The Walton Centre NHS Foundation Trust

Excellence in Neuroscience

ANTIMICROBIAL FORMULARY

Author and Contact details:	[redacted] – consultant microbiologist [redacted] [redacted] – neurosciences antimicrobial pharmacist	
Responsible Director:	Medical Director	
Approved by and date:	**Drugs and Therapeutics Committee**	**Jan 2023**
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Think of the environment…Do you have to print this out this document? **You can always view the most up to date version electronically on the Trust intranet.**

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1. INTRODUCTION

These “Antimicrobial Guidelines” within The Walton Centre NHS Foundation Trust have been approved by The Walton Centre Drugs and Therapeutics Group. It is the Trust’s policy that these Guidelines should be adhered to unless advised otherwise by a Consultant Microbiologist.

These guidelines have been benchmarked against neurosciences guidelines from other specialist centres including; Royal Preston NHS Trust, Salford Royal NHS Foundation Trust, Nottingham University hospitals NHS Trust, and National hospital for neurology and neurosurgery. The non-neurosciences guidance has been benchmarked with LUHFT antimicrobial guidance.

The implementation of these guidelines is supported through a ward-based Pharmacy service, consultant medical microbiologists, Liverpool Community Laboratory service based at LUHFT Royal site and trust wide collaborative antibiotic ward rounds

These guidelines are designed to encourage the rational use of antibiotics and to indicate first choice drugs in many clinical situations, together with an alternative drug or drugs for patients in whom a first choice drug cannot be used.

Close and early collaboration between clinicians and medical microbiologists is expected in all difficult, unusual or life threatening infections. The medical microbiologists can provide practical help and advice on appropriate antibiotic therapy in individual patients at any time. Whilst guidelines can provide practical help and advice they are not a substitute for due clinical thought and individual consideration for every patient.

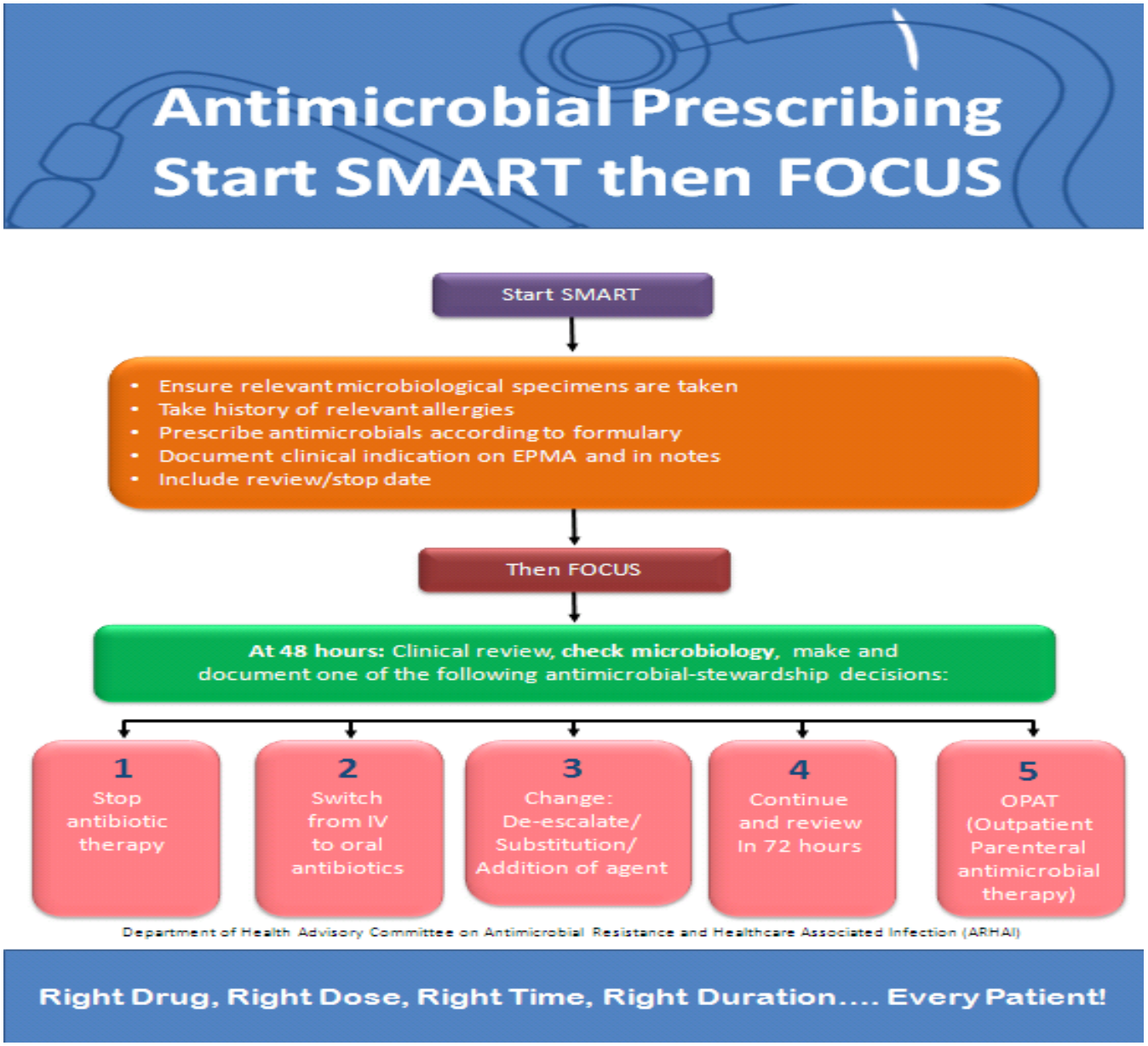
1.1. Contact Information

Medical microbiology	
Medical microbiology general office & enquiries (Mon-Fri 0900-1700, Sat 09:30-12:00)	[redacted]
[redacted], consultant microbiologist (Mon-Wed)	[redacted]
[redacted] (Mon-Fri)	[redacted]
Pharmacy	
Ward pharmacist	[redacted]
Senior neuroscience pharmacist office	[redacted]
Out of hours	[redacted]

Other clinical teams	
Infectious Diseases Unit, LUHFT Royal site	[redacted]

1.2. Antimicrobial Stewardship

Antimicrobial stewardship is the responsibility of ALL healthcare professionals to prevent the development and spread of antimicrobial resistance. Encompassing the principles of 'start SMART then FOCUS' should be applied to all patients being assessed for infection management.



All antibiotics must be prescribed on EPMA, including documentation of the indication and proposed duration of therapy within EPMA and the patient's medical notes.

A weekly collaborative antibiotic ward round takes place within the Trust which provides advice and assesses whether guidelines are being adhered to. Inappropriate prescribing of antibiotics will be discussed with individual prescribers to improve compliance with antimicrobial stewardship.

1.3. Sampling

- Every effort should be made to obtain all necessary bacteriological specimens e.g. blood cultures, CSF, wound swabs, before antibiotic therapy is commenced.
- If blood cultures are needed: 2 independent sets should be sent. Refer to blood cultures sampling policy.

Out-of-hours staff MUST contact the on-call lab technician to process urgent samples including CSF, brain pus etc. This should be done via the hospital switchboard. And it must be ensured that the portering service has delivered the sample to the specimen reception at LUHFT Aintree site labs ready for transport to The LUHFT Royal site.

1.4. Hypersensitivity to Penicillins

- Always take a complete history and avoid confusion with drug side effects (i.e. vomiting, diarrhoea, thrush). If in doubt, confirm the history by reviewing GP records and discuss with the ward pharmacist
- Penicillin-allergic patients may react to all penicillins.
- Meropenem may be given with **caution**.
- Cephalosporins **can be** given to patients with mild reactions to penicillin (e.g. rash)
- Do not give cephalosporins to patients who have anaphylactic or angioedema reaction to penicillins.

1.5. MRSA

If systemic MRSA infection is suspected or proven refer to Trust guidelines on the treatment of MRSA infections on the intranet:

[redacted]

1.6. Clostridium difficile

If clostridium difficile infection is suspected refer to Trust guidelines for management on the intranet.

[redacted]

2. PERIOPERATIVE PROPHYLAXIS

General principles:

- **Single dosing is generally recommended** (i.e. no additional antibiotics post-surgery)
- Dose to be given **30minutes before** knife to skin
- Prescribe/record antibiotic(s) in the anaesthetist record/chart
- Post-operative dosing not recommended.
- If the patient is already on broad spectrum antibiotics it is unlikely they will need prophylaxis. Please discuss with surgical team/microbiologist.

Procedure	Recommended antibiotic	Repeated doses for prolonged surgery
All neurosurgical procedures	Cefuroxime IV 1.5g	Every 4 hours, max 4 doses or in the case of major intra-operative blood loss of >1500mL (dose after fluid replacement)
Procedures involving nasopharynx, oropharynx or opening of craniofacial air sinuses	ADD Metronidazole IV 500mg	Every 8 hours
Revisional shunt surgery	ADD Teicoplanin IV 1.2g NB. Bactiseal systems use rifampicin/clindamycin incorporated into plastic but standard antibiotics will also be required)	Not required
CSF leaks & lumbar drain insertion	Not required	-
Closed skull fractures	Not required	-
Insertion/changing of urinary catheters	Not required	-
Penicillin allergy (type 2 or more anaphylactic response – see table below	Gentamicin IV 160mg PLUS teicoplanin IV 1.2g	Not required
MRSA positive	ADD Teicoplanin IV 1.2g	Not required
CPE positive	Discuss with microbiology in advance of planned procedures	Discuss with microbiology in advance of planned procedures

Anaphylactic reaction grades	
1	Rash, erythema
2	Unexpected hypotension – not severe e.g. not requiring treatment *and/or* Bronchospasm – not severe e.g. not requiring treatment +/- Grade 1 features
3	Unexpected severe hypotension and/or Severe bronchospasm and/or Swelling with actual or potential airway compromise +/- Grade 1 features
4	Cardiac arrest – i.e. fulfilling the indications for CPR
5	Fatal

3. ANTIMICROBIAL TREATMENT REGIMENS

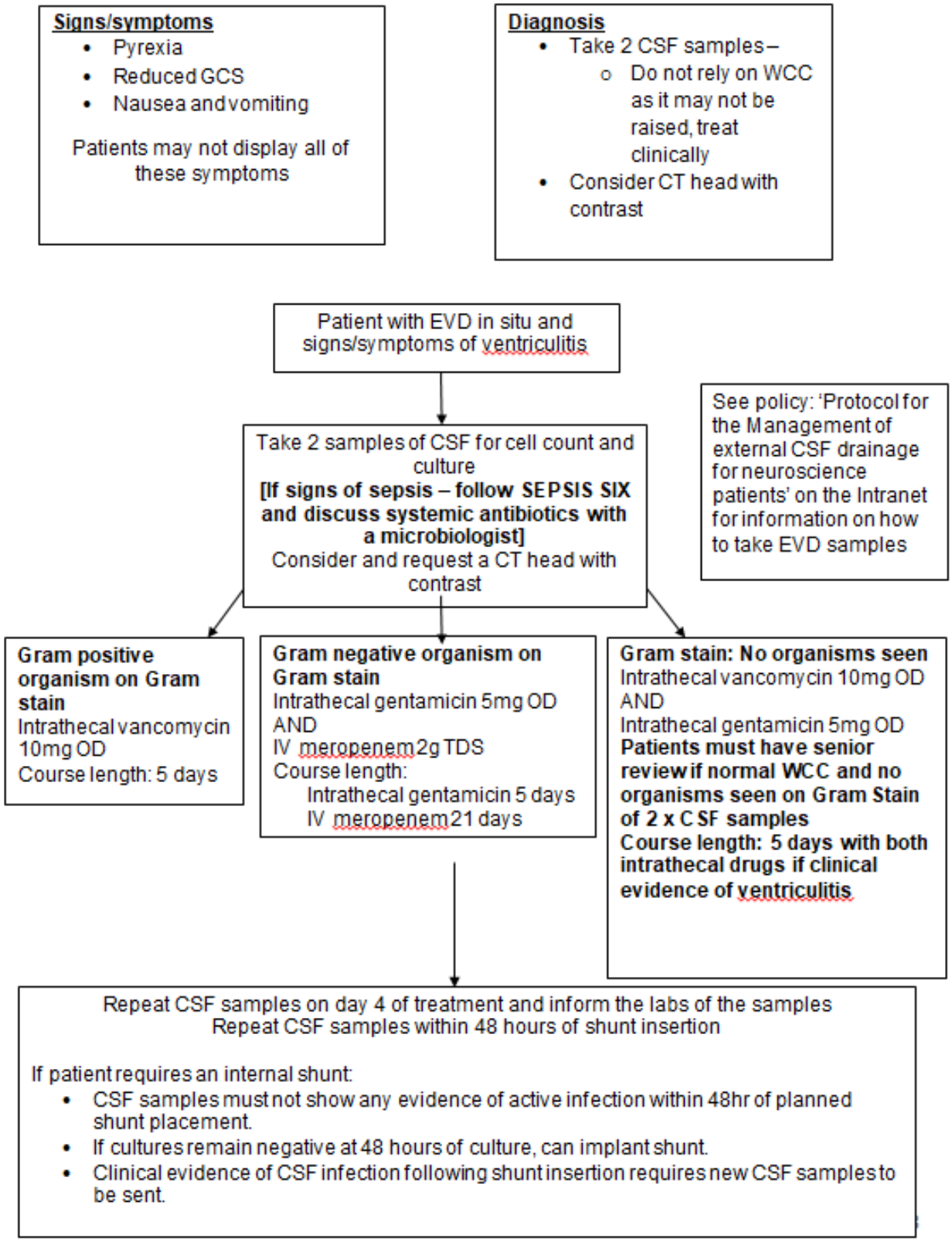
3.1. CRANIAL

Neurosurgical infection	First line Treatment	Alternative in penicillin allergy	Comments
Post-operative meningitis	Meropenem IV 2g TDS Known MRSA carrier: ADD vancomycin IV Known CPE carrier: discuss with microbiology Duration: 14days for Gram positive/ no culture meningitis, 21days Gram negative	-	Take two independent blood cultures, wound swabs and CSF sample. If patient has recently been treated with meropenem discuss with microbiology
Bone flap infection	Ceftriaxone IV 2g BD Known MRSA carrier: ADD vancomycin IV	Ciprofloxacin PO 750mg BD/ IV 400mg TDS PLUS vancomycin IV	There must be no evidence of subdural infection for this treatment regime
	Duration: Following bone flap removal give 2weeks IV followed by 2weeks oral		
Spontaneous subdural empyema/ brain abscess (no previous surgery)	Ceftriaxone IV 2g BD PLUS Metronidazole PO 400mg/ IV 500mg TDS Known MRSA carrier: ADD vancomycin IV	Ciprofloxacin PO 750mg BD/ IV 400mg TDS PLUS vancomycin IV PLUS metronidazole PO 400mg/ IV 500mg TDS	Surgical evacuation and washout. Monitor response by serial imaging & clinical progress
	Duration: 6 weeks		
Post-operative brain abscess/ subdural collection	Meropenem IV 2g TDS Duration: 6 weeks	-	
Infected pseudomeningocele	Meropenem IV 2g TDS	-	

	Duration: 2weeks then review with C&S		
Neurosurgical infection	**First line Treatment**	**Alternative in penicillin allergy**	**Comments**
Superficial shunt infection	Flucloxacillin IV 2g QDS Known MRSA carrier: teicoplanin IV Duration: review day 5 with C&S	Teicoplanin IV	Infection may involve shunt and consider need for imaging N.B. teicoplanin does not cross over BBB
Deep seated shunt infections	Ceftriaxone IV 2g BD If abdominal source: ADD metronidazole PO 400mg/IV 500mg TDS Known MRSA carrier: ADD vancomycin IV Duration: review with C&S and discuss with microbiology	Meropenem IV 2g TDS	Infected shunt must be removed. Send blood cultures, CSF from theatre.
Penetrating craniocerebral injuries/ open skull fractures (non-operated) e.g. gunshot wounds, craniocerebral injuries	Ceftriaxone IV 2g BD PLUS metronidazole PO 400mg TDS	Ciprofloxacin PO 750mg BD/ IV 400mg TDS PLUS metronidazole PO 400mg TDS PLUS vancomycin IV	Review tetanus status of the patient
	Duration: 5days		
Depressed skull fractures	With or without CSF leak there is NO indication for antibiotic		
Post-operative CSF leaks	CSF leak by itself does not mean infection and does not require treatment		Wound swab +/- CSF sample is vital NB- for transphenoidal leaks, CSF

		samples are not required Wound washout may prove necessary

3.2. VENTRICULITIS



No therapeutic drug monitoring is required for intrathecal doses of antibiotics

3.3. SPINAL

In clinically stable patients obtain blood and wound/surgical sample prior to starting treatment

Neurosurgical Infection	First line Treatment	Alternative in penicillin allergy
Post-operative superficial wound infection including pin site infections	Flucloxacillin IV 2g QDS/ PO 1g QDS	Teicoplanin IV
	Duration: 7-10days	
Post-operative deep seated wound infection (with/without metal work) <30days post-op	Flucloxacillin IV 2g QDS/PO 1g QDS	Teicoplanin IV
	Duration: 6 weeks	
Post-operative deep seated infection WITHOUT metal work >30days post op	Ceftriaxone IV 2g BD PLUS Metronidazole PO 400mg TDS	Teicoplanin IV
	Duration: 6 weeks	
Post-operative deep seated infection WITH metal work >30days post op	Teicoplanin IV PLUS Ciprofloxacin PO 750mg BD	-
	Duration: 6 weeks then review	
Paraspinal / epidural abscess / Discitis	Ceftriaxone IV 2g BD	Ciprofloxacin PO 750mg BD PLUS teicoplanin IV
	Duration: 6 weeks	

3.4. FUNCTIONAL

Implant Infections (DBS/IPG/SCS)	First line Treatment	Alternative in penicillin allergy
Acute purulent infection presentation	Flucloxacillin IV 2g QDS/ PO 1g QDS	Teicoplanin IV
	Duration: 5 days and review	
Indolent presentation (>30days post-operatively)	Teicoplanin IV Duration: review with C&S	-

3.5. NEUROLOGICAL

Infection	First line Treatment	Alternative in penicillin allergy	Comments
Spontaneous bacterial meningitis (non-surgical)** <55years of age	Ceftriaxone IV 2g BD Give IV dexamethasone 0.15mg/Kg every 6 hours for 4 days starting prior to or at the same time as the first dose of antibiotics. STOP steroids if meningococcal or septicaemia	Chloramphenicol IV 25mg/kg QDS	**Chloramphenicol monitoring** Chloramphenicol levels should be taken after 48 hours of treatment. Pre dose and 2hours post dose levels required Desired ranges: Trough <15mg/L Peak (2 hour post dose) 10-25mg/L Samples should be placed in mustard bottle and protected from light
	Duration: pneumococcal or culture negative 14days Meningococcal 7days		
Spontaneous bacterial meningitis (non-surgical)** Over 55years of age or immunocompromised	Treat as bacterial meningitis as above PLUS amoxicillin IV 2g 4hourly to cover listeria	Treat as bacterial meningitis as above PLUS co-trimoxazole 30mg/kg 6hourly	Contact pharmacy for advice on co-trimoxazole levels
	Duration: 21 days		
Encephalitis	As per bacterial meningitis above PLUS Aciclovir IV 10mg/kg TDS	As per bacterial meningitis above PLUS Aciclovir IV 10mg/kg TDS	Must discuss with virologist
	Duration: 21 days		
Lyme Disease Encephalitis	Ceftriaxone IV 2g BD	Doxycycline PO 200mg BD	NICE guidance, Lyme disease
	Duration: 21 days		

**Non-neurosurgical meningitis is a notifiable disease and should be reported within 24 hours of admission to the Health Protection Unit (HPU) by the attending clinician. Take two independent blood cultures, EDTA blood sample for meningococcal/ pneumococcal PCR, bacterial throat swab for meningococcal carriage and CSF.

Infection	First Line Treatment	Alternative in penicillin allergy	Comments
Toxoplasma encephalitis	Discuss with infectious diseases		Visualised typically as multifocal lesions on contrast CT brain or MRI, especially affecting basal ganglia. Most commonly seen in immune-compromised patients
Whipple's Disease	Ceftriaxone IV 2g BD for 2weeks Followed by Co-trimoxazole 960mg BD for 1 year		Diagnosis requires CSF PCR and biopsy. Samples are sent to the microbiology reference lab

NB: If neurological involvement is suspected in syphilis or Lyme disease, serology can be performed on the CSF but the CSF sample must always be accompanied by a serum sample.

3.6. SEPSIS

General principles:

- Follow the Sepsis Pathway
- Take TWO independent blood culture sets
- Aim to investigate and start appropriate antimicrobial therapy within ONE hour

Infection	First line Treatment	Alternative in penicillin allergy	Comments
Sepsis of unclear focus	Piperacillin/tazobactam IV 4.5g TDS PLUS gentamicin IV STAT	Teicoplanin IV PLUS gentamicin IV	
	Duration: review at 48-72hours with C&S. Total duration 5 days		
Neutropenic sepsis	Piperacillin/tazobactam IV 4.5g QDS PLUS gentamicin IV STAT	Mild allergy: Meropenem IV 1g TDS PLUS gentamicin IV STAT Severe allergy: Aztreonam IV 2g TDS PLUS teicoplanin IV PLUS Metronidazole IV 500mg TDS PLUS gentamicin IV STAT	Neutrophil count <1.0 and immunocompromised patients
	Duration: review at 48-72hours with C&S. Total duration 5 days		
Central IV catheter sepsis	Teicoplanin IV PLUS gentamicin IV STAT	-	Paired central and peripheral blood cultures essential and clearly marked on microbiology request form. ITU review and central line removal need to be considered.
	Duration: review at 48-72hours with C&S.		

Infection	First Line Treatment	Alternative in penicillin allergy	Comments
Urosepsis/ Pyelonephritis	Piperacillin/tazobactam IV 4.5g TDS PLUS gentamicin IV STAT	Ciprofloxacin PO 750mg BD PLUS gentamicin IV STAT	If pseudomonas infection, increase frequency of piperacillin/ tazobactam to QDS
	Duration: review at 48-72hours with C&S for oral stepdown. Treat for 7days (total including IV therapy)		
Intraabdominal sepsis/peritonitis	Piperacillin/tazobactam IV 4.5g TDS PLUS gentamicin IV STAT	Tigecycline 100mg IV STAT, then 50mg every 12 hours PLUS gentamicin IV STAT	If pseudomonas infection, increase frequency of piperacillin/ tazobactam to QDS
Chest Sepsis	See section 3.8		

3.7. URINARY

General principles:

- Asymptomatic bacteriuria (bacterial growth in the urine without symptoms) is common, especially in elderly and catheterised patients and does NOT require treatment. Only prescribe antibiotics when there are signs/symptoms of an infection
- Do NOT start treatment solely on the result of a ward test urine in the absence of symptoms
- In the event of a positive ward test urine result, send a midstream specimen of urine (MSU) to the laboratory for culture and detail the positive result in the case notes. Review the patient's signs and symptoms before starting any treatment
- In the event of a negative result, consider an alternative diagnosis as a UTI is unlikely
- Never perform a ward test urine on a catheter sample – in systemically unwell patients send a catheter specimen of urine (CSU) for culture and take TWO sets of blood cultures

Infection	First line Treatment	Second line treatment	Third line treatment
UTI	Nitrofurantoin PO 50mg QDS (avoid if eGFR<45mL/min)	Pivmecillinam PO 400mg STAT then 200mg TDS Or fosfomycin PO 3g STAT (females only)	Trimethoprim PO 200mg BD
	Duration: Females 3 days, males/complicated 7 days		
Catheter associated UTI (CAUTI)	Piperacillin/tazobactam IV 4.5g TDS* PLUS gentamicin IV STAT * If pseudomonas infection, increase frequency of piperacillin/ tazobactam to QDS	Ciprofloxacin PO 750mg BD PLUS gentamicin IV STAT	-
	Duration: 7 days		

If urosepsis is suspected see section 3.6: Sepsis

3.8. RESPIRATORY

Consider possible COVID infection in all patients with respiratory symptoms – refer to Trust policies on COVID management and further treatment options

COVID-19 is a viral infection, do NOT give antibiotics unless co-existing bacterial infection suspected.

Treat as CAP if onset within 48hours of admission. CURB-65 scoring for CAP. 1 point for each:

- New onset/worsening confusion
- Urea > 7 mmol/L
- Respiratory rate ≥ 30 breaths per minute
- Systolic blood pressure <90mmHg or diastolic blood pressure ≤60mmHg
- Age > 65

Infection	First line Treatment	Alternative in penicillin allergy
Exacerbation of COPD	Amoxicillin PO 1g TDS Give doxycycline if recently had a course of amoxicillin	Doxycycline PO 200mg STAT then 100mg BD
	Duration: 5 days	
Mild community acquired pneumonia (CAP) CURB-65: 0-1	Amoxicillin PO 1g TDS	Doxycycline PO 200mg STAT then 100mg BD
	Duration: 5days	
Moderate CAP CURB-65: 2	Amoxicillin PO 1g TDS PLUS clarithromycin PO 500mg BD	Doxycycline PO 200mg STAT then 100mg BD
	Duration: 5days	
Severe CAP CURB-65: 3+	Amoxicillin IV 2g TDS PLUS clarithromycin PO 500mg BD	Teicoplanin IV PLUS clarithromycin PO 500mg BD
	Duration: review at 48-72hours for oral stepdown. Total 5days including IV therapy	

<table>
<tr><th>Infection</th><th>First Line Treatment</th><th>Alternative in penicillin allergy</th></tr>
<tr><td rowspan="2">HAP

(onset greater than 48hrs after admission)</td><td>Piperacillin/tazobactam IV 4.5g TDS*

Known MRSA:
ADD teicoplanin IV

* If pseudomonas infection, increase frequency of piperacillin/ tazobactam to QDS

Oral stepdown:
Co-amoxiclav 500/125mg TDS</td><td>Mild allergy:
Meropenem IV 1g TDS
Known MRSA:
ADD teicoplanin IV

Severe allergy:
Teicoplanin IV
PLUS
ciprofloxacin PO 750mg BD

Oral stepdown:
Doxycycline 200mg stat then 100mg BD & ciprofloxacin 750mg BD</td></tr>
<tr><td colspan="2">Duration: 5days (including IV and oral therapy)</td></tr>
<tr><td rowspan="2">Aspiration pneumonia

Community-acquired</td><td>Amoxicillin IV 1g TDS
PLUS
metronidazole IV 500mg TDS</td><td>Clarithromycin IV 500mg BD
PLUS
metronidazole IV 500mg TDS</td></tr>
<tr><td colspan="2">Duration: review at 48-72hours for oral stepdown. Total 5days including IV therapy.</td></tr>
<tr><td rowspan="2">Aspiration pneumonia

Hospital- acquired</td><td>Piperacillin/tazobactam IV 4.5g TDS*

* If pseudomonas infection, increase frequency of piperacillin/ tazobactam to QDS</td><td>Ciprofloxacin IV 400mg BD*
PLUS
Teicoplanin IV
PLUS
Metronidazole IV 500mg TDS

* If pseudomonas infection, increase frequency of IV ciprofloxacin to TDS</td></tr>
<tr><td colspan="2">Duration: review at 48-72hours for oral stepdown. Total 5days including IV therapy.</td></tr>
<tr><td>Tuberculosis (including non-pulmonary TB)</td><td colspan="2">Discuss all suspected cases with the microbiologist/infectious disease consultant, the infection control team, the physicians in the department of thoracic medicine, LUHFT Aintree site and refer to the TB MDT at LUHFT Royal site.

Review the Walton Centre TB Policy for assessment and appropriate infection control precautions.</td></tr>
</table>

3.8.1 INFLUENZA

Refer to UKHSA guidance for full details:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1058443/ukhsa-guidance-antivirals-influenza-11v4.pdf

Treatment of suspected or confirmed
Oseltamivir PO 75mg BD for 5days (10days in immunocompromised patients)
Dose adjustments in renal impairment:

Creatinine clearance	Recommended treatment dose (5 day course)
>30ml/min	75mg TWICE a day
11-30ml/min	75mg ONCE daily
<10ml/min	75mg ONCE as a single dose
Haemodialysis	30mg STAT then 30mg THREE times a WEEK after HD session (Dialysed)
Haemodiafiltration	75mg THREE times a WEEK after dialysis session (Dialysed)
Peritoneal dialysis	30mg ONCE as a single dose
Haemo(dia)filtration 1-1.8L/hr exchange rate (continuous dialysis)	30mg ONCE a day
Haemo(dia)filtration 1.9-3.6 L/hr exchange rate (continuous dialysis)	30mg TWICE a day
Haemo(dia)filtration >3.6 L/hr exchange rate (continuous dialysis)	75mg TWICE a day

Discuss second line treatment with infectious diseases/medical virology.

Post-exposure prophylaxis
(For patient inclusion criteria please see IPC guidance on the intranet)

Oseltamivir PO 75mg OD for 10days.
Dose adjustments in renal impairment:

Creatinine clearance	Recommended prophylactic dose (10 day course)
>30ml/min	75mg ONCE daily
11-30ml/min	30mg ONCE daily
<10ml/min	30mg ONCE weekly (for 2 doses)
Haemodialysis	30mg STAT then 30mg after every SECOND HD session
Haemodiafiltration	30mg THREE times a week after dialysis session (Dialysed)
Peritoneal dialysis	30mg ONCE weekly (for 2 doses)
Haemo(dia)filtration 1-1.8L/hr exchange rate (continuous dialysis)	30mg every 48 hours
Haemo(dia)filtration 1.9-3.6 L/hr exchange rate (continous dialysis)	30mg ONCE daily
Haemo(dia)filtration >3.6 L/hr exchange rate (continuous dialysis)	75mg ONCE daily

Discuss second line treatment with infectious diseases/medical virology.

Please note that LCL labs report renal function in terms of eGFR. This is not interchangeable with creatine clearance (CrCl) which can be calculated using the following formula:

Calculating Creatinine Clearance

$$\text{CrCl (mL/min)} = \frac{\text{N x [140-age (in years)] x weight (in kg)}}{\text{Serum creatinine (micromol/L)}}$$

Where N = (males 1.23; females 1.04)

3.9. SKIN AND SOFT TISSUE

Infection	First line Treatment	Alternative in penicillin allergy
Cellulitis	Flucloxacillin IV 2g QDS For 48hours then review for oral step down flucloxacillin PO 1g QDS	Mild cellulitis: Clarithromycin PO 500mg BD Severe cellulitis: Teicoplanin IV
	Duration: review day 5 with view to stop depending on clinical response	
MRSA suspected or confirmed	Teicoplanin IV	-
	Duration: review day 5 with view to stop depending on clinical response	

4. ANTIBIOTIC ASSAYS

4.1. Principles

- If a patient requires gentamicin, teicoplanin or vancomycin the dose will be either initially calculated or if already commenced, checked by a pharmacist.
- Pharmacists will advise on levels and dosing – please ensure ward pharmacist/ on call pharmacists are **always informed**. This service is available 7 days per week.
- Out-of-hours the initial dose should be given and then contact on call pharmacist for advice on maintenance dose and blood level monitoring.
- Pre-dose (trough) levels: take samples immediately before next dose is due. Do not omit the dose whilst awaiting levels, unless advised by a pharmacist.
- Antibiotic assays should be sent to the Clinical Laboratory Department at LUHFT Aintree site. Use the blue microbiology request form.
- Teicoplanin samples are sent to RLUH for analysis via Aintree labs. They therefore need to be in a separate sample bottle from other bloods requested.
- ALWAYS RECORD TIME OF DOSE & TIME OF BLOOD SAMPLE ON REQUEST FORM.

4.2. GENTAMICIN

Treatment	Cautions	Administration	Monitoring (essential):
Gentamicin **Dosing:** Once daily doses **5mg/kg** (maximum dose 450mg OD) This dosing does not apply for patients being treated for endocarditis Use adjusted or actual body weight, see Trust policy for dosing guidance **Gentamicin monograph** Due to its ability to impair neuromuscular transmission gentamicin is contraindicated in myasthenia gravis. Contact microbiology for an alternative in patients with myasthenia gravis or discuss with neurology	Potential nephrotoxic and ototoxic agent **Renal impairment** e.g. Serum creatinine > 200mmol/L or creatinine clearance/ eGFR < 30mL/min. Discuss choice with a consultant medical microbiologist	IV bolus over 3-5 mins or infusion in 50-100mL of 0.9% sodium chloride or 5% glucose over 20 minutes	**For patients given 5mg/kg dose:** Take ONE level 8-12 hours post dose. Plot level against gentamicin nomogram: Urban & Craig nomogram Adjust dosing frequency as required/indicated by the nomogram Measure trough/ pre-dose level (should be <1mg/L) twice weekly thereafter. DO NOT withhold dose while awaiting results, unless advised Peak levels are not routinely necessary, unless otherwise advised. **Levels not required for STAT doses** Renal function should be monitored daily

N.B:

(i) Avoid using other drugs that enhance nephrotoxicity or ototoxicity e.g. furosemide, bumetanide, NSAIDS etc. if possible

(ii) Avoid courses longer than 5 days unless recommended by a microbiologist.

(iii) Doses should be given at the exact time(s) annotated on the prescription.

(iv) Monitoring of plasma gentamicin levels is not required for intrathecal (IT) gentamicin administration.

(v) Intrathecal gentamicin should be administered by practitioners specifically trained to do so only.

4.3. VANCOMYCIN

Treatment	Cautions	Administration	Monitoring (essential):
Vancomycin **Dosing:** Ward pharmacist/oncall pharmacist will advise on maintenance dose Prescribe STAT dose 1g IV and contact pharmacist to discuss further dosing Horsley ITU *may* dose patients using continuous vancomycin infusions, see separate guideline. This practice is restricted to Horsley ITU only	Nephrotoxic agent Prescribe in caution in patients with significant renal impairment (e.g. Serum creatinine > 200mmol/L or creatinine clearance/ eGFR < 30mL/min) In such cases early consideration should be given to discussing antibiotic choice with consultant medical microbiologist	Give 1g doses over two hours in at least 200mL of 0.9% sodium chloride or 5% glucose	**Alert pharmacist** Take trough levels only. Peak measurement not recommended Aim for 15-20 mg/L (except for continuous infusions on Horsley, see guideline on intranet for range) Take 1st level immediately before the fourth dose. DO NOT withhold dose while awaiting results (unless otherwise advised)

N.B:

(i) Avoid using other drugs that enhance nephrotoxicity or ototoxicity e.g. furosemide, bumetanide, NSAIDS etc. if possible

(ii) Doses should be given at the exact time(s) annotated on the prescription.

(iii) **Do not take levels** in patients being treated with a STAT dose of vancomycin.

(iv) Monitoring of plasma vancomycin levels is not required for intrathecal vancomycin administration.

(v) Intrathecal vancomycin should be administered by practitioners specifically trained to do so only.

4.4. TEICOPLANIN

Treatment	Cautions	Administration	Monitoring (essential)
Teicoplanin Loading Dose (to be given to all patients): 12mg/kg (rounded to nearest 200mg) every 12hours for 2 days Followed by **maintenance dose**: 12mg/kg once daily (eGFR> 60mL/min) See below for dose adjustments in renal impairment In patients who are >100Kg, discuss dosing with pharmacy in working hours (dosing remains 12mg/kg up to max 2000mg per single dose)	Does not provide BBB coverage, do not use in cranial infections. Potentially nephrotoxic, monitor renal function May cause blood dyscrasias, weekly FBC monitoring recommended	IV bolus over 3-5mins Or IV infusion in 0.9% sodium chloride or glucose 5% over 30mins	Routine teicoplanin levels are advised for the following indications: - Bone and joint infections - Bacteraemia - Prolonged courses under microbiology/infectious diseases advice - If a patient has renal impairment or is of extreme body weight A pre-dose (trough) level should be taken on day 4 then weekly thereafter. For advice on target levels and dose adjustment, speak to pharmacy. For most deep-seated infections aim for a pre-dose (trough) level of 20 – 60mg/L A higher target trough of 30 – 60mg/L is needed for infective endocarditis

Maintenance Dosing in renal impairment for teicoplanin:

Estimated glomerular filtration rate (eGFR mL/min)	Maintenance dose of teicoplanin to be prescribed following loading dose (round to nearest 200mg)
30 – 60mL/min	6mg/Kg once daily
<30mL/min	4mg/Kg once daily
Peritoneal dialysis	dose as eGFR <30ml/min
Haemodialysis	12mg/Kg three times a week given after dialysis

Note: renal dosing is not according to SPC

5. SAFETY ALERTS

5.1. Fluoroquinolones

The MHRA have released a safety alert with new restrictions on the prescribing of fluoroquinolone antibiotics due to very rare reports of disabling and potentially long-lasting or irreversible adverse reactions affecting musculoskeletal and nervous systems. From the alert there are very few indications for using fluoroquinolones. Ciprofloxacin is the only fluoroquinolone that is included within The Walton Centre Antimicrobial formulary. It is recommended in penicillin allergic patients for the following conditions:

1. Bone flap infection/osteomyelitis
2. Spontaneous subdural empyema
3. Brain abscess
4. Paraspinal /epidural abscess
5. Discitis
6. Implant infections
7. Penetrating craniocerebral injuries/open skull fractures
8. HAP
9. Aspiration pneumonia

The antimicrobial stewardship group has reviewed ciprofloxacin for these indications, all of which are severe infections, and use is acceptable within the remit of the MHRA alert. Fluoroquinolones should not be used for any other indication unless discussed with a microbiologist.

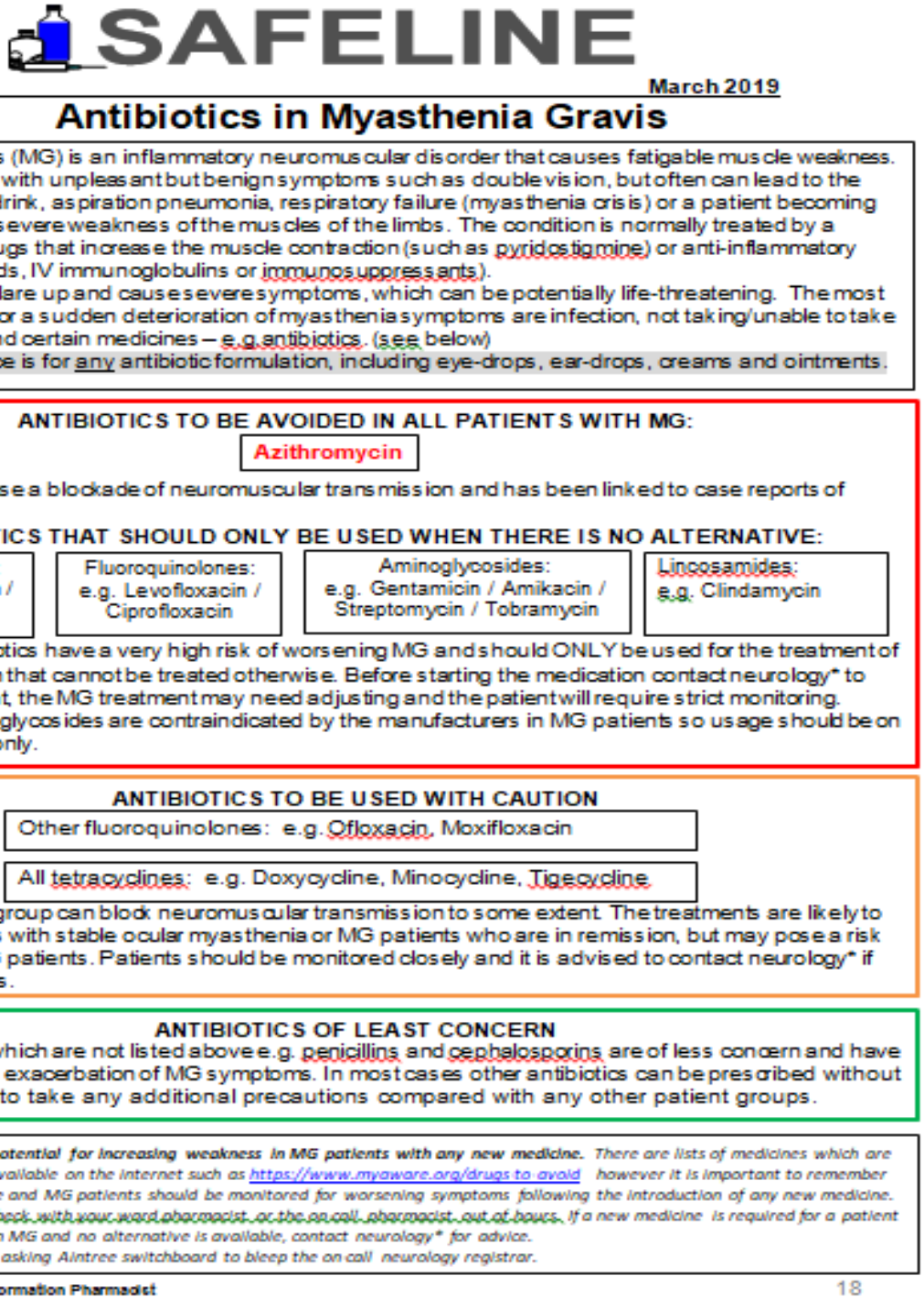
Caution should be exercised in patients with the following:

- History of seizures/at risk of seizure
- Co-administration of corticosteroids (e.g. dexamethasone, prednisolone)
- Previous serious adverse reactions to quinolone or fluoroquinolone antibiotics
- Over 60 years of age
- Renal impairment
- Solid-organ transplants
- Abdominal aortic aneurysms

Patients should be advised to monitor for any adverse reactions and treatment should be discontinued at the first signs of tendon pain, muscle weakness, inflammation and any central nervous system effects.

Further information on the alert can be found at https://www.gov.uk/drug-safety-update/fluoroquinolone-antibiotics-new-restrictions-and-precautions-for-use-due-to-very-rare-reports-of-disabling-and-potentially-long-lasting-or-irreversible-side-effects

5.2. Antibiotics in MG



SAFELINE

March 2019

Antibiotics in Myasthenia Gravis

Myasthenia Gravis (MG) is an inflammatory neuromuscular disorder that causes fatigable muscle weakness. This can manifest with unpleasant but benign symptoms such as double vision, but often can lead to the inability to eat or drink, aspiration pneumonia, respiratory failure (myasthenia crisis) or a patient becoming bedridden due to severe weakness of the muscles of the limbs. The condition is normally treated by a combination of drugs that increase the muscle contraction (such as pyridostigmine) or anti-inflammatory treatments (steroids, IV immunoglobulins or immunosuppressants).
The disease can flare up and cause severe symptoms, which can be potentially life-threatening. The most common causes for a sudden deterioration of myasthenia symptoms are infection, not taking/unable to take MG medication and certain medicines – e.g. antibiotics. (see below)
N.B. This advice is for any antibiotic formulation, including eye-drops, ear-drops, creams and ointments.

ANTIBIOTICS TO BE AVOIDED IN ALL PATIENTS WITH MG:

Azithromycin

This drug can cause a blockade of neuromuscular transmission and has been linked to case reports of myasthenia crisis.

ANTIBIOTICS THAT SHOULD ONLY BE USED WHEN THERE IS NO ALTERNATIVE:

Other Macrolides: e.g. Erythromycin / Clarithromycin	Fluoroquinolones: e.g. Levofloxacin / Ciprofloxacin	Aminoglycosides: e.g. Gentamicin / Amikacin / Streptomycin / Tobramycin	Lincosamides: e.g. Clindamycin

All of these antibiotics have a very high risk of worsening MG and should ONLY be used for the treatment of a serious infection that cannot be treated otherwise. Before starting the medication contact neurology* to discuss the patient, the MG treatment may need adjusting and the patient will require strict monitoring.
In addition, aminoglycosides are contraindicated by the manufacturers in MG patients so usage should be on specialist advice only.

ANTIBIOTICS TO BE USED WITH CAUTION

Other fluoroquinolones: e.g. Ofloxacin, Moxifloxacin

All tetracyclines: e.g. Doxycycline, Minocycline, Tigecycline

Medicines in this group can block neuromuscular transmission to some extent. The treatments are likely to be safe in patients with stable ocular myasthenia or MG patients who are in remission, but may pose a risk for less stable MG patients. Patients should be monitored closely and it is advised to contact neurology* if there are concerns.

ANTIBIOTICS OF LEAST CONCERN

Other antibiotics which are not listed above e.g. penicillins and cephalosporins are of less concern and have not been linked to exacerbation of MG symptoms. In most cases other antibiotics can be prescribed without the need to take any additional precautions compared with any other patient groups.

Please note – there is potential for increasing weakness in MG patients with any new medicine. *There are lists of medicines which are known to worsen MG available on the internet such as https://www.myaware.org/drugs-to-avoid however it is important to remember that no list is exhaustive and MG patients should be monitored for worsening symptoms following the introduction of any new medicine. If in any doubt please check with your ward pharmacist, or the on call pharmacist out of hours. If a new medicine is required for a patient that is known to worsen MG and no alternative is available, contact neurology* for advice.*
**Contact neurology by asking Aintree switchboard to bleep the on call neurology registrar.*

Sue Smith Medicines Information Pharmacist 18

6. REFERENCES

- LUHFT antimicrobial guidelines online, November 2021
- EUCAST susceptibility breakpoints, interpretation and reporting guidance, v11 2021
- BMJ Best Practice – Whipples disease (April 2020)
- Aciclovir in critical care monograph, October 2020

6.1. Supporting policies/clinical guidance

- NICE guideline NG138: pneumonia (community-acquired) antimicrobial prescribing 2019
- NICE guideline NG139: pneumonia (hospital-acquired) antimicrobial prescribing 2019
- NICE guidelines NG111: pyelonephritis (acute): antimicrobial prescribing 2018
- NICE guidelines NG109: urinary tract infection (lower): antimicrobial prescribing 2018
- NICE guideline NG95: Lyme Disease 2018
- Corticosteroids in the Treatment Of Covid-19
- Remdesivir in Covid-19
- Guidance on Management of Anticoagulation for Inpatients during the COVID-19 Pandemic
- Guidance on VTE Prevention for Patients with Suspected or Confirmed COVID-19 Infection