Children's Health Ireland

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Antimicrobial Guidelines 2021

Departments of Pharmacy, Infectious Diseases and Microbiology
Children's Health Ireland at Crumlin, Temple Street and Tallaght

Note: These guidelines were originally developed for use in Our Lady's Children's Hospital, Crumlin (OLCHC) and Temple Street Children's University Hospital (TSCUH). They are now approved for use across all Children's Health Ireland (CHI) sites. Antimicrobial choices and management advice reflect the type of patients and infections seen at these hospitals and are not necessarily applicable to the management of infections in other hospital settings.

If there are any comments, queries or errors noticed, please contact Kara Tedford (kara.tedford@olchc.ie) or Aisling Rafferty (aisling.rafferty@cuh.ie). **Please discard any previous versions in circulation.**

These guidelines may be adapted for use in other hospital settings, but CHI must be acknowledged as the source of the guidelines. For the purposes of this document, CHI at Crumlin is referred to as Crumlin, CHI at Temple Street will be referred to as Temple St and CHI at Tallaght will be referred to as Tallaght.

What's new in this edition?

- Updated information
  - Ventilator-Associated Pneumonia (VAP)
  - Empyema/abscess
  - Dental/dentoalveolar infection
  - Balanitis
  - Neurosurgical Prophylaxis
  - Helicobacter Pylori
  - Penetrating Eye Injury WITHOUT clinical signs of infection
  - Endophthalmitis Following Penetrating Eye Injury or Cataract/ Glaucoma Surgery
  - Vancomycin infusion reaction

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Introduction to CHI Antimicrobial Guidelines

Prudent antimicrobial prescribing is associated with improved clinical outcomes for the individual patient, reduced side effects from unnecessary antibiotic use and reduced potential for the development of antimicrobial resistance.

Antimicrobial resistance is increasing and has become a major global public health problem. There is an increasing need to use antibiotics wisely and in a manner that is supported by evidence of effectiveness. Control of antimicrobial prescribing is a crucial part of any strategy to limit the development of resistance. The National Standards for the Prevention and Control of Healthcare Associated Infections in Ireland 2009 require all hospitals to have antimicrobial guidelines in place.

The purpose of this document is to guide clinicians in the empiric use of antibiotics. Empiric treatment is the choice of an antibiotic prior to sensitivity results being available.
This guide will help to choose agents that are active against the likely pathogens and can adequately penetrate the site of infection.

Empiric antibiotic choice should be reviewed once gram stain/microscopy/ culture/sensitivity or PCR results (where appropriate) are available and should be changed to directed therapy as soon as possible. Directed therapy should be the narrowest spectrum antibiotic to adequately cover the pathogens identified.

This guide cannot cover all situations and is not intended to replace existing antibiotic policies in specialist units within the hospital. In Crumlin, please see latest edition of the Haematology/Oncology Handbook for full details on the management of oncology & haematology patients.

The Consultant Microbiologist & Consultant in Infectious Diseases can be contacted at any time through the hospital switchboard for advice on any aspect of antibiotic therapy.

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Infection Control Nurse Specialists, Temple St	Ext 4389/4783 or Bleep 778
Infection Control Nurse Specialists, Tallaght	Bleep 2210/2211/2609

Useful Links available from within hospital via intranet

Infection Control Guidelines: for information on hand hygiene, isolation precautions, notifiable diseases, MRSA management and more
Crumlin: Infection Control Manual A-Z
Temple Street: http://templenet.cuh.net/index.php/infection-control/
Tallaght: See QPulse

Lab User's Handbook: for guidelines on specimen collection and sample requirements.
Crumlin: http://olchlab.return2sender.ie/Account/Login.aspx
Temple Street: https://www.cuh.ie/healthcare-professionals/departments/laboratory/
Tallaght: https://www.tuh.ie/Departments/Laboratory-Medicine/Lab-User-Manual-v8-9.pdf

Prescribing guides/formulary:

The CHI Paediatric Formulary is available via local intranet, ward tablets or to download from the App store/Play store. Detailed instruction on the administration of IV antimicrobials is listed under the Administration tab in Formulary App.

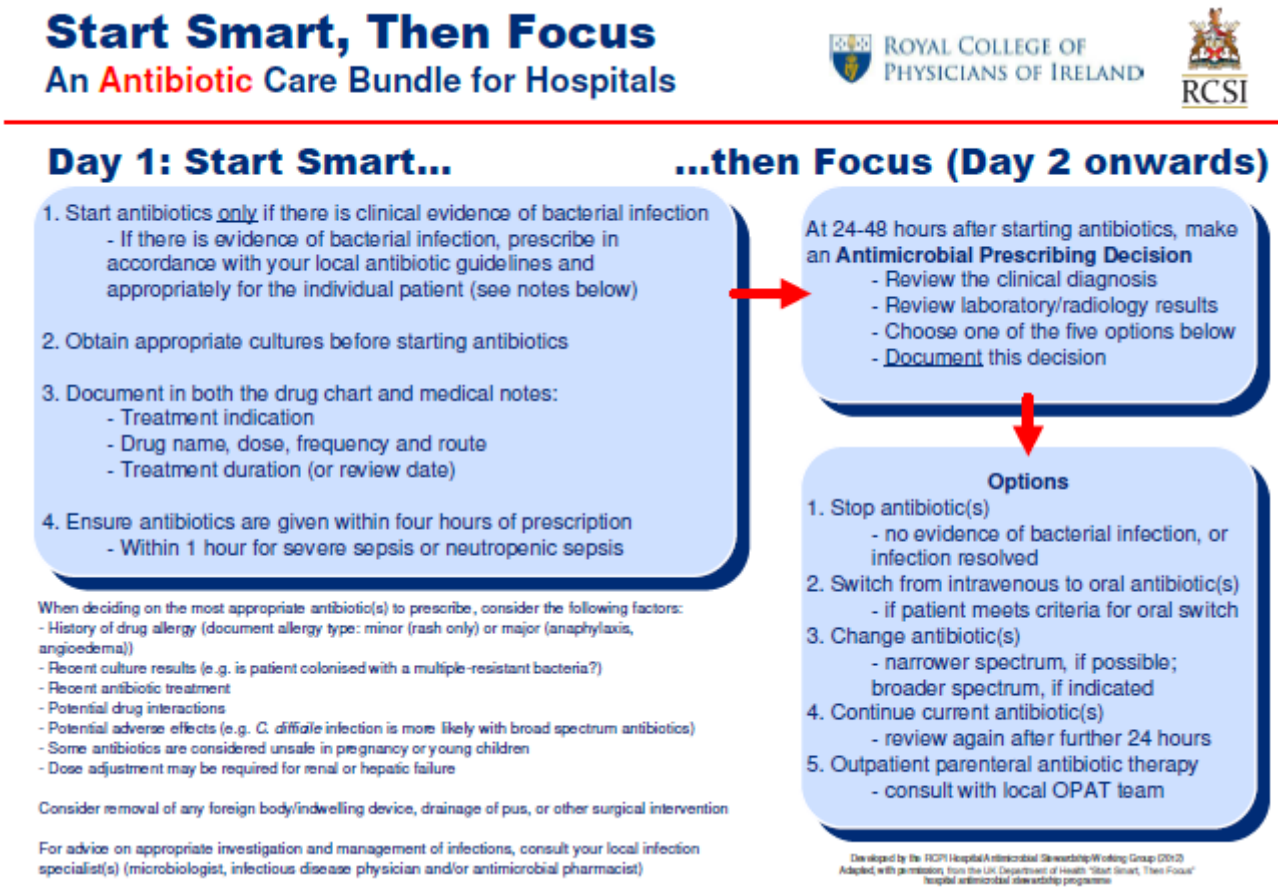
Useful websites

National Immunisation Guidelines- National Immunisation Office - HSE.ie

National Tuberculosis Guidelines -Tuberculosis (TB) - Health Protection Surveillance Centre (hpsc.ie)

Guidelines for the Emergency Management of Injuries (including needle stick and sharps injuries, sexual exposure and human bites, where there is a risk of transmission of blood borne viruses or other infectious diseases)
http://www.hpsc.ie/hpsc/A-Z/Hepatitis/EMIToolkit/

Principles of Antibiotic Prescribing



- Ensure that appropriate microbiological specimens are taken prior to commencing antimicrobials.
- Children with cardiac defects who require blood cultures should have three sets of cultures obtained prior to commencing antimicrobials.
- Only prescribe antibiotics where there is clinical evidence of infection or a clear indication for prophylaxis.
- Use generic names of antimicrobials
- Antimicrobial therapy should be reviewed in the light of microbiological investigations
- Consider previous microbiology results including colonisation with resistant organisms.
- Intravenous antibiotics should be changed to an oral antibiotic as soon as clinically appropriate. Refer to IV to PO switch guidelines below.
- In the event that the patient does not respond within 24-36 hours of commencing therapy, ensure that dosage is correct, that pus is drained and SEEK ADVICE from ID/Micro consultant.
- Avoid unnecessarily prolonged courses of antimicrobials. **Suggested durations** are given throughout this guideline however these should be used only as a guide. Ultimately, the duration of treatment will be influenced by the severity of the infection, the clinical condition of the patient and the infecting pathogen.

- In general, avoid topical use of antibiotics. Where topical use is indicated, do not use antibiotics that are used systemically.
- Ensure any history of allergy and nature of the allergy is documented in the patient's medical notes and on the front of the medication chart before prescribing antibiotics. See Evaluating for Antibiotic Allergy before prescribing antimicrobials below for more information.
- Consult the section on dosage in renal failure in the "BNF for Children" available on the Crumlin intranet or Temple Street Clinical Portal. Alternatively, contact the Renal team or pharmacy department for advice
- Doses are not given in this guideline. Please refer to the latest edition of the CHI Formulary on the hospital intranet or via the App. Note that for some serious infections doses higher than routinely recommended are necessary to ensure effectiveness. Specific details can be found under each individual drug.
- Consult the Summary Product Characteristics via http://www.HPRA.ie for information on drug interactions, adverse events and contraindications. Contact the pharmacy department for further advice.

Evaluating for Antibiotic Allergy before Prescribing Antimicrobials

Background

Before prescribing any antimicrobial agent, a history of possible contraindications, adverse reactions, allergies, must be sought. Rashes, including urticarial rashes are common occurrences in childhood febrile illnesses. Over 90% of reported paediatric "allergic" reactions to antimicrobials cannot be repeated or were merely well described side effects such as penicillin induced diarrhoea or macrolide induced nausea. Unnecessary use of alternative antibiotics increases the risk of development of antimicrobial resistance. Incorrect labelling of antibiotic allergy can lead to unnecessary use of more toxic alternative antimicrobials and increase hospital stay.

Types of allergic reactions:

Immediate hypersensitivity reactions (Type 1):

Type 1 reactions are IgE-mediated and occur <1 hour post dose. Clinical signs include urticarial or pruritic rash, angioedema, rhinitis, respiratory and or cardiovascular compromise.

Delayed Hypersensitivity reactions (Type II, III, IV):

Type II reactions are IgG mediated and occur > 72 hours post dose. These are not true 'allergic reactions' however these reactions should lead to avoidance of future use of the suspected drug. Common manifestations of this type of reaction include haemolytic anaemia, neutropenia or thrombocytopenia.

Type III reactions are generally associated with immune complex deposition and complement activation (e.g. serum sickness like reaction to cefaclor, glomerulonephritis).

Type IV reactions are the most common drug hypersensitivity reactions encountered. These are not antibody mediated but relate to T cell activity. The skin is most often involved in generalised maculopapular eruptions (e.g. beta- lactam related rashes typically developing after a number of days on treatment).

Taking a drug allergy history

The parent should be asked to describe the previous reaction, including timing of the reaction, the type of rash, distribution and how long it took to resolve. Photos if available should be reviewed. Maculopapular rashes that develop in young children on day 3 or 4 post commencing a course of oral antibiotic and resolve quickly are very unlikely to indicate future risk of severe allergic reaction.

Red flags: (Symptoms more likely to indicate risk of future reactions)

- History of angioedema
- History of breathing difficulties
- History suggestive of cardiovascular compromise

The symptoms listed above are strongly suggestive of a previous Type 1 reaction and thus future prescribing would be contraindicated

- Joint swelling

A history of joint swelling may indicate serum sickness like reaction. Further administration can trigger a Type 1 reaction. In the first instance avoidance is advised.

- History of hospitalisation due to previous drug eruption.
- History of skin peeling or desquamation
- History of bruising (vasculitis)
- History of involvement of mucous membranes
- History of internal organ involvement, abnormal blood parameters

The symptoms listed suggest a previous severe adverse cutaneous reaction (SCAR). In this case re-prescribing of the suspected agent is contraindicated as SCAR carry a mortality rate of 10 %.

Management Options:

No	Conclusion	Outcome
1	History of adverse reaction is not consistent with drug allergy	The recommended antimicrobial can be prescribed
2	History suggests a probable drug allergy	Choose alternative antimicrobial and consider referral to the allergy team for consideration for elective drug provocation test
3	History indicates a probable allergic reaction but alternative antimicrobial choices are limited.	Choose alternative antimicrobial in the short term and consider referral to the allergy team for possible formal drug provocation test
4	History clearly suggests previous Type 1 allergic reaction but alternative antimicrobial choices are limited.	Choose alternative antimicrobial and consider referral to the allergy team regarding appropriateness of desensitisation
5	The history is suggestive of a previous SCAR.	Retrial of antibiotic completely contraindicated. Caution re cross reactivity. Discuss antibiotic selection with allergy/ID/Micro team.
6	Patient has previously confirmed by the allergy team to have a drug allergy.	Choose alternative antibiotic.

Note: Discussion with the ID/Microbiology may be necessary, in order to choose the most appropriate alternative antimicrobial.

Recording adverse drug reactions:

If the clinician determines from the history that use of a particular antimicrobial is contraindicated, this should be documented:

1. On the most recent Kardex dated and signed
2. A more detailed note should be recorded in the medical notes documenting all aspects of the history that lead to the decision to avoid the antibiotic.
3. A follow up plan should be made and documented in the medical notes: see above re management options.
4. The drug allergy **must also** be recorded on the inside of the patient's medical notes.

Essential data to record in the medical notes.

1. The date of the reaction
2. The time of onset with relation to the most recent course of antibiotics.
3. If multiple antibiotics have been prescribed, document the date of onset of each one.
4. Record all symptoms and clinical signs including those that may not be (at first glance) involved.

- **Rash:** Include its distribution, characteristics, mucous membrane involvement/not, obvious areas that are spared.
- Presence or absence of Lymphadenopathy (check all sites).
- Evidence of internal organ involvement
- Presence or absence of fever
- Also record any abnormal laboratory indices: LFTs, eosinophilia, cytopenia etc.

Choosing alternative antibiotics:

Patients with a history of Type 1 reactions to penicillin or amoxicillin are likely to tolerate monobactams and carbapenems. Patients with a history of Type 1 reactions to amoxicillin are likely to react to cephalosporins with a similar side chain on the β-lactam ring i.e. 1st and 2nd generation cephalosporins. These should be avoided. Other cephalosporins (3rd, 4th and 5th generation) with different side chains are more likely to be tolerated in penicillin allergic individuals. If the initial reaction was severe (anaphylaxis) discuss with allergy team before administration.

Patients with a history of delayed reactions such as morbilliform or maculopapular rash may also tolerate 1st and 2nd generation cephalosporins.

Patients with a history of SCARs (SJS, TENS, DRESS) or haemolytic anemia should not be commenced on a beta lactam without discussion with allergy/ ID/Micro teams.

Antibiotic Formulary

The purpose of an antimicrobial formulary is to reduce the large number of available antibiotics to a manageable list.

For a full list of available antibiotics see the CHI Paediatric Formulary which can be accessed by downloading the App via iTunes/Google Play store or via the hospital intranet.

Additional antibiotics & antifungals may be required from time to time to treat multi-resistant or very uncommon infections. Requests for non-formulary antibiotics & antifungals must be sanctioned by a Consultant in ID/Micro.

Formal requests including all supporting documentation should be sent to the Drugs & Therapeutics Committee for approval.

Restricted Agents

A small number of high risk antibiotic & antifungal agents have been restricted to use following advice from a Consultant in ID/Micro with some exceptions. These are agents that may have a propensity to select out resistant pathogens, cause a significant risk of adverse events and/or are high-cost agents. They will not be generally stocked on wards and will not be dispensed from pharmacy unless approval from ID/Micro has been granted.

These agents will be identified throughout the guideline with the symbol (R).

Antibiotics:

- Carbapenems (Meropenem*, Ertapenem)
- Ceftazidime*
- Ceftazidime/avibactam (Zavicefta®)
- Ceftolozane/tazobactam (Zerbaxa ®)
- Colistimethate sodium*
- Daptomycin
- Fosfomycin
- Linezolid
- Piperacillin/Tazobactam**
- Quinolones (Ciprofloxacin,levofloxacin,moxifloxacin) $
- Temocillin
- Tigecycline

Antifungals:

- AmBisome® ^
- Caspofungin^
- Itraconazole*
- Posaconazole*
- Voriconazole *

* Except for use in Cystic Fibrosis or Haematology/Oncology patients as part of protocols

** Restricted in Temple St only

$ Except for use in Cystic Fibrosis, Nephro/urology or Haematology/Oncology (Consultant prescribing only)

^Except for use in Haematology/Oncology patients as part of protocols

Switching from IV to Oral Antibiotics

The route of administration of an antibiotic often depends on the severity and/or the site of infection. If antimicrobial treatment has been started intravenously, it should be regularly reviewed and switched to oral treatment at the earliest opportunity based on cultures and sensitivities (C&S).

Early conversion (after 48 hours) from IV to PO therapy should be considered for <u>all</u> uncomplicated infections including:		
Uncomplicated UTI	Pharyngitis/Tonsillitis	Community acquired pneumonia
Skin and soft tissue infections/cellulitis	Sinusitis	Uncomplicated lymphadenitis

Conversion from IV to PO therapy can be considered after 5-7 days for	
Acute septic arthritis	Acute osteomyelitis
Always discuss with ID/Consultant Microbiologist. Patient must be clinically well, afebrile for 5 days with decreasing CRP /ESR.	

Please consider the following before switching:

Check the patient:

- Is haemodynamically stable and afebrile for the previous 24-48 hours
- Is clinically improving and has a peripheral white cell count (WCC) and C-reactive protein (CRP) returning to normal. Note: CRP may be suppressed by corticosteroid use therefore interpret with caution in patients on corticosteroids
- Is not vomiting or having diarrhoea, has a functioning GI tract, are able to tolerate oral intake or have an NG or PEG tube in place.
- Is not neutropaenic
- Does not have a high risk or deep-seated infection (see below)
- There must be a suitable oral equivalent.

Exemptions from Early IV to PO Switch	
HIGH RISK INFECTIONS:	
Meningitis (full course IV)	Severe necrotising soft tissue infections
Endocarditis (full course IV)	Infected implants or prosthetics
MRSA/*Legionella* pneumonia	Exacerbations of CF / bronchiectasis
Bacteraemia	Intracranial abscess or encephalitis
Severe infections during chemotherapy-related neutropaenia	Incompletely drained abscesses or empyema
DEEP SEATED INFECTIONS:	
Empyema	Neonatalseptic arthritis and neonatal osteomyelitis
Mediastinitis	Abdominal, pelvic or liver abscess

Antimicrobial that are as effective orally as IV. Do not use IV unless not tolerating PO or specifically advised by ID/ Micro	
Clindamycin	Erythromycin
Ciprofloxacin (R)	Linezolid (R)
Clarithromycin	Rifampicin
Co- trimoxazole	Voriconazole (R) and fluconazole

NOTE: Neonates are at high risk of bacteraemia and may have variable absorption of oral medication so switching from IV to oral antibiotics is not recommended.
Always check culture results when available and contact ID/Micro for advice if necessary.

IV-Oral Switch Options

Classification	IV	Oral	Comments on oral treatment
Aminoglycosides	Gentamicin	Follow C&S and ID/Micro advice	No oral preparations however isolate may be susceptible to an oral agent in a different antimicrobial class
Carbapenems	Meropenem	Follow C&S and ID/Micro advice	No oral preparations however isolate may be susceptible to an oral agent in a different antimicrobial class
Cephalosporins (About 0.5–6.5% of penicillin-sensitive patients will also be allergic to the cephalosporins)	1st generation Cefazolin	Cefalexin (Excellent oral absorption ~90%)	For treatment of Gram positive and negative infections including skin and soft tissue and uncomplicated urinary tract infection. Cefalexin is widely distributed in the body but does not enter the CSF in significant quantities.Dose reduce in renal impairment Ensure high dose for serious infection (e.g. bone & joint)
Cephalosporins	2nd generation Cefuroxime	Cefuroxime (poor oral bioavailability) Co-amoxiclav	For skin, soft tissue infection. Caution is advised when substituting oral for IV cefuroxime as **tissue concentrations may not be adequate for treatment of penicillin resistant** Pneumococci or *Haemophilus influenzae* in hard to reach sites e.g. middle ear or bone. Co-amoxiclav may be a better alternative. Where Staphylococcal infection is a primary concern flucloxacillin, cefalexin or clindamycin can be used.
	3rd generation (cefotaxime ceftriaxone ceftazidime)	Follow C&S and ID/Micro advice	Cefixime, provided the isolate is susceptible can be used for treatment of urinary tract infections. Dose reduce in renal impairment Co-amoxiclav or cefalexin could all be suitable depending on site of infection and likely organism.
Clindamycin	Clindamycin	Clindamycin (Excellent oral absorption ~90%)	Mainly bacteriostatic for serious anaerobic infections, pneumococci, staphylococci and streptococci. Good penetration into bone, lung, skin and soft tissue but poor CNS penetration. No activity against *Kingella Kingae* (a cause of bone and joint infection in young children). Significant potential for causing pseudomembranous colitis so reserved for when alternative drugs are unsuitable. Discontinue immediately if diarrhoea develops. Mostly metabolised with 10% excreted unchanged in the urine. **NOTE: liquid is unlicensed, contact community pharmacy prior to discharge**

Classification	IV	Oral	Comments on oral treatment
Fluoroquinolone **Note:** Additional warnings on the long term side effects and extended adverse effects of fluoroquinolones have been circulated by the HPRA and EMA (**EMA**) in 2018. Consider alternatives and/or discuss with Microbiology/I.D. where appropriate.	Ciprofloxacin	Ciprofloxacin	Fluoroquinolones are associated with prolonged serious, disabling and potentially irreversible adverse reactions and should not be used to treat mild or self-limiting conditions, traveller's diarrhoea or to prevent recurring lower urinary tract infections. It should only be used where there is no alternative antibiotic available. Widely distributed including liver, bile, lungs and urine. Use with caution in patients pre-disposed to seizures, G6PD deficiency, myasthenia gravis and conditions predisposing to prolonged QT interval. Good oral absorption reduced by magnesium, aluminium, calcium and dairy products. Administer ciprofloxacin **2 hours before** or **4 hours after** these agents. A feeding break, where possible, of **1 hour before** and **2 hours after** administration via an enteral feeding tube is recommended. Inhibitor of P450 CYP1A2 so–may cause clinically significant interactions. See SPC for details 30 – 50% unchanged in the urine and 20 – 40% metabolised. **NOTE: liquid is unlicensed, contact community pharmacy prior to discharge**
Glycopeptides	Vancomycin Teicoplanin	Follow C&S and ID/Micro advice Consider high dose flucloxacillin if sensitive.	No oral preparations however isolate may be susceptible to an oral agent in a different antimicrobial class
Linezolid	Linezolid	Linezolid (Excellent oral absorption ~100%) Avoid prolonged use Maximum duration of use should not exceed 28 days	Reserved for deep seated infection, including skin, respiratory, VRE, MRSA Monitor FBC weekly for blood dyscrasias while on therapy. It is a reversible non-selective MAOI. Avoid large amounts of tyrosine rich food e.g. yeast extracts, fermented soya bean products and use with other MAOIs, antidepressants and pethidine. The elimination half-life of linezolid is about 5 to 7 hours. **Must be prescribed via the HSE High-Tech Hub**

Classification	IV	Oral	Comments on oral treatment
Macrolides	Clarithromycin	Azithromycin	Azithromycin is widely distributed throughout tissues. Poor penetration into CSF. The terminal plasma-elimination half-life closely follows the tissue depletion half-life from 2 to 4 days. Azithromycin does not interact significantly with the hepatic cytochrome P450 system. Prolongs QT interval thus use with caution with other drugs that prolong the QT interval. Small amounts of azithromycin are demethylated in the liver, and it is excreted in bile mainly as unchanged drug and 20% excreted unchanged in the urine.
Metronidazole	Metronidazole	Metronidazole	Metronidazole is rapidly and almost completely absorbed on oral administration; peak plasma concentrations occur after 20 minutes to 3 hours. Widely distributed in body tissues, including CSF. Extensively metabolised in the liver with 20% excreted unchanged in the urine
Anti-pseudomonal Penicillins	Piperacillin-tazobactam	Be guided by C&S and ID/ microbiology advice	NA
Penicillins	Benzylpenicillin (Penicillin G)	Phenoxymethyl-penicillin (Penicillin V)	Phenoxymethylpenicillin is widely distributed including skin and tonsils but oral bioavailability may be erratic and oral penicillin is not suitable for serious infections. Give 1 hour before food or 2 hours after. It is metabolised in the liver to a greater extent than benzylpenicillin. 20% to 40% of an oral dose is excreted in the urine in 24 hours.
	Amoxicillin	Amoxicillin	Amoxicillin distributes into liver, bile, lungs, middle ear effusions, good urinary penetration (not for empiric treatment of UTI due to high resistance rates). Poor penetration in to CSF. Maculopapular rashes may occur <u>but are not usually related to true penicillin allergy</u> (more common in children with EBV or CMV infection, and in ALL). 60% excreted unchanged in the urine

Penicillin	**IV**	**Oral**	**Comments on oral treatment**
	Co-amoxiclav	Co-amoxiclav Use not advised in Neonates- contact ID/Micro for advice.	Co-amoxiclav is a combination of amoxicillin and the beta-lactamase inhibitor clavulanic acid and has a broad spectrum of activity. It should not be used if the organism is sensitive to amoxicillin (or flucloxacillin) both of which are more selective. Distributed into liver, bile, lungs, middle ear effusions, sinus secretions, urine. Poor penetration into CSF. Maculopapular rashes may occur but are not usually related to true penicillin allergy (more common in children with EBV or CMV infection, and in ALL). 60-70% amoxicillin and 40-65% clavulanic acid excreted in the urine. Clavulanic acid extensively metabolised.
	Flucloxacillin	Flucloxacillin	Flucloxacillin diffuses well into most tissues. Poor penetration into CSF. Give 1 hour before food or 2 hours after. 66 – 76% excreted in the urine. **Cefalexin** is a useful PO alternative option in skin/soft tissue infection, it is well absorbed and more palatable than flucloxacillin. >80% excreted unchanged in the urine, and is widely distributed.

Gentamicin Dosing & Monitoring Guideline

Exceptions to this guide:

1. This guideline does not apply to those with known mitochondrial m.1555A>G mutation.
2. This guideline excludes patients on renal replacement therapy; consult local protocols and nephrology department for advice in these cases.
3. Note as part of treatment regimens for specific forms of bacterial endocarditis a different once daily dosing approach (using a lower dose of 3mg/kg) is now recommended in guidelines published by the European Society of Cardiology as well as the American Heart Association. This indication and dosing approach is outside the scope of this guidance.

Paediatric Gentamicin Dosing General Guidance

- Use extended interval or once daily dosing except where recommended by ID/Micro.
- Dose using ideal weight for height in obesity (dose should not exceed maximum adult daily dose of 480mg or as per local policy). However, individual hospitals may have specific protocols for particular patient groups which recommend different maximum daily doses.
- Dose based on renal function (i.e. review urea and creatinine, urine output, consider any known kidney abnormality or dialysis. However, this should not delay the first dose of gentamicin in patients with suspected sepsis).
- If possible, dehydration should be corrected before starting gentamicin.
- Assess need to continue other ototoxic or nephrotoxic drugs. Where concomitant use is unavoidable, administration should be separated by as long a period as practicable (e.g. gentamicin and an ototoxic diuretic such as furosemide).
- Regular review and documentation of ongoing need for gentamicin is essential.
- The time of blood sampling and the time the last dose was administered must be recorded in order to accurately interpret gentamicin level results.
- This guideline excludes patients on renal replacement therapy; consult local protocols and nephrology department for advice in these cases.

Recommended Paediatric Gentamicin Initial Dosing Regimen

NOTE: Dosing guidelines in individual centres should be agreed locally with input from ID/Micro, nephrologists and pharmacy.

**The interval may be shortened, based on clinical judgment, for example if the baby appears very ill.*

Age	Renal Function (in renal impairment see below)	Initial Dose
Neonates < 7 days	normal	5mg/kg IV 36 hourly
Neonates > 7 days	normal	5mg/kg IV 24 hourly
Children > 28 days	normal	7mg/kg IV 24 hourly

Paediatric Gentamicin Monitoring

Why are levels taken?

- ***Pre dose (trough)*** *levels* are taken to ensure that the previous dose of gentamicin has been sufficiently cleared by the kidneys before the next dose is given. Failing to clear doses due to renal impairment can result in toxic levels and kidney damage.
- ***Post dose*** **(peak)** levels are not routinely performed with extended interval or once daily dosing. They may occasionally be required, but should only be done under expert guidance.

When should first level be taken?

- The prescriber must decide on initial timing of therapeutic drug monitoring (TDM) and order first serum pre-dose level in advance of prescribing 1st dose if more than one dose is planned.
- The first pre dose level can be taken either before the 2nd or the 3rd dose depending on the clinical situation.
- For the majority of patients **with normal renal function**, taking a pre-dose level before the 3rd dose is appropriate. This prevents unnecessary levels from being taken in patients that are likely to stop gentamicin within the first 36-48 hours of therapy.

  For example:

  1. Patients who are likely to be switched to oral antibiotics after 48 hours of IV therapy e.g. treatment of uncomplicated UTI.
  2. Patients being treated for febrile neutropenia who are well, with no clinical focus of infection and where gentamicin will be stopped after 48 hour negative cultures.
- If there are any concerns about a patient's renal function a level should be taken before the 2nd dose of gentamicin.

For example:

1. Patients with acute renal impairment due to sepsis/or with profound circulatory compromise and/or on inotropes especially in intensive caresettings.
2. Any patients with chronic renal impairment or with a known kidney abnormality.
3. Neonates may have a level taken before the 2nd or the 3rd dose depending on the clinical situation. Hospital systems should consider providing blood culture results 36 hours after starting gentamicin to facilitate timely discontinuation of treatment.
4. If the decision is made to continue gentamicin at 36 hours, a 'pre-dose' level can be taken before the second dose and the result reviewed before giving the third dose.

Timing of levels

- Ideally the blood sample should be taken immediately before the next dose is due.
- However in order to facilitate phlebotomy and laboratory times, levels can be taken in the following time windows:
    1. Up to 8 hours before dose is due if on 24 hourly dosing (i.e. 16-24 hours post dose)
    2. Up to 8 hours before dose is due if on 36 hourly dosing (i.e. 28-36 hours post dose)
- The time of blood sampling and the time previous dose was administered must be recorded in order to accurately interpret the results.

Subsequent doses

Give 2nd or 3rd dose as appropriate without waiting for result, unless there is evidence of renal dysfunction (e.g. elevated serum creatinine or urea concentrations, decreased urine output).

- In patients with renal dysfunction, wait for result before giving any further doses.
- In acutely septic patients, dose may be given if clinically appropriate under direction of a senior clinician.

Interpreting results

Aim for pre-dose levels < 1mg/L (or < 2mg/L in neonates if 3 doses or less have been given). If levels are above recommended range:

- Double check that the level was taken in the correct time window (i.e.16-24 hours or 28-36 hours post dose as appropriate).
- If the levels are high in acutely septic patients, contact ID team/Microbiology consultant for advice.
- In patients with a level >1mg/L who are not acutely septic, hold the next dose and repeat level

12 hours later.

- Recommence dosing if levels are ≤1mg/L and amend the dosage interval to reflect the time required to clear the previous dose (e.g. from every 24 hours to every 36 hours).

Frequency of monitoring

- Check U&E/creatinine each time gentamicin level is checked
- In patients with normal renal function: Repeat level every 3 doses.
- In patients with renal impairment: Before every dose until discussed with Consultant Nephrologists/Microbiologist or ID.

Gentamicin Dosing and Monitoring in Normal Renal Function: for 'Extended Interval' and 'Once Daily' Dosing ONLY

Neonate dose		Take level (Repeat level every 3 doses)	Target level	Subsequent doses
< 7 days	5mg/kg 36 hourly	Before the 2nd or 3rd dose. Ideally, take immediately before dose; otherwise 28-36 hours after the previous dose.	<1mg/L or < 2mg/L in neonates if 3 doses or less have been given	Review microbiology results at 36 – 48 hours. If continuing therapy, take level and give the next dose without waiting for result. **NB: See exceptions below***
>7 days	5mg/kg 24 hourly	Before the 3rd dose i.e. 16 - 24 hours after the 2nd dose.		Give 3rd dose without waiting for result. **NB: See exceptions below***
Children > 28 days dose		**Take level (Repeat level every 3 doses)**	**Target level**	**Subsequent doses**
>28 days	7mg/kg**	Before the 3rd dose i.e. 16 - 24 hours after the 2nd dose.	<1mg/L	Give 3rd dose without waiting for result.

*Exceptions: If renal function deteriorates (urine output drops, creatinine or urea rises) or patient has profound circulatory compromise &/or is on inotropes - wait for result before giving subsequent dose. In acutely septic patients, dose may be given if clinically appropriate under direction of senior clinician.

**Dose should not exceed maximum adult daily dose of 480mg or as per local policy

It is essential to document the time the blood was drawn and the time the last dose was administered in order to accurately interpret the results.

Gentamicin Dosing and Monitoring in Renal Impairment (Including Neonates): Single Dose ONLY

Degree of renal impairment	Dose (single dose only)	Take level	Target level	Subsequent doses
Mild (GFR 30-70mL/min)	5mg/kg	Before the 2nd dose i.e. 16 - 24 hours after the 1st dose if 24 hourly dosing or 28 – 36 hours after the 1st dose if 36 hourly dosing.	<1mg/L	Await the result and decide on regimen in consultation with ID/Micro or Nephrology consultant. The interval between doses may need to be increased and will be driven by levels.
Moderate (GFR 10-30mL/min)	3mg/kg			
Severe/HD (GFR <10mL/min)	2mg/kg			

Guidelines for Intermittent Intravenous Administration of Vancomycin in Paediatrics for Preterm, Neonates, Infants and Children Up To 17 Years

1. Background

Vancomycin is a glycopeptide antibiotic active against *Staphylococcus aureus* and other gram positive susceptible bacterial infections. It is indicated for use when there is resistance pattern such as methicillin-resistant *Staphylococcus aureus* (MRSA) or when the patient demonstrates intolerance to alternative antibiotics. It is not the first line treatment for methicillin-sensitive *Staphylococcus aureus* (MSSA) as it is less effective than beta-lactams.

i. *Mechanism of action*: Vancomycin acts by inhibiting the production of the peptidoglycan polymers of the bacterial cell wall by preventing the transfer and addition of the muramylpentapeptide building blocks that make up the peptidoglycan molecule itself.

ii. *Time dependent killing*: For vancomycin, it has been shown that its efficacy is best predicted by the area under the concentration-time curve over 24 hours (AUC24) divided by the MIC (AUC/MIC). This method of therapeutic drug monitoring is not practical at a ward level, therefore trough levels taken an hour before the dose is due is recommended in this guideline to determine efficacy.

(1) When treating an infection caused by bacteria with a vancomycin MIC less than 1 mg/L, aim for a trough of 10-15mg/L

(2) If the vancomycin MIC is greater than 1 mg/L, a trough of 15-20mg/L may be required

Under dosing and sub-therapeutic levels may result in the emergence of drug resistance and subsequent treatment failure.

2. Adverse Effects

Common: Decrease in blood pressure, flushing of the upper body (“vancomycin infusion reaction”, previously known as “red man syndrome”), exanthema and mucosal inflammation, pruritus, urticarial, renal insufficiency, increased serum creatinine and serum urea.

Uncommon: Transient or permanent loss of hearing (ototoxicity associated with persistent high levels)

Rare: Hypersensitivity reactions, anaphylactic reactions, vertigo, tinnitus, dizziness, nausea.

Rapid infusions can result in "vancomycin infusion reaction" ("previously known as "red man syndrome"). "Vancomycin infusion reaction" is a red rash over the upper body that is mediated by a mass histamine release. "Vancomycin infusion reaction" is NOT an allergy.

Please contact microbiology or ID for advice. Note the rate and the concentration the rate reaction has occurred. Further infusions should be run at a slower rate and more dilute concentration. Document changes in the kardex and patient notes.

3. Vancomycin Dosing, Therapeutic Drug Monitoring and Dose Adjustments in Patients with Normal Renal Function

A. Dosing

In all patients without renal impairment the starting intravenous unit dose is **15mg/kg,** Frequency will vary depending on age; preterm, term and >1 month-17 years. Please see table below.

Loading dose of **25mg/kg (max 2g)** can be given to achieve faster therapeutic levels. A loading dose would be indicated for patients with bacteraemia, endocarditis, osteomyelitis, meningitis, necrotising fasciitis and empyema 12 years and above or under if advised by Micro/ID.

Example of dosing schedule: loading dose 25mg/kg THEN AFTER 6 HOURS 15mg/kg every 6 HOURS

Vancomycin Paediatric dose for all ages with normal renal function is 15mg/kg (Max 3g/day)
Frequency of dosing recommendations

Preterm (<37/40 weeks gestation)		
Weight	**≤7 days of life**	**>7 days of life**
<1.2kg	18 HOURLY	
1.2-2kg	12 HOURLY	
>2kg	12 HOURLY	8 HOURLY
Term (≥37/40 weeks gestation)		
≤7 days of life		**>7 days of life**
12 HOURLY		8 HOURLY
1 month-17 years		
6 HOURLY **Maximum single dose in normal renal function is 750mg**		

B.Vancomycin monitoring in normal renal function

- Levels should be taken through venepuncture or capillary blood samples.
- Do not withhold the dose when waiting for a level to come back.
- Sub-therapeutic levels can result in treatment failure or the emergence of drug resistance.
- Toxic or high levels of vancomycin can result in nephrotoxic and/or ototoxicity. It is important to monitor renal function for the duration of treatment of vancomycin as it is renally cleared. Monitor creatinine and urea a minimum of twice weekly for the duration of vancomycin treatment.
- If a prolonged course of vancomycin is require a base line auditory test should be carried out.
- If the patient is on additional nephrotoxic medication (e.g. NSAID's, aciclovir, aminoglycosides, diuretics, omeprazole), monitor renal function more frequently. For Acute Kidney Injury (AKI) monitoring and classification please see **section 4** below.

Important

Vancomycin levels should rarely be required to be measured outside of normal working hours. Blood can be taken, sent to the lab and stored to be **processed within normal working hours (e.g. the following morning) for all patients unless there is an exception.** The two exceptions to this are:

1. A patient with renal impairment whose next dose is determined by levels
2. A patient showing signs of vancomycin toxicity

Ensure the request form states the exact time of sampling and the start time of the last dose.

Inform the lab if the patient is an ** exception**

(Note: levels will not be processed in the lab between 12 midnight and 8am).

NB: Check U&E/ creatinine each time you check a vancomycin level

Vancomycin target trough concentration	
Uncomplicated infections:	**10 to 20 mg/L**
Complicated infections: (e.g. Bacteraemia, endocarditis, osteomyelitis, meningitis, necrotising fasciitis and empyema)	**15 to 20 mg/L**

Vancomycin trough levels based on Frequency in normal renal function (Post treatment initiation or dose adjustment, repeat level as below)	
Dosing Frequency	**When to take a trough level**
18 HOURLY	Immediately before or up to ONE HOUR before the **2nd** dose *When levels are therapeutic, repeat every 2 days*
12 HOURLY	Immediately before or up to ONE HOUR before the **3rd** or **4th** dose *When levels are therapeutic, repeat every 2 days*
8 HOURLY	Immediately before or up to ONE HOUR before **4th** or **5th** dose *When levels are therapeutic, repeat every 2 days*
6 HOURLY	Up to ONE HOUR before **4tn**, **5tn** or **6tn** dose *When levels are therapeutic, repeat every 3 days*
In patients with normal renal function, DO NOT withhold the next dose while awaiting the result of the trough level – this may result in the patient being under dosed	

C. Recommended dose adjustment based on vancomycin trough levels for Preterm (<37/40 weeks gestation), Term (≥37/40 weeks gestation) and for >1 month of age-17 years

- **After all dose adjustments repeat level as per recommendations above**
- If there is a rise in creatinine, please calculate GFR and dose adjust as per recommendations in **section 4**. Additionally assess patient for AKI as per the KIDGO definition in **section 4.I**.

Trough level interpretation and maintenance dose adjustment for Preterm (<37/40 weeks gestation) and Term (≥37/40 weeks gestation)		
Pre dose (trough) target	**Pre dose (trough) level (mg/L)**	**Dose adjustment~**
10-20mg/L **If signs of AKI contact micro/ID and see section 4**	< 5	**Increase frequency** 18 hourly>12 hourly>8 hourly. E.g. if 18 hourly then increase to 12 hourly
	5-9	Increase dose by 10%
	10-20	No change (unless target level is 15-20mg/L for complicated infections* contact micro/ID)
	21-24	Decrease dose by 10% and contact micro/ID
	≥25	Contact microbiology/ ID or Pharmacy for advice
	~Post dose adjustment, repeat level as per table above *Complicated infections: Severe infection, reduced sensitivities, bacteraemia, endocarditis, osteomyelitis, meningitis, necrotising fasciitis and empyema	

Trough level interpretation and maintenance dose adjustment for >1 month of age-17 years (15mg/kg 6 hourly)		
Pre dose (trough) target	**Pre dose (trough) level (mg/L)**	**Dose adjustment~**
10-20mg/L **If signs of AKI contact micro/ID and see section 4**	Less than 5	Increase dose by 20%
	5-9	Increase dose by 10%
	10-20	No change (unless target level is 15-20mg/L for complex infections* contact micro/ID)
	21-24	Decrease dose by 10%, but do not omit a dose
	≥25	Contact micro/ID for advice
	~**Post dose adjustment, repeat level as per table in B** *Complicated infections: Severe infection, reduced sensitivities bacteraemia, endocarditis, osteomyelitis, meningitis, necrotising fasciitis and empyema	

4. Vancomycin Dosing, Therapeutic Drug Monitoring and Dose Adjustments in Patients with Renal Impairment for Infants And Children >1 Month -17 Years

- Dosing is based on estimated GFR in patients with renal impairment. Please use the Schwartz formula below to calculate GFR
- Dosing and monitoring are expressed in the table below
- Please be aware that impaired renal function should be taken into account for both chronic kidney disease (CKD) and in acute kidney injury (AKI)
- If trough is high, consult nephrologist/ID for advice on subsequent dosing

GFR can be estimated by the Schwartz formula:
Child over 1 year:
GFR (mL/min/1.73 m^2) = (40 × Height in cm) / Creatinine in micromol/L
Neonate:
GFR (mL/min/1.73 m^2) = (30 × Height in cm) / Creatinine in micromol/L

To monitor for AKI please use the KIDGO model, if a patient is showing signs of AKI please review vancomycin and all nephrotoxic medication prescribed.

KIDGO classification of Acute Kidney Injury (AKI)

Stage 1: Increase in creatinine of ≥50%
Or
Absolute increase in creatinine of 26.5 micromol/L
Stage 2: Increase in creatinine of ≥100%
Stage 3: Increase in creatinine of ≥200%

Dose Adjustment and monitoring for renal impairment in infants and children >1 month of age			
GFR (ml/min/1.73 m^2)	**IV Dose**	**Frequency**	**When to take a trough level**
30-50	15mg/kg	12 HOURLY	Immediately before or up to ONE HOUR before the **3rd** dose. ** HOLD the dose until level is back **
10-29	15mg/kg	24 HOURLY	Immediately before or up to ONE HOUR before the **2nd** dose. ** HOLD the dose until level is back **
<10 HD/ PD	10-15mg/kg	Determined by serum levels. **Hold** subsequent dosing until trough is within target range	Take level **12-18** HOURS after first dose.
Continuous renal replacement therapy (Vancomycin dialysed)	15mg/kg	Determined by serum levels. **Hold** subsequent dosing until trough is within target range.	Take level **12-24** HOURS post dose

5. Vancomycin Reconstitution and Administration

Dilution of reconstituted vials (500mg and 1g)	Dilute with sodium chloride 0.9% or glucose 5% to a concentration of up to 5mg/mL i.e. dilute each 500mg with at least 100mL
Rate of infusion	The rate must not exceed 10mg/minute, give over at least 60 minutes minimum using an infusion pump E.g. 750mg over at least 75 minutes, 1000mg over at least 100 minutes etc
Infusion reactions	Rapid infusion may cause severe hypotension (including shock and cardiac arrest), wheezing, dyspnoea, urticaria, pruritus, flushing of the upper body (vancomycin infusion reaction), pain and muscle spasm of back and chest. Stop the infusion if they occur. Effects may last between 20 minutes and up to several hours after stopping administration Peripheral administration may cause injection site pain and thrombophlebitis - rotate injection sites

Bone & Joint

Acute Osteomyelitis or Septic Arthritis **Consult Infectious Diseases/Microbiology.**

Age/ modifying circumstances	Likely Causative Organism	Empiric Treatment	Duration of Therapy	Switching to Oral	Comments
<3 months	*S. aureus* *Group B streptococcus* H. *influenza* & other gram negatives	Cefotaxime IV **plus** Flucloxacillin IV ***plus*** Gentamicin IV	Consult Infectious Diseases/Microbiology	**< 2 months** should have IV antibiotics for entire duration of treatment **> 2 months** who are afebrile and who have shown improvement both clinically and in inflammatory markers can change to oral antibiotics after 5-7 days. **Discuss optimum choice of oral antibiotic with Infectious Diseases, Microbiology or Antimicrobial Pharmacist.** For difficult to treat organisms, IV therapy will be required for longer.	
≥ 3 months	S. *aureus* *Group A streptococcus* *Kingella Kingae* if ≤ 5 years (*H. influenza* in septic arthritis in unvaccinated)	**If ≤ 5 years:** Cefazolin IV **If >5 years:** Flucloxacillin IV **OR** Cefazolin IV	Consult Infectious Diseases/Microbiology		*Kingella* susceptible to cephalosporins but not to flucloxacillin
Osteomyelitis in sickle cell disease or galactosaemia	*S. aureus* Group A streptococci *Salmonella*	Flucloxacillin IV ***plus*** Ceftriaxone IV **OR** Cefotaxime IV	Consult Infectious Diseases/Microbiology		
Osteomyelitis following penetrating injury to foot	*Pseudomonas aeruginosa* *S. aureus* Streptococci	Piperacillin/tazobactam IV **+/-** Gentamicin IV	Consult Infectious Diseases/Microbiology		
Osteomyelitis in an immune-compromised child	Consult Infectious Diseases/Microbiology	Consult Infectious Diseases/Microbiology	Consult Infectious Diseases/Microbiology		

Chronic Osteomyelitis **Consult Infectious Diseases/Microbiology.**

It is never an emergency to start antibiotics for chronic osteomyelitis. Where possible, it is better to obtain good microbiology samples first, so that treatment may ultimately be appropriately tailored.

Cardiac

Endocarditis Consult Infectious Diseases/Microbiology.

Setting	Likely Causative Organism	Empiric Treatment	Duration of Therapy	Switching to Oral	Comments
Native valve with no prior heart surgery	Streptococci Enterococci Staphylococci HACEK Gram-negative bacilli	Vancomycin IV **plus** Cefotaxime IV	Consult Infectious Diseases/Microbiology	Continue IV therapy for entire duration	Empiric therapy should be changed to directed therapy as soon as the organism and susceptibility patterns are known – please discuss with Infectious Diseases/Microbiology teams
Any of following: • Prosthetic heart valve or shunts in situ • Hospital-acquired infection • Major penicillin allergy • Known or suspected MRSA colonisation	Streptococci Enterococci Staphylococci Gram-negative bacilli	Vancomycin IV ***plus*** Gentamicin IV ***plus*** Rifampicin PO/IV	Consult Infectious Diseases/Microbiology	Continue IV therapy for entire duration	

Important:

- **Consult Infectious Diseases/Microbiology for all suspected or confirmed cases**
- When possible children with congenital heart disease who present with fever and no obvious source should have 3 sets of blood cultures from separate venepunctures **before** starting antibiotics. This should not delay the administration of antibiotics to clinically septic children.
- **Use maximum antibiotic doses**, as detailed in CHI Formulary . Aim for **vancomycin trough level of 15-20mg/L.**
- Once the causative organism is identified and susceptibilities are known, tailor therapy appropriately.

Central Nervous System

Acute Bacterial Meningitis

Age	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral	Comments
Birth - 4 weeks	*Group B streptococcus, Listeria monocytogenes E. coli &* other gram negative bacilli	Cefotaxime IV* ***plus*** Amoxicillin IV ***plus*** Gentamicin IV	For <u>uncomplicated</u> meningitis with known organism: *N. meninigitidis* 7 days *H. influenzae* 10 days *S. pneumoniae* 14 days *Group B streptococcus* 14-21 days *E. coli &* Gram-neg bacilli 21 days *L. monocytogenes* 21 days Longer durations may be required if persistent fever or other complications Suspected bacterial meningitis where no organism found: Age <3 months 14 days Age >3 months 10 days	Continue IV therapy for entire duration	*In patients > 4 weeks, cefotaxime may be switched to ceftriaxone (once daily) after 24 hours once diagnosis is clear and/or patient has stabilised. Note contraindications as per BNFc.
> 4 weeks - ≤ 8 weeks	*N. meningitidis, S. pneumoniae, Group B streptococcus E. coli Listeria monocytogenes*				
> 8 weeks - 15 years	*N. meningitidis S. pneumoniae H. influenzae (Group B Streptococcus if* ≤12 weeks*)*	Cefotaxime IV*			
Also consider:					
Any age:	Consider adding **Vancomycin IV** if ***S. pneumoniae*** suspected based on: • Post head injury or CSF leak • Gram +ve cocci in CSF Gram stain • High likelihood of pneumococcal pneumonia • Not received pneumococcal vaccine • Recent travel to area with high prevalence of penicillin resistant pneumococci				
> 6 weeks old:	Add **Dexamethasone 0.15mg/kg (max 10mg) 6 hourly IV for 4 days** if ***H. influenzae/ S. pneumoniae*** meningitis is suspected or confirmed as it may reduce long term complications. In this case, ideally it should be given just before or within 1 hour of the first dose of antibiotics**. N.B. Consult Infectious Diseases/Microbiology**				

Central Nervous System

Post-meningococcal exposure prophylaxis

Age	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral	Comments
All ages (including pregnant women)	*N. meningitidis*	Ciprofloxacin	Single dose	NA	Antibiotic prophylaxis should be given as soon as possible (ideally within 24 hours) after the diagnosis of the index case

Brain Abscess **Consult Infectious Diseases/Microbiology**

All ages	α-haemolytic streptococci Anaerobes *S. aureus* *Pseudomonas aeruginosa (see comments)*	Cefotaxime IV ***plus*** Metronidazole IV ***plus*** Vancomycin IV	Consult Infectious Diseases/Microbiology	Continue IV therapy for entire duration	If *Pseudomonas* suspected (e.g. abscess related to chronic ear focus or chronic sinusitis, or immunocompromised host): Replace Cefotaxime IV with **Ceftazidime (R)IV** Empiric therapy should be changed to directed therapy as soon as the organism and susceptibility patterns are known

Central Nervous System

Encephalitis **Consult Infectious Diseases/Microbiology**

Age	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral	Comments
All ages	Herpes simplex virus (HSV) Enteroviruses Influenza *Mycoplasma pneumoniae*	Aciclovir IV **To be commenced only if clinical features of encephalitis e.g.** • **Seizures** • **Altered consciousness /↓GCS** A macrolide (azithromycin PO or clarithromycin IV) may be added if history suggestive of mycoplasma infection.	Treat for 21 days, or until HSV infection has been excluded (negative CSF HSV PCR at >72 hours following onset of neuro symptoms AND low clinical suspicion of HSE)	Continue IV therapy for entire duration **Prolonged oral aciclovir** may be beneficial following **neonatal** HSV encephalitis	Use **high dose Aciclovir:** Ensure adequate hydration while on aciclovir IV to prevent renal toxicity. *Addition of Aciclovir not necessary in the absence of seizures or signs of encephalitis.* Should be reviewed on a case by case basis depending on the clinical situation.

Ventriculitis with CNS Shunt **Consult Infectious Diseases/Microbiology**

All ages	*S. epidermidis* *S. aureus* Gram negative bacilli	Vancomycin IV ***plus*** Ceftazidime (R) IV	Consult Infectious Diseases/Microbiology	Continue IV therapy for entire duration	Shunt removal is usually required.

ENT

Condition	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral	Comments
Cervical Lymphadenitis	*S. aureus* Group A streptococcus Anaerobes Group B strep or *S. aureus* if <3mths	**Mild (outpatient)** Flucloxacillin PO **OR** Co-amoxiclav PO **OR** Cefalexin PO	2 weeks	N/A	
		Moderate/Severe (hospitalised) Flucloxacillin IV ***plus*** Clindamycin PO or IV	2-3 weeks	Y	If suppuration present, incise & drain
Peritonsillar abscess, Retropharyngeal/ Parapharyngeal abscess	Group A streptococcus *S. aureus* Anaerobes	Cefotaxime IV OR Ceftriaxone IV ***plus*** Clindamycin PO or IV	Total IV & PO 14 days	Y	
Epiglottitis- Acute	*S. pneumoniae* Group A & C streptococcus *S. aureus* (*H. influenzae,* now rare)	Cefotaxime IV **OR** Ceftriaxone IV	7-10 days	Continue IV therapy for entire duration	
Tracheitis - Bacterial	*S. aureus* *H. influenzae,* *M. catarrhalis* Group A streptococcus	Cefuroxime IV **OR** Co-amoxiclav IV	10 to 14 days	Y	
Tracheitis in patient with tracheostomy	Above plus *P. aeruginosa*	Add Ciprofloxacin PO (R) to above if *Pseudomonas* a consideration.	7 days (or longer depending on response)	N/A	**N.B**. Take a sample for gram stain and culture before starting antibiotics
Mastoiditis **Acute**	*S. pneumoniae* Group A strep *S. aureus*	Cefotaxime IV **OR** Ceftriaxone IV	Minimum 7-10 days IV, total 4 weeks.	Y	If MRSA, add vancomycin If history of recent antibiotic use and otorrhoea, may need *Pseudomonas aeruginosa* cover. (i.e. switch to ceftazidime (R))
Chronic	Often polymicrobial Anaerobes, *S. aureus*. *Enterobacteriaceae* *Pseudomonas aeruginosa*	**Consult Infectious Diseases/Microbiology** Antimicrobial treatment should be guided by results of culture and sensitivity.	As above	Y	**Chronic:** Antibiotic treatment should begin after drainage. Obtain samples before starting therapy.

Condition	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral	Comments
Dental/dentoalveolar infections	Anaerobes Viridans streptococci	Mild, slowly progressive local spread: Amoxicillin PO **OR** Metronidazole PO (1st line if penicillin allergic) **OR** Clindamycin PO (2nd line if penicillin allergic) Severe: Seek Dental consult Amoxicillin IV ***plus*** Metronidazole IV **OR** Clindamycin IV (if penicillin allergic)	5 days	 Y	Antibiotics are only required in the case of spreading infection (cellulitis, lymph node involvement, swelling) or systemic involvement (fever, malaise) Severe infection: significant trismus, extra oral swelling, eye closing, floor of mouth swelling, difficulty breathing, systemic symptoms or rapidly progressing spread of infection
Otitis externa	*S. aureus* *Pseudomonas aeruginosa* (*Aspergillus*)	If antibiotic necessary: Flucloxacillin PO If *Pseudomonas* isolated discuss with **Infectious Diseases/Microbiology**	 5-7 days		Local cleaning and antiseptic application are often sufficient. Control seborrhoea with dandruff shampoo.
Otitis media- Acute	Often viral *H. influenzae* (<5 years), *S. pneumoniae* Group A strep (*Moraxella catarrhalis*),	<u>First episode</u>: Amoxicillin PO <u>Recurrent or failure to respond after 3 days</u>: Co-amoxiclav PO **OR** Clarithromycin PO <u>Severe, unresponsive to PO therapy:</u> Ceftriaxone IV	10 days	N/A N/A Y	**Most cases, whether viral or bacterial, resolve spontaneously**; consider delaying antibiotic therapy for 48 hours in previously well children of > 2 years, and treating then if still symptomatic **Note:** Use the highest end of dose range where one exists.

Condition	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral	Comments
Pharyngitis **Or** **Tonsillitis**	Viruses (most cases) *Group A strep.* (*S. pyogenes*)	See comments If treatment considered necessary: Phenoxymethylpenicillin PO **OR** Amoxicillin PO **OR** Azithromycin PO (if penicillin allergic)	 10 days 10 days 5 days		**Treat only if proven bacterial cause.** In recurrent and/or refractory infection, consult **Infectious Diseases/Microbiology**
Sinusitis - Acute	*S. pneumoniae,* Group A strep (*Moraxella catarrhalis*)	See comments If treatment considered necessary: 1st line: Amoxicillin PO 2nd line: May switch to Co-amoxiclav PO if not responding	 10-14 days		Most resolve spontaneously. Treat with antibiotics only if not resolving after 10 days. Give high dose in severe infection.

EYE

Conjunctivitis

Consult Infectious Diseases/Microbiology if Group B streptococcus is identified

Age & Severity	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral	Comments
< 1 month Mild	α-haemolytic streptococci Group B streptococci, *S. aureus*	Chloramphenicol eye drops	5- 7 days	N/A	
Severe, purulent and/or serosanginous discharge, early onset (2 – 4 days after birth)	*N. gonorrhoea* *Chlamydia trachomatis* *S. aureus*	Cefotaxime IV ***plus*** Chloramphenicol eye drops/ointment ***plus*** Azithromycin PO	Cefotaxime IV for 3 days Azithromycin 20mg/kg for 3-5 days		Use the maximum dose of cefotaxime as per the CHI Formulary Frequent saline washes if *N. gonorrhoea* isolated. Treat parents also
> 1 month Mild	**Viruses** (most cases): Enteroviruses, Adenovirus Herpes simplex virus **Bacteria** *H. influenza, S. pneumoniae* *M. catarrhalis*	See comments Chloramphenicol eye drops	 5- 7 days		Treat only if proven bacterial conjunctivitis. Most cases, whether viral or bacterial, resolve spontaneously.

Cellulitis – Pre-septal / Orbital

Mild	*S. aureus* Group A streptococcus Pneumococcus *H. influenzae* (in unvaccinated)	Co-amoxiclav PO **OR** Cefalexin PO	10 -14 days		**In severe pre-septal & post septal cellulitis:** **Ensure that pus is examined urgently.** Take blood cultures prior to commencing antibiotics For children ill enough to require IV therapy, CT scan is recommended to determine: -underlying sinusitis -subperiosteal abscess -intracranial extension Change to the most appropriate agents based on results of cultures
Severe	As above	Cefotaxime IV **OR** Ceftriaxone IV	Total IV & PO 10 -14 days	As per clinical response	

Cellulitis – Post-septal / Orbital

Age & Severity	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral	Comments
All ages	*S. pneumonia* *S. aureus* Aerobic Gram negative bacilli Anaerobes	Cefotaxime IV **OR** Ceftriaxone IV ***plus*** Metronidazole IV	Total IV & PO 14-21 days	As per clinical response Minimum 5-7 days IV	

Penetrating Eye Injury WITHOUT clinical signs of infection

Age & Severity	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral	Comments
All ages	Penetrating eye injury can result in any organism being detected. A branch or an outdoor injury high likelihood of infection Staphylococcus spp Gram negative bacilli Fungi If MRSA colonised contact ID/Micro	**Consult Ophthalmology:** 1. Ciprofloxacin PO ***plus*** 2. Ofloxacin 0.3% **or** Chloramphenicol eye drops 3. If corneal laceration with no sign of infection **and posterior chamber of the eye is intact:** **Intracameral Cefuroxime **OR** ****Breach of the posterior chamber**: [$]Intravitreal vancomycin ***plus*** Intravitreal ceftazidime Intravitreal dexamethasone may be required	10 days	NA	[$]Intravitreal vancomycin has a risk of haemorrhagic occlusive retinal vasculitis; however for a penetrating eye injury or endophthalmitis, the benefit outweighs the risk. **Contact pharmacy for supply

Endophthalmitis Following Penetrating Eye Injury or Cataract/ Glaucoma Surgery

Age & Severity	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral	Comments
Cataract/ Glaucoma Surgery or Penetrating Eye Injury with clinical signs of acute bacterial endophthalmitis: **All ages**	*Intra-ocular surgery or Penetrating eye injury can result in any organism being detected.* Staphylococcus spp Gram negative bacilli Fungi *If vegetative matter high likelihood of fungal infection. For fungal endophthalmitis contact ID/Micro*	**Consult Ophthalmology** 1. [$]**Intravitreal vancomycin ***plus*** Intravitreal ceftazidime **Intravitreal dexamethasone may be required may be required 2. Consider ceftazidime IV ***plus*** vancomycin IV 3. **Consider ceftazidime eye drops ***plus*** Vancomycin eye drops	Total IV & PO 10 days Longer duration of systemic antibiotics if associated with systemic sepsis	As per clinical response	[$]Intravitreal vancomycin has a risk of haemorrhagic occlusive retinal vasculitis; however for a penetrating eye injury or endophthalmitis, the benefit outweighs the risk. **Contact pharmacy for supply

Febrile Neutropenia

Age/Patient condition	Empiric Treatment See Chapter 3 page 6 Management of Haematology/Oncology Patients with Fever and Neutropenia

Rationale: Approximately one-third of febrile episodes in neutropenic patients are attributable to bacterial infection.
Empiric antibiotic therapy is primarily directed against Gram-negative aerobic bacilli because of the high mortality with such infection in these patients.
Likely Causative Organism Aerobic Gram negative bacilli, coagulase-negative staphylococci (CoNS), Streptococci, *Candida* species (occasionally), *Aspergillus* species (rarely)

Guidelines for initial empiric antibiotic selection in patients not already receiving empiric antibiotics

Day 0:

All ages Patients *with no significant Beta-lactam reactions:*	Piperacillin/tazobactam IV *plus* Gentamicin IV Add **Teicoplanin,** if additional coverage against resistant Gram positive organisms (e.g. coagulase negative staphylococci, *MRSA*) is clinically indicated. For patients colonised with VRE, the addition of **Linezolid** may be necessary – discuss with ID Team/Consultant Microbiologist
Patients with **mild** *Beta-lactam reaction(s):* e.g. rash only	Ceftazidime IV ***plus*** Gentamicin IV If anaerobic organism is suspected (e.g. severe gingivitis, potential gastrointestinal focus). **Add** Metronidazole IV
Patients with **moderate/severe** *Beta-lactam reaction(s):* e.g. anaphylaxis	Ciprofloxacin IV (R) ***plus*** Gentamicin IV ***plus*** Clindamycin IV

Day 3: Culture Negative patients

Assess patient's risk of septic complications: See Chapter 3 page 9
http://olchcnet.hse.ie/Haematology_Oncology_Shared_Care/Supportive_Care_Guidelines/Treatment_of_Infections_in_the_Neutropenic_or_Immunosuppressed_Patient_1.pdf

If patient is classified as low risk of septic complications AND afebrile for >24 hours AND well, consider discontinuing intravenous antibiotics and convert to oral antibiotic (e.g. Cefixime) to facilitate out-patient management.

If patient does not satisfy criteria for classification as low risk of septic complication AND has no focus of infection AND regardless of temperature (even if persistently febrile) discontinue Gentamicin (and Teicoplanin if applicable) and continue with Piperacillin/tazobactam monotherapy only.(Continue teicoplanin only if evidence of MRSA, ongoing skin focus of infection, or persistent severe mucositis)

Consider patient's underlying diagnosis and treatment (relative risk of septic complications), clinical condition, culture report, Absolute Neutrophil Count and temperature.

If patient remains febrile & neutropenic on Day 3, with clinical evidence of **oral herpes** or **severe mucositis**, take viral swabs for HSV and consider introducing **Aciclovir IV**

Day 5-7: Culture Negative patients

If patient remains febrile & neutropenic, perform a fungal work-up, commence AmBisome® **IV** (If factors (e.g. renal impairment) preclude use of Liposomal Amphotericin IV , consult with ID/Microbiology for most suitable alternative)

Day 7+: Culture Negative patients: Return of fever in patient receiving empiric antibiotic therapy

If patient having responded to initial antibiotic regimen becomes febrile again or has had persistent fever and fungal work-up not yet done, perform fungal work-up and commence on appropriate empiric antifungal treatment.

Day 10-14+: Culture Negative patients: If persistently neutropenic patient becomes febrile again after discontinuation of a 10–14 day course of antibiotics

Reculture and restart broad-spectrum antibiotics as per Day 0. If fever persists for further 48 hours or more, re-culture and add in appropriate empiric anti-fungal treatment.

Culture Positive patients:

If patient becomes afebrile and is clinically well but still neutropenic:
Continue broad spectrum IV antibiotics (as at Day 0) for at least 7-10 days. (Advisable to continue until the ANC >0.5 x 10^9/L.)
Modify treatment once sensitivity data available. Antibiotics specifically directed toward the identified organism should be added to the broad spectrum therapy if the initial antibiotics do not provide adequate coverage. Alternatively, the antibiotic regimen may be adjusted to provide BOTH broad-spectrum AND organism-specific coverage. **Broad spectrum coverage must not be replaced by organism specific antibiotic(s) alone in the neutropenic patient.**

If patient becomes afebrile and is clinically well but neutropenia resolved: Tailor antibiotics to target organism.

If patient continues to be febrile: If presumptive diagnosis is staphylococcal infection**, add teicoplanin.** If MSSA confirmed, switch to appropriate Beta-lactam antibiotic
If streptococcal infection identified, specific Vancomycin Resistant Enterococcus (VRE) cover may be required, contact ID team for advice.

Patients who are persistently febrile but stable: Continue initial empiric antibiotic regimen (as at Day0)

Antibiotics for patients who deteriorate (become haemodynamically unstable) while already receiving initial empiric antibiotic regimen

All ages: **No history of anaphylaxis** to Beta-lactam antibiotics (i.e. if there is a history of rash only, can still use Meropenem)	Meropenem IV **and** Amikacin IV **and** Teicoplanin IV (If VRE present add Linezolid (R) in place of Teicoplanin)
History of definite anaphylaxis *to Beta-lactam antibiotics*	Ciprofloxacin IV (R) **and** Metronidazole IV **and** Amikacin IV **and** Teicoplanin IV

Duration of therapy

There is no indication that continuing treatment for longer than 5 days after temperature settles is of value. Certain deep-seated infections such as osteomyelitis, fungal infections and *staphylococcus aureus* may require longer treatment. Proven bacteraemia is usually treated for 7-10 days and for 14 days in the case of *staphylococcus aureus* or gram negative sepsis. When an antifungal has been started continue until resolution of fever plus any other clinical signs, symptoms or positive tests and the FBC is normalising.
A decision to discontinue IV antibiotic treatment can only be considered when the absolute minimum factors are satisfied: the cultures remain negative (following at least 48 hours incubation in the Microbiology department), not necessarily 48 hours following admission. Patients who continue with intravenous antibiotic treatment for >48 hours should continue with such until afebrile for >24 hours AND no clinical focus evident AND evidence of neutrophil count recovery AND well.
Note: It is not necessary to keep the patient in hospital for 24 hours following discontinuation of IV antibiotic therapy.
See Management of Haematology/Oncology Patients with Fever and Neutropenia for full details.

Fungal Infection

Condition	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral	Comments
Aspergillosis - invasive	*A. fumigates, A. niger, A. flavus*	Voriconazole IV (R) Consult **ID/Micro**	Total IV & PO Minimum 6 weeks	Y	Serum voriconazole levels should be monitored
Candidiasis -cutaneous	*C. albicans*	Miconazole topically	3-5 days		Expose affected area to air
Candidiasis -oro-mucosal	*C. albicans*	**Mild:** Nystatin/Miconazole PO **Moderate:** Fluconazole PO	3-5 days 5-7 days		
Candidiasis - systemic Uncomplicated central venous catheter associated infection	*C. albicans,* other species of *Candida*	**Clinically stable patient:** Fluconazole IV **If patient has prior azole exposure or non albicans species:** Liposomal Amphotericin (AmBisome® IV (R) **OR** Caspofungin IV (R) **Consult ID/Micro**	Total IV & PO 10-14 days Consult ID/Micro	Y	Ensure to review choice of agent in light of species identification and sensitivities. Early CVL removal is indicated where feasible.
Candidiasis - systemic Disseminated candidiasis	*C. albicans,* other species of *Candida*	**Clinically stable patient:** Fluconazole IV (if uncomplicated, otherwise **Consult Infectious Diseases/Microbiology** **Severely ill or PICU patient**: Liposomal Amphotericin (AmBisome® IV) (R) or Caspofungin IV (R) **Consult Infectious Diseases/Microbiology**	4-6 weeks Minimum 4-6 weeks	N N	
Candiduria - *candida* urinary tract infection	*C. albicans,* other species of *Candida*	If clinical/radiological findings suggestive of active Candida urinary tract infection (e.g. candida pyelonephritis or myectoma), **consult Infectious Diseases/Microbiology** to discuss if treatment is necessary.	7 days post resolution & sterile cultures	N	Asymptomatic candiduria should **not** be treated unless the child is: - Neutropaenic - Neonate with low birth weight - Due to undergo urological procedure - Post renal transplant
Neonatal invasive candidiasis or candidemia	*C. albicans* Other *Candida* species *or prior Fluconazole prophylaxis*	Fluconazole IV Liposomal Amphotericin IV (AmBisome®) (R) **Suggest consult ID/Microbiology**	4 weeks 4-6 weeks	N N	Meningitis or arthritis may be present in 50% and endophthalmitis may be present in 20% of cases of systemic candidosis in the neonate
Fungal Nail Infection	*Microsporum, Epiderm -ophyton, Trichophyton*	5% amorolfine nail lacquer (for superficial) **2nd Line:** Itraconazole PO (R)	Fingers – 6/12 Toes – 12/12		Take nail clippings: Start therapy if infection confirmed by laboratory

Note: Candida isolated from respiratory specimens (sputum, cough swab, BAL or endotracheal secretions) almost always represents colonisation or contamination and does not require treatment

Gastrointestinal

Condition	Likely Causative Organism	Empiric Treatment	Suggested Duration of Therapy	Comments
***Campylobacter* enteritis**	*Campylobacter jejuni/coli*	See comments. If treatment considered necessary: Azithromycin PO If positive blood cultures **Add** Gentamicin IV **Consult Infectious Diseases/Microbiology**	3 days 10 days	Treat **only** if one of the following applies 1. under one year of age 2. severe symptoms 3. bacteraemia
Acute Gastroenteritis	Usually viral	Antibiotic **rarely if ever** indicated		
Haemolytic-Uraemic syndrome following acute diarrhoeal illness	*E. coli* 0157 and other verocytotoxin producing strains of *E. coli*	Antibiotics **contraindicated**		There is evidence to suggest that antibiotics may worsen HUS caused by vtec *E. coli*
Salmonellosis	*Salmonella* species	Antibiotic **rarely** indicated (see comments) If treatment considered necessary: Cefotaxime IV ***plus*** Ciprofloxacin PO or IV (R) **Consult Infectious Diseases/Microbiology**	10 -14 days	Treat **only** if one of the following applies 1. age <3 months, 2. immune-compromised 3. signs of sepsis Review therapy once antibiotic susceptibilities available
Shigellosis	*Shigella species* including *Shigella sonneii, Shigella boydii*	Co-trimoxazole PO **or** Azithromycin PO Severe cases: Ceftriaxone IV **Consult Infectious Diseases/Microbiology**	Co-trimoxazole for 5 days **or** Azithromycin for 3 days	

Condition	Likely Causative Organism	Empiric Treatment	Suggested Duration of Therapy	Comments
Helicobacter Pylori **(ESPGHAN/ NASPHGAN Guidelines 2016)**	*Helicobacter Pylori*	See comments. Antimicrobial therapy indicated for endoscopy-proven disease using culture-based sensitivities where available. When antibiotic susceptibility profiles are not known, high dose: Amoxicillin PO ***plus*** Metronidazole PO ***plus*** Proton pump inhibitor PO	14 days	The diagnosis of *H. pylori* infection: based on either positive biopsy culture or a combination of histopathology plus another biopsy-based test A ''test and treat'' strategy, using empirical therapy for eradication in children is <u>not</u> recommended in paediatrics.

Intra-abdominal

Condition	Likely Causative Organism	Empiric Treatment	Suggested Duration of Therapy	Switching to Oral	Comments
Acute abdominal sepsis **E.g.** • **ascending cholangitis** • **infected ascites in chronic liver disease** • **fulminant liver failure**	*E. coli* and other gram negative bacilli Anaerobes Streptococci Staphylococci.	Piperacillin/tazobactam IV ***plus*** Gentamicin IV	Minimum 10-14 days	Consult ID/Micro	Add vancomycin in infected ascites if MRSA is suspected
Antibiotic-associated-diarrhoea ***Clostridium difficile* infection**	*C. difficile* First episode mild First episode or first reoccurrence moderate Severe Second or subsequent recurrence	Metronidazole PO Vancomycin PO Vancomycin PO +/- Metronidazole IV **Consult Infectious Diseases/Microbiology**	10-14 days		**Important:** Stop offending antibiotics *C. difficile* carriage is common but disease is very rare in infancy and uncommon in older children with the exception of children with bowel motility problems

Intra-abdominal

Condition	Likely Causative Organism	Empiric Treatment	Suggested Duration of Therapy	Switching to Oral	Comments
Enterocolitis (non C. diff) or Faecal peritonitis	*E. coli* and other gram negative bacilli Anaerobes Streptococci	Amoxicillin IV ***plus*** Gentamicin IV ***plus*** Metronidazole IV	If source of faecal soiling of peritoneum has been sealed and no abscess, then treatment duration of 5 days is sufficient	N	
Necrotising enterocolitis	Multifactorial condition, organisms that may be involved include Staphylococci, *Clostridium. perfringens, Klebsiella spp.*	Amoxicillin IV ***plus*** Gentamicin IV ***plus*** Metronidazole IV	Minimum 10-14 days IV	N	If child is known to be colonised with drug resistant organisms (ESBL or CRE), drug choices may need to be modified: **Consult Infectious Diseases/ Microbiology**
Peritonitis complicating peritoneal dialysis	Coagulase negative staphylococci, aerobic Gram negative bacilli, *S. aureus*, *Pseudomonas*	Vancomycin ***plus*** Ciprofloxacin (R) intraperitoneally	Refer to Peritonitis Protocol/Renal Ward.		Review in light of culture results
Toxic megacolon in inflammatory bowel disease	*E. coli* and other gram negative bacilli, Anaerobes Streptococci Staphylococci *C. difficile*	Treatment can vary depending on previous antibiotic therapy, risk of *C. difficile* etc. **Consult Infectious Diseases /Microbiology**	Consult Infectious Diseases /Microbiology		

Malaria

Consult Infectious Diseases/Microbiology for all confirmed or suspected cases.

Condition	Likely Causative Organism	Note:	Empiric Treatment	Suggested Duration of Therapy	Comments
Uncomplicated malaria	***Plasmodium falciparum*** ***or*** **Species not identified**	Consideration must be given to admit patient for a minimum of 24 hours. All confirmed or suspected cases must be discussed with Infectious Diseases/Microbiology before discharge.	**1st line:** Artemether-lumefantrine PO (Riamet®) ***OR*** ***2nd*** **line:** Atovaquone-proguanil PO (Malarone / Malarone Paed ®)	3 days 3 days	Take with fat containing food or whole milk. Take with food or whole milk.
	Plasmodium malariae **or** **P*lasmodium* knowlesi**	**Acquired in any region**	Chloroquine phosphate PO	3 days	
	Plasmodium vivax ***or*** ***Plasmodium ovale***	**Acquired in any region** (Except Papua New Guinea and Indonesia)	Chloroquine phosphate PO ***plus*** Primaquine phosphate PO	3 days 14 days	**Screen for G6PD deficiency:** Primaquine may cause haemolytic anaemia in G6PD deficiency May be used in mild-to-moderate G6PD deficiency, refer to CHI Paediatric formulary for dose modification. Avoid primaquine in patients with severe G6PD deficiency. Seek advice on primaquine use in patients < 6 months old.
	Plasmodium vivax	**Chloroquine-resistant** (Papua New Guinea and Indonesia)	Artemether-lumefantrine PO ***plus*** Primaquine phosphate PO **OR** ***2nd*** line: Atovaquone-proguanil PO ***plus*** Primaquine phosphate PO	3 days 14 days 3 days 14 days	
Severe malaria* (warrants ICU admission)	***Plasmodium falciparum*** most likely	**All regions**	**1st line**: Artesunate IV (Artesun®) Then complete treatment with: Artemether -lumefantrine PO (Riamet®) **2nd line:** Contact ID/Micro	As per clinical response, minimum 24 hours Artesunate IV*, then may switch to Artemether/lumefantrine PO Complete 3 days PO Total IV & PO: 7 day course	**N.B.** * Give artesunate IV therapy for a minimum of 24 hours (irrespective of the patient's ability to tolerate oral medication earlier)

***Severity indicators:** Hyperparasitaemia > 5%, Neurological abnormality, renal impairment, acidosis, hypoglycaemia, respiratory distress, Hb <8g/dl, spontaneous bleeding/DIC, shock, haemoglobinuria.

Respiratory Lower Tract

Condition	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral	Comments
Community acquired pneumonia					
≤ 2 month	Group B streptococcus, *E. coli* & other gram negative bacilli, S. aureus *Listeria monocytogenes* CMV, v rarely HSV.	**Always admit** Amoxicillin IV ***plus*** Gentamicin IV ***plus*** Cefotaxime IV	2-3 weeks	N	Stop antibiotics if viral aetiology proven. In neonates, use aciclovir if HSV pneumonia.
> 2 month	*S. pneumoniae* *Mycoplasma pneumoniae* *H. influenzae* *S.aureus* *Bordetella pertussis* (<3 months) *Chlamydia pneumoniae* May also be viral: RSV Parainfluenza	**<u>If not clinically unwell</u>:** Amoxicillin PO **<u>Or</u>** Azithromycin (if patient has received a course of amoxicillin/co-amoxiclav in the community or presumed atypical infection) **<u>If clinically unwell and fever:</u>** Admit **<u>Pneumonia without signs of sepsis or effusion:</u>** Amoxicillin IV * **Add** azithromycin PO for 3 days if • Prior course of amoxicillin or co-amoxiclav in the community pre-admission • No response to 1st line therapy within 48 hours • *Mycoplasma/Chlamydia pneumoniae* suspected (rare in patients <3 years) **<u>Complicated pneumonia and/or pleural effusion:</u>** Cefuroxime [#] ***plus*** Azithromycin PO [^]	7 days 3 days 7-14 days depending on organism & clinical response 14-21 days depending on organism & clinical response	N/A Y	*If a sensitive *S. aureus* is isolated or if pneumatocele, switch to flucloxacillin IV instead of amoxicillin. If MRSA pneumonia add vancomycin (or clindamycin if sensitive) [#] If meningeal cover considered necessary, use 3rd generation cephalosporin – ceftriaxone or cefotaxime instead of cefuroxime [^] If patient cannot tolerate azithromycin PO, clarithromycin IV can be used.
Pertussis (whooping cough)	*Bordetella pertussis*	Azithromycin PO	5 days		<u>Chemoprophylaxis for household contacts:</u> Azithromycin PO x 5 days recommended irrespective of age and immunization status

Condition	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral possible	Comments
Empyema or Lung abscess	Most common: - *S. pneumoniae* - *S. aureus* - Group A *Streptococcus* Less common: - *Mycoplasma pneumoniae* (usually small effusion) - *Mycobacterium tuberculosis* Chronic lung disease/peg fed -All of above -Gram negative bacilli -Anaerobes	Cefotaxime IV ***plus*** Azithromycin PO (or clarithromycin IV if not tolerating PO) ***Add*** Clindamycin PO or IV if multiple abscesses or pneumatocele, or if concerns re Group A *Strep or* community acquired MRSA **Consult Infectious Diseases/Microbiology** Piperacillin/tazobactam IV **monotherapy** If haemodynamically unstable: ***Add*** Gentamicin (rationalize as directed by sputum / BAL). (***Add*** Vancomycin if known MRSA)	1-4 weeks (longer if residual disease)	Y	Check Tuberculin (mantoux) Early drainage is recommended for large empyemas NB: Tailor antibiotic according to available microbiologic data e.g. may need to modify if colonised with multidrug resistant organisms
Pneumonia with bullae	*S. aureus*	Flucloxacillin IV ***plus*** Clindamycin IV/ PO	Minimum of 14 days	Y	If MRSA colonised or high risk of (e.g. parent health care worker) add vancomycin instead of flucloxacillin.
Aspiration Pneumonia (community)	Streptococci, oral flora including anaerobes, aerobic Gram negative bacilli	Co- amoxiclav IV	7 days	Y	Antibiotics are not indicated for aspiration without evidence of pneumonia
Pneumonia in hospital in-patients with severe infection (PICU) or risk factors:	*S. pneumoniae* *S. aureus* Aerobic Gram negative bacilli (if chronic lung disease /intubated/tracheostomy/ PICU)	**Risk factors:** • **Ventilator associated Pneumonia (VAP)** • **Post procedural pneumonia (PPP) (< 5 days post-surgery)** • **Patients with tracheostomy** Piperacillin/tazobactam IV **monotherapy** If haemodynamically unstable: ***Add*** Gentamicin (rationalize as directed by sputum / BAL). (***Add*** Vancomycin if known MRSA)	5days and review	Y	Antibiotic therapy should **not** be given for: - Positive sputum or endotracheal aspirate culture without clinical or radiological evidence of pneumonia - Post-operative atelectasis - Temporary atelectasis secondary to asthma

Condition	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral possible	Comments
Pneumonia in inpatients without risk factors above	As for community acquired pneumonia above	Treat as community acquired pneumonia			
CF patients	*S. aureus* *P. aeruginosa* *B. cepacia* *(*Atypical *mycobacteria* *Aspergillus)*	Anti-pseudomonal penicillin IV (piperacillin/tazobactam) **or** cephalosporin IV (ceftazidime) ***plus*** an aminoglycoside IV (tobramycin)	14 days May be longer if inadequate response	Continue IV for entire duration	Other agents that may be useful if clinical response not satisfactory include meropenem, colistemethate If MRSA implicated vancomycin or teicoplanin should be added.

Skin, soft tissue & surgical wound

Condition	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral Possible	Comments
Burns **If burn is infected:**	Should not initially be treated with antibiotics **Treat only if infected** and on the advice of the Consultant Be aware of potential for toxic shock syndrome in children who often have only relatively small burns (fever, rash, diarrhoea, and ultimately shock)				
Early: **<5 days post hospitalisation**	Group A strep *S. aureus*	Flucloxacillin IV **OR** Cefazolin IV (***plus*** Clindamycin PO/IV in severe infection)	Total IV & PO 10 days	Y	
Late: **>5 days post hospitalisation**	Above plus Aerobic Gram negative organisms (e.g. *Pseudomonas aeruginosa*)	Above ***plus*** gentamicin	Total IV & PO 10 days	Y	
Cellulitis	Group A strep *S. aureus*	Flucloxacillin IV **OR** Cefazolin IV (***plus*** Clindamycin PO/IV in severe infection)	Total IV & PO 10 days	Y	**In severe cellulitis seek Urgent ID/ Microbiology consult**.
Cellulitis post varicella infection	Group A strep *S. aureus*	Cefotaxime IV **OR** Ceftriaxone IV ***plus*** Clindamycin PO/IV	Consult ID/Micro	Y	If MRSA, add vancomycin
Erysipelas	Group A strep	Benzylpenicillin IV if extensive and/or involving the face	Total IV & PO 10 days	Y	
Impetigo	*S. aureus* Group A strep	**Mild or localised infection:** Topical fusidic acid cream	10 days	N/A	
		Widespread or recurrent infection: Flucloxacillin PO **OR** Cefalexin PO	10 days	N/A	* All infants with S. aureus skin infection must be isolated for at least 24 hours after starting therapy
		In neonates: Flucloxacillin IV *	Total IV & PO 10 days	Y	
Septic spots in neonates	*S. aureus*	No systemic antibiotic necessary Note: Do <u>not</u> use topical antibiotics			Bath daily & seek ID/Micro advise

Condition	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral Possible	Comments
Umbilical infections	*S. aureus* Groups A and B haemolytic streptococcus *E. coli* & other Gram negative bacilli Anaerobes	See comments; If antibiotic treatment necessary: Flucloxacillin IV ***plus*** Gentamicin IV ***Severe infection:*** Vancomycin IV ***plus*** Gentamicin IV ***plus*** Clindamycin IV	Minimum 7 days	Consult ID/Micro	Sticky umbilicus, no signs of infection, no local "flare" or erythema, and no systemic signs: Clean and apply chlorhexidine solution daily for 3 days Take swab for culture, prior to starting antibiotic therapy
Balanitis	*Candida albicans* (most common) *S. aureus* Group A *streptococcus* (may result in severe genital rash that is weeping and raw)	See comments; If antimicrobial treatment necessary: Candidal balanitis: Topical clotrimazole cream Bacterial: Cefalexin PO In severe cellulitis seek Urgent ID/ Microbiology consult. If fever is present, urine culture should be performed to exclude concomitant UTI.	7 days	NA	Minor redness and/or soreness of the tip of the foreskin is common and can be managed with reassurance and avoidance of chemical/physical triggers Treatment: Soaking in warm saltwater settles swelling and discomfort.
Surgical site infection	*S. aureus* predominantly	**Mild:** Flucloxacillin PO **OR** Cefalexin PO **Moderate to severe:** Flucloxacillin IV **OR** Cefazolin IV If Gram negative organism suspected: (e.g. Abdominal wound) **Add** Gentamicin IV	5 days		Adjust antimicrobials to culture and sensitivities Use Vancomycin IV if MRSA
Severe skin & soft tissue infection with systemic illness: **e.g.** **Necrotising fasciitis** **Toxic shock like illness**	Group A strep. *S. aureus*	Ceftriaxone **OR** Cefotaxime IV ***plus*** Clindamycin IV ***plus*** Gentamicin IV ***plus*** Vancomycin IV **SEEK URGENT ADVICE FROM ID/MICRO**	Consult ID/Micro	Consult ID/Micro	**Seek advice re need for surgical debridement** Consider IVIG if signs suggest shock/toxaemia. Broader antibiotic cover given initially until clear microbiologic diagnosis established. Then adjust antimicrobials to culture and sensitivities

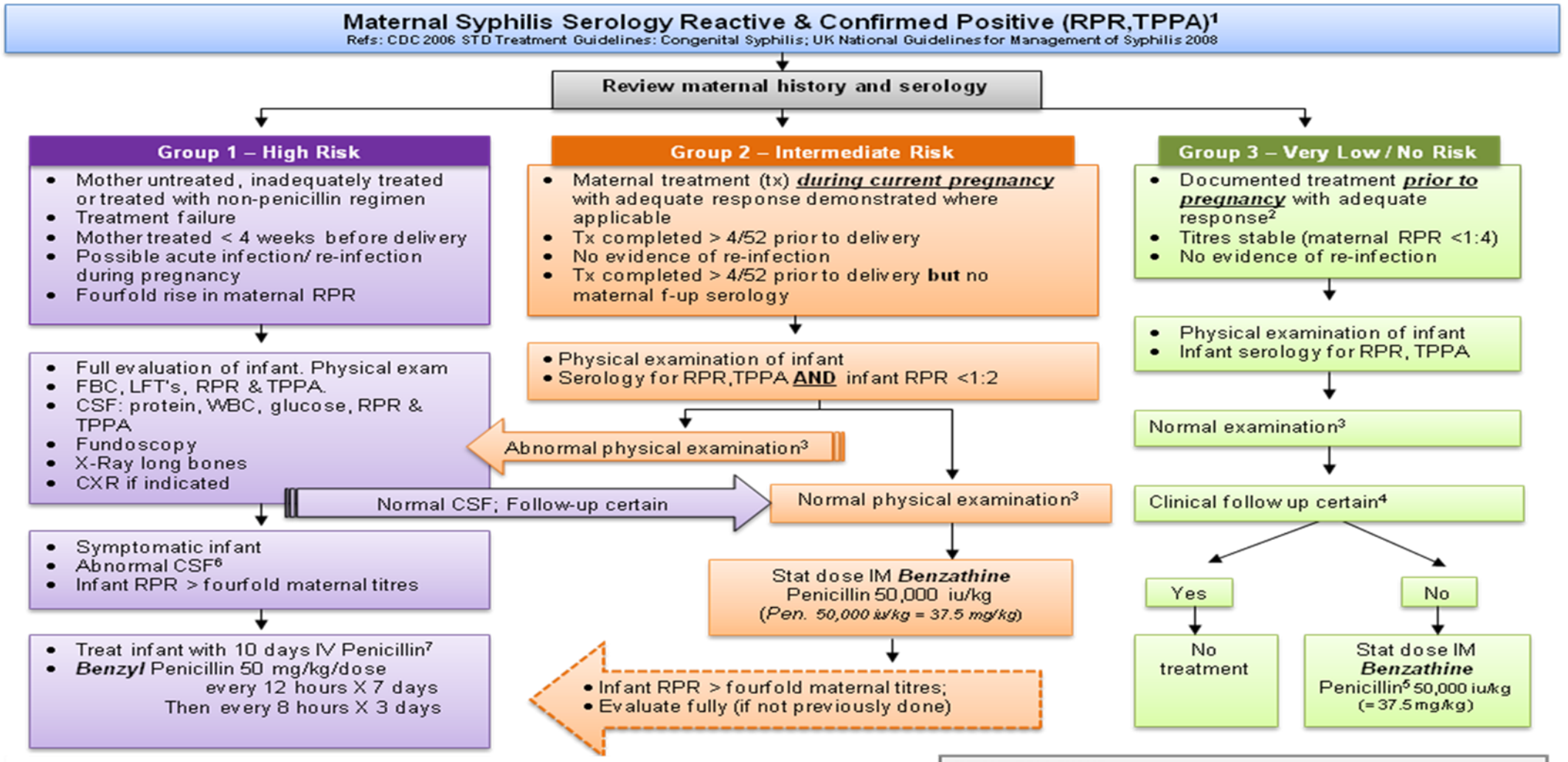
Condition	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral Possible	Comments
Synergistic gangrene	Mixed aerobic/anaerobic bacteria *Clostridium perfringens*	Meropenem(R) IV ***plus*** Clindamycin IV ***plus*** Gentamicin IV **SEEK URGENT ADVICE FROM ID/MICRO**	Consult ID/Micro	Consult ID/Micro	
Animal bite, Human bite	*Pasteurella species,* oral anaerobes, *S. aureus,* ß haemolytic streptococci	Co-amoxiclav PO	3-5 days		

Neonatal Sepsis

Condition	Likely Causative Organism	Empiric Treatment	Suggested Duration	Switching to Oral Possible	Comments
Neonatal sepsis Early onset (in first 48 hours)	Group B strep, *E. coli* *L. monocytogenes*	Benzylpenicillin IV ***plus*** Gentamicin IV (***plus*** cefotaxime IV if meningitis is suspected)	If cultures are negative and sepsis is not suspected, discontinue antibiotics. Otherwise, continue antibiotics, making appropriate changes as indicated by culture report Duration depends on pathogen	N	
Neonatal sepsis: Late onset (developing after first 48 hours in an infant who is hospitalised)	Group B strep *E. coli* *S. epidermidis* *S. aureus* Enterococci Other aerobic gram negative bacteria *L. monocytogenes*	Amoxicillin IV ***plus*** Gentamicin IV (***plus*** cefotaxime IV if meningitis is suspected)	If cultures are negative and sepsis is not suspected, discontinue antibiotics. Otherwise, continue antibiotics, making appropriate changes as indicated by culture report Duration depends on pathogen	N	

Syphilis

MANAGEMENT OF INFANTS BORN TO MOTHERS WITH POSITIVE SYPHILIS SEROLOGY



FOOTNOTES:

1 Maternal TPPA positive; RPR positive, neat or negative.
2 Maternal treatment prior to pregnancy with Penicillin regime confirmed by adult services with serology post treatment documented.
3 No evidence of congenital infection at birth. Any infant with signs of congenital syphilis should receive full evaluation and treatment regardless of maternal treatment history.(see INFANT FOLLOW-UP)
4 In general if follow up uncertain infant should receive treatment with single dose Benzathine Penicillin.
5 Procaine Penicillin is not a substitute for Benzathine Penicillin.
6 CSF, WBC >5, protein >0.4g/l, Normal CSF does not exclude neurosyphilis. Interpret with clinical findings and serology.
7 If > 1 day of therapy is missed, the entire course should be re-started.

NB: Always check other maternal serology and STI screen.

INFANT FOLLOW-UP:

a) Non-Treponemal test (RPR): measures treatment response.
   i. If 4x rise in infant RPR during f'up, re-evaluate and re-treat infant.
   ii. Check RPR at 6 wks & 3 monthly, as necessary, until 2 consecutive RPRs are negative.
b) Treponemal test (TPPA): includes/excludes congenital infection.
   i. Check at 18 months; positive test diagnostic of congenital infection.
   ii. If TPPA is negative (& RPR neg) at ≥12 mos can discharge from further f'up.
c) If initial CSF abnormal repeat at 6 months.

Tuberculosis

Consult Infectious Diseases/Microbiology for all confirmed or suspected cases

Condition	Likely Causative Organism	Empiric Treatment	Duration of Therapy	Comments
Pulmonary Tuberculosis *Known to be* ***drug susceptible***	*Mycobacterium tuberculosis*	Rifampicin **+** isoniazid **+** pyrazinamide followed by Rifampicin + isoniazid	2 months 4 months	Treatment courses must be prolonged if pyrazinamide cannot be used.
Pulmonary Tuberculosis **Possible drug resistant strain** e.g. child of immigrant from Eastern Europe, Russia, Asia, Africa or Latin America **or** when there is a risk of non-compliance	*Mycobacterium tuberculosis*	Rifampicin + Isoniazid + pyrazinamide + ethambutol initially; As soon as sensitivity is established ethambutol can be discontinued. **N.B.** Continuation therapy will be dictated by susceptibility results.	Consult ID/Micro	
Tuberculous Meningitis	*Mycobacterium tuberculosis*	Rifampicin + isoniazid + pyrazinamide + ethambutol Followed by Rifampicin + isoniazid	2 months 10 months	Corticosteroids (e.g. prednisolone) may decrease mortality & long-term neurological impairment in TB meningitis, but should be given only when accompanied by appropriate anti-TB therapy.
Miliary TB **Bone/Joint TB**	*Mycobacterium tuberculosis*	Rifampicin + isoniazid + pyrazinamide + ethambutol Followed by Rifampicin + isoniazid	2 months 10 months	
TB Adenitis or Scrofula	Need to rule out atypical mycobacteria	Primary treatment is excision. Anti-tuberculous therapy rarely required		
BCG Adenitis or Abscess		Seek advice **Infectious Diseases/Microbiology**		

Peripheral neuritis or convulsions caused by inhibition of pyridoxine metabolism are extremely rare in childhood. However pyridoxine supplementation (5-10mg/day) may be recommended by the Infectious Diseases team for children and adolescents on anti TB treatment.

Urinary tract infection

The following advice pertains to a child who has had only a single UTI

Age	Likely Causative Organism	Empiric Treatment	Duration of Therapy	Switching to Oral Possible	Comments
≤ 2 months ***≥2-3 months if suspicious of CNS involvement treat as ≤ 2 months with triple antibiotics***	*E. coli*, *Proteus* species, *Klebsiella*, other aerobic gram negative bacilli, *enterococci*	Amoxicillin IV ***plus*** Gentamicin IV ***plus*** Cefotaxime IV	10 days	Age dependant	Preterm babies require specialist advice.
≥2 months – 6 months	*E. coli*, *Proteus* species, *Klebsiella*,other aerobic gram negative bacilli, enterococci	Co-amoxiclav IV ***plus*** Gentamicin IV	10 days	Y See notes below also	
>6 months – 16 years	*E. coli*, *Proteus* species, *Klebsiella*,other aerobic gram negative bacilli, enterococci	**If systemically unwell:** Co-amoxiclav IV ***plus*** Gentamicin IV	10 days	Y See notes below also	Oral cephalosporin (e.g. cefixime) determined by sensitivity can also be used
>6 months-16 years	*E. coli*, *Proteus* species, *Klebsiella*,other aerobic gram negative bacilli, enterococci	**If upper UTI and well or after an IV-PO switch:** Cefalexin PO **If lower UTI and well:** Cefalexin PO or Trimethoprim PO **or** Nitrofurantoin PO	7-10 days 3 days	N/A Y See notes below also	

Switching to oral therapy:

Children (excluding neonates) can be switched to oral antibiotics and sent home after 48 hours if:

a) they have received 48 hours IV antibiotics
b) clinically well
c) afebrile for 48 hours
d) blood cultures are negative at 36- 48 hours
e) no significant abnormality on renal USS
f) a suitable oral antibiotic is available based on urine culture sensitivity

Surgical Prophylaxis

Principles of Surgical Prophylaxis:

1. Intravenous antibiotics for surgical prophylaxis should be given ≤ 60 minutes before skin is incised. A single dose immediately before the incision is made is all that is usually required. The administration of additional doses of antibiotic after the end of surgery provides little or no additional benefit.

2. Antimicrobial prophylaxis should be administered so that the antibiotic is present in the tissues of the wound in inhibitory concentrations beginning just before the initial incision and lasting at least through the duration of the surgery:
   - Start ≤ 60 minutes pre-operatively and give in the operating theatre prior to prep. (Exception - vancomycin: administration of infusion should begin 90 -120 minutes before skin incision.)
   - Give additional intra-op doses if using short acting agent and if surgery is prolonged (> 4 hours)
   - In the event of major intra-operative blood loss in children, (25mL/kg), additional dosage of prophylactic antibiotics should be considered after fluid replacement.

3. The choice of agent will be governed by the procedure and the likely potential pathogens

4. The choice of agent may also be influenced by recent or previous infection, prolonged hospital stay, or colonisation with MRSA or other resistant organisms. In such circumstances, it is advisable to consult the latest sensitivity reports and consult with Microbiology / Infectious Diseases.

5. An agent that may be appropriate for surgical prophylaxis may not be the optimal agent for the therapy of established infection. Therefore, the continuation of an agent initially used for prophylaxis, as treatment, may represent sub-optimal therapy.

6. All active infections should be under treatment prior to surgery.

7. Patients should have their tetanus status checked if a contaminated wound is present, as well as receiving prophylactic antimicrobials. Please refer to the Immunisation Guidelines for Ireland for latest guidance on risk assessment.
   https://www.hse.ie/eng/health/immunisation/hcpinfo/guidelines/immunisationguidelines.html

8. Gentamicin and vancomycin assays are not indicated if only 1-2 doses are administered, but must be undertaken if continued as part of therapeutic regimen.

9. Doses of antibiotics used for surgical prophylaxis are the same as the standard dose used for therapy. These can be found in the CHI Paediatric Formulary

12. MRSA positive patients should undergo topical eradication therapy in an attempt to eradicate MRSA skin colonization. Some patients may remain MRSA positive despite multiple (& modified) eradication attempts. In such patients, the decision to proceed with surgical procedures must rest with the operating surgeon, balancing the need & benefit of the operation against the risk of infection.

13. Penicillin allergy - In the absence of a documented hypersensitivity reaction, a cephalosporin may be used. In patients with a positive history of hypersensitivity, i.e. anaphylaxis, urticaria or rash, consult individual guidelines below or contact Microbiology / Infectious Diseases.

14. For patients with known heart valve disease who require dental and surgical prophylaxis, see Endocarditis Guidelines below.

16. Surgical prophylaxis guidelines will be reviewed annually with reference to local antimicrobial resistance data.

17. In general, clean surgery in patients who are immunocompetent, who do not require implants, and have no infection at another site do not require prophylaxis.

18. Antibiotic prophylaxis is recommended before:
    - clean surgery involving the placement of a prosthesis or implant
    - clean-contaminated surgery
    - contaminated surgery.
    - dirty surgery

Classification of operation

Class	**Definition**
Clean	Operations in which no inflammation is encountered and the respiratory, alimentary or genitourinary tracts are not entered. There is no break in aseptic operating theatre technique
Clean-contaminated	Operations in which the respiratory, alimentary or genitourinary tracts are entered but without significant spillage.
Contaminated	Operations where acute inflammation (without pus) is encountered, or where there is visible contamination of the wound. Examples include gross spillage from a hollow viscus during the operation or compound/open injuries operated on within four hours.
Dirty	Operations in the presence of pus, where there is a previously perforated hollow viscus, or compound/open injuries more than four hours old.

1.1. Cardiothoracic Surgery

Procedure	1st line prophylaxis	Penicillin allergy* (see note below also)	MRSA colonised	Intra-op / post op doses **Additional intra-operative doses** of antibiotics are warranted in the event of **prolonged procedures** (>4 hours) or **major intra-operative blood loss (>25mL/kg).**
Cardiac catheterisation	Cefuroxime IV	Vancomycin IV	Vancomycin IV	No
Open heart surgery **Closed heart surgery**	Cefuroxime IV	Vancomycin IV ***plus*** Gentamicin IV	Vancomycin IV & Gentamicin IV	**Intra-op,** for prolonged procedures, a second dose of cefuroxime should be given at the 4-hour point. No re-dosing of gentamicin or vancomycin is needed. **Post op:** Continue for a total of 24 hours (including induction dose)
Penicillin Allergy*	Cefuroxime may be used in patients with mild hypersensitivity reaction to penicillins eg: rash onset 3 or more days post penicillin. Do not use cefuroxime if there is a history of anaphylaxis, angioedema or immediate onset rash post penicillin administration			
Cefuroxime dosing and timing	**> 1 month:** Give after central line insertion in theatre. Dose: 50mg/kg (max 1.5g) as a slow IV injection over 3-5 minutes. Ensure that the antibiotic is given AT INDUCTION (OR NO MORE THAN 60 MINUTES BEFORE SKIN INCISION). Subsequent doses should be given at 30mg/kg (max 750mg)			
Vancomycin dosing and timing	**> 1 month:** If giving **stat** dose of vancomycin at induction: 15mg/kg (max 1g) **infused over at least 60 mins**. (doses > 600mg should be given at a max. rate of infusion of 10mg/min) Infusion should begin 90 -120 minutes before skin incision. **For courses > 1 dose of vancomycin,** 15mg/kg six hourly (maximum 3g/day) **infused over at least 60 minutes**			
Gentamicin dosing and timing	**> 1 month:** 2.5mg/kg (up to a maximum dose of 120mg/dose) slow IV injection over at least 3 minutes. Ensure that the antibiotic is given AT INDUCTION (OR NO MORE THAN 60 MINUTES BEFORE SKIN INCISION).			
Therapeutic drug monitoring	Not routinely required when vancomycin or gentamicin are discontinued after 3 doses, unless serious renal impairment is suspected.			
Severe renal impairment	Dose vancomycin and gentamicin according to serum antibiotic levels. Post-operatively, if further doses are clinically indicated as above but if the urine output is less than 1mL/hour, consider holding all doses of vancomycin and gentamicin. Discuss with anaesthetist on duty.			
Other:	For dosing of other antibiotics & neonatal doses, consult CHI Paediatric Formulary			
Patients chronically colonised with bacteria other than MRSA:	Contact Microbiology/ID			

1.2. Endocarditis Prophylaxis

Procedure	Underlying cardiac condition	Prophylactic antibiotics
Dental procedures Only required for dental procedures with manipulation of gingival or apical region of teeth, or perforation of oral mucosa **Not required for:** - Local anaesthetic injection - Dental x-rays - Removal of sutures - Placement/adjustment of orthodontic devices - Loss of deciduous teeth - Oral trauma	Prophylaxis only required if: - Prosthetic valve - Previous endocarditis - Cyanotic congenital heart disease if: • unrepaired • repaired within previous 6 months • repaired, but residual defect present	Amoxicillin 50mg/kg PO or IV (max 2g) (single dose, 30-60 minutes before procedure) If history of penicillin allergy: Clindamycin 20mg/kg (max 600mg) (single dose, 30-60 minutes before procedure)
Respiratory, gastrointestinal, urological, or skin/soft tissue procedures	**Prophylaxis not recommended**	

1.3. ENT Surgery

Procedure	1st line prophylaxis	Intra-op / post op doses **Additional intra-operative doses** of antibiotics are warranted in the event of **prolonged procedures** (>4 hours) using short acting antibiotics or **major intra-operative blood loss (>25mL/kg).**
Adenoidectomy, insertion of grommets, Tonsillectomy	Antibiotics not usually required unless infection or abscess present.	
Examples where prophylaxis may be required Mastoidectomy, tympanoplasty Ear surgery e.g. pinnoplasty Nose or sinus surgery	Co-amoxiclav IV	No further post op doses necessary
Major head & neck surgery	Co-amoxiclav IV	Up to 24 hours

1.4. General Surgery

Procedure	1st line prophylaxis	Intra-op / post op doses **Additional intra-operative doses** of antibiotics are warranted in the event of **prolonged procedures** (>4 hours) using short acting antibiotics or **major intra-operative blood loss (>25mL/kg).**
General Procedures		
Non-perforated Appendix[1,2]	Co-amoxiclav IV	No further doses post op
Perforated Appendix[1,2]	Co-amoxiclav IV & Gentamicin IV	Continue for 72 hours and assess
[1]Immunocompromised: Piperacillin-tazobactam and Gentamicin IV [2]Severe penicillin allergy use Ciprofloxacin and Metronidazole IV		
Small bowel & colorectal surgery	Co-amoxiclav IV & Gentamicin IV	Continue for 5 days. Switch to oral antibiotic after 2 days if tolerating diet.
Intussusception Splenectomy Cholecystectomy Gastrostomy (Open & PEG) Fundoplication Cholecystitis	Co-amoxiclav IV	One dose is sufficient in most cases. For cholecystitis, the duration depends on clinical condition
Pyloric Stenosis	Cefuroxime IV	No further doses post op
Neonatal Procedures		
For patients already on therapy – continue treatment antibiotics over the time of surgery. Administer doses as close to the time of surgery as possible.		
Gastroschisis	Amoxicillin IV & gentamicin IV	Continue for 5 days from closure
Exomphalous	Prophylaxis not recommended	
Oesophageal atresia	Amoxicillin IV & gentamicin IV	7 days
Abdominal surgery	Amoxicillin IV & Gentamicin IV & Metronidazole IV	5 days IV NEC: Continue for 10-14 days or as advised by ID/Microbiology

Thoracic Procedures	**1st line prophylaxis**	**Intra-op / post op doses** **Additional intra-operative doses** of antibiotics are warranted in the event of **prolonged procedures** (>4 hours) using short acting antibiotics or **major intra-operative blood loss (>25mL/kg).**
Empyema	Continue treatment antibiotics as per Respiratory/ID team over the time of surgery. Administer doses as close to the time of surgery as possible or as below if new antibiotics.	
Thoracic surgery	Co-amoxiclav IV	No further doses post op
Other		
Insertion of non-tunnelled & tunnelled central lines	Prophylaxis not recommended	
Penicillin Allergy	Cefuroxime (or cefotaxime in neonates) may be used instead of co-amoxiclav in patients with mild hypersensitivity reaction to penicillins e.g.: rash 3 or more days post penicillin onset. Add metronidazole if extra anaerobic cover is needed. Do not use cefuroxime if there is a history of anaphylaxis, angioedema or immediate onset rash post penicillin administration Clindamycin & Gentamicin ± metronidazole can be used in these cases.	
MRSA colonised patients	Add vancomycin at induction. Continue for same duration as other prophylactic antibiotics. Use vancomycin alone if only staphylococcal cover needed.	
Patients chronically colonised with bacteria other than MRSA	Contact Microbiology/ID	
Antibiotic dosing and timing	Ensure that the antibiotic is given AT INDUCTION (OR NO MORE THAN 60 MINUTES BEFORE SKIN INCISION).	
Co- amoxiclav	> 1 month: 30mg/kg (max 1.2g) as a slow IV injection over 3-5 minutes.	
Amoxicillin	> 1 month: 50mg/kg (max 1g) IV bolus.	
Gentamicin	> 1 month: 7mg/kg (max 480mg) once daily IV infusion over at least 30 minutes.	
Metronidazole	> 1 month: 7.5mg/kg (max 500mg) eight hourly as an IV infusion over 20-30 minutes	
Cefuroxime	> 1 month: Dose in theatre: 50mg/kg (max 1.5g) as a slow IV injection over 3-5 minutes.	
Vancomycin Dosing & Timing	Infusion should begin 90 -120 minutes before skin incision.	
	> 1 month: If giving **stat** dose of vancomycin at induction: 15mg/kg (max 1g) **infused over at least 60 minutes**. (doses > 500mg should be given at a max. rate of infusion of 10mg/min) **For longer courses of vancomycin,** 15mg/kg six hourly (maximum 3g/day) **infused over at least 60 minutes.**	
Other:	For dosing of other antibiotics & neonatal doses, consult CHI Paediatric Formulary	

1.5. Orthopaedic Surgery

Procedure	1st line prophylaxis	Penicillin allergy* (see note below also)	MRSA colonised	Intra-op / post op doses **Additional intra-operative doses** of antibiotics are warranted in the event of **prolonged procedures** (>4 hours) using short acting antibiotics or **major intra-operative blood loss (>25mL/kg).**
Closed clean procedures without prosthesis/implants	Prophylaxis not recommended			
Standard procedures with prosthesis/implants	Cefuroxime IV	Vancomycin IV	Vancomycin IV	No further post op doses are necessary
Open fractures / wounds[1]	Intravenous antibiotics are administered as soon as possible after injury and continued until wound debridement. Administer antibiotic doses pre-operatively (no more than 60 minutes before skin incision) to ensure optimum plasma and tissue concentrations at the time of procedure			
	Co-amoxiclav IV + Gentamicin IV	Clindamycin IV + Gentamicin IV	Vancomycin IV + Metronidazole IV + Gentamicin IV	Continue for 72 hours or until definitive wound closure whichever is sooner.
Spinal Surgery **Insertion of instrumentation**	Cefuroxime IV + Gentamicin IV	Vancomycin IV + Gentamicin IV	Vancomycin IV + Gentamicin IV	**Intra-op,** for prolonged procedures, a **second dose of cefuroxime should be given at the 4-hour point.** Additional doses of vancomycin or gentamicin are not necessary **Post op: No further doses required**
Penicillin Allergy*	Cefuroxime may be used in patients with mild hypersensitivity reaction to penicillins e.g.: rash 3 or more days post penicillin onset. Do not use cefuroxime if there is a history of anaphylaxis, angioedema or immediate onset rash post penicillin administration			
Cefuroxime dosing and timing	**> 1 month:** Dose in theatre: 50mg/kg (max 1.5g) as a slow IV injection over 3-5 minutes. Ensure that the antibiotic is given AT INDUCTION (OR NO MORE THAN 60 MINUTES BEFORE SKIN INCISION). If a tourniquet is to be applied, a 15 minute period is required between the end of antibiotic administration and tourniquet application.' Subsequent doses should be given at 30mg/kg (max 750mg)			
Vancomycin dosing and timing	**> 1 month:** If giving **stat** dose of vancomycin at induction: 15mg/kg (max 1g) **infused over at least 60 minutes**. (doses > 500mg should be given at a max. rate of infusion of 10mg/min) Infusion should begin 90 -120 minutes before skin incision. If a tourniquet is to be applied, a 15-minute period is required between the end of antibiotic administration and tourniquet application.' **For courses >1 dose of vancomycin,** 15mg/kg six hourly (maximum 3g/day) **infused over at least 60 minutes**			
Gentamicin dosing and timing	**> 1 month:** 7mg/kg (up to a maximum dose of 480mg) IV infusion over at least 30 minutes. Ensure that the antibiotic is given AT INDUCTION (OR NO MORE THAN 60 MINUTES BEFORE SKIN INCISION). If a tourniquet is to be applied, a 15 minute period is required between the end of antibiotic administration and tourniquet application.'			
Neonatal Recommendations:	Use amoxicillin instead of co-amoxiclav in neonates, add metronidazole if anaerobic cover is needed			
Other:	For dosing of other antibiotics & neonatal doses, consult CHI Formulary			
Patients chronically colonised with bacteria other than MRSA: Contact Microbiology/ID for advice				

1.6. Plastic Surgery

Procedure	1st line prophylaxis	Intra-op / post op doses **Additional intra-operative doses** of antibiotics are warranted in the event of **prolonged procedures** (>4 hours) using short acting antibiotics or **major intra-operative blood loss (>25mL/kg).**
Cleft lip & palate repair	Co-amoxiclav IV	No further post op doses necessary
Clean procedures (e.g. congenital hand)	Prophylaxis not recommended	
Trauma wounds (e.g. nail bed injury)	Co-amoxiclav IV	No further post op doses necessary
Surgery with implants or tissue expanders	Co-amoxiclav IV	Up to 24 hours
Penicillin Allergy	Cefuroxime (or cefotaxime in neonates) may be used instead of co-amoxiclav in patients with mild hypersensitivity reaction to penicillins e.g.: rash 3 or more days post penicillin onset. Do not use cefuroxime if there is a history of anaphylaxis, angioedema or immediate onset rash post penicillin administration Clindamycin can be used in these cases or if anaerobic cover is needed.	
MRSA colonised patients	Add vancomycin at induction. Continue for same duration as other prophylactic antibiotics. Use vancomycin alone if only staphylococcal cover needed	
Patients chronically colonised with bacteria other than MRSA	Contact Microbiology/ID	
Co- amoxiclav dosing and timing	**> 1 month:** 30mg/kg (max 1.2g) as a slow IV injection over 3-5 minutes. Ensure that the antibiotic is given AT INDUCTION (OR NO MORE THEN 60 MINUTES BEFORE SKIN INCISION). If a tourniquet is to be applied, a 15-minute period is required between the end of antibiotic administration and tourniquet application.	
Vancomycin dosing and timing	**> 1 month:** If giving stat dose of vancomycin at induction: 15mg/kg (max 1g) infused over at least 60. Infusion should begin 90 -120 minutes before skin incision. If a tourniquet is to be applied, a 15-minute period is required between the end of antibiotic administration and tourniquet application.' For longer courses of vancomycin, 15mg/kg six hourly (maximum 3g/day) infused over at least 60 minutes.	
Neonatal Recommendations	Use amoxicillin instead of co-amoxiclav in neonates, ± gentamicin (+ metronidazole if anaerobic cover is needed)	
Other:	For dosing of other antibiotics & neonatal doses, consult CHI Formulary	

1.7. Urology Surgery

Procedure	1st line prophylaxis	Intra-op / post op doses **Additional intra-operative doses** of antibiotics are warranted in the event of **prolonged procedures** (>4 hours) using short acting antibiotics or **major intra-operative blood loss (>25mL/kg).**
Circumcision, orchidopexy, hernia repair hypospadias repair, epispadias repair, meatotomy.	Prophylaxis not routinely recommended Where a urinary catheter has been inserted following hypospadias repair, antibiotic prophylaxis should be considered until the catheter is removed.	
Bladder augmentation	Amoxicillin IV & Gentamicin IV & Metronidazole IV	Continue for 5 days.
Cystoscopy Cystoscopic STING	Gentamicin IV	No further doses of gentamicin post op
Uretic re-implant Pyeloplasty Heminephrectomy	Co-amoxiclav IV & Gentamicin IV	No further doses of gentamicin post op Co-amoxiclav can be continued for up to for 5 days post op in uretic re-implant and up to 24 hours in pyeloplasty and heminephrectomy
Nephrectomy	Prophylaxis not routinely recommended	
MCUG	All infants < 3 months old & Children >3 months old with a high risk of pyelonephritis (e.g. single kidney) Gentamicin IV	No further doses of gentamicin post procedure **Note:** Where patients do not receive IV antibiotics: Co-amoxiclav PO (or similar) treatment dose can be prescribed for 48 hours, starting the evening before MCUG. Should decide on appropriate treatment option with consultant when booking MCUG - give appropriate prescription.

Procedure	1st line prophylaxis	Intra-op / post op doses **Additional intra-operative doses** of antibiotics are warranted in the event of **prolonged procedures** (>4 hours) using short acting antibiotics or **major intra-operative blood loss (>25mL/kg).**
Penicillin Allergy	Cefuroxime (or cefotaxime in neonates) may be used instead of co-amoxiclav in patients with mild hypersensitivity reaction to penicillins e.g.: rash 3 or more days post penicillin onset. Add metronidazole for extra anaerobic cover. <u>Do not</u> use cefuroxime if there is a history of anaphylaxis, angioedema or immediate onset rash post penicillin administration Clindamycin & Gentamicin ± metronidazole can be used in these cases.	
MRSA colonised patients	Add vancomycin at induction. Continue for same duration as other prophylactic antibiotics.	
Patients chronically colonised with bacteria other than MRSA: Contact Microbiology/ID for advice		
Neonatal Recommendations	Use amoxicillin + metronidazole instead of co-amoxiclav in neonates	
Antibiotic dosing and timing	Ensure that the antibiotic is given AT INDUCTION (OR NO MORE THAN 60 MINUTES BEFORE SKIN INCISION).	
Co-amoxiclav	**> 1 month:** 30mg/kg (max 1.2g) as a slow IV injection over 3-5 minutes.	
Gentamicin	**> 1 month:** 5mg/kg (max 480mg) once daily IV infusion over at least 30 minutes.	
Amoxicillin	**> 1 month:** 50mg/kg (max 1g) IV bolus.	
Metronidazole	**> 1 month:** 7.5mg/kg (max 500mg) eight hourly as an IV infusion over 20-30 minutes	
Vancomycin Dosing & Timing	Infusion should begin 90 -120 minutes before skin incision.	
	> 1 month: If giving **stat** dose of vancomycin at induction: 15mg/kg (max 1g) **infused over at least 60 minutes**. Doses > 500mg should be given at a max. rate of infusion of 10mg/min) **For longer courses of vancomycin,** 15mg/kg six hourly (maximum 3g/day) **infused over** at least **60 minutes**	
Other:	For dosing of other antibiotics & neonatal doses, consult CHI Formulary	

1.8. Neurosurgery

Procedure	1st line prophylaxis	Penicillin allergy* (see note below also)	MRSA colonised	Intra-op / post op doses **Additional intra-operative doses** of antibiotics are warranted in the event of **prolonged procedures (>4hours)** using short acting antibiotics or **major intra-operative blood loss (>25ml/kg).**
Ventriculoperitoneal shunt insertion (see note below also)	Cefuroxime IV	Teicoplanin IV	Teicoplanin IV	No further post op doses are necessary
External Ventricular Drain (EVD) insertion or revision	Cefuroxime IV	Teicoplanin IV	Teicoplanin IV	No further post op doses are necessary
Craniotomy (not for suspected infection)	Cefuroxime IV	Teicoplanin IV	Teicoplanin IV	No further post op doses are necessary
Implant and non-implant -Spinal and Cranioplasty	Cefuroxime IV + Gentamicin IV	Teicoplanin IV + Gentamicin IV	Teicoplanin IV + Gentamicin IV	**Intra-op,** for prolonged procedures, a **second dose of cefuroxime should be given at the 4-hour point.** Additional doses of Teicoplanin or gentamicin are not necessary **Post op: No further doses required** **If contaminated or dirty wound, please contact ID/ Microbiology for advice on prophylaxis**
Penicillin Allergy*	Cefuroxime may be used in patients with mild hypersensitivity reaction to penicillins eg: rash 3 or more days post penicillin onset. Do not use cefuroxime if there is a history of anaphylaxis, angioedema or immediate onset rash post penicillin administration			
Cefuroxime dosing and timing	**> 1 month:** Dose in theatre: 50mg/kg (max 1.5g) as a slow IV injection over 3-5 minutes. Ensure that the antibiotic is given AT INDUCTION (OR NO MORE THAN 60 MINUTES BEFORE SKIN INCISION). If a tourniquet is to be applied, a 15-minute period is required between the end of antibiotic administration and tourniquet application. Subsequent doses should be given at 30mg/kg (max 750mg).			
Teicoplanin dosing and timing	For a **stat** dose of Teicoplanin at induction: See CHI Formulary for dosing Ensure that the antibiotic is given AT INDUCTION (OR NO MORE THAN 60 MINUTES BEFORE SKIN INCISION). If a tourniquet is to be applied, a 15 minute period is required between the end of antibiotic administration and tourniquet application.			
Gentamicin dosing and timing	**> 1 month:** 7mg/kg (up to a maximum dose of 480mg) IV infusion over at least 30 minutes. Ensure that the antibiotic is given AT INDUCTION (OR NO MORE THAN 60 MINUTES BEFORE SKIN INCISION). If a tourniquet is to be applied, a 15 minute period is required between the end of antibiotic administration and tourniquet application.'			
Other:	**Pneumococcal vaccination:** Cerebrospinal fluid leaks, cochlear implant require pneumococcal vaccine administration. Pneumococcal vaccine status should be confirmed and brought up to date if necessary. Additional PPV23 may also be required. Please see Chapter 16 of the HSE immunisation guidelines for more guidance. For dosing of other antibiotics & neonatal doses, consult CHI Formulary			
Patients chronically colonised with bacteria other than MRSA or patients who have a complex medical history: Contact Microbiology/ID for advice				