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Evaluation and Management of a Patient with Acute Limb Ischemia

Description of the Activity	Acute ischemia of either the upper or lower extremities is a common problem managed by vascular surgeons. All vascular surgeons must have a comprehensive understanding of the etiology and management approach for acute limb ischemia, including diagnostic techniques, medical management, and open and endovascular surgical interventions. Additionally, all vascular surgeons should understand perioperative management, including recognition and treatment of complications of surgical intervention, needed follow-up, and surveillance strategies.

Functions	Nonoperative/Preoperative
	
	❖ Synthesize essential information from a patient's referring providers, records, history, physical examination, and initial diagnostic evaluation to develop a differential diagnosis.
	❖ Perform a timely, cost-effective, evidence-based diagnostic evaluation to confirm and grade the degree of ischemia, the anatomic extent of the disease, and the underlying etiology.
	❖ Recognize complications of acute extremity ischemia requiring emergency revascularization.
	❖ Determine whether revascularization is indicated and the timing of intervention.
	  ❖ Recognize clinical scenarios in which revascularization is not indicated and major amputation or palliative care should be considered.
	❖ Synthesize the optimal medical management and preoperative optimization of the patient's comorbidities in preparation for revascularization, including the role of anticoagulation and its contraindications.
	❖ Select a surgical approach consistent with a patient's anatomy, comorbidities, and symptoms.
	❖ Counsel a patient regarding the durability of potential revascularization procedures and the prognosis for limb salvage versus the likelihood of amputation.
	❖ Obtain informed consent. Describe the indications, risks, benefits, alternatives, and potential complications of the planned operation, and ensure patient/caregiver understanding.
	❖ Synthesize an operative plan that demonstrates understanding of the operative anatomy, etiology, indications, contraindications, risks, benefits, alternatives, and potential complications of:
	  ❖ Thrombectomy – both open and endovascular
	  ▪ Upper extremity
	  • Axillary
	  • Brachial
	  • Forearm
	  ▪ Lower extremity
	  • Aortoiliac
	  • Femoropopliteal
	  • Tibial
	  ❖ Revascularization – both open and endovascular
	  ▪ Upper extremity
	  ▪ Lower extremity

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- Fasciotomy
  - Upper extremity – forearm
  - Lower extremity
    - Calf
    - Thigh

Intraoperative

- Perform the endovascular procedures required for acute extremity ischemia with either thrombectomy or revascularization.
- Perform the open procedures required for acute extremity ischemia with either thrombectomy or revascularization.
- Integrate new information discovered intraoperatively or intraoperative complications requiring modification of the surgical plan or technique, such as:
  - ✓ Anastomotic stenosis
  - ✓ Distal embolization
  - ✓ Graft thrombosis
  - ✓ Inadequate arterial outflow
  - ✓ Reperfusion injury
  - ✓ Vasospasm
- Recognize the indications for decompressive fasciotomy, and perform upper and lower extremity fasciotomies as necessary.
- Work with anesthesia staff, nursing staff, and other perioperative health care professionals to create and maintain an intraoperative environment that promotes patient-centered care.

Postoperative

- Initiate and oversee postoperative care, including assessing the neuromuscular function of the extremity, prescribing appropriate medical therapy, and determining follow-up imaging and longer-term care.
- Communicate with the patient/caregiver(s) and members of the health care team to ensure understanding of postprocedure instructions and the patient's ability to carry out the resultant plan within the context of their life (eg, transportation, living situation, insurance, access to a pharmacy).
- Recognize, evaluate, and manage early and late complications following extremity revascularization.
  - ✓ Access site complications
  - ✓ Bleeding
  - ✓ Compartment syndrome
  - ✓ Infectious complication (access/surgical site and prosthetic material)
  - ✓ Recurrent extremity ischemia
  - ✓ Reperfusion injury

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	✓ Target lesion restenosis/occlusion with the potential need for reintervention ❖ Identify a surveillance plan and indications for reintervention.
Scope	In scope ❖ Lower extremity acute limb ischemia secondary to embolic or thrombotic disease Out of scope ❖ Acute limb ischemia secondary to trauma, including iatrogenic causes ❖ Adventitial cystic disease ❖ Arterial thoracic outlet ❖ Blue toe secondary to arterio-arterial microembolization ❖ Chronic critical limb ischemia ❖ Hemodialysis access–related ischemia ❖ Mycotic peripheral embolic secondary to endocarditis ❖ Popliteal entrapment ❖ Radiation arteritis ❖ Sciatic artery aneurysm ❖ Thromboangiitis obliterans (Buerger disease) Special Population ❖ Patients with: ✓ Acute aortic occlusion ✓ Acute lower extremity ischemia secondary to aortic dissection and malperfusion ✓ Acute lower extremity ischemia secondary to intra-arterial devices (eg, extracorporeal membrane oxygenation [ECMO]) ✓ Thrombosed aortic and peripheral aneurysms

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1 **Limited Participation** Demonstrates understanding of information and has very basic skills **Framework:** What a learner directly out of medical school should know The attending can show and tell.	• Elicits a history (acute onset/duration of symptoms) and performs a relevant vascular exam (absent pulses, motor/sensory deficits) • Prepares a patient for surgery by ordering labs (Cr, type and cross) and anticoagulation • Recognizes the need for operative intervention in a patient with ALI and indications for urgent vs emergent treatment	• Demonstrates understanding of sharps safety, safe use of devices, and surgical field sterility • Performs basic surgical tasks efficiently, including suturing and knot-tying • Demonstrates basic surgical skills, including making an incision and closure • Identifies potential crises (bleeding, dissection, vessel injury) that could occur during an open approach to ALI • Describes the potential for compartment syndrome after an open approach for ALI	• Demonstrates understanding of sharps safety, safe use of devices, and surgical field sterility • Uses US to visualize access vessels • Recognizes the importance of maintaining wire access • Identifies potential crises (loss of access, ruptured artery, dissection) that could occur during endo treatment of ALI • Describes the potential for compartment syndrome after an endo approach for ALI	• Describes risk factors for ALI, including AFib, DM, and smoking, recognizing that these factors can impact the outcome of interventions • Identifies a basic postop problem (pain, access site complication, compartment syndrome) and initiates management with supervision • Identifies critical data points for a postop hand-off (pulse/signal exam, anticoagulation plan) • Recognizes common patient safety issues unique to this population (in-hospital fall, medication error, narcotic overdose)
2 **Direct Supervision**	• Orders imaging and interprets findings, including a differential for underlying etiology	• Demonstrates respect for tissues (gentle handling of vessels) and developing skill in	• Uses US to obtain vascular access; demonstrates basic catheter and wire-handling techniques	• Formulates a postop plan that includes management of medical comorbidities and

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Demonstrates understanding of the steps of the operation but requires direction through principles and does not know the nuances of a basic case **Framework:** The learner can use the tools but may not know exactly what, where, or how to do it. The attending gives active help throughout the case to maintain forward progression.	• Ensures basic equipment is ready for an endo approach (US, entry kit, sheath, basic catheters) or an open approach (Fogarty embolectomy balloons, sutures); ensures the patient is prepped and positioned; recognizes the importance of C-arm positioning (R/L side) • Recognizes the need for urgent/emergent operative intervention and determines when a patient needs an open vs endo procedure	instrument handling (using a Castroviejo needle driver) • Performs parts of an anastomosis with frequent prompting and assistance • Describes most potential operative errors and intraop findings; needs assistance to demonstrate how to avoid errors • Describes findings with arterial injury, venous injury, and dissection that can be encountered during open treatment for ALI	• Describes radiographic and clinical findings with arterial rupture, embolization, or dissection that can occur during endo treatment for ALI • Describes most potential operative errors and intraop findings; needs assistance to demonstrate how to avoid errors • Describes findings with arterial injury, venous injury, and dissection that can be encountered during endo treatment for ALI	appropriate use of anticoagulation, antiplatelets, lytic infusions, and statins • Manages a common postop problem (anemia, change in pulse exam, compartment syndrome, hematoma), including ordering and interpreting additional testing • Coordinates patient care with the interprofessional team (nursing, pharmacy, PT, ICU, cardiology) • Guides care and instructs a patient (prescribes non-narcotic meds, advocates use of side rails, calls nurse to mobilize) to avoid common patient safety issues
3 **Indirect Supervision** Can do a basic operation but will not recognize	• Interprets physical exam and imaging results to determine a treatment plan (endo vs open [lysis, percutaneous vs open thrombectomy vs bypass])	• Demonstrates efficient instrument handling and safe exposure, dissection, and control of vessels	• Performs a diagnostic angiogram, efficiently traverses a stenosis, and delivers stents/balloons to the appropriate location	• Recognizes complications and side effects of antiplatelet and anticoagulation medications and the need for follow-up

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abnormalities and does not understand the nuances of an advanced case **Framework:** The learner can perform the operation in straightforward circumstances. The attending gives passive help. This help may be given while scrubbed for more complex cases or during a check-in for more routine cases.	• Anticipates unexpected challenges and recognizes the need for additional equipment when the preop plan is not progressing • Ensures all endo equipment (lysis catheters, devices) or open equipment is ready; ensures the patient is prepped widely and positioned to allow ease of procedure; recognizes the importance of C-arm positioning (R/L side) to facilitate the procedure • Develops a specific surgical plan for the clinical situation and identifies alternative treatment options	• Performs a complete thrombectomy (passes Fogarty with minimal tension until a negative pass), endarterectomy, anastomosis, and patch with minimal prompting and passive assistance • Describes an appropriate response to bleeding, venous injury, or dissection during open intervention for ALI	• Develops an endo plan (percutaneous or hybrid) with backup options if the initial plan fails; demonstrates understanding of device limitations based on a patient's anatomy and device instructions for use • Describes an appropriate response to loss of arterial access, dissection, embolization, or arterial rupture during endo intervention for ALI	• Manages a postop complication (target lesion/graft occlusion, compartment syndrome, bleeding), recognizing the need to return to the OR • Participates in analysis of patient safety events and analyzes complications • Coordinates the care of a post-ALI procedure patient with multiple services in a complex situation (periop MI, need for take-back, fasciotomy)
4 **Practice Ready** Can manage more complex patient presentations and operations and take care of most cases **Framework:**	• Synthesizes patient data, including medical comorbidities (COPD, DM, MI), and establishes a plan for endo or open intervention for ALI; independently determines the best treatment plan considering the patient's comorbidities and history (eg, revascularization vs	• Proficiently handles instruments and equipment, uses assistants, guides the conduct of the operation, and makes independent intraop decisions; anticipates when assistance is needed	• Plans and performs an intervention, including appropriate endo/thrombectomy device sizing and selection and alternate access (pedal, brachial) thrombectomy devices • Anticipates patient-specific complications during endo intervention for ALI	• Plans careful postop follow-up for a patient, including discussion of all aspects of risk factor modification, consultation as needed, and screening for comorbidities • Leads the team and provides supervision in the management of a

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The learner can treat all straightforward ALI cases and has a strong understanding of surgical options and techniques for less common scenarios. The attending is available at the request of the learner but is not routinely needed for common presentations, though input may be needed for more complex presentations.	amputation, hybrid intervention) • Independently determines the best alternative treatment when an initial revascularization plan is unsuccessful; ensures that appropriate equipment is available • Ensures the OR is set up appropriately for an advanced open intervention, including a plan for bypass conduit if needed • Adjusts a plan for intervention based on evolving preoperative information (eg, change in level of ischemia)	• Anticipates patient-specific complications during an open intervention, including potential arterial and venous injury from redo operative fields and difficulty establishing inflow control due to calcification; describes appropriate management of these situations, including alternative exposures or incorporation of endo techniques	(potential arterial injury from small access, heavily calcified lesion, difficult iliac bifurcation, long lesion); describes appropriate management of the complication, including conversion to an open procedure • Adapts a management plan based on a change in a patient's anatomy or clinical situation (conversion to CTO or worsening ischemia), including from endo to open	complex complication (target lesion/graft occlusion, bleeding) • Leads multidisciplinary analysis and discloses a safety event to a patient/caregiver(s) • Ensures safe transition of care from the ICU to the floor and at discharge for a post-ALI procedure patient, including with other disciplines and specialties and in a complex situation

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