



# Endovascular Infection

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# Outline

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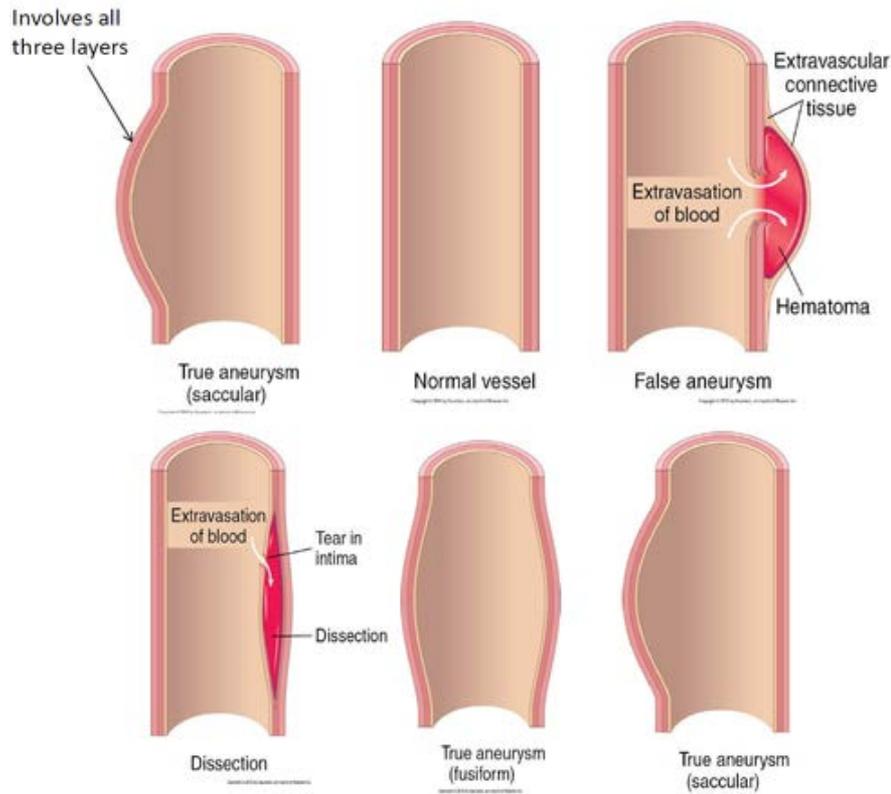
- **Mycotic aneurysm**
- **Suppurative thrombophlebitis**
  - Definition
  - Epidemiology
  - Risk factor
  - Pathogenesis
  - Microbiology
  - Diagnosis
  - Treatment



# Mycotic aneurysm

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# Definition



- An aneurysm is an abnormal focal arterial dilation
- True aneurysms: arterial dilatation involve all 3 layers of arterial wall (intima, media, adventitia)
- False or pseudo-aneurysm: arterial dilatation with disruption of one or more layers of its walls



# Definition

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- **Mycotic aneurysm** coined by Osler in 1885 to describe a mushroom-shaped aneurysm
- Mycotic aneurysm still used for all aneurysms of infectious etiology **except for syphilitic aortitis**
- Significant morbidity and mortality
- Preexisting aneurysms can become secondarily infected, but can also be the result of infection



# Definition

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- **Endarteritis:** inflammation of the arterial wall, occur with or without coexistent aneurysmal dilation
- **Arteries are highly resistant to infection**
  - Deep anatomic location → less prone to trauma
  - Tunica adventitial resists most forms of injury
  - Endothelial cell as a barrier to invasion by organism
  - Rapidly immune and RE systems clearance



# Epidemiology

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- Incidence figures are unavailable
- 2.6% of aortic aneurysms
- 0.03% in IVDU
- Male:female = 3:1
- Mean age 65 yrs
- Mean age 40 yrs in IE



# Risk factor

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- **Arterial injury**
  - Pseudoaneurysm is common
  - IVDU, Iatrogenic (invasive monitoring, percutaneous access)
- **Antecedent infection**
- **Impaired immunity**
  - Diabetes, alcoholism, chronic glucocorticoid therapy, chemotherapy, and malignancy
- **Atherosclerosis**
- **Preexisting aneurysm**
  - Risk for secondary infection due to bacteremia or spread from a contiguous infection

J R Soc Med 1999; 92:255

Am J Cardiol 1997; 79:873

J VascSurg 2001; 34:900



# Pathogenesis

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- **4 Mechanisms**

- Embolomycotic aneurysms
- Hematogenous seeding
- Extension from a contiguous infected focus
- Direct contamination

- **Mycotic aneurysms**

Intracranial arteries → Visceral arteries → Upper or Lower extremity arteries

- Typically occurring at arterial bifurcations



# Pathogenesis

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## Embolomycotic Aneurysms

- Septic microemboli → **vasa vasorum** of artery or preexisting aneurysm
- Usually occur with active IE
- Often at points of bifurcation of the affected artery
- Estimated embolism occur between 25 - 50 % of IE patients
- Only about 1/5 develop symptomatic mycotic aneurysm



# Pathogenesis

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## Hematogenous seeding

- Most common mechanism
- Bacteremic seeding through an existing intimal injury, atherosclerotic plaque, or preexisting aneurysm
- Primary bacteremia most commonly originates from distal infections in soft tissue, lung, bone, or joint
- Atherosclerosis accounts for ➡ existing intimal injury, preexisting aneurysm
- Aorta is the most common location



# Pathogenesis

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## Extension from a contiguous infected focus

- Direct penetration of the vessel wall
- Circuitously via the lymphatics
- Common mechanism for tuberculous aortitis
- Post operative and non operative
  - Pyogenic vertebral osteomyelitis: present in 1/3 of cases
  - Extension of a postoperative infection described in the setting of appendectomy, cholecystectomy, and following knee or hip replacement surgery



# Pathogenesis

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## Direct contamination

- Injury by self-inflicted, iatrogenic, accidental, or due to assault (gunshot, stab)
- The femoral artery is the most commonly involved arterial site
- > 80% located in the extremities
- More extensive local tissue inflammation



# Microbiology

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- Blood cultures are positive in 50 to 85 % of cases
- Isolated organisms from aneurysmal tissue up to 76 % of patients
- **Nontyphoid *Salmonella* species** and ***S. aureus***  
most common causative organisms
  - *S aureus*: Western countries
  - Non typhoid *Salmonella* species: Asia
- Different organism determined by preexisting or IE associated



# Microbiology

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- Bacteriology of infected aneurysms in a series of 43 patients treated at the Mayo Clinic 1976-2000

Organism	Total (n = 43)
Culture negative	10 (23%)
<i>S aureus/epidermidis</i>	11 (26%)
<i>E coli</i>	6 (14%)
Streptococcus species	5 (12%)
Salmonella species	4 (9%)
<i>Listeria</i>	1 (2%)
<i>Candida</i>	1 (2%)
Other	5 (12%)



# Microbiology

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- Mycotic aneurysm in Northeast Thailand: the importance of *Burkholderia pseudomallei* as a causative pathogen 1993-2007 (n=40)

Organisms	Numbers (%)
<i>B. pseudomallei</i>	17 (42.5%)
<i>Nontyphoidal Salmonella</i> species	12 (30%)
<i>E. coli</i>	2
<i>Pseudomonas</i> species	2
<i>S. aureus</i>	1



# Microbiology

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- **Preexisting atherosclerotic vessel**
- Gram-positive organisms (60%)
  - $> 2/3$  *S. aureus*
  - *Streptococcus* spp. (10%)
  - *Enterococcus* spp.
- Gram-negative bacilli (30-40%)
  - Most common *Salmonella* spp. (20%)
- Polymicrobial cultures (IVDU)
- **Mycotic aneurysm associated IE**
- Before the antibiotic era
  - More virulent organism:  
GAS
- Now
  - *Streptococci* or *Staphylococci* ( $\geq 60\%$  of cases)
  - *Enterococcus* spp.
  - *S. pneumoniae*



# Microbiology

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- **Geographic areas**

- Tuberculosis aortitis is seen in endemic countries
- Endemic melioidosis
- *B. pseudomallei* was the
- most common pathogen (42.5%)

- **Sites of Infection**

- *Salmonella* :

- 83% Abdominal aorta
- 17% Thoracic aorta

- *B. pseudomallei*:

- 87.5% Abdominal aorta
- Syphilis: Thoracic aorta > Abdomen
- (ascending > arch > descending)
- Tuberculosis:
- 2/3 abdominal aorta
- 1/3 thoracic aorta



# Clinical manifestations

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- **The classic presentation**

- Painful, Pulsatile, and Enlarging mass with systemic, such as fever
- Found only superficial infected aneurysms (common femoral artery)

- **For deeper sites**

- Depend imaging studies
- Abdominal or back pain
- Fever of unknown origin
- Some remain undiagnosed until rupture



# Clinical manifestations

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- **In the setting of IE**
- Infected aneurysm of the intracerebral vessels → stroke or subarachnoid haemorrhage
- **Undiagnosed, infected aneurysms**
- Sepsis, thrombosis, or haemorrhage
  - Depend on location (eg. GI Bleeding, Congestive heart failure, Mesenteric ischemia)



# Diagnosis

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- **Diagnosis is established by**

- Clinical symptoms\*\*
- Aneurysm architecture
- Operative findings
- Positive aneurysm wall, thrombus and/or blood culture

- **\*\* Positive tissue cultures in the absence of clinical findings do not confirm mycotic aneurysm**

- Continuing bacteremia despite “appropriate” ATB in elderly (esp. diabetic) pt without signs of IE suggests an infected intravascular site
- CTA definitively diagnoses the aneurysm



# Diagnosis

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## If suspected infected aneurysms

- Blood culture (negative 25-50%)
- Look for primary source of bacteremia
- ESR, CRP
- Imaging
- Intraoperation: G/S, Cultures, Pathology
  - Cultures will confirm the diagnosis/the selection of appropriate antibiotics

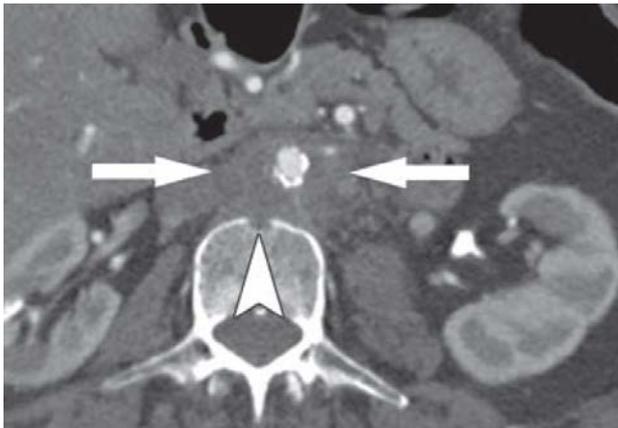
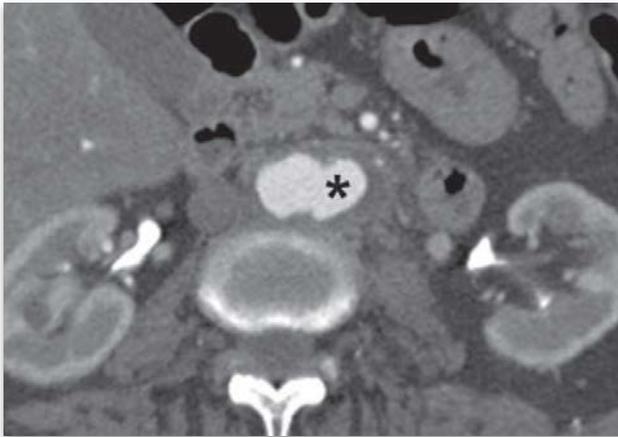


# Imaging

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- **CTA is the most useful for diagnosing** infected aneurysm  
(Sensitivity of 92-96% Specificity of 93-100%)
- MRA is an alternatives
- Repeated scan can be performed to evaluate for rapid enlargement or changes to the aneurysm
- Nuclear medicine studies, including FDG-PET, gallium are alternatives

# CTA



## Characteristics

- Saccular, eccentric aneurysm or multilobulated aneurysm
- Soft tissue inflammation or mass around a vessel
- Aneurysm with intramural air or air collection around the vessel
- Perivascular fluid collection



# Infected vs inflammatory

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## Infected Aneurysm

- Saccular, eccentric, or multilobulated AAA
- Soft tissue inflammation surrounding the aorta
- Intramural air, or air collection around the vessel
- Perivascular fluid collection

## Inflammatory Aneurysm

- Thickening of the adventitia ( $\geq 1$  cm of adventitia)
- +/- Periaortic soft tissue density
- Planes between the aorta and retroperitoneum are indistinct
- Fibrosis of the adjacent retroperitoneum

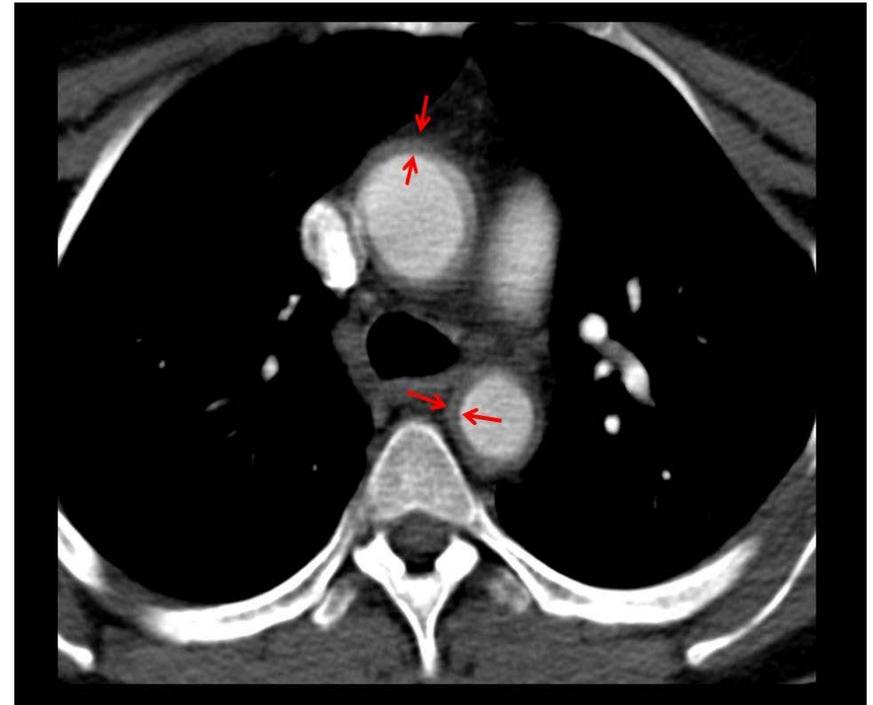
# Infected vs inflammatory

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## Infected Aneurysm



## Inflammatory Aneurysm





# Management

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- No Randomized trials
- 2 modalities

## 1. Antibiotics

- Antibiotic therapy combined with surgical debridement with or without revascularization

## 2. Surgery

- Aneurysm excision and ligation without arterial reconstruction
- With reconstruction (immediate and interval)
- Revascularization procedures are performed depending upon status of distal perfusion
- Endovascular techniques are emerging as a treatment alternative for infected aneurysm



# Antibiotic therapy

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- Initial choice of ATB based upon the clinical circumstances and should be initiated ASAP
- Optimal duration of ATB is uncertain
- **At least six weeks** of parenteral and/or oral antimicrobial therapy is administered
- If surgical drainage is performed, this time period commences from the day of surgery
- A longer duration of treatment in the setting of
  - Antibiotic-resistant organisms
  - Persistently positive cultures
  - And/or inflammatory markers that are slow to normalize



# Antibiotic therapy

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- If surgery is not emergent
- **Course of ATB for 2 - 4 weeks prior to surgery is recommended**
- To improve local surgical conditions, associated with better outcome
- Suppressive oral antibiotics following prosthetic graft material during active infection
- Serial imaging in case of unruptured aneurysm



# Surgery

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- Removal of all necrotic and infected tissue and management of any ensuing ischemia
- Vascular reconstruction
  - Patient's underlying vascular status
  - Anatomic site of the aneurysm
  - Availability of autologous graft material



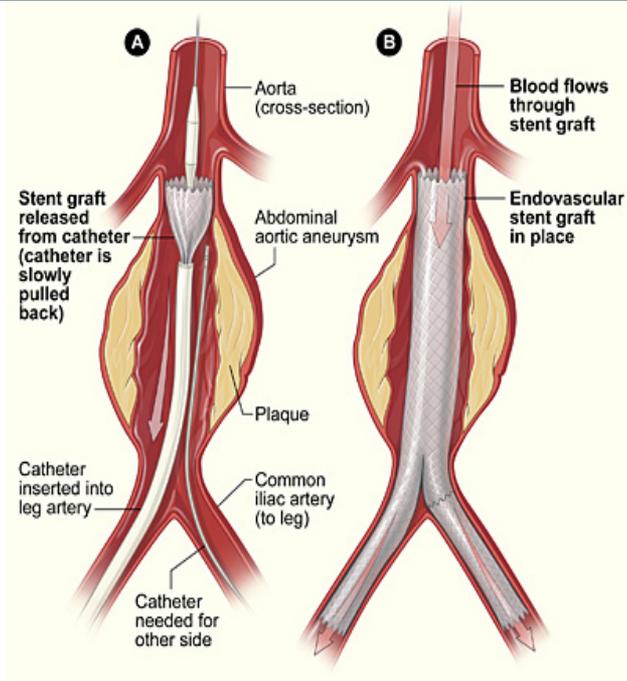
# Surgery

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- **Aneurysm excision and ligation without arterial reconstruction**
- **Excision with immediate reconstruction**
  - Patients who are likely to develop acute ischemia
  - Potential for recurrent infection
  - Autogenous superficial vein < prosthetic grafts
- **Excision with interval reconstruction**
  - Only mild to moderate limb ischemia
  - Interval with ATB IV 2-4 weeks

# Endovascular Aneurysm Repair (EVAR)

## Endovascular Aortic Repair (EVAR)



- Suitable for high-risk patients for open surgery
- Beneficial for temporizing measure
- Additional surgical therapy is indicated after acute problem
- Should not be considered permanent therapy



# Endovascular Aneurysm Repair (EVAR)

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- From September 2005 to May 2010
- 21 patients, 17 abdominal and 4 thoracic infected aortic aneurysms were treated with an endovascular stent graft at Songklanagarind Hospital
- Overall in-hospital mortality was 19% (4/21):
- 60% (3/5) in the fistula group and only 6% (1/16) in the nonfistula group
- Endovascular therapy, as a definite treatment for infected aortic aneurysms, provided excellent results in patients without fistula complications



# Summary

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- Mycotic aneurysm causes development of a **new aneurysm** or when a preexisting aneurysm becomes **secondarily infected**
- The organisms with the greatest affinity for the arterial wall are ***Staphylococcus spp* and *Salmonella***
- The diagnosis of an infected aneurysm is based upon **clinical and imaging**
- **Surgical excision** of the aneurysm and wide debridement of infected tissues is the treatment of choice with or without revascularization
- **Endovascular techniques** may be useful as a palliative measure for patients who refuse surgery, those with a prohibitive risk for surgery



# Suppurative thrombophlebitis

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# Definition

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- **Venous thrombosis associated with inflammation in the setting of bacteremia**
- Histologic findings consist of inflammation and suppuration within the vein wall
- Thrombus with or without pus may be seen within the vein lumen, with evidence of perivascular inflammation



# Definition

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- **Persistent bacteremia after 72 hours of appropriate ATB (esp. intravascular catheter)**
- Diagnosis
  - Culture
  - Radiographic evidence of thrombosis
- Treatment
  - Removing the focus of infection (eg, intravenous catheter)
  - Prompt administration of IV ATB
  - Surgical intervention
  - Anticoagulation



# Pathogenesis

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Peripheral vein	Jugular vein	Vena cava
<ul style="list-style-type: none"><li>• Intravenous catheter or PICC</li><li>• 7 % of intravenous catheter sepsis</li><li>• Risk factors<ul style="list-style-type: none"><li>• Burns</li><li>• Steroids</li><li>• Injection drug use</li></ul></li></ul>	<ul style="list-style-type: none"><li>• Lemierre's syndrome, postanginal sepsis</li><li>• Preceded by pharyngitis, dental infection</li><li>• Infectious involvement of the carotid sheath vessels + bacteremia</li><li>• Oropharynx to the parapharyngeal or lateral pharyngeal space</li><li>• Intravenous catheter</li></ul>	<ul style="list-style-type: none"><li>• Setting of a central venous catheter</li></ul>



# Microbiology

Peripheral vein	Jugular vein	Vena cava
<ul style="list-style-type: none"><li>• <i>S. aureus</i> (most common)</li><li>• Streptococci</li><li>• Enterobacteriaceae</li><li>• Burn patients may have polymicrobial infection</li></ul>	<ul style="list-style-type: none"><li>• Normal oropharyngeal flora (most common)</li><li>• <i>Fusobacterium necrophorum</i></li><li>• other <i>Fusobacterium</i> species (eg, <i>F. nucleatum</i>)</li><li>• <i>Eikenella corrodens</i></li><li>• Catheter associated jugular vein: skin flora and nosocomial pathogens</li></ul>	<ul style="list-style-type: none"><li>• Nosocomial organisms including <i>S. aureus</i> and Enterobacteriaceae</li><li>• Fungi are more common</li><li>• <i>Candida</i> spp.</li></ul>



# Clinical manifestations

Peripheral vein	Jugular vein	Vena cava
<ul style="list-style-type: none"><li>• Fever, erythema, tenderness, and purulent drainage at the site of the involved vessel</li><li>• Septic pulmonary emboli and secondary pneumonia</li></ul>	<ul style="list-style-type: none"><li>• Fever (&gt;39°C) and rigors, respiratory distress</li><li>• Most patients have localized neck and/or throat pain</li><li>• Oropharynx: ulceration, a pseudomembrane, or erythema</li><li>• Tenderness, swelling, at jugular vein, over angle of the jaw or sternocleidomastoid muscle</li></ul>	<ul style="list-style-type: none"><li>• Systemic symptoms (fever, rigors and hypotension)</li><li>• Localized findings are not common</li></ul>



# Diagnosis

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Peripheral vein	Jugular vein	Vena cava
<ul style="list-style-type: none"><li>• <b>An ultrasound may not be needed</b></li><li>• Baseline ultrasound may be useful if subsequent repeat evaluation is needed to evaluate for extension of thrombus</li></ul>	<ul style="list-style-type: none"><li>• <b>CT scan with contrast</b></li><li>• It may demonstrate filling defects or thrombus, with or without soft tissue swelling</li></ul>	<ul style="list-style-type: none"><li>• <b>CT scan with contrast</b></li><li>• It may demonstrate filling defects or thrombus, with or without soft tissue swelling</li></ul>



# Antibiotic therapy

Peripheral vein	Jugular vein	Vena cava
<ul style="list-style-type: none"><li>• Empiric therapy: activity against Staphylococci such as vancomycin</li><li>• Duration of ATB is at minimum of 2 weeks</li></ul>	<ul style="list-style-type: none"><li>• Ampicillin-sulbactam for <i>Fusobacterium necrophorum</i></li><li>• Empirical treatment cover MRSA for catheter associated jugular vein</li><li>• Duration of ATB is at least 4 weeks, including a minimum of 2 weeks intravenous therapy followed by oral therapy</li></ul>	<ul style="list-style-type: none"><li>• Empirical treatment cover MRSA, Enterobacteriaceae</li><li>• Duration of ATB is up to 4 to 6 weeks</li></ul>



# Surgery

Peripheral vein	Jugular vein	Vena cava
<ul style="list-style-type: none"><li>• <b>Not responded appropriately to antimicrobial therapy</b></li><li>• Incision and drainage and, potentially, excision of the affected vein and its tributaries may be needed</li></ul>	<ul style="list-style-type: none"><li>• <b>Ligation or excision of the internal jugular vein</b></li><li>• Adjacent peritonsillar or other neck abscess in the vicinity of a catheter should prompt surgical incision and drainage as well as catheter removal</li></ul>	<ul style="list-style-type: none"><li>• <b>Surgical excision or ligation is not possible for vena cava</b></li><li>• Resection of the infected thrombus may be warranted if proximal thrombus propagation occurs</li><li>• Transabdominal and transfemoral venous thrombectomy (IVC)</li></ul>



# Anticoagulation

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Peripheral vein	Jugular vein	Vena cava
<ul style="list-style-type: none"><li>• <b>Uncertain</b></li><li>• Favor anticoagulation only if there is evidence for extension of thrombus</li></ul>	<ul style="list-style-type: none"><li>• <b>Controversial</b></li><li>• Favor anticoagulation only if there is evidence for extension of thrombus</li></ul>	<ul style="list-style-type: none"><li>• <b>Most favor anticoagulation</b></li><li>• No controlled studies</li></ul>



# Summary

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- Persistent bacteremia after 72 hours of appropriate ATB
- Fever, erythema, tenderness and purulent drainage at the site of the involved vessel
- Culture data and radiographic evidence of thrombosis
- Removing the focus of infection (eg, intravenous catheter)
- Prompt administration of IV ATB
- Consideration regarding surgical intervention and/or anticoagulation



**Thank You**

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