

Vascular Surgery Clinical Pathways

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About

This book is to be used as a resource for vascular surgery trainees as a quick reference in caring for the vascular surgery patient based on the most up to date available evidence.

Usage

The goal is to have this be a quick reference with clear citations of evidence for the perioperative management of the vascular surgery patient. Save this book in a place where you can find and navigate it easily.

Additional Resources

EVAR

Patients with AAA and straightforward anatomy most often undergo EVAR in the elective setting and patients often leave the next day. EVAR is more commonly used in the emergent or symptomatic setting and discharge is determined by patient stability and comorbidities.

Common Issues

1. **Femoral access issues** - the majority of procedures are performed with percutaneous access, but many require a cut-down and arterial repair if there are issues with large bore femoral access.
2. **Endoleak** - Most endoleaks should be corrected before leaving the OR, but some patients have small Type 1 or 2 endoleaks that can be watched and may seal on their own. It is important for the team to be aware of patients with ongoing leaks in the perioperative period.
3. **Acute graft syndrome** - Patients sometimes have a physiologic response to graft implantation that includes abdominal pain, fever, leukocytosis, and thrombocytopenia. These patients should have a traditional fever workup to rule out other causes of sepsis, but if more dangerous etiologies are ruled out, this can be managed conservatively.
4. **Colonic ischemia** - The IMA is covered in all of these procedures. Rarely, this results in colonic ischemia. This presents with worsening abdominal pain, bloody stools and signs of sepsis. Immediate management should be resuscitation and endoscopy.

Post-op Pathway

POD 0

- Level of care: Stepdown
- Diet: Comorbidity specific diet
- Activity: Bedrest overnight
- Labs:
 - PACU: CBC, Chem 7 depending blood loss and comorbidities

- AM: CBC, Chem 7
- Nursing:
 - Neurovascular checks bilateral lower extremities
- Medications
 - Pain control – non-opiates often sufficient
 - Cardiac – restart home BP medications
 - Antibiotics - 24hr perioperative abx (Ancef 2g q8 x2 doses)

POD 1-Discharge

- Level of care: Transfer to floor status or discharge home
- Activity: OOB with assistance and ambulate TID
- Wound care: Remove groin dressings

Complex EVAR (Zfen, PMEG, Parallel graft)

Patients with complex thoracoabdominal aneurysms with significant comorbidities can be repaired with custom fenestrated endovascular devices. This can be done as a standalone procedure or as part of a staged repair of a more extensive aneurysm. Disposition for these patients is often limited more by their comorbidities instead of the procedure themselves.

Common issues

1. **Femoral access issues** – the majority of procedures are performed with percutaneous access, but many require a cut-down and arterial repair if there are issues with large bore femoral access. If you are called to evaluate determine hemodynamic stability of the patient, presence of hematoma, ecchymosis, pseudoaneurysm or active bleeding. Most can be solved with additional pressure but may require a skin stitch or further evaluation with imaging.
2. **Endoleak** – Most endoleaks should be corrected before leaving the OR, but some patients have small Type 1 or 2 endoleaks that can be watched and may seal on their own. It is important for the team to be aware of patients with ongoing leaks in the perioperative period.
3. **Acute graft syndrome** – Patients sometimes have a physiologic response to graft implantation that includes abdominal pain, fever, leukocytosis, and thrombocytopenia. These patients should have a traditional fever workup to rule out other causes of sepsis, but if more dangerous etiologies are ruled out, this can be managed conservatively.
4. **Colonic ischemia** – The IMA is covered in all of these procedures. Rarely, this results in colonic ischemia. This presents with worsening abdominal pain, bloody stools and signs of sepsis. Immediate management should be resuscitation and endoscopy.
5. **Visceral arterial occlusion** – The SMA, Celiac and renal arteries are accessed and stented during these procedures. They should be followed

closely for signs of hepatic, mesenteric or renal ischemia.

6. **Spinal ischemia** – depending on the extent of the aneurysm these patients are at high risk for spinal ischemia. Preventative measures to reduce spinal ischemia include optimizing tissue oxygenation by avoiding anemia and hypotension and spinal drain placement. Important physical exam findings are hip flexion.

Post-op Pathway

POD 0

- Level of care: SICU
- Diet: NPO on maintenance IVF
- Activity: Bedrest
- Patient parameters
 - SBP 140-180, MAP 90
 - Hgb > 10
 - Plts > 100
 - INR < 1.4
- Labs:
 - SICU: CBC, Chem 7, LFTs, coags, lactate, ABG
 - AM: CBC, Chem 7, LFTs, coags, lactate, ABG
- Nursing:
 - Neurovascular checks bilateral lower extremities
 - Spinal drain monitoring
- Wound care
 - Ace wrap to arm if brachial access utilized.
- Medications
 - Pain – non-opiates often sufficient
 - Cardiac – Drips to maintain BP parameters, especially important if spinal drain in place and high risk for spinal cord ischemia
 - Antibiotics – 24hr perioperative abx (Ancef 2g q8 x2 doses)
 - Heme – DVT PPx, make sure to hold around the time of spinal drain removal.

POD 1-3

Advance with BP within range without drips and spinal drain removed

- Level of care: Transfer to stepdown
- Diet: Comorbidity specific diet
- Activity: Ambulate TID
- Wound care: Remove bilateral groin dressing.

TEVAR

Patients with thoracic aneurysms or type B dissections with significant comorbidities can be repaired with custom fenestrated endovascular devices. This can be done as a standalone procedure or as part of a staged repair of a more extensive aneurysm. Disposition for these patients is often limited more by their comorbidities instead of the procedure themselves.

Common issues

1. **Femoral access issues** – the majority of procedures are performed with percutaneous access, but many require a cut-down and arterial repair if there are issues with large bore femoral access. If you are called to evaluate determine hemodynamic stability of the patient, presence of hematoma, ecchymosis, pseudoaneurysm or active bleeding. Most can be solved with additional pressure but may require a skin stitch or further evaluation with imaging.
2. **Endoleak** – Most endoleaks should be corrected before leaving the OR, but some patients have small Type 1 or 2 endoleaks that can be watched and may seal on their own. It is important for the team to be aware of patients with ongoing leaks in the perioperative period.
3. **Acute graft syndrome** – Patients sometimes have a physiologic response to graft implantation that includes abdominal pain, fever, leukocytosis, and thrombocytopenia. These patients should have a traditional fever workup to rule out other causes of sepsis, but if more dangerous etiologies are ruled out, this can be managed conservatively.
4. **Colonic ischemia** – The IMA is covered in all of these procedures. Rarely, this results in colonic ischemia. This presents with worsening abdominal pain, bloody stools and signs of sepsis. Immediate management should be resuscitation and endoscopy.
5. **Visceral arterial occlusion** – The SMA, Celiac and renal arteries are accessed and stented during these procedures. They should be followed closely for signs of hepatic, mesenteric or renal ischemia.
6. **Spinal ischemia** – depending on the extent of the aneurysm these patients are at high risk for spinal ischemia. Preventative measures to reduce spinal

ischemia include optimizing tissue oxygenation by avoiding anemia and hypotension and spinal drain placement. Important physical exam findings are hip flexion.

7. **Retrograde dissection**
8. **Antegrade dissection**

Post-op Pathway

POD 0

- Level of care: SICU
- Diet: NPO on maintenance IVF
- Activity: Bedrest
- Patient parameters
 - SBP 140-180, MAP 90
 - Hgb > 10
 - Plts > 100
 - INR < 1.4
- Labs:
 - SICU: CBC, Chem 7, LFTs, coags, lactate, ABG
 - AM: CBC, Chem 7, LFTs, coags, lactate, ABG
- Nursing:
 - Neurovascular checks bilateral lower extremities
 - Spinal drain monitoring
- Wound care
 - Ace wrap to arm if brachial access utilized.
- Medications
 - Pain – non-opiates often sufficient
 - Cardiac – Drips to maintain BP parameters, especially important if spinal drain in place and high risk for spinal cord ischemia
 - Antibiotics – 24hr perioperative abx (Ancef 2g q8 x2 doses)
 - Heme – DVT PPx, make sure to hold around the time of spinal drain removal.

POD 1-3

Advance with BP within range without drips and spinal drain removed

- Level of care: Transfer to stepdown
- Diet: Comorbidity specific diet
- Activity: Ambulate TID
- Wound care: Remove bilateral groin dressing.

Open abdominal or thoracoabdominal aorta aneurysm repair

Patients usually stay for 5-7 days requiring a day or two in the ICU.

Common issues

1. **Visceral arterial occlusion** – The SMA, Celiac and renal arteries are accessed and stented during these procedures. They should be followed closely for signs of hepatic, mesenteric or renal ischemia.
2. **Spinal ischemia** – depending on the extent of the aneurysm these patients are at high risk for spinal ischemia. Preventative measures to reduce spinal ischemia include optimizing tissue oxygenation by avoiding anemia and hypotension and spinal drain placement. Important physical exam findings are hip flexion.
3. These patients are very high risk for standard peri-operative complications of pneumonia, DVT and wound infection. We should monitor closely and manage prophylactic measures aggressively.

Post-op Pathway

POD 0-1

- Level of care: SICU
- Diet: NPO on maintenance IVF
- Activity: Bedrest
- Patient parameters - keep attending updated on labs (normal or abnormal) and patient condition every 6-12hrs
 - SBP 140-180, MAP 90

10 OPEN ABDOMINAL OR THORACOABDOMINAL AORTA ANEURYSM REPAIR

- Hgb > 10
 - Plts > 100
 - INR < 1.4
- Labs:
 - q6hr CBC, Chem 7, LFTs, coags, lactate, ABG
- Nursing:
 - Neurovascular checks bilateral lower extremities
 - Spinal drain monitoring
- Wound care
 - Ace wrap to arm if brachial access utilized.
- Medications
 - Pain – Sedation/pain control per ICU
 - Cardiac – Drips to maintain BP parameters, especially important if spinal drain in place and high risk for spinal cord ischemia
 - Antibiotics – 24hr perioperative abx (Ancef 2g q8 x2 doses)
 - Heme – DVT PPx, make sure to hold around the time of spinal drain removal.

POD 2

- For the most part, the patient stays sedated and no major changes.
- Remove R femoral 5fr sheath with vascade

POD 3-4

- Neuro
 - Wean sedation and pain control
 - Keep spinal drain until thorough neuro exam completed and stable
- Cardiac
 - Pressors or antihypertensives to maintain SBP 140-180s, MAPs 90
 - Monitor for arrhythmias and start beta-blocker if pressure can tolerate
- Pulmonary
 - Wean to extubate
- GI
 - Keep NPO, no duo tube or feeding prior to extubation
 - GI prophylaxis while intubated
- Renal

- Follow hemodynamics and diuresis when pressures will tolerate
- Infectious disease
 - No antibiotics after initial 24hrs
- Heme - DVT PPx, make sure to hold around the time of spinal drain removal.
- Disposition - Transfer to step down and floor pending perioperative hemodynamics. PT/OT eval and mobilization encouraged.

12OPEN ABDOMINAL OR THORACOABDOMINAL AORTA ANEURYSM REPAIR

Carotid Endarterectomy or Carotid stenting (TCAR)

Most patients leave the next day after carotid artery procedures.

Common issues

1. **Stroke** - the most dreaded complication after the carotid intervention is an ischemic cerebral event either from intra-operative hypo-perfusion, dissection flap or embolization. Any neuro changes should be thoroughly evaluated and stroke should be ruled out if focal neurologic deficits persist.
2. **Bleeding** - Bleeding from the carotid incision has high morbidity due to compromise of the airway. Patients with increasing hematoma or signs of airway obstruction should be evaluated and escalated immediately.
3. **Cerebral hyperperfusion syndrome** – Patients with very tight stenosis or bilateral disease can develop hyperperfusion, which presents as headache and hypertension. This is very serious and if hypertension is not controlled can progress to seizures.

Post-op Pathway

POD 0

- Level of care: 7 Hudson North Stepdown
- Diet: NPO for 6 hours until the neuro exam is stable and then comorbidity specific diet
- Activity: Bedrest for 6 hours until neuro exam stable and then OOB and ambulate TID
- Labs: AM CBC and Chem 7
- Nursing:
 - Neuro checks for 6hrs postoperatively
 - Wound checks
 - D/C aline and foley at 6hrs if neuro checks stable

14 *CAROTID ENDARTERECTOMY OR CAROTID STENTING (TCAR)*

- Medications
 - Pain - non-opiates often sufficient
 - Cardiac - resume all home BP meds with hold parameters for SBP <120 and HR < 50. Order neo and Cardene drip to be available if SBP outside the range of 100 - 150. Very important to avoid hypo or hypertension.
 - Antibiotics – 24hr perioperative abx (Ancef 2g q8 x2 doses)
 - Heme - DVT PPx, ASA +/- Plavix (per attending/fellow) on day of surgery

POD 1

- Level of care: Transfer to floor or discharge home
- Wound care:
 - Remove dressing prior to discharge
- Medications - Ensure all home medications are restarted

Lower Extremity Angiogram - Diagnostic or therapeutic

We perform angiograms for many different reasons in vascular surgery, most frequently for peripheral vascular disease. We often access via the femoral artery, but can also access through the upper extremity or distal in the lower extremity. We sometimes perform debridements at the same time. The majority of patients can go back to their primary team or are discharged the same day pending management of comorbidities.

Common issues

1. **Femoral access issues** – the majority of procedures are performed with percutaneous access, but many require a cut-down and arterial repair if there are issues with large bore femoral access. If you are called to evaluate determine hemodynamic stability of the patient, presence of hematoma, ecchymosis, pseudoaneurysm or active bleeding. Most can be solved with additional pressure but may require a skin stitch or further evaluation with imaging.
2. **Graft occlusion** - Any increasing pain, change in neuro exam, or loss of signals in the operative extremity should be escalated quickly as this can be a sign of early graft failure which is likely a technical issue and can be salvaged if acted upon quickly.

Post-op Pathway

POD 0

- Level of care: Back to pre-operative service/room or discharged home
- Diet: Comorbidity specific diet
- Activity: Bedrest with HOB at 30 degrees for 4-6 hours depending on closure device and access size, to be determined by fellow or attending.
- Labs: None

16 *LOWER EXTREMITY ANGIOGRAM - DIAGNOSTIC OR THERAPEUTIC*

- Nursing:
 - Neurovascular and groin checks while in PACU
- Wound care
 - Remove dressings at 24hrs and can shower
- Medications
 - Pain - non-opiates usually sufficient
 - Restart all home medications
 - Heme - ASA, Plavix or AC load per attending/fellow pending placement of a stent

Thrombolysis

Thrombolysis is a technique required in acute limb ischemia and sometimes used in more chronic occlusions. These patients require a subsequent return to the OR for the management of thrombosis and underlying etiology. Patients remain in ICU for 24-48hrs and in the hospital for up to a week pending clinical course.

Common issues

1. **Bleeding** - catheter-based administration of TPA can cause system coagulopathy so these patients are monitored closely for bleeding with frequent labs and physical exams. Bleeding can present as bleeding from the access site, retroperitoneal hematoma, GI bleed or stroke.

Perioperative Pathway

Pre-op

- Medications
 - 10mg tPA bolus
 - tPA drip 12mg in 250cc - add comment "To be administered through the thrombolysis catheter, DO NOT mix until notified by the OR staff"
 - Heparin 300u - add comment "To be administered through the arterial sheath."

POD 0

- Level of care: SICU
- Diet: Clear liquids, advance to comorbidity specific diet on POC
- Activity: Bedrest
- Labs: q6 CBC, PTT, PT/INR, fibrinogen, active T&S at all times
- Nursing:
 - Neuro checks
 - Neurovascular checks of affected extremities

- Catheter care
 - Frequent exams for signs of bleeding
- Wound care
 - The access site is secured with ioban. Notify fellow/attending for signs of bleeding that are saturating access site dressing
- Medications
 - Pain - non-opiates usually sufficient, however if in the setting of acute ischemia, may need a PCA as the leg slowly revascularizes
 - Infectious disease - Keep patient on antibiotics while lysis catheter is in place.
 - Heme
 - * tPA 0.5-2 mg/hr through the thrombolysis catheter, need to remind SICU to reorder. Titrate per attending/fellow based on fibrinogen.
 - * Heparin 300 through the access sheath. This is not titrated based on PTT.
 - * No systemic anticoagulation.
 - * Can continue antiplatelet medications
- Additional
 - Should be carded and consented from angiogram/plasty/stent the following day.

POD 1

- Level of care: Return to OR, then stepdown or ICU (if catheter left in place)
- Diet: Comorbidity specific diet after procedure and thrombolysis catheter removed.
- Activity: Bedrest with HOB at 30 degrees for 4-6 hours depending on closure device and access size, to be determined by fellow or attending.
- Labs:
 - PACU: CBC, q6 PTT (if on heparin drip for systemic anticoagulation)
 - AM: CBC, Chem 7, PTT, PT/INR
- Medications
 - Heme - Anticoagulation per attending/fellow

POD 2-discharge

- Level of care: Floor status if no cardiac or bleeding events
- Activity: OOB ambulate TID
- Labs: AM CBC, Chem 7, PTT, PT/INR
- Wound care: All dressings should be removed, and dressing wound with dry gauze per patient preference
- Medications
 - Heme - transition to oral anticoagulation

Lower extremity bypass or open endarterectomy

Patients undergo bypass in the acute or elective setting. Patients usually stay for 3-5 days post-operatively.

Common issues

1. **Managing comorbidities** - These are often patients with significant comorbidities that often extend the post-operative course more than issues related to their surgeries. Close attention should be paid to their home medications and management of underlying cardiac disease, hypertension, diabetes or cerebrovascular disease.
2. **Bleeding** - These patients should be monitored closely for bleeding, particularly when on anticoagulation
3. **Graft occlusion** - Any increasing pain, change in neuro exam, or loss of signals in the operative extremity should be escalated quickly as this can be a sign of early graft failure which is likely a technical issue and can be salvaged if acted upon quickly.
4. **Wound infection** - Groin wounds are particularly prone to infection. We sometimes utilize Prevena VAC dressings over a closed wound to reduce the risk of infection. These wounds should be kept dry and evaluated daily to ensure no signs of dehiscence or infection. Unlikely to present in the immediate post-operative period, but should be kept in mind.

Perioperative Pathway

POD 0

- Level of care: Stepdown
- Diet: Comorbidity specific diet
- Activity: Bedrest overnight
- Labs:

- PACU: CBC, Chem 7 depending blood loss and comorbidities
 - AM: CBC, Chem 7
- Nursing:
 - Foley
 - Neurovascular checks per protocol
- Wound care
 - Elevate on 2 pillows
 - Dressing and ace wrapping is attending and patient specific
- Medications
 - Pain – standing Tylenol, PCA
 - Cardiac – restart home BP meds
 - Antibiotics – 24hr perioperative abx (Ancef 2g q8 x2 doses)
 - Heme – DVT ppx, aspirin 81
 - Plavix and AC pending attending discretion
 - Endocrine – Insulin CDI

POD 1

- Level of care: Floor status if no cardiac events overnight
- Activity: OOB with assistance, PT/OT evaluation for dispo planning
- Labs: AM CBC, Chem 7
- Nursing:
 - D/C Foley, DTV
 - Continue neurovascular checks
- Wound care
 - Takedown wrap
 - Leave dressing if no concerns for infection or bleeding, remove if any question
- Medications
 - Pain – transition to PO regimen
 - Cardiac – Continue home medications
 - Antibiotics – Stop if no signs of infection or distal signs of gangrene
 - Endocrine – titrate insulin after starting a diet

POD 2 - Discharge

- Activity: Ambulate TID
- Labs: AM CBC, Chem 7
- Wound care: All dressings should be removed, and dressing wound with dry gauze per patient preference
- Medications
 - Hep lock if possible
- Dispo planning
 - Follow up on PT/OT evaluation, coordinate potential rehab or
 - Patient education – signs, and symptoms of acute limb ischemia

Amputation

Length of stay is often limited by management of patient comorbidities. However, if well controlled, length of stay is usually 4-5 days pending adequate stump healing and evaluation by physical therapy.

Common Issues

1. **Wound infection or flap ischemia** – sometimes it is difficult to distinguish, and these can present with erythema and drainage. Both may require washout and revision and should be monitored closely.

Perioperative Pathway

POD 0

- Level of care: 7 Hudson North
- Diet: Comorbidity specific diet
- Activity: Bedrest
 - BKA: with knee immobilizer.
- Labs:
 - PACU: CBC, Chem 7 depending blood loss and comorbidities
 - AM: CBC, Chem 7
- Nursing:
 - Wound care: Dressing to be changed by MD
- Medications:
 - Pain - Standing non-opiate analgesics and PCA
 - Restart home medications
 - Heme - DVT prophylaxis
 - Infectious disease - Stop antibiotics after 24hrs if operative site is clean, even when amputations are performed for infection
 - * Bacteremia related to wound for which amputation is performed
 - continue antibiotics for 2 weeks to treat for bacteremia

POD 1-3

- Activity: OOB with assistance, PT/OT evaluation
- Medications
- Pain - Transition to oral medications with IV medications for breakthrough

POD 4

- Wound care: Ensure adequate pain control and remove dressings. Dry dressings only as needed. Evaluate leg for any pressure wounds and determine the need for immobilization

Split Thickness Skin Graft (STSG)

These are often done for patients where we have chronically been managing their wounds, have had multiple debridements. These may be wounds related to arterial disease, venous stasis, diabetes or trauma. Patients stay at a minimum of 4-5 days until the initial operative dressing is removed.

Common issues

1. **VAC malfunction** - most patients have a VAC coming out of the OR. Ideally, the VAC stays in place without manipulation until the reveal. If the VAC is malfunctioning it should be fixed ASAP and reinforced to ensure an adequate seal. If it cannot be repaired it can be removed under the observation of a senior or attending.

Perioperative Pathway

POD 0-3

- Level of care: Floor or pre-operative level of care, we often take these patients onto our service after STSG
- Diet: Comorbidity specific diet
- Activity: Bedrest, sometimes can be OOB with bathroom privileges
- Labs: AM CBC and Chem 7
- Wound care:
 - VAC at -125 mmHg at all times. Normal VAC care by bedside nurse.
- Medications
 - Pain control - MMA
 - Antibiotics - may need to continue abx in the perioperative period depending on the etiology of the underlying wound.
 - Heme - DVT ppx, restart blood thinners 24-48hrs post-operatively.

POD 4

- Activity: OOB and ambulate TID
- Wound care
 - Remove VAC on AM rounds and dry dressing

Dialysis Access

We have a high volume of patients undergoing surgery for permanent dialysis access. They either present as inpatient consults or outpatients who undergo same-day procedures.

Common issues

1. **Access maturation** – We often need to address the acute need for dialysis with temporary catheters until access matures. The earliest most surgical access can be used is 4-6wks post-operatively, but depends on maturation particularly for autogenous fistulas.
2. **Bleeding** – Access ulcerations or bleeding after access in HD can be vascular emergencies. Acute bleeding can often be controlled with a permanent figure of 8 stitch and a pressure dressing. Depending on the extent of ulceration or severity of bleeding, then the patient should either be taken emergently to the OR for ligation/revision or evaluated for central stenosis via ultrasound.
3. **Thrombosis** – these are often managed by medical teams and IR, but sometimes we are called to assist if it is relatively fresh access that we created.
4. **Steal syndrome** – presents as acute or chronic limb ischemia, often associated with worsening pain, motor or sensory deficits.

Perioperative Pathway

Pre-op

- Diet: NPO at midnight the night before the planned procedure
- Radiology: Bilateral upper extremity venous mapping
- Nursing:
 - Limb alert on the non-dominant upper extremity, remove all IVs

POD 0

- Level of care: Back to primary team or discharge to home
- Diet: Renal diet
- Activity: No heavy lifting in operated extremity
- Nursing: Neurovascular checks until discharge from PACU
- Wound care: All dressings should be removed, and dressing wound with dry gauze per patient preference

POD 1

- Wound care: All dressings should be removed, and dressing wound with dry gauze per patient preference