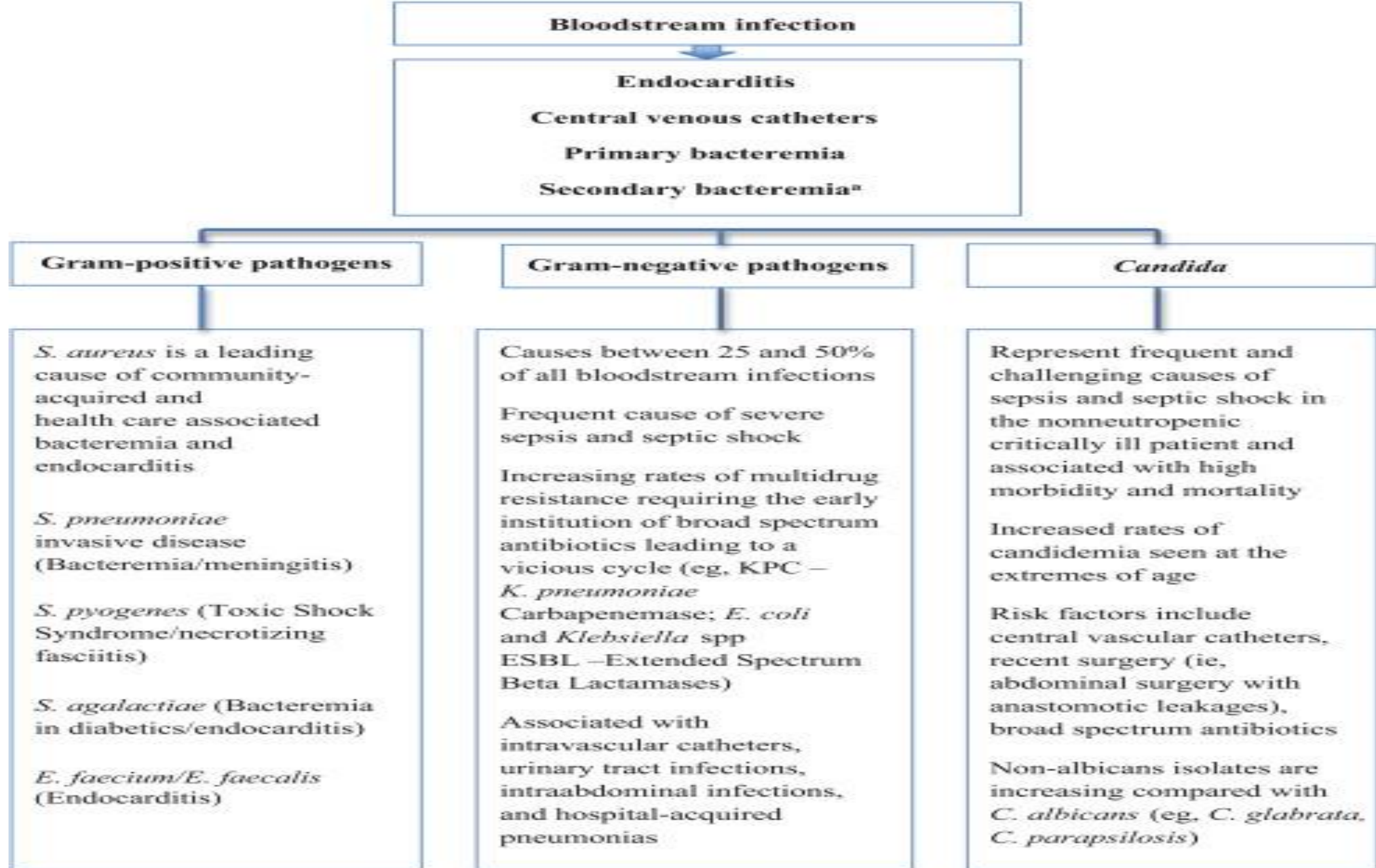


Blood Stream Infections



^aPrimary bacteremia (primary source none identified). Secondary bacteremia implies spillage of viable bacteria into the bloodstream from a focal infection such as a urinary tract infection, pneumonia, or abscess.

Terminology

- **Bacteremia** - presence of bacteria in the bloodstream
- **Septicaemia** - infection is established within the bloodstream
- **Sepsis**: systemic inflammatory response
- **Septic shock** - **the most severe form**

S.N.	Bacteremia	Septicemia
1.	Bacteremia is the simple presence of bacteria in the blood.	Septicemia is the presence and multiplication of bacteria in the blood.
2.	Bacteremia is not as dangerous as Septicemia.	Septicemia is a potentially life-threatening infection.
3.	Less amount of bacteria are present in blood.	Large amounts of bacteria are present in the blood.
4.	This may occur through a wound or infection, or through a surgical procedure or injection.	It can arise from infections throughout the body, including infections in the lungs, abdomen, and urinary tract.
5.	Toxins are not produced.	Toxins may be produced by bacteria.
6.	Bacteremia usually causes no symptoms or it may produce mild fever.	It shows symptoms like chills, fever, prostration, very fast respiration and/or heart rate.
7.	It can resolve without treatment.	Untreated septicemia can quickly progress to sepsis.
8.	Rapidly removed from the bloodstream by the immune system.	Antibiotics will be used to treat the bacterial infection that is causing septicemia.
9.	Caused by <i>Staphylococcus</i> , <i>Streptococcus</i> , <i>Pseudomonas</i> , <i>Haemophilus</i> , <i>E. coli</i> , dental procedures, herpes (including herpetic whitlow), urinary tract infections, peritonitis, <i>Clostridium difficile</i> colitis, intravenous drug use, and colorectal cancer.	<i>Staphylococci</i> , are thought to cause more than 50% of cases of sepsis. Other commonly implicated bacteria include <i>Streptococcus pyogenes</i> , <i>Escherichia coli</i> , <i>Pseudomonas aeruginosa</i> , <i>Klebsiella</i> species and even <i>Candida</i> spp.

Bacteremia

- **viable bacteria in the blood**
- asymptomatic bacteremia - daily activities (oral hygiene, after minor medical procedures)
- healthy person- clinically benign, transient, no sequelae
- indwelling catheters, dental, gastrointestinal, genitourinary, wound-care

Primary and Secondary bacteremia

Primary - no source of infection was documented

Secondary - bacteria have entered body at another site

Ethiology of bacteremia

- Gram-negative bacteremia – from genitourinary or gastrointestinal tract or in the skin (decubitus ulcers)
- Chronically ill, immunocompromised - gram negative, gram-positive cocci, anaerobes, (+ fungemia)
- injection drug users, i.v. catheters – staphylococcal bacteremia
- patients with infections of abdomen and pelvis, female genital tract - *Bacteroides*
- infection in the abdomen - most likely gram-negative bacillus
- infection above the diaphragm - most likely a gram-positive coccus or bacillus.

Pathophysiology of bacteremia

Transient or sustained bacteremia - can cause:

- metastatic infection of meninges, serous cavities (pericardium) or joints
- Multiple metastatic abscesses – staphylococcal bacteremia
- Endocarditis - staphylococcal, streptococcal, enterococcal bacteremia - patients with structural heart disease (eg, valvular disease, certain congenital anomalies), prosthetic heart valves, or other intravascular prostheses
- Staphylococci - injection drug users
 - tricuspid valve
 - hematogenously spread
 - vertebral osteomyelitis

Symptoms, diagnosis and treatment of bacteremia

- asymptomatic or mild fever
- tachypnea, shaking chills, persistent fever, altered sensorium, hypotension, gastrointestinal symptoms (abdominal pain, nausea, vomiting, diarrhea)
suggests sepsis or septic shock (next slide)
- cultures of blood and other specimens
- empiric intravenous antibiotics
- early treatment
- continuing therapy - antibiotics according to the results of culture and susceptibility testing
- draining any abscesses
- removing any internal devices

Sepsis and Septic shock

- **Sepsis** - spectrum of disease with mortality risk ranging from moderate (eg, 10%) to substantial (eg, > 40%) depending on various pathogen and host factors
- **Septic shock** is a subset of sepsis with significantly increased mortality due to severe abnormalities of circulation and/or cellular metabolism -persistent hypotension (need for vasopressors - arterial pressure \geq 65 mm Hg, and a serum lactate level $>$ 18 mg/dL [2 mmol/L])

SEPSIS VS SEPTIC SHOCK

Sepsis is a life-threatening condition that arises when the body's response to infection injures its own tissues and organs

Not as severe as Septic shock

Septic shock is a subset of sepsis which is associated with a significant rate of mortality as a result of various fatal abnormalities of blood circulation and cellular metabolism

The last stage of Sepsis

Ethiology of Sepsis and Septic Shock

- hospital-acquired gram-negative bacilli or gram-positive cocci, rarely - *Candida*
- patients with chronic diseases, postoperative infection
- toxic shock syndrome – staphylococcal, streptococcal
- neonatal sepsis, older people, pregnant women

Predisposing factors :

- Diabetes mellitus
- Cirrhosis
- Leukopenia
- Invasive devices
- Prior treatment with antibiotics or corticosteroids
- Recent hospitalization

Common sites of infection - lungs , urinary, biliary, gastrointestinal tracts

- <https://www.global-sepsis-alliance.org/sepsis>

Pathophysiology of Sepsis and Septic shock

- inflammatory stimulus (eg, a bacterial toxin) - proinflammatory mediators (TNF), (IL)-1
- neutrophil–endothelial cell adhesion- clotting mechanism- microthrombi
- other mediators - leukotrienes, lipoxygenase, histamine, bradykinin, serotonin, and IL-2- opposed by anti-inflammatory mediators(IL-4 and IL-10) - negative feedback mechanism
- arteries and arterioles dilate- decreasing peripheral arterial resistance- cardiac output increases - warm shock
- Later - cardiac output may decrease, blood pressure falls
- vasoactive mediators cause blood flow to bypass capillary exchange vessels
- Poor capillary flow - decreases delivery of oxygen
- decreased perfusion - dysfunction / failure of one or more organs
- Coagulopathy - intravascular coagulation, consumption of clotting factors, fibrinolysis

Symptoms of Sepsis and Septic shock

sepsis :

- fever, tachycardia, diaphoresis, tachypnea
- blood pressure remains normal
- signs of the causative infection may be present

septic shock:

- **early sign** – confusion, decreased alertness
- blood pressure decreases, warm skin
- **later** - extremities - cool and pale, peripheral cyanosis
- organ dysfunction - additional symptoms (oliguria, dyspnea)

Diagnosis and Treatment of Sepsis and Septic shock

- Clinical manifestations, blood pressure, heart rate, oxygen monitoring, complete blood count (CBC) with differential, central venous pressure, central venous oxygen saturation
- Sepsis suspected – if known infection develops systemic signs of inflammation /dysfunction
- **culture of urine, blood , body fluids**
- blood levels of C-reactive protein - often elevated in severe sepsis

- broad-spectrum gram-positive and gram-negative bacterial coverage
- antifungal drugs - in immunocompromised
- empiric **gram-positive** coverage – vancomycin, linezolid
- empiric **gram-negative** coverage - broad-spectrum penicillins (eg, piperacillin/tazobactam), 3rd- or 4th-generation cephalosporins, imipenems, aminoglycosides

Endocarditis (infective)

- infection of the endocardium (ie, infective endocarditis)
- occurs at any age, men affected twice as often as women
- intravenous drugs, immunocompromised , prosthetic heart , indwelling intravascular catheters
- normal heart - resistant to infection- bacteria and fungi do not adhere to endocardial surface

2 factors required for endocarditis:

- predisposing abnormality of the endocardium
 - microorganisms in the bloodstream (bacteremia)
-
- (noninfective endocarditis - sterile platelet and fibrin thrombi form on cardiac valves)

Ethiology of Endocarditis (infective)

- Microorganisms – from infected sites (cutaneous abscess, inflamed or infected gums, urinary tract infection)
- implanted foreign material (eg, ventricular or peritoneal shunt, prosthetic device) - risk of bacterial colonization
- result from asymptomatic bacteremia - invasive dental, medical, or surgical procedures
- causative microorganisms – streptococci, *Staphylococcus aureus*, Enterococci, gram-negative bacilli, [HACEK organisms](#) (*Haemophilus* species, *Actinobacillus actinomycetemcomitans*, *Cardiobacterium hominis*, *Eikenella corrodens*, and *Kingella kingae*), and fungi
- causative microorganisms - produce polysaccharide biofilms
- disease develops in 3 stages:
- Bacteremia Adhesion Colonization

Classification of Endocarditis (infective)

1 Subacute bacterial endocarditis (SBE) - progresses slowly (weeks to months)

cause - streptococci (especially viridans, group D streptococci, enterococci)

- less commonly - *S. aureus*, *Staphylococcus epidermidis*,

Haemophilus species

SBE - abnormal valves - after asymptomatic bacteremia - periodontal, gastrointestinal, genitourinary infections

Symptoms - fever ($< 39^{\circ}$ C), night sweats, fatigability, malaise, weight loss, retinal emboli, petechiae, painful erythematous subcutaneous nodules on or near the tips of digits (Osler nodes), transient ischemic attacks, stroke, toxic encephalopathy, if mycotic - CNS aneurysm ruptures, brain abscess, subarachnoid hemorrhage.

Classification of Endocarditis (infective)

2 Acute bacterial endocarditis (ABE)

- progresses rapidly (days)
- affect normal valves
- *S. aureus*, group A hemolytic streptococci, pneumococci, gonococci

Symptoms - similar to subacute bacterial endocarditis - **more rapid**

Classification of Endocarditis (infective)

3 Prosthetic valvular endocarditis (PVE)

- 2 to 3% of patients within 1 year after valve replacement
- more common after aortic valve replacement

Early-onset - (< 2 months after surgery) - cause –
contamination during surgery

(*S. epidermidis*, diphtheroids, coliform bacilli, *Candida* species, *Aspergillus* species)

Late-onset – cause - contamination with low-virulence organisms during surgery

(streptococci; *S. epidermidis*; diphtheroids; gram-negative bacilli, *Haemophilus* species, *Actinobacillus actinomycetemcomitans*, *Cardiobacterium hominis*)

Diagnosis and Treatment of Endocarditis (infective)

- endocarditis - suspected – fever, no obvious source of infection, heart murmur
- blood cultures - positive + heart valve disorder, invasive procedures, IV illicit drugs
- identification of the organism + susceptibility to antimicrobials
- Duke criteria

Diagnosis and Treatment of Endocarditis (infective)

- Blood culture (hemocultivation) - 3 blood samples for culture (20-mL each)
- > 6 hours apart
- acute bacterial endocarditis - 2 cultures within the first 1 to 2 hours)
- each set of cultures - from a separate site (not from preexisting vascular catheters)
- endocarditis + no prior antibiotic therapy = blood cultures usually positive
- prior antimicrobial therapy = results may be negative
- *Aspergillus*) - may not produce positive cultures
- *Coxiella burnetii*, *Bartonella* species, *Chlamydia psittaci*, *Brucella* species) -
- serodiagnosis
- *Legionella pneumophila* - special culture media /PCR

Central venous catheter (CVC) related blood stream infections (CRBSI)

Catheter-related bloodstream infection (CRBSI)

- **presence of bacteremia originating from intravenous catheter**
- the most common cause of nosocomial bacteremia

CVC used for:

- [Kidney dialysis](#) several times a week
- Chemotherapy cancer treatment
- Long-term antibiotic treatment
- Bowel problems requiring supplemental nutrition
- Need for frequent blood tests
- Requirement for self-treatment at home

Central venous catheter related blood stream infections (CRBSI)

- **long-term CVC** - surgically implanted – for prolonged therapy
- **short-term CVC** - do not require surgical implantation
 - **most CVC-related bloodstream infections**

Infections may develop near:

- Exit site
- External catheter surface
- Catheter hub
- Internal catheter surface

Central venous catheter related blood stream infections (CRBSI) - cause

- CVC insertion- CVC coated with plasma proteins- bacteria migrate from skin along the catheter - embedded in protein sheath- **colonization**
- **biofilm**

Central venous catheter related blood stream infections (CRBSI) - criteria

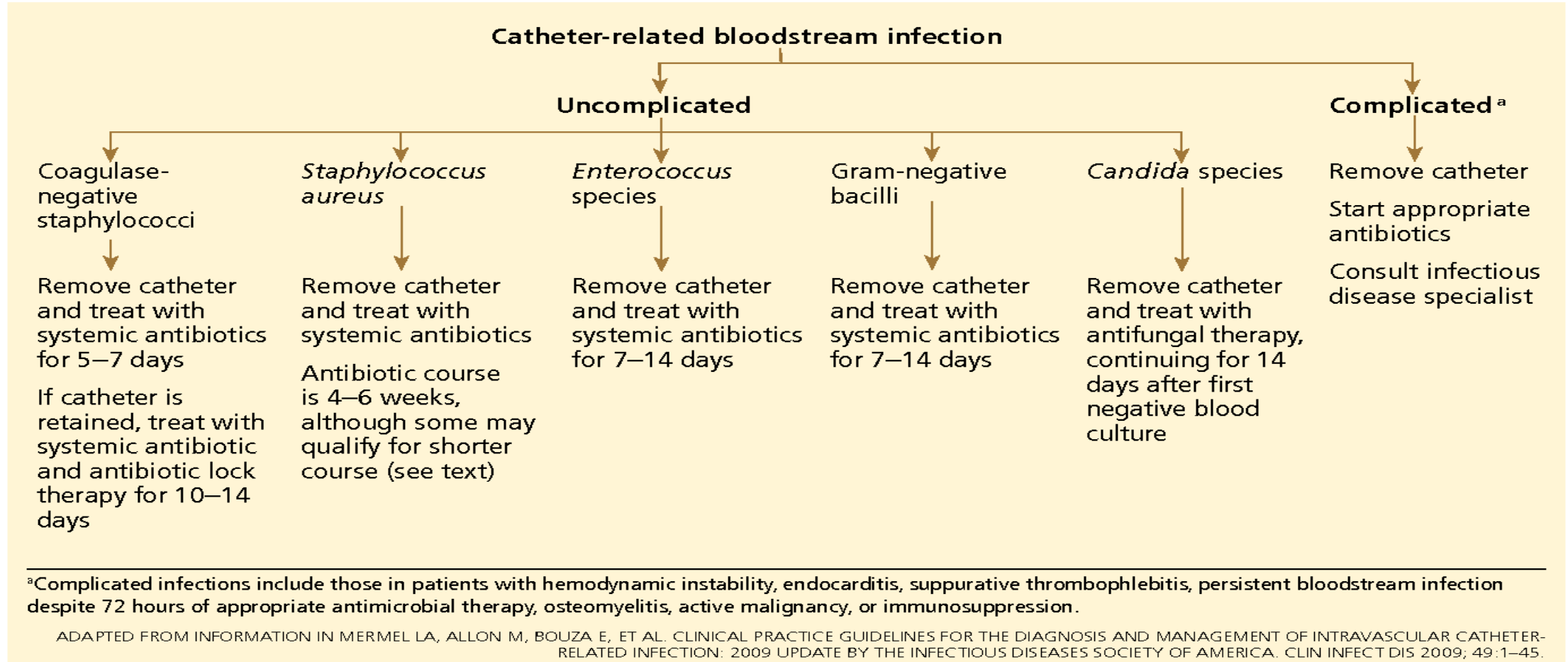
PROBABLE CRBSI

- Clinical manifestations of infection (fever $>38^{\circ}\text{C}$, chills/rigors, or hypotension)
- No apparent source of the sepsis/bloodstream infection other than the catheter
- Common skin organisms (e.g., coagulase-negative staphylococci) isolated from two blood cultures from patients with intravascular device or a known pathogen (*Staphylococcus aureus* or *Candida*) isolated from a single blood culture

DEFINITE CRBSI

- Probable CRBSI criteria outlined above with any of the following:
 - Differential quantitative blood cultures with 5:1 ratio of the same organism isolated from blood drawn simultaneously from the central venous catheter (CVC) and peripheral vein
- or
- Differential positivity time (positive result of culture from a CVC is obtained at least 2 hr earlier than positive result of culture from peripheral blood)
- or
- Positive quantitative skin culture whereby the organism isolated from an infected insertion site is identical to that isolated from blood
- or
- Isolation of the same organisms from the peripheral blood and from a quantitative or semi-quantitative culture of a catheter segment or tip

Central venous catheter related blood stream infections (CRBSI)



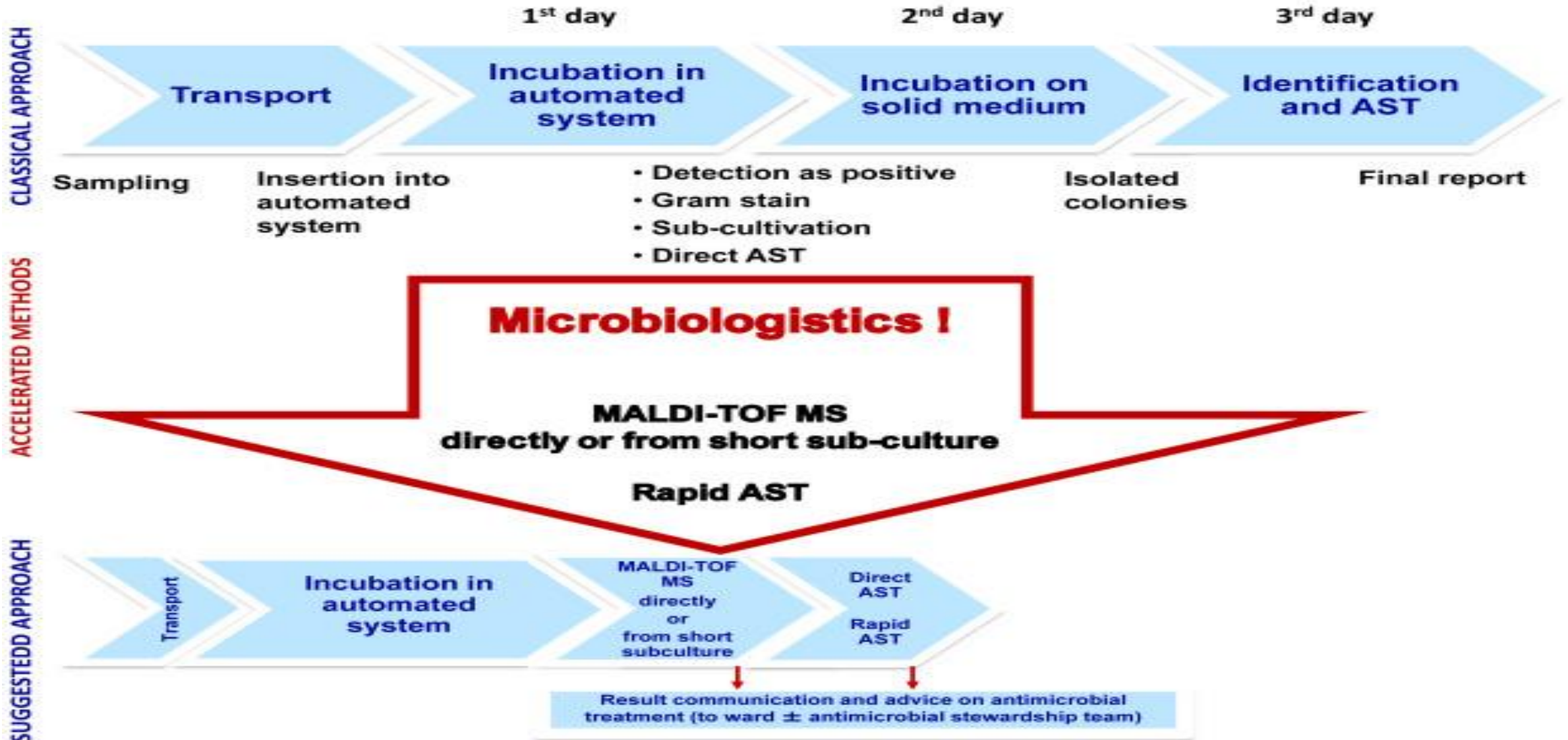
Diagnosis of blood stream infections - hemoculture

- **at least 2 blood samples**
- multiple samples - accurate results
- blood samples - placed in bottles - growth of bacteria/yeast
- sample transport - ideally within **four hours** of collection
- **do not store in a refrigerator**
- positive growth – inoculation of sample - non-selective media + Gram stain

recommended volume of blood:

- Bactec Plus Aerobic/F bottle: 5-10 ml
- Bactec Lytic 10 Anaerobic/F bottle: 5- 10 ml
- Bactec PEDS Plus/F bottle: 1-3 ml

Diagnosis of blood stream infections



sources

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