CARDIOVASCULAR AND BLOOD STREAM INFECTIONS

Dr. Teresa Wang

Learning objectives

1. Understand the pathophysiology of endocarditis and endovascular infections
2. Name the common causative agents for different types of cardiovascular infections
3. Know how endocarditis is diagnosed
4. Remember the principles of treatment for endocarditis

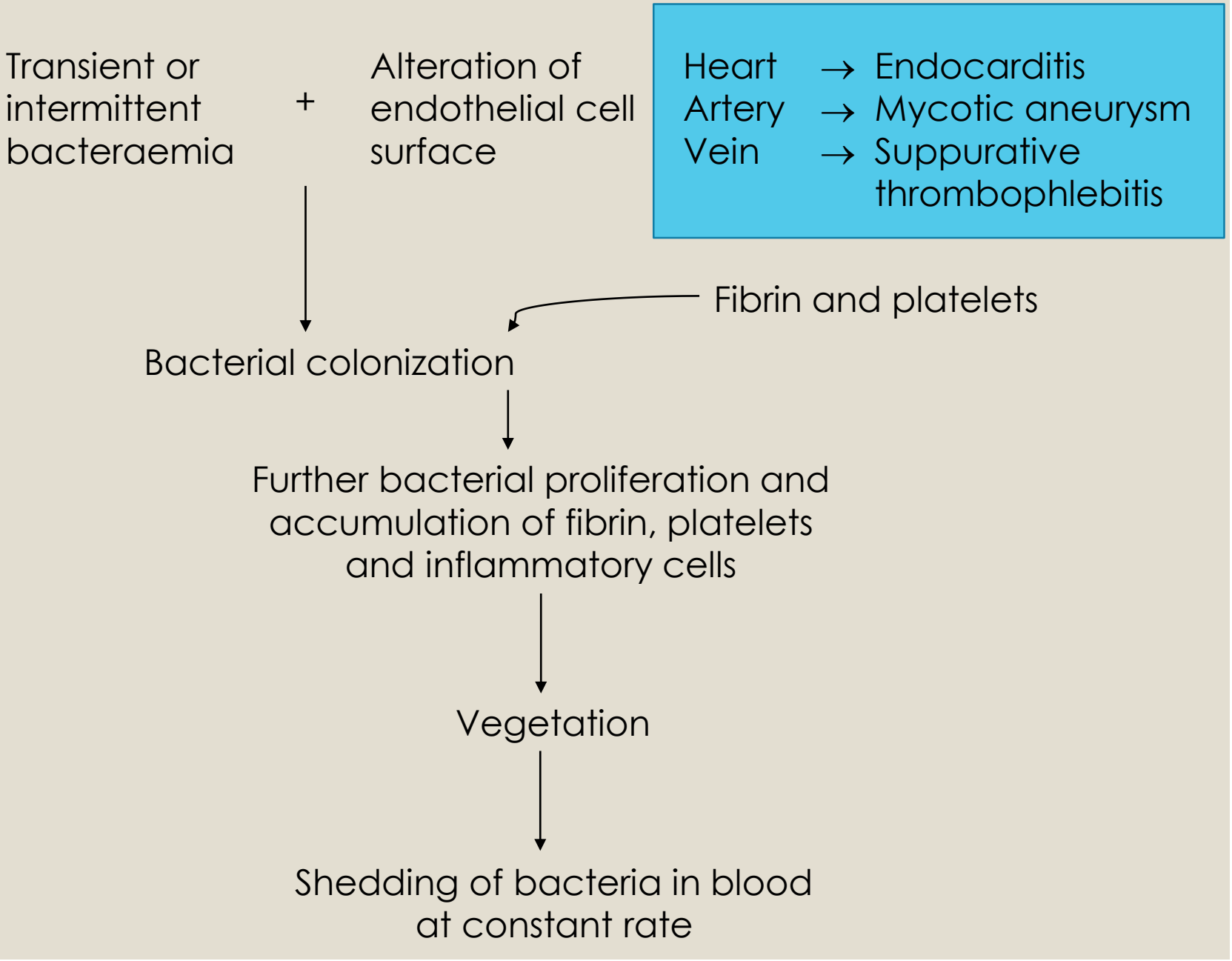
Bloodstream infections

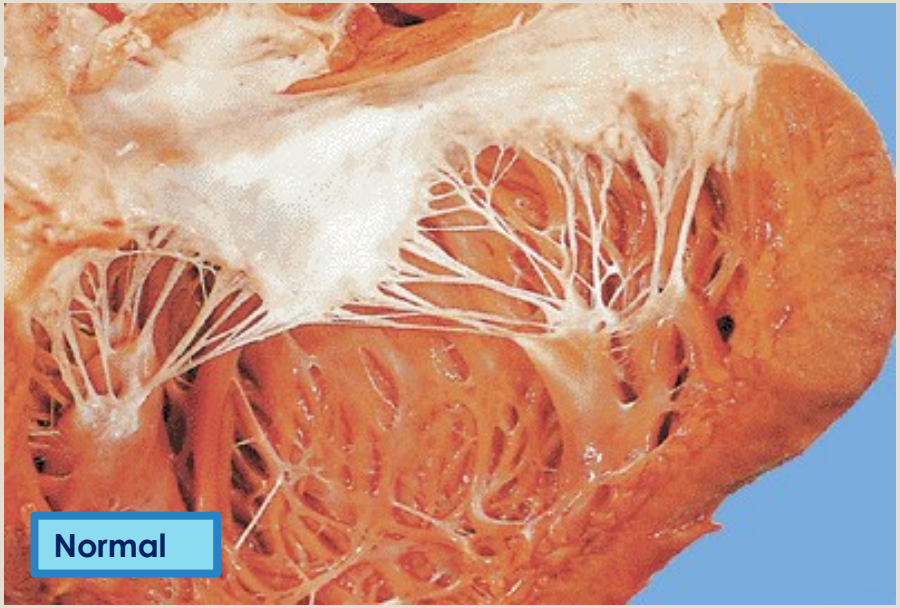
Bacteraemia	Bacteria in blood
Viraemia	Viruses in blood
Fungaemia	Fungi in blood
Parasitaemia	Parasite in blood

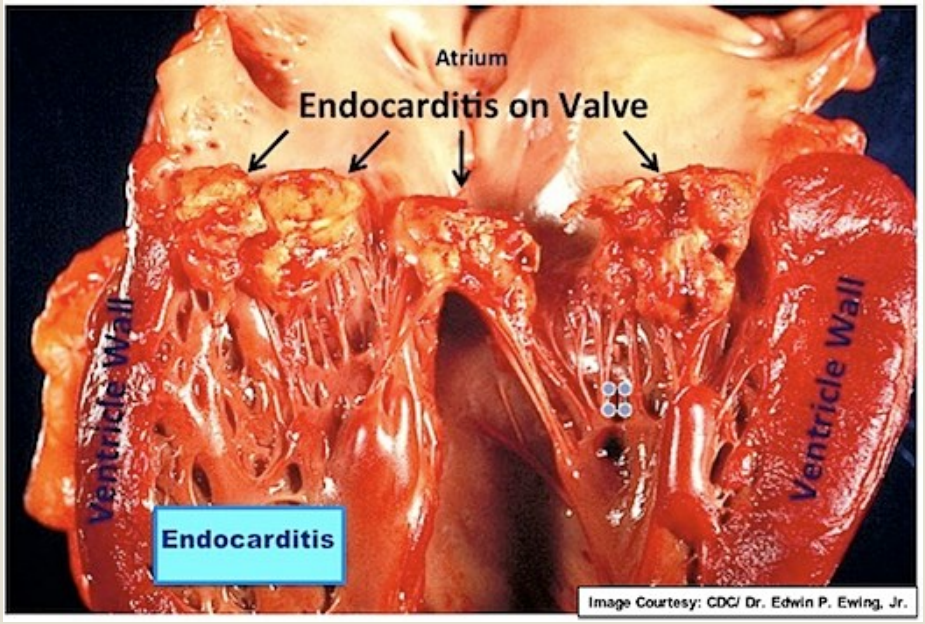
HOW DO BACTERIA GET INTO BLOODSTREAM?

Transient bacteraemia			Continuous bacteraemia	Intermittent bacteraemia
Breakthrough of normal flora of skin and mucosal surfaces			Endocarditis Endovascular infections	Deep-seated focus of infection
	Skin	Oral lesions/dental procedures		E.g. Undrained abscess Osteomyelitis/spondylitis
Normal host	CoN *S. aureus* Enterococci β-haemolytic streptococci	Viridans streptococci *Haemophilus* spp. *Aggregatibacter* spp. *Cardiobacterium hominis* *Eikenella corrodens* *Kingella kingae* (HACEK)		
IVDA	CoN *S. aureus* Environmental bacteria			
Patients with iv access	Same as above plus Yeasts			

AN EVOLUTION OF TRANSIENT OR INTERMITTENT BACTERAEMIA TO ENDOCARDITIS AND ENDOVASCULAR INFECTIONS


Transient or intermittent bacteraemia
+
Alteration of endothelial cell surface
Heart → Endocarditis
Artery → Mycotic aneurysm
Vein → Suppurative thrombophlebitis
Fibrin and platelets
Bacterial colonization
Further bacterial proliferation and accumulation of fibrin, platelets and inflammatory cells
Vegetation
Shedding of bacteria in blood at constant rate


Normal


Atrium
Endocarditis on Valve
Ventricle Wall
Ventricle Wall
Endocarditis
Image Courtesy: CDC/ Dr. Edwin P. Ewing, Jr.

Causative agents

Category	Pathogen
Native valve	
Community onset	Viridans streptococci, *Staphylococcus aureus*, *Streptococcus bovis*, *Enterococcus* spp.
Health-care associated	*S. aureus*, *Enterococcus* spp., *Staphylococcus epidermidis*
Intravenous drug user	*S. aureus*, gram-negative rods such as *Pseudomonas* spp., *Candida* spp.
Prosthetic valve	
Early	*S. epidermidis*, *S. aureus*
Late	*S. aureus*, viridian streptococci, *Enterococcus* spp., *S. epidermidis*
Pacemaker or defibrillator	*S. epidermidis*, *S. aureus*
Culture-negative	*Bartonella* spp., *Coxiella burnetii*, *Brucella* spp.

Clinical features

- Constitutional symptoms
  - Fever, chills and rigors
  - Anorexia
  - Generalized malaise
- Consequence associated with destruction of structures
  - Heart valves
    - Heart murmur
    - Arrhythmias (heart block)
    - Heart failure
  - Arteries
    - Palpable pulsatile mass
    - Hypovolaemic shcok if ruptured
  - Veins
    - Engorgement of veins

Clinical features

- Embolic phenomena
  - Left-sided endocarditis: Brain abscess
  - Right-sided: septic pulmonary emboli
  - Splinter haemorrhages
  - Janeway lesions
  - Retinal haemorrhages
  - Conjunctival haemorrhages
- Antigen-antibody deposition
  - Osler's nodes
  - Roth's spots
  - Glomerulonephritis
  - Arthritis

Splinter Hemorrhages

1. Nonspecific
2. Nonblanching
3. Linear reddish-brown lesions found under the nail bed
4. Usually do NOT extend the entire length of the nail

Janeway Lesions

1. More specific
2. Erythematous, blanching macules
3. Nonpainful
4. Located on palms and soles

Osler's Nodes

1. More specific
2. Painful and erythematous nodules
3. Located on pulp of fingers and toes
4. More common in subacute IE

Investigations

- Multiple blood cultures to demonstrate continuous bacteraemia
  - Different time
    - 3 blood cultures taken at least over 1 hour
  - Different site
    - Central lines + peripheral blood cultures
  - **Strict aseptic technique**

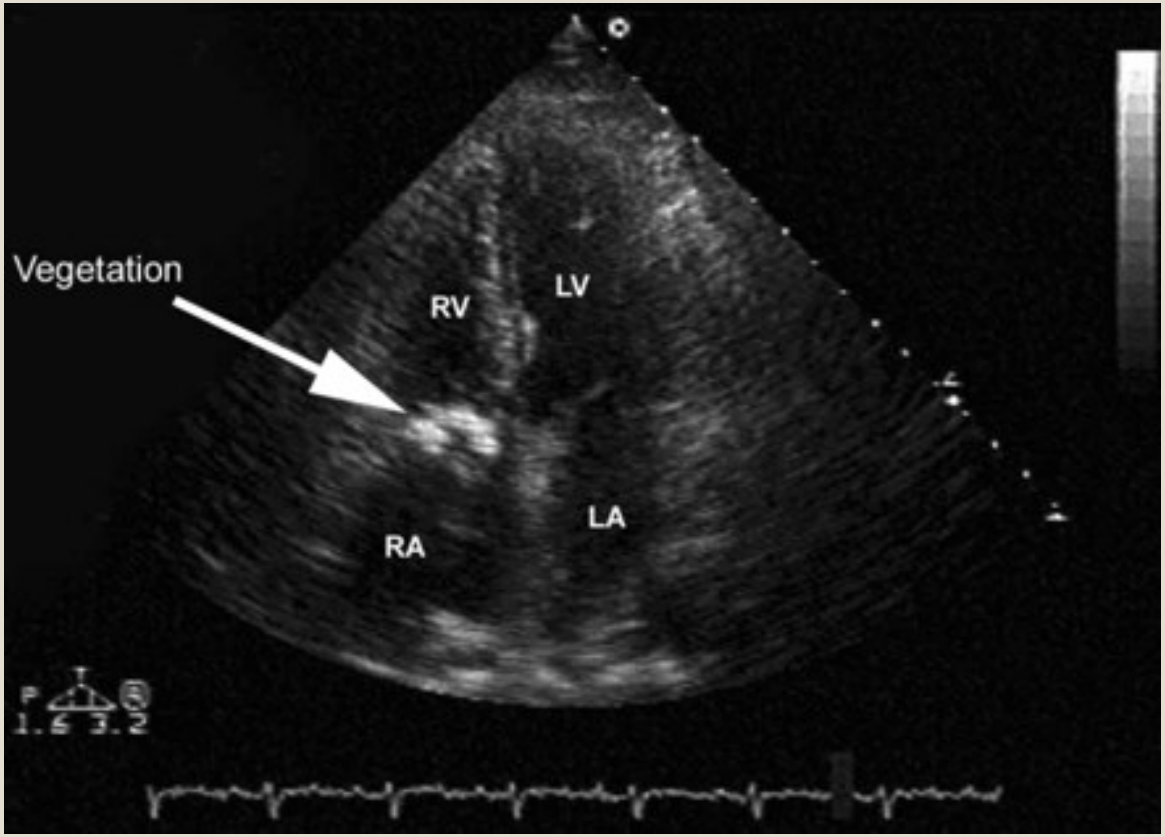

BD BACTEC
Plus Aerobic/F
Culture Vials
BD BACTEC
40 mL
Culture Vials

Investigations

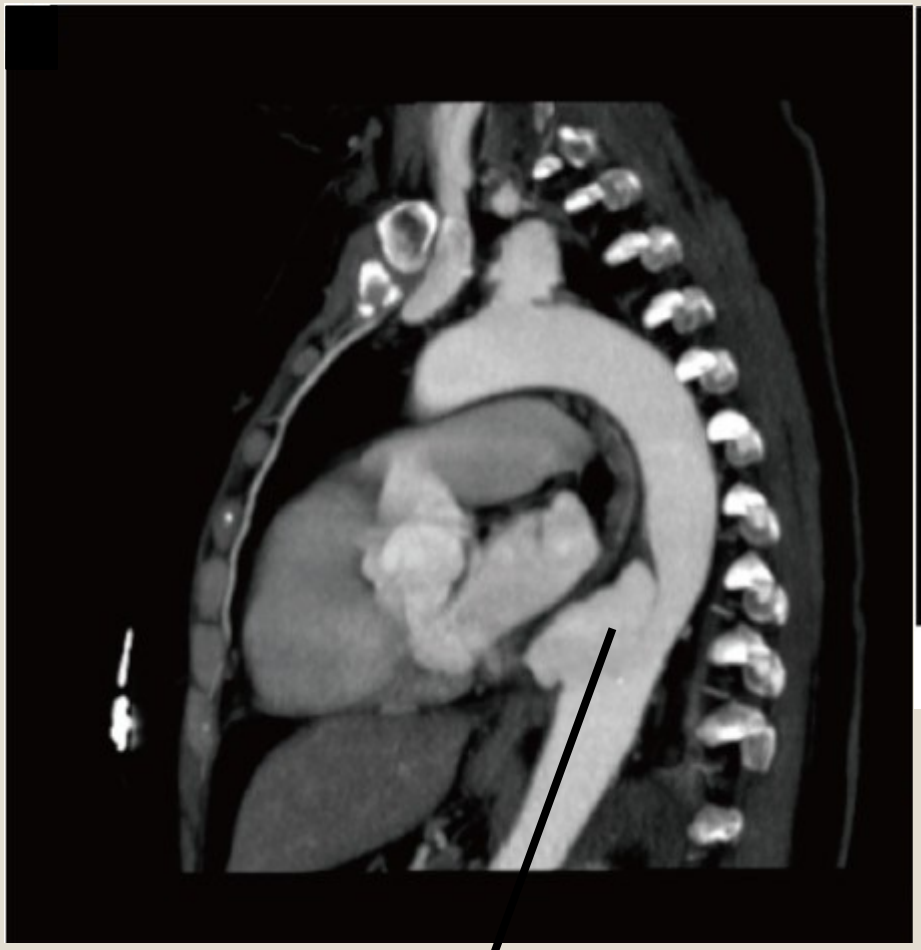
- Culture-negative endocarditis
  - Prior antibiotics before blood cultures
  - Serology for fastidious organisms that are difficult to culture or not culturable
    - *Bartonella* spp.
    - *Coxiella burnetii*

Investigations

- Imaging
  - Echocardiogram for vegetations
  - CT angiogram for mycotic aneurysm
  - Doppler ultrasonography for thrombophlebitis



Transthoracic echocardiogram; large, echo bright mass (arrow) in the right atrium



CT scan of thorax revealing a mycotic aneurysm in descending aorta

CT scan of abdomen revealing a large mycotic aneurysm with contained rupture into the left psoas muscle and erosion of the lumbar vertebrae

TABLE 1.

Summary of Modified Duke Criteria for Diagnosis of Infective Endocarditis*

Major Criteria

- Positive blood cultures for IE.
  - Typical microorganisms for IE from two separate blood cultures.
  - Persistently positive blood cultures with a microorganism consistent with IE.
  - Single positive blood culture for *Coxiella burnetii* or IgG antibody titer > 1:800.
- Evidence of endocardial involvement.
- Positive echocardiogram for IE.
- New valvular regurgitation.

Minor Criteria

- Predisposing heart condition or history of intravenous drug use.
- Fever, defined as temperature > 38.0° C.
- Vascular phenomena (eg, major arterial emboli, mycotic aneurysm, Janeway lesions).
- Immunologic phenomena (eg, glomerulonephritis, Osler's nodes, Roth spots) .
- Microbiologic evidence not meeting major criteria as noted above.

**A definitive diagnosis of infective endocarditis is established if two major criteria, one major and three minor criteria, or five minor criteria are fulfilled. A diagnosis is "possible" if one major criterion and one minor criterion are fulfilled or if three minor criteria are fulfilled.*

IE = infective endocarditis; IgG = immunoglobulin G.

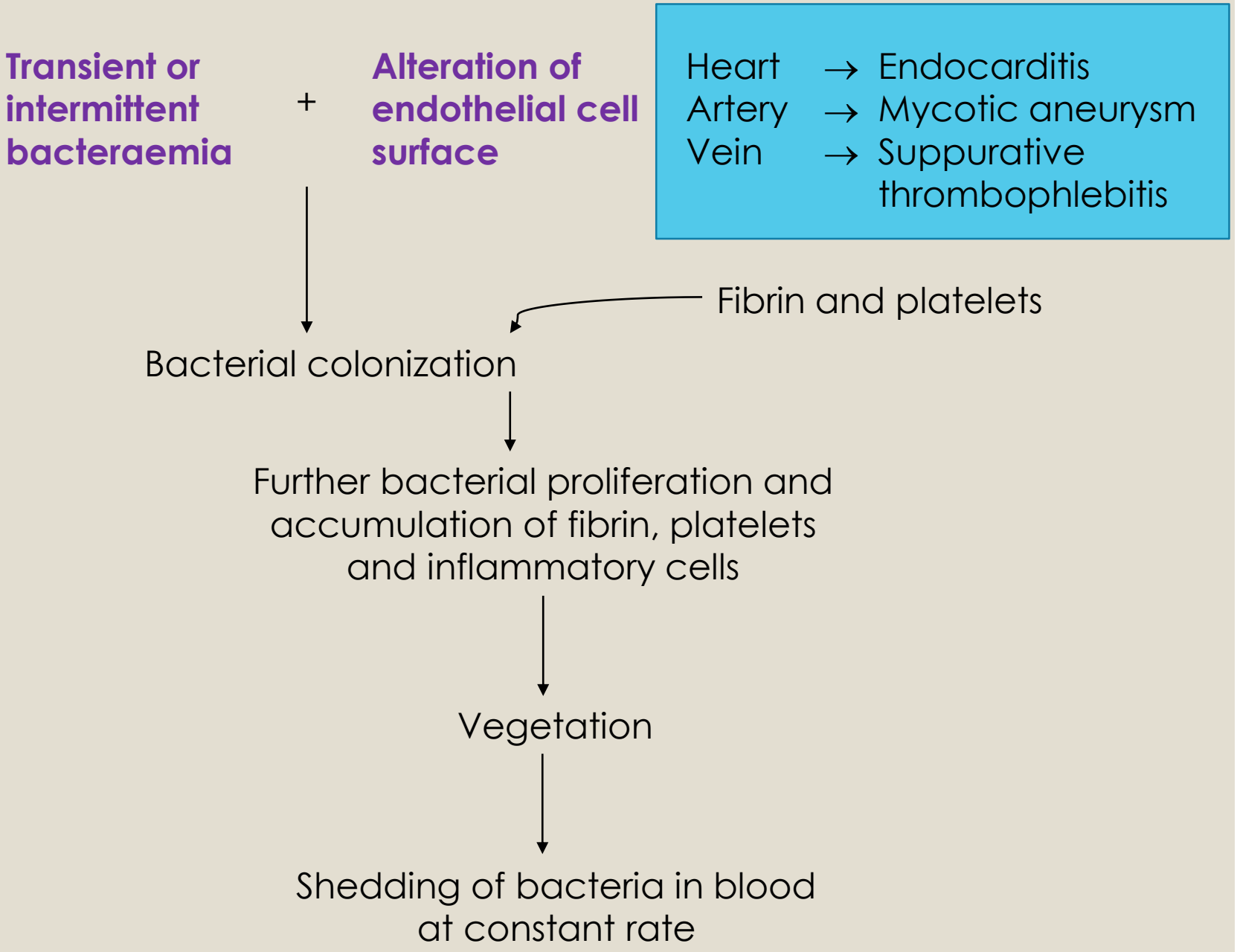
Data from Li et al[9]

Treatment

- Antibiotics
  - Bactericidal
  - Intravenous
  - Prolonged course (at least 4 weeks)

- Surgical removal of infected valve/vessel/thrombi

PREVENTION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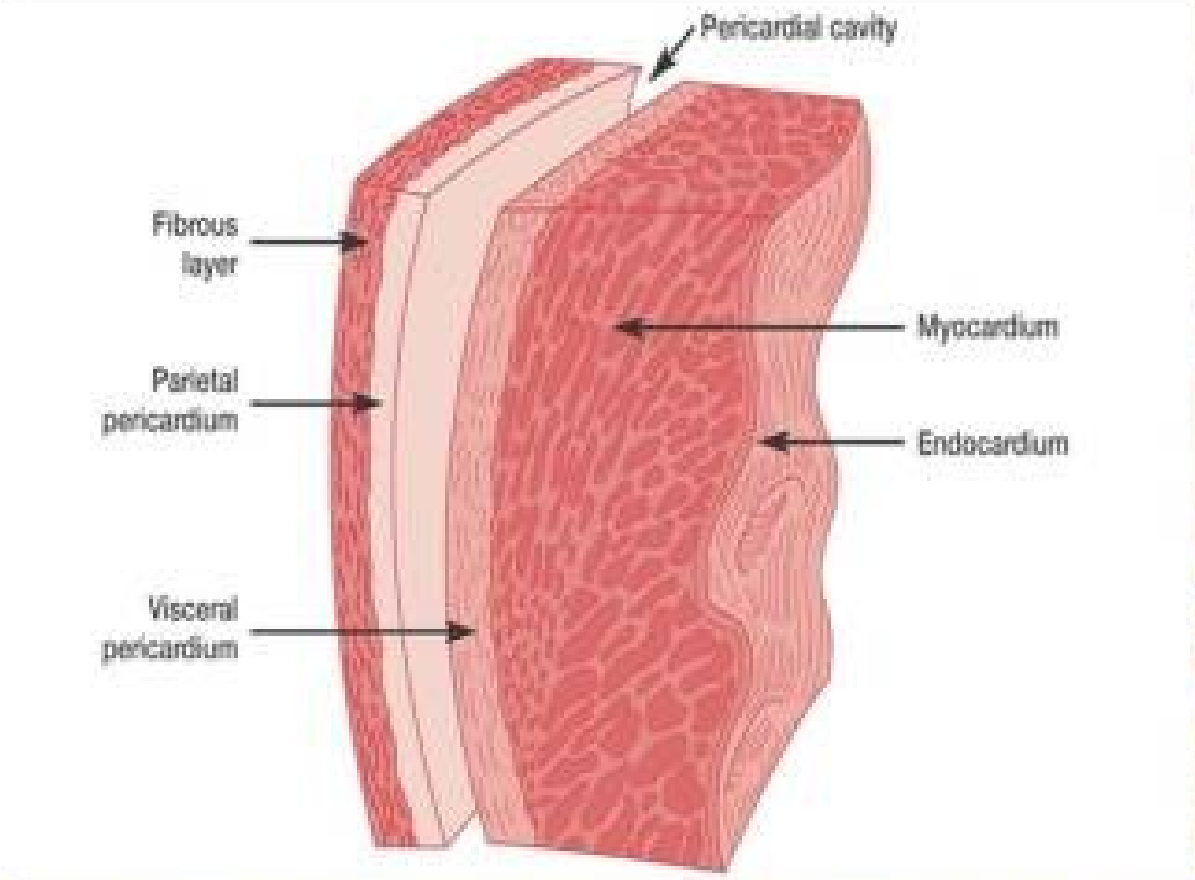
Alteration in endothelial cells

- Underlying heart valve diseases
  - E.g.
    - Prosthetic valves
    - Rheumatic heart disease
- Congenital heart disease
  - E.g.
    - Small atrial septal defect

Prevention of transient bacteraemia

- Prophylactic antibiotics prior to certain procedures
  - Dental procedures
  - Surgery involving respiratory mucosa
  - Surgery of infected tissues

Besides endocarditis...

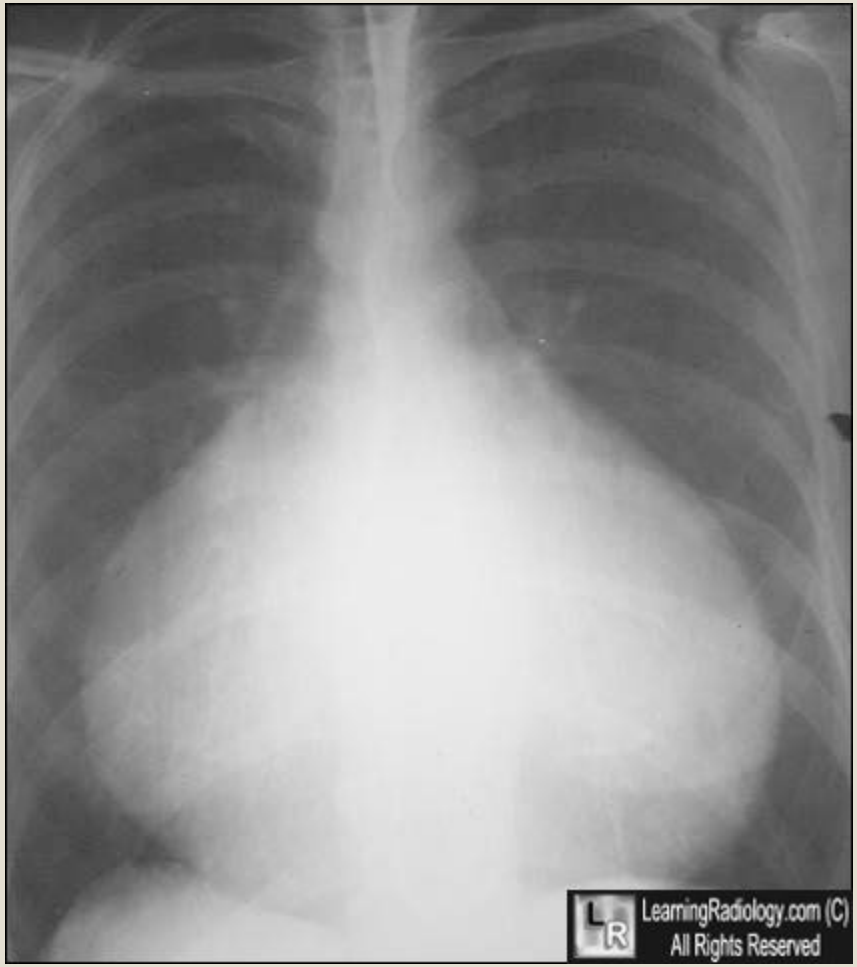


Myocarditis

- Inflammation of heart muscle (myocardium)
- Mostly caused by haematogenous spread of pathogens
  - Usually viruses
  - Coxsackie viruses
- Occasionally caused by direct spread from adjacent structure
- Associated with heart failure

Pericarditis

- Inflammation of fascial sac covering the heart (pericardium)
- Closely associated with myocarditis
- Often caused by viruses (Coxsackie viruses)
- *Mycobacterium tuberculosis* can also caused pericarditis
- C/F: chest pain, friction rub
- May have pericardial effusion leading to cardiac tamponade and heart failure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Summary

1. Presence of transient or intermittent bacteraemia, alteration of endothelial cell surface and accumulation of fibrin, platelets and inflammatory cells leads to the formation of vegetation with continuous shedding of bacteria in bloodstream.

2. Bacteria, such as *S. aureus*, viridans *Streptococcus*, are the causative agents for endocarditis; viruses, such as Coxsackie virus, cause myocarditis and pericarditis.

3. Clinical signs, blood culture results and echocardiogram findings all help to diagnose endocarditis.

4. Proper treatment of endocarditis requires prolonged course of bactericidal antibiotic given intravenously.

References

1. Levinson W. Review of Medical Microbiology and Immunology. 14th edition. McGraw-Hill Education, 2016.
2. Tille P. Bailey and Scott's Diagnostic Microbiology. 13th edition. Elsevier Mosby, 2014.