Antimicrobial Prescribing Guidelines in Children

The Royal Hospital for Children and Young People (RHCYP), Edinburgh

Reference: PNDTC 01

Issue Date: Oct 2019

Authors: Dr P Kalima, Dr L Jones, C Philip

Review Date: 2022

Published by: AMT

Ratified by: PD&T, AMC

CONTENTS

Introduction

The Antibiotic Prescribing Guidelines for Children aim to encourage rational prescribing of antimicrobial drugs for the initial treatment of infections and thereby improve the results of treatment, reduce drug-related toxicities and limit the emergence of resistant strains.

It consists of advice on the appropriate initial management of commonly seen conditions and includes route of administration and duration of treatment when necessary. Where allergic reactions to penicillins are a problem an alternative agent has been suggested. Recommendations for prophylactic use of antibiotics are also given. Antibiotics have been selected for the guidelines on the basis of evidence, availability, local sensitivity data, safety and efficacy.

Further advice and guidance for conditions not in the guidelines can be obtained from relevant senior medical staff or microbiology (ext. 31924, or 26028 during working hours, via switchboard out-of-hours). This includes cases where recent antibiotic therapy has failed or where previous adverse drug reactions limit the treatment choice. In addition, if more specific advice on the antimicrobial therapy/investigation of individual patients is required, a clinical microbiologist or infectious diseases consultant will be pleased to discuss the case further.

For doses refer to BNF-C, with the exception of gentamicin, vancomycin and tobramycin where staff should use the relevant RHCYP guideline/monograph. Monographs for the intravenous administration of antimicrobial agents are available in each clinical area or on the intranet.

These guidelines have been approved by the Paediatric and Neonatal Drug and Therapeutics Committee and were developed in consultation with the relevant Clinical Management Teams and the Antimicrobial Management Team (AMT). The advice contained within this document will be reviewed every two years and updated where necessary.

Penicillin allergy

The most important side-effect of the penicillins is hypersensitivity which causes rashes and anaphylaxis and can be fatal. Allergic reactions to penicillins occur in 1–10% of exposed individuals; anaphylactic reactions occur in less than 0.05% of treated patients. Patients with a history of atopic allergy (e.g. asthma, eczema, hay fever) are at a higher risk of anaphylactic reactions to penicillins. Individuals with a history of anaphylaxis, urticaria, or rash immediately after penicillin administration are at risk of immediate hypersensitivity to a penicillin; these individuals should not receive a penicillin.

Individuals with a history of a minor rash (i.e. non-confluent, non-pruritic rash restricted to a small area of the body) or a rash that occurs more than 72 hours after penicillin administration are probably not allergic to penicillin and in these individuals a penicillin should not be withheld unnecessarily for serious infections; the possibility of an allergic reaction should however be borne in mind. Other beta-lactam antibiotics (including cephalosporins) can be used in these patients. Occurrence of cross reactivity between penicillin allergy and cephalosporins is now thought to be 0.5% - 6.5% (BNF) hence even in more severe reactions cephalosporin use may be appropriate if severe infection outweighs risks.

Alternative agents have been suggested for when allergic reaction to penicillins are a concern.

Good Practice Guidelines

- Avoid using antimicrobial agents for self-limiting disease processes
- Before starting treatment make a clinical diagnosis, and consider, by specific name(s) the likely pathogens
- Follow the local policy
- Write review date
- If appropriate, send specimens for microbiological investigations before starting "best informed guess" treatment

  Investigations include:

  Blood cultures in all babies

  Lumbar puncture should be considered in all septic neonates.

  Skin swabs if clinically indicated

  Clean catch urine or suprapubic aspirate. Bag urine specimens are not helpful due to frequent contamination
- If appropriate, modify initial therapy once sensitivity results are available
- Consult a microbiologist if the patient does not respond within 48 to 72 hours
- Use the oral or rectal route if there is no reason to suspect absorption will be impaired. Review the need for parenteral treatment 48 hours after initiation and at least every 24 hours thereafter. Change to oral or rectal routes as soon as possible if appropriate
- Use the shortest effective length of course of treatment. Prolonged courses are wasteful, may lead to super-infection, can result in toxicity and needlessly increase the risk of resistance
- For dosage information refer to the intravenous monographs on the intranet and BNF-C for dosage information

Tables of Treatment Recommendations

Table 1 Sepsis in the neonate [28 days or less post term (corrected age)]

Likely Diagnosis	Likely Organisms	Recommended Therapy	Notes
Sepsis in neonate - no obvious source	Group B Streptococci, *E.coli, Listeria monocytogenes*, *Haemophilus influenzae*, *Staphylococcus aureus* and Enterococcus	**Benzylpenicillin** intravenously *plus* **Gentamicin** intravenously Second line **Cefotaxime** intravenously *plus* **Amoxicillin** intravenously	Review recent hospital admission for potential risk factors for infection. If cultures positive, discuss with microbiology/paediatric ID for advice about duration of therapy. If all cultures negative but clinical impression of sepsis then give antibiotics for 7 days. Stop amoxicillin once Listeria is excluded. If cultures are negative/ viral agent detected and child not clinically septic on admission, consider stopping earlier.
Confirmed group B streptococcal bacteraemia		**Benzylpenicillin** intravenously	Treat for minimum of 10 days if CSF clear. If CSF not available, treat as for meningitis (see below).

Mainly for patients presenting with community-acquired infection.

Table 2 Septicaemia, in older children

Likely Diagnosis	Likely Organisms	Recommended Therapy	Notes
Community-acquired septicaemia in child older than 28 days and < 3 months of age*	*E.coli,* *Klebsiella* spp., *Salmonella* spp., *Staphylococcus aureus*	**Cefotaxime** intravenously	Obtain travel history. Consider adding gentamicin if *Pseudomonas* or other resistant Gram-negative infection suspected, add flucloxacillin if Gram-positive infection highly likely.
Community-acquired septicaemia in child older than 3 months of age		**Cefotaxime** intravenously	Obtain travel history. Consider adding gentamicin if *Pseudomonas* or other resistant Gram-negative infection suspected, add flucloxacillin if Gram-positive infection highly likely.
Neutropenic patient (not previously known to have underlying condition e.g. "haematological/oncological" malignancy)	*Pseudomonas aeruginosa, E.coli*, *Klebsiella* spp.	**Piperacillin/tazobactam** intravenously Seek urgent advice and follow specific unit protocols.	Obtain blood cultures before antibiotics are given. Obtain all other microbiology specimens as soon as possible.
Suspected MRSA septicaemia	MRSA	**Vancomycin** intravenously	
Proven *Staphylococcus aureus* bacteraemia	*Staphylococcus aureus*	**Flucloxacillin** intravenously	Treat for minimum of 14 days. Investigate source.

*For neonates [less than 28 days post term (corrected age)] see Table 1. Sepsis in the neonate (page 5).

Cardiovascular System

Table 3 – Intravascular catheter-related sepsis

Patient Group	Likely Organisms	Recommended Therapy	Notes
Long-term TPN (*usually surgically-implanted/ tunnelled)* and Cystic fibrosis and other patients with tunnelled lines	Coagulase-negative staphylococci, Gram-negative bacilli, enterococci	**Teicoplanin** intravenously *plus* **Gentamicin** intravenously	Refer to RHCYP Edinburgh TPN protocol for detailed guidance. Coagulase-negative staphylococcal infections can be treated without removal of the catheter. Treat for 10 days. Teicoplanin is preferred instead of vancomycin because these patients frequently have single lumen vascular catheters and are often on TPN. For infections with ***Staphylococcus aureus*** (including MRSA), ***Pseudomonas*** spp.***, Ecoli, Klebsiella*** spp.***, Enterobacter*** spp.***, Candida*** spp., CVC should be removed and seek advice.

Patient Group	Likely Organisms	Recommended Therapy	Notes
Haematology/oncology post bone marrow transplant recipients (*usually surgically-implanted or tunnelled)*	Coagulase-negative staphylococci, *Staphylococcus aureus*, Gram-negative bacilli, *Enterococcus* spp.	See current RHCYP guidelines or individual plan	These patients often present with fever and neutropenia, therefore, the empirical regimen should include cover against Gram-negative bacilli. Coagulase-negative staphylococcal infections may be treated without removal of the catheter. For infections with ***Staphylococcus aureus*** (incl. MRSA), ***Pseudomonas*** spp***, E. coli, Enterobacter*** spp., ***Stenotrophomonas maltophilia, Candida*** spp., CVC should be removed and seek advice.
Central venous catheters, non-tunnelled (including arterial cannulae)	Coagulase-negative staphylococci	**Vancomycin** intravenously	Consider removal of the line. Coagulase-negative staphylococcal infections can be treated without removal of the catheter. Duration of treatment, 10 days
Central venous catheters, non-tunnelled (including arterial cannulae)	Other organisms	Discuss with Microbiology	For infections with ***Staphylococcus aureus*** (incl. MRSA), ***Pseudomonas*** spp***, coliforms, Candida*** spp., removal of catheter is strongly recommended.

Bacterial Endocarditis

Consult a Cardiologist immediately and liaise with the Microbiology and Pharmacy departments. Ensure 3 sets of blood cultures are obtained PRIOR to initiation of antibiotic therapy and that adequate volumes are obtained.
If the disease is slowly progressing and the patient is stable, consider delaying antimicrobial therapy pending blood culture results.

For children with structural heart defects that are at risk of endocarditis who present with fever should have 2 sets of blood cultures prior to antimicrobial therapy irrespective of focus of infection.

Prophylaxis for Bacterial Endocarditis

The Scottish Dental Clinical Effectiveness Programme (SDCEP) has recently published Implementation Advice on *Antibiotic Prophylaxis against Infective Endocarditis*. This has been developed to facilitate the implementation of NICE Clinical Guideline 64 *Prophylaxis against infective endocarditis (2018)*. The advice aims to support the dental team to manage the routine dental care of patients at increased risk of infective endocarditis. It emphasises the importance of including the patient in discussions about their care and provides information about identifying those increased risk patients who may require special consideration for antibiotic prophylaxis/non-routine management.

The implementation advice, along with supporting tools including patient information and a separate advice sheet for cardiology and cardiac surgical teams, can be accessed via the SDCEP website

For all patients at increased risk of infective endocarditis:

1. Assess whether the patient should be considered for routine or non-routine management based on their specific cardiac condition (see Table 4.1 Patients at Increased Risk of Infective Endocarditis and Appendix 2 Summary Flowchart).
2. Patients who have a cardiac condition from the **special consideration** subgroup may require **non-routine** management. These **special consideration** patients should be assessed in consultation with their cardiology consultant, cardiac surgeon or local cardiology centre (see Section 4.3 Non-Routine Management).

Taken from Advice on the Provision of Antibiotic Prophylaxis against Infective Prophylaxis - Scottish Dental Clinical Effectiveness Program (SDCEP) 2018

Table 4.1 Identifying the special consideration sub-group

Patients at increased risk of IE	Sub-group requiring special consideration

• acquired valvular heart disease with stenosis or regurgitation;
• hypertrophic cardiomyopathy;
• **previous infective endocarditis**;
• **structural congenital heart disease, including surgically corrected or palliated structural conditions**, *but excluding* isolated atrial septal defect, fully repaired ventricular septal defect or fully repaired patent ductus arteriosus, and closure devices that are judged to be endothelialised;
• **valve replacement**.
	• prosthetic valve, including transcatheter valves, or where any prosthetic material was used for valve repair;
	• previous infective endocarditis;
	• congenital heart disease (CHD):
	  ○ any type of cyanotic CHD;
	  ○ any type of CHD repaired with a prosthetic material, whether placed surgically or by percutaneous techniques, up to 6 months after the procedure or lifelong if residual shunt or valvular regurgitation remains.

General terms such as "lower respiratory tract infection" (LRTI) can cover many infections – a more specific classification must be sought (and documented in the patient's note) before appropriate treatment can be selected.

Table 4 Respiratory Tract Infections

Infection	Likely Organisms	Recommended Therapy	Notes
Community-acquired pneumonia (CAP) or Post-operative pneumonia within 3 days of admission	*Streptococcus pneumoniae* Others: *Haemophilus influenzae, Staphylococcus aureus, Moraxella catarrhalis* Consider *Mycoplasma pneumoniae* If clinical signs/chest x-ray suggestive of atypical pneumonia	**Amoxicillin** orally or intravenously *Penicillin allergy* Clarithromycin orally or intravenously *Alternatives* **Co-amoxiclav** intravenously or orally or Cefotaxime intravenously Add **Clarithromycin** orally	Oral therapy is safe and effective. Intravenous therapy is only indicated in those who are severely ill. Change to oral therapy as soon as response is satisfactory. A 7-day course would be reasonable in most cases.
Aspiration pneumonia (not prophylaxis following aspiration)	Polymicrobial, including anaerobes, *Streptococcus pneumonia, Haemophilus influenza, E.coli* and *Klebsiella* spp.	First line **Amoxicillin** intravenously *plus* **Metronidazole** intravenously Second line **Co-amoxiclav** intravenously	

Infection	Likely Organisms	Recommended Therapy	Notes
Hospital-acquired pneumonia (e.g. patients admitted with non-respiratory illness who have been in hospital for >4 days)	*Pseudomonas* and/or MRSA	**Piperacillin-tazobactam** intravenously If MRSA *add* **Vancomycin** intravenously	Review risk of MRSA infection and available microbiology/virology results. A 7-day course would be reasonable in most cases
Bronchiectasis, acute exacerbation	Colonisation with *Streptococcus pneumoniae, Haemophilus influenzae, M.catarrhalis*	**Co-amoxiclav** orally or intravenously If in doubt, seek specialist advice	Up to date culture and sensitivity results should be reviewed since sensitivities are likely to change. Treat for 10 to 14 days.
Cystic Fibrosis, acute infective exacerbation	*Staphylococcus aureus, Haemophilus influenzae, or no previous positive microbiology*	**Co-amoxiclav** intravenously Alternatives: **Flucloxacillin** intravenously for *S.aureus* **Ceftriaxone** intravenously	Seek CF specialist advice during working hours. Always review most recent microbiology results. Consider last admission antimicrobial choices/outcomes and response.
Cystic Fibrosis, acute infective exacerbation	*Pseudomonas aeruginosa; B. cepacia*	**Ceftazidime** intravenously *plus* **Tobramycin** intravenously or **Piperacillin-tazobactam** intravenously *plus* **Tobramycin** intravenously or **Meropenem** intravenously *plus* **Tobramycin** intravenously	Refer to treatment guidelines information on dosing and frequencies. Minimum duration of treatment, 14 days

Respiratory syncytial virus (RSV) infection	RSV	Antibiotics not routinely recommended	
Varicella pneumonitis	Varicella zoster virus	Aciclovir intravenously at high dose	Patients should be adequately hydrated during high dose aciclovir therapy. Ensure urine output is at least 1 ml/kg/hr. Treat for at least 7 days.
Tuberculosis	*Mycobacterium tuberculosis*		Liaise with paediatric infectious diseases physician
Pneumocystis jiroveci pneumonia (PCP)	*Pneumocystis jiroveci*	Co-trimoxazole intravenously at high dose In conjunction with high dose prednisolone.	Treat for at least 14 days. If immunocompromised, give for 21 days.

Table 5 Central Nervous System

Infection	Likely Organisms	Recommended Therapy	Notes
Meningitis In neonate and child up to 3 months old	Organism **unknown**	**Amoxicillin** intravenously *plus* **Cefotaxime** intravenously	Change to treatment below once organism identified. Stop amoxicillin if/ when Listeria excluded. Once a **clinical** diagnosis is made, report case to a consultant in public health/ health protection team. If lack of response consider repeating LP after 48 hours of treatment. **Consider re-LP after 2 weeks depending on the initial LP result.** If organism unknown treat for 14 days.
	Once organism **known** Gram-Negative bacillus (e.g. *E.coli, Klebsiella* spp.)	**Cefotaxime** intravenously *plus* **Gentamicin** intravenously	Treat Gram-negative meningitis for at least 3 weeks with cefotaxime.
	Group B streptococcus	**Cefotaxime** intravenously	Treat Group B streptococcal infection for at least 14 days. May require 21 days or longer if ventriculitis, cerebritis or suppurative complications occur.

	Listeria monocytogenes	**Amoxicillin** intravenously *plus* **Gentamicin** intravenously	Treat Listeria meningitis for 21 days. Consider stopping gentamicin after 5-7 days.-
	N. meningitidis	**Cefotaxime** intravenously	Treat meningococcal meningitis for a minimum of 7 days
	Haemophilus influenzae	**Cefotaxime** intravenously	Treat haemophilus meningitis for a minimum of 10 days.
	Strep. pneumoniae	**Cefotaxime** intravenously	Treat pneumococcal meningitis for a minimum of 14 days. Up to 21 days may be required if cerebritis or suppurative complications occur. Consider repeating LP after 10 days of treatment.
Viral encephalitis	Herpes simplex virus	**Aciclovir** intravenously (high dose)	Patients should be adequately hydrated during high dose aciclovir therapy. Ensure urine output is at least 1 ml/kg/hr. Treatment should be continued for a minimum of 21 days. If atypical clinical scenario seek paediatric neurology advice.
CSF shunt-associated ventriculitis		Seek specialist advice	
Cerebral abscess		Seek specialist advice	

TB meningitis		Seek specialist advice	

Table 6 Genitourinary Tract

Delay in starting treatment is associated with increased risk of scarring. All children under 3 years of age who have not achieved day time continence, who have signs of an upper urinary tract infection require prophylaxis after treatment, and referral to the UTI clinic (RHCYP) or to general paediatrics (SJH) for further imaging. Please see RHCYP Urinary Tract Infection Protocol on the intranet for full details and definitions.

Always review your choice of antibiotic with the culture result.

Infection	Likely Organisms	Recommended Therapy	Notes
UTI in infants	Group B streptococci, *E. coli*, *Klebsiella* spp.	Seek specialist advice. Normally require therapy with **Amoxicillin** intravenously +/- **Gentamicin** intravenously	Suprapubic or clean-catch urine is required for diagnosis. All children aged < 6 months with systemic illness should be treated with intravenous therapy initially. Suggest 3 to 5 days intravenous therapy initially, followed by 5 days oral therapy when tolerated. Intravenous therapy must be considered for infants and ill children. If there is no clinical improvement by 48 hours perform a repeat urine culture, and consider other urgent investigations. Do not stop prophylaxis while treating acute infection -but appropriateness of choice should be reviewed.

			Treatment is followed with prophylaxis. Follow-up is required.
Uncomplicated lower UTI (cystitis) *(Non-diabetic, with no symptoms/signs of pyelonephritis)*	*E. coli*, *Klebsiella* spp.	In a well child, Trimethoprim orally Second line Treat as per susceptibilities If possible avoid nitrofurantoin suspension.	Simple lower UTIs will require 3 days of therapy. Re-check urine culture to ensure eradication of infection. Treat for longer in severe infections. Monitor temperature response and/or CRP.
Complicated upper UTI, with systemic symptoms (including pyelonephritis)	*Ecoli, Klebsiella* spp., enterococci	Co-amoxiclav intravenously or orally +/- Gentamicin intravenously	Clean catch urine is required for culture (not bag or pad urine sample). If there is no clinical improvement by 48 hours perform a repeat urine culture, and consider other urgent investigations. Consider oral therapy in children with mild symptoms that can tolerate oral medication. Duration is 7 days. Consider longer if remain symptomatic. Consider multi-drug resistant organisms in those with relevant travel history or previous resistant culture results.
UTI post urological surgery	*Ecoli, Klebsiella* spp., enterococci, *Pseudomonas aeruginosa*.	Amoxicillin intravenously *plus* Gentamicin intravenously	Urine must be sent for culture. Check previous results for gentamicin resistance.

Asymptomatic bacteriuria	*Ecoli, Klebsiella* spp., enterococci	No specific treatment required, unless renal scarring or obstructive uropathy present. If so, seek advice from the renal team.	Secondary enuresis may be a "silent" symptom.
Prophylaxis in the following groups 1. Less than 3 years old, after first episode of UTI 2. Recurrent UTI		**Trimethoprim** at night. **Trimethoprim** or **Nitrofurantoin** at night, orally depending on culture results.	Do not prescribe antibiotic prophylaxis routinely for children following first-time urinary tract infection (UTI). Do not use nitrofurantoin if eGFR<45ml/minute. Breakthrough infections are due to non-compliance or true antimicrobial resistance. Review antibiotic prophylaxis for recurrent UTI at least every 6 months. Assess the success of prophylaxis. Discuss continuing, stopping or changing prophylaxis (taking into account the person's preferences for antibiotic use and the risk of antimicrobial resistance). Remind the parents/carers about behavioural and personal hygiene measures and self-care treatments. If antibiotic prophylaxis is stopped, ensure that the child has rapid access to treatment if they have an acute UTI.
Vulvovaginitis	Group A *Streptococcus*	**Phenoxymethylpenicillin** orally or **Amoxicillin** orally	

Threadworms		Mebendazole orally	Use mebendazole for children aged over 6 months in combination with hygiene measures. A second dose of mebendazole may be required after 2 weeks.
Vaginal discharge or suspected sexually-transmitted infection	*Chlamydia trachomatis, Neisseria gonorrhoeae, Trichomonas vaginalis*	Seek specialist advice from paediatric consultant	

Table 7 Gastrointestinal System

Infection	Likely Organisms	Recommended Therapy	Notes
Acute gastroenteritis	Viruses e.g. rotavirus		Antimicrobial therapy seldom indicated unless systemic invasion is suspected. Consult microbiology or GI or infectious diseases consultant before starting antibiotics.
Acute bacterial gastroenteritis	*Salmonella* spp.	**Cefotaxime** intravenously	Obtain travel history for all gastroenteritis **Testing for sensitivities is essential and must be requested.** Give antibiotic treatment to all children **if** suspected or confirmed septicaemia or those malnourished, immunocompromised, with haemoglobinopathy and salmonella gastroenteritis. **Those with bacteraemia require prolonged IV therapy.** Discuss with microbiology /paediatric ID.
	Shigella spp.,	**Usually no treatment**	
	Campylobacter spp.,	**Usually no treatment** Consider **Clarithromycin** orally in severe disease.	
Confirmed Salmonella gastroenteritis (not typhoid or paratyphoid)		**Usually no treatment** **Cefotaxime** intravenously	Treat children < 6 months, and children of any age who are immunocompromised or malnourished. **Testing for sensitivities is essential and must be requested.**
Enteric fever (typhoid and paratyphoid)	*Salmonella typhi; Salmonella paratyphi*	**Cefotaxime** intravenously	Bacteraemia and severe infection treat for 14 days. May require prolonged therapy. Beware of complications e.g. osteomyelitis, meningitis. If these present, treatment should be given for longer. Seek paediatric ID advice.
Ecoli O157 and other STEC		**No antibiotics**	NSAIDs, loperamide and antibiotics are contraindicated.
Mild antibiotic-associated diarrhoea	*C. difficile*	**Metronidazole** orally See BNF-C for dosing	Stop any antibiotics if possible. Seek advice if concurrent antibiotics cannot be stopped.

Moderate-severe antibiotic-associated diarrhoea	*C. difficile*	**Vancomycin** orally See BNF-C for dosing	Send a stool sample for toxin testing and culture Treat for 10 to 14 days. Stop at day 10 if symptoms resolved. If patient unable to tolerate oral vancomycin, give metronidazole intravenously plus high dose oral/ NG vancomycin liquid ***and*** IV metronidazole. (IV vancomycin should never be used in the treatment of *C.difficile*). See HPS Guidance on Prevention and Control of Clostridium difficile Infection (CDI) in Health and Social Care Settings in Scotland.
Ascending cholangitis and acute cholecystitis	*Ecoli, Klebsiella* spp., anaerobes	**Cefotaxime** intravenously *plus* **Metronidazole** intravenously *In patients who are severely ill or have had previous instrumentation or surgery, add* **amoxicillin** intravenously	The role of antibiotics in uncomplicated acute cholecystitis remains unclear. If allergic to penicillin seek advice. Duration of treatment 7 – 10 days. If not improving, seek advice regarding 2nd line therapy (e.g. piperacillin/ tazobactam +/- gentamicin)
Peritonitis eg post appendicitis		**Cefuroxime** intravenously *plus* **Metronidazole** intravenously In severe penicillin allergy **Gentamicin** intravenously *plus* **Metronidazole** intravenously	Duration of treatment: 5 days after source control.

Spontaneous bacterial peritonitis	*Streptococcus pneumoniae,* E.*coli,* and beta-haemolytic streptococci	Cefotaxime intravenously	Seek urgent surgical and GI review. In patients with liver disease and ascites consider peritoneal tap and send aspirate for urgent microscopy and culture. Prophylaxis may be required after treatment of infection. Seek GI advice.
Peritonitis associated with dialysis		Seek specialist advice.	

Table 8 Acute Bone and Joint Infections

Take blood cultures and send joint aspirates for culture before starting empirical antibiotic therapy.

Infection	Likely Organisms	Recommended Therapy	Notes
Septic arthritis and acute osteomyelitis	When organism **not known:** Aim to cover *Staphylococcus aureus,* Pneumococcus*, Streptococcus pyogenes* In children under 2 years of age: *Kingella kingae*	**Initial Empirical therapy**	**In all cases seek specialist advice at the outset.** Do not start antibiotic therapy until appropriate samples have been obtained for culture.
		Age: 0-3 months old **Flucloxacillin** intravenously *plus* **Cefotaxime** intravenously	Age: 0-3 months Initial duration is 2 weeks of intravenous therapy. If culture negative, then use 4 weeks oral co-amoxiclav after IV regime
		Age: >3 months – 16 years **Flucloxacillin** intravenously *plus* **Clindamycin** intravenously	Age: > 3 months Initial intravenous therapy for 72 hours. If cultures negative then use 4 weeks oral co-amoxiclav after IV regime.
	When organism **known** – e.g. *Staphylococcus aureus* – rationalise antimicrobial therapy	If blood culture positive for ***Staphylococcus aureus*** – 6 weeks therapy. Continue **flucloxacillin** intravenously for minimum of 14 days, thereafter give **flucloxacillin** orally for 4 weeks **Clindamycin** can be delivered orally after 72 hours. of IV therapy Severe penicillin allergy **vancomycin** intravenously	For positive blood cultures with other organisms, discuss with microbiology.

Infection	Likely Organisms	Recommended Therapy	Notes
		If blood culture positive for *Streptococcus* spp. – 6 weeks therapy Give benzylpenicillin intravenously for a minimum of 10 days, followed by 4 weeks of oral amoxicillin Clindamycin can be given orally after 72 hours of IV therapy. Severe penicillin allergy vancomycin intravenously	
Chronic osteomyelitis	*Staphylococcus aureus,* coliforms, *Pseudomonas* spp., atypical mycobacterium and anaerobes	Seek specialist advice.	Appropriate specimens should be taken for bacteriologic investigations prior to starting therapy.

Table 9 Eye infections

Infection	Likely Organisms	Recommended Therapy	Notes
Conjunctivitis	Viruses, *Staphylococcus aureus, Haemophilus influenzae, Strep.pneumoniae*	**Chloramphenicol** 0.5 % drops. Apply 1 drop topically every 2 hours initially, then 6 hourly when infection controlled	Continue treatment for 48 hours after resolution of infection. Use separate bottles for each eye. Chloramphenicol ointment can also be used. Consult ophthalmologist if infection is severe, or if worsening signs.
Chlamydia conjunctivitis	*Chlamydia trachomatis*	**Erythromycin** oral	Treatment duration 2 weeks. Discuss with senior colleague about appropriate therapy or referral to ophthalmology. Parents will require testing
Blepharitis	*Staphylococcus aureus*	**Fusidic acid** eye drops m/r Applied twice daily.	Treatment duration 2 weeks.
Corneal abrasions		**Chloramphenicol** eye ointment. Apply 3 to 4 times daily.	Refer to ophthalmologist.
Gonococcal conjunctivitis	*N. gonorrhoeae*	Seek specialist advice from microbiology *Single dose* **Cefotaxime** intravenously	Clinician needs to discuss and arrange GUM referral for parents.
Endophthalmitis		Seek ophthalmologist advice	
Keratitis	*Herpes simplex* virus	**Aciclovir** orally *plus* **Ganciclovir** 0.15% w/w eye gel Apply 5 times a day	Refer case to ophthalmologist promptly.
Ophthalmic zoster	*Varicella zoster* virus	**Aciclovir** intravenously	Refer case to ophthalmologist promptly.

Infection	Likely Organisms	Recommended Therapy	Notes
infection		*plus* **Ganciclovir 0.15% w/w eye gel.** Apply topically 5 times a day	

Table 10 Ear Nose and Throat Infections

Infection	Likely Organisms	Recommended Therapy	Notes
Otitis externa	*Pseudomonas* spp., coliforms	Analgesia and localised heat. **Acetic acid** 2% ear spray 3 times daily for 7 days *or* **Otomize®** ear spray 3 times daily (if the eardrum is not perforated) for 7-14 days	Consider ENT surgeon advice. May need topical ciprofloxacin. In diabetics *pseudomonas* can cause "malignant otitis externa". This requires prompt parenteral therapy. Seek advice.
	Staphylococcus aureus (in acute infections)	**Flucloxacillin** orally If allergic to penicillins, consider **Clarithromycin** orally.	Duration 7 days. If cellulitis/disease extending outside ear canal start flucloxacillin and refer to ENT to exclude malignant otitis externa. If penicillin allergic use clarithromycin. Ciprofloxacin is not suitable due to inadequate staph/strep cover. Topical therapy with otomize® ear spray can be considered after aural toilet if there is eczematous inflammation.
Acute Otitis Media (AOM)	Viruses, *Strep.pneumoniae*, *Haemophilus*	Antibiotics not routinely recommended as initial therapy.	In recurrent AOM or in complicated cases with e.g. mastoiditis, facial palsy, seek ENT advice.

Infection	Likely Organisms	Recommended Therapy	Notes
	influenzae, Moraxella catarrhalis	If clinically unwell, consider **amoxicillin** orally	If unwell treat for 5 days.
Mastoiditis	Viruses, *Strep.pyogenes*, *Haemophilus influenza*, *Staphylococcus aureus*, *Moraxella catarrhalis* and anaerobes	Seek ENT advice. **Cefotaxime** intravenously *plus* **Metronidazole** intravenously	Step-down to co-amoxiclav orally once improving. Minimum 2 week total therapy.
Pharyngotonsillitis	Viruses, *Strep.pyogenes,* occasionally Group C streptococci	Most infections are due to viruses and require no specific antimicrobial therapy **Phenoxymethylpenicillin** orally If allergic to penicillin, consider **Clarithromycin** orally.	Duration of treatment 10 days Duration of treatment is 5 days

Infection	Likely Organisms	Recommended Therapy	Notes
Sinusitis	Most cases are due to viruses. *Strep.pyogenes, Staphylococcus aureus, Strep.pneumoniae*, *Haemophilus influenzae*	Seek ENT advice. Consider **Phenoxymethylpenicillin** orally **Coamoxiclav** If allergic to penicillin, consider **Clarithromycin** orally.	The role of antibiotic therapy is controversial. Reserve antibiotics for patient with severe illness particularly if purulent nasal discharge present or symptoms with no improvement for more than 10 days. Duration treatment 5 days. First choice if systemically very unwell, symptoms and signs of a more serious illness/ condition, or high risk of complications - Duration treatment 5 days.

Skin and Soft Tissue Infections

In skin and soft tissue infections surgical intervention or toilet is often useful. Tetanus prophylaxis should not be forgotten. For superficial fungal infections seek microbiology advice.

Table 11 Skin and Soft Tissue Infections

Infection	Likely Organisms	Recommended Therapy	Notes
Cellulitis and erysipelas (for pre-septal cellulitis, see joint A&E/ENT protocol)	*Staphylococcus aureus, Strep.pyogenes,* occasionally other β-haemolytic streptococcus	**Flucloxacillin** intravenously or orally *If allergic to penicillin* *Mild illness* **clindamycin** orally More severe illness **clindamycin** orally *or* **Vancomycin** intravenously	Distinction between cellulitis and erysipelas is rarely clear-cut. Therapy may be modified if microbiology results are available. Most cases require intravenous therapy. When patient is improving and able to tolerate oral medication therapy should be changed to the oral flucloxacillin or penicillin (clarithromycin or clindamycin if penicillin-allergic). Duration depends on clinical response; 7 to 10 days of treatment is usually sufficient.
Serious post-operative wound infection: clean procedure	*Staphylococcus aureus*	**Flucloxacillin** intravenously *If allergic to penicillin,* **Vancomycin** intravenously	Consider switch to oral therapy if temperature is normal for 48 hours. If not improving, seek advice. 7 days of treatment is usually sufficient. Assess the risk of MRSA infection in each case and treat appropriately.

Infection	Likely Organisms	Recommended Therapy	Notes
Serious post-operative wound infection: Clean/contaminated procedure	Mixed, possibly including anaerobes	**Co-amoxiclav** intravenously *If allergic to penicillin,* **Cefotaxime** intravenously *plus* **Metronidazole** intravenously *Severe penicillin allergy* **Co-trimoxazole** intravenously *plus* **Metronidazole** intravenously	Send a wound swab for culture. Further therapy should be guided by laboratory results. Assess the risk of MRSA infection and treat appropriately.
Periorbital/preseptal cellulitis	*Strep.pneumoniae, Haemophilus influenzae, S aureus*	**Cefotaxime** intravenously, *If allergic to penicillin* **Ciprofloxacin** intravenously *plus* **Clindamycin** intravenously	Multi-disciplinary management including paediatric, ENT and ophthalmology for review for any moderate, moderate/severe infections or if eye signs present (restricted eye movement, pain, proptosis, reduced vision.) If remains febrile after 48h despite recommended IV therapy, consider adding metronidazole and ensure multi-disciplinary review. Patients can be converted to oral antibiotics when improving clinically, afebrile for at least 24 hours and able to tolerate oral medication (co-amoxiclav). If allergic to penicillin, discuss appropriate therapy with microbiology. Treat for 7 to 10 days.

Infection	Likely Organisms	Recommended Therapy	Notes
Necrotising fasciitis including gas gangrene	Probable (type I) *Strep.pyogenes* (Group A strep) infection *Beware of risk of transmission in healthcare settings* Type II, Polymicrobial, including *Staphylococcus aureus,* Gram-negatives, anaerobes. Especially infection involving trunk, groin, perineum or post-surgery.	**Cefotaxime** intravenously *plus* **Clindamycin** intravenously	Seek surgical review. Urgent surgical debridement is crucial. Specimens should be sent for Gram stain and culture to help determine aetiology. Contact microbiology BMS to arrange examination. **Seek advice** as broad spectrum therapy may be required

Infection	Likely Organisms	Recommended Therapy	Notes
Human and animal bites	Anaerobes, *Staphylococcus aureus, Strep.pyogenes,* Coliforms, *Pasteurella multocida, Eikenella corrodens*	**Co-amoxiclav** intravenously or orally *If allergic to penicillin* **Co-trimoxazole** orally *plus* **Metronidazole** orally	Give antibiotic prophylaxis in all human, cat, dog and puncture bites. Treat for minimum of 7days **Penicillin allergy**: Review all at 24 and 48 hours as not all pathogens are covered. Get travel history. Wound care and thorough irrigation is important. **Assess risk of tetanus;** HIV; hepatitis B and C in human bites, and rabies in animal bites.
Other bites	Viral infections possible especially if other pets e.g. monkeys involved.	Seek ID advice	For other animal bites give antibiotic prophylaxis when hand, foot, face, joint, tendon, ligament involved; or when patient immunocompromised, diabetic, asplenic, presence of prosthetic valves or joints. If accompanied by marked cellulitis consider parenteral antibiotic therapy and seek plastic surgery advice.

Table 12 Common Viral Infections

Infection	Likely Organisms	Recommended Therapy	Notes
Chickenpox	Varicella zoster virus	Not usually required If required **Aciclovir** (orally if well, intravenously in immunocompromised)	Consider aciclovir if: onset of rash <24 hours, and one of the following: >14 years of age; severe pain; dense/oral rash; taking steroids; smoker. Duration of treatment 7 days. If immunocompromised treat for 10 days in total (intravenously for initial 7 days). In patients with symptoms /signs of pneumonitis, give intravenous therapy initially. and watch for significant respiratory compromise **Beware chickenpox is a highly contagious disease.** If admitted, child should be nursed in an isolation room.
Shingles	Herpes zoster virus	Consider **aciclovir** orally *In severe cases or in immunocompromised,* **aciclovir** intravenously	**Aciclovir** may reduce severity, pain and duration of viral shedding if treatment started within 72 hours of onset of rash. Treat for 7 days.
Gingivostomatitis	HSV type 1	*In severe cases,* **aciclovir** orally	If immunocompromised, seek specialist advice.
Viral diarrhoea	Rotavirus, Norovirus	Supportive treatment, no specific antiviral therapy.	Hand hygiene and infection control precautions very important. Child should be nursed in isolation room.
Influenza (flu)	Influenza A, B	Seek virology advice	

Prophylaxis – Medical

Antimicrobial prophylaxis should be considered for individuals thought to be at risk of acquiring an infection as a result of being immunocompromised, asplenic or being in contact with a highly infectious case.

For prophylaxis in surgical procedures see local directorate guidelines.

Antimicrobial Prophylaxis for Selected Medical Conditions

Condition/Infection	Likely Organisms	Recommended Therapy	Notes
Meningococcal meningitis	*N.meningitidis*	Recommended for index case if NOT treated with ceftriaxone. *For contacts:* **ciprofloxacin** orally Neonates: single dose ciprofloxacin 30mg/kg, maximum dose 125mg Child 1 month to 4 year: single dose ciprofloxacin: 125 mg Child 5 to 11 years: 250 mg single dose Child >12 years and adult: 500mg single dose. *For close contacts who are/may be pregnant* **ciprofloxacin** can be used	Always discuss with on-call consultant in public health medicine (CPHM) without delay when clinical diagnosis is made. Healthcare workers in close contact with the patient (e.g mouth-to-mouth resuscitation and likely to have been exposed to respiratory secretions) should be offered prophylaxis. Prophylaxis consists of a single dose only. Ciprofloxacin is not licensed in neonates and children aged less than 1 year, use in these groups is off-label. PHE update 2019 confirmed that The recent EU review of fluoroquinolones does not affect the use of ciprofloxacin chemoprophylaxis for meningococcal disease

Condition/Infection	Likely Organisms	Recommended Therapy	Notes
Haemophilus influenzae in blood culture plus clinical diagnosis of epiglottitis	*Haemophilus influenzae* type B	**Rifampicin** orally Neonates and less than 3 months 10mg/kg once per day for 4 days Children >3 months and adults 20mg/kg once per days for 4 days max 600mg	Always discuss with the consultant in public health medicine.
Splenectomy, hyposplenic, asplenic individuals (Not for patients with coeliac disease)	*Strep.pneumoniae, Haemophilus influenzae, N.meningitidis* Influenza virus	**Phenoxymethylpenicillin** (pen V) orally *If penicillin allergy:* **erythromycin** orally	Management-of-Patients-with-an-absent-or-dysfunctional-spleen for full antibiotic and immunisation guidance.
Viral conditions to which healthcare workers may be exposed	Chickenpox, zoster, blood-borne viruses – needle-stick injuries	Contact occupational health nurse. If out-of-hours contact A&E. Seek further advice if necessary.	Some of these conditions may require appropriate infection control precautions to be undertaken. Consult NHS Lothian Infection Control Policy or seek advice. All staff must be aware of the NHSL policy for HIV post-exposure prophylaxis (PEP).

Guidelines for Therapeutic Drug Monitoring

Therapeutic drug monitoring is important in order to ensure effective concentrations of antimicrobials are achieved and also to avoid toxicity.
Therapeutic monitoring should be carried out for the following antimicrobial agents: aminoglycosides (gentamicin, tobramycin and amikacin), glycopeptides (vancomycin, teicoplanin, 5-flucytosine (5-FC) and co-trimoxazole.

See Childrens Services IV monographs on the intranet for monitoring of gentamicin (conventional and extended interval dosing), vancomycin and teicoplanin.

Antimicrobial Monitoring Guidelines

Drug	Time to Steady State	Ideal Sampling Time	Target Range	Blood Tube	Comments
5-Flucytosine	1 day	Trough levels checked just before dose Peak levels checked at 2 hours post dose	Trough: 30 to 40mg/litre Peak: 70 to 80mg/litre	White topped bottle	Monitoring serum levels is desirable in all patients and mandatory in those with renal impairment
Co-trimoxazole *(in Pneumocystis jiroveci pneumonia (PJP), formerly known as Pneumocystis carinii pneumonia (PCP)*	3 days	Trough levels Peak levels checked at 2 hours after oral dose, or 1 hour after end of intravenous infusion	Trough: 5 to 7mg/litre **trimethoprim** <100mg/litre sulfamethoxazole Peak: 5 to 10mg/litre but <20mg/litre **trimethoprim,** 120 to 150mg/litre but <200mg/litre sulfamethoxazole	White topped bottle	Monitoring is required in those with impaired renal function. Discuss with microbiology. Monitor at least once weekly.

Drug	Time to Steady State	Ideal Sampling Time	Target Range	Blood Tube	Comments
Tobramycin	1 day	*Conventional dosing:* Sample around 3rd or 4th dose. Trough – just before the dose, Peak, at 1 hour after the dose. *Extended interval:* 23 hours after 1st dose – see guideline	Trough: < 2.0 mg/litre. Peak: > 8-12 mg/litre. Trough <1mg/litre	White-topped bottle	Check levels more frequently in impaired renal function. Monitor U&Es, Mg, Ca, Recheck at least every 7 days, more frequently if trough has increased or was at 1.5 to 2 mg/litre initially.

Intravenous to oral conversions

Review all intravenous antimicrobial therapy 48 hours after starting and switch to oral therapy where possible.
Oral antibiotic preparations are more child friendly, staff friendly and less costly.

Criteria for 'oral switch'

- Clinically improving on intravenous therapy (e.g. improving WBC, temperature trend towards normal, improving CRP/ESR, improving signs and symptoms of infection)
- Oral fluids/food are tolerated and there is no reason to believe that oral absorption may be poor

Exceptions where longer term intravenous treatment warranted:

- Meningitis, shunt infections, and other specific neurological conditions
- Endocarditis, septicaemia, bacteraemia
- Some immunocompromised patients
- Cystic fibrosis
- Deep abscess and empyema, septic arthritis, osteomyelitis, severe or necrotising soft tissue infection – require a prolonged intravenous course
- Oral route compromised (e.g. nil by mouth, unconscious, intractable vomiting, reduced gastrointestinal absorption (e.g. severe diarrhoea, steatorrhoea, short bowel syndrome), mechanical swallowing disorder)
- Possibly children less than 1 year old (seek specialist advice)

Antibiotics with excellent oral bioavailability:

These are comparable to intravenous formulations with the oral formulation is preferred to intravenous when the oral route is not compromised.
These include quinolones (ciprofloxacin/ofloxacin etc), fluconazole, clindamycin, sodium fusidate, co-trimoxazole, metronidazole and rifampicin).

Stepping down from intravenous therapy to oral

A direct switch to the same oral preparation is recommended for:

· Aciclovir	· Clarithromycin	· Flucloxacillin
· Amoxicillin	· Clindamycin	· Fluconazole
· Ciprofloxacin	· Co-amoxiclav	· Metronidazole

Recommendations when direct switch to the same oral preparation is not available/ not recommended.	
· Benzylpenicillin	Step down to amoxicillin orally
· Ceftriaxone · Ceftazidime · Cefotaxime · Cefuroxime	Check sensitivity results, if not available, co-amoxiclav most suitable
· Meropenem, · Gentamicin · Tobramycin · Piperacillin/tazobactam · Vancomycin	Check sensitivity results where available-if not seek microbiology advice.