

## Septicaemia and Bacteraemia

- commonly used interchangeably to refer to the presence of bacteria in the circulating blood
  - other workers no longer use septicaemia
    - use bacteraemia to refer to the presence of bacteria in blood generally
  - entry of bacteria into the blood can occur
    - a. through breakages of blood vessels including capillaries or small veins
    - b. via phagocytic cells into the capillaries or the lymphatic system
- confirmed by culture of bacteria from blood

## Septicaemia

- strictly used to refer to severe clinical condition associated with manifestations which are due to
  - a. effects of a large number of bacteria with or without bacterial toxins in the blood
  - b. manifestations of predisposing illness

## Bacteraemia

- strictly refers to the presence of viable bacteria in the circulating blood
  - may or may not cause clinical manifestations

## Endotoxaemia

- condition which results from effects of bacterial endotoxin in the blood

# Causes

- include
  1. focus of infection in other tissues including
    - a. peritonitis
    - b. pneumonia
    - c. meningitis
    - d. abscesses of internal organs
  2. generalized infections including enteric fever and brucellosis
  3. others
    - a. unidentified sites
    - b. normal flora
    - c. contaminated items in invasive procedures
    - d. contaminated indwelling devices including urinary catheters or other foreign material in

## Types

1. Gram negative bacteraemia
  - majority due to bacteria in family Enterobacteriaceae and Pseudomonas
  - others include a. *N. meningitidis* b. *Brucella* spp
2. Gram positive bacteraemia several pyogenic cocci
3. Mixed bacteraemia
  - more than one species including Gram negative bacilli (GNB) or mixed cocci and GNB
4. Bacteraemia due to anaerobic organisms
  - a. *B. fragilis* most common
  - b. other anaerobic GNB
    - may be in association with abdominal

## Nosocomial

- caused by a variety of agents commonly associated with hospital acquired infections including  
*Klebsiella pneumoniae*    *Pseudomonas aeruginosa*  
*Serratia marcescens*
- organisms show multiple antimicrobial agents resistance

## Complications of bacteraemia

- include
  - spread of infection to other sites
  - shock
    - septic shock by Gram positive cocci
    - Gram negative shock due to effects of endotoxin

## Labs

specimens include

a. blood for culture

b. pus other fluids

infected tissue where

there is a focus of infection

## procedures

1. Gram's stain and microscopy on suitable specimens other than blood

## 2. cultures

▪ incubation a. in air b. anaerobically

c. in additional 5 to 10% carbon dioxide

▪ identification by standard bacteriological methods

#### 4. Antimicrobial susceptibility tests

- choice of antibiotics and methods of tests used are determined by the isolated organism

#### Antimicrobial management of bacteraemia

1. adequate treatment with appropriate bactericidal antimicrobial agents
2. treatment of predisposing condition
3. prevention and treatment of complications

## Pyrexia of unknown origin or PUO

- pyrexia or fever of unknown origin abbreviated as PUO or FUO refers to a condition characterized by
  1. persistently elevated temperature of over  $38^{\circ}\text{C}$ 
    - for one week or longer
    - can be as long as 3 weeks
  2. no obvious identifiable cause despite immediate
    - a. clinical examination by a clinician
    - b. laboratory investigation
      - both performed in a health care institution for at least one week

1. infections responsible for the majority  
• can be viral bacterial fungal  
parasitic or other
2. non-infectious illnesses

## Bacterial infections and diseases which may manifest as PUO

- A. generalized infections include  
infective endocarditis leptospirosis  
tuberculosis Q-fever  
enteric fever

## B. localized infections associated PUO

1. abscesses which can be
  - intra-pulmonary
  - sub-phrenic
  - pelvic
2. mycoplasma pneumonia
3. sinusitis
4. others

1. blood cultures repeatedly at least 3 times
2. examination of other specimens including
  - urine examination
  - stool microscopy and culture particularly where there is associated diarrhoea
  - sputum
3. serological tests including
  - a. Widal test or other tests for enteric fever
  - b. for atypical pneumonia
  - c. for leptospirosis

## Endocarditis

- refers to infection of the endocardium and or the heart valves
  - an intra-vascular infection which occurs within the heart

### Infective endocarditis

- refers to endocarditis caused by any disease causing microorganism

### Bacterial endocarditis

- restricted to endocarditis caused by bacteria

## Conditions which predispose to bacterial endocarditis

1. artificial or prosthetic heart valve
2. history of previous endocarditis
3. damaged or scarred heart valves associated with various conditions including rheumatic heart disease
4. congenital or acquired heart defects
5. intra-venous drug injections without adequate aseptic measures including improper skin disinfection
6. bacteraemia

## Development of bacterial endocarditis

- a predisposing heart condition causes damage to the endocardium
- the damage causes roughness of the endocardium
- thrombi of fibrin and platelets form on the roughened surface
- organisms from the circulating blood adhere to and colonize the thrombi

## Sources of infection and causative agents of bacterial endocarditis

- include
  1. normal flora
    - in transient asymptomatic bacteraemia mostly from
      - a. skin *Staph. epidermidis* *Staph. aureus*
        - also encountered in association with intra-venous drug injections under minimal aseptic conditions
      - b. mouth *Strep. viridans*
      - c. large intestine

2. septicaemia

- associated with several organisms including *Staph. aureus* and *Strep. pneumoniae*

3. hospital environment

- associated bacteria include Enterococcus species as hospital acquired endocarditis

Other organisms

- some fastidious bacteria which are not easily isolated in cultures
- grouped together and referred to as HACEK organisms
  - includes Haemophilus species

## Laboratory investigation for bacterial endocarditis

1. blood culture for isolation and identification of culturable causative bacteria
  - a. performed repeatedly if necessary
    - 2 to 6 samples taken over 48 hours
    - or 3 samples taken within 24 hours
  - b. incubated aerobically in air
    - in 5 to 10% CO<sub>2</sub> and anaerobically
- most suitable specimen is taken before administration of antimicrobial agents
  - however treatment should not be delayed

b. tests during treatment of bacterial endocarditis

1. estimation of antimicrobial agent levels in patient's serum
  - may or may not be necessary
  - ensures achievement of expected levels
  - over dosage with potentially toxic agents can be avoided
  - ensures levels are maintained when changing routes of administration
2. measurement of indicators of inflammation including C-reactive protein
  - may be useful in assessment of response to treatment

## Negative blood cultures in bacterial endocarditis

- may be due to
  1. uncommon organisms including *Coxiella burnetii*
    - serological tests may yield useful information
  2. recent antimicrobial agent treatment
    - blood cultures may be repeated a few days later while the patient is not on antimicrobial treatment
  3. infection due to fastidious organisms which do not grow easily on commonly used culture media
    - might require longer incubation or a repeat blood culture using specifically prepared media for the suspected organisms

## Antimicrobial treatment of bacterial endocarditis

- high doses of bactericidal antimicrobial agent(s) administered intravenously initially ensures
  - a. maximum diffusion into the thrombi if present
  - b. elimination of the organisms
- combination of two agents is given for better results
  - can be penicillin and an aminoglycoside for uncomplicated *Strep. viridans* endocarditis
- duration of treatment depends on the
  - a. causative agent and its susceptibility
  - b. clinical response
- generally requires about six weeks treatment

## Prevention of bacterial endocarditis

1. antibiotic prophylaxis
  - recommended for individuals at a higher risk when undergoing surgical or instrumentation medical procedures involving parts which harbour normal flora in large numbers
  - regular use of antimicrobial agents for prevention is associated with disadvantages including
    - a. adverse effects of antibiotics
    - b. predisposition to antibiotic resistance
2. improvement of oral hygiene in predisposed people with low levels of oral hygiene

- ### BLOOD CULTURE
- laboratory test performed in bacteriology to isolate bacteria from blood in circulatory system
  - mostly performed to
    - detect bacteraemia or septicaemia and determine the causative bacteria
    - establish the diagnosis and causative agents in specific infections including
      - meningitis
      - osteomyelitis
      - endocarditis
      - severe pneumonia
      - sepsis including puerperal and neonatal sepsis
    - investigation of PUO and fever in hospitalized

## Blood culture media for inoculation of blood specimen

- nutritionally enriched liquid media or broths
  - prepared in the laboratory or commercially obtained
  - suitable for growth of most
    - a. strict aerobes and facultative anaerobes
    - b. strict anaerobes
- commonly used media include
  - a. brain heart infusion (BHI)
  - b. Tryptone soya broth for aerobes and facultative anaerobes
  - c. BHI or Tryptone soya broth and thioglycollate for strict anaerobes

- media may be available as
1. **bottled liquid medium or broth**
    - a. in 50 ml volumes for adults and 10 ml for children
      - sealed and fitted with provision for inoculation
    - b. commercially obtained with instructions for use including the volume of blood required
  2. **biphasic medium**
    - semi solid part and a liquid part of broth both in one bottle
    - includes Castaneda system for culture of Brucella and other organisms
  3. **specific media for uncommon organisms**

## Specimen collection

- contamination is minimized as much as possible
- aseptic techniques applied during
  - a. venipuncture
  - b. specimen delivery to the laboratory
  - c. sampling

including

- washing of hands and allowing them to dry
- identification of the most suitable venipuncture site
- cleansing and disinfection the skin over the site
  - 70% ethanol then 1% iodine or iodophor or 1 to 2% chlorhexidine may be used

- use of sterile needle and syringe to take blood
- change of needle before inoculation of the required volume into the blood culture bottle

### quantity of blood specimens

- samples are taken at the same time for aerobic and anaerobic cultures
  - adults at least 10 millilitres (mls) of blood per culture is most suitable
    - 5 mls per bottle of aerobic and anaerobic cultures
  - children at least 1.0 ml of blood to be added to 10 mls of broth

- generally for adults and children
  - optimal blood to broth volume ratio is 1:5 to 1:10
    - adequately neutralizes the antibacterial agents in the blood
  - commonly used anticoagulant in the medium is liquid (sodium polyanethol sulphate)
    - may help to reduce the antibacterial effects for some organisms or may have inhibitory effects on the growth of others
  - automated detection systems tend to require smaller volumes which are indicated according to the specific system and containers

## Number and timing of blood samples

- where several samples are collected each sample constitutes one blood culture set
- two or three blood culture sets are considered sufficient to confirm or rule out bacteraemia
- one set is rarely sufficient
- the optimal time for specimen collection is before onset of fever as bacteraemia precedes the febrile episode
- samples are delivered to the laboratory as soon as possible
- incubated appropriately at 35° to 37° centigrade

- Detection of bacterial growth in blood samples
- incubated samples are examined daily for at least one week for evidence of growth and sampling longer incubation may be necessary where fastidious organisms which grow slowly are suspected
  - care is taken to avoid contamination
  - subcultures are made on commonly used semi-solid media and incubated appropriately
  - organisms isolated are identified applying the standard microbiological methods
  - antimicrobial susceptibility tests are performed on isolated organisms

## Other methods of detection for bacterial growth in blood culture specimens

- include radiometric method referred to as BACTEC
  - consists of automated systems which detect  $\text{CO}_2$  produced by bacterial metabolism in broth medium
  - based on various radiometric methods or fluorescent techniques
    - detects bacteraemia faster
    - requires smaller blood volumes
    - decreases the laboratory work load

- may be influenced by
  1. clinical judgment

possibility of bacteraemia  
and the causative organism

2. specimen collected

- a. quality

possibility of contamination

- b. quantity

- in most infections the organisms are scanty  
so large volumes of blood will increase the  
chances of isolation

## Interpretation

- a. a single culture of a properly collected sample  
yielding bacterial growth is significant