Peripheral Venous Catheter Infection - Microbiology Full Clinical Guideline

Reference number: CG-ANTI/4006/22

Introduction

- Peripheral venous catheters breach the integrity of the skin.
- The skin breach may enable invasion by colonising microorganisms.
- Common causes of superficial, soft tissue infection include *Staphylococcus aureus* and beta haemolytic streptococci.
- The commonest causes of peripheral venous catheter with bloodstream infection are Gram positive cocci:
    - *Staphylococcus aureus*.
    - Coagulase negative staphylococci, e.g. *Staphylococcus epidermidis*.
    - *Enterococcus* species.
- Other notable causes of peripheral venous catheter with bloodstream infection are Enterobacteriaceae (e.g. *Enterobacter* species, *Escherichia coli*, *Klebsiella* species), and *Pseudomonas aeruginosa*.
- The microbial invasion and host inflammation may manifest itself with pain, erythema, warmth, tenderness, and swelling of the skin.
- Temperatures > 38 ° C or < 36 ° C, respiratory rate > 20 breaths/minute, heart rate > 90 beats/minute, and hypotension can denote progression of localised infectious disease into sepsis and septic shock.
- NB Please note that specific hospital guidelines exist for central venous catheter infection.

Investigation

- Blood sciences:
    - Full blood count (FBC), C reactive protein (CRP), lactate, urea and electrolytes (U&E), and liver function tests (LFT).
- Microbiology:
    - ± Tip for culture and susceptibilities: for example, if clinical concerns re bloodstream infection, sepsis, or septic shock.
    - ± Pus/Wound swab: e.g. if purulent discharge.
    - ± Blood cultures. Indications for initial blood cultures include:
        - Differential diagnoses of bloodstream infection, sepsis, or septic shock.
        - Initiation of treatment with intravenous antibiotics.

Treatment: peripheral venous catheter localised infection **without** sepsis

Removal of the peripheral venous catheter

- The insertion of peripheral venous catheters introduces foreign devices into sterile sites.
- In general, host responses to foreign devices include a macromolecule-coating; microbial adherence to this protein-coat facilitates invasion; and microorganism biofilm formation enables persistence.
- Therefore, removal of the peripheral venous catheter is recommended.

Empiric, per oral antibiotics

- With anti-bacterial spectra covering the commonest causes of superficial, soft tissue infection:
    - First line: flucloxacillin 1 g 6 hourly.
    - Second line: clarithromycin 500 mg 12 hourly.
    - Third line: doxycycline 100 mg 12 hourly.
    - Fourth line: clindamycin 300-450 mg 6 hourly.
    - Fifth line: linezolid 600 mg 12 hourly.

Empiric, intravenous antibiotics

- With anti-bacterial spectra covering the commonest causes of superficial, soft tissue infection:
    - First line: flucloxacillin 2 g 6 hourly.
    - Second line, if penicillin allergy and/or clinical concerns re the risk of methicillin resistant *Staphylococcus aureus* (MRSA): glycopeptide (vancomycin or teicoplanin), dose as per hospital guidelines, vancomycin target pre dose level 15-20 mg/l, teicoplanin target pre dose level 15-30 mg/l.
    - Third line, if penicillin allergy: clindamycin 600 mg 6 hourly.
    - Fourth line, if penicillin allergy and/or clinical concerns re the risk of MRSA: linezolid 600 mg 12 hourly (NB or per oral [absorption 100%]).
    - Fifth line, if penicillin allergy and/or clinical concerns re the risk of MRSA: daptomycin 4-6 mg/kg daily.

Directed, intravenous antibiotics (with susceptibilities)

- Methicillin susceptible *Staphylococcus aureus*, according to susceptibilities:
    - First line: flucloxacillin 2 g 6 hourly.
    - Second line: glycopeptide (vancomycin or teicoplanin), dose as per hospital guidelines, vancomycin target pre dose level 15-20 mg/l, teicoplanin target pre dose level 15-30 mg/l.
    - Third line: clindamycin 600 mg 6 hourly.
- Methicillin resistant *Staphylococcus aureus*, according to susceptibilities:
    - First line: glycopeptide (vancomycin or teicoplanin), dose as per hospital guidelines, vancomycin target pre dose level 15-20 mg/l, teicoplanin target pre dose level 15-30 mg/l.
    - Second line: clindamycin 600 mg 6 hourly.
    - Third line: linezolid 600 mg 12 hourly (NB or per oral [absorption 100%]).
- Beta haemolytic streptococci, according to susceptibilities:
    - First line: benzylpenicillin 1.2 g 6 hourly.
    - Second line: glycopeptide (vancomycin or teicoplanin), dose as per hospital guidelines, vancomycin target pre dose level 15-20 mg/l, teicoplanin target pre dose level 15-30 mg/l.
    - Third line: clindamycin 600 mg 6 hourly.

Directed, per oral antibiotics (with susceptibilities)

- Methicillin susceptible *Staphylococcus aureus*, according to susceptibilities:
    - First line: flucloxacillin 1 g 6 hourly.
    - Second line: clarithromycin 500 mg 12 hourly.
    - Third line: doxycycline 100 mg 12 hourly.
- Methicillin resistant *Staphylococcus aureus*, according to susceptibilities:
    - First line: clarithromycin 500 mg 12 hourly.
    - Second line: doxycycline 100 mg 12 hourly.
    - Third line: clindamycin 300-450 mg 6 hourly.

- Beta haemolytic streptococci, according to susceptibilities:
    - First line: amoxicillin 500 mg 8 hourly.
    - Second line: clarithromycin 500 mg 12 hourly.
    - Third line: doxycycline 100 mg 12 hourly.

Duration of antibiotics

- 5-7 days.

Treatment: peripheral venous catheter infection with sepsis

- Definition, sepsis: life threatening organ dysfunction caused by a dysregulated host immune response to infection.
- If for empiric, intravenous antibiotics as per peripheral venous catheter infection with sepsis, ensure completion of the Sepsis 6.

Removal of the peripheral venous catheter

- The insertion of peripheral venous catheters introduces foreign devices into sterile sites.
- In general, host responses to foreign devices include a macromolecule-coating; microbial adherence to this protein-coat facilitates invasion; and microorganism biofilm formation enables persistence.
- Therefore, removal of the peripheral venous catheter is recommended.

Empiric, intravenous antibiotics

- With anti-bacterial spectra covering the diagnosed causes of peripheral venous catheter with bloodstream infection:
    - First line:
        - Glycopeptide (vancomycin or teicoplanin), deep-seated dosage as per hospital guidelines, vancomycin target pre dose level 15-20 mg/l, teicoplanin target pre dose level 30-40 mg/l; **and**
        - Piperacillin tazobactam 4.5 g 6 hourly.
    - Second line, if non-immediate without systemic involvement penicillin allergy:
        - Glycopeptide (vancomycin or teicoplanin), deep-seated dosage as per hospital guidelines, vancomycin target pre dose level 15-20 mg/l, teicoplanin target pre dose level 30-40 mg/l; **and**
        - Ceftazidime 2 g 8 hourly.
    - Third line, if immediate rapidly evolving or non-immediate with systemic involvement penicillin allergy:
        - Glycopeptide (vancomycin or teicoplanin), deep-seated dosage as per hospital guidelines, vancomycin target pre dose level 15-20 mg/l, teicoplanin target pre dose level 30-40 mg/l; **and**
        - Ciprofloxacin 400 mg 8 hourly.

Directed, intravenous antibiotics (with susceptibilities)

- Methicillin susceptible *Staphylococcus* species, according to susceptibilities:
    - First line:
        - Flucloxacillin 2 g 6 hourly.
    - Second line, if non-immediate without systemic involvement penicillin allergy:
        - Cefuroxime 1.5 g 8 hourly.

    - Third line, if immediate rapidly evolving or non-immediate with systemic involvement penicillin allergy:
        - Glycopeptide (vancomycin or teicoplanin), deep-seated dosage as per hospital guidelines, vancomycin target pre dose level 15-20 mg/l, teicoplanin target pre dose level 30-40 mg/l.
- Methicillin resistant *Staphylococcus* species, according to susceptibilities:
    - First line:
        - Glycopeptide (vancomycin or teicoplanin), deep-seated dosage as per hospital guidelines, vancomycin target pre dose level 15-20 mg/l, teicoplanin target pre dose level 30-40 mg/l.
    - Second line:
        - Daptomycin 6-8 mg/kg daily.
    - Third line:
        - Linezolid 600 mg 12 hourly (or per oral [absorption 100%]).
- *Enterococcus* species, according to susceptibilities:
    - First line:
        - Amoxicillin 1 g 6 hourly.
    - Second line:
        - Glycopeptide (vancomycin or teicoplanin), deep-seated dosage as per hospital guidelines, vancomycin target pre dose level 15-20 mg/l, teicoplanin target pre dose level 30-40 mg/l.
    - Third line:
        - Linezolid 600 mg 12 hourly (or per oral [absorption 100%]).
- *Enterobacter* species, according to susceptibilities:
    - First line:
        - Beta lactam (piperacillin tazobactam; or, if non-immediate without systemic involvement penicillin allergy, meropenem) standard dosage.
    - Second line, if immediate rapidly evolving or non-immediate with systemic involvement penicillin allergy:
        - Ciprofloxacin 400 mg 12 hourly.
    - Third line, if immediate rapidly evolving or non-immediate with systemic involvement penicillin allergy:
        - Co-trimoxazole 960 mg 12 hourly.
- *Escherichia coli*, according to susceptibilities:
    - First line:
        - Beta lactam (narrowest spectrum of amoxicillin, co-amoxiclav, piperacillin tazobactam; or, if non-immediate without systemic involvement penicillin allergy, narrowest spectrum of cefuroxime, ceftriaxone, or meropenem) standard dosage.
    - Second line, if immediate rapidly evolving or non-immediate with systemic involvement penicillin allergy:
        - Ciprofloxacin 400 mg 12 hourly.
    - Third line, if immediate rapidly evolving or non-immediate with systemic involvement penicillin allergy:
        - Co-trimoxazole 960 mg 12 hourly.
- *Klebsiella* species, according to susceptibilities:
    - First line:
        - Beta lactam (narrowest spectrum of co-amoxiclav, piperacillin tazobactam; or, if non-immediate without systemic involvement penicillin allergy, narrowest spectrum of cefuroxime, ceftriaxone, or meropenem) standard dosage.
    - Second line, if immediate rapidly evolving or non-immediate with systemic involvement penicillin allergy:

        - Ciprofloxacin 400 mg 12 hourly.
    - Third line, if immediate rapidly evolving or non-immediate with systemic involvement penicillin allergy:
        - Co-trimoxazole 960 mg 12 hourly.
- *Pseudomonas aeruginosa*, according to susceptibilities:
    - First line:
        - Piperacillin tazobactam 4.5 g 6 hourly.
    - Second line, if immediate rapidly evolving or non-immediate with systemic involvement penicillin allergy:
        - Ceftazidime 2 g 8 hourly.
    - Third line, if immediate rapidly evolving or non-immediate with systemic involvement penicillin allergy:
        - Ciprofloxacin 400 mg 8 hourly.

± Directed, per oral antibiotics (with susceptibilities)

- Methicillin susceptible *Staphylococcus* species, according to susceptibilities:
    - Please note, *Staphylococcus aureus* bloodstream infection (BSI) warrants antibiotics intravenously for 7-14 days.
    - Please liaise with the microbiology consultant responsible for sterile site investigations, or collaborate and discuss within multi-disciplinary meetings, regarding *Staphylococcus aureus* BSI.
    - Per oral options may include:
        - Flucloxacillin 1 g per oral 6 hourly; or
        - Cefalexin 1 g 8 hourly; or
        - Doxycycline 100 mg 12 hourly; or
        - Clindamycin 300-450 mg 6 hourly.
- Methicillin resistant *Staphylococcus* species, according to susceptibilities:
    - Please note, *Staphylococcus aureus* BSI warrants antibiotics intravenously for 7-14 days.
    - Please liaise with the microbiology consultant responsible for sterile site investigations, or collaborate and discuss within multi-disciplinary meetings, regarding *Staphylococcus aureus* BSI.
    - Per oral options may include:
        - Doxycycline 100 mg 12 hourly; or
        - Clindamycin 300-450 mg 6 hourly; or
        - Co-trimoxazole 960 mg 12 hourly.
- *Enterococcus* species, according to susceptibilities:
    - First line:
        - Amoxicillin 1 g 8 hourly.
    - Second line:
        - Linezolid 600 mg 12 hourly.
    - Third line:
        - Collaborate with the microbiologist.
- *Enterobacter* species, according to susceptibilities:
    - First line:
        - Ciprofloxacin 500 mg 12 hourly.
    - Second line:
        - Co-trimoxazole 960 mg 12 hourly.
    - Third line:
        - Collaborate with the microbiologist.
- *Escherichia coli*, according to susceptibilities:
    - First line:

        - Beta lactam (narrowest spectrum of amoxicillin 1 g 8 hourly; or co-amoxiclav 625 mg 8 hourly plus amoxicillin 500 mg 8 hourly).
    - Second line:
        - Ciprofloxacin 500 mg 12 hourly.
    - Third line:
        - Co-trimoxazole 960 mg 12 hourly.
- *Klebsiella* species, according to susceptibilities:
    - First line:
        - Co-amoxiclav 625 mg 8 hourly plus amoxicillin 500 mg 8 hourly.
    - Second line:
        - Ciprofloxacin 500 mg 12 hourly.
    - Third line:
        - Co-trimoxazole 960 mg 12 hourly.
- *Pseudomonas aeruginosa*, according to susceptibilities:
    - Ciprofloxacin 750 mg 12 hourly.

Peripheral venous catheter infection with sepsis: duration of antibiotics

- *Staphylococcus aureus*: ≥ 14 days, from removal of the peripheral venous catheter. Please note hospital guidelines on *Staphylococcus aureus* BSI.
- Coagulase negative staphylococci: ≤ 7 days, from removal of the peripheral venous catheter.
- *Enterococcus* species: 7 days, from removal of the peripheral venous catheter.
- Gram negative bacilli: ≥ 7 days, from removal of the peripheral venous catheter. Please note hospital guidelines on blood cultures and BSI.

Management: peripheral venous catheter localised infection **without** sepsis

Clinical concerns re peripheral venous catheter localised infection (e.g. pain, erythema, warmth, tenderness, and/or swelling of the skin) without sepsis

↓

Treatment: remove the peripheral venous catheter

↓

Investigate
- Blood sciences:
  - FBC, CRP, lactate, U&E, and LFT
- Microbiology:
  - ± Tip for culture and susceptibilities: for example, if clinical concerns re bloodstream infection, sepsis, or septic shock
  - ± Pus/Wound swab: e.g. if purulent discharge
  - ± Blood cultures. Indications for initial blood cultures include the initiation of treatment with intravenous antibiotics

Treatment: empiric, per oral antibiotics
- First line: flucloxacillin 1 g 6 hourly
- Second line: clarithromycin 500 mg 12 hourly
- Third line: doxycycline 100 mg 12 hourly
- Fourth line: clindamycin 300-450 mg 6 hourly
- Fifth line: linezolid 600 mg 12 hourly

or*

Treatment: empiric, intravenous antibiotics*
- First line: flucloxacillin 2 g 6 hourly
- Second line, if penicillin allergy and/or clinical concerns re the risk of MRSA: glycopeptide (vancomycin or teicoplanin), dose as per hospital guidelines, vancomycin target pre dose level 15-20 mg/l, teicoplanin target pre dose level 15-30 mg/l
- Third line, if penicillin allergy: clindamycin 600 mg 6 hourly
- Fourth line, if penicillin allergy and/or clinical concerns re the risk of MRSA: linezolid 600 mg 12 hourly (NB or per oral [absorption 100%])
- Fifth line, if penicillin allergy and/or clinical concerns re risk MRSA: daptomycin 4-6 mg/kg daily

↓

Directed antibiotics with microbiology cultures and susceptibilities
Duration of antibiotics 5-7 days

* Indications for empiric, intravenous antibiotics include: (1) progression of symptoms and signs after 48 hours of per oral antibiotics; (2) suboptimal vasculature - e.g. chronic venous insufficiency, diabetes mellitus, peripheral vascular disease - impeding delivery of antibiotics; (3) intolerant of per oral antibiotics

Management: peripheral venous catheter infection with sepsis

Clinical concerns re peripheral venous catheter infection (e.g. pain, erythema, warmth, tenderness, and/or swelling of the skin) **and** Clinical concerns re sepsis (life threatening organ dysfunction caused by a dysregulated host immune response to infection) or septic shock

↓

Treatment: remove the peripheral venous catheter

↓

Investigate
- Blood sciences:
  - FBC, CRP, lactate, U&E, and LFT
- Microbiology:
  - Blood cultures
  - ± Tip for culture and susceptibilities: for example, if clinical concerns re bloodstream infection, sepsis, or septic shock
  - ± Pus/Wound swab: e.g. if purulent discharge

↓

If for empiric, intravenous antibiotics, ensure completion of the Sepsis 6

↓

Treatment: empiric, intravenous antibiotics
- First line: glycopeptide (vancomycin or teicoplanin), deep-seated dosage as per hospital guidelines, vancomycin target pre dose level 15-20 mg/l, teicoplanin target pre dose level 30-40 mg/l; **and** piperacillin tazobactam 4.5 g 6 hourly
- Second line, if non-immediate without systemic involvement penicillin allergy: glycopeptide (vancomycin or teicoplanin), deep-seated dosage as per hospital guidelines, vancomycin target pre dose level 15-20 mg/l, teicoplanin target pre dose level 30-40 mg/l; **and** ceftazidime 2 g 8 hourly
- Third line, if immediate rapidly evolving or non-immediate with systemic involvement penicillin allergy: glycopeptide (vancomycin or teicoplanin), deep-seated dosage as per hospital guidelines, vancomycin target pre dose level 15-20 mg/l, teicoplanin target pre dose level 30-40 mg/l; **and** ciprofloxacin 400 mg 8 hourly

Blood cultures positive

↓

Antibiotics intravenously ± per oral

↓

Please note relevant hospital guidelines on *Staphylococcus aureus* bloodstream infection, blood cultures and bloodstream infections, and native and prosthetic valve infective endocarditis

Blood cultures negative 48-72 hours

↓

Stop antibiotics intravenously

- Directed, per oral antibiotics with microbiology cultures and susceptibilities. Total duration of antibiotics 5-7 days
- **or**
- Empiric, per oral antibiotics (flucloxacillin or clarithromycin or doxycycline, etc.) Total duration of antibiotics 5-7 days

References

Bennett, J. E., Dolin, R., and Blaser, M. J. 2015. Mandell, Douglas, and Bennett's Principles and Practice of Infectious Disease, 8th Edition. Elsevier.
Calderwood, M. S. 2019. Intravascular non-hemodialysis catheter-related infection: Clinical manifestations and diagnosis. UpToDate. Available at: Intravascular non-hemodialysis catheter-related infection: Clinical manifestations and diagnosis - UpToDate (accessed May 2020).
Calderwood, M. S. 2019. Intravascular non-hemodialysis catheter-related infection: Treatment. UpToDate. Available at: Intravascular non-hemodialysis catheter-related infection: Treatment - UpToDate (accessed May 2020).
CREST. 2005. Guidelines on the management of cellulitis in adults. Available at: http://www.acutemed.co.uk/docs/Cellulitis%20guidelines,%20CREST,%2005.pdf (accessed July 2019).
Gaynes, R. and Jacob, J. T. 2020. Intravascular catheter-related infection: Epidemiology, pathogenesis, and microbiology. UpToDate. Available at: Intravascular catheter-related infection: Epidemiology, pathogenesis, and microbiology - UpToDate (accessed November 2020).
Mermel, L. A. 2017. Short-term Peripheral Venous Catheter-Related Bloodstream Infections: A Systematic Review. Clinical Infectious Diseases.
National Institute for Health and Care Excellence (NICE). 2019. Cellulitis and erysipelas: antimicrobial prescribing (Draft for consultation, April 2019). Available at: www.nice.org.uk (accessed May 2019).
Ripa, M., Morata, L., Rodriguez-Nunez, O., Cardozo, C., Puerta-Alcade, P., Hernandez-Meneses, M., Ambrosioni, J., Linares, L., Bodro, M., Valcarcel, A., Casals, C., de los Angeles Guerrero-Leon, M., Almela, M., Garcia-Vadal, C., del Rio, A., Marco, F., Mensa, J., Martinez, J. A., and Soriano, A. 2018. Short-Term Peripheral Venous Catheter-Related Bloodstream Infections: Evidence for Increasing Prevalence of Gram-Negative Microorganisms from a 25-Year Prospective Observational Study. Antimicrobial Agents and Chemotherapy.
Smith, R. N. and Nolan, J. P. 2013. Central venous catheters. BMJ.
Spelman, D. 2019. Cellulitis and skin abscess: Clinical manifestations and diagnosis. Available at: https://www.uptodate.com/contents/cellulitis-and-skin-abscess-clinical-manifestations-and-diagnosis?topicRef=110530&source=see_link (accessed May 2019).
Spelman, D. 2019. Cellulitis and skin abscess in adults: Treatment. Available at: https://www.uptodate.com/contents/cellulitis-and-skin-abscess-in-adults-treatment (accessed May 2019).
Sullivan, T. and de Barra, E. 2018. Diagnosis and management of cellulitis. Clinical Medicine.
Weng, Q. Y., Raff, A. B., and Cohen, J. M. 2017. Costs and Consequences Associated With Misdiagnosed Lower Extremity Cellulitis. The Journal of the American Medical Association Dermatology.

Document control

Development of guidelines:	Angelina Dyche, Kayleigh Lehal, Dr Peter Slovak
Consultation with:	Antimicrobial Pharmacist, Lead Antimicrobial Pharmacist, Microbiology Consultant
Version:	1
Approval date:	AMSG – 08/03/2022, CDCS – 22/03/2022, Surgery – April 2022, Medicine - Pending
Changes from previous version:	Introduction, Investigation, Treatment, Management, References, Document control
Date uploaded:	14/7/2022
Next review date:	pending
Key contacts:	Dr Peter Slovak, Microbiology Consultant p.slovak@nhs.net Kayleigh Lehal, Lead Antimicrobial Pharmacist kayleigh.lehal@nhs.net Angelina Dyche, Antimicrobial Pharmacist angelinadyche@nhs.net