Gastrointestinal and Genitourinary Fluoroscopy

Educational Guideline

May 2017

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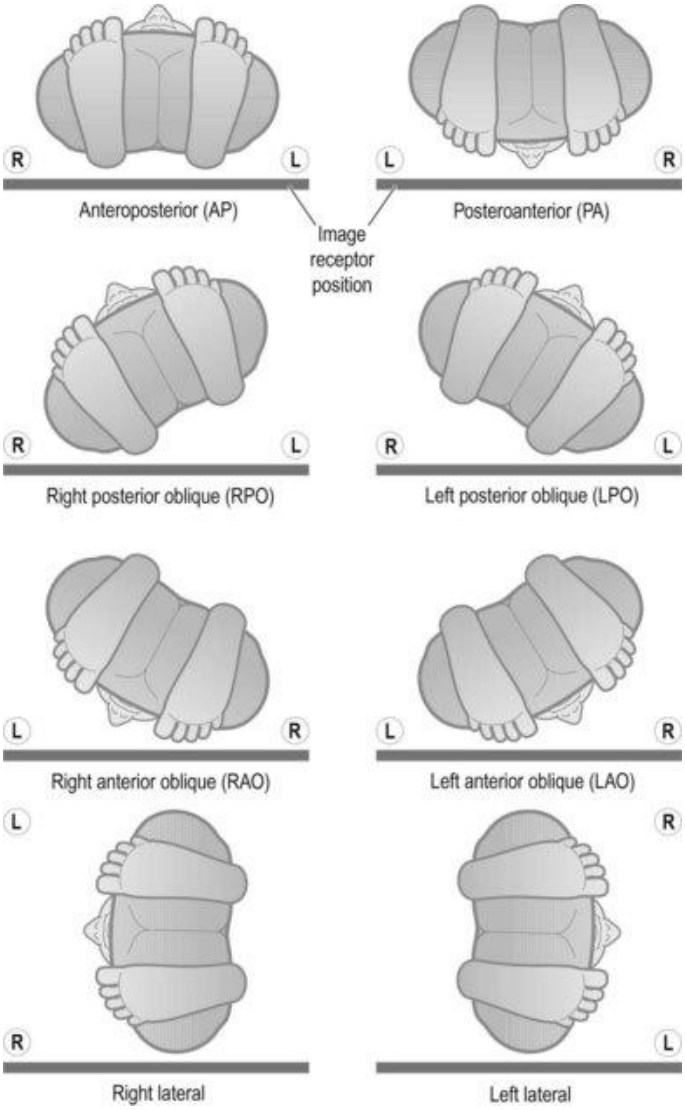
Terminology for patient positioning

- AP: Patient facing upward, away from image receptor (table)
- PA: Patient facing downward, toward image receptor (table)
- RPO: Patient facing upward, right posterior side of the patient is nearest the image receptor (table)
- LPO: Patient facing upward, left posterior side of the patient is nearest the image receptor (table)
- RAO: Patient facing downward, right anterior side nearest the image receptor (table)
- LAO: Patient facing downward, left anterior side nearest the image receptor (table)
- Right Lateral: Patient is 90 degrees to table with right side down
- Left Lateral: Patient is 90 degrees to table with left side down



References:

http://radiologykey.com/gastrointestinal-tract-4/
http://radtechsociety.blogspot.com/2012/11/anatomical-body-positions.html

General comments

Prior to most exams, in particular esophagogram, upper GI and small bowel follow through :

1. Review medical chart, including history, indication for exam, prior imaging and prior GI surgery.
2. Obtain / confirm a brief history from patient, including reason for exam.
3. Explain to patient what will be done during the procedure.

Exam title: <u>Double contrast esophagram</u>

Indications:
Pre-op, dysphagia, epigastric pain, to evaluate for GERD, hiatal hernia, tumors, ulcers, webs, and achalasia.

Contraindications:
Suspected esophageal perforation, suspected aspiration, suspected tracheoesophageal fistula, and evaluation of esophageal motility

Patient preparation:
None

Material needed:
1. Effervescent agent (usually carbon dioxide crystals) in small medicine cup
2. Small cup of water (15 ml)
3. Thick barium in cup (200- 250% weight/volume)
4. Thin (diluted) barium in cup with bendy straw (± 60 mL of regular barium (60% w/v) diluted with 60 mL of water)
5. Barium pill (optional)

Scout Radiograph:
None

Minimal required fluoro spot images:

Area to be evaluated	**Patient position**
Upper, mid and lower esophagus distended and collapsed	LPO - upright
Upper, mid and lower esophagus while drinking	RAO - prone
Evaluate for hiatal hernia - focus on GE junction	Prone
Evaluate for reflux	Supine oblique – evaluate with dry swallow, cough, Valsalva, and water siphon test
If suspected pharyngeal/ upper esophageal diverticulum	Frontal and lateral view of the pharynx/upper esophagus

Overhead images:
- Drinking esophagus

Additional Notes/Special Circumstances:
1. If patient has a history of surgery in the esophageal region, scout image should be performed to assess for surgical material
2. Have the patient stand on a footboard in the LPO position to offset the esophagus from the spine.
3. Instruct the patient to keep his/her left arm & the cup of barium lateral to the body so as not to be included in imaging
4. Have the patient take a small sip of the dense barium to become acclimated to its consistency. If the patient appears unable to tolerate the dense barium, change to a

single-contrast esophagram. Also, if there is food residue in the esophagus or obvious obstruction, change to single contrast.

5. Crystals first, followed by water to help swallow them, then thick barium.
6. If suspicion for pharyngeal abnormality, such as history of aspiration, dysphagia obtain images of pharynx and upper esophagus. Can use phonation or modified Valsalva (whistling or blowing through pursed lips) to distend pharynx.
7. If exam is otherwise normal, give barium pill (1/2 inch, 12.7 mm) as last step if history of sensation of food getting "stuck" or history of dysphagia.. Can also use barium pill to further evaluate a possible stricture seen on initial assessment.
8. Thin barium, single contrast portion performed while prone or slightly RAO.
9. Assess height of barium column when evaluating for reflux for severity.
10. If standing column of esophageal barium, watch, keep patient upright to prevent aspiration. Document near total emptying of esophagus before terminating

References:

- http://www.auntminnie.com/index.aspx?sec=ref&sub=wht&pag=dis&ItemID=52930.
- Levine, Marc S., Parvati Ramchandani, and Stephen E. Rubesin. Practical Fluoroscopy of the GI and GU Tracts. 1st ed. Cambridge: Cambridge University Press, 2012.

Exam title: <u>Single contrast esophagram (remote post op)</u>

Indications:
Remote post op patients, such as post Nissen fundoplication, post Toupet fundoplication, post esophagectomy, post esophageal dilation, and possible esophageal dysmotility.

Contraindications:
Suspected esophageal perforation, suspected aspiration, suspected tracheoesophageal fistula, and evaluation of esophageal motility

Patient preparation:
None

Material needed:
1. Thin barium in cup with bendy straw

Scout Radiographs:
AP or oblique centered over the surgical area/anastomosis

Minimal required fluoro spot radiographs:

Area to be evaluated	**Patient position**
Upper, mid and lower esophagus distended and collapsed	LPO - upright
Upper, mid and lower esophagus while drinking	RAO - prone
Evaluate for hiatal hernia (when appropriate)	Prone
Evaluate for reflux (when appropriate)	Supine
If suspected pharyngeal/ upper esophageal diverticulum	Frontal and lateral view of the pharynx/upper esophagus

Overhead images:
- Drinking esophagus

Additional Notes/Special Circumstances:
1. If patient has a history of surgery in the esophageal region, scout image should be performed to assess for surgical material
2. Instruct the patient to keep his/her left arm & the cup of barium lateral to the body so as not to be included in imaging
3. Thin barium, single contrast portion performed while prone or slightly RAO. Have patient take a single swallow to assess for complete primary peristaltic waves. Multiple rapid swallows can then be obtained to distend the esophagus and accentuate hiatal hernia.
4. Assess height of barium column when evaluating for reflux.
5. If standing column of esophageal barium, watch and don't let them aspirate.
6. Give barium pill (1/2 inch, 12.7 mm) if history of sensation of food getting "stuck" or history of dysphasia with initial evaluation being normal.

References:

- http://www.auntminnie.com/index.aspx?sec=ref&sub=wht&pag=dis&ItemID=52930.
- Levine, Marc S., Parvati Ramchandani, and Stephen E. Rubesin. Practical Fluoroscopy of the GI and GU Tracts. 1st ed. Cambridge: Cambridge University Press, 2012.

Exam title: <u>Single contrast esophagram (recent post op)</u>

Indications:
Recent post op patients, such as post esophagectomy and post Nissen fundoplication.

Relative contraindication:
Suspected aspiration, suspected tracheoesophageal fistula

Patient preparation:
None

Material needed:

1. Water soluble iodinated contrast (not to be given in patients with high risk of aspiration)
2. Thin barium in cup with bendy straw (optional)

Scout Radiographs:
AP or oblique centered over the surgical area/anastomosis

Minimal required fluoro spot radiographs:

Area to be evaluated	**Patient position**
Surgical area (assess for surgical material that might complicate interpretation of exam)	AP or LPO
Upper, mid and lower esophagus distended and collapsed	LPO (left posterior shoulder close to table) - upright
Additional images to maximize evaluation for possible leak if patient can tolerate	Supine and obliques, in the areas of anastomosis
Upper abdomen to evaluate passage of contrast into small bowel	Supine or upright

Overhead images:

- Drinking esophagus
- High KUB (standing if possible)

Additional Notes/Special Circumstances:

1. Instruct the patient to keep his/her left arm & the cup of barium lateral to the body so as not to be included in imaging
2. Can ask the patient to drink a few sips of water to exclude major aspiration.
3. Water-soluble contrast material first (if no aspiration, given that iodinated contrast can cause pulmonary edema), followed by thin barium (if major leak excluded).
4. Can obtain additional images on supine position to maximize evaluation of possible leak, in particular assessing the anastomotic sites.
5. Evaluate for gastric empting since there could be pyloric dysfunction as a complication of surgery.
6. Need documentation of contrast in proximal small bowel

References:

- http://www.auntminnie.com/index.aspx?sec=ref&sub=wht&pag=dis&ItemID=52930.
- Levine, Marc S., Parvati Ramchandani, and Stephen E. Rubesin. Practical Fluoroscopy of the GI and GU Tracts. 1st ed. Cambridge: Cambridge University Press, 2012.

Exam title: <u>Bi-phasic air contrast upper GI</u>

Indications:
Preoperative or remote postoperative evaluation, abdominal pain, epigastric discomfort, weight loss, malrotation. Requires patient cooperation, mobility, optimal prep, and preferably not too large for reasonable image quality.

Contraindications:
Suspected perforation, suspected aspiration, suspected tracheoesophageal fistula, and evaluation for dysmotility

Patient Preparation:
The patient should be NPO (nothing by mouth, not even liquids – need "dry" stomach) for 6 hours prior to the exam.

Material Needed:
1. Effervescent agent (usually carbon dioxide crystals) in small medicine cup
2. Small cup of water (10-15 ml); more water interferes with gastric wall coating by barium.
3. Thick barium in cup (200- 250% weight/volume)
4. Thin (diluted) barium in cup with bendy straw (± 60 mL of regular barium (60% w/v) diluted with 60 mL of water)
5. Barium pill (optional)

Scout Radiograph:
None

Minimal required fluoro spot radiographgs:

Area to be evaluated	Patient position
Upper, mid and lower esophagus distended and collapsed	LPO - upright
Gastric body and antrum	Supine/LPO (after patient rotates 360o on table)
Gastric cardia and fundus	Right lateral and RAO, prone
Duodenal bulb and sweep	LPO (prone if LPO suboptimal)
Upper, mid and lower esophagus while drinking	RAO – prone (motility, distensibility)
Evaluate for hiatal hernia	Prone (Valsalva)
Evaluate for reflux	Supine

Overhead images:
- Drinking esophagus
- RAO stomach
- Prone abdomen

Additional Notes/Special Circumstances:
1. Obtain scout image in setting of prior surgery.
2. Have the patient stand on a footboard in the LPO position to offset the esophagus from the spine.

3. Instruct the patient to keep his/her left arm & the cup of barium lateral to the body so as not to be included in imaging
4. Crystals first, followed by water to help swallow them, then thick barium.
5. Move table to horizontal position and have patient rotate at least 360 degrees to coat the stomach, ending in supine position. (work quickly to obtain optimal images before excessive gastric emptying occurs)
6. Obtain images of the stomach before prone evaluation of the esophagus given that contrast will progress into small bowel and obscure the stomach. . Always confirm adequate mucosal coating with barium before taking spot views; rotate or reposition as needed to optimize barium coating.
7. Thin barium, single contrast portion performed while prone or slightly RAO.
8. Assess height of barium column when evaluating for reflux.
9. Give barium pill if history of sensation of food getting "stuck" or history of dysphasia with initial evaluation being normal.

References:

- Levine, Marc S., Parvati Ramchandani, and Stephen E. Rubesin. Practical Fluoroscopy of the GI and GU Tracts. 1st ed. Cambridge: Cambridge University Press, 2012.
- http://www.auntminnie.com/index.aspx?sec=ser&sub=def&pag=dis&ItemID=53089
- http://www.med.uottawa.ca/radiology/assets/documents/gi_gu_imaging/articles/Double%20Contrast%20Upper%20GI%20ination%20–%20Technique%20and%20Interpretation.pdf
- http://www.uasom.uab.edu/PublicDocuments/Radiology/P&P/GI%20Protocols%20Revised_8-09.pdf

Exam title: <u>Single contrast upper GI (recent post op)</u>

Indications:
Recent post op patients, such as post gastric by-pass and post Nissen fundoplication.

Contraindications:
Suspected aspiration, suspected tracheoesophageal fistula

Patient preparation:
None

Material needed:

1. Water soluble iodinated contrast (not to be given in patients with high risk of aspiration)
2. Thin barium in cup with bendy straw (optional)

Scout Radiograph:
AP of epigastrium, including regions of anastomosis / surgery

Minimal required fluoro spot radiographs:

Area to be evaluated	**Patient position**
Surgical area (assess for surgical material that might complicate interpretation of exam)	AP or LPO
Upper, mid and lower esophagus distended and collapsed	LPO (left posterior shoulder close to table) - upright
Area of anastomosis such as gastric pouch, for possible leak or obstruction	Supine and obliques, in the areas of anastomosis
Upper abdomen to evaluate passage of contrast into small bowel	Supine

Overhead images:

- Drinking esophagus
- High KUB (standing, if possible)

Additional Notes/Special Circumstances:

1. Instruct the patient to keep his/her left arm & the cup of barium lateral to the body so as not to be included in imaging
2. If there is a high suspicion for aspiration, you can start by observing the patient swallow water to determine if aspiration is likely.
3. Water-soluble contrast first (if no risk of aspiration given that iodinated contrast material can cause pulmonary edema), followed by thin barium if major leak excluded and further evaluation required.
4. Can obtain additional images on supine position to maximize evaluation of possible leak, in particular assessing the anastomotic sites.
5. Evaluate for gastric empting since there could be pyloric dysfunction as a complication of surgery.
6. Need documentation contrast in proximal small bowel

References:

- http://www.auntminnie.com/index.aspx?sec=sup&sub=xra&pag=dis&ItemID=53089

Exam title: <u>Timed barium swallow</u>

Indications:
Achalasia patients who need assessment of esophageal emptying. In general, it is obtained prior to and after interventions.

Contraindications:
None

Patient preparation:
Fasting for 4 h.

Material needed:
-Low density barium suspension (45% weight/volume) - 100 to 250 mL

Scout Radiograph:
None

Minimal required fluoro spot radiographs:

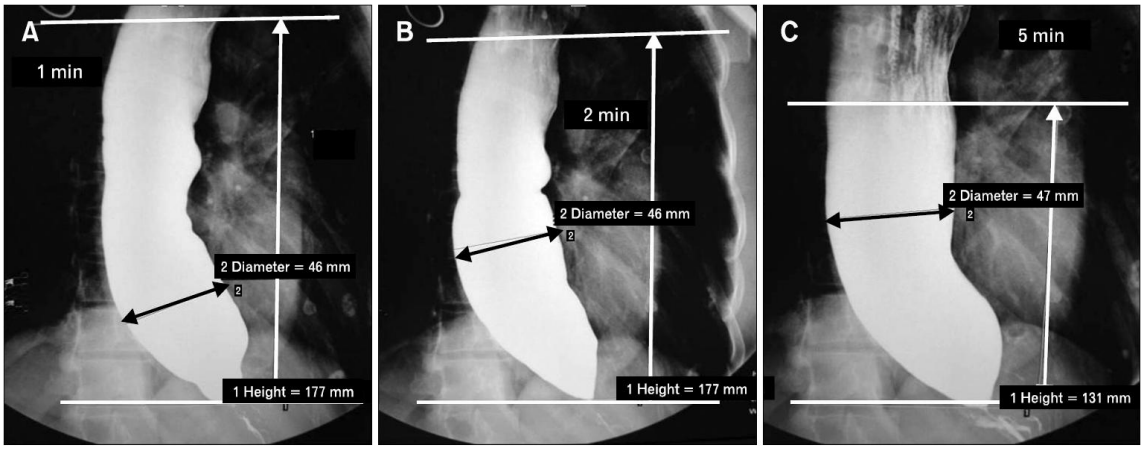
Area to be evaluated	Patient position
Upper, mid and distal esophagus – 1 min	LPO (left posterior shoulder close to table) - upright
Upper, mid and distal esophagus – 2 min	LPO (left posterior shoulder close to table) - upright
Upper, mid and distal esophagus – 3 min	LPO (left posterior shoulder close to table) - upright

Overhead images:
- None

Additional Notes/Special Circumstances:
1. Entire study is performed in the erect posture.
2. A low density barium suspension (45% wt by vol) is ingested within 15-20 seconds.
3. The volume of suspension (usually 100 to 250 mL) used for this study should be such that patient can tolerate it well without regurgitation or aspiration and the dilated achalasic esophagus can be filled adequately. It is better to have a fixed volume as a standard protocol.
4. Left posterior oblique films are taken 1, 2 and 5 minutes after barium ingestion.
5. The distance between the fluoroscope carriage and the patient is kept constant during all three spot films.
6. If barium completely clears from the esophagus on the 2- minute film, the 5-minute film may be omitted.
7. For sequential studies before and after treatment for achalasia, one should consume the same volume of barium as ingested for the baseline examination to have consistent results.
8. Two horizontal parallel lines are drawn to measure the height of barium column, one at the lowest and the other at the highest barium level and the distance between the two is measured (figure bellow). The superior aspect of the barium column is measured at a point where the margin is reasonably well defined at the barium and foam/food residue interface.
9. Width of barium column is the diameter of the esophagus measured at the widest part of the barium column perpendicular to the long axis of the esophagus.

10. Barium completely empties from esophagus in 1 minute in most and in 5 minutes in all healthy individuals.

Optional:
A lead ruler can be stuck to the table behind the patient to use as a reference for measurements.



Reference:
- Neyaz Z1, Gupta M, Ghoshal UC. How to perform and interpret timed barium esophagogram. J Neurogastroenterol Motil. 2013 Apr;19(2):251-6

Exam title: <u>Small bowel follow through</u>

Indications:
Melena, hematochezia, unexplained abdominal pain, suspected IBD, fistula, suspected partial small bowel obstruction, malabsorptive symptoms. Evaluation of small bowel abnormalities, such as diverticula, masses, extraluminal tethering, strictures, partial obstruction, and abnormal motility.

Note: Small bowel follow through only evaluates the bowel lumen, mucosa and transit time. CT enterography and MR enterography are better tests to assess the bowel wall and adjacent structures.

Contraindications:
Contraindications for barium SBFT including high risk for aspiration, complete bowel obstruction, paralytic ileus, recent postoperative status, left-sided colonic obstruction

Patient preparation:
The patient should be NPO (nothing by mouth) for 8 hours prior to the exam .

Material needed:
1. 500-1000 mL low density barium (28-42% weight/volume) in cup with bendy straw
   OR
2. Full concentration Omnipaque 240 water soluble iodinated contrast only used to exclude perforation (not to be given in patients with high risk of aspiration)
3. Palpation paddle with leaded glove

Scout Radiographs:
If no upper GI is being performed concomitantly, obtain scout KUB

Minimal required examination images:

Area to be evaluated	Patient position
Overhead radiographs of the abdomen with fluoroscopic evaluation every 15-45 minutes until the enteric contrast reaches the terminal ileum and enters the ascending colon	Supine; overhead SB films should generally be obtained prone if at all possible – this helps "separate" sb loops!!!

Additional Notes/Special Circumstances:
1. Small bowel follow through is a single contrast exam (oral contrast, either barium or water-soluble contrast), often performed after an upper GI fluoroscopic exam but may also be performed by itself..
2. The patient drinks 1-2 cups of the enteric contrast (barium or water-soluble), and a single contrast upper GI is performed.
3. After this, the patient drinks an additional 1-2 cups and waits outside the fluoroscopy suite.
4. After 15-30 minutes, an overhead radiograph of the abdomen is obtained and the patient is re-evaluated with fluoroscopy.

5. A spot radiograph with fluoroscopic re-evaluation is continued every 15-45 minutes until the enteric contrast reaches the terminal ileum and enters the ascending colon.
6. The patient is usually positioned during interval fluoroscopy for better evaluation of small bowel loops and paddle palpation is used to spread out bowel loops.
7. Normal small bowel transit ranges between 30-120 minutes.
8. SBFT, CT and MR enterography have been shown to be relatively equivalent in the assessment of active Crohn's disease. The ACR appropriateness criteria suggest CT enteography be the first line evaluation. MR enterography is preferred when there is the question of low-grade obstruction or when the clinician desires to assess response to immunomodulator therapy in the absence of patient symptomatology.[

References:

- https://radiopaedia.org/articles/small-bowel-follow-through
- http://www.uasom.uab.edu/PublicDocuments/Radiology/P&P/GI%20Protocols%20Revised_8-09.pdf
- http://www.slideshare.net/RobbinPoudyal/barium-follow-through-amp-small-bowel-enema-ranju
- Guimaraes L, Fidler JL, Fletcher JG, et al. Assessment of appropriateness of indications for CT enterography in younger patients. Inflamm Bowel Dis. 2010;16:226–232.
- American College of Radiology. ACR Appropriateness Criteria®. Available at: http://www.acr.org/secondarymainmenucategories/quality_safety/app_criteria.aspx.Accessed August 11, 2010.

Exam: <u>Double Contrast Barium Enema</u>

Indications:
Screening for colonic polyp or mass. Suspected malignancy or IBD. Diverticular disease, failed colonoscopy, non-specific abdominal pain.

Note: Double contrast barium enema has lower sensitivity and specificity than CT colonography (CTC) for the evaluation of colonic polyp and should only be used when CTC can not be performed (e.g. not approved for reimbursement).

Contraindications:
Toxic megacolon, pseudomembranous colitis, rectal or colonic biopsy or colonic procedure within the past 7 days.

Patient preparation:
1 Day Before Procedure

Breakfast: Patient may have a clear liquid breakfast: clear broth, fruit juice without pulp, soft drinks, Gatorade, black coffee, tea, and Jell-O that is not red.
12:00pm: Patient may have a clear liquid lunch: clear broth, fruit juice without pulp, soft drinks, Gatorade, black coffee, tea, and Jell-O that is not red.
1:00pm: Patient drinks one 8-ounce glass of water.
2:00pm: Patient drinks one 8-ounce glass of water.
3:0pm: Patient drinks one 8-ounce glass of water.
4:00pm: Patient drinks one 8-ounce glass of water.
5:00pm: Patient may may have a clear liquid dinner: clear broth, fruit juice without pulp, soft drinks, Gatorade, black coffee, tea, and Jell-O that is not red.
5:30pm: Patient drinks the 10-ounce bottle of Magnesium Citrate or use powder mixed as directed.
6:00pm: Patient drinks one 8-ounce glass of water.
7:00pm: Patient drinks one 8-ounce glass of water.
7:30pm: Patient takes the 4 Bisacodyl tablets with an 8-ounce glass of water.
8:00pm: Patient drinks one 8-ounce glass of water.
9:00pm: Patient drinks one 8-ounce glass of water.
Patient takes nothing by mouth after 9:00pm.

Day of Procedure:
2 hours before procedure: Patient inserts suppository by following the package instructions. Bowel evacuation usually occurs within 15-60 minutes.

Material needed:
1. Wide bore enema tip
2. Lubricant
3. 20% concentration barium in enema bag
4. Gas pump

Scout Radiographs:
Supine KUB scout radiograph before exam (If findings suggestive of large fecal burden, exam should be postponed).

Minimal required fluoroscopic spot images:

Area of Interest	Patient position
Rectum	LLD, supine, opposite lateral
Sigmoid	Supine, LPO
Descending Colon, Splenic Flexure	Upright RPO
Mid Transverse Colon	Supine +/- obliquities
Hepatic Flexure, Ascending Colon	Upright LPO
Cecum	Supine +/- obliquities

Overhead radiographs obtained by tech:
Post evacuation AP view of the abdomen.

- If further evaluation is required the technologist can obtain the following overheads:
RT lateral decubitus abdomen, cross-table
LT. lateral decubitus abdomen, cross-table
Cross table rectum
KUB
LPO angle (30 degrees ceph.) to include rectosigmoid
Prone Kub
Prone angle (30 degrees caud.) to include rectosigmoid

Additional Notes/Special Circumstances:

1. Double contrast barium enema is rapidly being replaced by CT colongraphy (CTC) and currently only used when CTC or colonoscopy can not be performed
2. Possible DRE in patients w/ history to suggest difficult tip placement.
3. Insert wide bore enema tip with patient LLD with knees pulled toward chest. Direct tip posteriorly as rectum parallels sacrum.
4. Routine use of enema tip balloon is unnecessary. Instruct patient to take slow deep breaths and hold enema tip.
    a. In those with poor anal tone, partially inflate balloon (90-100 mL) once tip is placed and under fluoro vizualization, pull back against sphincter to create "ball valve" mechanism.
5. Contrast is instilled in the colon by gravity. Begin in prone position. When barium reaches mid transverse colon, begin insufflating air. Do not allow air to get "ahead" of the barium column. Once barium reaches the hepatic flexure, place patient in right lateral decubitus position and continue insufflating air to move barium to cecum. Upright or semi-upright positioning can help barium drop all the way down to cecum.
6. Once contrast column reaches the hepatic flexure/ ascending colon, air should be pumped to push contrast into cecum and distend colon. Once barium reaches the cecum and colon is well-distended with gas, rotate the patient 360 degrees, once or twice, for optimal coating of the entire colon. Additional gas may need to be insufflated if patient is leaking.
7. Images should be obtained once colon is distend by gas. Selective spot views may be obtained by radiologist, but primary views are obtained with overhead tube.

References:

- Levine MS, Ramchandani P, Rubesin SE. Practical Fluoroscopy of the GI and GU Tracts. Cambridge University Press. 2012.
- http://www.uasom.uab.edu/PublicDocuments/Radiology/P&P/GI%20Protocols%20Revised_8-09.pdf

Exam: **<u>Single Contrast Barium Enema</u>** - No Hx of recent rectal surgery

Indications:
Obstruction, suspected or confirmed malignancy, IBS, change in bowel movements, abdominal pain. Less sensitive for detection of IBD or polyps (<1 cm) than double contrast enema.

Contraindications:
Toxic megacolon, pseudomembranous colitis, rectal or colonic biopsy or colonic procedure within the past 7 days.

Patient preparation:
If no obstruction is suspected clinically, a prep should be administered:

1 Day Before Procedure

Breakfast: Patient may have a clear liquid breakfast: clear broth, fruit juice without pulp, soft drinks, Gatorade, black coffee, tea, and Jell-O that is not red.
12:00pm: Patient may have a clear liquid lunch: clear broth, fruit juice without pulp, soft drinks, Gatorade, black coffee, tea, and Jell-O that is not red.
1:00pm: Patient drinks one 8-ounce glass of water.
2:00pm: Patient drinks one 8-ounce glass of water.
3:0pm: Patient drinks one 8-ounce glass of water.
4:00pm: Patient drinks one 8-ounce glass of water.
5:00pm: Patient may may have a clear liquid dinner: clear broth, fruit juice without pulp, soft drinks, Gatorade, black coffee, tea, and Jell-O that is not red.
5:30pm: Patient drinks the 10-ounce bottle of Magnesium Citrate or use powder mixed as directed.
6:00pm: Patient drinks one 8-ounce glass of water.
7:00pm: Patient drinks one 8-ounce glass of water.
7:30pm: Patient takes the 4 Bisacodyl tablets with an 8-ounce glass of water.
8:00pm: Patient drinks one 8-ounce glass of water.
9:00pm: Patient drinks one 8-ounce glass of water.
Patient takes nothing by mouth after 9:00pm.

Day of Procedure:
2 hours before procedure: Insert suppository by following the package instructions. Bowel evacuation usually occurs within 15-60 minutes.

Material needed:
1. Wide bore enema tip
    a. If remote history rectal surgery or J-pouch, use 22 French Foley Catheter (aka "red rubber")
2. Lubricant
3. 20% concentration barium in enema bag (use water soluble iodinated contrast material - 20-30% concentration Omnipaque 240 in enema bag if patient is obstructed or diverted)
4. Compression paddle and lead glove

Scout radiographs:

Supine scout radiograph before exam (If findings suggestive of fulminant colitis or large fecal burden, exam should be postponed).

Minimal required fluoroscopic spot images:

Area of Interest	Patient position
Rectum	LLD, supine, opposite lateral
Sigmoid	Supine, LPO
Descending Colon, Splenic Flexure	RPO
Mid Transverse Colon	Supine +/- obliquities
Hepatic Flexure, Ascending Colon	LPO
Cecum	Supine +/- obliquities

Overhead radiographs obtained by techs:
Post evacuation AP view of the abdomen

Additional Notes/Special Circumstances:

1. Do not perform within 7 days of procedure which compromises colonic mucosa, such as colonic biopsy, resection.
2. Possible DRE in patients w/ history to suggest difficult tip placement.
3. Insert wide bore enema tip with patient LLD with knees pulled toward chest. Direct tip posteriorly as rectum parallels sacrum.
    a. In patients with remote history of rectal surgery or J-pouch, use 22 French Foley Catheter (aka "red rubber")
4. Routine use of enema tip balloon is unnecessary. Instruct patient to take slow deep breaths and hold enema tip.
    a. In those with poor anal tone, partially inflate balloon (90-100 mL) once tip is placed and under fluoro vizualization, pull back against sphincter to create "ball valve" mechanism.
5. Contrast is instilled in the colon by gravity.
6. The single contrast barium enema, especially if evaluating for mass or polyp, requires manual palpation as barium flows through colon. Filling defects are often better seen when the amount of barium in the colon is small.

References:

- Levine MS, Ramchandani P, Rubesin SE. Practical Fluoroscopy of the GI and GU Tracts. Cambridge University Press. 2012.
- http://www.uasom.uab.edu/PublicDocuments/Radiology/P&P/GI%20Protocols%20Revised_8-09.pdf

Exam: <u>Single Contrast Water Soluble Enema</u> - Hx of recent rectal surgery or J pouch.

Indications:
Assessment for postoperative complication, such as leak or stricture, and before colonic reanastomosis or ileostomy take down.

Contraindicaionts:
Toxic megacolon, pseudomembranous colitis,

Patient preparation:
None

Material needed:
1. 22 French Foley Catheter (aka "red rubber")
2. Lubricant
3. 20-30% concentration Omnipaque 240 in enema bag

Scout radiographs:
LLD scout radiograph before exam to visualize the staple/suture line and to exclude pre-existing contrast collections.

Minimal required fluoroscopic spot images:

Area of Interest	**Patient position**
Rectum/J-pouch	LLD, supine, opposite lateral
Sigmoid	Supine, LPO
Descending Colon, Splenic Flexure	RPO

Overhead radiographs obtained by the tech:
Post evacuation AP view of the pelvis to further assess for leak

Additional Notes/Special Circumstances:
1. Possible DRE in patients w/ history to suggest difficult tip placement.
2. Insert 22 French Foley tip. Direct tip posteriorly as rectum parallels sacrum.
3. Instruct patient to take slow deep breaths and hold enema tip.
4. Evaluate for leak or stricture.

References:

- Levine MS, Ramchandani P, Rubesin SE. Practical Fluoroscopy of the GI and GU Tracts. Cambridge University Press. 2012.
- http://www.uasom.uab.edu/PublicDocuments/Radiology/P&P/GI%20Protocols%20Revised_8-09.pdf

Exam: **Defecography**

Indications:
Incomplete defecation, constipation, pelvic floor disorder, rectal prolapse, and fecal incontinence

Contraindications:
Postoperative rectum

Patient preparation:

1. The patient should drink 500 ml of thin barium upon arrival and wait 30-60 minutes before starting procedure so the small bowel is opacified.

Material needed:

2. 500 ml of thin barium
3. Thick barium paste
4. Large bore soft catheter (Miller catheter)
5. Three 60 ml syringes
6. Lubricant

Scout radiographs:
Left lateral decubitus with patient's knees to chest

Minimal required fluoroscopic spot images:

Area of Interest	Patient position
Rest imaging of the rectum and anus	Lateral
Squeeze imaging of the rectum and anus (Kegel maneuver)	Lateral
Straining imaging of the rectum and anus (as if they were about to defecate)	Lateral
Defecation imaging of the rectum and anus	Lateral
Postevacuation image with straining should be obtained to look for retained material or enterocoele	Lateral

Overhead radiographs to be obtained by the tech:
None

Additional Notes/Special Circumstances:

1. Contraindicated in postoperative rectum (e.g. coloanal anastomosis)
2. Before the exam takes place:
    a. Female patients
        i. Opacify small bowel with 500 ml of barium PO and wait 30-60 minutes
        ii. Opacify vagina with ~5 ml barium paste – EZ paste (should not be performed if the patient has never been sexually active)
    b. Male patients
        i. Opacify only rectum.

3. Rectal contrast administrations
    a. Patient in left lateral decubitus position
    b. 2-3 x 60 ml of thick barium paste is introduced into the rectum with a large bore soft catheter (Miller catheter) - three 60 ml syringes
    c. If the patient has an urge to defecate, the instillation of contrast can cease
4. Radioopaque marked placed in region of perineum

References:

- https://radiopaedia.org/articles/evacuation-proctography
- http://www.dirjournal.org/sayilar/32/buyuk/pdf_DIR_299.pdf
- http://www.radiologyassistant.nl/en/p4412ca5e2c21a/rectum-dynamic-examination.html

Exam : Cystogram.

Indications:
Evaluation for leak, fistula, VUR (recurrent or chronic UTIs), difficulty with/incomplete voiding, suspected urethral diverticula (primarily in females), bladder outlet obstruction, hematuria, trauma.

Contraindications:
Pregnancy, active clinical UTI, contrast allergy

Patient preparation:
Patient should have indwelling Foley catheter (technologist should contact primary team prior to exam to ensure this is placed).

Material needed:

1. Bottled Omnipaque 240 between 30-60% concentration. May need 2 or more bottles.
2. IV pole and gravity drip tubing.

Scout radiographs:
AP spot radiograph of the pelvis prior to filling. In postoperative patient, visualize staple/suture lines on scout.

Minimal required fluoroscopic spot radiographs :

Area of Interest	**Patient position**
Scout Radiograph	Supine
Partial filling (~50-100 mL)	Supine
Maximal distention (~300-600 mL)	Supine, right and left obliquities (lateral cross table, if posterior leak suspected)

Overhead radiographs to be obtained by tech:
Post evacuation

Additional Notes/Special Circumstances:

1. Newer Foley catheters have a side port: hook to that. If no sideport, unplug Foley bag and replace with gravity trip tubing with Christmas tree adapter.
2. Drain bladder completely prior to exam.
3. Fill until patient indicates discomfort. Distention of bladder until the time of detrusor contraction is essential to rule out small leaks. For high risk patients, consider performing the cystogram under fluorosocpic control.
4. If vesico-ureteral reflux is present, document extent.
5. At the end of the procedure place contrast bottle in dependent position to drain bladder prior to obtaining post evacuation images.

References:

- Levine MS, Ramchandani P, Rubesin SE. Practical Fluoroscopy of the GI and GU Tracts. Cambridge University Press. 2012.
- https://radiopaedia.org/articles/cystography-1

- http://www.acr.org/~/media/9c0d8c09790c45af85cc06f85bb0b0db.pdf

Exam title: <u>Hysterosalpingogram</u> (aka "tubogram")

Indications:
Infertility (assess uterine morphology and tubal patency), history of tubal occlusion.

Contraindications:
Pregnancy, active pelvic infection, recent uterine or tubal surgery.

Patient Preparation:
1. If OB/GYN present, will place the cannula/catheter into the endometrial cavity.
2. If no OB/GYN present (aka "rad-to-do"), radiology resident will place the cannula/catheter.
3. Patient should not be pregnant and exam should preferably be performed on days 5-12 of their menstrual cycle.
4. If there is concern that the patient is pregnant, a pregnancy test should be done in the gynecologist's office.

Material needed:
1. 6Fr Foley catheter with balloon or metal cannula.
2. Water soluble iodinated contrast.

Scout Radiograph:
AP of the pelvis with Left/Right marker

Minimal required fluoroscopic spot radiographs:

View/ area to be evaluated	Patient position
Fluoro spot films (take several "fluoro stores" of tubes filling). Should have one proper image of uterus, others can be fluoro stores; otherwise keep fluoro time to a minimum!	Supine
Full exposures: Full uterine cavity, fallopian tubes and peritoneal spill (should be sufficient to show free spill ('regional peritoneogram')	Supine or left posterior oblique when evaluating left tube and right posterior oblique for right tube
Full exposure: Full uterine cavity, taken immediately after the balloon is let down to show the entire uterine cavity full of contrast, unobstructed by the catheter balloon – the OBGYNS request this view, need to coordinate timing with them)	Supine

Overhead radiographs to be taken by tech:
None

Additional Information/Special circumstances:

1. Rad to-do steps: Prime the 6Fr Foley catheter with saline to clear bubbles, do the speculum exam , clean the cervix with iodine, cannulate the uterus, and inject the contrast while someone else does the fluoro
2. OB-GYN to do steps: Mag up. Take a scout with a Left/Right marker before they inject (then tell OBGYN ok to start). Intermittent fluoro during tube filling. Full exposure to document free spill. Full exposure when they let down the balloon. Can have them oblique to try to help the tube spill (left posterior oblique when evaluating left tube and right posterior oblique for evaluating right tube - roll the patient towards the blocked tube).
3. If unclear whether or not contrast has spilled – take obliques to evaluate for loculated spill.
4. Post Essure placement: take magnified view of the uterine cornua and tubal region in LPO and RPO, once cornua are maximally distended.

References:

- Simpson WL, Beitia LG, Mester J. Hysterosalpingography: a reemerging exam. Radiographics. 26 (2): 419-31.
- Chalazonitis A, Tzovara I, Laspas F et-al. Hysterosalpingography: technique and applications. Curr Probl Diagn Radiol. 38 (5): 199-205.
- http://www.hcp.essure-us.com/assets/pdf/250-018-0001-13d_ect_process_for_e-use.pdf

Exam title: Abscessogram

Indications:
Post percutaneous catheter drainage to evaluate for fistula, prior to catheter removal (usually when catheter output is equal or less than 5-10 cc/d of clear serous fluid).

Contraindications:
Contrast allergy, sepsis

Patient Preparation:
None

Material Needed:
1. One bottle of Omnipaque 300, 50 ml
2. 20cc Luer lock sterille syringe
3. Alcohol swab
4. Sterile Specimen Cup
5. Pad on table

Scout radiographs:
AP and lateral scout radiographs of the area of interest

Minimal required fluoroscopic spot radiographs:

Area to be evaluated	Patient position
Scout radiograph in the area of the catheter tip	Supine (to be obtained by technologist)
Region around catheter tip after initial injection	Supine
Region around catheter tip after more contrast administration	Right and left obliques; or laterals

Overhead radiographs to be obtained by tech:
None

Additional Notes/Special Circumstances:
1. Review prior images for possible site/ organs with which the fistula may communicate.
2. Review scout image to identify possible residual radiopaque contrast material or surgical material .
3. Clean catheter 3-way with alcohol swab and connect the syringe.
4. Always acquire oblique views with 90-degree difference or supine and lateral views.
5. Aspirate or remove residual contrast at conclusion of exam.
6. If the catheter is to stay in after the procedure, flush the catheter with saline

References:

- http://www.uasom.uab.edu/PublicDocuments/Radiology/P&P/GI%20Protocols%20Revised_8-09.pdf

- http://individual.utoronto.ca/ecolak/gi_techniques/techniques/sinograms_fistula_studies/sinograms.htm

Exam title: Sinogram/Fistulogram

Indication:
Evaluation of a known fistula or sinus tract

Contraindications:
Contrast allergy, sepsis

Patient Preparation:
None

Material Needed:

1. One bottle of Omnipaque 300, 50 ml
2. 60cc Cath Tip syringe
3. Sterile Specimen Cup
4. 8 Fr. Or 10 Fr. Rob Nel Catheter
5. Pad on table
6. Surgilube
7. Blue chux

Scout radiographs:
AP and lateral scout radiographs of the area of interest

Minimal required fluoroscopic spot radiographs:

Area to be evaluated	Patient position
Scout radiograph in the area of the skin opening	Supine (to be obtained by technologist)
Fistula/sinus tract after contrast injection	Supine
Fistula/sinus tract after contrast injection	Right and left obliques; or laterals

Overhead radiographs obtained by tech:
None

Additional Notes/Special Circumstances:

1. Review prior images for possible sites/organs with which the fistula/sinus tract may communicate.
2. Review scout image to identify possible radiopaque material such as residual contrast, surgical staples or other material .
3. Use the catheter to try to enter the fistula/sinus tract and inject contrast.
4. Always acquire oblique views with 90 degree difference or supine and lateral views
5. If the catheter is to stay in after the procedure, flush the catheter with saline

References:

- http://www.uasom.uab.edu/PublicDocuments/Radiology/P&P/GI%20Protocols%20Revised_8-09.pdf
- http://individual.utoronto.ca/ecolak/gi_techniques/techniques/sinograms_fistula_studies/sinograms.htm

Exam title: Gastrostomy or Jejunostomy tube check

Indications:
Malfunctioning G or J tubes

Contraindications:
Contrast allergy

Patient Preparation:
None

Material Needed:
1. One bottle of Omnipaque 300, 50 ml
2. Sterile Specimen Cup
3. Pad on table

Scout radiographs:
Lateral radiograph centered over tube

Minimal required fluoroscopic spot radiographs:

Area to be evaluated	Patient position
Region of tube tip after initial injection	Supine
Tube tip and adjacent bowel after more contrast administration	Right and left obliques; or laterals

Overhead radiographs obtained by tech:
None

Additional Notes/Special Circumstances:
1. Review scout image to identify possible residual radiopaque contrast material or surgical material
2. Always acquire oblique views with 90 degree difference or supine and lateral views
3. If the catheter is to stay in after the procedure, flush the catheter with saline

References:

- http://www.uasom.uab.edu/PublicDocuments/Radiology/P&P/GI%20Protocols%20Revised_8-09.pdf

Exam title: <u>Cholangiography</u>

Indications:
Evaluation of biliary tree after a surgically placed biliary catheter for possible residual stone, leak or stricture. Note. – Catheters placed by Angio/IR are evaluated by Angio/IR service

Contraindications:
Sepsis

Patient Preparation:
None

Material Needed:

1. Bottled Omnipaque 240 between 30-60% concentration
2. Sterile syringe
3. Alcohol swab

Scout radiographs:
AP scout radiograph of the right upper quadrant

Minimal required fluoroscopic spot radiographs:

Area to be evaluated	Patient position
Scout radiograph in the area of the biliary tube (right upper quadrant)	Supine (to be obtained by technologist)
Biliary tube tip after initial injection	Supine
Biliary tube tip after more contrast administration	Right and left obliques; or laterals

Overhead radiographs obtained by tech:
None

Additional Notes/Special Circumstances:

1. Review surgical notes and prior images to understand the anatomy.
2. Review scout image to identify possible residual radiopaque contrast material or surgical material.
3. Aspirate contrast in the syringe and remove all the air (so as not to simulate filling defects).
4. Clean biliary tube with alcohol swab and connect the syringe with contrast material. Sterile technique is important.
5. Always acquire oblique views with 90 degree difference or supine and lateral views.

References:

- http://www.uasom.uab.edu/PublicDocuments/Radiology/P&P/GI%20Protocols%20Revised_8-09.pdf

Exam title: Video swallow

Indications:
Aspiration

Contraindications:
None

Patient Preparation:
None

Material needed (Prepared by the speech pathologist team):
- Varibar Thin Liquid
- Varibar Nectar
- Varibar Thin Honey
- Varibar Pudding

Scout radiographs
None

Minimal required fluoroscopic spot radiographs:

View/ area to be evaluated	Patient position
Lateral view of the pharynx after swallowing materials with different consistencies	Sitting
Brief screening of the esophagus for out patients	Frontal

Overhead radiographs obtained by tech:
None

Additional Information/Special circumstances:
1. Brief screening of the pharynx and esophagus in out patients

References:

- https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0ahUKEwjoksDb27LPAhUJQCYKHcKICqQQFgguMAI&url=http%3A%2F%2Fwww.springer.com%2Fcda%2Fcontent%2Fdocument%2Fcda_downloaddocument%2F9781493911080-c1.pdf%3FSGWID%3D0-0-45-1470460-p176760859&usg=AFQjCNHYe2iZqQOz0gECfzwdd-TQ1Y0Bfg&bvm=bv.134052249,d.dmo&cad=rja
- Belafsky PC, Kuhn MA. The Clinician's Guide to Swallowing Fluoroscopy. Springer. New York. 2014. (available as e-book via countway library)

Exam title: <u>Fluoroscopy-guided placement of naso- enteral feeding tubes*</u>

Indications:
-Primary team failed several (2-3) good faith attempts to place the enteric tube in an awake patient.
- Patients awake and alert, but with decreased or absent cough reflex, in which an attempted has failed or if it is deemed unsafe to place on the ward.
(Exceptions to these indications can be considered on a case-by-case basis, but would likely require an attending-to-attending discussion of the specific details.)

Note: , Bellow there is an appendix with a guideline for placing the tube on the ward without image guidance – which can be shared with primary team when needed.

Contraindications:
. If the patient is comatose, obtunded, or otherwise unable to cooperate sufficiently, it is suggested that these patients be referred to Gastroenterology for placement with endoscopy, or referred to bronchoscopy.
. If the tube cannot be passed beyond the nasal passages at the bedside (e.g. choanal atresia or other obstruction), fluoroscopic guidance will not help with this problem.
.

Patient Preparation:
None

Material needed:
- Feeding tube with guide wire (usually 10-French Corflo Entera, NG/NI feeding tube with Stylet, with 106 cm or 137 cm in length)
- Lubricant
- 60 ml syringe

Scout radiographs
None

Minimal required fluoroscopic spot radiographs:

View/ area to be evaluated	Patient position
Fluoro spot film as the tube in being advanced into mid esophagus to confirm it is not in the trachea	Supine
Fluoro spot film as the tube in being advanced into distal esophagus / stomach	Supine
Spot radiograph with the final tip position	Supine

Overhead radiographs obtained by tech:
None

Additional Information/Special circumstances:
- - The stocked for use tube comes equipped with a thin metal introducer wire, which helps passage by stiffening the otherwise floppy tube, and allowing for some degree of steering and torque

- The tube is usually placed nasally, advanced into the stomach while asking the patient to swallow as you pass the tube.
- Giving the patient a cup of water with a straw may help.
- Patients may gag but should not cough. If there is any coughing during this process, it is a warning sign that the tube may be in the airway rather than the esophagus.
- Once the tube is in the stomach, insufflate approximately 300cc of air into the stomach to help open the pylorus.
- Once the tube passes the pylorus, the tube is advanced and the stiffener wire is removed.
- If the tube cannot be advanced beyond the pylorus, leave it in the stomach, and consider using a pro-motility agent such as Reglan 10 mg IV for approximately 12-24 hours, and recheck KUB next day.
- In general, the tube is positioned at or just beyond the ligament of Treitz. A fluoro spot film is obtained to confirm proper position, the tube taped at the nose, and the patient is returned to the ward.
- To reduce radiation dose, it is recommended that the pulse rate of fluoroscopy be turned down once the tube is clearly in the esophagus and not the trachea (3 frames per second). Using the least magnification possible, collimating, and turning off the grid will also reduce dose.
- The exam is dictated stating procedure and outcome. A teaching physician's presence statement must be included in the report as for other interventional procedures. The statement, "Dr. (Teaching Physician's name) was present for the entire radiologic portion of the procedure", must be included.

*The entire policy can be found on GI manual. A summary of the policy in listed bellow.

Appendix: Steps for NG feeding tube placement in an awake patient without imaging guidance

Step 1:
Measure tube from tip of nose to subxyphoid process (about 30-35cm in most patients)

Step 2:
- Place tube through nares and ask patient to swallow as you pass the tube
- Giving the patient a cup of water with a straw may help
- *IMPORTANT Patients may gag but should not cough.

* If there is any coughing during this process, it is a warning sign that you may be in the airway rather than the esophagus

Step 3:
At 35 cm, STOP to confirm that tube is in esophagus and not main stem bronchus. Get a chest x-ray (EPIC code: XR.TH.CXRPOR).

*If the feeding tube follows the path of the trachea and continues into the R or L main stem bronchus, airway placement has occurred, and the tube should be pulled out and reinserted.

GI placement is confirmed if you see the tube continuing straight below the carina on chest x-ray
(without following a bronchus)

Step 4:
Once confirmed feeding tube is past carina then advance feeding tube to stomach, check placement by insufflating with air, and then insufflate ~300cc of air into stomach to help open pylorus

Step 5:
Advance feeding tube to about 80-100cm

Step 6:
- Leave guide wire in place and obtain an abdominal x-ray (EPIC code: XR.AB.ABD1).
- If tube is post-pylorus, secure tube to patient's nose
- If tube is not post-pylorus, reattempt to advance tube with guide wire in place. Can consider promotility agent either prior to feeding tube placement or after first attempt if not successful. Reglan 10mg IV.
- Recheck abdominal radiograph. If still not post-pyloric place patient on Reglan for ~12-24 hours and recheck abdominal radiograph next day*.

* When subsequent image is warranted after tube reposition, a new order has to be placed in EPIC.

Key Tips for Safety
- Measure nose to subxyphoid before starting
- Remove the tube at any point if any coughing
- Perform CXR at the point when at subxyphoid
- Do not rely on the sound of air insufflation to check correct position
- Always check the final X-ray reading before beginning tube feeds

Exam title: <u>Sitz Marker Study</u>

Indications:
Chronic constipation – estimate colonic transit time

Contraindications:
None

Patient Preparation:
Discontinue laxatives or enemas prior to taking the marker

Material needed:

- Capsule with radio-opaque markers (25 markers) administered orally by the GI team in the clinic.

Imaging Protocol (Single capsule-single radiograph technique):
Day 1: Capsule ingestion.
Day 6: Single KUB radiograph
END OF STUDY

Other protocols like single capsule-multiple radiograph technique (single capsule ingestion followed by serial daily radiographs) and multiple capsules technique (one capsule/day for three days followed by radiographs on days 4, 7 and 10) are not performed at BWH.

Things to be included in the report:

1. Presence or absence of markers on the radiograph
2. If present, number of markers by the segment of the colon

Interpretation:

- Normally >80% markers pass by Day 6 radiograph (≤5 markers).
- Delayed colonic transit time is defined as retention of >20% markers on Day 6 radiograph (>5 markers).
- If retained markers scattered all over the colon, the cause is colonic hypomotility or inertia.
- If retained markers seen only in the rectosigmoid region, the cause is functional outlet delay (rectal prolapse, anismus).

Additional Information/Special circumstances:

- Patients are instructed not to take any laxatives or enemas after ingesting the capsule

References:

- Kim ER, Rhee PL. How to interpret a functional or motility test - colon transit study. Journal of neurogastroenterology and motility. 2012;18(1):94-99.
- Lin HC, Prather C, Fisher RS et-al. Measurement of gastrointestinal transit. Dig. Dis. Sci. 2005;50 (6): 989-1004.
- Southwell BR, Clarke MC, Sutcliffe J et-al. Colonic transit studies: normal values for adults and children with comparison of radiological and scintigraphic methods. Pediatr. Surg. Int. 2009;25 (7): 559-72.

Technologists' role:

For fluoro studies, the x-ray technologist is an integral part of the team during the procedure. The technologist should actively participate in preparing the patient, collecting medical history, explaining the exam, positioning the patient, giving the patient contrast to hold and drink, turning contrast on or off for administration by gravity, assisting the patient with pillows, pads, foot rests, etc. The technologist can also assist by positioning the fluoroscopy monitor and foot pedal.

- **Patient preparation**:
  . Bring patient to the room
  . Obtain a brief history from patient including reason for exam, prior fluoro studies, and prior GI surgery
  . Explain the procedure
  . Take scout images when appropriate, per outlines above

- **Scout images:**
  . Cystogram
  . Abscessogram
  . Enema

- **Overhead images:**
  . Obtain overhead images per protocols:
    a. Enema: Post evacuation AP view of the abdomen

- **For cystograms**:
  . Contact primary team prior to exam to ensure the patient has a Foley catheter placed before exam
  . Drain bladder completely prior to exam.