General Principles

• Vascular emergencies are secondary to:

- Disruption of a vessel wall
  - Blood loss
  - Hypotension - Shock

- Occlusion of a blood vessel
  - Ischemia
  - Tissue necrosis
General Principles

Management

• A: Airway, B: Breathing, C: Circulation

• Treat associated unstable or acute comorbidities or other life-threatening injuries
General Principles

Stop the bleeding

- Manual pressure
- Avoid clamping the bleeding vessel
- Avoid tourniquets
- Do no remove foreign bodies
General Principles

Treat and prevent shock

- Two Large-IV (16 gauge)
- Labs include coagulation
- Type and cross
- Volume infusion
  - Crystalloids
  - Blood
General Principles

Prevent further vascular or nerve injury
- Stabilize fractures
- Reduced joint dislocation
- Control bleeding

Minimize ischemia
- Keep ischemic legs horizontal
- Do not use torniquets
General Principles

Relieve pain
- Provide analgesia
- Keep in mind the patient’s hemodynamics

Early surgical consultation
- Trauma
- Orthopedics
- Cardiothoracic
- Vascular
- Plastics
General Principles

Vascular Emergencies

• **Bleeding**
  - Rupture aneurysm
  - Penetrating trauma
  - Infected/bleeding arterial graft

• **Thrombosis**
  - Acute limb ischemia
  - Acute mesenteric ischemia
  - Phlegmasia alba/cerulea dolens

• **Others**
  - Aortic dissection
  - Joint dislocation (knee)
Abdominal pain
Case

- 69 year old man presents to the ER with sudden onset of abdominal pain and near syncope
- PMH: Hypertension, CAD, hyperlipidemia, smoking
- On exam: BP: 82/50, diaphoretic
- No murmurs, pulses faint, abdomen distended with a pulsatile mass, femoral pulses intact, feet well perfused
Ruptured Abdominal aortic aneurysm

- Classic presentation: Abdominal/back pain, hypotension, with/without syncope, and a pulsatile mass
- Mortality used to be up to 50%
- EVAR era: mortality has decreased to 20%
Work up

- Labs: CBC, chemistry, coags, type and cross, transfused as needed
- FAST (focused assessment with sonography in trauma): Easy access, operator dependent
- CT angiogram:
  - Gold standard
  - Consider the hemodynamic status of the patient
  - Crucial for EVAR planning
Treatment

• ABC’s
• Permissive hypotension
• Fluid resuscitation, transfused as needed
• Imaging as patient’s condition allows
• Stable or volume responsive patients: CT angiogram
• Unstable patients:
  • Consider aortic balloon occlusion
  • Repair: Open vs Endovascular
• Where to go: Hybrid room: Capabilities for open and endovascular repair
Endovascular vs Open repair

- Endovascular repair when:
  - Adequate anatomy (47%-67%)
  - Availability of trained staff
  - Availability of equipment
  - Availability of the endograft
  - Availability of the interventionalist

- For the rest: Open repair
- None available: Transfer
Endovascular Repair

- Minimally invasive
- Can be done under local anesthesia (selective)
- Lower mortality
- Lower morbidity
- Less blood loss
- Shorter hospital stay
- Faster recover
Endovascular Repair

Aortic occlusion balloon

Endograft
Endovascular Repair

**Postoperative considerations**
- Abdominal compartment syndrome
  - Retroperitoneal hematoma
  - Ongoing bleeding from lumbar and IMA
  - Visceral edema
  - Suspect when: distended, firm abdomen, hypotension, increased peak airway pressures, decreased urine output, worsening renal function and increased bladder pressure
- Associated with 50 % mortality
- Treatment: Decompression laparotomy
Endovascular Repair

Postoperative considerations

• Ischemic colitis
  • Secondary to occlusion of the inferior mesenteric artery and inadequate collateral flow
  • Presents as bloody diarrhea and abdominal pain and leukocytosis
  • Dx: Flexible sigmoidoscopy
  • Management: NPO, IVF, IV abx, colectomy (advanced cases)
Endovascular Repair

Postoperative considerations
- **Endoleaks**
  - Persistent flow within the aneurysmal sac
  - Pressurization of the sac may lead to rupture
  - Types I – V
  - Treat immediately: type I and III
  - Treat type II if sac continues to expand
Open Repair
Ruptured Abdominal Aortic Aneurysm
Ruptured Abdominal Aortic Aneurysm
Ruptured Abdominal Aortic Aneurysm

Case resolution

- CT angiogram demonstrated a ruptured 7.4 cm AAA and retroperitoneal hematoma
- Treated with an endovascular repair under local anesthesia using aortic occlusion balloon
- Patient was discharged on postoperative day 2
- Follow up CT scans up to 18 months, no endoleaks, sac size decreased to 4.5 cm
Chest Pain
Case

• 51 year old female presents with several days of sharp/stabbing chest pain radiated to her back
• PMH: Hypertension on HCTZ
• Smoker 1 PPD/30 years
• Exam: BP: 170/74, HR 91
  • Anxious, abdomen non tender, symmetrical radial, femoral and pedal pulses
Differential Diagnosis

• Acute onset of chest pain
  • Cardiac
  • Vascular
  • Musculoskeletal
  • Gastrointestinal
• Concentrate in the acute threatening conditions
  • Myocardial infarction and aortic dissection
• Clues to aortic dissection
  • Genetic disorders: Marfan, Erlens-Danlos, and Loeys Dietz syndrome
  • Inflammatory syndromes
Work up

• Electrocardiogram: **Sinus tachycardia**

• CBC, CMP, amylase, lipase and troponins: **Normal**

• Consider toxicology screen
Work up

- Imaging
  - Computed tomography
Work up

• Imaging
  • Computed tomography
Diagnosis: Acute Aortic Dissection

• Incidence: 2.5 to 30 cases per million people
• Pathogenesis: Disruption of the intima and subsequent separation of the intima and media
• Classification timing
  • Hyperacute: < 24 hours
  • Acute: 24 hours to 2 weeks
  • Subacute: 2 to 6 weeks
  • Chronic: > weeks
Diagnosis: Acute Aortic Dissection

• Anatomic classification

Surgical Emergency
Consult CT surgery

Medical Therapy vs Intervention
Diagnosis: Acute Aortic Dissection

- Presentation
  - Sudden onset of chest, back or abdominal pain
  - Quality: sharp, stabbing, tearing

- Malperfusion
  - Abdominal pain
  - Peripheral numbness
  - Absent of distal pulses
Diagnosis: Acute Aortic Dissection

- Complicated
  - Malperfusion
  - Size > 5.5 cm
  - Annual increase in size > 4 mm
  - Aortic rupture
  - Failure of medical management: persistent hypertension and/or chest pain despite three agents
  - Hypotension: suggest rupture, malperfusion, cardiac involvement or intraabdominal catastrophe
Diagnosis: Acute Aortic Dissection

- Medical therapy
  - Admit to monitor setting
  - Blood pressure (<110 mmHg) and heart rate control (60/min)
    - Beta blockers IV: Esmolol, Labetalol
    - Calcium channel blockers
    - Nitropruside: reflex tachycardia
    - ACEI...
  - Serial abdominal exams
  - Serial labs: renal function and lactate
  - If medical therapy fails: malperfusion or refractory pain/hypertension
    - Conversion to endovascular or endovascular therapy
Diagnosis: Acute Aortic Dissection

• Endovascular repair
Diagnosis: Acute Aortic Dissection

- Open repair
Diagnosis: Acute Aortic Dissection

Aortic Dissections

Type A
- Open Heart Surgery

Type B
- Complicated
  - TEVAR
  - Open Repair
- Uncomplicated
  - Medical Therapy
Case resolution

- Blood pressure controlled with esmolol and nicardipine infusions
- HR decreased to 60/min and BP < 120 mmHg
- CT scan 24 hours: stable dissection
- Serial labs: stable Creatinine, amylase, lipase, and lactic acid level
- Examination within normal limits
- Transitioned to Oral agents
- Repeat images at 7 days: stable dissection
- Discharge and repeat images at 1 month, 3 months, 6 months and then annually
Leg Pain
Case

- 57 year old male patient with recent acute myocardial infarction 6 weeks prior, s/p PCI. He presents with right lower extremity pain and numbness for 5 hours
- Reports difficulty moving his leg
- No trauma
- PMH: Hypertension
- On exam: HR 140/min and irregular, BP 100/60
- Palpable femoral and pedal pulses on the left, absent in the right
- Right leg is cool, and mottled, with decreased sensation and motor function
- Laboratory: within normal limits
Acute Limb ischemia - Presentation
# Acute Limb ischemia - Classification

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description and Prognosis</th>
<th>Findings</th>
<th>Doppler Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Limb viable, not immediately threatened</td>
<td>Sensory Loss: None</td>
<td>Arterial: Audible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Muscle Weakness: None</td>
<td>Venous: Audible</td>
</tr>
<tr>
<td>II</td>
<td>Limb threatened</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIA</td>
<td>Marginally threatened, salvageable if</td>
<td>Sensory Loss: Minimal (toes) or none</td>
<td>Arterial: Often inaudible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Muscle Weakness: None</td>
<td>Venous: Audible</td>
</tr>
<tr>
<td>IIB</td>
<td>Immediately threatened, salvageable with immediate revascularization</td>
<td>Sensory Loss: More than toes, associated</td>
<td>Arterial: Usually inaudible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Muscle Weakness: Mild or moderate</td>
<td>Venous: Audible</td>
</tr>
<tr>
<td>III</td>
<td>Limb irreversibly damaged, major tissue loss or permanent nerve damage inevitable</td>
<td>Sensory Loss: Profound, anesthetic</td>
<td>Arterial: Inaudible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Muscle Weakness: Profound, paralysis (rigor)</td>
<td>Venous: Inaudible</td>
</tr>
</tbody>
</table>
Acute Limb ischemia

- Causes
  - Embolism
    - Thrombus
    - Atherosclerotic plaque
    - Tumors
  - Insitu thrombosis
    - Pre existent peripheral arterial disease
    - Hypercoagulable state
Work up

• Evaluate the patient overall condition and comorbidities
  • ABC’s
  • CBC, chemistry, coagulation profile, cardiac enzymes
  • Correct any abnormality as needed
  • EKG
  • ? Echocardiogram (should not delay your management)
Work up

- Confirm the diagnosis
  - Choose wisely. Consider degree of ischemia and availability of resources
  - ABI/PVR
  - Arterial duplex
  - Angiogram: diagnostic/therapeutic
  - CT angiogram with run off
  - MRA

Figure 1. Left common femoral angiogram demonstrating a hazy filling defect (arrow) in the profunda femoris, obstructing the ostium of the left superficial femoral artery.
Diagnosis and Treatment

• Case: Acute limb ischemia secondary to emboli in the setting of atrial fibrillation and inadequate anticoagulation, besides atrial fibrillation with rapid ventricular response
• Anticoagulation with heparin
• Rate control
• Cardiac enzymes are normal
• CTA abdomen and pelvis with run off
  • Acute thrombus in the right external iliac and common femoral artery with distal reconstitution, three vessels run off
Treatment

- Open thrombectomy under local anesthesia (recent myocardial infarction)
- If unsuccessful: femoro femoral bypass
Acute Limb Ischemia

Special considerations

- Fasciotomies: for advanced and prolonged ischemia
- Think about alternative sources of inflow
- Be ready for tibial thrombectomy
- Completion angiogram when necessary
Acute Limb Ischemia

**Case resolution**
- After open thrombectomy, extremity was reperfused
- Renal function and electrolytes remained normal
- Heparin was bridged to warfarin
Abdominal pain
Case

- 78 year old woman with history of atrial fibrillation, on warfarin, presents with sudden onset of severe abdominal pain and emesis
- PMH: no smoker, no alcoholic, no previous abdominal operation
- On exam: HR 111/min, BP: 89/60 mmHg
- Abdominal tenderness but no peritoneal signs, peripheral pulses are palpable
Differential diagnosis

- Extensive
  - Peptic ulcer disease
  - Acute pancreatitis
  - Acute cholecystitis
  - Acute diverticulitis
  - Acute urologic conditions
  - Acute bowel obstruction
  - Acute mesenteric ischemia
Work up

- CBC: elevated WBC
- Chemistry: normal creatinine
- Coagulation profile: subtherapeutic INR
Work up

- CT abdomen and pelvis
Acute Mesenteric Ischemia

**Emboli**
- History of atrial fibrillation
- Recent myocardial infarction
- Congestive heart failure
- Peripheral emboli

**Thrombosis**
- History of postprandial abdominal pain, weight loss

**NOMI**
- Critically ill
- Significant hemodynamic insult
Acute Mesenteric Ischemia

Embolism

- Most common (40%-50%)
- Sources:
  - Heart [arrhythmias, MI, Cardiomyopathy, Tumors], Most common
  - Endocarditis: Septic emboli
  - Aorta: mural thrombus, aneurysms
- Thrombus Lodges several cm from the origin
Acute Mesenteric Ischemia

Thrombosis
- 20-30%
- Preexistent atherosclerosis
- Hypercoagulable states
- **Affects the SMA origin**
- Usually symptoms of Chronic ischemia are present
- Mortality rate is higher than embolic ischemia
Acute Mesenteric Ischemia

Non Occlusive Mesenteric ischemia

- Impaired mesenteric perfusion in the absence of thromboembolic occlusion
- Atherosclerosis may be present
- Vasospasm is the main feature
- Usually very sick patients on several vasopressors
Acute Mesenteric Ischemia

Clinical – High index of suspicion
• Differential diagnosis is extensive
• Pain out of proportion of physical exam
• Abdominal distention, diarrhea, sepsis, GI bleeding
Acute Mesenteric Ischemia

**Laboratory**
- Hemoconcentration
- Leukocytosis
- High anion gap
- Lactic acidosis
- Elevated amylase, AST, LDH
- D-Dimer: exclusion
Acute Mesenteric Ischemia

Plain X-ray
- Thumbprinting
- Pneumatosis
- Bowel dilation

Duplex
- Can identify stenosis
- Not useful in acute mesenteric ischemia
Acute Mesenteric Ischemia

Computer Tomography
• High sensitivity and specificity
• Visualizes bowel and vasculature
• Biphasic: arterial and venous
• Findings suggesting bowel ischemia:
  • Bowel thickening
  • Pneumatosis
  • Portal venous gas
  • Decreased contrast enhancement
Acute Mesenteric Ischemia
Acute Mesenteric Ischemia
Acute Mesenteric Ischemia

Embolic

Thrombosis
Acute Mesenteric Ischemia

Angiogram
• Diagnostic: substituted by CT
• Therapeutic: NOMI
• Adjuvant in hybrid procedures

MRA: not useful in acute mesenteric ischemia
Acute Mesenteric Ischemia

Treatment
• ABC’s
• Fluid management
• Correct electrolytes
• Invasive monitoring
• Antibiotics
• Anticoagulation if not contraindicated
• Avoid vasopressors, never alpha agonists
Acute Mesenteric Ischemia

Endovascular

- Possible but limited use
- Thrombolysis and thrombectomy has been used
- Can not evaluate bowel viability
- Complex and long lesions can be challenging and frustrating
- Continuously evolving
Acute Mesenteric Ischemia

Surgical Management: Embolectomy
Acute Mesenteric Ischemia

Surgical Management: Bypass

- Celiac artery
- SMA
- Graft
- Aorta
- Vein graft
- Common Iliac artery
Acute Mesenteric Ischemia

Surgical Management: Hybrid
Acute Mesenteric Ischemia
Acute Mesenteric Ischemia
Acute Mesenteric Ischemia
Acute Mesenteric Ischemia

**Non occlusive mesenteric ischemia**

- Medical management
- Surgical exploration only if signs of bowel gangrene
- Endovascular: catheter directed intra arterial infusion of vasodilators: papaverin (30-60 mg/h), prostaglandin
Acute Mesenteric Ischemia

Case Resolution

- Patient underwent and open embolectomy
- Bowel was dusky but not necrotic
- Second look 24 hours later: viable bowel, abdomen closed
- Diet advanced
- Discharged to nursing home