Blood Cultures and Bloodstream Infections in Adults - Microbiology Full Clinical Guideline

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Introduction

- Microbial invasion establishes infective foci within the cells, tissues, organs, or systems of the body.
- The onset of symptoms and signs marks the transition into disease.
- Microorganisms can disseminate from the localised focus of infection. Microbial invasion of the blood, sepsis, septic shock, organ dysfunction, and death can ensue.

- Bloodstream infection can be caused by every microbial kingdom.
- Bloodstream infection with bacteria (i.e. bacteraemia) can be caused by Gram positives (bacterial cell wall with inner cytoplasmic membrane and thick peptidoglycan layer) and Gram negatives (bacterial cell wall with inner cytoplasmic membrane, thin peptidoglycan layer, and outer membrane):
    - *Staphylococcus aureus* and *Streptococcus pneumoniae* are examples of Gram positive pathogens capable of causing bacteraemia.
    - *Escherichia coli*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* are examples of Gram negative pathogens capable of causing bacteraemia.
- Bloodstream infection with fungi (i.e. fungaemia) can be caused by yeasts and moulds; however, only yeasts, presently, are commonly detected via blood culture:
    - *Candida* species are an example of yeasts capable of causing fungaemia.

Investigation: blood cultures

Indications

- Blood cultures enable the culture of bacteria and fungi from blood.
- Investigation with blood cultures requires healthcare professionals to combine their clinical acumen with the diverse symptoms, signs, and investigative findings of infection.
- Bloodstream infection, and progression into sepsis or septic shock, can be marked by:
    - Symptoms and signs:
        - Body system stigmata; obtundation, temperature > 38°C or < 36°C; flushed and warm skin, or cyanosed and cool skin; respiratory rate > 20 breaths/minute; hypotension, heart rate > 90 beats/minute; oliguria, anuria; absent bowel sounds.
    - Investigative findings:
        - White blood cells > 12×10^9/l or < 4×10^9/l, thrombocytopenia; activated partial thromboplastin time prolongation or international normalised ratio raised, C-reactive protein raised, creatinine increase, hypoxemia, hyperbilirubinema, hyperglycaemia, hypokalaemia, hyponatraemia, lactate raised.
- Indications for initial blood cultures include:
    - Differential diagnoses of:
        - Bloodstream infection, sepsis, or septic shock; or
        - Infective endocarditis; or
        - Central venous catheter infection.

Blood, blood culture bottles, and specimen transport

- With the blood culture procedure outlined (Appendix 1):
    - Introduce 8-10 ml of blood into an aerobic bottle and 8-10 ml of blood into an anaerobic bottle:

If the differential diagnosis includes bloodstream infection, sepsis, or septic shock	Blood cultures ≥ × 2; drawn approximately 1-15 minutes apart; from ≥ 2 locations/venepunctures
If the differential diagnosis includes infective endocarditis	If the patient is clinically stable: blood cultures × 3; drawn approximately 12 hours apart; from 3 locations/venepunctures If the patient is clinically unstable, blood cultures × 3; drawn approximately 1-15 minutes apart; from 3 locations/venepunctures
If the differential diagnosis includes central venous catheter infection	Paired blood cultures: centrally (if multiple lumens, blood cultures from every catheter hub) and peripherally

- Blood culture bottles to be transported:
    - In a sealed, plastic bag to pathology reception; and
    - In timely fashion to ensure ≤ 4 hours from venepuncture to loading onto a continuous monitoring blood culture system.

Specimen processing: clinical details

- The provision of clinical details is the responsibility of the requesting healthcare professional.
- The provision of clinical details:
    - Enables optimal investigation of the patient; and
    - Safeguards the medical laboratory assistants (MLA) and biomedical scientists (BMS) processing the blood cultures; and
    - Enables optimal vetting, prioritising, and guidance from the consultant microbiologist.
- Clinical details that facilitate optimal investigation by the microbiology team are:
    - The history and examination findings; and/or
    - Differential diagnoses; and/or
    - The location of the blood culture sample (peripheral or central; type of vascular catheter; lumen colour); and/or
    - Past, present, or future antimicrobial chemotherapy.

Specimen processing: microscopy

- Aerobic and anaerobic bottles are continuously monitored for metabolic evidence of growth.
- Blood culture bottles that flag positive are processed by the MLA and BMS laboratory team.
- Fluid from the aerobic and/or anaerobic bottles is, firstly, subjected to microscopy with Gram stain.
- In both the Royal Derby Hospital (RDH) and Queen's Hospital Burton (QHB), the BMS reports findings of either bacteria or fungi:
    - With regard to the more common finding of bacteria, the BMS records:
        - The presence of Gram positive/negative/variable bacteria; and

        - Spherical (coccus), rod (bacillus), or coccobacillus shapes; and
        - Resemblance to staphylococci, streptococci, etc.
    - With regard to the less common finding of fungi, the BMS records:
        - The presence of yeasts.

Specimen processing: culture and bacterial susceptibilities

- After microscopy, fluid from the aerobic and/or anaerobic bottles is cultured.
- The culture plates may be:
    - Reviewed after ≥ 4 hours and:
        - In the RDH, subjected to matrix assisted laser desorption ionisation (MALDI) time of flight (TOF) mass spectrometry to enable rapid preliminary identification; or
        - In the QHB, subjected to biochemical tests (for example, catalase and coagulase for Gram positive cocci, and oxidase for Gram negative bacilli) to enable rapid preliminary identification.
    - Reviewed after overnight incubation.
- Final identifications are released, in general, the day after the microscopy result.
- After culture, significant bacterial isolates are (or fluid from the aerobic and/or anaerobic bottles is) next subjected to anti-bacterial susceptibility testing:
    - Resistances and susceptibilities are detected either by:
        - Disk diffusion; or
        - Concentration gradient.
- Antibiograms are released, in general, ≥ 24 hours after the microscopy result.
- If in-house MALDI-TOF and metabolic panels are unsuccessful, or if disk diffusion and concentration gradients are unsuccessful, potentially significant bacterial isolates may be referred to reference laboratories for further identification and/or susceptibility testing.

Specimen processing: fungal susceptibilities

- Yeasts are referred to either the Chesterfield Royal Hospital or the Mycology Reference Laboratory for susceptibility testing.

Specimen processing: communication of microscopy, culture, and susceptibilities

- In general, the microbiologist responsible for sterile sites communicates microscopy, culture, and susceptibility results to the medical and surgical teams.
- The microscopy and culture results are reviewed with:
    - The clinical details from the requesting healthcare professional; and
    - Further information on Lorenzo/Meditech.
- The microscopy and/or cultures are vetted and prioritised, and significant microscopies/isolates are communicated either:
    - On the medical and surgical wards to the healthcare professionals; or
    - From the microbiology department to the teams.
- The microscopy and culture results enable microbiologists to provide guidance to the medical and surgical teams regarding:
    - Potential foci of infection; and
    - Potential associated pathologies; and
    - Investigation; and
    - Treatment with empiric intravenous (IV) or per oral (PO) antibiotics.
- The susceptibilities and resistances enable microbiologists to provide further guidance to the medical and surgical teams regarding:

    - Rationalisation of therapy; and
    - Narrowing of antimicrobial spectrum; and
    - PO step down; and
    - Outpatient parenteral antimicrobial therapy (OPAT) options; and
    - Duration of treatment.

- NB Please note the pivotal nature of the clinical details to the communication:
    - If the microscopy and/or culture – in combination with the clinical details – are deemed significant:
        - The consultant microbiologist ensures timely communication and release of results.
    - If the microscopy and/or culture – in combination with the clinical details – are deemed questionable:
        - The consultant microbiologist may release the results without direct communication.
    - To illustrate:
        - Blood cultures with clinical details "," or "." growing coagulase negative staphylococci could be authorised without direct communication and with pathology safety netting comments only.
        - However, coagulase negative staphylococci bacteraemia with the clinical details "Prosthetic valve. Fever. ?Endocarditis? For vancomycin/teicoplanin." would be communicated promptly, with consultant microbiologist guidance regarding infectious diseases management.

Investigation: repeat blood cultures

- Patients that have had initial blood culture investigation can, periodically, require blood culture repeats.
- Indications include:
    - Clinical deterioration (for example, total NEWS2 score of ≥ 5), with concerns re bloodstream infection/sepsis/septic shock, on broad spectrum antibiotics.
    - Escalation of treatment from one broad spectrum antibiotic to a second line antimicrobial.
    - A differential diagnosis of infective endocarditis.
    - A differential diagnosis of central venous catheter infection.
    - A diagnosis of *Staphylococcus aureus* bloodstream infection:
        - For evidence of clearance.
    - A diagnosis of *Candida* species bloodstream infection:
        - For evidence of clearance.
- NB Periodically, patients may spike temperatures once, twice, thrice, or more during the day. The answer to the question of investigating with blood culture repeats × 1, × 2, × 3, or more remains unanswered. A pragmatic approach – extrapolating from infective endocarditis investigation for persistent bacteraemia – could be blood cultures × 3 within a 24 hour period.

Management: *Staphylococcus aureus* bloodstream infection (https://derby.koha-ptfs.co.uk/cgi-bin/koha/opac-detail.pl?biblionumber=1881)

- The bacteria *Staphylococcus aureus* is:
    - Gram positive; and
    - Spherically shaped (coccus).
- *Staphylococcus aureus* bloodstream infection can be community or hospital acquired in origin.

- *Staphylococcus aureus* bloodstream infection is associated with mortality rates of 20-40%.

Risk factors

- *Staphylococcus aureus* bloodstream infection is associated with a diverse array of risk factors including:
    - Past medical history:
        - Immunodeficiency (e.g. human immunodeficiency virus [HIV]).
        - Dialysis.
        - Diabetes mellitus.
        - Medical devices (e.g. cardiac device, central/peripheral venous catheter); surgical devices (e.g. orthopaedic prosthesis).
    - Drug history:
        - Corticosteroids.
    - Social history:
        - IV drug use.
    - Investigative history:
        - *Staphylococcus aureus* nasal colonisation.

Investigation

- *Staphylococcus aureus* can invade every body system.
- Notable organs, systems, and devices associated with *Staphylococcus aureus* bloodstream infection include the heart, bones, joints, soft tissues, and vascular catheters.
- *Staphylococcus aureus* bloodstream infection can, therefore, require:
    - Revisiting the history and re-examining for symptoms and signs of native and prosthetic valve infective endocarditis:
        - Echocardiogram is mandatory:
            - The frequency of infective endocarditis ranges from 25-32%.
        - Repeat blood cultures are mandatory, on anti-staphylococcal chemotherapy, 2-3 days after the first culture of *Staphylococcus aureus*:
            - The likelihood of infective endocarditis increases if repeat blood cultures reculture *Staphylococcus aureus*.
    - Revisiting the history and re-examining for symptoms and signs of musculoskeletal system disease:
        - With ± extra investigations as per hospital guidelines on:
            - Vertebral osteomyelitis and discitis, spinal epidural abscess, chronic osteomyelitis of upper and lower limbs, septic arthritis, and prosthetic joint infection.
    - Revisiting the history and re-examining for symptoms and signs of superficial (e.g. cellulitis) and deep (e.g. splenic abscess) soft tissue infection:
        - With ± extra investigations as per hospital guidelines on:
            - Erysipelas and cellulitis.
        - With ± imaging of the spleen.
    - Re-visiting the past medical history for cardiac devices, central/peripheral venous catheters, et cetera:
        - With ± extra investigations as per hospital guidelines on:
            - Cardiac implantable electronic device lead infection, cardiac implantable electronic device pocket infection, and central venous catheter infection.

- NB Case by case, *Staphylococcus aureus* bloodstream infection may warrant evaluation for underlying risk factors.

Treatment (with susceptibilities)

- IV antibiotics – with antimicrobial spectrums that encompass methicillin susceptible *Staphylococcus aureus* (MSSA) – include:
    - Flucloxacillin 2 g 6 hourly.
    - Cefuroxime 1.5 g 8 hourly.
    - Vancomycin; teicoplanin.
- IV antibiotics – with antimicrobial spectrums that encompass methicillin resistant *Staphylococcus aureus* – include:
    - Vancomycin; teicoplanin.
    - Daptomycin ≥ 6 mg/kg 24 hourly.
    - Linezolid 600 mg 12 hourly.
- In general, microbiologists rationalise therapy and reduce antibiotic spectra to the narrowest range of anti-bacterial activity.
- Duration of antibiotics requires tailoring to the specific patient, in collaborative discussion with the consultant microbiologist.
    - In general, antibiotics (IV and PO total) ≥ 14 days:
        - The medical literature is relatively uniform in recommending that anti-staphylococcal therapy for ≥ 2 weeks represents best practice. However, opinions vary regarding the proportion of the ≥ 14 days that is administered either IV or PO.
            - If there are:
                - Neither symptoms nor signs of deep (e.g. heart, bone, joint) foci of infection; and
                - The echocardiogram is negative re infective endocarditis; and
                - Repeat blood cultures provide evidence of clearance

              After IV antibiotics for 7 days, collaborative discussions between microbiologists and healthcare professionals may culminate in PO step down.
            - Equally, if there are:
                - Differentials or diagnoses of deep (e.g. heart, bone, joint) foci of infection

              After IV antibiotics for 7 days, collaborative discussions between microbiologists and healthcare professionals may culminate in prolonged IV therapy.
    - Regarding specific musculoskeletal and cardiovascular system, deep foci of infection:
        - Durations as per hospital guidelines on:
            - Vertebral osteomyelitis and discitis, spinal epidural abscess, chronic osteomyelitis of upper and lower limbs, septic arthritis, and prosthetic joint infection.
            - Native and prosthetic valve infective endocarditis, cardiac implantable electronic device lead infection, cardiac implantable electronic device pocket infection, and central venous catheter infection.
    - Regarding specific integumentary, superficial foci:
        - Cellulitis: IV antibiotics for 7-14 days; PO step down and duration to be tailored to the patient in collaboration with the microbiology consultant; antibiotics (IV and PO total) minimum of 14 days.

        - Cutaneous abscess: incision and drainage (I&D); IV antibiotics for 7-14 days; PO step down and duration to be tailored to the patient in collaboration with the microbiology consultant; antibiotics (IV and PO total) minimum of 14 days, from the date of I&D.
- NB In the context of immunocompromise, please ensure discussion of antibiotics, including duration, between the specialty team and the microbiology consultant.

Management: *Streptococcus pneumoniae* bloodstream infection

- The bacteria *Streptococcus pneumoniae* is:
    - Gram positive; and
    - Spherically shaped (coccus).
- *Streptococcus pneumoniae* bloodstream infection is more commonly community acquired (rather than hospital acquired) in origin.
- *Streptococcus pneumoniae* bloodstream infection is associated with mortality rates of 15-20%.

Risk factors

- Invasive pneumococcal disease is associated with an eclectic array of risk factors including:
    - Paediatric (< 2 years) and geriatric (≥ 65 years) subpopulations.
    - Past medical history:
        - Chronic pulmonary disease (e.g. asthma, chronic obstructive pulmonary disease).
        - Chronic cardiovascular disease (e.g. cardiomyopathy, heart failure); immunodeficiency (e.g. haematologic malignancy, hematopoietic cell transplant, solid organ transplant, HIV); impaired splenic function (e.g. sickle cell disease, splenectomy).
        - Chronic renal failure.
        - Chronic liver disease (e.g. cirrhosis); inflammatory bowel disease.
        - Diabetes mellitus.
    - Drug history:
        - Glucocorticoids.
    - Social history:
        - Alcohol abuse; cigarettes; crack cocaine use; opioid use.

Investigation

- *Streptococcus pneumoniae* can invade every body system.
- Notable organs and systems associated with *Streptococcus pneumoniae* bloodstream infection include the lung and central nervous system. Rarely, invasive disease can cause the triad of pneumococcal pneumonia, endocarditis, and meningitis (Austrian's syndrome/Osler's triad).
- *Streptococcus pneumoniae* bloodstream infection can, therefore, require:
    - Revisiting the history and re-examining for symptoms and signs of respiratory system disease:
        - With ± extra investigations as per hospital guidelines on:
            - Community-acquired pneumonia.
    - Revisiting the history and re-examining for symptoms and signs of central nervous system disease:
        - With ± extra investigations as per hospital guidelines on:
            - Community-acquired meningitis.

        - Revisiting the history and re-examining for symptoms and signs of cardiovascular system disease:
            - With ± extra investigations as per hospital guidelines on:
                - Native and prosthetic valve infective endocarditis.
- NB Case by case, *Streptococcus pneumoniae* bloodstream infection may warrant evaluation for underlying risk factors. For example, investigation for immunodeficiency (e.g. HIV, multiple myeloma) or impaired splenic function.

Treatment (with susceptibilities)

- IV antibiotics – with antimicrobial spectrums that encompass *Streptococcus pneumoniae* – include:
    - Benzylpenicillin 1.2 g 6 hourly.
    - Cefuroxime 1.5 g 8 hourly.
    - Vancomycin; teicoplanin.
    - Co-trimoxazole 960 mg 12 hourly.
    - Levofloxacin 500 mg 12 hourly.
- PO antibiotics – with antimicrobial spectrums that encompass *Streptococcus pneumoniae* – include:
    - Amoxicillin 500 mg – 1 g 8 hourly.
    - Clarithromycin 500 mg 12 hourly.
    - Doxycycline 100 mg 24 hourly.
    - Co-trimoxazole 960 mg 12 hourly.
    - Levofloxacin 500 mg 12 hourly.
- In general, microbiologists rationalise therapy and reduce antibiotic spectra to the narrowest range of anti-bacterial activity.
- Duration of antibiotics requires tailoring to the specific patient, in collaborative discussion with the consultant microbiologist.
    - In general, antibiotics (IV and PO total) ≥ 7 days, e.g. IV 2 days and PO ≥ 5 days.
- NB In the context of immunocompromise, please ensure discussion of antibiotics, including duration, between the specialty team and the microbiology consultant.

Management: *Escherichia coli* and *Klebsiella pneumoniae* bloodstream infection

- The bacteria *Escherichia coli* and *Klebsiella pneumoniae* are:
    - Gram negative; and
    - Rod shaped (bacillus).
- *Escherichia coli* and *Klebsiella pneumoniae* bloodstream infection can be community or hospital acquired in origin.
- Gram negative bloodstream infection is associated with mortality rates of 12-38%.

Risk factors

- Gram negative bloodstream infection is associated with a diverse array of risk factors including:
    - Past medical history:
        - Vascular device (insertion, in situ, or removal); immunodeficiency (e.g. hematopoietic stem cell transplant, solid organ transplant, HIV); neutropenia; hypoalbuminaemia.
        - Chronic haemodialysis; urinary retention; urinary catheterisation (insertion, in situ, or removal); urogenital surgery.

        - Endoscopic retrograde cholangiopancreatography; gastrointestinal surgery; liver failure.
        - Diabetes mellitus.
        - Prostate biopsy.
        - Pulmonary disease.
    - Drug history:
        - Glucocorticoids.

Investigation

- *Escherichia coli* and *Klebsiella pneumoniae* can invade every body system.
- Notable organs and systems associated with community and hospital acquired Gram negative bloodstream infection include the urinary and gastrointestinal tracts. Hospital acquired *Escherichia coli* and *Klebsiella pneumoniae* bloodstream infection can also be associated with the respiratory tract.
- Gram negative bloodstream infection can, therefore, require:
    - Revisiting the history and re-examining for symptoms and signs of urinary system disease:
        - With ± extra investigations as per hospital guidelines on:
            - Urinary tract infection.
    - Revisiting the history and re-examining for symptoms and signs of gastrointestinal system disease:
        - With ± extra investigations as per hospital guidelines on:
            - Acute cholecystitis, acute cholangitis, infected necrotising pancreatitis, intra-abdominal peritonitis (lower gastrointestinal tract origin), and intra-peritoneal abscess.
    - Revisiting the history and re-examining for symptoms and signs of respiratory system disease:
        - With ± extra investigations as per hospital guidelines on:
            - Hospital-acquired pneumonia.
- NB Case by case, *Escherichia coli* and *Klebsiella pneumoniae* bloodstream infection may warrant evaluation for underlying risk factors.

Treatment (with susceptibilities)

- IV antibiotics – with antimicrobial spectrums that encompass *Escherichia coli* and *Klebsiella pneumoniae* – include:
    - Piperacillin tazobactam 4.5 g 8 hourly; co-amoxiclav 1.2 g 8 hourly (*Escherichia coli* can also be susceptible to amoxicillin 1 g 8 hourly).
    - Cefuroxime 1.5 g 8 hourly.
    - Co-trimoxazole 960 mg 12 hourly.
    - Ciprofloxacin 400 mg 12 hourly.
- PO antibiotics – with antimicrobial spectrums that encompass *Escherichia coli* and *Klebsiella pneumoniae* – include:
    - Co-amoxiclav 625 mg plus amoxicillin 500 mg 8 hourly (*Escherichia coli* can also be susceptible to amoxicillin 1 g 8 hourly).
    - Co-trimoxazole 960 mg 12 hourly.
    - Ciprofloxacin 500 mg 12 hourly.
- In general, microbiologists rationalise therapy and reduce antibiotic spectra to the narrowest range of anti-bacterial activity.
- Duration of antibiotics requires tailoring to the specific patient, in collaborative discussion with the consultant microbiologist.
    - In general, antibiotics (IV and PO total) ≥ 7 days, e.g. IV 2 days and PO ≥ 5 days.

- NB In the context of immunocompromise, please ensure discussion of antibiotics, including duration, between the specialty team and the microbiology consultant.

Management: *Pseudomonas aeruginosa* bloodstream infection

- The bacteria *Pseudomonas aeruginosa* is:
    - Gram negative; and
    - Rod shaped (bacillus).
- *Pseudomonas aeruginosa* bloodstream infection is more commonly hospital acquired (rather than community acquired) in origin.
- *Pseudomonas aeruginosa* bloodstream infection is associated with mortality rates of 30-39%.

Risk factors

- *Pseudomonas aeruginosa* bloodstream infection is associated with an eclectic array of risk factors including:
    - Geriatric (≥ 65 years) subpopulations; recent hospitalisation.
    - Past medical history:
        - Central venous catheter; immunodeficiency (e.g. haematologic malignancy, bone marrow transplant, solid organ transplant, HIV); neutropenia.
        - Urinary catheter.
        - Pancreatic and biliary tract disease.
        - Burns; soft tissue trauma associated with fresh water exposure.
    - Drug history:
        - Antimicrobial chemotherapy in the past 3 months.

Investigation

- *Pseudomonas aeruginosa* can invade every body system.
- Notable organs, systems, and devices associated with *Pseudomonas aeruginosa* bloodstream infection include the gastrointestinal tract, biliary tract, urinary tract, vascular catheters, lung, and ± soft tissues.
- *Pseudomonas aeruginosa* bloodstream infection can, therefore, require:
    - Revisiting the history and re-examining for symptoms and signs of gastrointestinal system disease:
        - With ± extra investigations; as per hospital guidelines on:
            - Acute cholecystitis and infected necrotising pancreatitis.
    - Revisiting the history and re-examining for symptoms and signs of urinary system disease:
        - With ± extra investigations; as per hospital guidelines on:
            - Urinary tract infection.
    - Re-visiting the past medical history for central venous catheters:
        - With ± extra investigations; as per hospital guidelines on:
            - Central venous catheter infection.
    - Revisiting the history and re-examining for symptoms and signs of respiratory system disease:
        - With ± extra investigations; as per hospital guidelines on:
            - Hospital-acquired pneumonia.
- NB Case by case, *Pseudomonas aeruginosa* bloodstream infection may warrant evaluation for underlying risk factors.

Treatment (with susceptibilities)

- IV antibiotics – with antimicrobial spectrums that encompass *Pseudomonas aeruginosa* – include:
    - Piperacillin tazobactam 4.5 g 6 hourly.
    - Ceftazidime 2 g 8 hourly.
    - Meropenem 1 g 8 hourly.
    - Ciprofloxacin 400 mg 8 hourly.
- PO antibiotics – with antimicrobial spectrums that encompass *Pseudomonas aeruginosa* – are limited and include:
    - Ciprofloxacin 750 mg 12 hourly.
- In general, microbiologists rationalise therapy and reduce antibiotic spectra to the narrowest range of anti-bacterial activity.
- Duration of antibiotics requires tailoring to the specific patient, in collaborative discussion with the consultant microbiologist.
    - In general, antibiotics (IV and PO total) ≥ 7 days, e.g. IV 2 days and PO ≥ 5 days.
- NB In the context of immunocompromise, please ensure discussion of antibiotics, including duration, between the specialty team and the microbiology consultant.

Management: *Candida* species bloodstream infection

- *Candida* species bloodstream infection can be community or hospital acquired in origin.
- *Candida* species bloodstream infection is associated with mortality rates of 19-25%.

Risk factors

- *Candida* species bloodstream infection is associated with a diverse array of risk factors including:
    - Intensive care unit (level of healthcare).
    - Past medical history:
        - Central venous catheter; immunodeficiency (e.g. haematologic malignancy, hematopoietic cell transplant, solid organ transplant).
        - Acute renal failure; haemodialysis.
        - Total parenteral nutrition; gastrointestinal tract perforation; abdominal surgery; anastomotic leak.
        - Burns.
    - Drug history:
        - Broad spectrum antibiotics.
        - Immunosuppression (e.g. glucocorticoids).

Investigation

- Notable organs and systems associated with *Candida* species bloodstream infection include the heart, eye, and ± spleen.
- *Candida* species bloodstream infection can, therefore, require:
    - Revisiting the history and re-examining for symptoms and signs of native and prosthetic valve infective endocarditis:
        - Echocardiogram is recommended.
        - Repeat blood cultures are also recommended for evidence of clearance.
    - Revisiting the history and re-examining for symptoms and signs of eye disease:
        - Ophthalmology review is recommended.

- Revisiting the history and re-examining for symptoms and signs of deep (e.g. splenic abscess) soft tissue infection:
    - With ± imaging of the spleen.

Treatment (with susceptibilities)

- IV antibiotics – with antimicrobial spectrums that encompass *Candida* species – include:
    - Caspofungin:
        - If ≥ 81 kg, 70 mg intravenously 24 hourly.
        - If < 81 kg, 70 mg intravenously for the first 24 hours, and 50 mg intravenously 24 hourly thereafter.
    - Ambisome®: 3 mg/kg intravenously 24 hourly.
    - Fluconazole:
        - *Candida albicans*: 800 mg intravenously for the first 24 hours, and 400 mg intravenously 24 hourly thereafter.
        - *Candida glabrata*: 800 mg intravenously 24 hourly.
        - Other *Candida* species: collaborate with the microbiologist.
- PO antibiotics – with antimicrobial spectrums that encompass *Candida* species – are limited and include:
    - Fluconazole:
        - *Candida albicans*: 400 mg orally 24 hourly.
        - *Candida glabrata*: 800 mg orally 24 hourly.
        - Other *Candida* species: collaborate with the microbiologist.
    - Voriconazole 400 mg orally 12 hourly for the first 24 hours, and 200 mg orally 12 hourly thereafter. Therapeutic drug monitoring (TDM) recommended.
    - Posaconazole 300 mg tablet 12 hourly for the first 24 hours, and 300 mg tablet 24 hourly thereafter. TDM recommended.
- In general, microbiologists rationalise therapy and reduce antibiotic spectra to the narrowest range of anti-fungal activity.
- Duration of antibiotics requires tailoring to the specific patient, in collaborative discussion with the consultant microbiologist.
    - In general, if there is no evidence of fungal endophthalmitis/infective endocarditis:
        - Anti-fungals ≥ 2 weeks:
            - From reconstitution of immune function; and
            - From the first negative, repeat blood cultures.
- NB In the context of immunocompromise, please ensure discussion of antibiotics, including duration, between the specialty team and the microbiology consultant.

Appendix 1

PROCEDURE FOR TAKING A BLOOD CULTURE SAMPLE (printed on the sample collection packs)

Step 1: Equipment preparation

- Wash and dry your hands or use alcohol hand rub.
- Gather all equipment: a blood culture pack, gloves, sharps bin and place on a pre prepared ANTT tray, following ANTT principles
- Ensure that barcodes on the bottles are not covered by additional labels and that any tear-off barcode labels are not removed.
- Check the bottom of the blood culture bottle and do not use if there is a central yellow spot which indicates the bottle is contaminated.

↓

Step 2: Patient preparation

- Positively identify patient as per Trust policy and obtain verbal consent.
- Apply a disposable tourniquet **(included in the pack)** and palpate to identify an appropriate vein.
- Wash and dry hands or use alcohol hand rub and apply clean examination gloves (sterile gloves are not necessary)
- Clean any visibly soiled skin on the patient with soap and water then dry.
- Clean patient's skin with a 2% chlorhexidine in 70% isopropyl alcohol using the non touch pad (**Chloraprep Frepp in the pack**) for 30 seconds and allow drying for 60secseconds.
- If a culture is being collected from a central venous catheter, disinfect the access port with a 2% chlorhexidine in 70% isopropyl alcohol impregnated wipe. Please note blood cultures must only taken from CVCs if blood cannot be obtained from a peripheral vein or when a line related sepsis is suspected, then paired specimens should be obtained.
- Remove plastic caps and clean the top of each culture bottles with a separate 2% chlorhexidine in 70% isopropyl alcohol impregnated wipe (**Sani-cloths in the pack**) and allow to dry.

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Step 3: Sample collection

- Attach winged blood collection set **(in the pack)** to a blood collection adapter cap **(in the pack).**
- Insert needle into prepared site. **IMPORTANT:** Do not re- palpate vein again after cleaning.
- Place adapter cap over blood culture bottle **(in the pack)** and pierce septum. **IMPORTANT**: Fill Aerobic bottle first (blue top)
- Hold bottle upright and use the bottle graduation lines to accurately gauge sample volume and collect 10mls into each sample bottle.
- If blood is being collected for other tests, always collect the blood culture samples first. (see local vacutainer guides for order of draw)
- Release tourniquet and dispose.
- Remove the needle from the vein using the in vein activator on the collection set.
- Cover the puncture site with an appropriate dressing.
- Discard winged blood collection set in a sharps container.
- Label the bottles, including the collection site, ie, peripheral.
- Wash hands after removing gloves.
- Record the procedure with indication for culture and any complications in the patient's record. Also complete the audit sticker **(in the pack)** and place in patient record.

Appendix 2

Blood Culture **Only**
Practical Competency Assessment Form

Division		**Ward/Department**	
Full Name (as it appears on payslip)			
Job Title		**Assessors Name**	
Date		**Job Title**	

Please ensure that all details are legible. Failure to do so will result in your competency not being recorded and you will be required to re-attend training.

Preparation Zone	Yes	No
Effective hand washing was undertaken initially		Fail
Preparation took place in an appropriate setting		Fail
Practitioner adheres to Dress Code and appropriate use of Personal Protective Equipment (PPE)		Advise
Appropriate aseptic field selected		Fail
General aseptic field (if selected) was cleaned with 70% isopropyl alcohol wipe and allowed to fully air dry for at least 30 seconds		Fail
Check expiry date and the bottom of the blood culture bottle and do not use if there is a central yellow spot which indicates the bottle is contaminated		Fail
All key parts remain protected throughout preparation		Fail
Patient Zone	**Yes**	**No**
Positive Patient Identification is undertaken and informed consent sought to continue with procedure		Advise
Removes plastic caps and clean the top of each culture bottle with a separate 2% chlorhexidine in 70% isopropyl alcohol impregnated wipe and allow to dry for at least 30 seconds before continuing		Fail
Non-sterile key parts cleaned with an approved wipe and allowed to fully air dry		Fail
Apply tourniquet from pack, palpate and identify vein		Advise
Perform hand hygiene and apply gloves		Fail
Open Chloraprep Frepp, squeeze handle to click and activate, wipe north-south, east-west not circular for 30 seconds and allow to dry for at least 30 seconds before continuing		Fail
Unsheath butterfly needle, do not re-palpate vein, insert needle without compromising aseptic area, check for flashback Optional Secure 1 wing in north-south direction with tape		Fail
Place adapter cap over upright blood culture bottle (blue aerobic bottle first) and pierce septum to fill with 10mls of blood into each sample bottle. Release tourniquet and follow with other bloods if necessary		Fail
Release tape, place gauze swab over insertion site, activates safer sharp whilst needle is still insitu. Ensure haemostasis		Fail
Disposal and Documentation	**Yes**	**No**
Equipment disposed of correctly with regards to waste management and the safe handling and direct disposal of sharps		Advise
Effective hand washing was undertaken on completion of the procedure		Fail
Label bottles from patient (include the collection site), complete blue audit label and put in notes, clear away equipment and dispose of correctly. Send bottles to the lab immediately.		Advise

Outcome of Assessment

☐ **Pass**

☐ **Fail** (please outline action plan on reverse of this form)

Assessor Signature: _____

Practitioner Signature: **X**_____

Action plan or Comments

References

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Document control

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