Interventional Radiology
Global Curriculum

ANDREW KESSELMAN MD
FABIAN LAAGE GAUPP MD
FRANCES COLGAN MBBS
1.1 US-Guided FNA (for thyroid or superficial LN) 3
1.2 US-Guided Core Biopsy (for solid organs) 4
1.3 Image-guided Lumbar Puncture 5
1.4 Percutaneous Image-guided drainage 6
1.4.1 Percutaneous drain exchange 7
1.5 Percutaneous image guided aspiration 8
2.1 Peripherally Inserted Central Catheter 9
2.1.1 Non-tunneled Central Venous Catheter 10
2.2 Inferior Vena Cava (IVC) Filter Placement 12
2.3 Inferior vena cava filter retrieval 14
3.1 Percutaneous Nephrostomy Insertion 15
3.2 Percutaneous cholecystostomy 16
3.3 Percutaneous Gastrostomy 18
4.1 Pelvic trauma embolization 19
4.2 Hepatic artery trauma embolization 20
4.3 Renal artery trauma embolization 21
4.4 Splenic Artery Trauma Embolization 22
4.5 Bronchial Artery Embolization 23
4.6 Inferior epigastric artery embolization 24
4.7 Pre-operative bland embolization 25
1.1 US-Guided FNA (for thyroid or superficial LN)

**Equipment**
- Ultrasound with usually linear probe
- Skin prep
- Sterile probe cover
- Core Biopsy Kit
- Local anesthesia
- 25g needle
- Sample/specimen pot
- Sterile skin dressing

**Indications**
- Obtain tissue for microbiological or pathological diagnosis

**Relative Contraindications**
- Coagulopathy (see introduction)

**Absolute Contraindications**
- No safe access to lesion

**Risks**
- Bleeding
- Infection
- Nerve damage
- Non-diagnostic sample

**Conconsiderations**
- Consider media for sample transport (this may require discussion with lab):
  - E.g., formalin if pathology sample, saline if microbiology for culture, MTM fixative for solid organ biopsies or cytorich red for FNA.

**Aftercare**
- Observe for a short period of time prior to discharge

**References**
- [https://link.springer.com/article/10.1007%2Fs00270-017-1658-5](https://link.springer.com/article/10.1007%2Fs00270-017-1658-5)
1.2 US-Guided Core Biopsy (for solid organs)

**Indications**
- Obtain tissue for microbiological diagnosis to guide treatment (biopsy may be diffuse or targeted - e.g. focal lesion within liver)

**Relative Contraindications**
- Coagulopathy (see introduction)

**Absolute Contraindications**
- No safe access to lesion

**Equipment**
- Ultrasound with usually linear probe
- Skin prep
- Sterile probe cover
- Core Biopsy Kit
- Local anaesthesia
- Sample/specimen pot
- Sterile skin dressing

**Risks**
- Bleeding
- Infection
- Nerve damage
- Damage to adjacent structures
- Non-diagnostic sample
- Organ specific risks (e.g. liver biopsy comes with risk of bile leak)

**Considerations**
- Liver biopsy in the presence of bile duct dilatation is more likely to result in bile leak and careful consideration should be given to performing biopsy in this case.
- Abdominal ascites may also increase the risk of bleeding complication and if liver biopsy is necessary this could be drained first to allow safe access.
- A continued bleed and instability may require angiography with possible embolization.
- Consider media for transport (formalin if pathology, saline if microbiology for culture)

**Aftercare**
- Patients rest in bed for 2 hours post procedure to reduce the risk of bleeding. Respiratory rate, blood pressure and heart rate should be monitored to allow any bleeding to be detected.

**References**
- [https://link.springer.com/article/10.1007%2Fs00270-017-1658-5](https://link.springer.com/article/10.1007%2Fs00270-017-1658-5)
1.3 Image-guided Lumbar Puncture

**Equipment**
- Standard or biplane fluoroscopy
- Basic Pack
- Basic LP Kit
- Local anesthesia
- Spinal needle (typically 20-22g of appropriate length)
- CSF Collecting vials
- Contrast (for myelography)
- Sterile skin dressing

**Indications**
- CSF Analysis
- Assessment of CSF pressure
- Access for intrathecal chemotherapy infusion
- Injection of contrast material for CY myelography
- Failed bedside attempt and/or
- Unlikely bedside success (patient position, scarring, deformity)

**Relative Contraindications**
- Medical instability
- Infection
- Pregnancy
- Contrast allergy (for myelography)
- Elevated

**Absolute Contraindications**
- Uncorrected coagulopathy or anticoagulation
- Elevated intracranial pressure
- Clinical findings suggestive of CSF flow obstruction
- Low-lying conus, tethered cord and myelomeningocele

---

**Risks**
- Cerebral herniation
- Cord compression secondary to hemorrhage into epidural or subarachnoid space
- Nerve injury
- Infection and meningitis
- Headache
- Epidermoid tumor of thecal sac

**Considerations**
- Review of pre-procedure imaging if available to assess level of conus
- Always advance or withdraw needle with stylet in place
- If post-procedural hemorrhage is suspected due to abnormal clinical findings, assessment for hematoma with MRI or myelography can be performed.
- Fluoroscopy (dose, field size and screening time) should be kept to a minimum in all patients, especially children and pregnant women.

**Modifications**
- Three standard approaches can be considered: Prone midline, prone oblique and lateral

**Aftercare**
- Bed rest for 1 hour (flat)
- No strenuous activity for 24 hours
- Hydration to prevent headache

**References**
- [https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Myelog-Cisternog.pdf](https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Myelog-Cisternog.pdf)
1.4 Percutaneous Image-guided drainage

**Indications**
- Alleviate pain/discomfort related to collection, treat infection or for sampling of infected material to direct antibiotic therapy

**Risks**
- Damage to adjacent structures depending on route used (e.g., pneumothorax; bowel perforation; biliary injury; bleeding; infection

**Alternative Interventions**
- Surgical washout
- Conservative management

**Considerations**
- Tube placement can be confirmed with the instillation of contrast. Fistulas can be identified with abscessogram.
- Fluoroscopy (dose, field size and screening time) should be kept to a minimum in all patients, especially in children and pregnant women.
- Locking or non-locking drains may be used. Non-locking drains, where used, should be sutured in place to avoid inadvertent removal.

**Technique**
- US guided, Fluoroscopy guided, US/fluoroscopy guided, CT guided
- SELDINGER: access to collection with dilation and insertion of drainage tube over the wire
- TROCAR (direct): Insertion of drainage tube in single pass

**Aftercare**
- Patients rest in bed for 2 hours post procedure to reduce the risk of bleeding. Respiratory rate, blood pressure and heart rate should be monitored to allow any bleeding to be detected
- Stitches should be removed at an agreed interval
- Twice daily tube drain rinse with 10 mL of normal saline
- Longer-term plan for drain removal or routine change should be agreed with the referring clinical team (usually when output lesse than 30 cc over two consecutive days)

**References**
- https://www.acr.org/-/media/ACR/Files/Practice-Parameters/PDFAC.pdf
1.4.1 Percutaneous drain exchange

**Indications**
- Replacement of existing percutaneous drain

**Relative Contraindications**

**Absolute Contraindications**

**Equipment**
- Ultrasound, fluoroscopy and/or CT
- Basic Pack
- Analgesia – IV Analgesics, local usually not required
- Guidewire
- Appropriate drainage tube
- Closure: Suture, drain-fix or sterile skin dressing

---

**Risks**
- This is a low-risk procedure if done correctly, owing to the drain track already being established. In friable tissue, e.g., pancreatitis, there is an increased risk of bleeding and infection.

**Considerations**
- Tube placement can be confirmed with the instillation of contrast.
- Fluoroscopy (dose, field size and screening time) should be kept to a minimum in all patients, especially in children and pregnant women.
- Locking or non-locking drains may be used. Non-locking drains, where used, should be sutured in place to avoid inadvertent removal. Their use and removal procedure should be clearly documented to aid clinical team at the time of removal.

**Technique**
- US guided, Fluoroscopy guided, US/fluoroscopy guided, CT guided
- Wire access to collection via existing drain, drain tube is removed over guidewire and replaced with a new one.

**Aftercare**
- Plan for drain removal or routine change should be agreed with the referring clinical team
- Consideration of definitive management of underlying condition
1.5 Percutaneous image guided aspiration

**Indications**
- Alleviate pain/discomfort related to collection
- Treat infection
- Sampling of infected material to direct antibiotic therapy

**Contraindications**
- Coagulopathy (target INR <2; Plt >25,000)
- No safe access to lesion

**Equipment**
- Imaging – Ultrasound, fluoroscopy or CT
- Basic Pack
- Local anaesthesia
- Sample pot/specimen form
- Access needle (18g–22g)
- Syringes

**Risks**
- Damage to adjacent structures depending on route used:
  - Pneumothorax
  - Bowel perforation
  - Biliary injury
  - Bleeding
  - Infection

**Alternative Interventions**
- Surgical washout
- Conservative management

**Considerations**
- Fluoroscopy dose, field size and screening time should be kept to a minimum in all patients (especially children and pregnant women).

**Technique**
- US guided, Fluoroscopy guided, US/fluoroscopy guided, CT guided
- Yueh or sheathed needle versus thin wall needle

**Aftercare**
- Respiratory rate, blood pressure and heart rate should be monitored to allow any bleeding to be detected.
- Clean dressings changes as needed

**References**
- [https://www.acr.org/-/media/ACR/Files/Practice-Parameters/PDFAC.pdf](https://www.acr.org/-/media/ACR/Files/Practice-Parameters/PDFAC.pdf)
2.1 Peripherally Inserted Central Catheter

**Indications**
- Central venous line for medications, IV infusion or venous sampling - likely duration 7 days to 3 months

**Contraindications**
- Patients with CKD and potential plan for AV fistula
- Coagulopathy
- Infection

**Relative Contraindications**

**Absolute Contraindications**

**Equipment**
- Ultrasound/fluoro
- Basic Pack
- Vascular access equipment including local anesthesia and tourniquet
- PICC Line kit
- Closure: Sterile skin dressing

**Risks**
- Bleeding, hematoma
- Infection
- Venous thrombus
- Migration or occlusion of PICC
- Injury to vasculature

**Alternative Interventions**
- SC or IJ CVC
- Midlines
- PIV

**Considerations**
- Nondominant arm preferred. Basilic vein typically chosen.

**Aftercare**
- Saline flush

**References**
2.1.1 Non-tunneled Central Venous Catheter

**Indications**
- Central venous line for medications, IV infusion or venous sampling - likely duration less than 7-14 days
- Temporary dialysis or apheresis

**Contraindications**
- Relative - coagulopathy (target INR <2; Plt >25,000)

**Equipment**
- Ultrasound/fluoro
- Basic Pack
- Non-tunneled catheter kit
- Vascular access equipment including local anesthesia
- Sterile skin dressing

**Risks**
- Bleeding, hematoma
- Infection
- Venous thrombus
- Injury to vasculature

**Alternative Interventions**
- Peripheral venous access

**Considerations**
- IJ access preferred. Subclavian and femoral can be considered for alternative access.

**Aftercare**
- Saline flush

**References**
- [https://link.springer.com/chapter/10.1007/978-3-319-40845-3_85](https://link.springer.com/chapter/10.1007/978-3-319-40845-3_85)
2.1.2 Tunneled central venous catheter

**Indications**
- Central venous line for medications, IV infusion or venous sampling - duration greater than 30 days
- Long term dialysis or apheresis

**Relative Contraindications**
- Relative - coagulopathy (target INR <1.5; Plt >50,000)

**Absolute Contraindications**
- Central venous occlusion

**Equipment**
- Ultrasound/fluoro
- Basic Pack
- Vascular access equipment including local anesthesia
- Guidewire
- Tunneled catheter kit
- Sterile skin dressing

**Risks**
- Bleeding, hematoma
- Infection
- Venous thrombus
- Injury to vasculature

**Alternative Interventions**
- Non-tunneled central venous catheter

**Considerations**
- IJ access preferred. Subclavian, femoral, transhepatic and translumbar routes can be considered for alternative access.

**Aftercare**
- Flush with saline or heparin

**References**
- [https://link.springer.com/chapter/10.1007/978-3-319-40845-3_87](https://link.springer.com/chapter/10.1007/978-3-319-40845-3_87)
2.2 Inferior Vena Cava (IVC) Filter Placement

⚠️ Risks
- Filter fracture or migration
- IVC occlusion
- Deployment outside target area
- Bleeding, infection, and damage to adjacent structures such as nerves, arteries or veins
- Risks of sedation/anesthesia

💡 Considerations
- Venous access options: Internal jugular veins or common femoral veins - dependent on filter type
- Cavogram utilized to assess the following before deployment:
  - Thrombus presence in IVC,
  - Caval diameter (typically <30mm)
  - Number and position of renal veins,
  - Presence of anatomic variant (eg duplicate IVC)
- Fluoroscopy (dose, field size and screening time) should be kept to a minimum in all patients, especially in children and pregnant women.

🔧 Modifications
- Suprarenal filter placement may be indicated for the following:
  - IVC thrombus precluding infrarenal placement or thrombus extension above previously-placed filter
  - Pregnancy
  - Gonadal vein thrombosis
  - Duplication/short length of infrarenal IVC
  - Extrinsic compression/intrinsic narrowing of infrarenal IVC
  - Need for intraoperative IVC mobilization
- Infrarenal IVC diameter between 30-40mm may require Bird’s Nest filter, and >40mm may require bilateral iliac vein filters
- Duplicate IVC may necessitate dual filter insertion

_matched aftercare
- Bed rest and observation in immediate post-procedural period, with monitoring of respiratory rate, heart rate and blood pressure, typically going home in <3 hours
- Clinical reassessment for appropriateness and timing of filter removal during first 3 months

Equipment
- Ultrasound and fluoro
- Skin prep
- Sterile probe cover
- Local anesthetics
- Access needle
- Guidewire
- Contrast
- IVC Filter
- Sterile skin dressing
References

- https://www.acr.org/-/media/ACR/Files/Practice-Parameters/ivc-filterplacement.pdf?la=en
2.3 Inferior vena cava filter retrieval

**Indications**
- Patient no longer at risk for PE / full anticoagulation possible
- Treat symptomatic IVC filter stenosis/thrombosis/penetration

**Relative Contraindications**
- Coagulopathy (target INR <1.5; Plt >50,000)

**Absolute Contraindications**
- Residual embolus within filter

**Risks**
- Injury (e.g. artery, IVC, nerve, viscera)
- Hematoma
- Infection

**Alternative Interventions**
- Various techniques including dual IVC/CFV access; filter mobilisation; endovascular forceps or lasers for complicated cases – see further reading
- Leaving the IVC filter in place

**Considerations**
- Fluoroscopy dose, field size and screening time should be kept to a minimum in all patients (especially children and pregnant women).

**Modifications**
- PCN can often be performed entirely under ultrasound guidance to reduce screening time. Tube placement can be confirmed with instillation of agitated saline.

**Aftercare**
- Patients rest in bed for 2 hours post procedure to reduce the risk of bleeding.
- Respiratory rate, blood pressure and heart rate should be monitored to allow any bleeding to be detected

**References**
3.1 Percutaneous Nephrostomy Insertion

**Indications**
- Relief of renal obstruction causing urosepsis
- Renal failure
- Intractable pain
- Urinary diversion
- Diagnostic procedure
- Access for endourologic procedure

**Contraindications**
- Coagulopathy
- Extreme hyperkalemia
- Hypotension
- Terminal illness with imminent death

**Absolute Contraindications**
- No safe renal access

## Risks
- Bleeding
- Infection
- Nerve damage
- Damage to adjacent structures

## Considerations
- Fluoroscopy dose, field size and screening time should be kept to a minimum in all patients (especially children and pregnant women).
- Careful review of any cross-sectional imaging is recommended to avoid causing damage to colon.
- A continued bleed may require embolization.
- Locking or non-locking drains may be used. Non-locking drains, where used, should be sutured in place to avoid inadvertent dislodgment.

## Modifications
- Direct puncture technique may be considered in patients with straightforward access to collecting system if guidewire/needle combination are available.
- PCN can often be performed entirely under ultrasound guidance to reduce screening time. Tube placement can be confirmed with instillation of agitated saline.

## Aftercare
- Bed rest for 4 hours post procedure with monitoring of vitals for signs of bleeding.
- Removal of stitches at agreed-upon interval.
- Long-term plan established with patient and primary team regarding drain removal or exchange.

## References
- [https://www.jvir.org/article/S1051-0443%2815%2901140-9/pdf?code=jvir-site](https://www.jvir.org/article/S1051-0443%2815%2901140-9/pdf?code=jvir-site)
- [https://www.acr.org/-/media/ACR/Files/Practice-Parameters/percutaneous-nephros.pdf?la=en](https://www.acr.org/-/media/ACR/Files/Practice-Parameters/percutaneous-nephros.pdf?la=en)
3.2 Percutaneous cholecystostomy

**Indications**
- Alleviate severe acute cholecystitis, empyema, pericholecystic abscess, cholangitis, biliary obstruction, cholelithiasis dissolution, or gallbladder perforation in patients deemed too high risk for surgery (e.g., age, comorbidities, malignancy, sepsis, pregnant)

**Contraindications**
- Coagulopathy (target INR < 1.5; Plt > 50,000)
- Iodine allergy (e.g., fluoroscopic-guided PC)
- Ascites
- Severe cholelithiasis
- Interposed bowel

**Absolute Contraindications**
- Coagulopathy (target INR < 1.5; Plt > 50,000)
- Iodine allergy (e.g., fluoroscopic-guided PC)
- Ascites
- Severe cholelithiasis
- Interposed bowel

**Equipment**
- Imaging - Ultrasound (curvilinear probe) fluoroscopy or CT
- Basic Pack
- Analgesics: IV and local
- Sample/specimen pot
- Access needle (22g-18g)
- Guidewire
- Cholecystostomy tube (5F-8F size; pigtail, cope loop, accordion)
- Dilators (for Seldinger)
- Closure: Suture or drain-fix
- Sterile skin dressing
- Optional: Cholangiogram

**Risks**
- Damage to adjacent structures depending on route used:
  - Pneumothorax
  - Bowel perforation
  - Biliary-cutaneous fistula
  - Bile leak > biliary peritonitis
  - Bleeding
  - Infection

**Alternative Interventions**
- Endoscopic ultrasound-guided gallbladder drainage with stents
- Cholecystectomy
- Conservative management

**Considerations**
- Tube placement can be confirmed with the instillation of contrast.
- Fluoroscopy (dose, field size and screening time) should be kept to a minimum in all patients, especially in children and pregnant women.
- Locking or non-locking drains may be used. Non-locking drains, where used, should be sutured in place to avoid inadvertent removal

**Technique**
- Transhepatic (common): catheter stability, reduces bile leakage, quicker maturation for the catheter track, preferred in patients with ascites or interposed bowel | higher risk of bleeding, pneumothorax, and fistula formation
- Anterior/Anterolateral transperitoneal: preferred in patients with diffuse liver disease or coagulopathy | approach precluded by friable gallbladder
- Seldinger: access to GB with dilation and insertion of cholecystostomy tube
- Trocar (direct): Insertion of cholecystostomy tube in single pass

**Aftercare**
- Patients rest in bed for 2 hours post procedure to reduce the risk of bleeding. Respiratory rate, blood pressure and heart rate should be monitored to allow any bleeding to be detected
- Stitches should be removed at an agreed interval
- Twice daily tube drain rinse with 10 mL of normal saline
- Longer-term plan for drain removal or routine change
should be agreed with the referring clinical team (usually 3–6 weeks).

References


3.3 Percutaneous Gastrostomy

**Indications**
- Enteral access for patients requiring long-term nutritional support for a variety of conditions

**Relative Contraindications**
- Coagulopathy (target INR <1.5; Plt >50,000)

**Absolute Contraindications**
- No safe access to stomach

**Equipment**
- Ultrasound with usually curvilinear probe
- Basic Pack
- Gastropexy Kit
- Medications: Analgesics, local anesthesia and glucagon
- Access needle (19g or sheathed needle)
- Guidewire (260cm + for pull type)
- Gastrostomy tube (14F–20F; Ponsky, MIC, pigtail)
- Dilators (for push type)
- Sample/specimen pot

---

**Equipment**

**Risks**
- Damage to adjacent structures (small bowel, colon)
- Bleeding
- Infection (possible peritonitis)

**Alternative Interventions**
- Surgical or endoscopic placement
- Parenteral nutrition

**Technique**
- Fluoroscopy guided, CT guided
- Push: Common to place gastropexy (1–4) followed by 14F catheter or 16–20F MIC gastrostomy tube
- Pull: Single access and 20F mushroom type gastrostomy with long taper advanced over the wire after access out of the oral cavity through the GE junction

**Considerations**
- Exchange can be made once track mature (6–8 weeks) for low profile or larger caliber tube.
- Fluoroscopy (dose, field size and screening time) should be kept to a minimum in all patients.
- Balloon assisted gastrostomy can be performed instead of serial dilatation of the track.

**Aftercare**
- Gastrostomy tube to remain to drainage for 6–24 hours prior to being cleared for feeds.
- Respiratory rate, blood pressure and heart rate should be monitored to allow any bleeding to be detected.
- Gastropexy should be removed at an agreed interval (7–10 days)

**References**
4.1 Pelvic trauma embolization

**Indications**
- Active bleeding after pelvic trauma
- Hemodynamic instability and pelvic fracture

**Contraindications**
- Uncorrectable coagulopathy

**Equipment**
- Fluoroscopy
- Procedure Pack
- Local anesthesia
- 5–6 Fr Introductory sheath
- 4–5 Fr Diagnostic and selective catheter (optional microcatheters)
- Guidewire (optional microwires)
- Contrast
- Embolic agents (coils, plugs, gelfoam, etc.)
- Closure: Femoral Closure device, sterile skin dressing

**Risks**
- Rebleeding, persistent bleeding
- Non-target embolization
- Complications relating to access e.g. hematoma/thrombus/dissection

**Alternative Interventions**
- Conservative management
- Surgery

**Considerations**
- Empiric embolization of the internal iliac mostly used when there is diffuse bleeding, when multiple focal bleeding vessels exist, when patient is unstable, where site of bleeding not identified; however increased risk of gluteal ischemia with bilateral embolization
- Selective embolization preferred and performed for focal arterial source of bleeding

**Aftercare**
- Patients rest in bed post operatively with monitoring respiratory rate, blood pressure and heart rate should be monitored to allow any bleeding to be detected

**References**
4.2 Hepatic artery trauma embolization

**Indications**
- Active bleeding after penetrating or blunt trauma to the liver

**Relative Contraindications**
- Uncorrectable coagulopathy

**Absolute Contraindications**

**Equipment**
- Fluoroscopy
- Procedure Pack
- Local anesthesia
- 5–6 Fr Introductor sheath
- 4–5 Fr Diagnostic and selective catheter (optional microcatheters)
- Guidewire (optional microcatheters)
- Contrast
- Embolic agents (coils, plugs, gelfoam, etc.)
- Closure: Femoral Closure device, sterile skin dressing

**Risks**
- Rebleeding, persistent bleeding
- Non-target embolization
- Liver failure
- Complications relating to access eg hematoma/thrombus/dissection

**Alternative Interventions**
- Conservative management
- Surgery

**Considerations**
- Important to identify hepatic arterial variants
- If diffuse bleeding, when multiple focal bleeding vessels exist, when patient is unstable can consider non-selective lobar embolization with gelfoam
- Selective embolization preferred and performed for focal arterial source of bleeding
- If active extravasation or pseudoaneurysm of proximal branch can consider stent graft if feasible

**Aftercare**
- Patients rest in bed post operatively with monitoring respiratory rate, blood pressure and heart rate should be monitored to allow any bleeding to be detected
- Monitor liver function tests

**References**
4.3 Renal artery trauma embolization

**Indications**
- Active extravasation, pseudoaneurysm, AVF or enlarging perinephric hematoma after penetrating or blunt trauma to the kidney
- Refractory hematuria

**Relative Contraindications**
- Uncorrectable coagulopathy
- Hemodynamic instability

**Absolute Contraindications**

**Equipment**
- Fluoroscopy
- Procedure Pack
- Local anesthesia
- 5–6 Fr Introductory sheath
- 4–5 Fr Diagnostic and selective catheter (optional microcatheters)
- Guidewire (optional microwires)
- Contrast
- Embolic agents (coils, plugs, gelfoam, etc.)
- Closure: Femoral closure device, sterile skin dressing

**Risks**
- Rebleeding, persistent bleeding
- Non-target embolization
- Renal failure
- Complications relating to access eg hematoma/thrombus/dissection

**Alternative Interventions**
- Conservative management
- Surgery

**Considerations**
- Important to identify renal arteries including accessory and capsular branches
- Selective embolization needed to spare as much renal parenchyma as possible
- If active extravasation or pseudoaneurysm of proximal branch can consider stent graft if feasible

**Aftercare**
- Patients rest in bed post operatively with monitoring respiratory rate, blood pressure and heart rate should be monitored to allow any bleeding to be detected
- Monitor kidney function tests

**References**
4.4 Splenic Artery Trauma Embolization

**Indications**
- Active bleeding after splenic trauma
- Prevent delayed splenic rupture

**Contraindications**
- Hemodynamic instability requiring operative intervention

**Equipment**
- Fluoroscopy
- Procedure Pack
- Local anesthesia
- Introducer sheath
- Diagnostic Catheter (optional microwires)
- Guidewire (optional microwires)
- Contrast
- Embolic agents (coils, plugs, gelfoam, etc.)
- Suture or drain-fix
- Sterile skin dressing

**Risks**
- Rebleeding, persistent bleeding
- Splenic infarction / abscess
- Non-target embolization
- Bleeding
- Complications relating to access eg hematoma/thrombus/dissection

**Alternative Interventions**
- Conservative management
- Surgery

**Considerations**
- Proximal embolization mostly used when there is diffuse splenic bleeding, when multiple focal bleeding vessels exist, when patient is unstable, where site of bleeding not identified
- Distal embolization sometimes performed for focal arterial source of bleeding
- Pay attention to location of collateral supply to spleen to preserve splenic arterial supply and function (eg. left gastric artery; dorsal pancreatic artery)

**Aftercare**
- Patients rest in bed post operatively with monitoring respiratory rate, blood pressure and heart rate should be monitored to allow any bleeding to be detected

**References**
4.5 Bronchial Artery Embolization

**Indications**
- Massive hemoptysis: >300 mL/24 hours
- Recurrent bouts of moderate hemoptysis: >100 mL three times per week
- Chronic/slowly increasing hemoptysis
- Poor surgical candidates

**Relative Contraindications**
- Presence of spinal artery arising from bronchial artery
- Respiratory compromise (inability to lie flat)

**Absolute Contraindications**

**Risks**
- Spinal cord ischemia/transverse myelitis
- Chest pain
- Non-target embolization of esophagus
- Bleeding, infection, and damage to adjacent structures such as nerves, arteries or veins
- Inherent risks of sedation/anesthesia

**Considerations**
- Chest x-ray, CT scan and bronchoscopy can be utilized pre-procedurally to help determine likely location of hemorrhage and arterial anatomy
- Angiographic findings:
  - Active extravasation (only in ~10% of cases)
  - Vascular hypertrophy/tortuosity
  - Neovascularity/hypervascularity
  - Aneurysm formation
- Thoracic arterial contributions to the anterior spinal artery must be assessed to prevent spinal cord infarction

**Aftercare**
- Bed rest and observation in immediate post-procedural period, with monitoring of respiratory rate, heart rate and blood pressure
- Assessment for recurrence of hemorrhage

**References**
- [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3140255/pdf/sir28048.pdf](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3140255/pdf/sir28048.pdf)
- [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3036206/pdf/sir21043.pdf](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3036206/pdf/sir21043.pdf)
4.6 Inferior epigastric artery embolization

**Indications**
- Active bleeding

**Relative Contraindications**
- Coagulopathy (target INR <1.5; Plt >50,000)

**Absolute Contraindications**

**Equipment**
- Fluoroscopy
- Procedure Pack
- Skin prep
- Local anesthesia
- 5–6 Fr introducer sheath
- 4–5Fr diagnostic catheter (optional microwires)
- Guidewire (optional microwires)
- Contrast
- Embolic agents (coils, plugs, gelfoam, etc.)
- Closure: Suture/ drain-fix; Sterile skin dressing

**Risks**
- Rebleeding, persistent bleeding
- Non-target embolization
- Complications relating to access eg hematoma/thrombus/dissection

**Alternative Interventions**
- Conservative management
- Surgery

**Considerations**
- Can consider ipsilateral approach or contralateral approach depending on origin of the inferior epigastric artery.
- Avoid reflux of embolic into the common femoral artery

**Aftercare**
- Patients rest in bed post operatively with monitoring respiratory rate, blood pressure and heart rate should be monitored to allow any bleeding to be detected

**References**
4.7 Pre-operative bland embolization

**Risks**
- Non-target embolization
- Infection
- Complications relating to access eg hemATOMA/thrombus/dissection

**Alternative Interventions**
- Surgery without embolization

**Considerations**
- Isolate as many branches that supply lesion as possible with goal to obtain stasis.
- Recommend particle sizes between 300–900 microns

**Aftercare**
- Patients rest in bed post operatively with monitoring respiratory rate, blood pressure and heart rate should be monitored to allow any bleeding to be detected.

**References**

**Equipment**
- Fluoroscopy
- Procedure Pack
- Skin prep
- Local anesthetia
- 5–6 Fr introducer sheath
- 4–5Fr diagnostic catheter (optional microcatheters)
- Guidewire (optional microwires)
- Contrast
- Embolic agents (coils, plugs, gelfoam, etc.)
- Closure: Suture/ drain- fix; Sterile skin dressing