extracorporeal aka Extraductal Shock Wave Lithotripsy (ESWL) (rarely used)
 - 3rd consider placement of a pigtail stent (7F x 7,9,12cm depending on length of CBD) if infectious cholangitis is present or not certain if all stones have been removed
 - Viewing
 - Cholangiopancreaticoscopes
 - Use: visually directed lithotripsy and tissue sampling for indeterminate strictures
 - Pre: sphincterotomy
 - Wash w/ saline and inject secretin/CCK to clear things out
 - “Mother Daughter” (baby scope passes thru mother scope, requires two people) vs “Spy Glass” (need only one person)
 - Ultrasound Probes
 - Sphincter of Oddi Manometry (SOM) refer to SOD
- Complications
 - General
 - Divided into mild/moderate/severe
 - Overall risk is 5-10% w/ <0.5% risk of death (usually 2/2 cardiopulmonary complications)
 - Other Issues: Contrast Allergy, Radiation Exposure (CHECK PREGNANCY TEST)
 - **Post ERCP Pancreatitis (PEP)** (low risk 5% vs high risk 25% overall is 5-10%, incidence is actually decreasing, some say now that severe PEP occurs <1/1000 times)
 - Definition: New Pancreatic Type Ab Pain following ERCP + Amylase >3ULN >24hrs from ERCP + Admission or In-Pt >1d
 - ~50% of ERCPs have asymptomatic hyperamylasemia (this is not PEP)
 - ?% of ERCPs have pain but not hyperamylasemia (this is not PEP but likely 2/2 air insufflations, etc)
 - of those pts w/ pain in recovery room only 2/3 are from PEP
 - some cases of PEP develop after several hours not immediately
 - Mechanism: multifactorial including mechanical from wire manipulation, chemical from contrast, hydrostatic from overinjection, enzymatic from intestinal contents, microbiologic from intestinal contents, thermal from sphincterotomy
 - Problem: pts will get pain from air insufflation and elevated A/L b/c of manipulation but pancreatitis is not actually present therefor get CT
 - RFS
 - Definite (OR)
 - Pt: h/o PEP (5.3), Suspected SOD (2.6), Younger Age (2.1), Female (2.5), Absence of Chronic Panc (1.8)
 - Labs: Normal Bili (1.9)
 - Procedure: Difficult Cannulation (3.4), PD Contrast Injection w/ Acinarization (2.7), Balloon Dilation of Biliary Sphincter (4.5), Blended Current Panc Sphx vs Pure Cut (4.3)
 - Doctor: Low ERCP Volume, Fellow Involvement
 - Not: Small CBD Diameter, SO Manometry
 - Stage
 - Mild: In-Pt 1-3d
 - Mod: In-Pt 4-10d
 - Severe: In-Pt >11d OR Psuedocyst/Phlegmon OR Surgical/IR Intervention Needed
 - If pt is having pain afterwards then check KUB and CBC, CMP, Lipase, Amylase
 - Px: **only three proven (wire guided, PX PD stent, indomethacin)**
 - General
 - Avoid unnecessary ERCPs by utilizing MRCP
 - To decrease r/o PEP some give 1-2L of LR b/f and during ERCP
 - Technique
 - Wire guided cannulation
 - If you use contrast then try to aspirate out
 - Limit number of cannulation attempts
 - pancreatic stent
 - High Risk: Cook Greenen 5Fr x 2-3cm w/ internal/external flaps b/c you want it in there for 10d then take out endoscopically
 - Mod Risk: Hobbs Freeman 4Fr x 9cm w/ single pigtail w/ no internal flaps b/c you want it in there for >2d but fall out on its own (check KUB in 2wks)
 - pharmacologic agents to attenuate inflammatory response, relax sphincter of oddi, inhibition of pancreatic secretion (many have been looked at but most are not effective except possibly somatostatin, gabexate (protease inhibitor), NSAIDs, secretin, ulistatin (not effective at all: octreotide, corticosteroids, allupurinol, heparin, non-ionic contrast, nifedipine, lidocaine, BoTox))

- NEJM 2012 large multicenter RPCDBT (USCORE Trial) showed that giving indomethacin 100mg PR immediately after ERCP decreased r/o PEP by 40%
- **Bleeding (1%)**
 - Definition: clinical (not endoscopic) evidence of bleeding (eg. melena, etc) occurring immediately or delayed (up to 10d following ERCP) resulting in a drop in Hgb
 - Due to aberrant branch of retroduodenal artery
 - RFs
 - Definite: coagulopathy/thrombocytopenia, **cholangitis**, low experience, bleeding during procedure
 - Possible: cirrhosis, dilated CBD, CBD stones, periampullary diverticulum, precut sphincterotomy
 - Not: ASA/NSAIDs, ampullary tumor, long sphincterotomy
 - Stage
 - Mild: Hgb decreases but no transfusion needed
 - Mod: Need ≤ 4 U PRBC
 - Severe: Need ≥ 5 U PRBC OR Surgical/IR Intervention
 - Px
 - Don't do ERCP unless Plt $> 50k$ and INR < 1.5
 - Avoid sphincterotomy in pts w/ lots of RFs and consider just sphincteroplasty
 - Holding AC/AP meds and correcting values
 - Injection of sphincterotomy site w/ epi
 - Tx: Cutting wire of sphincterotome on coag mode, Epi irrigation, Epi/Contrast/Saline Injection at the apex of the cut, Balloon Tamponade, Thermal Therapy, Hemostasis Clips only after stents are placed, Angiography/Surgery
 - NB place a plastic stent after hemostasis is achieved
- **Perforation (0.5%)**
 - Definition: perforation of (1) bowel wall by scope, (2) papilla by extending sphincterotomy incision beyond the intramural portion of the duct w/ RP leakage, (3) ducts from guidewires/stents
 - NB can be diagnosed by injecting contrast at site and seeing if it extravasates
 - RFs
 - SOD, Sphincterotomy, Periampullary Diverticula, Intramural Contrast Injection
 - Stage
 - Mild: Mild leak, Tx w/ fluids/suction $< 3d$
 - Mod: Med leak, Tx w/ fluids/suction 4-10d
 - Severe: Severe leak, Tx w/ fluids/suction $> 10d$ OR need for surgery
 - Tx
 - (1) bowel (usually peritoneal, uncommon) perforations: surgery
 - (2) papillary (usually retroperitoneal, common) perforations: if small and asymptomatic (many are found incidentally) then just observe but if large and symptomatic then NGT suction, abx, NPO, IVF, hemostasis clips if at papilla, GS consult
 - (3) duct perforations: " " to (2) but place a biliary plastic stent across perforated CBD
- **Cholangitis, Cholecystitis, Sepsis, Infected Pseudocyst, Liver Abscess, Endocarditis (0.5%)**
 - RFs: failed/incomplete biliary drainage, use of combined percutaneous/endoscopic procedures
 - Px: abx (refer below)
 - Mix gent w/ contrast for strictures

General Endoscopy

- Companies
 - US Endoscopy, Boston Scientific, Cook, Kimberley Clark, Kendell, Abbott, Given, Olympus, Pentax, Erbe
- General
 - History: 1930s (rigid scopes) → 1960s (fiberoptic flexible scopes w/ biopsy capabilities) → 1970s (fiberoptic flexible scopes w/ therapy capabilities) → 1980s (Charge Coupled Device (CCD) chip at tip of flexible scope captures images and sends it electronically to video screen instead of having to look thru an eye piece)
 - Try to use 3rd finger to help with angulation controls, you should be able to fully angulate up and down 5x in 20sec
 - Brands: Olympus, Fujinon, Pentax (combined video processor and light source)
 - Components: umbilical/connector, body/handle, shaft/tube, tip: air/water port, suction/instrumentation port, light bulb, CCD
 - GIF-H180 gastroscope (2.8mm channel, 9.8mm shaft, air/water port (top R corner) vs suction/instrumentation port (bottom R corner) vs water jet (bottom L corner)) vs CF-H180 colonoscope (3.8mm channel, 12.8mm shaft, air/water port (top L corner) vs suction/instrumentation port (bottom L corner) vs water jet (?)) vs ped scope (3.2mm channel, 9.5 shaft)
 - Polyps (the more distorted/tubular/dendritic/irregular the pits/vasculature the more likely cancer)
 - Adenoma: Kudo pit pattern (irregular spaced, large, elongated, branched pits)
 - Hyperplastic: Kudo pit pattern (regular spaced, small, round, stellate pits)
 - Advanced Imaging (used for differentiating HP from AP, colonic dysplasia in colitis, esophageal dysplasia in BE)
 - Dye Chromoendoscopy (clean surface of mucus w/ NAC)
 - vital stains (methylene blue, Lugol's, indocyanine green, toluidine blue) = absorbed by different cellular components allowing one to differentiate between different types of tissue

- contrast stains (cresyl violet, indigo carmine) = accumulate at fissures accentuating surface topology
 - reactive stains (congo red, phenol red) = change color w/ pH
- Virtual Chromoendoscopy
 - Pentax I-Scan
 - Fujinon Intelligent Chromo Endoscopy (FICE)
 - Olympus Narrow Band Imaging (NBI) white light is composed of blue/green/red, in NBI a filter removes long wavelength red light leaving only short wavelength blue/green light which is not able to penetrate mucosa thus enhancing surface
- Magnification Endoscopy
 - Zoom Endoscopy
 - Pentax Built in or Cellvizio Confocal Laser Microscopy
- Pre (always assess competency, always give pts opportunity to ask questions, ensure decision is voluntary, always obtain family contact number, exceptions to consent include: emergency, pt waives right, legally mandated, pt is not competent)
 - Discuss I/R/B/L/A/P/P/A
 - Indication
 - Risk: describe nature/magnitude/probability/timing, try not to give fixed percentages as it varies from doctor to doctor, pt comorbidities, emergency of the procedure and specifically on what is done during the endoscopy aka therapeutic maneuvers but in general the risk of any type of complication (any unexplained event that requires pt to be admitted, stay longer than expected or undergo another intervention) morbidity & mortality is generally 0.1% (1/1000) & 0.01% (1/10,000) and 0.5% (1/200) & 0.05% (1/2000) for either upper and lower endoscopy, respectively, specific risks include...
 - Prep: electrolyte/fluid disturbances
 - CV/Pulm: 2/2 sedation, hypercarbia/hypoxia/aspiration, HDS instability, arrhythmias, MI & cardiac arrest, vasovagal reactions can occur because of painful manipulation of bowel resulting in bradycardia and hypotension therefore always have atropine at hand ("we continually monitor your vitals including HR/BP/O2sat")
 - NB interference w/ AICD in general is rare but when you are using a ground pad in monopolar cautery you should turn off AICD with a magnet (NB PM are fine)
 - NB remember that when you give oxygen you are depressing ventilator drive
 - Endoscopy
 - Perforation
 - overall 1/100-1000 depending on what is done
 - can be immediate or delayed
 - Where? at pharynx/esophagus during EGD or at RS jxn and descending colon during colonoscopy 2/2 dilation and air distention (barotraumas), deep electrocautery, loops, fixed bowel, use of overtubes, complex Bx/polypectomy esp in the proximal colon where the wall is thin
 - post-coagulation/polypectomy syndrome**
 - 0.5-1%
 - full thickness burn following cautery of large sessile polyps or accidental snaring of normal mucosa w/o perforation
 - fever + leukocytosis + localized ab pain (serositis/peritonitis) BUT no perforation (conversion is rare)
 - seen 1/2-5d after colonoscopy
 - conservative management (IVF, abx, bowel rest, KUB, serial exams, labs)
 - Tx
 - During endoscopy consider stents, glues, clips (direct closure or put clips around edges and then use endoloop to bring clips together)
 - conservative management (above) and if no improvement then GS consult
 - remember that retroperitoneal perforations can be very subtle w/o pneumoperitoneum
 - Bleeding
 - overall 1/50-200 depending on what is done
 - tell pts that they may need transfusions b/f endoscopy
 - immediate (<1d, 2/2 ineffective coagulation b/c thick stalk) vs delayed (1-21d, 2/2 formation of ulcer at base b/c of use of hot-snare, eschar falls off and then bleeds, most commonly large right sided pedunculated polyps)
 - 2/3 stop spontaneously otherwise repeat colonoscopy for hemostasis
 - Damage to Mesentery, Bowel w/ Volvulus, Solid Organs w/ Rupture
 - Abdominal Distention to Compartment Syndrome
- Benefits: most non-invasive way of diagnosing and potential treating the pt's problem

- Limitation: miss lesions esp in R colon, tandem studies show a missed rates of 27/6% for polyps >5/10cm
- Alternatives: radiography but risk of radiation exposure and no therapeutic effect
- Prep: refer
- Procedure: need driver to take you home b/c you will be legally drunk, door-to-door 4hrs w/ procedure taking 20min, little/big finger
- Anesthesia: this is a continuum, each pt responds differently, twilight state
 - Minimal Sedation aka Anxiolysis = low dose benzo/opiate
 - Moderate/Conscious Sedation (pt can ventilate on own, pt can maintain airway patency on own, pt can purposefully respond (not reflex) to verbal commands or light tactile stimulation) = high dose benzo/opiate and if you reached max doses then give Benadryl 50mg or Phenergan 25mg but you always need to asses why
 - Deep/Unconscious Sedation aka Monitored Anesthesia Care (MAC) (in between) = propofol w/ anesthesia
 - ASA $\geq 3/4$ (or any type of significant CV/Pulm problem) or Mallampati $\geq III$ (or any type of ENT problem including obesity, OSA, short neck, limited neck extension, edentulous, micrognathia, retrognathia)
 - ASA Score: 6 (brain dead), 5 (moribund patient who is not expected to survive w/ or w/o operation), 4 (severe systemic dz that is a constant threat to life), 3 (severe systemic dz), 2 (mild systemic dz), 1 (healthy)
 - Mallampati Score: IV (only hard palate), III (+ soft palate and base of uvula), II (+ whole uvula), I (+ side pillars)
 - poor response or adverse reaction to sedation last time
 - alcohol/drug abuse or anxiety/pain problem and using benzos/opiates
 - emergency (active GIB, foreign body, food impaction, cholangitis)
 - complex case w/ altered anatomy (consider getting imaging prior to anatomy, minimize air insufflations, evaluate anastomosis well)
 - General Anesthesia (opposite) = propofol + other + intubation and MV w/ anesthesia
 - Other: Lidocaine Pharyngeal Anesthesia Spray

	Min-Max Dose	Onset	Peak	Duration
midazolam (Versed)	2-10mg	3min	6min	4hrs
diazepam (Valium)	2-10mg	5min	10min	1.5hrs
fentanyl (Fentanyl)	50-200mcg	1min	10min	0.75hrs
meperidone (Demerol)	25-50mg	1min	10min	3hrs
Flumazenil (Romazicon)	0.2mg	1min		0.75hrs
Naloxone (Narcan)	0.4mg	1min		0.75hrs

- Orders
 - To GI lab on call in (Morning/Afternoon)
 - Functioning IV in R arm/hand w/ **D5W TKO starting at 0500**
 - Prep (refer below)
 - Permits on chart for (Procedure) by Dr. (Attending) & Anesthesia
 - Diet Changes: NPO after MN (or specifically clear liquids >2hrs, light meal (carbs) >6hrs, heavy meal (fat/protein) >8hrs)
 - Med Changes
 - *Vitamins/Iron/Pepto/Non-Important Meds*: hold x5d
 - *Antiemetics*: make sure PRN orders are written
 - *Insulin*: take ½ PM long acting insulin and hold AM short acting insulin and oral hypoglycemics
 - *AC/AP*: NO need to ever hold NSAIDs/Aspirin
 - Elective Endoscopy
 - Low Risk Procedure: **Biopsy**
 - no need to hold AP
 - no need to hold AC UNLESS suprathreshold
 - High Risk Procedure: **Polypectomy/Dilation/PEG/FNA/Sphincterotomy**
 - Hold AP (Plavix/Effient) x7d prior and restart next day if the pt is beyond the risk period for in stent thrombosis (>1yr for DES and >6wks for BMS) if not then try to defer endoscopy until that period of time
 - NB new studies are showing that one can actually safely perform polypectomy while on AP w/ a post risk of bleeding of ~1%
 - NB consider starting aspirin if you stop Plavix and pt was not on aspirin
 - Hold AC
 - If Low Risk Condition hold Coumadin/Pradaxa for x5d/x2d w/ goal of <1.5 and then resume Coumadin/Pradaxa that night

- If High Risk Condition (mitral mechanical valve, any mechanical valve w/ thromboembolic event, high CHADS2 Afib): same but bridge with therapeutic Heparin/Lovenox and stop Heparin/Lovenox 4-6/12-24hrs prior and resume after and then resume Coumadin/Pradaxa that night
 - NB there is insufficient evidence that prophylactic clips truly reduce risk of bleeding after polypectomy
- GIB Endoscopy (controversial)
 - Hold all AC/AP until hemostasis is achieved but the question is whether reversal of INR (3U FFP, Prothrombin Concentrate, VitK) should be done and if so what the target should be (1.5-2.5) and this is all based on how bad severity of GIB and the reason for AC (if recent stent or ACS then consult w/ cardiologist)
 - Resume when hemostasis has been achieved but if high risk stigmata of rebleed then consider heparin b/c you can stop it quickly if rebleeding occurs
 - additional controversial topic is prophylactic PPI in a pt who had a GIB = COGENT Trial was designed to assess this but it was also found that PPIs affect Plavix hence very controversial (some say give PPI if GIB and aspirin or AC or >60yo)
- Supratherapeutic INR
 - INR 3-5: hold next few coumadin doses and restart at lower dose
 - INR 5-9: " " + VitK 5mg PO
 - INR >9: " " + VitK 10mg PO
 - Bleeding: " " + VitK 10mg IV (slow b/c can cause anaphylaxis) + 1° PCC (Prothrombin Complex Concentrate) 2° FFP
- **Abx for Infection Px**
 - (1) pt-to-MD or vice versa
 - rare except for *Helicobacter pylori*
 - (2) pt-to-pt
 - scopes cannot be autoclaved and thus have to undergo mechanical cleaning w/ detergent, high level disinfection, rinsing, drying, storage <7d
 - prior to 2003 there were reported cases of *Salmonella*, *Pseudomonas*, *Helicobacter*, et al, NO HBV/HCV/HIV but transmission of viral infections is more difficult to assess b/c they have longer incubation periods, NO C.diff, NO fungi documented
 - (3) within pt
 - **Aspiration Pneumonia**
 - 2/2 impaired airway protective mechanisms, when the stomach is not empty, emergent endoscopy
 - **Bacteremia**
 - In 2007 the AHA/ASGE both recommended that administration of abx SOLELY TO PREVENT ENDOCARDITIS NOT BE DONE for pts undergoing a GI procedure regardless of the endoscopic procedure or cardiac condition
 - In addition no abx Px is needed for non-valve vascular graft, AICD/PD, joint prosthesis
 - Some still do if (1) there is an established GI infection eg. cholangitis + (2) high risk endoscopy eg. ERCP, + (3) Prosthetic Valve/Prior IE/Heart Transplant w/ Valvulopathy / CHD (unrepaired, repaired w/ prosthetic material w/in last 6mo, repaired but residual defect): Amoxicillin 2g PO 1hr prior OR Amp 2g IV 30min prior (if pt cannot tolerate PO) OR Clinda 600mg PO 1hr prior / 600mg IV 30min prior or Azithro/Clarithro 500mg PO 1hr prior (if pen allergic)
 - **Infection of Sterile GI/Adjacent Tissue**
 - EUS Drainage of Psuedocyst, EUS FNA of Cyst NOT Mass, EUS Peri-rectal FNA of anything, ERCP if PD communicates w/ psuedocyst (to prevent psuedocyst/cyst/mass infection) = **FQ x3d**
 - ERCP Drainage of Obstructed CBD and (1) only partial drainage is achieved (eg PSC) or (2) Obstruction is due to a Post-Transplant Biliary Stricture (to prevent cholangitis) = **FQ x3d**
 - PEG (to prevent peristomal infection) = **Cefazolin 1g IV 30min b/f or Vanc 1g IV 30min b/f if high r/o MRSA or Pen allergy**

- Post
 - Discharge Home if Aldrate ≥ 8 and Ramsey ≤ 2
 - Aldrate Score: based on activity/respiration/circulation/consciousness/SaO₂
 - Ramsey Score: 1 (anxious/agitated), 2 (cooperative/oriented/tranquil), 3 (responds to commands only), 4 (asleep but has a brisk response to glabellar tap or loud auditory stimulus), 5 (asleep but has a sluggish response to glabellar tap or loud auditory stimulus), 6 (no response)
- Maneuvers
 - Hemostasis
 - Injection
 - Saline, Epi (1:10,000, 0.5-1mL up to 10mL, at base of site), Sclerosants (eg. ethanolamine oleate (main one), ethanol, sodium tetradecyl sulfate, sodium morrhuate, polidocanol, cause thrombosis and endothelial damage resulting in endofibrosis and vascular obliteration, use a sclerotherapy needle, injected 2mL into OR around varix, not very effective and many SEs: tissue necrosis w/ ulceration, chest pain, bleeding, stricture, fistula, pleural effusion, sepsis, mediastinitis, perforation, pneumonia, SBP, PVT, vagotomy), Clotting Agents (Fibrin Glue, Thrombin, Cyanoacrylate)
 - Provides local tamponade \pm vasoconstriction/injury/clotting depending on which agent used
 - For thick stalked big polyps one can inject 1:10k epi into the stalk to cut off blood flow and make the polyp smaller
 - Thermal
 - General
 - Types (most use a blended current)
 - Cutting-Yellow (continuous high density current) = rarely used alone
 - Coagulation-Blue (modulated low density current) = used alone in APC
 - Power-P (Watts) = Current-I () x Voltage-V () = Energy-E (Joules) / Time-T (sec)
 - Monopolar (current flows b/t instrument and ground pad)
 - Grounding Pad: clean/dry, no hair, muscle not bone/scars, close to site of cautery eg. 1° flank 2° upper arm (UGI) vs thigh (LGI), some have a monitoring system
 - Types
 - Snare
 - Needle-Knife
 - Argon Plasma Coagulation (APC)
 - Indication: superficial low flow lesions eg. GAVE, -itis, AE/AVM, radiation enteritis, etc
 - Types: circumferential vs straight on (NB side type is no longer available)
 - Mech: high energy ionized gas is released and then energized creating a superficial burn
 - Settings
 - Thick Tissue (above mid stomach and below mid colon) = 30-60W & 1.0L/min
 - Thin Tissue (everything b/t mid stomach and mid colon) = 15-30W & 0.5L/min
- Bipolar (current flows b/t electrodes 1-2mm apart and thus current is concentrated close to tip)
 - NO Grounding Pad
 - Types
 - Heater Probe (just a piece of metal that gets hot, rarely used anymore)
 - Boston Scientific, US Endoscopy, Cook Gold Probe aka Contact BiPolar electroCAutery Probe (BICAP)
 - Indication: deep high flow lesions eg. vessels in ulcer base
 - NB some have a needle which can be used to inject epi and others have a central catheter which can shoot out saline
 - Settings
 - Thick Tissue = 30W 10F
 - Thin Tissue = 15W 7F
- Barrx HALO RF Ablation
 - General
 - 1mm burn
 - FDA approved for ND/LG/HG BE
 - Pinnacle (866-369-9290) to help get pre-cert
 - 360° Balloon Approach (circumferential BE)
 - *** Some give Toradol 30mg IV x1 before ablation to help with pain ***

The Mantis Manual

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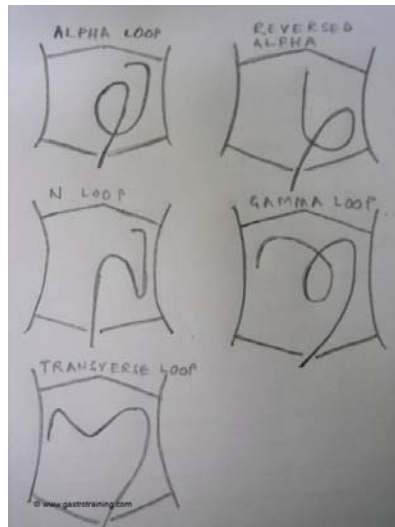
- 1st: determine size of balloon
 - determine top of gastric folds (TGF) and IM (TIM) and subtract 12cm from TGF
 - irrigate w/ 1% mucomyst (smells bad)
 - NB don't use saline b/c it prevents burning
 - NB don't use KY jelly on scope
 - place guidewire into antrum and remove scope
 - advance sizing balloon over guidewire and begin sizing at 12cm proximal to TGF and size every 1cm advancing distally until an abrupt larger diameter is found indicating stomach (hit grey button and then a number is given)
 - 5 different diameters
 - remove sizing balloon
- 2nd: ablate (10J/cm² for non-dysplastic BE vs 12J/cm² for dysplastic BE)
 - feed ablation balloon over guidewire
 - pass scope proximal to balloon
 - align ablation balloon 1cm above TIM and ablate (suck our air, inflate balloon by tapping grey peddle once, fire when you hear rapid beeps by tapping blue peddle once)
 - move down distally 3cm and ablate again
- 3rd: clean
 - remove balloon and guidewire and scope
 - place cap on scope and remove coagulated tissue
- 4th: ablate
 - repeat ablation but don't clean off eschar after 2nd ablation
- Post in GI Lab
 - Give some Maalox/Lidocaine Suspension
- Post at Home
 - PPI 40mg PO BID until next Tx
 - Carafate 1g PO QID x1wk
 - Maalox OTC PO QID x1wk
 - Lidocaine 4% Elixir 10mL PO Q6hrs prn pain x1wk
 - Acetaminophen with Codeine 300/30mg Elixir 5mL PO Q 6 hours prn pain x1wk
 - Zofran 4mg PO QID x1wk prn
 - No NSAIDs/Aspirin for 1wk
 - Full liquid diet for 1d then soft diet for 1wk
- Repeat: 2-3mo later w/ focal 90° pad ablation
 - 1cm 60°, 1cm 90°, 4cm 90°, TTS 1cm 90° Pad Approach (island BE, RPI, GAVE) device set at 12 o'clock
 - burn twice and then clean pad and debride eschar by scraping it off using Halo and then repeat ablation but don't debride afterwards
- Mechanical
 - Boston Scientific Resolution Hemostasis Clip (can be used in MRI but some artifact, can be removed w/ rat tooth snare, can be used to also close perforation <2cm and anchor J-tubes to wall, open jaw is 11mm wide, can be closed and reopened up to 5x, some remove the sheath allowing it to rotate more easily), Cook TriClip
 - Boston Scientific Speed Band 7 Multiple Band Ligator, Cook 4/6/10 Shooter Saeed Multi-Band Ligator
 - Regular EGD first then come out and set up banding apparatus (feed wire thru entry port until it exits, attach proximal wire end to small wheel, fix wheel w/ velcro to scope handle, attach distal wire end to plastic ring w/ bands and remove plastic cover, line up string so that it is at the lower L corner
 - Give a bolus of octreotide 100mcg x1 if actively bleeding or just increase rate to 100mcg/hr
 - If there is active bleeding then blindly band the GEJ junction circumferentially!!! (high r/o stricture but may save their life)
 - Band (suck and turn wheel) starting at most distal varix at EGJ (after you band never move scope past it b/c you will knock off band) then work your way up proximally in a spiral fashion at 2cm intervals banding every other varix, always suck and band quickly b/c sucking increases your risk of bleeding (NB mid/upper esophageal varices rarely bleed and thus do not band)
 - Post-Orders: octreotide or beta-blocker, remind pts of Sx, soft diet x3d, PPI x1mo, sucralfate x1wk, f/u EGD at 6wks for repeat banding
 - After a few days the band falls off and a small ulcer is present which can rebleed

- SEs: transient dysphagia, chest pain, post-banding ulcer bleed
- Tissue (position at 5 o'clock, consider tattooing site if malignant/unresectable/>1cm)
 - Type of Tissue
 - Sessile Polyp: Small (cold biopsy forceps), Medium (cold/guillotine snare), Large (piecemeal)
 - Pedunculated Polyp: Thin Stalk (hot snare) vs Thick Stock (EndoLoop/Epi then hot snare)
 - Multiple Polyps (resect ≤ 10 at once, send for genetics)
 - Mass (cold biopsy forcep at same spot to go deep into mass past necrotic layer)
 - Ulcer (cold biopsy forcep at Center base esp CMV and 4 quadrant margin esp HSV)
 - Stricture/Duct (cytology brushes w/ sleeve)
 - Devices (many companies make various ones)
 - Cold/HOT Biopsy Forceps (Boston Scientific Radial Jaw 4 Standard: 2.8mm closed / 7mm open, Jumbo: 3.2mm closed / 9mm open, Cook Captura Biopsy Forceps many different types, Kimberly-Clark Forceps many different types), NB hot forceps are no longer used b/c expensive, destroys tissue, high rate of serosal burns, etc but if you do use then use "soft coag" setting which only creates a light burn at the tip of the forcep, burn until base of polyp is white then pull
 - Cold/Hot Snare (various sizes/shapes/filaments just pick one, lasso the stalk → PUSH SHEATH AGAINST THE STALK (so that that loop tightens at stalk and not before it which can lead to the snare slipping off) → close loop → tent lesion by lifting up & DEFLATE → cut → try suction w/ trap tank but will likely need Roth Retrieval Net) 15-30W
 - No tenting w/ cold snare rather you want to do the opposite and push the snare against the wall!!
 - Tunnel Bx
 - You need to Bx at least 15 types to get very deep
 - These often bleed therefore Tx w/ APC
 - Endoscopic Mucosal Resection (EMR) aka Mucosectomy
 - Two Types: (1) Cook Duette Band Ligation Assisted Mucosectomy (creates a deeper removal therefore only do in thick tissue areas like esophagus, stomach, large intestine): no lift, suck tissue into cap (vary based on angle, size, flexibility), place a band, snare tissue below band and burn or (2) Olympus Cap Assisted Mucosectomy (creates a shallow removal therefore done in the small intestine): tissue lift by injecting w/ saline/1:200,000epi/indigo-carmin (before you enter needle into tissue starting ejecting and then place needle in slowly until you hit submucosa which quickly lifts, if you can't lift then don't do), feed snare and open so that lays along the inner lip of the cap, create a pseudopolyp, suck tissue into cap, no band, snare tissue and burn
 - First mark borders w/ APC b/c lifting makes margins unclear
 - Always talk to pathologist and explain what you did
 - At the end close the defect w/ clips if deep
 - Complications: perforation (1%), bleeding (5%), stricture (25%)
 - Post: PPI/Carafate, liquids x2d, soft mechanical x4d, f/u EGD in 8wks
 - Endoscopic Submucosal Dissection (ESD)
- Dilation
 - Pre
 - Always get an esophagram to characterize the lesion
 - Risk of Perf/Bleeding is 0.3% for benign stricture but slightly increases if 2/2 radiation, caustic, malignancy, EE, etc
 - Estimate diameter based on esophogram, start with a size and gradual increase until you feel resistance (that is #1) then dilate with one size up (that is #2) and then one more size up (that is #3) = "rule of three"
 - Goal: Increase diameter to >13mm thus passage of a 9.8mm gastroscopes does NOT mean the patient does not need dilation
 - If really stenotic consider using an ERCP jag wire, retrograde dilation thru PEG (Rendezvous Procedure), et al
 - Types
 - Proximal (exerts radial AND axial forces, reusable, cheap, more barbaric but gives you better tactile sense, Size: single-size 15 to 60 French (3F = 1mm))
 - (1) Mercury/Tungston Bougienage (Maloney/Hurst) = flexible, non-wire guided, usually passed blindly, tapered tip, used only for simple strictures, also good if you can't pass a wire
 - if no clear stricture then at end of EGD lube a 54F Malomey and then undo mouth guard and us left finger along outside of mouth guard to push tip of Maloney down beyond tongue into esophagus (it should pass easily w/o coughing)
 - (2) Polyvinyl Dilators (Savary-Gillard/American) = semi-firm, wire-guided, usually passed under fluoro (How? keep neck extended when you use them, place wire thru scope that is in stomach, fluoro shot, record distance and pull out scope, fluoro shot to determine wire hasn't moved, dilate), used for complex strictures

- Savary is the only one really used, start w/ 10mm/30F →→→ 20mm/60F, do routine EGD, place wire into stomach, as you remove scope put an equal amount of wire in (VERY IMPORTANT), hold head into an extended position, lube the entire length of the 1st Savary and feed over wire until ~6" are left out of the mouth, then go to the next higher Savary, as you remove Savary put an equal amount of wire in (VERY IMPORTANT), NB NEVER LET GO OF WIRE
 - Distal (exerts only radial forces, not reusable, expensive, more elegant but gives you less tactile sense)
 - (1) Boston Scientific CRE Hydrostatic Balloon Dilator, Cook Eclipse/Hercules/Quantum Wire Guided Balloon Dilator
 - Size: multistage 10-11-12, 14-15-16, 18-19-20mm
 - How? OTW ("over the wire") if you can't feed scope thru vs TTS ("thru the scope") if you can feed scope thru, advance scope into stomach, lubricate balloon, advance balloon w/ soft tip into stomach, you want to see the tip of white proximal end, pull back scope so that waist of balloon is centered at stricture, anchor balloon catheter with your finger against scope, inflate balloon w/ water, hold for 30 seconds, take picture thru inflated balloon
 - (2) Cook Pneumatic Balloon Dilator (refer to achalasia)
- Post
 - Assess post-dilation w/ endoscopy but you will always see tears/blood
 - If S/S (any complaint) of perforation then check CXR/Gastrograffin study and contact surgery though most pts can be managed nonsurgically (endoscopic clips/stents, abx, endoscopic placements of NGT to clear secretions)
 - Before sending home have pt drink some water at 1hr then soft diet x1d
 - You can repeat dilation after 3d
- For refractory/difficult strictures (esp anastomotic, radiation, caustic)
 - intralesional steroids (40mg/mL triamcinolone solution, inject 0.5mL (20mg) using a 22-gauge sclerotherapy into each quadrant before dilation which reduces collagen and fibrin)
 - **needle knife electroincision or use a forcep and take several deep bites**
 - self-dilation at home
 - Self-Expanding Metal/Plastic Stents (SEMS/SEPS)
 - General: metal better than plastic b/c easier to place, open to a greater degree (18-23mm vs 10-12mm), less complications thus SEPS are rarely used
 - Uses: malignancy, refractory strictures, fistulas/perforation/leaks
 - Pre: planning is very important (length, diameter, exact placement, how long you want it in place, etc)
 - Procedure: use fluoro w/ paperclips as markers, consider placing scope beside guidewire and stent as you deploy
 - Post: pts are usually kept ON in the hospital, check gastrograffin esophagram at 2hrs and if negative then clear liquids at 4hrs, soft diet for a few days, tell pts to always avoid very solid foods
 - NB biodegradable stents will be available in the future
 - Types
 - Esophageal (savary or guidewire guidewire placement)
 - Types: Boston Scientific (Polyflex, Ultraflex, Wallflex, Wallstent), Cook (Z-Stent, Evolution), EndoChoice (Bonastent), Merit (ALIMAXX)
 - Uncovered SEMS (NOT removable hence permanent)
 - Partially Covered SEMS aka ends are bare (moderately removable hence longer lasting)
 - Fully Covered SEMS/SEPS (removable by pulling on suture on both sides w/ rat-tooth forcep hence temporary)
 - silicon/polyurethane membrane prevents reepithelialization or tumor in-growth
 - migration is a complication
 - Intestinal (TTS placement)
 - Types: Boston Scientific (Enteral Wallstent)
 - mainly used for extrinsic compression from unresectable gastric/duodenal/pancreatic cancer, angulation is a big problem, always evaluate biliary tree first, stent ampulla before hand b/c (1) finding it after a duodenal stent is impossible and (2) obstruction occurs half of the time
 - Colonic (guidewire placement)

- Types: Boston Scientific (Wallstent, Wallflex, Ultraflex), Cook (Z-Stent)
 - Complications (20-40% esp when used in malignancy and especially if pt is concurrently getting chemo/XRT w/ increased r/o erosion into aorta and TE fistula)
 - Upper: foreign body sensation, tracheal compression, pain, globus, fistulas, aspiration therefore always place 2cm below UES
 - Lower: GERD therefore some are being developed w/ anti-reflux valves
 - General: tumor ingrowth w/in or overgrowth at edge (Tx w/ thermal therapy or place a coaxial stent over old stent), recurrent dysphagia (have pts eat small bites), migration, pain, erosions w/ TE fistula, bleeding, perforation, inadequate expansion, malposition, if tumor is very large when you expand it with a stent the tumor may impinge on airway
 - Other
 - NB choice of one stent over another is just endoscopist preference
 - NB stent does not preclude surgery/radiation/chemotherapy
- Upper & Mid aka Enteroscopy (no prep, NPO after MN)
 - Esophagogastroduodenoscopy (EGD)**
 - "proximal extent of hiatal narrowing / gastric folds / Z line is 40/37/36cm from incisors" (NB if distance b/t hiatal narrowing and gastric folds is >2cm then the pt has a hiatal hernia)
 - UES (20cm) vs pylorus (50cm)
 - Suck fundic fluid
 - hard R/up into duodenum
 - Intra-Op Enteroscopy** (gold standard, every new enteroscopic technique should be compared to intra-operative enteroscopy)
 - VCE**
 - Always do a 2nd look EGD/Colon before going on to VCE
 - Orders:
 - Surgical Clear Liquid Diet x1d then NPO after MN
 - Golytely 2L Prep at 1600 day before
 - Simethicone 80mg PO and Reglan 5g PO 2hrs before capsule swallow
 - To GI Analytical Lab for Capsule Endoscopy in AM
 - Permits in Chart for Capsule Endoscopy
 - What does it do? 2frames/sec = 50k images during 8hr battery life, 140 degree field of view
 - Incomplete Exams can be seen in hospitalized pts, diabetics, pts on narcotics/anticholinergics, ab surgeries
 - Report: mark landmarks (first stomach, duodenum, cecum), mark abnormal findings, do report, NB if you accidentally go to beginning click on "video" and "previous video action"
 - If colon is not reached then do a f/u KUB in 2wks
 - Patency capsule dissolves at 72hrs
 - No interference w/ all implantable cardiac devices
 - If dysphagia consider having the pt swallow a large vitamin pill or placing it into small intestine using snare or US Endoscopy AdvanCE Delivery Device
 - Push** (long flexible pediatric colonoscope passed orally and then pushed into the SI, the problem is that significant looping occurs)
 - Sonde** (similar to push enteroscopy but the scope is advanced thru SI by peristalsis using a mercury weight which takes a whole day)
 - Double/Single Balloon Enteroscopy (DBE/SBE)** (lower as spiral easier for upper)
 - Bring the overtube back to the scope handle then do normal colonoscopy until the overtube enters the anus then do the remainder of the colonoscopy reducing the colon as much as possible
 - Endoease Discovery Spiral Overtube** (very difficult to do lower)
 - Pre: fill spiral overtube w/ 1/2 of the lubricant and make a "U" motion then lock overtube at 140cm and then only mildly lube the spirals AND overtube
 - Intra: spiral aggressively thru esophagus, keep the endoscope as straight as possible to prevent kinking, in the SI spiral until you can't go anymore then unlock overtube and push scope in a little further, when you can't go any further lock overtube at 130cm, only pull out a little bit of the overtube at a time while unspiral w/ lots of tip action to prevent intussusception, when the overtube reaches 50cm then don't pull out anymore rather unspiral your way into the stomach this prevents the stomach collapsing and having spiral in duodenum and esophagus
 - NaviAid** (a catheter that has a balloon on its tip, you feed it down, blow it up, pull toward the scope pleating the small bowel)
 - New: The Snail, The Cockroach**
- Lower
 - Prior Week: Low Residue Diet (NO nuts, seeds, fruits)
 - Prior Day: Surgical Clear Liquid Diet, Prep starting at 1600 8oz PO Q10min until consumed
 - Problems

- Bad Taste: suck on a lifesaver b/c bad aftertaste, don't make super cold only chill it, use lemon flavored packet or Crystal Light
- N/V: chill prep even more, drink thru straw, drink slowly, ambulate, give Reglan 5mg and anti-emetics, if pt won't drink prep at all and they are in-pt consider NGT but watch closely for aspiration
- Poor Prep
 - Day 1: clear liquids
 - Day 2: clear liquids + MOM 1 bottle ~300mL or Dulcolax 10mg (afternoon) + 2L Prep (evening)
 - Day 3: 2L Prep (morning) then Colonoscopy
- Same Day: Prep starting at 4hrs prior to exam, finish 2hrs prior from exam, 8oz PO Q10min until 2L consumed (takes 2hrs)
 - Problems
 - Spastic Colon: Glucagon 0.5mg IV x1 or Hyoscyamine?
 - Bubbles in Colon: Simethicone 3tabs 80mg w/ total dose 240mg the night prior
- Preps
 - NuLYTELY Prep (main one)
 - Suprep is the new prep made of NaSO4 KSO4 MgSO4, osmotic effect hence smaller volume, split dosing, developed by Fordtran/Patel, split dosing 16oz day prior and 16oz day of w/ 32oz of water after each one
 - Gatorade Prep (40mg of Dulcolax at 1500 then mix 155g of Miralax in 64oz Gatorade starting at 1700)
 - 2L-HalfLyte (just less volume but give Delayed Release Dulcolax 20mg PO at 12)
 - 2L-MoviPrep-ascorbic acid (PEG w/ NaSO4, NaCl, KCl, NaAscorbate, better tasting)
 - 4L-GoLYTELY/Colyte
 - 4L-TriLYTELY/NuLYTELY (sulfate-free therefore better tasting)
 - NB Phosphasoda (Fleet Solution, OsmoPrep Pill, Visicol Pill) is no longer used much b/c can cause hyperphosphatemia and nephrocalcinosis even though it is a better prep and better tolerated (FDA black box warnings in 2008 for pts >55yo, kidney dz or on drugs that could affect kidney)
- Goals (GiQuick)
 - Cecal Intubation w/ Photodocumentation: 90% of total exams and >95% of CRC screening exams
 - Adenoma Detection Rate (ADR): >25/15% in male/female CRC screening exams (not surveillance)
- Other Exams
 - Flex-Sig: fleet enema, NB no anesthesia just use 2% lidocaine jelly instead of normal jelly
 - Colostomy: same
 - Ileostomy: 1L NuLyte
 - IPAA: fleet enema
- Sigmoidoscopy/Colonoscopy
 - General
 - Use CO2 in pts w/ poor prep b/c of the presence of combustible gas, known diverticular dz and functional bowel dz b/c it is quickly absorbed w/in 15min (100x faster than air)
 - Colon has various configurations based on the mesentery and fixations that form during embryology and thus the colon can have variable mobility
 - Loops suggested by pain, loss of one-to-one movement or even paradoxical movement, angulation control wires feel stiffer and have less effect
 - When you reduce loops do so at the straight parts of the colon by pulling back AND torquing either clockwise or counter to undo it
 - Contraindications: perforation, acute diverticulitis, deep ulcers, severe ischemic colitis
 - Pain = distension, mesentery traction, loop, younger age, female
 - Presence of fluid levels helps tell you where you are
 - Finger indentation, palpation, balloting
 - Pediatric colonoscopy for stomas
 - Consider using a US Endoscopy Entrada Colonic Overtube to keep the sigmoid fixed w/o looping
 - Anus
 - Before you insert do a finger exam and have pt to bear down afterwards to relax sphincter
 - Rotate the scope so that the fluid is at bottom!!!
 - b/c external hemorrhoidal veins do not drain into portal system but rather systemic system snaring a mistaken "pile" can result in hemorrhage and injecting epi can result in a fatal CV event
 - AR Jxn (3cm)
 - Rectum
 - Highly vascular
 - RS Jxn (15cm)
 - Sigmoid
 - Bad: scope goes towards head then turns back towards feet creating a **hairpin N loop, RLQ to suprapubic pressure prevents it and reduce it via clockwise rotation and pulling back**
 - Good: sometimes people intentionally create an **alpha loop** it by **placing constant counterclockwise torque during sigmoid intubation**



- SD Jxn (35cm)
- Descending
 - place pt on R lateral if difficult
 - there is a sharp acute angle at the SD jxn that sometimes makes it hard to traverse but once you pass it the descending colon is easy to transverse b/t it is fixed in left lateral RP gutter
 - water tends to collect here b/c pts are in the L lateral decubitus position
- Splenic Flexure (75cm)
 - LUQ pressure if difficult
 - Prevent alpha loops w/ suprapubic pressure and reduce alpha loops by “hooking” the tip then clockwise rotation and pulling back
 - the splenic flexure has an acute angle when the pt is on the L lateral decubitus which can be straightened out as you move the pt supine or to R lateral decubitus
 - sometimes the splenic flexure twists to the left and then back down and then to right making examination of the proximal colon difficult and this can be reversed by counter-clockwise rotation
- Transverse
 - place pt on supine if difficult
 - triangular folds
 - typically no fluid unlike in descending colon
 - once in transverse tighten/stiffen up the scope
 - always keep colon semi deflated from now on b/c the more inflated the longer it is
 - in women the transverse colon droops into the pelvis and is the main reason why colons are longer in females and colonoscopies more difficult with possible formation of a **gamma loop and this can be prevented suprapubic to MEG pressure and it can be reduced by counter-clockwise rotation**
- Hepatic Flexure (115cm)
 - RUQ pressure if difficult
 - have pt take a deep breath in
- Ascending Colon
 - place pt on L lateral if difficult
- Cecum (250cm)
 - 90% of time cecum is in anterior RLQ therefore check for transillumination and finger indentation but remember that 10% of pts have mobile cecum 2/2 persistent mesocolon
 - Appendiceal Orifice
 - Tenia coli fuse to form a Mercedes sign around the appendiceal orifice
 - Appendiceal orifice is usually a crescentic slit b/c the appendix is folded down across cecum towards the ICV creating a “Bow” with the “Arrow” pointing AWAY from ICV
 - After an appendectomy there is usually enough of a base for it to still look like a normal orifice (but not a slit) but in some cases it inverts looking a stump or polyp (don't Bx!!!)
 - ICV
 - on the proximal side of a fold 5cm from end of cecum b/t the cecum and ascending colon
 - to enter ICV deflate a little to make ICV supple and try to get ICV at 6-o'clock, start at appendiceal orifice and pull back with tip angulated, tip then hits mucosa w/ red out and as you pull back further mucosa changes from smooth/pitted colonic to bumpy ileal, then give a puff of air and enter TI

- Sometimes you can use a biopsy forcep as a guidewire or for just blind biopsy
 - Sometimes you can retroflex in the cecum to visualize the opening of the ICV
 - Always intubate TI if pt has diarrhea/ab-pain
 - If you can't get in consider ileal inflammation that has stenosed the ICV
 - TI has small lymphoid follicles (looks like polyps) to large Peyer's patches (looks like white plaques)
 - Withdrawal
 - Pulling back the scope to 80cm in the Cecum predictably helps you find the hepatic flexure (60cm), splenic flexure (50cm), SD jxn (30cm)
 - Always "work the folds" by deflecting them back
 - NB distance of insertion is very inaccurate for localization therefore only document distances after you are reached the cecum and pulled back creating a predictable "question mark" colon

- Other

- NOTES

- Goal: reproduce surgical technique endoscopically or actually do something entirely different and thus be a substitute
 - Why? less complications (cosmetic), less adhesions, less ileus, less pain, easier esp in obese pts
 - Risks: intra-abdominal infection
 - The Apollo Group in 1998 developed the concept of NOTES and first published in 2001
 - Transvaginal approach is also being looked at
 - Problem: endoscope is flexible so you can't apply lots of force, can't triangulate, etc (NB Cobra Scope is a new device designed to move beyond these challenges)
 - Examples of how endoscopy has replaced surgeries: Stents for biliary bypass, PEG for lab gastrostomy, varices ligation/sclerotherapy for portosystemic shunt, ablation for esophagectomy
 - Other: GERD Tx, Bariatric Tx
 - It is going the other way around where surgeons are using endoscopes thru the axilla to neck to do parathyroidectomies

X-ray

- Radiation Exposure:** 10,000mRem exposure = 1% increased r/o cancer (esp thyroid, breast, uterine, gonads) Chest: MRI~0mRem vs CXR~10mRem vs CT ~200-1500mRem, Whole Body PET 2000mRem, NB WWII atomic bomb = 5000mRem
- PET (Positron Emission Topography)** metabolic activity by glucose metabolism by uptake of 18F-fluorodeoxyglucose vs **SPECT (Single Photon Emission Computer Topography)** metabolic activity by blood flow w/ 99m-technetium labeled RBC
- Three Phase Bone Scan:** technetium-99m is injected and accumulates in bone proportional to the degree of bone turnover aka new bone thus osteoblastic activity (inflammation esp infection, tumor, fracture) shows up as increased uptake (NB osteolytic activity technically shows up as decreased uptake but this not sensitive at all hence skeletal survey)
- Skeletal Survey:** Lytic Bone Lesions on plain radiographic skeletal survey (NB bone scan is not sensitive at for detecting lytic lesions)
- Ab Xray (Supine PA View) vs Obstructive Series (Upright PA Chest + Supine Ab + Left Lateral Ab)** look for bowel gas pattern, free air under diaphragm, gastric bubble size

Fluoroscopy

- NB always specify contrast, single vs double, study type, Video/Cine (motility problem) vs Spot PA/L (structural problem), what precipitates Sx, etc
- Contrast
 - Non-Water Based Contrast: Barium (bad if r/o perforation b/c if outside viscus it causes a granulomatous response therefore use water based contrast, you can create different consistencies, when using barium you can do a double contrast study by giving oral effervescent crystals or air per rectum, you can't do double contrast for small bowel follow thru)
 - Water Based Contrast: Gastrograffin NB Hypaque/Omnipaque are not used anymore (bad if risk of aspiration b/c it causes a pneumonitis, these are high osmolality contrasts so when given via enema they pull water into lumen leading to stool removal)
- Upper
 - Pharyngograms** (NPO 1hr prior) NB "**Modified Barium Swallow**" or **Dysphagiogram** is a pharyngogram that focuses on swallowing dysfxn
 - Indications: mainly done by STs w/ radiology assistance to assess swallowing function (pt is given various consistencies of barium from thin to nectar to honey to pudding to cracker), abnl food transit time, NP reflux, aspiration, cricopharyngeal hypertrophy, strictures, webs, diverticulae
 - These have to be video b/c of the fast sequence of events that results in swallowing
 - Aspiration Study**
 - 1st Bed Side Swallow Study (SS)** in which dieticians given first sterile ice/water (b/c if they aspirate it is best w/ sterile ice/water) then various liquids/solids (NB water is most difficult)
 - 2nd Dysphagiogram** if pt is healthy on floor and can go to radiology labs or **Bedside Flexible Endoscopic Exam of Swallowing (FEES)** if pt is sick in ICU and cannot go to radiology lab (dietician places endoscope thru nares into trachea and the gives various colored foods and watches for aspiration)

- **Esophagogram** (NPO 1hr prior)
- **Upper GI Series** (NPO 6hrs prior or after MN)
 - Indications: stomach/duodenum motility/structural problems, esp pre-op gastric bypass to evaluate anatomy for surgery or post-op gastric bypass to assess presence of strictures/leaks
- **Mid**
 - **Small Bowel Series aka Small Bowel Follow Through (SBFT)** (NPO 6hrs prior or after MN)
 - pt drinks barium and various X-rays are taken when barium is in SI and pt's ab is "compressed" in various directions to isolate certain parts of the bowel for an image (good to follow partial obstructions, Crohn's, etc)
 - **Enteroclysis**
 - DHT tube is placed and barium is instilled into duodenum and X-ray is taken when barium is in SI (not done much anymore b/c of SBFT)
- **Lower**
 - **Barium/Gastrografin Enema** (clear liquids 1d prior, MgCitrate at 8pm, Dulcolax at 11pm, NPO after MN, Dulcolax at 7am, NB give the mucosal drying agent bisacodyl to help barium bind mucosa)
 - Indications: diverticular dz, strictures, fistulas

CT

- **Mech:** takes advantage of the different x-ray attenuation of tissues to generate an image w/ contrast b/t bone/air/fluid/soft-tissue (Hownsfield Units: Air (-200s), Fat (-100s), Water (0), Liquid (+10s), Soft Tissue (+100s), Bone (+200s))
- **Description:** hypo/hyperdense
- **First:** always look at scout image, change to appropriate window
- **NB Neuro:** MRI is better than CT except for bone and bleeds
- **Contrast**
 - Try to specify what you are looking for so the radiologist can time the contrast to hit the organ of interest, sometimes a multiphase study is done where images are taken before-arterial/during/after-venous contrast hits
 - Try to use both IV Contrast (all iodine based, Omni350 or Visipaque300 if high Cr but not as great opacification and very expensive, arterial phase 30sec vs venous phase 60sec vs delayed phase 5min) and PO contrast (Gastrografin/Barium or Volumin if doing CT enterography/colonography b/c not as opacifying and therefore good at looking at mucosal contour, give 2hrs before so that it can opacify small and large bowel)
 - **Allergy Pre-Med**
 - Tx: Methylprednisolone 32mg PO on the night prior to study and then 32mg PO and Benadryl 50mg PO 2hrs prior to study
 - NB there some belief that if you had a shellfish/iodine allergy that you would be at increased risk but this is a MYTH, 25% recurrent reaction if re-exposed, everyone feels warmth/flushing during infusion but this is not an allergy
 - **Nephropathy Pre-Med**
 - Tx: hydrate/alkalinize w/ 1amp NaHCO₃ in 1/2NS at 1mg/kg/hr for 8hrs prior and 8hr after, antioxidantize w/ NAC 600mg IV QD or PO BID x1d prior and x1d after
 - NB occurs <1-2d, peaks at 3-5d, resolves 7-10d, Mechanism: hyperosmolar damage to endothelium of small vessels, oxidative injury to tubular cells, etc, RFs: CKD (<1.5 ok contrast, 1.5-1.8 consider no contrast, >1.8 no contrast), DM, HTN, CHF, the higher the osm/volume of contrast, old females, hypovolemia), there is some evidence that Theophylline and Fenoldopam are helpful, nephro-benign contrasts are being developed that are low volume and hypo-osmotic
 - HOLD Metformin x48hrs
- **CTA/P Approach**
 - **Solid Organs**
 - Liver/Gallbladder (darker than liver) non-contrast phase, arterial phase (best for hypervascular lesions because they enhance more than the surrounding parenchyma), portal venous phase (parenchyma is enhanced), delayed phase (some lesions retain contrast eg. hemangiomas)
 - Adrenals (thin y shaped)
 - Kidneys, Ureter, Bladder
 - Spleen
 - Pancreas (follow from tail to head looking at duct, parenchyma, surrounding area)
 - Diaphragm Crus (big Y around aorta/spine), Peritoneum (line posterior to liver and anterior to kidneys)
 - **Viscus**
 - Start from anus and work your way proximally following colon (has air unlike SI) to Cecum/Appendix/TI
 - SI (typically no air, start in esophagus and work your way down to SI, hard to follow out just look at them overall specifically at wall thickness and mesentery)
 - **Vasculature** (arterial/venous/portal)
 - **Bone**
 - **Soft Tissue, Omentum, etc** (ascites is more dense then omentum/fat)
 - **LN's** (<1cm on short axis)
 - **Other** (fiducials are metallic beads used as markers to direct radiation)

MRI

- Mech: uses the different responses of nuclei in varying chemical environments to radiofrequency pulses and gradient coils to generate an image
- Description: hypo/hyperintense
- Contraindications: PM, metallic implants, metal in orbit
- give ativan prn or "CRNA to provide adequate sedation"
- NB MRI contrast aka gadolinium is rarely allergic unlike the iodinated contrast used for CT and it was thought to be nephro-benign but recently it has been associated with "nephrogenic systemic fibrosis" therefore even though not directly nephrotoxic it is not used in CKD pts
- T1 (bone is white, soft tissue is light grey (white matter) vs mod grey (grey matter), CSF/Water is dark grey, air is black) = look at anatomy
- T2 (CSF/Water is white, soft tissue and bone is mixed grey, air is black) = looks at pathology (GAD tells you how active inflammation)
- FLAIR aka FLuid Attenuation Inversion Recovery (hyperintense CSF signal in T2 interfere w/ interpreting edema aka "watery" pathology of tissue near ventricles therefore FLAIR is used to suppress CSF signal) = looks at pathology
- DWI aka Diffusion Weighted Images and ADC aka Apparent Diffusion Coefficient (assess the movement/restriction of movement of water, creates a very grainy grey image, good for differentiating types of edema: cytotoxic vs vasogenic)
 - Cytotoxic Edema from Acute (most acute change that can be seen on MRI) Ischemia = DWI (white) vs ADC (dark) while normal soft tissue is dark grey
 - Vasogenic Edema from Inflammation = DWI (white) vs ADC (normal/white)

Nuclear Scintigraphy (NPO after MN)

- 99m-Tc Tagged HIDA Scan (refer to biliary notes)
- 99m-Tc Tagged Octreotide Scan aka OctreoScan (refer to Carcinoid notes)
- 99m-Tc Tagged RBC Scan (refer to GIB notes)
- 99m-Tc Tagged Per technetate Scan aka Meckel's (refer to GIB notes)
- Gastric Emptying Study (refer to N/V notes)
- Liver-Spleen Scan
- Schilling Test (never done anymore)

The
Mantas
Manual



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