Catholic Health Guide to Antimicrobials & Infection Prevention

2024 Edition

Developed by the Catholic Health Antimicrobial Stewardship Committee & Infection Prevention and Control Department

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INTRODUCTION

Infectious diseases are consistently among the top diagnoses for patients seeking medical care across Catholic Health acute care facilities. Indeed, a national survey performed by the Centers for Disease Control and Prevention revealed that nearly forty percent of hospitalized individuals are on antimicrobials at any given time.

This staggering statistic, combined with the coalescence of immunocompromised individuals, shared equipment, invasive procedures and multiple human contacts gives rise to an ideal environment for the evolution and transmission of highly resistant pathogens.

The Catholic Health Guide to Antimicrobials and Infection Prevention provides guidance for clinicians on antimicrobial use and infection prevention strategies as a means of protecting our patients, staff and visitors. The *Guide* is a valuable reference that draws upon evidence-based national guidelines as well as local epidemiological data. Most recommendations are directed toward the inpatient acute care adult population. Section 2.10 offers recommendations regarding outpatient empiric regimens applicable to patients evaluated in outpatient clinics or discharged from the emergency department.

As with any guidance document, individual patient characteristics should be incorporated into all clinical decisions. Recommendations made within this guideline should not act as a substitute for clinical judgement or infectious diseases consultation where appropriate.

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SECTION 1
Antimicrobial Formulary and Application

An antibiogram is a table listing antibiotic sensitivity patterns for common bacteria in a particular healthcare institution (or group of institutions). These data help guide decisions involving empiric antibiotic selection for common infection syndromes.

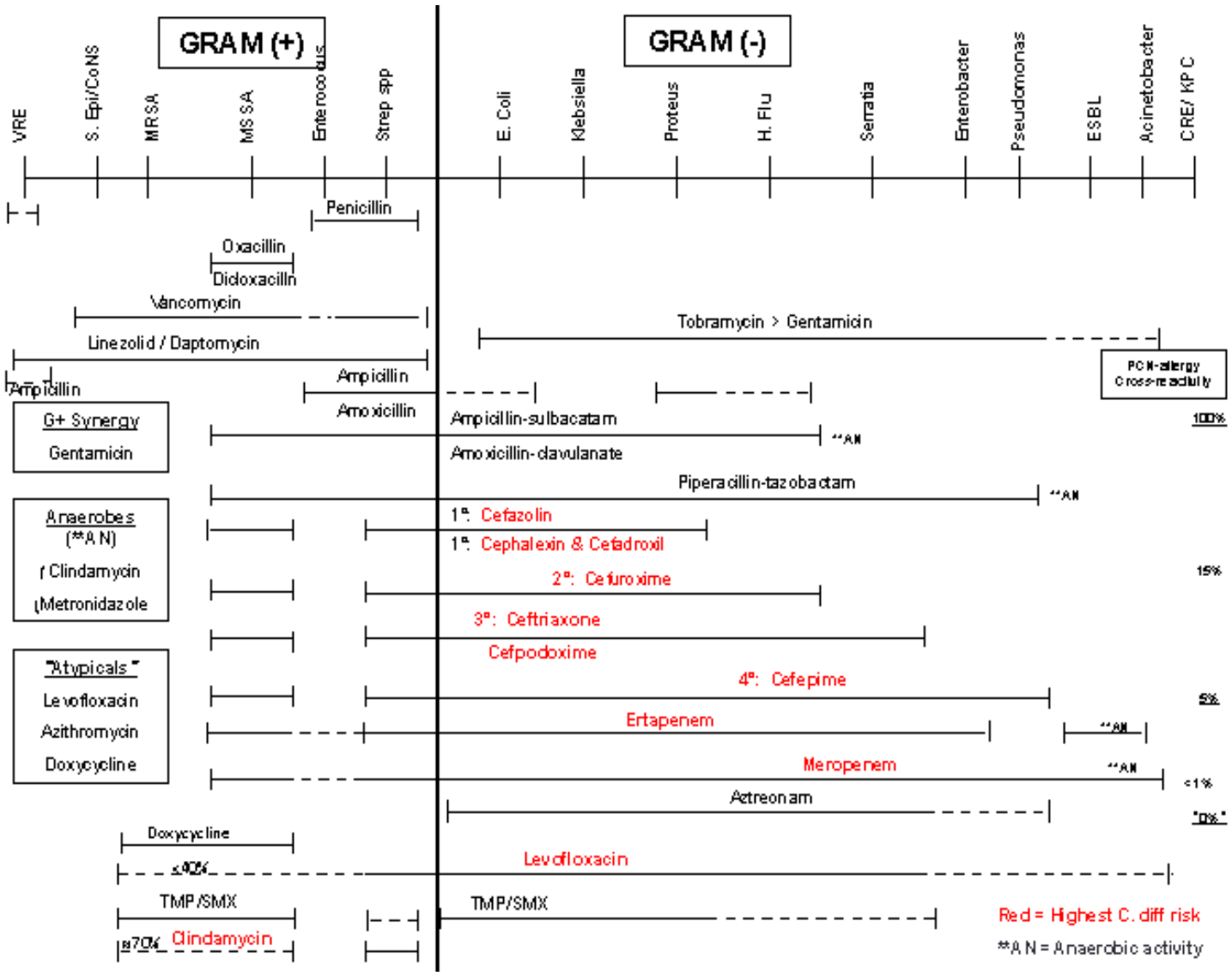
The antibiogram is a fluid document that changes periodically based on resistance patterns of bacteria in a community. The source of the isolates tested is delineated between different body sites because resistance patterns from patients treated in Catholic Health facilities often differ between anatomical locations (e.g. sputum vs. urine). The numbers expressed in the tables show percentages of isolates for each species that are susceptible to a given antibiotic over the past year. Data are collected and presented using Clinical and Laboratory Standards Institute methods.[1]

1.1 Table 1. Antimicrobials on Catholic Health Formulary*

Penicillins Penicillin G (IV) Penicillin VK (PO) Amoxicillin (PO) Amoxicillin clavulanate (PO) Ampicillin (IV) Ampicillin sulbactam (IV) Dicloxacillin (PO) Oxacillin (IV) Piperacillin/Tazobactam (IV) ***Cephalosporins*** Cefadroxil (PO) Cefazolin (IV) Cefoxitin (IV) Cefotaxime (IV →NICU only) Cefdinir (PO) Ceftazidime (IV →NICU only) Ceftriaxone (IV) Cefepime (IV) Ceftaroline (IV) Ceftolozane/Tazobactam (IV) Ceftazidime/Avibactam (IV) ***Carbapenems*** Ertapenem (IV) Meropenem (IV) ***Monobactams*** Aztreonam (IV)	***Lincosamides*** Clindamycin (PO/IV) ***Aminoglycosides*** Gentamicin (IV, Oph) Tobramycin (IV) ***Tetracyclines & Glycycyclicines*** Doxycycline (PO/IV) Minocycline (PO) Tigecycline (IV) ***Sulfonamides*** Trimethoprim-Sulfamethoxazole (PO/IV) Sulfacetamide (Oph) ***Nitrofuran derivatives*** Nitrofurantoin (PO) ***Macrolides and Macrocyclics*** Azithromycin (PO/IV) Fidaxomicin (PO) ***Antitubercular Agents*** Rifampin (PO/IV) Isoniazid Ethambutol Pyrazinamide ***Antifungal –Systemic*** Amphotericin (IV) Lipid complex Amphotericin (IV) Fluconazole (PO/IV) Micafungin (IV)
Fluoroquinolones Levofloxacin (PO/IV) Ciprofloxacin (Oph/Otic) ***Anaerobicide/ Amebacide*** Metronidazole (PO/IV)	***Topical Antibacterial Agents (skin)*** Neomycin/Bacitracin/Polymyxin Mupirocin ***Topical Antifungals*** Nystatin Clotrimazole Miconazole
Glycopeptides Vancomycin (IV, PO→*C.diff* treatment only) ***Oxazolidinones*** Linezolid (PO/IV) ***Lipopeptides*** Daptomycin (IV)	***Anti-Herpetic Agents*** Acyclovir (IV) Valacyclovir (PO) Trifluridine (Oph) ***Anti-Influenza Agents*** Oseltamivir (PO)

*Restricted Agents listed in Red

1.2 Figure 1. Summary of Antimicrobial Spectrums



Notes:

1. Antimicrobial spectrums listed above are based on national trends. Specific local resistance data can be found in the following antibiogram tables (see Tables 2-5). Dashed lines represent variable sensitivity patterns or suboptimal drug effect for the given organism.

S. aureus and Group B Streptococci (S. agalaciatae) resistance to clindamycin is common in Western New York (see Tables 3,4,5).

2. Antipseudomonal antibiotic resistance varies considerably across different specimen locations. The highest levels of resistance are typically seen among respiratory specimens (see Table 4).

3. Anaerobes above and below the diaphragm (gut) are well covered by any of the following: metronidazole, beta-lactam/betalactamase inhibitors and carbapenems. Metronidazole has no aerobic activity and should be not be used as monotherapy in cases of mixed aerobic and anerobic infection. Resistance to clindamycin is now common for anaerobes in the gut and is generally not recommended for this purpose.

4. VRE: Vancomycin Resistant Enterococcus; MSSA: Methicillin Sensitive S. aureus; MRSA: Methicillin Resistant S. aureus; ESBL: Extended Spectrum Beta-lactamase producing Enterobacteriaciae; CRE: Carbapenem Resistant Enterobacteriaciae

1.3 Antibiograms Table 2. Urine Isolates % Susceptible (Hospitalized Patients)

GRAM NEGATIVE BACTERIA	N	Ampicillin/Sulbactam	Ampicillin	Aztreonam	Ceftriaxone	Cefazolin	Cefepime	Daptomycin	Ertapenem	Gentamycin	Gentamycin HL Synergy	Levofloxacin	Linezolid	Meropenem	Nitrofurantoin	Oxacillin	Penicillin	Piperacillin/Tazobactam	Rifampin	Trimethoprim-Sulfamethoxazole	Tetracycline	Tobramycin	Vancomycin
Escherichia coli	1708	63	57	90	91	71	92		99	93		75		100	97			99		77		92	
Klebsiella pneumoniae	432	86	0	94	94	90	95		99	97		96		99	51			97		90		97	
Proteus mirabilis	205	95	80	97	99	81	99		99	92		74		99	0			100		68		93	
Pseudomonas aeruginosa	150						93			89		86		95				99				97	
Enterobacter cloacae	77	0	0	70	61	0	92		87	92		97		100	25			82		91		94	
Citrobacter freundii	68	0	0	82	81	0	100		100	94		99		99	94			97		84		94	
Klebsiella oxytoca	67	81	0	97	96	28	99		100	99		100		100	93			96		91		99	
Enterobacter aerogenes	37	0	0	95	86	0	100		97	100		100		100	22			95		100		100	
Morganella morganii	29	7	0	72	76	0	100		100	76		86		100	0			97		58		97	
Serratia marcescens	26	0	0	69	62	0	100		100	100		96		100	0			65		100		100	
GRAM POSITIVE BACTERIA																							
Staphylococcus aureus, all isolates	98	49				50		100		97			100			50			97	96	97		100
Enterococci, all isolates	479		86					97			69		98		93		85						78
Enterococcus faecalis	109		100					98			39		99		99		99						49
Enterococcus faecium	57		11					82			96		95		47		9						26

Notes:

1.Organisms that appear in RED - Statistical validity of susceptibility estimates for organisms with fewer than thirty isolates are limited.

2. Staphylococci: Susceptibility to Amoxicillin/Clavulanic acid and Ampiciliin/Sulbactam can be deduced from Oxacillin testing results. If Oxacillin is susceptible, Amoxicillin/Clavulanic acid and Ampicillin/Sulbactam will be reported as susceptible. Amoxicillin without Clavulanic acid should not be used to treat any Staphylococcal infection. Rifampin should not be used alone for antimicrobial therapy.

3. Enterococci: Susceptibility to Amoxicillin/Clavulanic Acid can be deduced from Penicillin and Ampicillin testing results. If Penicillin and Ampicillin are susceptible, amoxicillin/clavulanic acid will be reported as susceptible.

4. Absence or rare occurrence of resistant strains precludes defining any results category other than susceptible for linezolid among the following organisms: Enterococcus species, Staphylococcus species, Streptococcus agalactiae, Streptococcus pneumoniae

Table 3. Blood Isolates % Susceptible (Hospitalized Patients)

GRAM NEGATIVE BACTERIA	N	Ampicillin/Sulbactam	Ampicillin	Aztreonam	Ceftriaxone	Cefazolin	Cefepime	Clindamycin	Daptomycin	Erythromycin	Ertapenem	Gentamycin	Gentamycin HL Synergy	Levofloxacin	Linezolid	Meropenem	Oxacillin	Penicillin	Piperacillin/Tazobactam	Rifampin	Trimethoprim-Sulfamethoxazole	Tetracycline	Tobramycin	Vancomycin
Escherichia coli	214	64	56	90	90	74	95				99	93		81		100			98		76		91	
Klebsiella pneumoniae	56	80	0	96	95	88	96				100	95		93		100			95		91		95	
Enterobacter cloacae	23	0	0	74	61	0	100				96	96		100		100			91		96		100	
Proteus mirabilis	23	100	91	91	100	87	100				100	96		65		100			100		65		91	
Pseudomonas aeruginosa	23						96					100		91		100			100				96	
GRAM POSITIVE BACTERIA																								
Staphylococcus aureus, all isolates	218	66				66		68	100			99			100		66			98	98	96		100
Coagulase negative Staphylococcus	71	49				49		58	100			77			100		49			100	70	89		100
Streptococcus agalactiae	53		100		100			55										100						100
Enterococci, all isolates	39		85						100				77		100			85						87
Enterococcus faecalis	32		100						100				72		100			100						97
Streptococcus viridans, all isolates	26		84		92			96										85						100
Streptococcus pneumoniae	25				100			92		72				100				76						100
Streptococcus pyogenes	21		100		100			90										100						100
Group G Streptococcus	16		100		100			75										100						100
Group C Streptococcus	12		100		100			92										100						100

Notes:

1. 1.Organisms that appear in RED - Statistical validity of susceptibility estimates for organisms with fewer than thirty isolates are limited.
2. Rifampin should not be used alone for antimicrobial therapy.
3. Absence or rare occurrence of resistant strains precludes defining any results category other than susceptible for the following antimicrobials
   a. linezolid: Enterococcus species, Staphylococcus species, Streptococcus agalactiae, Streptococcus pneumoniae
   b. vancomycin: Streptococcus agalactiae, Streptococcus pyogenes, Viridans group Streptcoccus

Table 4. Respiratory Isolates % Susceptible (Hospitalized Patients)

GRAM NEGATIVE BACTERIA	N	Ampicillin/Sulbactam	Ampicillin	Aztreonam	Ceftriaxone	Cefazolin	Cefepime	Clindamycin	Daptomycin	Erythromycin	Ertapenem	Gentamycin	Gentamycin HL Synergy	Levofloxacin	Linezolid	Meropenem	Oxacillin	Penicillin	Piperacillin/Tazobactam	Rifampin	Trimethoprim-Sulfamethoxazole	Tetracycline	Tobramycin	Vancomycin
Pseudomonas aeruginosa	142						91					89		90		96			98				98	
Escherichia coli	66	56	47	83	83	61	83				100	94		61		100			95		70		92	
Klebsiella pneumoniae	50	86	0	84	86	80	86				100	96		90		100			92		90		96	
Serratia marcescens	36	0	0	75	70	R	100				100	100		97		100			61		100		97	
Stenotrophomonas maltophilia	30													90							97			
Enterobacter cloacae	27	0	0	63	56	R	93				89	96		96		100			78		93		96	
Klebsiella oxytoca	23	65	0	87	87	17	91				100	91		96		100			91		91		91	
Acinetobacter baumannii complex	12	83			33		83				92			92		100					75		92	
Proteus mirabilis	12	75	58	75	83	75	92					92		92		100			100		58		92	
GRAM POSITIVE BACTERIA																								
Staphylococcus aureus, all isolates	376	56				56		62				98			100		56			98	98	97		100
Streptococcus pneumoniae	59				98			90		66				100				75						100

Notes:

1. Organisms that appear in RED - Statistical validity of susceptibility estimates for organisms with fewer than thirty isolates are limited.
2. Rifampin should not be used alone for antimicrobial therapy.
3. Absence or rare occurrence of resistant strains precludes defining any results category other than susceptible for the following antimicrobials
   a. linezolid: Enterococcus species, Staphylococcus species, Streptococcus agalactiae, Streptococcus pneumoniae
   b. vancomycin: Streptococcus agalactiae, Streptococcus pyogenes, Viridans group Streptcoccus

Table 5. Non-blood-urine-respiratory Isolates % Susceptible (Hospitalized Patients)

Isolates listed below were cultured from miscellaneous sites including wounds, intra-abdominal sites, bone, cerebral spinal fluid and other tissues.

GRAM NEGATIVE BACTERIA	N	Ampicillin/Sulbactam	Ampicillin	Aztreonam	Ceftriaxone	Cefazolin	Cefepime	Clindamycin	Daptomycin	Erythromycin	Ertapenem	Gentamycin	Gentamycin HL Synergy	Levofloxacin	Linezolid	Meropenem	Oxacillin	Penicillin	Piperacillin/Tazobactam	Rifampin	Trimethoprim-Sulfamethoxazole	Tetracycline	Tobramycin	Vancomycin
Escherichia coli	298	62	56	91	91	72	94				100	96		73		100			96		79		94	
Pseudomonas aeruginosa	241						88					91		81		94			98				97	
Proteus mirabilis	129	92	81	91	91	81	96				99	88		82		100			99		72		89	
Enterobacter cloacae	102	0	0	0	76	0	93				93	98		98		99			91		91		98	
Klebsiella pneumoniae	98	81	0	89	90	86	91				99	95		93		100			97		85		92	
Klebsiella oxytoca	40	0	0	74	61	0	100				96	96		100		100			91		96		100	
Serratia marcescens	35	0	0	74	72	0	100				100	100		94		100			72		100		97	
Citrobacter freundii	31	0	0	71	74	R	100				100	94		100		100			97		90		94	
Stenotrophomonas maltophilia	26													100							96			
Morganella morganii	25	12	0	80	76	0	100				100	80		80		100			100		76		96	
GRAM POSITIVE BACTERIA																								
Staphylococcus aureus, all isolates	858	55				55		54	100			92			100		55			99	98	93		100
Coagulase negative Staphylococcus	97	55				55		58	100			77			100		49			100	70	89		100
Enterococci, all isolates	428		85						97				84		99			84						75
Enterococcus faecalis	89		100						100				43		99			99						46
Enterococcus faecium	59		10						83				98		100			10						17
Streptococcus pneumoniae	12				100			92		75				100				67						100
Streptococcus agalactiae	9		100		100			33										100						100

Notes:

1. Organisms that appear in RED - Statistical validity of susceptibility estimates for organisms with fewer than thirty isolates are limited.
2. Rifampin should not be used alone for antimicrobial therapy.
3. Absence or rare occurrence of resistant strains precludes defining any results category other than susceptible for the following antimicrobials
   a. linezolid: Enterococcus species, Staphylococcus species, Streptococcus agalactiae, Streptococcus pneumoniae
   b. vancomycin: Streptococcus agalactiae, Streptococcus pyogenes, Viridans group Streptcoccus

1.4 Penicillin Allergy[2,3]

Throughout the entirety of recommendations made in this CHS Guide, it is important to have the correct mindset surrounding penicillin allergies and the changes in therapy decisions they may necessitate. In most cases, antibiotics in the "beta-lactam" category are first line therapies. If a patient has a beta-lactam allergy listed (penicillin, cephalosporin), it often time results in them not receiving any beta-lactam. These alternate drugs are often times less effective, more toxic, or both. Many beta-lactams are safe to take even if there was a serious reaction to a different beta-lactam, making a detailed history of any reaction is so important.

Penicillin allergies are over-reported, with studies showing negative penicillin skin-testing in 90% of patients claiming a Type-I IgE-mediated hypersensitivity (e.g. anaphylaxis). Beyond that, in patients with a true penicillin allergy, the frequency of positive results on skin testing decreases by 10% per year of avoidance. **Therefore, >80% of patients are expected to test negative for penicillin allergy >10 years after their reaction.**

Documentation of all known info on drug allergy (especially a beta-lactam allergy) is a key part of any proper medication reconciliation, and could have serious effects on treatment course. Once a patient has been shown to tolerate a beta-lactam, it is important to note this under their allergy history, and the patient to be aware that they can indeed tolerate that specific antibiotic.

Important questions to ask patients who report a penicillin or other beta-lactam allergy:

1) Which specific drug were you taking when the reaction occurred? (E.g. penicillin, amoxicillin, cephalexin/"Keflex", "Augmentin", etc.)
2) How long ago did the reaction occur?
3) Can you describe the symptoms you experienced?
   a) Was there swelling in the face, mouth, or neck?
   b) Was there skin blistering or skin ulcers?
4) How was the reaction managed? How did it resolve/ what was the outcome?
   a) Were any medications given to manage symptoms?
   b) Were you hospitalized due to the reaction? Need for breathing tube?
5) Since the reaction, have you ever been prescribed penicillin, amoxicillin, cephalexin/"Keflex", cefpodoxime/"Vantin", cefdinir/"Omnicef", ceftriaxone/"Rocephin", cefepime?
   a) If so, did you tolerate the antibiotic?
6) Are there other antibiotics you've taken without any allergic issues?

Other useful ways to determine if a drug or drug class can be used:

1. Review medications administered in the hospital on prior visits (specifically looking at agents that were given *after* the reported allergic event). For example, cefazolin used for surgical prophylaxis
2. Review outpatient fill records and call the patient's pharmacy to ask if any drugs in the class of reported allergy were given (*after* reported allergic event). For example, cephalexin or amoxicillin in a reported penicillin-allergic patient.

Table 6. Cross-reactivity of Beta-Lactam Agents

Beta-Lactam Agents	Amoxicillin†	Ampicillin†	Oxacillin	Penicillin	Piperacillin§	Cefadroxil	Cefazolin	Cephalexin*	Cefoxitin	Cefprozil*	Cefuroxime*	Cefixime*	Cefdinir	Cefotaxime*	Cefpodoxime*	Ceftazidime¥	Ceftriaxone	Cefepime	Ceftaroline	Ceftolozane§	Cefiderocol*	Ertapenem	Meropenem	Aztreonam
Amoxicillin†		X[1]	X[5]	X[4]	X[5]	X[1]	✓	X[1]	✓	X[2]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ampicillin†	X[1]		X[5]	X[4]	X[5]	X[2]	✓	X[2]	✓	X[2]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Oxacillin	X[5]	X[5]		X[5]	X[5]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Penicillin	X[4]	X[4]	X[5]		X[5]	✓	✓	✓	X[3]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Piperacillin§	X[5]	X[5]	X[5]	X[5]		X[3]	✓	X[3]	✓	X[3]	✓	✓	✓	✓	✓	✓	✓	✓	✓	X[6]	✓	✓	✓	✓
Cefadroxil	X[1]	X[2]	✓	✓	X[3]		✓	X[1]	✓	X[2]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cefazolin	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cephalexin*	X[1]	X[2]	✓	✓	X[3]	X[1]	✓		✓	X[2]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cefoxitin	✓	✓	✓	X[3]	✓	✓	✓	✓		✓	X[2]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cefprozil*	X[2]	X[2]	✓	✓	X[3]	X[2]	✓	X[2]	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cefuroxime*	✓	✓	✓	✓	✓	✓	✓	✓	X[2]	✓		X[3]	✓	X[1]	✓	X[3]	X[1]	X[2]	✓	✓	✓	✓	✓	✓
Cefixime*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X[3]		X[2]	X[3]	✓	X[3]	X[3]	✓	X[3]	X[3]	✓	✓	✓	✓
Cefdinir	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X[2]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cefotaxime*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X[1]	X[3]	✓		X[2]	X[3]	X[1]	X[1]	X[3]	X[3]	✓	✓	✓	✓
Cefpodoxime*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X[2]		✓	X[2]	X[2]	X[3]	X[3]	✓	✓	✓	✓
Ceftazidime¥	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X[3]	X[3]	✓	X[3]	✓		X[3]	✓	X[3]	✓	X[2]	✓	✓	X[1]
Ceftriaxone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X[1]	X[3]	✓	X[1]	X[2]	X[3]		X[1]	X[3]	X[3]	✓	✓	✓	✓
Cefepime	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X[2]	✓	✓	X[1]	X[2]	✓	X[1]		X[3]	X[3]	X[3]	✓	✓	✓
Ceftaroline	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X[3]	✓	X[3]	X[3]	X[3]	X[3]	X[3]		✓	X[3]	✓	✓	✓
Ceftolozane§	✓	✓	✓	✓	X[6]	✓	✓	✓	✓	✓	✓	X[3]	✓	X[3]	X[3]	✓	X[3]	X[3]	✓		✓	✓	✓	X[2]
Cefiderocol*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X[2]	✓	X[3]	X[3]	✓		✓	✓	X[2]
Ertapenem	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		X[5]	✓
Meropenem	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X[5]		✓
Aztreonam	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X[1]	✓	✓	✓	X[2]	X[2]	✓	✓	

*non-formulary agents for adult patients at Catholic Health

†Also applies to beta-lactamase inhibitor combinations (amoxicillin/clavulanate and ampicillin/sulbactam)

§product is co-formulated with beta-lactamase inhibitor tazobactam (ceftolozane product brand name: Zerbaxa®)

¥formulary product is co-formulated with beta-lactamase inhibitor avibactam (brand name Avycaz®), ceftazidime alone is non-formulary for adult patients

LEGEND

✓	Different Structure CONSIDERED SAFE TO PRESCRIBE **EVEN IF REACTION IS TYPE I IgE MEDIATED**: (anaphylaxis, angioedema, wheezing, laryngeal edema, bronchospasm, hypotension, hives/urticaria)

For allergy history listing drug-induced cytopenias or other lab abnormalities such as nephrotoxicity, management can be per the primary team, contact ID pharmacist if necessary.

Reaction likely based on side chain:	
X[1]	AVOID-- Same side chain, clinical evidence of cross-reaction
X[2]	AVOID-- Same side chain, theoretical risk of cross-reaction, no clinical studies
X[3]	USE WITH CAUTION-- Similar side chain, potential for cross-reaction, monitor closely after first dose
Reaction likely based on beta-lactam ring	
X[4]	AVOID-- Clinical evidence of cross-reaction
X[5]	AVOID-- Theoretical risk of cross-reaction, no clinical studies
Reaction possible based on formulation	
X[6]	USE WITH CAUTION-- Both piperacillin and ceftolozane are only available as co-formulations with the beta-lactamase inhibitor tazobactam

Avoid ALL beta-lactams if:

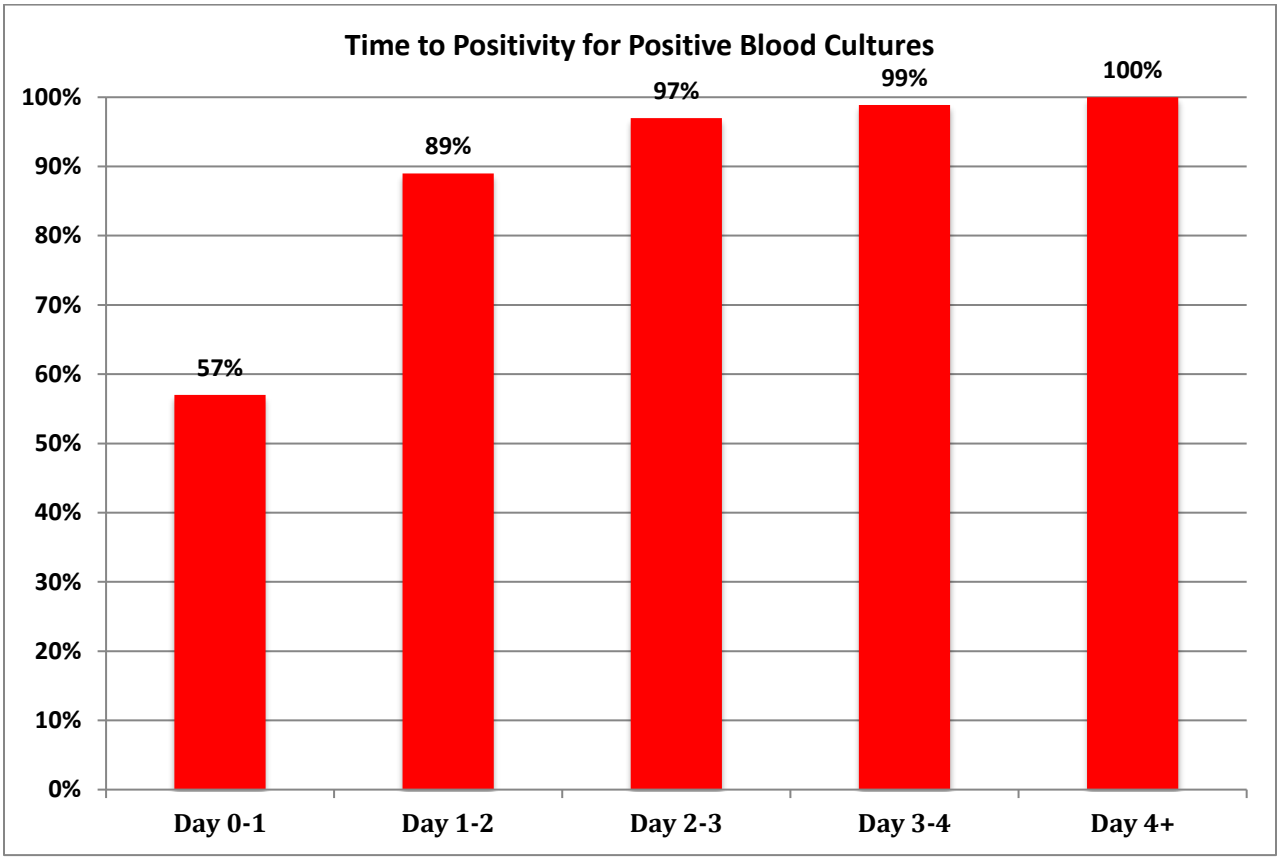
	Delayed severe skin allergic reactions: • Stevens-Johnson Syndrome (SJS) • Toxic Epidermal Necrolysis (TEN) • Exfoliative Dermatitis • Acute Generalized Exanthematous Pustulosis (AGEP) • Drug Reaction with Eosinophilia and Systemic Symptoms (DRESS)
	Delayed allergic reaction causing: • Hepatitis • Hemolytic Anemia • Serum Sickness • Drug Fever • Vasculitis • Immune Hepatitis
	ICU Admission related to allergy with details unknown

1.5 Diagnostic Testing

Blood Cultures

Approximately 5-8% of all blood cultures drawn in the inpatient setting will be positive. The chart below depicts the timing of blood culture positivity among CHS patient data. Nearly ninety percent of cultures will turn positive within 2 days of collection.

Figure 2. Blood Culture Time to Positivity*



*CHS microbiology lab data

Procalcitonin

Procalcitonin (PCT) is a molecule secreted by the human body in response to cytokine signals triggered by bacterial infection. Several clinical trials have demonstrated PCT monitoring to be a safe and effective strategy for guiding initiation and duration of antibiotic therapy. The use of PCT measurement is best studied in cases of respiratory tract infection and in severe sepsis and septic shock. Like all tests, other clinical factors must be weighed in clinical decision-making regarding antimicrobial therapy.

Suggested use case for PCT ordering

The use of PCT is best studied in the context of ruling in/out bacterial respiratory tract infection as well as determining antibiotic duration in cases of severe sepsis. For respiratory tract infection, we do not endorse using PCT levels in cases with high suspicion for pneumonia. Instead, it could be useful in determining whether or not to start antibiotics in patients with questionable infection versus heart failure exacerbation versus non-bacterial COPD exacerbation. In such cases, PCT levels below 0.25 µg/L should prompt consideration for withholding antibiotics (and levels below 0.1 µg/L prompting strong consideration for holding). For aiding length of antimicrobial therapy decisions, trending PCT can be used as an alternative to traditional length of therapy recommendations in patients with severe sepsis. This is done by establishing a baseline (or "peak") PCT, with follow-up PCT levels drawn until the value is reduced to below 0.5 µg/L or an 80% decrease from baseline. The half-life of PCT is approximately 24 hours, therefore PCT levels should decrease each day by 50% in a patient that is responding very well to the current treatment. PCT should not be solely relied upon for any decision regarding antimicrobial therapy, and especially should not be used to withhold antibiotics in patients otherwise thought to be septic.

Limitations of PCT monitoring

PCT may be normal in the first 6-24 hours of bacterial infections. Therefore, the test should be repeated in 24 hours if initial testing was normal. See table below that lists false positive and false negative procalcitonin scenarios. In addition to this, there may be higher baseline PCT levels in patients with significant renal dysfunction as well as patients with significant heart failure.

<table>
<tr><th colspan="2">False Positive Potential</th><th>False Negative Potential</th></tr>
<tr><td>Pancreatitis</td><td>Major Burns</td><td rowspan="2">Sequestered Infections
(Mediastinitis, Empyema, Osteomyelitis, Abscesses)</td></tr>
<tr><td>Severe Trauma</td><td>Inhalation Injury</td></tr>
<tr><td>Major Surgery</td><td>Small Cell Lung Cancer</td><td rowspan="2">Level drawn early in infectious course</td></tr>
<tr><td colspan="2">Thyroid Carcinoma</td></tr>
<tr><td colspan="2">Resuscitated Cardiac Arrest</td><td rowspan="2">Profound Immune Compromise
(does NOT include corticosteroid use)</td></tr>
<tr><td colspan="2">Circulatory or Hemorrhagic Shock</td></tr>
</table>

Methicillin-resistant Staphylococcus aureus* (*MRSA) Nares Screening

Antibiotic therapy directed against MRSA is recommended in at-risk patients by the Infectious Diseases Society of America guidelines on the treatment of pneumonia (see section on CAP treatment later in the Guide. However, data suggests a low prevalence of confirmed MRSA pneumonia when compared to the overall pool of patients in which empiric MRSA coverage is justified. Risks of unnecessary MRSA-directed antibiotics include increased antimicrobial resistance (e.g. VRE), nephrotoxicity or other adverse drug reactions, drug-drug interactions, and increased costs related to drug dosing/delivery/administration/monitoring.

MRSA nares swabs help to identify patients whose upper airway is colonized with MRSA and are therefore at a higher risk of MRSA pneumonia. Available literature suggests a high negative predictive value (NPV) for this test (>98%), meaning patient's with pneumonia and a negative MRSA nares swab have an extremely low likelihood of having MRSA pneumonia.

While the NPV for MRSA pneumonia of a nares swab is as high as 98.5%, the positive predictive value (PPV) is much lower (around 30%). This means that a negative test result effectively rules out MRSA pneumonia, whereas a positive result *does not* effectively rule *in* MRSA pneumonia. Such a test can provide maximum value on medical/surgical floors where obtaining high-quality respiratory cultures may be more sporadic.

Patient's appropriate for MRSA nares PCR screening:

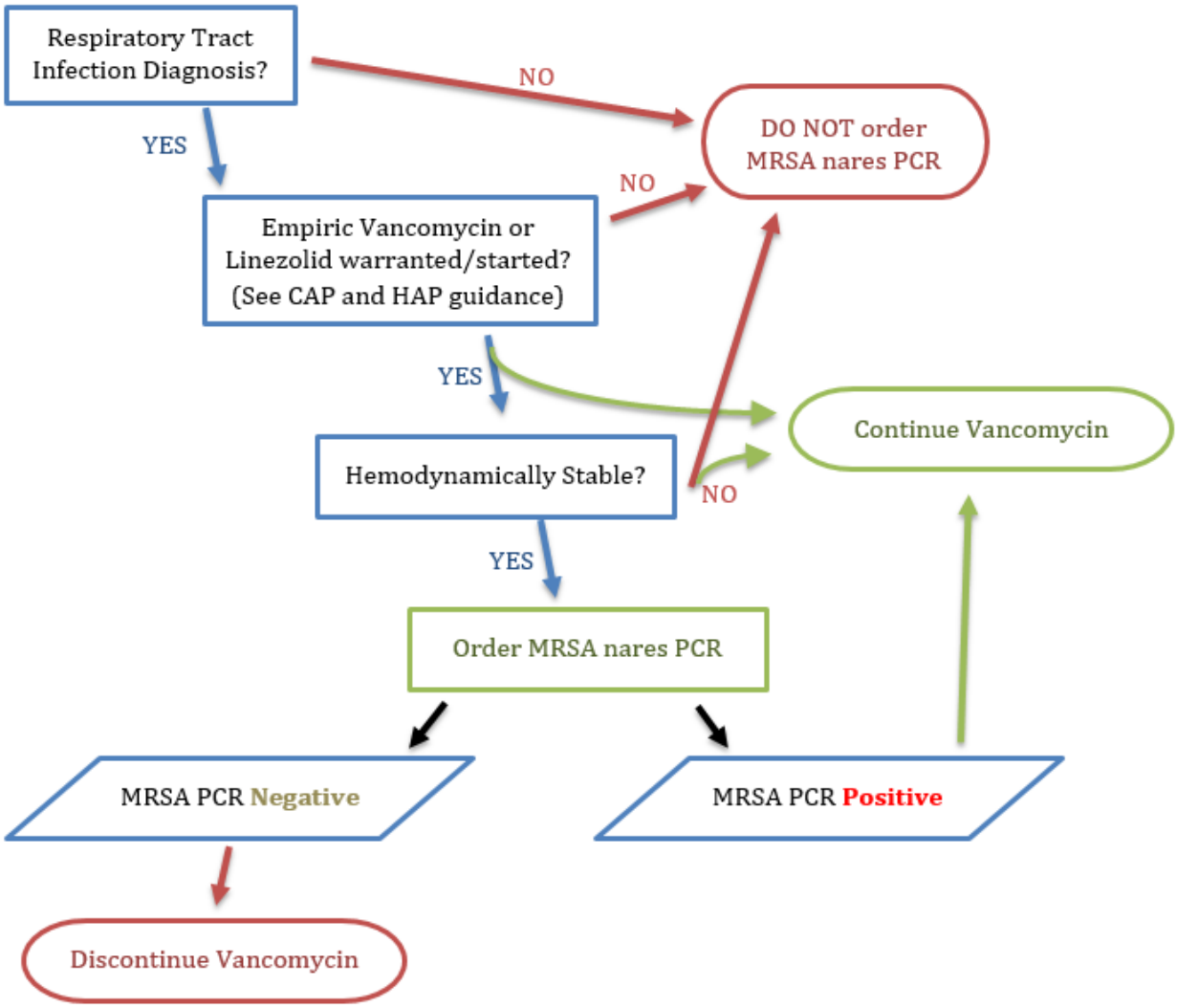
Patients being treating for empirically for respiratory tract infection with an anti-MRSA agent (e.g. vancomycin, linezolid). ***Patients not thought to be at high enough risk to prompt empiric MRSA coverage should <u>not</u> have a MRSA nares PCR ordered (poor positive predictive value).***

Suggested exclusions for ordering a MRSA nares PCR:

1) ICU patients, especially in cases of hemodynamic instability. Screening can be effective here, however these patients often times have a more reliable rate of respiratory sample procurement (e.g. endotracheal aspirate, bronchoalveolar lavage).
2) Recent nasal decolonization during the current hospitalization (e.g. mupirocin ointment, not routinely practiced at CHS inpatient facilities outside of cardiac surgery patients)
3) Patients who have already received >48 hours of systemic anti-MRSA therapy (there is possible disruption of nares colonization at this point). Ideally, the sample is obtained as early as possible, but the receipt of a vancomycin dose DOES NOT nullify the utility of MRSA nares swab results.
4) Patients with known, significant structural lung disease (e.g. cystic fibrosis, bronchiectasis), as bacterial colonization can differ between the upper and lower respiratory tract in these patients.

Interpretation of results and expected action

Therefore, a negative result should prompt a recommendation to discontinue vancomycin or other anti-MRSA agent. A positive MRSA swab likely presents a scenario where vancomycin is continued for an entire treatment course unless quality respiratory cultures fail to grow MRSA (at which point MRSA coverage is likely unnecessary).



Utility of swab for MRSA beyond respiratory tract infection

Some literature shows a high NPV of MRSA nares screening on MRSA infection in several other sites of infection. This includes wound infection (NPV=93.1%), bloodstream infection (NPV=96.5%), intra-abdominal infection (NPV=98.6%), and urinary tract infection (NPV=99.2%). Therefore, it is possible that a negative MRSA nasal swab within 7 days of a new infection can help to rule out MRSA as a cause. However, **a majority of the clinical research in this area relates to MRSA nares screening as a way of ruling out MRSA respiratory tract infection**. Ultimately, the use of MRSA nares screening for evaluation of infection outside of the respiratory tract should be used with caution.

1.5 Treatment of Select Drug-Resistant Bacteria

Guidance on Treatment of Organisms with Extended-Spectrum β-Lactamase (ESBL) Production

ESBLs are enzymes that inactivate most penicillins, cephalosporins, and aztreonam, but generally remain susceptible to carbapenems. ESBLs do not inactivate non β-lactam antibiotics (fluoroquinolones, aminoglycosides, trimethoprim-sulfamethoxazole [TMP-SMX], and nitrofurantoin), however, there are clinically significant rates of co-resistance to some of these agents by other resistance mechanisms. While any gram-negative organism can harbor ESBL genes, expression is most prevalent in *Escherichia coli*, *Klebsiella pneumoniae*, *Klebsiella oxytoca*, and *Proteus mirabilis*.

Treatment Recommendations

Diagnosis	Preferred Treatment (subject to in-vitro susceptibility results)	Alternative Treatment (subject to in-vitro susceptibility results)
Uncomplicated Cystitis	**Nitrofurantoin** (avoid in CrCl<30) **Trimethoprim-sulfamethoxazole** (TMP-SMX)	**Levofloxacin** **Fosfomycin** (no sensitivity testing available) **Tobramycin** **Ertapenem**
Pyelonephritis	**Trimethoprim-sulfamethoxazole** (TMP-SMX) **Levofloxacin**	**Ertapenem** (when susceptibility or toxicity precludes use of TMP-SMX or fluoroquinolones) **Tobramycin**
ESBL infection outside the Urinary Tract	**Ertapenem** or other carbapenem (preference **Meropenem** in cases of CNS or critical illness with hypoalbuminemia)	Oral **TMP-SMX** or oral **Levofloxacin** for completion of therapy after appropriate clinical response is achieved

Piperacillin/Tazobactam should generally be avoided for infections with ESBL-producing organisms, even if sensitivity to piperacillin/tazobactam is demonstrated in the culture report. Tazobactam has limited inhibitory activity against ESBL enzymes, and there is mixed clinical outcomes data on piperacillin/tazobactam use in serious ESBL infections. One exception could be treatment of uncomplicated cystitis where initial therapy was piperacillin/tazobactam and, after clinical improvement, the culture yields and ESBL organism. In such scenario, the piperacillin/tazobactam therapy could be considered as complete, appropriate therapy.

Cefepime use for infections with ESBL-producing organisms can be looked at very similarly to piperacillin/tazobactam described above. Cefepime is infrequently reported as sensitive to an ESBL-producing organism, but should not be used even in the scenario where sensitivity is demonstrated in the culture report. The same exception for uncomplicated cystitis described for piperacillin/tazobactam above holds true for cefepime.

Cephamycins such as cefoxitin are not recommended for the treatment of ESBL infections. Cephamycin structure is usually able with withstand ESBL enzyme hydrolysis, and culture results often report ESBL-producing organisms as "sensitive". Despite this, there is an extreme lack of clinical outcomes data to support their use for any level of severity of infection with ESBL-producing organisms.

Novel β-lactams (cefiderocol, ceftazidime-avibactam, imipenem-cilastatin-relebactam, meropenem-vaborbactam), while possessing activity against ESBL-producing organisms, should be reserved for treating organisms displaying carbapenem resistance. Ceftolozane-tazobactam may possess in-vitro activity against ESBL-producing organisms, however this drug should be reserved for infections cause by *Pseudomonas aeruginosa* with difficult-to-treat resistance. All of these novel agents require Infectious Diseases consult.

For more in-depth information, please see the section on treatment of ESBL-Producing Enterobacterales in the document published on the IDSA website at:

https://www.idsociety.org/practice-guideline/amr-guidance/#References

Guidance on Treatment of Organisms with Suspected AmpC Production

AmpC is a β-lactamase produced by a number of gram-negative organisms. Its production can either be constant or induced by exposure to certain antibiotics (resistance develops within a treatment course). Constant production of AmpC presents less of a treatment issue than inducible AmpC production, because the antimicrobial sensitivity profile will clearly show which antibiotics can be utilized. In the case of inducible AmpC production, isolates may show sensitivity to antibiotics (namely ceftriaxone) that have elevated risk of treatment failure if selected as a definitive treatment choice, thereby complicating treatment decisions.

The acronyms "SPACE" or "SPICE" have traditionally been used to identify organism known to produce AmpC, however only a select few organism are worrisome for inducible AmpC production. The organisms most commonly associated with clinically significant inducible AmpC production are *Enterobacter cloacae*, *Klebsiella aerogenes*, and *Citrobacter freundii*. The specific species is very important here, and there are other species of the same genus (e.g. *Klebsiella oxytoca* and *Citrobacter koseri*) that do not commonly harbor the capacity to produce this resistance factor.

	Strong Inducers of AmpC	**Weak/Unknown Inducers of AmpC**
Cleaved by AmpC (not sensitive if AmpC is induced)	**Aminopenicillins** (ampicillin/amoxicillin) **1st gen. cephalosporins** (cefazolin, cefadroxil, cephalexin) **Cephamycins** (cefoxitin, cefotetan)	**Ceftriaxone, ceftazidime, cefotaxime, piperacillin, aztreonam**
Durable against AmpC (maintains activity in the presence of AmpC)	**Imipenem**	**Cefepime** **Ertapenem (unknown induction potential)** **Meropenem (unknown induction potential)**

Treatment Decisions

When *Enterobacter cloacae*, *Klebsiella aerogenes*, or *Citrobacter freundii* are identified in culture, regardless of sensitivity information, antimicrobial agents that are cleaved by AmpC should be avoided (boxes highlighted in yellow above). Most notably, **ceftriaxone is not recommended for invasive infections caused by these organisms**. However, it can still be acceptable to use ceftriaxone against these organisms in cases of uncomplicated cystitis where sensitivity is demonstrated. **Piperacillin-Tazobactam should in general be avoided for serious infections** as it has mixed success rates at treating these organisms due to AmpC cleavage of piperacillin and poor tazobactam inhibition of AmpC.

Instead, **consider selecting a carbapenem for severe infection and/or bacteremia**. **Cefepime can be considered for non-severe infection or when MIC of the organism is demonstrated to be ≤2 mcg/mL** (due to concern over possible co-production of ESBLs).

Non-β-lactam antibiotics (fluoroquinolones, trimethoprim-sulfamethoxazole [TMP-SMX], aminoglycosides, etc.) are important treatment options as they are unaffected by β-lactamase activity. **TMP-SMX or fluoroquinolones should be considered, especially as oral step-down therapy**, where appropriate based on clinical scenario. Nitrofurantoin, TMP-SMX, and aminoglycosides can be considered for uncomplicated cystitis.

Novel β-lactams (cefiderocol, ceftazidime-avibactam, imipenem-cilastatin-relebactam, meropenem-vaborbactam), while possessing good activity against AmpC-producing organisms, should be reserved for treating organisms displaying carbapenem resistance.

For more in-depth information, please see the section on treatment of AmpC β-lactamase-Producing Enterobacterales in the document published on the IDSA website at:

https://www.idsociety.org/practice-guideline/amr-guidance/#References

SECTION 2

Guidelines for the Empiric Treatment of Common Syndromes

All treatment guidelines listed below are for the adult inpatient population. Patient and clinical characteristics should be considered when making final treatment decisions. All doses listed are based on normal renal function. Dose adjustment may occur for abnormal creatinine clearance per pharmacy policy.

2.1 Urinary Tract Infection (UTI)[4-7]

Urinary tract infections may present with urinary urgency, increased frequency, dysuria or delirium without other explanation (particularly in the elderly). Infections involving the upper GU tract (e.g. pyelonephritis) may have accompanying back or flank pain as well as nausea and vomiting.

Enteric gram-negative rods (e.g. *E. coli*) are responsible for most urinary tract infections. Other species, including *Pseudomonas* and gram positive organisms occur more frequently in patients with indwelling urinary catheters, prior antimicrobial exposures and recent GU manipulation. **When available, previous urine cultures should be reviewed. If highly resistant organisms were present (e.g. ESBL + E. coli) then empiric coverage should include an antimicrobial active against that isolate.**

Asymptomatic bacteriuria[54]
Asymptomatic bacteriuria is defined by the presence of bacteria in urine without accompanying symptoms of infection. **Asymptomatic bacteriuria, even with pyuria, should not be routinely treated unless the patient is pregnant or undergoing an invasive genitourinary procedure.** Urine cultures should not be sent because of urine odor, cloudy appearance, or color change in the absence of other symptoms.

Catheter-Associated UTI Diagnosis

Asymptomatic bacteriuria and candiduria are common in patients with indwelling urinary catheters.[8] Catheter-associated bacteriuria is usually indicative of colonization and an infrequent cause of fever or secondary bloodstream infection unless an obstruction is present[9].

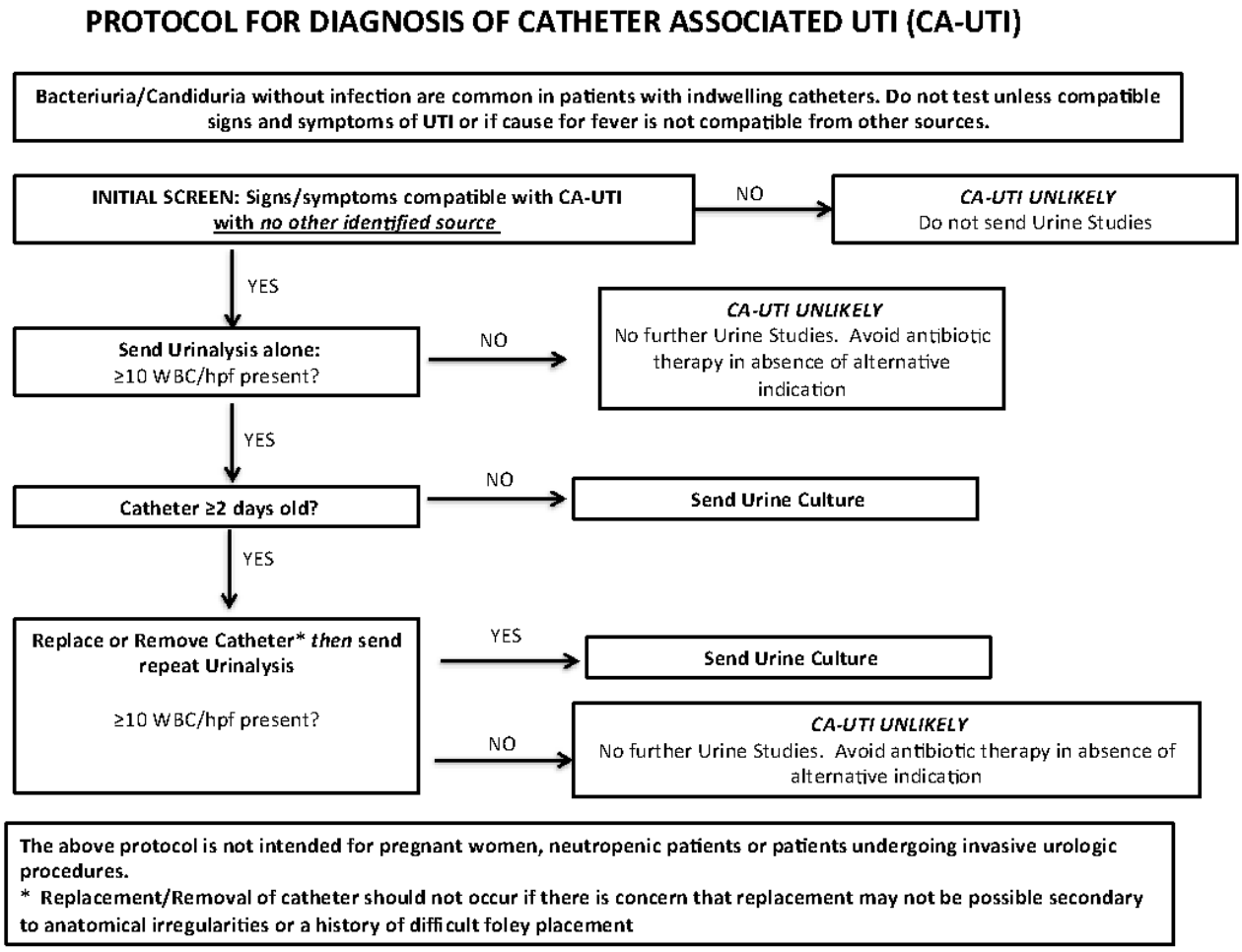
The rate of catheter colonization ranges from 3-8% per dwell day; 21%-56% of catheterized patients off antibiotics have bacteria in the urine by day seven of catheterization. Catheter colonization does not predict symptomatic UTI.[5,8,10-13]

The American College of Critical Care Medicine (ACCCM) and the Infectious Diseases Society of America (IDSA) **recommends that when evaluating fever in critically ill patients with catheters, urine cultures should only be ordered in the following circumstances:**[9]

- kidney transplantation recipients
- neutropenic patients
- patients that recently had genitourinary surgery
- patients with evidence of urinary obstruction.

When considering Catheter associated UTI, the protocol outlined in Figure 6 (below) is advised.

Figure 6.



Urinary Tract Infection	**Community-Acquired**		**Healthcare-Associated**	
*Empiric Non-Catheterized**	*Preferred*	*Alternatives*	*Preferred*	*Alternative*
Cystitis	Nitrofurantoin 100mg PO q12h *(Avoid for CrCl <30)*	Cefdinir 300mg PO q12h TMP/SMX 1 DS PO q12h	Cefepime 2gm IV q8h	Aztreonam 2gm IV q8h
Pyelonephritis (without severe sepsis)	Ceftriaxone 1gm IV q24h	Levofloxacin 750mg q24 *PLUS* Tobramycin 5mg/kg IV X1	Cefepime 2gm IV q8h	Aztreonam 2gm IV q8h
Severe Sepsis	Ceftriaxone 1gm IV q24h *PLUS* Tobramycin 5mg/kg IV X1	Levofloxacin 750mg q24 *PLUS* Tobramycin 5mg/kg IV X1	Cefepime 2gm IV q8h *PLUS* Tobramycin 5mg/kg IV X1	Aztreonam 2gm IV q8h *PLUS* Tobramycin 5mg/kg IV X1
Indwelling Urinary Catheter –See Comments above on Catheter UTI Diagnosis				
*Empiric Catheterized**	*Preferred*		*Alternative*	
Clinically Stable	Cefepime 2gm IV q8h		Levofloxacin 250mg IV/PO q24h *PLUS* Tobramycin 5mg/kg IV X1	
Severe Sepsis	Cefepime 2gm IV q8h *PLUS* Vancomycin IV[∞] *PLUS* Tobramycin 5mg/kg IV X1		Aztreonam 2gm IV q8h *PLUS* Vancomycin IV[∞] *PLUS* Tobramycin 5mg/kg IV X1	

*Empiric therapy should be tailored based on culture and susceptibility reports. Conversion to oral agent should occur when improvement in fever and inflammatory markers.

Durations:

Cystitis: 5 days if using Nitrofurantoin or Cefdinir
3 days of TMP/SMX for uncomplicated cases

Pyelonephritis:

- 10 days for non-quinolone choices.
- 5 days of Levofloxacin 750mg PO q24h if rapid improvement in symptoms, vitals and inflammatory markers.
- Longer courses of levofloxacin (e.g. 10 days) may be required if slower resolution.

Catheter-associated UTI:

- 7 days if catheter must remain in (catheter should be exchanged if plans to maintain device)
- 3 days if catheter removed AND not replaced AND woman ≤65 years old

[∞] Pharmacy dosing per CHS guidelines for weight and creatinine clearance

2.2 Respiratory Tract Infections

Aspiration Pneumonitis & Aspiration Pneumonia [14-16]

Aspiration pneumonitis is an acute inflammatory injury to the lung induced by inhalation of particulate and acidic materials from the stomach. It is marked by a rapid decline in respiratory status, often accompanied by fever, abrupt leukocytosis and new infiltrates reminiscent of pneumonia on chest imaging within 24 hours of the insult. Eighty to ninety percent of patients that aspirate recover spontaneously and *do not* develop bacterial pneumonia. **Anaerobic organisms are uncommon in patients hospitalized with suspected aspiration, and the addition of anaerobic coverage (e.g. metronidazole) should not be routine unless suspicion for empyema or lung abscess.**[16] Clindamycin is not recommended for routine use due to its associated risk for *C. difficile.*

	Event occurred <3 days from admission	***Event occurred ≥3 days after admission***
Aspiration Event ***Hemodynamically stable***	Prophylactic antibiotics have not been shown to be helpful in preventing the development of pneumonia after acute aspiration events.[35] Provide suppportive care and monitor for signs of secondary bacterial pneumonia. *Secondary bacterial pneumonia should be suspected if:* • Failure to improve 48h following aspiration event • Worsening symptoms develop after an initial improvement	
Aspiration Event ***Hemodynamically unstable* or *suspicion aspiration event >48h preceding evaluation*** *Empiric Antibiotics should be discontinued within 48 hours if clinical and radiographic resolution*	Ampicillin/Sulbactam 3 g IV q6h *OR* Ceftriaxone 1 g IV daily *Severe Beta-lactam allergy:* Levofloxacin 750mg IV daily	Piperacillin-tazobactam 3.375gm IV q8h *PLUS* Vancomycin IV∞ *Severe Beta-lactam allergy:* Levofloxacin 750mg IV daily *PLUS* Vancomycin IV∞
Bacterial Aspiration Pneumonia* *Bacterial Aspiration pneumonia should be suspected if failure to improve 48h following aspiration event or if marked worsening symptoms after an initial improvement.*	***<3 days from admission***	***≥3 days after admission***
	Ampicillin/Sulbactam 3 g IV q6h *OR* Ceftriaxone 1 g IV daily *Severe Beta-lactam allergy:* Levofloxacin 750mg IV daily	Piperacillin-tazobactam 3.375gm IV q8h *PLUS* Vancomycin IV∞ X 5 days *Severe Beta-lactam allergy:* Levofloxacin 750mg IV daily *PLUS* Vancomycin IV∞ (obtain MRSA nares swab)
	Duration: Five days	

*Antimicrobials should be adjusted based on sputum culture data, if available. "Oral flora" obtained from an adequate sputum specimen can be treated with Ceftriaxone or Ampicillin-sulbactam.

∞ Pharmacy dosing per CHS guidelines for weight and creatinine clearance

Community-Acquired Pneumonia (CAP) [17]

The Healthcare-associated pneumonia (HCAP) category as established in the 2005 ATS/IDSA HAP/VAP guideline is now abandoned. The term "HCAP" should no longer be used. The "risk factors" for HCAP outlined in this 2005 guideline (recent hospitalizations, residence in a nursing home, home infusion therapy, chronic dialysis, home wound care, family member with an MDR pathogen) are no longer valid and have since been shown in many studies to not be predictive of infection with multidrug-resistant (MDR) pathogens. Use of these outdated risk factors results in unnecessarily broad antibiotic use. See the empiric recommendation chart on the following page for guidance on when to cover for MDR pathogens**.**

Causative pathogens

The most common etiological agents of community-acquired pneumonia that lead to hospitalization include *Streptococcus pneumoniae*, viruses (e.g. influenza, RSV, SARS-CoV-2, rhinoviruses), *H. influenzae* and *Legionella*.[37] Atypical organisms including *Mycoplasma* and *Chlamydophila* are uncommon in patients requiring hospitalization for CAP.[38]

Testing

- Sputum cultures should be obtained when possible, especially in patients with intravenous antibiotic exposure within the preceding 90 days
- *Legionella* and *S. pneumoniae* urinary antigen testing should be performed for all patients hospitalized with CAP. In the event of a positive urine antigen test, antimicrobials should be narrowed to the specific pathogen detected.
    - Pneumococcal urine antigen testing is 60% sensitive, 99% specific for cases of newly diagnosed pneumonia.[39]
    - Legionella Urine Antigen only detects *L. pneumophila* types 1a and 1b. Overall, it is 70-80% sensitive, 99% specific for detection of Legionella pneumonia.[40] Additional testing with Legionella sputum culture or Legionella sputum PCR is recommended if high suspicion of Legionella infection after negative urine antigen testing.
    - Urine antigens can persist for weeks after successful treatment of pneumonia. Therefore, repeat testing is not advised.
- Serum ***procalcitonin should not be used*** to make decisions on ***initiation*** of antibiotics in patients with clinically suspected and radiographically confirmed CAP
- Influenza testing is recommended for all patients requiring admission with a diagnosis of pneumonia during periods of high influenza activity.
    - Additional empiric coverage for *Staphylococcus aureus* (including MRSA) can be considered in patients with post-influenza pneumonia and in critically ill patients with CAP pending respiratory culture results (see pg. 30 MRSA screening algorithm to de-escalate).

Streamlining and therapy considerations

- Empiric antimicrobial therapy should be tailored if culture and susceptibility reports become available
- Oral conversion should occur with normalization of vital signs and improvement in inflammatory markers. Oral conversion monotherapy with amoxicillin-clavulanate 875/125mg PO q12h or cefdinir 300mg PO q12h is reasonable in cases with low suspicion for *Legionella*.
- Doxycycline IV/PO is a reasonable alternative to azithromycin for empiric atypical organism coverage, and should be considered in patients with macrolide allergies, a prolonged QTc interval, or recent/recurrent *C. difficile* infection.

Community-Acquired Pneumonia (Inpatient)		***Preferred***	***Alternative for Beta-lactam Allergy***
Non-ICU admission *profound immune compromise (e.g. chemo-induced leukopenia) warrants empiric coverage of MRSA and *Pseudomonas*	**Standard**, *even for intravenous antibiotic use within 90 days*	Ceftriaxone 1gm IV q24h* *PLUS* Azithromycin 500 mg PO/IV q24h[¥] (obtain sputum culture if IV antibiotics within 90 days)	Levofloxacin 750mg PO/IV q24h (obtain sputum culture if IV antibiotics within 90 days)
	History of MRSA from respiratory tract	Ceftriaxone 1gm IV q24h* *PLUS* Azithromycin 500 mg PO/IV q24h[¥] *PLUS* Vancomycin IV[∞] (obtain MRSA nares swab)	Levofloxacin 750mg PO/IV q24h *PLUS* Vancomycin IV[∞] (obtain MRSA nares swab)
	History of *Pseudomonas* from respiratory tract, History of bronchiectasis	*Option 1*: Cefepime 2gm IV q8h *PLUS* Azithromycin 500 mg PO/IV q24h[¥] *Option 2*: Piperacillin-tazobactam 3.375 IV q8h[º] *PLUS* Azithromycin 500 mg PO/IV q24h[¥]	Levofloxacin 750mg PO/IV q24h
ICU admission	No septic shock and no MDR risk	Ceftriaxone 1gm IV q24h* *PLUS* Azithromycin 500 mg PO/IV q24h[¥]	Levofloxacin 750mg PO/IV q24h
	Septic shock, IV antibiotics within 90 days, prior isolation of MDR organism (MRSA, *Pseudomonas*)	*Option 1*: Cefepime 2gm IV q8h *PLUS* Vancomycin IV[∞] *PLUS* Azithromycin 500 mg IV q24h[¥] *Option 2*: Piperacillin-tazobactam 3.375 IV q8h[º] *PLUS* Vancomycin IV[∞] *PLUS* Azithromycin 500 mg IV q24h[¥]	Levofloxacin 750mg IV q24h *PLUS* Aztreonam 2 gm IV q8h *PLUS* Vancomycin IV[∞] *PLUS* +/- Tobramycin 7mg/kg IV X1

Duration:

- Five days of therapy with beta-lactam or levofloxacin is typically sufficient to treat uncomplicated CAP if afebrile ≥48h. Longer courses are required for *Legionella* and in cases complicated by slow resolution, empyema or immunocompromise.
- [¥] Azithromycin can be stopped ≤3 days if *Legionella* testing negative *and* low suspicion for *Legionella* infection.
- When *Pseudomonas* or *S. aureus* are isolated, duration of therapy can vary, but the 2016 ATS/IDSA HAP/VAP guideline provides a baseline recommendation of 7 days.

[∞] Pharmacy dosing per CHS guidelines for weight and creatinine clearance [º] Four hour infusion

Hospital-Acquired Pneumonia (HAP)[18]

HAP is defined as a ***new onset*** pneumonia (not incubating at the time of admission) occurring >48 hours after admission.

<table>
<tr><td colspan="3">****See VAP guidelines for ventilated patients****
A reassessment of antimicrobial need should occur at 48-72h in cases where HAP is not certain (e.g. HAP versus pulmonary edema, atelectasis).</td></tr>
<tr><td>Empiric Healthcare-Associated Pneumonia†</td><td>Preferred</td><td>Alternative for Severe ß-lactam allergy</td></tr>
<tr><td rowspan="2">HAP -without septic shock

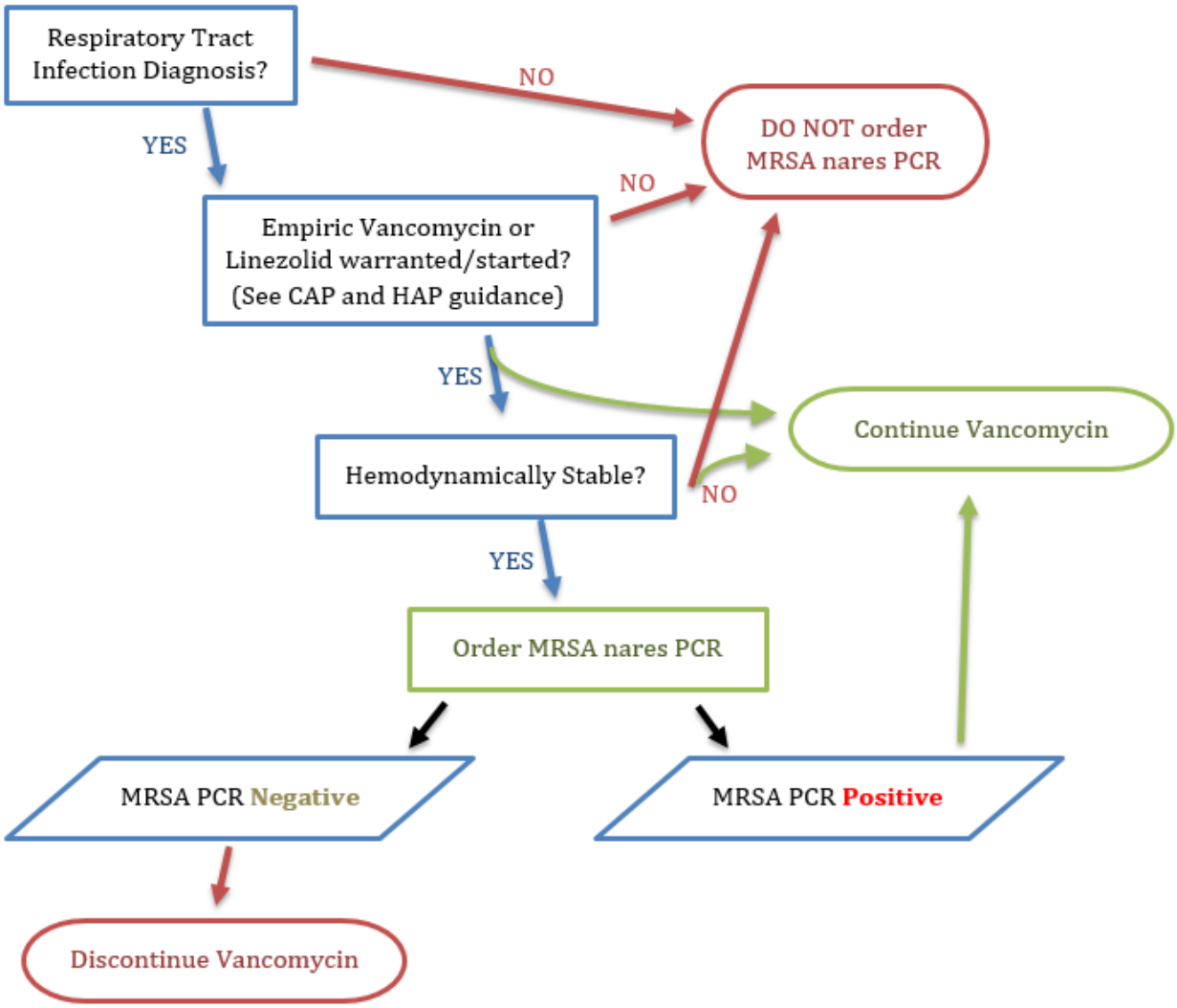
Empiric Antibiotics should be narrowed based on culture results†</td><td>Option 1:
Cefepime 2gm IV q8h
PLUS
Vancomycin IV∞</td><td rowspan="2">Levofloxacin 750mg IV/PO q24h
PLUS
Vancomycin IV∞</td></tr>
<tr><td>Option 2:
Piperacillin-tazobactam 3.375 IV q8h♀
PLUS
Vancomycin IV∞</td></tr>
<tr><td rowspan="2">HAP -with Septic Shock

Empiric Antibiotics should be narrowed based on culture results†</td><td>Option 1:
Cefepime 2gm IV q8h
PLUS
Vancomycin IV∞
PLUS
Levofloxacin 750mg IV q24h</td><td rowspan="2">Aztreonam 2gm IV q8h
PLUS
Levofloxacin 750mg IV q24h
PLUS
Vancomycin IV∞
PLUS
+/- Tobramycin 7mg/kg IV X1</td></tr>
<tr><td>Option 2:
Piperacillin-tazobactam 3.375 IV q8h♀
PLUS
Vancomycin IV∞
PLUS
Levofloxacin 750mg IV q24h</td></tr>
<tr><td colspan="3">Duration: Most HAP can be treated with 5-7 days of antibiotics.</td></tr>
<tr><td colspan="3">∞ Pharmacy dosing per CHS guidelines for weight and creatinine clearance
♀ Four hour infusion
†In general, coverage of MRSA and Pseudomonas can be stopped if respiratory cultures fail to yield these organisms. Legionella testing should be performed in cases that do not improve with HAP coverage</td></tr>
</table>

De-escalation of MRSA coverage for Pneumonia using MRSA Nares Screening[19-20]

The absence of MRSA colonization in the upper airway is a negative predictor for MRSA pneumonia. The following algorithm may be used to aide in the decision making for vancomycin de-escalation in stable, non-critical patients diagnosed with HAP.

Figure 4.



Ventilator-Associated Pneumonia (VAP)[18]

- Ventilator-Associated Pneumonia is defined by the presence of **new onset** pneumonia in a patient on mechanical ventilation for ≥48h at the time of diagnosis.

- All patients with suspected VAP should have endotracheal aspirate cultures sent as soon as possible -ideally before antimicrobial administration. These may be used to de-escalate therapy.

- *A diagnosis of VAP cannot be made by respiratory culture alone.* Chest imaging, vital signs, changes in ventilator requirements, inflammatory markers and sputum characteristics should all be considered when making the diagnosis of VAP.

- Enteric gram-negative organisms (e.g. *Klebsiella, E. coli*), *Pseudomonas* and *S. aureus* (including MRSA) are responsible for a large fraction of VAP. Candida is commonly cultured in sputum from hospitalized patients and is usually considered a colonizer. It does not routinely require treatment as a cause for VAP.

<table>
<tr><td colspan="3">A reassessment of antimicrobial need should occur at 48-72h in cases where VAP is not certain (e.g. VAP versus pulmonary edema, atelectasis).</td></tr>
<tr><td>Empiric Ventilator-Associated Pneumonia</td><td>Preferred</td><td>Severe ß-lactam allergy</td></tr>
<tr><td rowspan="2">No Septic Shock

Empiric Antibiotics should be narrowed based on culture results</td><td>Option 1:
Cefepime 2gm IV q8h
PLUS
Vancomycin IV∞</td><td rowspan="2">Aztreonam 2gm IV q8h
PLUS
Levofloxacin 750mg IV q24h
PLUS
Vancomycin IV∞</td></tr>
<tr><td>Option 2:
Piperacillin-tazobactam 3.375 IV q8hº
PLUS
Vancomycin IV∞</td></tr>
<tr><td>With Septic Shock

Empiric Antibiotics should be narrowed based on culture results</td><td>Piperacillin-tazobactam 3.375 gm IV q8hº
PLUS
Levofloxacin 750mg IV q24h
PLUS
Vancomycin IV∞</td><td>Aztreonam 2gm IV q8h
PLUS
Levofloxacin 750mg IV q24h
PLUS
Vancomycin IV∞
If history of resistant pseudomonas add
Tobramycin 7mg/kg IV X1</td></tr>
<tr><td colspan="3">Recommended duration: Most VAP can be treated with 7 days of antibiotics.</td></tr>
<tr><td colspan="3">∞ Pharmacy dosing per CHS guidelines for weight and creatinine clearance
º Four hour infusion</td></tr>
</table>

Chronic Obstructive Pulmonary Disease (COPD) Exacerbation [21-23]

COPD exacerbations are defined by an acute change in lower respiratory symptoms leading to a change in medication. Exacerbations are characterized by increased sputum volume, change in sputum character (color/consistency), worsening cough and worsening dyspnea.

Viral and bacterial infections are responsible for many COPD exacerbations. The most common bacteria implicated in COPD exacerbations are *Haemophilus influenzae*, *Streptococcus pneumoniae* and *Moraxella catarrhalis*. **Antibiotics are recommended for severe exacerbations** characterized by marked increase in purulent sputum and marked increase in dyspnea. Many patients hospitalized for COPD exacerbation fall into the severe category. *Pseudomonas* and other gram-negative rods occasionally cause exacerbations, however, these pathogens are usually found in patients with extensive structural lung disease that have had frequent antimicrobial exposures.

<table>
<tr><th>Severe COPD Exacerbation</th><th>Preferred</th><th>Azithromycin Exposure in past 4 weeks</th></tr>
<tr><td rowspan="2">Empiric Levofloxacin is discouraged unless patient has a known history of infection with organisms resistant to standard therapies</td><td rowspan="2">Azithromycin 500mg PO/IV q24h X 3 days∞</td><td>Option 1:
Doxycycline 100mg PO/IV q12h X 5 days</td></tr>
<tr><td>Option 2:
Amoxicillin-clavulanate 875mg PO q12h X 5 days
OR
Ampicillin-sulbactam 3gm IV q6h X5 days</td></tr>
<tr><td colspan="3">∞ Azithromycin has a long intracellular half-life. Three days of therapy offers about a week of coverage.</td></tr>
</table>

***Influenza*[24,25]**

Influenza infection is characterized most often by fever, cough, myalgia and upper respiratory symptoms –often with an abrupt onset. Influenza may progress to severe, life threatening respiratory failure in high-risk individuals. Secondary bacterial pneumonia may also complicate influenza infection.

Influenza season typically occurs between November and May in the Northeastern United States. In Western New York, peak season is usually seen from December to February for Influenza A with a second smaller rise in activity seen in early spring for Influenza B.

All patients admitted to the hospital during Influenza season with Influenza like illness should be tested for infection. Antivirals should be initiated as early as possible if influenza is suspected. [47,48] Molecular testing is the most sensitive assay available in CHS facilities (order: Influenza RT PCR) and should be ordered for admitted patients with suspicion of influenza.

Neuraminidase inhibitors (oseltamivir, zanamivir and peramivir) are active against most circulating influenza strains.

Additional coverage and testing for secondary bacterial pneumonia (especially *Streptococcus pneumoniae* and *S. aureus*) should be considered if clinical features of bacterial pneumonia are also present (e.g. purulent sputum with infiltrates on chest imaging).

Influenza A or B	**Treatment†**
*Droplet precautions should be in place for hospitalized patients X 7 days from symptom onset**	Oseltamivir 75mg PO q12h X 5 days§
†Provide antibiotics per bacterial pneumonia guidelines if concurrent bacterial pneumonia suspected *Antiviral therapy does not shorten droplet isolation for hospitalized patients. §Assumes normal creatinine clearance.	

2.3 Skin and Soft Tissue Infections

Cases with signs or symptoms of necrotizing infection and those with evidence of severe sepsis or septic shock should be treated using necrotizing fasciitis recommendations along with the severe sepsis management algorithm (section 2.8).

Non-purulent Cellulitis (without severe sepsis)[26]

Non-purulent cellulitis is characterized by diffuse erythema, pain and warmth at the infected site. Streptococcus spp. cause the majority of cases.

Cellulitis[†] (non-purulent)	**Oral Therapies*[†]**		**Intravenous Therapies[†§]**	
Refer to Necrotizing Fasciitis and Sepsis recommendations for cases presenting with signs of Severe Sepsis/Septic Shock or necrotizing skin infections	*Preferred*	*Penicillin allergy*	*Preferred*	*Severe ß-lactam allergy*
	Cefadroxil 500 mg PO q12h	Linezolid 600 mg PO q12h	Cefazolin 2 gm IV q8h	Vancomycin IV[∞] *OR* Clindamycin 600 mg IV q8h.
***Recommended duration*:** • 5 days • Treatment should be extended if the infection has not improved within this time period • Antimicrobial failure should prompt evaluation for abscess, retained foreign body or resistant organisms such as MRSA				
*Conversion to oral agent can be made when improvement is demonstrated by fever resolution, cessation of spread and improvement in inflammatory markers. [†] Use of anti-MRSA coverage (e.g. Vancomycin IV) should be considered in cases where there is known MRSA colonization, penetrating trauma or intravenous drug abuse. [∞] Pharmacy dosing per CHS guidelines for weight and creatinine clearance				

Cellulitis with Skin Abscess/Carbuncle/Furuncle[26]

Purulent skin infections of the head, trunk and limbs are typically caused by *Staphylococcus aureus* (MSSA and MRSA) pyogenic Streptococci. Skin and soft tissue infections in the foot, perianal, genital and perineal regions are often polymicrobial. Patients with a history of intravenous drug abuse with skin abscess may have polymicrobial infection secondary to injection of contaminated fluids.

Incision and drainage is the cornerstone to therapy for skin abscesses. In patients without systemic symptoms, small abscesses with minimal surrounding cellulitis can often be treated without antibiotics using incision and drainage alone.

<table>
<tr><th>Skin Abscesses
(Purulent cellulitis)</th><th>Empiric Therapies*</th><th>Organism-Specific Recommendations</th></tr>
<tr><td>Head, Trunk & Extremities

See Necrotizing fasciitis for cases with severe sepsis/shock or necrotizing infection</td><td>TMP/SMX 1 DS tab PO q12h
OR
Doxycycline 100 mg PO q12h
OR
Linezolid 600 mg PO/IV q12h
(restricted antimicrobial)
OR
Vancomycin IV∞</td><td><u>MSSA or Streptococcus:</u>
Cefadroxil 500 mg PO q12h
OR
Cefazolin 2gm IV q8h

<u>MSSA or Streptococcus with non-severe penicillin allergy</u>:
Linezolid 600 mg PO q12h
(restricted antimicrobial)
OR
Cefazolin 2gm IV q8h

<u>Severe ß-lactam allergy or MRSA</u>:
Refer to microbiology report</td></tr>
<tr><td>Perianal/Genital, Foot & Intravenous Drug abuse-related

See Necrotizing fasciitis for cases with severe sepsis/ septic shock</td><td>Vancomycin IV∞
PLUS
Piperacillin-tazobactam 3.375gm IV q8hº

Severe Beta lactam Allergy:
Vancomycin IV∞
PLUS
Levofloxacin 750mg IV q24
PLUS
Metronidazole 500 mg IV q12h</td><td>Narrow coverage as soon as possible based on Culture and Sensitivity Reports.</td></tr>
<tr><td colspan="3">Recommended duration: 5 days following adequate drainage
Consider re-evaluation for residual collections and extending antimicrobial duration if minimal improvement after 5 days of suitable coverage</td></tr>
<tr><td colspan="3">*Conversion to oral agent can be made when improvement is demonstrated by fever resolution, cessation of spread and improvement in inflammatory markers.
∞ Pharmacy dosing per CHS guidelines for weight and creatinine clearance
º Four hour infusion</td></tr>
</table>

Necrotizing Fasciitis, Fournier's Gangrene & Severe Sepsis[26]

Necrotizing fasciitis is a severe form of skin and soft tissue infection characterized by rapid spread along subcutaneous planes. Fournier's gangrene involves necrotizing fasciitis in the perineal and genital regions and is often polymicrobial.

All necrotizing fasciitis cases should have urgent surgical consultation for debridement.
Consider consultation with Infectious Diseases as well.

<table>
<tr><th>Necrotizing Fasciitis & Fournier's Gangrene</th><th>Empiric</th><th>Group A Streptococcus in culture (S. pyogenes)</th></tr>
<tr><td rowspan="2">Empiric Antimicrobial therapy should be tailored based on culture and susceptibility reports.</td><td>Vancomycin IV∞
PLUS
Piperacillin-tazobactam 3.375gm IV q8h♀
PLUS
Clindamycin 900 mg IV q8h</td><td rowspan="2">Penicillin G 4 million units IV q4h
PLUS
Clindamycin 900 mg IV q8h</td></tr>
<tr><td>Severe Penicillin Allergy
Vancomycin IV∞
PLUS
Levofloxacin 750mg IV q24
PLUS
Clindamycin 900 mg IV q8h</td></tr>
<tr><td colspan="3">Conversion to oral agent can be made when improvement is demonstrated by fever resolution, cessation of spread and improvement in inflammatory markers.
∞ Pharmacy dosing per CHS guidelines for weight and creatinine clearance
♀ Four hour infusion</td></tr>
</table>

2.4 Abdominal Infections[27,28]

Biliary Tract Infections

Enteric gram-negative rods (e.g. *Escherichia coli* and *Klebsiella*) and *Streptococcus spp.* are the most commonly isolated organisms in biliary tract infections. Cases with significant prior antimicrobial exposure, surgical manipulation or prolonged hospitalization may be complicated by more resistant gram-negative and gram-positive organisms including *Pseudomonas, Enterococcus and Staphylococcus aureus*. Empiric anaerobic coverage is not required for community-onset cases. Empiric coverage for *Candida* and *Enterococci* is not routinely recommended. However, appropriate antimicrobial therapy for these species should be initiated if culture data suggest their presence.

Cholangitis	**Community-Acquired[§]**		**Severe Sepsis, Healthcare-Acquired* or history of previous biliary anastomosis/manipulation/stent**	
Empiric Antimicrobial therapy should be tailored when culture and susceptibility reports become available	*Preferred Therapy*	*Alternative for severe ß-lactam allergy*	*Preferred Therapy*	*Alternative for ß-lactam allergies*
	Ceftriaxone 1gm IV q24h	Levofloxacin 750mg IV q24h	Piperacillin-tazobactam 3.375gm IV q8h[º] *PLUS* Vancomycin IV[∞]	Aztreonam 2gm IV q8h *PLUS* Vancomycin IV[∞] *PLUS* Metronidazole 500 mg IV q12h
***Duration*:** • Antibiotics should be discontinued within 5 days after adequate source control achieved (e.g. biliary stent) unless ongoing sepsis. Shorter durations following source control may be used in milder cases without evidence of sepsis. • If ongoing signs of infection after completion of antibiotics then further evaluation for infection within and outside the abdomen should be performed.				

[§] Anaerobic therapy is not indicated unless a biliary-enteric anastomosis is present. Add metronidazole 500mg IVq12h in such instances.

*Hospital length of stay before the operation ≥3 days or prolonged preoperative antimicrobial therapy should prompt healthcare-acquired coverage.

[∞] Pharmacy dosing per CHS guidelines for weight and creatinine clearance

[º] Four hour infusion

Cholecystitis	**Community-Acquired[§]** Mild to moderate infection		**Severe Sepsis or Healthcare-Acquired***	
Empiric Antimicrobial therapy should be tailored when culture and susceptibility reports become available	*Preferred Therapy*	*Alternative for severe ß-lactam allergy*	*Preferred Therapy*	*Alternative for severe ß-lactam allergy*
	Ceftriaxone 1gm IV q24h	Levofloxacin 750mg IV q24h	Piperacillin-tazobactam 3.375gm IV q8h[º] *PLUS* Vancomycin IV[∞]	Aztreonam 2gm IV q8h *PLUS* Vancomycin IV[∞] *PLUS* Metronidazole 500 mg IV q12h

***Duration*:**

- In uncomplicated cases antibiotics can be discontinued 24 hours after source control achieved (e.g. cholecystectomy, percutaneous drain)
- In septic/complicated cases or when infection extends beyond the gallbladder wall then antibiotics should be discontinued 5 days after adequate source control achieved unless ongoing sepsis.
- If ongoing signs of infection after completion of antibiotics then further evaluation for complications within and outside the abdomen should be considered.

§ Anaerobic therapy is not indicated unless a biliary-enteric anastomosis is present. Add metronidazole 500mg IVq12h in such instances.

*Hospital length of stay before the operation ≥3 days or prolonged preoperative antimicrobial therapy should prompt healthcare-acquired coverage.

[º] Four hour infusion

[∞] Pharmacy dosing per CHS guidelines for weight and creatinine clearance

***Diverticulitis*[27,28,29-32]**

Gram-negative enteric rods (e.g. *Escherichia coli* and *Klebsiella*) plus anaerobes are responsible for most infections. Expanded empiric coverage for yeast and more resistant organisms (e.g. *Pseudomonas*) should be initiated in cases of severe sepsis or prior multiple antimicrobial exposures.

Complicated diverticulitis is defined as free perforation, abscess, obstruction or fistula and typically requires surgical or percutaneous intervention to achieve cure. In such instances, antimicrobial duration may vary according to timing of intervention and/or resolution of sepsis.

<table>
<tr><th>Diverticulitis</th><th colspan="2">Mild to Moderate Disease</th><th colspan="2">Severe Sepsis, Multiple Antibiotic Exposures†§</th></tr>
<tr><td rowspan="3">Empiric Antimicrobial therapy should be tailored if culture and susceptibility reports become available</td><td>Preferred Therapies</td><td>Alternative for severe ß-lactam allergy</td><td>Preferred Therapy</td><td>Alternative for severe ß-lactam allergy</td></tr>
<tr><td>Ceftriaxone 1gm IV q24h
PLUS
Metronidazole 500 mg IV q12h</td><td>Levofloxacin 750mg IV q24h
PLUS
Metronidazole 500 mg IV q12h</td><td rowspan="2">Piperacillin-tazobactam 3.375gm IV q8hᵍ
PLUS
Vancomycin IV∞
PLUS
Micafungin§ 100mg IV q24h</td><td rowspan="2">Aztreonam 2gm IV q8h
PLUS
Vancomycin IV∞
PLUS
Metronidazole 500 mg IV q12h
PLUS
Micafungin§ 100mg IV q24h</td></tr>
<tr><td>Oral:
Cefdinir 300 mg PO q12h
PLUS
Metronidazole 500 mg PO q12h</td><td>Oral:
Levofloxacin 750 mg PO q24h
PLUS
Metronidazole 500 mg PO q12h</td></tr>
<tr><td colspan="5">Duration:
• 5-7 days for uncomplicated cases*
• If ongoing signs of infection after completion of antibiotics then evaluation for invasive interventions for unremitting/complicated diverticulitis should be considered</td></tr>
<tr><td colspan="5">*Complicated diverticulitis defined as free perforation, abscess, fistula or obstruction. Phlegmon without abscess is not considered complicated disease. Source control procedures (percutaneous drainage, surgery) should be considered in cases with abscess and other complicated cases as defined above.
†Hospital length of stay before the operation ≥3 days or prolonged preoperative antimicrobial therapy should prompt healthcare-acquired coverage.
§ Antifungal coverage should be continued only in cases where Candida is grown from fluid
ᵍ Four hour infusion
∞ Pharmacy dosing per CHS guidelines for weight and creatinine clearance</td></tr>
</table>

Gastroenteritis/ Infectious Colitis [33-36]

Cases of acute infectious diarrhea without fever or dysentery do not usually require antimicrobials. All cases should be given supportive care with fluid and electrolyte repletion as needed. Exposure history, immune compromise and duration of symptoms should inform need for additional testing.

Empiric Treatments for Acute, Community-Acquired Infectious Diarrhea (<7 days duration)		
Syndrome	**Recommended Testing***	**Empiric Treatment**
Afebrile, non-bloody (watery) diarrhea without travel history *e.g. Norovirus, rotavirus, adenovirus*	• C. difficile assay, if risk factors present • Consider other non-infectious etiologies (e.g. medications) • No other test indicated in most instances unless outbreak setting or persistent/worsening symptoms*	*Low concern C. difficile:* • Rehydration, electrolytes • Antimotility Agents PRN • Antimicrobials NOT recommended *C. difficile suspected* • Avoid antimotility agents • Avoid other Antibiotics • C. difficile-directed therapy if test positive
Afebrile/ (T≤100 F) with bloody diarrhea e.g. Shiga toxin-producing Escherichia coli (STEC, E. coli O157:H7), Campylobacter, Yersinia, Salmonella	• Stool Culture • C. difficile assay if risk factors present *(note: bloody diarrhea is rare in cases of C. difficile)*	*Low concern C. difficile:* • Avoid antimotility agents • Avoid empiric antibiotics pending culture • Treat based on pathogen-specific recommendations (see table) **if stool culture positive** *C. difficile suspected* • Avoid Antimotility agents • Avoid other Antibiotics • C. difficile directed therapy
Fever or Dysenteric Symptoms (frequent scant bloody stools, fever, abdominal cramps, tenesmus, sepsis) e.g. Shigella, Enteric fever	• Stool Culture • C. difficile assay if risk factors present *(note: bloody diarrhea is rare in cases of C. difficile)* • Blood Cultures	• Avoid Antimotility agents • Azithromycin 500mg PO/IV daily X3 days • Adjust antibiotics, if needed, based on pathogen-specific recommendations (below)
**Additional testing and treatments may be warranted based on specific risk factors obtained on history such as international travel, exposure to untreated drinking water, sexual practices, presence of severe immunocompromise such as AIDS or transplant recipient status*		

Gastroenteritis/Infectious Colitis: Pathogen-Specific Therapies[36]		
Pathogen	**Risk Factors Requiring treatment**	**Recommended Treatment if Risk Factors Present**
Campylobacter[18,19,22] (Incubation 2-5 days)	All cases	Azithromycin 500mg PO/IV q24h X 3 days
Clostridium difficile (Incubation: variable)	All Symptomatic Cases	See *C. difficile* section, p. 20
Cryptosporidium[23] (Incubation: 2-10 days)	Severe Cases Immunocompromised	Nitazoxinide 500mg PO q12h X 3 days
Entamoeba histolytica[22] Incubation: 14-28 days)	All Cases regardless of symptoms	Metronidazole 750 mg PO q8hX 10 days PLUS Paromomycin, 500 mg PO q8h X 7 days
Giardia lamblia[24] (Incubation: 7-14 days)	Symptomatic Cases	Metronidazole 500mg PO q8h X 5 days
E. coli O157:H7; other Shiga Toxin Producing E. coli (STEC) [19-21]	Monitor for Hemolytic Uremic Syndrome	Avoid antimicrobials Supportive Care
Salmonella, non-typhi, non-paratyphi. [18,19,21,22,25] (Incubation: <1-3 days)	*Complicated cases only:* • Immunocompromised • Valvular Heart Disease • Severe Atherosclerosis • Prosthetic materials • Severe Illness • Elderly	Ciprofloxacin 500mg PO q24h X 5 days Or Ceftriaxone 1gm IV daily X 5 days *If symptoms persist, bacteremia or severe immunocompromise consider Infectious Disease consultation (extended course may be required)*
Salmonella enterica serovars Typhi & Paratyphi. [18,19,21,22,25] (Incubation: <1-3 days)	All Cases	Ciprofloxacin 500mg PO q24h X 5 days Or Ceftriaxone 1gm IV daily X 5 days *Consider Infectious Disease consultation If bacteremia or immunocompromise (extended course may be required).*
Shigella spp. [18,19,22] (Incubation 1-2 days)	All Cases	Azithromycin 500mg PO/IV X3 days
Travellers diarrhea (e.g. enterotoxigenic, E. coli) [18,19,22] (Incubation: 1-3 days)	Symptomatic cases	Mild: Bismuth subsalicylate 30 mL q4-6h PRN Moderate to Severe: Azithromycin 1000mg PO X1
Yersinia spp. [18,19,22] (Incubation 1-2 days)	Severe illness Only	*Most cases do not require antibiotics.* Levofloxacin 500mg PO q24h X3 days
Vibrio cholera (incubation: 18-48 hrs)	All Cases	*Volume repletion cornerstone of treatment* *Doxycycline 100mg IV/PO q12h X3-5 days*
Vibrio parahemolyticus (Incubation: 2-48 hrs)	Antibiotics do not decrease illness duration	*Symptoms typically last 5-7 days.* Avoid antimicrobials, Supportive Care

Peritonitis[27,28]

Enteric gram-negative rods (e.g. *Escherichia coli* and *Klebsiella*) and anaerobes (e.g. *Bacteroides* and *Clostridium*) are responsible for most infections. Expanded empiric coverage for yeast and more resistant organisms (e.g. *Pseudomonas*) should be initiated in cases of severe sepsis or prior multiple antimicrobial exposures. Most cases of peritonitis can be treated with brief antibiotic courses following source control.[5]

Peritonitis	**Community-Acquired**		**Severe Sepsis or Healthcare-Acquired*§**	
	Preferred Therapy	*Alternative for severe ß-lactam allergy*	*Preferred Therapy*	*Alternative for severe ß-lactam allergy*
Empiric Antimicrobial therapy should be tailored if culture and susceptibility reports become available.	Ceftriaxone 1gm IV q24h *PLUS* Metronidazole 500 mg IV q12h	Levofloxacin 750mg IV q24h *PLUS* Metronidazole 500 mg IV q12h	Piperacillin-tazobactam 3.375gm IV q8h[ϙ] *PLUS* Vancomycin IV[∞] *PLUS* Micafungin[§] 100mg IV q24h	Aztreonam 2gm IV q8h *PLUS* Vancomycin IV[∞] *PLUS* Metronidazole 500 mg IV q12h *PLUS* Micafungin[§] 100mg IV q24h

***Duration*:**

- Antibiotics should be discontinued within 5 days once adequate source control is achieved unless ongoing sepsis. Shorter durations following source control may be used in milder cases without evidence of sepsis.
- Antibiotics can be stopped at 24 hours following source control in cases of uncomplicated appendicitis and penetrating, blunt, or iatrogenic trauma that is repaired within 12 h of injury onset.
- If ongoing signs of infection after completion of antibiotics then further evaluation for infection within and outside the abdomen should be performed.

*Hospital length of stay before the operation ≥3 days or prolonged preoperative antimicrobial therapy should prompt healthcare-acquired coverage.

§ Antifungal coverage should be continued only in cases where *Candida* is grown from peritoneal fluid

ϙ Four hour infusion

∞ Pharmacy dosing per CHS guidelines for weight and creatinine clearance

2.5 *Clostridioides (formerly Clostridium) difficile colitis*

C. difficile is a contagious, spore-forming gram-positive bacillus transmitted by the fecal-oral route. Spores are transmitted when unwashed hands of healthcare workers and contaminated equipment come into contact with susceptible patients.

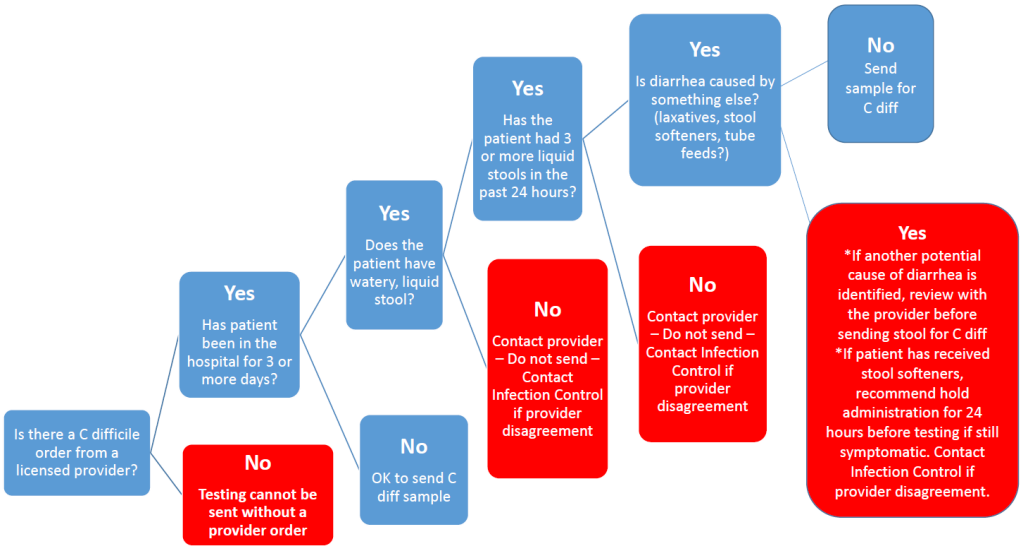
The spectrum of illness from *C. difficile* infection ranges from watery diarrhea to dysenteric bowel movements with septic features. In its most extreme form, it culminates with a toxic ileus and septic shock.

C. difficile Risk Factors:
The strongest risk factor for development of *C. difficile* is exposure to antibiotics.[37,38] Nearly all antibiotic classes are associated with *C. difficile.* Cephalosporins, fluoroquinolones, carbapenems, and clindamycin are particularly high risk for inducing *C. difficile* infection.[8]

Gastric acid suppression medications, particularly proton pump inhibitors, are also associated with increased risk of *C. difficile* infection.[38,40] Patient risk factors for developing *C. difficile* infection include age ≥65, kidney disease, hypoalbuminemia, prolonged hospitalization, and prior history of *C. difficile.*[38]

C. difficile is preventable:
- Avoid using unnecessary antibiotics.
- Use the narrowest spectrum antibiotic possible based on culture and clinical data.
- Always perform hand hygiene before and after patient contact.
- Always clean shared equipment between patient contacts.
- Avoid gastric acid suppression medications unless a clear indication is present. Most patients outside of critical care do not require "GI prophylaxis".
- Immediately place suspected *C. difficile* cases on contact precautions at the time the test is ordered-- do not wait for the result to initiate precautions.

Who to test for C. difficile:[39]
- Newly admitted patients with liquid bowel movements and *C. difficile* risk factors
- Hospitalized patients with *C. difficile* risk factors and ≥3 liquid bowel movements in 24h that cannot be explained by another cause (e.g. laxatives, chronic stable diarrhea)



C. difficile Test Result Interpretation:

C. difficile testing at Catholic Health begins with a highly sensitive test (PCR) used to screen for *C. difficile* DNA. If *C. difficile* DNA is detected, then a more specific toxin assay will be performed to assess for evidence of *C. difficile* toxin, the cause of active *C. difficile* disease.

***C. difficile* Test Result**	**Interpretation**
C. difficile PCR DNA: **Not detected**	**No evidence of disease or colonization** **Isolation can be discontinued**
C. difficile PCR DNA: **Detected** *C. difficile* Toxin: **Positive**	**Active Infection**. Treatment recommended. *These findings are consistent with active C. difficile infection. Repeat testing should not be performed.* **Isolation required for patient's entire hospital stay per infection control policy.**
C. difficile PCR DNA: **Detected** *C. difficile* Toxin: **Negative**	**Possible Colonization versus Infection.** Treatment is advised if suspicion for active infection based on clinical presentation. *These findings may reflect colonization or active infection with low levels of toxin that were not detected on the toxin assay. Clinical correlation with patient exam, symptoms, studies, and history is advised regarding decision to treat. Repeat testing should not be performed.* **Isolation required. Hospitalized patients with *C. difficile* DNA results detected during their stay require contact isolation per infection control policy, regardless of treatment decision.** Consultation with Infection Control is required to remove anyone from enteric contact isolation with *C. difficile* DNA detected testing.

***Clostridioides (formerly Clostridium) difficile* treatment[39,41-43]**

In all instances, other antibiotics should be discontinued whenever possible. Avoid gastric acid suppression medications whenever possible.

Severity	***First Episode***	***Recurrent***	***Multiple Recurrences***
Non-severe and Severe cases receive the same treatment recommendations ***Severe Episode defined by:*** • ***WBC ≥15,000/L OR*** • ***Serum creatinine ≥1.5 mg/dL (unless elevation is baseline)*** ***See next table for Fulminant C. difficile treatment guidance***	*Vancomycin 125mg PO q6h X10 days* ***OR*** *Fidaxomicin 200 mg PO q12h x 10 days* *Note: metronidazole is not recommended as monotherapy, even for non-severe cases*	*Fidaxomicin 200 mg PO q12h x 10 day[41]* ***OR*** *Fidaxomicin 200 mg PO BID x 5 days, then 200 mg PO q48h x 10 doses* ***OR*** *[§]Vancomycin 125mg PO q6h X 10 days, then Vancomycin 125mg PO BID x 7 days, then Vancomycin 125mg PO daily x 7 days, then Vancomycin 125 mg PO q48h x 2-8 weeks [41]* *Consider Infectious Diseases consultation for possible Bezlotoxumab administration after hospital discharge*	*Fidaxomicin 200 mg PO BID x 5 days, then 200 mg PO q48h x 10 doses* ***OR*** *[§]Vancomycin 125mg PO q6h X 10 days, then Vancomycin 125mg PO BID x 7 days, then Vancomycin 125mg PO daily x 7 days, then Vancomycin 125 mg PO q48h x 2-8 weeks [41]* *Consider Infectious Diseases consultation for possible Bezlotoxumab or fecal transplant administration after hospital discharge or other advanced C. difficile therapies***

**The mean time to clinical response for treatment of C. difficile (decreased stool frequency, less watery stools, falling WBC) is 3-4 days.[10]*

§This is an example of a vancomycin pulse or taper regimen. There are several such regimens regularly used, none of which are known to show any superiority over others.

***Bezlotoxumab may be appropriate at discharge in certain high-risk populations. Fecal Microbiota Transplantation may be appropriate in cases of recurrent disease or refractory disease. Fecal Microbiota Transplantation requires consultation with providers experienced in its use. Fecal microbiota preparations are restricted agents and require infectious disease approval.*

Clostridioides difficile **treatment (continued)**

Severity	***First Episode***	***Recurrent***	***Multiple Recurrences***
Fulminant (Uncommon) **Defined as disease complicated by:** • **Hypotension/ Septic Shock** • **Acute ileus** • **Megacolon** • **Organ Failure due to *C. difficile*** *Consider early Surgical Consultation*	*Vancomycin 500mg PO q6h* ***PLUS*** *Metronidazole 500mg IV q8h* *If ileus: Vancomycin 500mg per 500mL O.9% Saline Enema q6h*	*Vancomycin 500mg PO q6h* ***PLUS*** *Metronidazole 500mg IV q8h* *If ileus: Vancomycin 500mg per 500mL O.9% Saline Enema q6h* *Then:* *§Vancomycin 125mg PO q6h X 10 days, then Vancomycin 125mg PO BID x 7 days, then Vancomycin 125mg PO daily x 7 days, then Vancomycin 125 mg PO q48h x 2-8 weeks*[41]	*Consider Infectious disease consultation for possible advanced C. difficile therapies***

**The mean time to clinical response for treatment of C. difficile (decreased stool frequency, less watery stools, falling WBC) is 3-4 days.*[10]
§This is an example of a vancomycin pulse or taper regimen. There are several such regimens regularly used, none of which are known to show any superiority over others.
***Bezlotoxumab may be appropriate at discharge in certain high-risk populations. Fecal Microbiota Transplantation may be appropriate in cases of recurrent disease or refractory disease. Fecal Microbiota Transplantation requires consultation with providers experienced in its use. Pre-screened commercial fecal microbiota preparations are restricted agents and require infectious disease approval.*

2.6 Central Nervous System Infections[44-46]

Meningitis

Meningitis typically presents with headache, photophobia and neck pain or stiffness. Meningitis may result from bacterial, viral and non-infectious insults. Bacterial meningitis is a medical emergency and requires prompt treatment and diagnosis. The diagnosis of meningitis is made with lumbar puncture. The empiric addition of dexamethasone is recommended in cases of possible pneumococcal meningitis under age 50. It should be discontinued if *S. pneumoniae* meningitis is not diagnosed. **Antimicrobial therapy should not be delayed pending lumbar puncture.**

In cases with significant confusion, stupor or coma (**Encephalitis and Meningoencephalitis**), the addition of **Acyclovir 10mg/kg IV q8h (ideal body weight)** to any of the following regimens is recommended pending Herpes Simplex Virus PCR testing from CSF.

Meningitis[#]	***Preferred Empiric***	***Severe ß-lactam allergy***
Adults <50 years old *(S. pneumoniae,* *N. meningiditis)*	Ceftriaxone 2gm IV q12h *PLUS* Vancomycin IV[∞] *PLUS* Dexamethasone* 0.15 mg/kg IV q6h (max dose 10mg IV q6h)	Vancomycin IV[∞] *PLUS* Aztreonam 2gm IV q6h *PLUS* Dexamethasone* 0.15 mg/kg IV q6h (max dose 10mg IV q6h) *Call infectious Diseases*
>50 years old or Immunocompromised *(S. pneumoniae,* *L. monocytogenes* *N. meningiditis)*	Ceftriaxone 2gm IV q12h *PLUS* Vancomycin IV[∞] *PLUS* Ampicillin 2gm IV q4h *PLUS* Dexamethasone* 0.15 mg/kg IV q6h (max dose 10mg IV q6h)	Vancomycin IV[∞] *PLUS* Aztreonam 2gm IV q6h *PLUS* TMP/SMX 5mg/kg IV q8h *PLUS* Dexamethasone* 0.15 mg/kg IV q6h (max dose 10mg IV q6h) *Call infectious Diseases*
Post Neurosurgery or CSF Shunt *(S. aureus.* *S. epidermidis,* *Pseudomonas,* *Enterobacteriaciae)*	Vancomycin IV[∞] *PLUS* Cefepime 2gm IV q8h	Vancomycin IV[∞] *PLUS* Aztreonam 2gm IV q6h *PLUS* Levofloxacin 750 mg IV q24h

Duration:

S. pneumoniae: minimum 10 days

N. meningitides: 7 days

Listeria: 21 days

Aerobic Gram Negative Bacilli (e.g. *Pseudomonas, E.coli*): 21 days

[#]Community-acquired meningitis cases should be on droplet precautions for the first 24h of therapy pending workup for *Neisseria meningitides*

*Dexamethasone dose should be given 10-20 min before 1st antimicrobial dose. It should be continued X 3 days if *S. pneumoniae* infection is confirmed. It should be discontinued if *S. pneumoniae* not isolated. It should not be given if antimicrobials already infused.

[∞] Pharmacy dosing per CHS guidelines for weight and creatinine clearance

2.7 Neutropenic Fever[47-50]

<table>
<tr><th colspan="3">Administer antibiotics within 1 hour of diagnosis</th></tr>
<tr><td rowspan="2">Inpatient/High Risk</td><td>Preferred therapy *</td><td>Alternative for Severe B-lactam allergy</td></tr>
<tr><td>Piperacillin-Tazobactam 3.375gm IV q8h
OR
Cefepime 2gm IV q8h</td><td>Aztreonam 2gm q8h
PLUS
Vancomycin
(If evidence of septic shock add Tobramycin 5mg/kg IV X1)</td></tr>
<tr><td colspan="3">*Vancomycin is NOT recommended as a standard part of the preferred initial regimen unless there is evidence to suggest any of the following: suspected catheter-related infection, skin/soft tissue infection, pneumonia, hemodynamic instability</td></tr>
<tr><td>Antifungal Therapy
Indicated if persistent/recurrent fever after 7 days of antibiotics and neutropenia duration > 7 days</td><td colspan="2">Voriconazole 6mg/kg IV q12h x 2 doses then 3-4mg IV q12h[a]
OR
Micafungin 100mg IV q24h

[a]If pulmonary findings suggestive of an invasive mold infection, Voriconazole is preferred.</td></tr>
<tr><td>LOW RISK (OUTPATIENTS ONLY)
<u>Must meet all criteria below:</u>
• Good functional status (ECOG PS ≥2)
• Anticipated neutropenia duration < 7 days
• No major comorbid conditions (including moderate to severe COPD, Chronic cardiovascular disease)
• No abdominal pain
• Hemodynamicly stable
• Normal mentation
• Tolerating PO without signs of volume depletion</td><td>Amoxicillin/Clavulanate 875/125mg
PLUS
Levofloxacin 750mg q24h</td><td>Clindamycin 600mg q8h
PLUS
Levofloxacin 750mg q24h</td></tr>
<tr><td colspan="3">Length of therapy: In patients with clinically documented infections, antibiotics should continue for at least the duration of the neutropenia (until ANC≥500 cells/mm^3). Alternatively, if an appropriate treatment course has been given (based on any isolated organism and infection site) and signs and symptoms of infection have resolved, patients can resume prophylaxis (if indicated) until marrow recovery.</td></tr>
<tr><td colspan="3">Important Notes:
G-CSF therapy may shorten duration of neutropenia but NOT duration of fever and does not affect mortality risk
▪ Restrict use to severely neutropenic patients who do not respond to treatment or when prolonged delay in marrow recovery anticipated
Mean time to defervescence after antibiotic initiation:
▪ Hematologic malignancies – 5 days, Solid tumors – 2 days</td></tr>
</table>

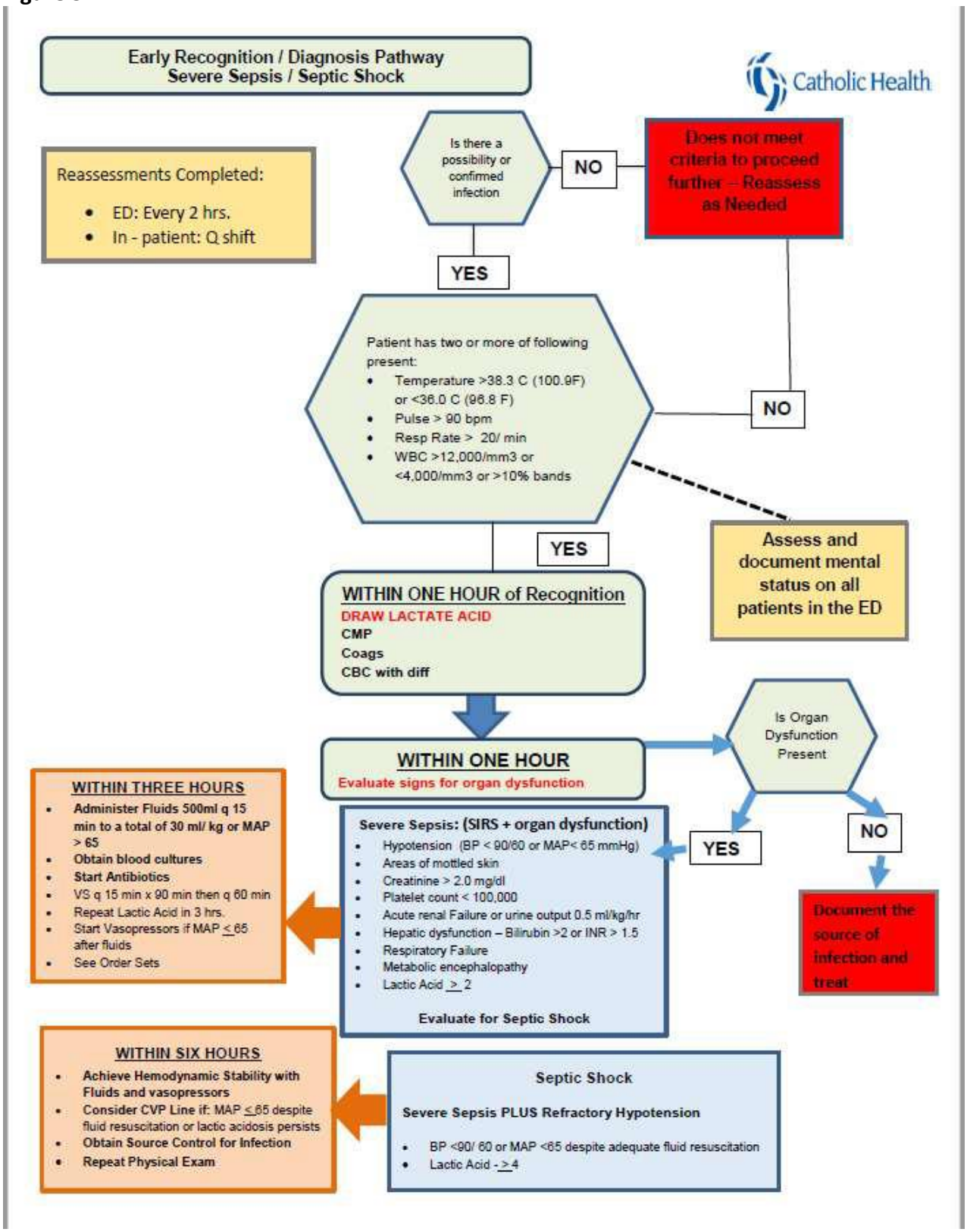
2.8 Severe Sepsis and Septic Shock[51]

Severe sepsis and septic shock are time critical emergencies. Sepsis is defined by the presence of organ dysfunction as a consequence of an infectious process. Evidence of organ dysfunction may include any of the following (if not clearly from another cause):

- Acute kidney injury, oliguria
- Coagulopathy
- Thrombocytopenia
- Acute liver injury (transaminitis, hyperbilirubinemia)
- Cardiac dysfunction (elevated troponin, stress cardiomyopathy)
- Acute respiratory failure
- Lactate >2 mmol/L
- Persistent hypotension (MAP<65 mmHg) despite fluid resuscitation (Septic Shock)

All patients with evidence of severe sepsis and septic shock require rapid administration of antimicrobials, fluids and vasopressors (when BP parameters not achieved). The choice of antimicrobials should be based on diagnosis driven guidelines outlined within the guide and elsewhere.

Figure 5.


Early Recognition / Diagnosis Pathway
Severe Sepsis / Septic Shock
Catholic Health
Reassessments Completed:
ED: Every 2 hrs.
In - patient: Q shift
Is there a possibility or confirmed infection
NO
Does not meet criteria to proceed further – Reassess as Needed
YES
Patient has two or more of following present:
Temperature >38.3 C (100.9F) or <36.0 C (96.8 F)
Pulse > 90 bpm
Resp Rate > 20/ min
WBC >12,000/mm3 or <4,000/mm3 or >10% bands
NO
YES
Assess and document mental status on all patients in the ED
WITHIN ONE HOUR of Recognition
DRAW LACTATE ACID
CMP
Coags
CBC with diff
WITHIN ONE HOUR
Evaluate signs for organ dysfunction
Is Organ Dysfunction Present
YES
NO
Severe Sepsis: (SIRS + organ dysfunction)
Hypotension (BP < 90/60 or MAP< 65 mmHg)
Areas of mottled skin
Creatinine > 2.0 mg/dl
Platelet count < 100,000
Acute renal Failure or urine output 0.5 ml/kg/hr
Hepatic dysfunction – Bilirubin >2 or INR > 1.5
Respiratory Failure
Metabolic encephalopathy
Lactic Acid > 2
Evaluate for Septic Shock
Document the source of infection and treat
WITHIN THREE HOURS
Administer Fluids 500ml q 15 min to a total of 30 ml/ kg or MAP > 65
Obtain blood cultures
Start Antibiotics
VS q 15 min x 90 min then q 60 min
Repeat Lactic Acid in 3 hrs.
Start Vasopressors if MAP < 65 after fluids
See Order Sets
WITHIN SIX HOURS
Achieve Hemodynamic Stability with Fluids and vasopressors
Consider CVP Line if: MAP < 65 despite fluid resuscitation or lactic acidosis persists
Obtain Source Control for Infection
Repeat Physical Exam
Septic Shock
Severe Sepsis PLUS Refractory Hypotension
BP <90/ 60 or MAP <65 despite adequate fluid resuscitation
Lactic Acid - > 4

2.9 Guidance for Treatment of Select Organisms in the Blood

Empiric Antimicrobial Therapy in Patients with New Positive Blood Cultures

The chart below contains suggestions for initiating antibiotics in patients with complete lack of organism coverage at the time of positive culture result. This can also serve as a guide for patients already on antibiotics at the time of positive culture, though therapy may not necessarily need to be changed. The goal at this point in therapy is to adequately cover possible pathogens and not necessarily to streamline to a single, targeted agent.

Culture Result	Antibiotic Therapy
Gram-positive cocci in clusters (groups)	
Rapid ID PCR test: Positive *Staph. aureus*, Positive MRSA	Vancomycin
Rapid ID PCR test: Positive *Staph. aureus*, Negative MRSA (i.e. MSSA)	Oxacillin or Cefazolin* *avoid cefazolin in CNS infections
Rapid ID PCR test: Negative *Staph. aureus*, Negative MRSA (coagulase-negative *Staphylococcus*) Assess for possible contaminant. If indwelling line, profound immune compromise, otherwise concern for true infection, or speciation results as *Staphylococcus lugdunensis*, initiate antibiotics. If contaminant is suspected but antibiotics are still desired, repeat blood cultures *before* administering any antibiotics.	Vancomycin
Gram-positive cocci in pairs or chains	
Suspected *Streptococcus*, *Enterococcus*, or unclear source If high suspicion of Enterococcus or Enterococcus is subsequently identified, ampicillin or daptomycin should be favored over vancomycin. Metronidazole should be added if suspected intra-abdominal source.	Vancomycin OR Ampicillin (2g IV q4h to start) OR Daptomycin† (preferred if history of VRE that is also PCN-resistant)
Gram-negative rods	
No MDR organism history Stable patients with bacteremia secondary to UTI who are currently receiving ceftriaxone may receive tobramycin 5 mg/kg IV x1 dose or expand to the therapy listed to the right pending organism susceptibilities. Metronidazole should be added to cefepime if suspected intra-abdominal source.	Cefepime or Piperacillin/Tazobactam
History of ESBL without history of *Pseudomonas*	Ertapenem†
History or concern of ESBL, with history or concern for *Pseudomonas* (e.g. hospital acquired and/or recent broad-spectrum antibiotic exposure)	Meropenem†
Yeast	Micafungin† (Fluconazole if source is UTI)

Common Blood Culture Contaminants

While any organism has the potential to represent a true positive bacteremia, there are several organisms that often represent contamination. Assessment should be made of any indwelling lines and hardware. If the positive blood culture does not match the clinical situation, consider these organisms to be contaminants, repeating blood cultures before any antibiotic initiation where appropriate.

Gram positive cocci in clusters (groups)—coagulase negative *Staphylococcus*- see above (e.g. *S. epidermidis*, *S. hominis*), *Micrococcus*
Gram positive bacilli (rods)—*Corynebacterium* species other than *C. jeikieum*, *Bacillus* species (non-*anthracis*), *Propionibacterium acnes* (anaerobic), *Clostridium perfringens* (anaerobic)
Gram positive cocci in chains—Viridans group streptococcus (generally alpha-hemolytic, e.g. *S. mitis*, *S. mutans*, *S. salivarius*)—can be pathogenic but still have a significant contamination rate

MRSA= Methicillin-resistant *Staphylococcus aureus*, MSSA= Methicillin-sensitive *Staphylococcus aureus*, MDR= multi-drug resistant, VRE= Vancomycin-resistant *Enterococcus*, PCN= Penicillin, ESBL= Extended-Spectrum Beta-Lactamase, UTI= urinary tract infection

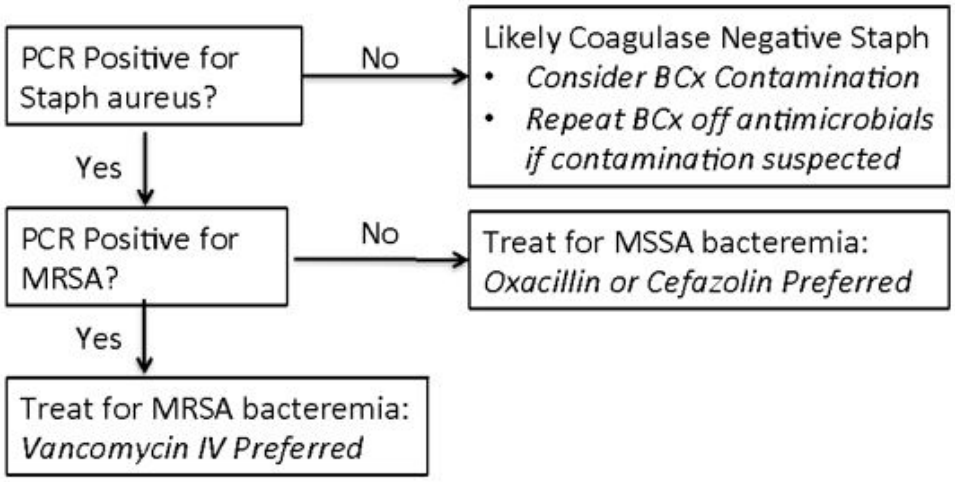
†Restricted drug. Infectious Diseases consult order is NOT mandatory at the time of initial order.

***Staphylococcus aureus* Bloodstream Infection[52-55]**

Staphylococcus aureus bacteremia is associated with substantial morbidity and mortality. All cases of *S. aureus* bacteremia (both MSSA and MRSA) should be aggressively evaluated for metastatic complications and endocarditis. Metastatic infection occurs in up to one-third of cases. Endocarditis is found in one in six cases of *S. aureus* septicemia.[53]
Early Infectious Disease consultation for *S. aureus* bacteremia is associated with a 28-50% risk reduction in mortality.[56-58]

Other *Staphylococcus* species ("coagulase-negative" Staphylococci) often represent blood culture contamination. In some instances, these organisms can cause clinical infection, often in the setting of an indwelling foreign body (e.g. central line, prosthetic heart valve) or in instances of severe immune compromise. *S. lugdunensis* is a highly pathogenic coagulase-negative Staphylococcus species and should be regarded as a pathogen in most instances when found on blood culture.

Interpreting Preliminary Blood Cultures with Gram Positive Cocci in Groups or Clusters*



*** "Gram positive cocci in chains" or "pairs and chains" is suggestive of Streptococcus spp or Enterococcus spp. and do not undergo PCR testing for S. aureus**

Complicated *S. aureus* bloodstream infection requires prolonged antimicrobial therapy and investigation for metastatic and persistent endovascular foci of infection. The *Staphylococcus aureus* bloodstream (SAB) infection score can help predict the likelihood of complicated cases[53]:

- Community acquired =1 point
- Skin findings of embolic disease = 1 point
- Persistent fever at 72h =1 point
- Positive Blood Cultures after 48-96h of appropriate therapy =2 points

SAB Score	Risk of Complicated Infection
0	16%
1	30%
2	40%
3	70%
4	80%
5	90%

Guidance for Managing *Staphylococcus aureus* Bacteremia

Organism	Preferred Agents	Alternative Agents	Duration	Recommended Actions
MSSA	Oxacillin 2gm IV q4h† OR Cefazolin 2gm IV q8h (avoid if CNS involvement)	Vancomycin IV OR Daptomycin*	For uncomplicated cases *minimum* 14 days IV therapy from first set of negative Blood Culture ***Longer durations often required for complicated cases.*** *Evidence of metastatic foci, prolonged bacteremia, persistent sepsis, hematogenous osteomyelitis and endocarditis usually require prolonged durations, often 6 weeks.*	• ID Consultation • Remove any central lines in place preceding bacteremia ASAP • Drain any identified abscesses • Echocardiogram • Repeat Blood Cultures on Rx • Avoid PICC lines until blood cultures clear • Monitor for signs of metastatic foci (septic joints, spine, paraspinal abscess etc.)
MRSA	Vancomycin IV	Daptomycin*		

Notes:

Patients on long term IV antibiotics require weekly monitoring for drug induced toxicity:

- *Oxacillin, Cefazolin → CBC and CMP*
- *IV Vancomycin → CBC, BMP and Vancomycin trough (usual target 15-20 µg/mL)*
- *Daptomycin → CBC, CMP and CPK*

**Requires ID approval for use*

† Oxacillin for home infusion may be ordered as 12gm IV continuous infusion q24h via a portable pump

Gram-Negative bacteremia due to a Urinary Source[59]

Urinary tract infections are a common primary source for gram-negative septicemia at Catholic Health facilities. Common urinary pathogens from the Enterobacteriaciae family such as *E. coli, Klebsiella, Serratia and Proteus* may enter the bloodstream in patients with a severe UTI.

Recommended Actions for Gram-negative bacteremia due to urinary source:

- Assess for upper urinary tract obstruction (renal ultrasound or non-contrast CT)
    - Consult urology if obstruction of upper tract detected
- Assess for lower urinary tract obstruction (post void bladder scan)
    - Place urinary catheter if bladder outlet obstruction detected
- **For uncomplicated patients with rapid clinical improvement, 7 days of organism-directed therapy is adequate for UTI associated Enterobacteriaceae bacteremia (e.g. non-resistant strains of *E. coli, Klebsiella, Serratia)*[59]**
    - Conversion to PO antimicrobials with high a bioavailability agent is appropriate if clinical improvement and patient able to take oral therapy. Nitrofurantoin should never be used to treat bacteremia.
- Longer courses of therapy may be required in cases of UTI-associated bacteremia with Pseudomonas, multidrug resistant gram-negatives, retained stones, and in patients with significant immune compromised status or indwelling ureteral stents.

Pharmacokinetics of Common PO Antimicrobials with Enterobacteriaciae spectrum of coverage

Drug	Dose	Bioavailability
Amoxicillin[60]	500 mg PO q8h	76%
Cephalexin[60]	500 mg PO q6h	90%
Cefdinir[60]	300 mg PO q12h	21%
Levofloxacin[61]	500 mg PO q24h	100%
Trimethoprim/Sulfamethoxazole[60,62]	1 DS tab PO q12h	90%

***Enterococcus* Bacteremia**

Enterococci appear as gram-positive cocci in pairs and chains on gram stain. *Enterococcus faecalis* and *E. faecium* are the two most common *Enteroccus* species responsible for human disease. *E. faecalis* is the more common of the two, accounting for 95% of *Enterococcus* isolates from blood cultures at Catholic Health. The most common sources for bacteremia are genitourinary and bowel.

Enterococci exhibit several important phenotypic characteristics that are associated with increased risk of treatment failure in cases of bacteremia.

- ***Enterococcus* species are always resistant to cephalosporins**. Therefore, empiric use of cepahlosporins for "gram positive cocci in chains" before blood culture species identification is not advised. In contrast, 97% of *Enterococcus* isolated in blood at Catholic Health are sensitive to Ampicillin.
- *Enterococcus* bacteremia may appear with minimal symptoms, often with a subacute presentation of fevers and malaise. Therefore, one should not assume a contaminant if the patient looks "stable".
- Serious *Enterococcus* infections (e.g. endocarditis) typically require two antimicrobials (synergy) to achieve cure.
- *Enterococcus* endocarditis has a subacute presentation. Classical extra-cardiac exam findings of endocarditis are rarely seen in *Enterococcus* endocarditis.
- Risk factors associated with endocarditis in cases of *Enterococcus* bacteremia include: Male sex (OR 2.1), Community-acquired (OR 2.6), unknown primary source (OR 2.9), valvular disease/murmur (OR 2.5) and presence of pacer or ICD (OR 1.9).[63]
- Presence of Vancomycin Resistance (VRE) does not imply ampicillin or penicillin resistance.

Guidance for Managing *Enterococcus* Bacteremia/Suspected *Enterococcus* Endocarditis[64]

Phenotype S =sensitive R= resistant	**Preferred**	**Alternative Agents**	**Duration**	**Recommended Actions**
Ampicillin S **Vancomycin S** **Gent Syn S** **Daptomycin S** **Linezolid S**	Ampicillin 2gm IV q4h *PLUS* Ceftriaxone† 2gm IV q12h	Vancomycin IV *PLUS* Gentamicin 1mg/kg IV q8h	For uncomplicated cases *without evidence of endocarditis 10-14 days therapy* ***Longer durations required for cases of endocarditis or evidence for hematogenous seeding (e.g. discitis) durations, often 6 weeks***.	• ID Consultation • Remove any central lines in place preceding bacteremia ASAP • Evaluate for Endocarditis if risk factors present (see above) • Repeat Blood Cultures while on Rx • Avoid PICC lines until blood cultures clear • Monitor for signs of metastatic foci (septic joints, spine, paraspinal abscess etc.) • Consider colonoscopy if primary source not known
Ampicillin S **Vancomycin R** **Gent Syn S or R** **Daptomycin S** **Linezolid S**	Ampicillin 2gm IV q4h *PLUS* Ceftriaxone† 2gm IV q12h	Daptomycin 10mg/kg q24h *		
Ampicillin R **Vancomycin R** **Gent Syn S or R** **Daptomycin S** **Linezolid S**	Daptomycin 10mg/kg q24h*	Linezolid*		

Notes:

Patients on longterm IV antibiotics require weekly monitoring for drug induced toxicity:

- *Ampicillin, penicillin and ceftriaxone → CBC and CMP*
- *IV Vancomycin → CBC, BMP and Vancomycin trough (usual target 15-20 µg/mL)*
- *Daptomycin → CBC, CMP and CPK*
- *Gentamicin → trough & peak (trough goal <1µg/mL, peak goal 3-4µg/mL), BMP*

† Enterococcus is resistant to ceftriaxone, however when given in combination with Ampicillin or Penicillin there is a synergistic bactericidal effect that significantly improves likelihood of cure. It should never be used as monotherapy for any Enterococcus infection.

**Requires ID approval for use*

Candidemia[65]

Disease specific mortality due to *Candida* blood stream infections is estimated to be 10-20%. Risk factors for *Candida* blood stream infection include: total parenteral nutrition, central venous catheters, recurrent gastrointestinal perforation (e.g. anastamotic leaks), prolonged use of corticosteroids and prolonged use of broad spectrum antibiotics in patients with indwelling vascular catheters.

	Preferred Agent	**Duration**	**Recommended Actions**
Candida -species unknown	Micafungin 100mg IV q24h*§	For uncomplicated cases 14 days therapy from first set of negative blood cultures ***Longer durations often required for complicated cases.*** *E.g. Evidence of metastatic foci, prolonged fungemia, persistent sepsis, hematogenous seeding*	• ID Consultation • Remove any central lines in place preceding fungemia ASAP • Drain any identified abscesses • Repeat blood cultures on therapy (routine blood cultures are adequate) • Ophthalmological exam • Request antifungal susceptibility testing on blood isolates
C. albicans	Fluconazole 800mg IV/PO X 1 then 400mg IV/PO q24h		
C. glabrata *C. krusei*	Micafungin 100mg IV q24h*§		
C. parapsilosis *C. tropicalis*	Micafungin 100mg IV q24h*§ pending susceptibilities, if Fluconazole susceptible then Fluconazole 800mg IV/PO X 1 then 400mg IV/PO q24h		

Notes:

* Requires ID approval >48h use

§ Micafungin is not recommended for the treatment of *Candida* UTI

2.10 Outpatient Regimens for Common Syndromes

The following tables are provided for guidance on empiric antimicrobial choices for patients evaluated in outpatient clinics or discharged from the emergency department. The guidance is based on national guidelines and local resistance trends. In the emergency setting, IV antibiotic doses in accordance with inpatient recommendations may be appropriate before discharge to home. Individual patient factors including drug interactions, kidney disease, history of resistant organisms and other comorbidities should also inform clinical decisions.

Empiric Adult Outpatient Antibiotic Recommendations for Common Syndromes

Diagnosis			Adult Outpatient PO**	Adult Outpatient PO Alternative**	Duration of Therapy
SSTI	Abscess	Purulent	Doxycycline 100mg q12h **OR** SMX-TMP 1 DS tab q12h	Linezolid 600 mg PO BID	5-7 Days
	Cellulitis	Non-Purulent	Cefadroxil 500mg q12h	Cefadroxil 500mg q12h **OR** Linezolid 600 mg PO BID	5-7 Days
	Bites/ Puncture	Human/ Dog/Cat	Augmentin 875mg q12h	Doxycycline 100mg q12h + Metronidazole 500mg q12h	5 days
GI	Diverticulitis		Cefdinir 300mg q12h + Metronidazole 500mg q12h	Ciprofloxacin 500mg q12h + Metronidazole 500mg q12h	5-7 Days
	Colitis		Antibiotics often not warranted if not C. diff, see pp 15-16		
UTI	Cystitis		Nitrofurantoin 100mg q12h x 5d or SMX-TMP 1 DS tab q12h x 3d	Ciprofloxacin 250 mg q12h x 3 days	3 – 5d (7d if CA-UTI)
	Pyelonephritis		Ciprofloxacin 500mg q12h x 7 days	Cefdinir 300mg q12h x 10 days	Depends on agent
Resp.	Upper	Pharyngitis (Group A)	Penicillin V 500mg q12h x 10d	Azithromycin 500mg daily x 5d	Depends on agent
		Sinusitis* (bacterial)	Augmentin 875/125mg q12h	Doxycycline 100mg q12h	5-7 Days
		Otitis Media	Amoxicillin 500mg q12h x 5-7 days or 875mg q12h x 10 days if severe	Azithromycin (Z-Pak) for 5 days	Depends on agent
	Lower	CAP without comorbidities[$]	Amoxicillin 1 g q8h **OR** Doxycycline 100mg q12h	Azithromycin (Z-Pak)	5 Days
		CAP with comorbidities[$]	Augmentin 875/125mg q12h *or* Cefdinir 300mg q12h **PLUS** either: Azithromycin (Z-Pak) *or* Doxycycline 100mg q12h	Levofloxacin 750 mg daily	
Dental Abscess			Augmentin 875/125mg q12h	Clindamycin 300mg q8h	7 days
Shingles			Valacyclovir 1gm q8h	Acyclovir 800mg 5 x day	7 days

**SMX-TMP, ciprofloxacin, levofloxacin, nitrofurantoin, valacyclovir, acyclovir, amoxicillin, cefdinir, and Augmentin may require dose adjustment for renal dysfunction

Notes:* Diagnose acute **bacterial sinusitis based on symptoms that are: **Severe (>3-4 days),** such as a fever ≥39°C (102°F) and purulent nasal discharge or facial pain; OR **Persistent (>10 days) without improvement**, such as nasal discharge or daytime cough; OR **Worsening** with new onset fever, daytime cough, or nasal discharge with *after* initial improvement of a viral upper respiratory infections (URI) that lasted 5-6 days.

[$]Comorbidities include: chronic heart, lung, liver, or renal disease, diabetes mellitus, alcoholism, malignancy, or asplenia

Sexually Transmitted Infection Treatment Recommendations[66]

Sexually Transmitted Infections			
Type of Infection	**Preferred Therapy**	**Alternative Option**	**Duration of Therapy**
Chlamydia	Doxycycline 100mg q12h x 7 days	Azithromycin 1 gm PO x1	Depends on agent
Gonorrhea	Ceftriaxone 500mg IM x 1 (1g x1 for patient weight≥150 kg)	Gentamicin 240mg IM x 1 PLUS Azithromycin 2gm x 1	1X dose
Syphilis, Primary, Secondary & early latent	Benzathine Penicillin G 2.4 million units IM X1	Doxycycline 100mg PO q12h X14 days	Depends on agent
Syphilis, late latent & unknown latency	Benzathine Penicillin G 2.4 million units IM qweek X 3 doses	Doxycycline 100mg PO q12h X28 days	Depends on agent
Syphilis, Tertiary	*Normal CSF/No CNS or Ocular Symptoms:* Benzathine Penicillin G 2.4 million units IM qweek X 3 doses *Abnormal CSF/Neurosyphilis/Ocular:* Penicillin G 3-4 million units q4h X10-14 days	Consult ID	Varies
PID	Ceftriaxone 250mg IM x 1 + Doxycycline 100mg q12h +/- metronidazole 500mg q12h	Levofloxacin 500mg daily + metronidazole 500mg BID	14 days
Trichomonas	Women: Metronidazole 500 mg PO BID x 7 days Men: Metronidazole 2 g PO x 1 dose		
HSV2	Valacyclovir 1gm q12h	Acyclovir 400mg q8h	7-10 Days
Bacterial Vaginosis	Metronidazole 500mg q12h x 7d OR Metronidazole gel 0.75% vaginally daily x 5d	Clindamycin cr 2% vaginally QHS x 7d OR Clindamycin 300mg q12h x 7d	Depends on agent

Empiric Pediatric Antibiotic Outpatient Recommendations

Diagnosis			Pediatric Outpatient PO	Pediatric PO Alternative	Duration of Therapy
SSTI	Abscess	Purulent	SMX-TMP 5mg/kg/dose (of TMP component; max 160mg) q12h	Clindamycin 10mg/kg/dose (max 300mg) q8h	5-7 Days
	Cellulitis & Impetigo	Non-Purulent	Cephalexin 10mg/kg/dose (max 500mg) q6h	Clindamycin 10mg/kg/dose (max 300mg) q8h	5-7 Days
	Bites/ Puncture	Human/ Dog/Cat	Augmentin 15mg/kg/dose q12h	SMX-TMP 5mg/kg/dose (of TMP component; max 160mg) q12h **AND** Metronidazole 10mg/kg/dose (max 500mg) q12h	5 days
GI	Gastroenteritis/ Colitis		Antibiotics usually not warranted		
UTI	Cystitis		Cefdinir 14mg/kg/dose daily (max 600mg)	SMX-TMP 5mg/kg/dose (of TMP component; max 160mg) q12h	5 – 10 days
Resp.	Upper	Pharyngitis (Group A)	Amoxicillin 25mg/kg/dose (max 500mg/dose) q12h x 10 days	Azithromycin 12mg/kg (max 500mg) x 5d	Depends on agent
		Sinusitis*	Augmentin 45mg/kg/dose q12h (max 2g/dose) x 7 – 10 days	Cefdinir 14mg/kg/dose daily (max 600mg) **OR** Levofloxacin 20mg/kg/dose daily (max 500mg)	10 days
		Otitis Media†	Amoxicillin 45mg/kg/dose q12h (max 1.5g/dose) **OR** Augmentin 45mg/kg/dose q12h (max 2g/dose)	Cefdinir 14mg/kg/dose daily (max 600mg) x 10 d **OR** Azithromycin 10mg/kg/dose (500mg) x 1, then 5mg/kg/dose x 4 more days	Depends on agent
	Lower	CAP	Amoxicillin 80-90mg/kg/day divided q12h-q8h (max of 3g/day)	Cefdinir 14mg/kg/dose daily (max 600mg) **OR** Azithromycin 10mg/kg/dose (max 500mg) x 1, then 5mg/kg/dose (max 250mg) x 4 more days	7-10 Days

Notes: Augmentin: use Augmentin ES 600mg/5mL for OM, sinusitis, and CAP in children >3 months and weight less than 40kg otherwise **use Augmentin 250mg/5mL.** Bactrim supplied as 200mg SMX – **40mg TMP/5mL.** Cephalexin suspension = 250mg/5mL Clindamycin suspension = 75mg/5mL.

*Bacterial Sinusitis can be diagnosed if any of the following criteria are met: A) nasal discharge or daytime cough >10 days; B) worsening or new onset fever, daytime cough, or nasal discharge after initial improvement of a viral URI; C) fever ≥102°, purulent nasal discharge for at least 3 consecutive days.

† Mild otitis cases with unilateral symptoms in children 6-23 months of age or unilateral or bilateral symptoms in children >2 years may be appropriate for watchful waiting based on shared decision-making.

2.11 Perioperative Antibiotic Prophylaxis[67,68]

Antibiotics given prior to surgical incision can dramatically reduce the risk of post-operative surgical site infection. Antibiotic prophylaxis is only effective if the first dose is provided before the initial incision. Additional doses should be given intra-operatively in cases of excessive blood loss or if the procedure extends beyond two half-lives of the prophylactic drug given (e.g. cefazolin if the procedure is ongoing after 4 hours from the initial dose). **There are no data to support additional antibiotic prophylaxis in uninfected individuals after the case is completed. Further, there are no data to support continuation of antimicrobials when drains are left in place in uninfected patients.**

Refer to the Pre-op Surgery Antibiotic order set in Epic. An example of the language used in this order set is shown on the following page.

The goal of this order set is to give patients the best possible therapy, with first-line options usually being a cephalosporin. As preoperative antibiotics, these drugs have shown to be more effective at preventing infection AND have lower rates of adverse reactions. Special attention should be paid to the language regarding when there is need to avoid cephalosporins in patients with listed beta-lactam agent allergies. In many cases, patients with listed beta-lactam allergies can still safely receive the first-line cephalosporin agent.

SURGICAL INFECTION PROPHYLAXIS

A goal of prophylaxis with antibiotics is to provide benefit to the patient. Administration of antibiotics for more than a few hours after the incision is closed offers no additional benefit to the surgical patient. **Prolonged administration increases the risk of Clostridium difficile infection and the development of antimicrobial resistant pathogens**.

The following antibiotic(s) is to be initiated within 60 minutes ***prior*** to incision (120 minutes prior to incision for levofloxacin (Levaquin) and Vancomycin). See selection in matrix below.

Intra-Abdominal
Bowel Resection, Appendectomy, Colorectal

Preferred therapy:

- ❑ Ceftriaxone 2 gram IV + Metronidazole 500mg IV

*Preferred therapy includes patients with no antibiotic allergy considerations as well as patients with a penicillin/amoxicillin/ampicillin allergy with anything EXCEPT a Serious Type II-IV Hypersensitivity (HSR, see figure 1) OR any non-ceftriaxone/cefepime/cefotaxime/cefditoren/cefpodoxime/ceftaroline cephalosporin allergy with anything EXCEPT a Serious Type II-IV HSR (see figure 1)

Alternative for: Penicillin/Amoxicillin/Cephalosporin (any)/Carbapenem allergy with a Serious Type II-IV HSR (see figure 1) OR any ceftriaxone/cefepime/cefotaxime/cefditoren/cefpodoxime/ceftaroline allergy that isn't simply a drug intolerance (nausea, headache, diarrhea, etc., see figure 1)

- ❑ Levofloxacin 500 mg IV + Metronidazole 500 mg IV

Esophageal, Gastroduodenal, Biliary Tract, Cholecystitis

Preferred therapy:

- ❑ Cefazolin 2 grams IV
- ❑ Cefazolin 3 grams IV [patients ≥ 120 kg (264 lbs.)]

*Preferred therapy includes patients with no antibiotic allergy considerations as well as patients with a penicillin/amoxicillin/ampicillin with allergy with anything EXCEPT a Serious Type II-IV HSR (see figure 1) OR any non-cefazolin cephalosporin allergy with anything EXCEPT a Serious Type II-IV HSR (see figure 1)

Alternative for: Cefazolin allergy OR Penicillin/Amoxicillin/Cephalosporin (any)/Carbapenem allergy with a Serious Type II-IV HSR (see figure 1)

- ❑ Levofloxacin (Levaquin) 500 mg IV

Table 1. Hypersensitivity Reactions (HSRs)

Type I Hypersensitivity Reactions (IgE-mediated)	Serious Type II-IV Hypersensitivity Reactions (avoid ALL beta-lactams)	Mild Reactions/ Side effects/ Non-Allergies
Anaphylaxis	Serum Sickness	Itching
Angioedema	Stevens-Johnson Syndrome	Minor Rash (mild Type IV hypersensitivity)
Wheezing	Toxic Epidermal Necrolysis	Nausea
Laryngeal edema	Acute Interstitial Nephritis	Vomiting
Bronchospasm	Acute generalized exanthematous pustulosis	Diarrhea
Hypotension	Drug Reaction with Eosinophilia and Systemic Symptoms Syndrome	Headache
Hives/Urticaria	Hemolytic Anemia	Dizziness
	Drug Fever	Record lists allergy but patient denies
	Neutropenia	Family history of allergy (patient has never received the drug)
	Thrombocytopenia	
	Vasculitis	
	Immune Hepatitis	

Open Fracture Antibiotic Prophylaxis Recommendations pending repair*

Type of Fracture	Preferred	Alternative for cephalosporin allergy or history of MRSA
Type 1 + 2	Cefazolin 2gm IV q8h	Vancomycin 1gm IV q12h (1.5g if >90kg)
Type 3	Ceftriaxone 1gm IV q24h *Water exposure:* Cefepime 2gm IV q8h	Vancomycin 1gm IV q12h (1.5g if >90kg) *PLUS* Levofloxacin 500mg IV q24h

* Tetanus vaccine status should be addressed and guidelines followed for tetanus vaccination when indicated
Gustilo-Anderson grades for open fracture:
Type 1: wound less than 1 cm long and clean
Type 2: clean laceration greater than 1 cm long without extensive soft tissue damage, flaps, or avulsions
Type 3: large wound with extensive soft tissue damage, or a traumatic amputation

Perioperative Antibiotic Re-dosing Frequencies

Perioperative Antibiotic	Intraoperative Re-dosing	Re-dosing Frequency (if case not completed)
Cefazolin (Ancef)	Yes	≥4h from last dose
Ceftriaxone (Rocephin)	Not Necessary	N/A
Cefoxitin	Yes	≥2h from last dose
Cefepime	Not Necessary	N/A
Aztreonam	Yes	≥4h from last dose
Ampicillin-sulbactam	Yes	≥2h from last dose
Piperacillin-tazobactam	Yes	≥2h from last dose
Gentamicin	Not Necessary	N/A
Metronidazole	Not Necessary	N/A
Clindamycin	Yes	≥6h from last dose
Vancomycin	Not Necessary	N/A
Levofloxacin	Not Necessary	N/A
Ertapenem	Not Necessary	N/A
Daptomycin	Not Necessary	N/A
Linezolid	Not Necessary	N/A

Miscellaneous

Table 7. Daily Sodium Content of Common Intravenous Antimicrobials[69]

Default admixtures are highlighted in gray where applicable

Antibiotic	Regimen	Diluent	Total volume per 24 hours	Total Sodium per 24 hours
Penicillin G Potassium	4 million units IV q4h	NS	600 mL	2340 mg
		D5W	600 mL	160 mg
Ampicillin	2 grams IV q6h	NS	400 mL	1940 mg
Ampicillin/Sulbactam	3 grams IV q6h	NS	400 mL	1880 mg
Oxacillin	2 g IV q4h	NS	600 mL	2890 mg
		D5W	600 mL	770 mg
Piperacillin/ Tazobactam	3.375 grams IV q8h (ext. inf.)	NS	300 mL	1550 mg
		D5W	300 mL	490 mg
Cefazolin	2 grams IV q8h	NS	300 mL	1200 mg
		D5W	300 mL	290 mg
		Premix product	150 mL	280 mg
Ceftriaxone	1 gram IV q24h	NS	100 mL	440 mg
		D5W	100 mL	80 mg
		Premix product	50 mL	80 mg
Cefepime	2 grams IV q8h	NS	300 mL	1060 mg
		D5W	300 mL	0 mg
		Premix product	150 mL	0 mg
Aztreonam	2 grams IV q8h	NS	300 mL	1060 mg
		D5W	300 mL	0 mg
Ertapenem	1 gram IV q24h	NS	100 mL	490 mg
Meropenem	1 gram IV q8h	NS	300 mL	1330 mg
		Premix product	150 mL	870 mg
Levofloxacin	750 mg IV q24h	Premix product	150 mL	0 mg
Azithromycin	500 mg IV q24h	NS	250 mL	1000 mg
		D5W	250 mL	110 mg
Vancomycin*	1 gram IV q12h**	NS	500 mL	1770 mg
		D5W	500 mL	0 mg
Daptomycin	500 mg IV q24h	NS	50 mL	180 mg
Linezolid	600 mg IV q12h	NS premix product	600 mL	2400 mg
		D5W premix product	600 mL	230 mg
Ceftaroline	600 mg IV q12h	NS	200 mL	350 mg
		D5W	200 mL	0 mg
Doxycycline	100 mg IV q12h	NS	200 mL	700 mg
		D5W	200 mL	0 mg
Clindamycin	900 mg IV q8h	Premix product	150 mL	0 mg
TMP/SMX	350 mg IV q8h	D5W	1500 mL	0 mg
Metronidazole	500 mg IV q12h	Premix product	200 mL	640 mg

Default diluents are based on availability and may vary by CHS site. Unless specified in an order, drug will be supplied by pharmacy in this form. In general, values above can be proportionately adjusted to patient-specific drug regimens (e.g. lower doses due to renal dose adjustments).

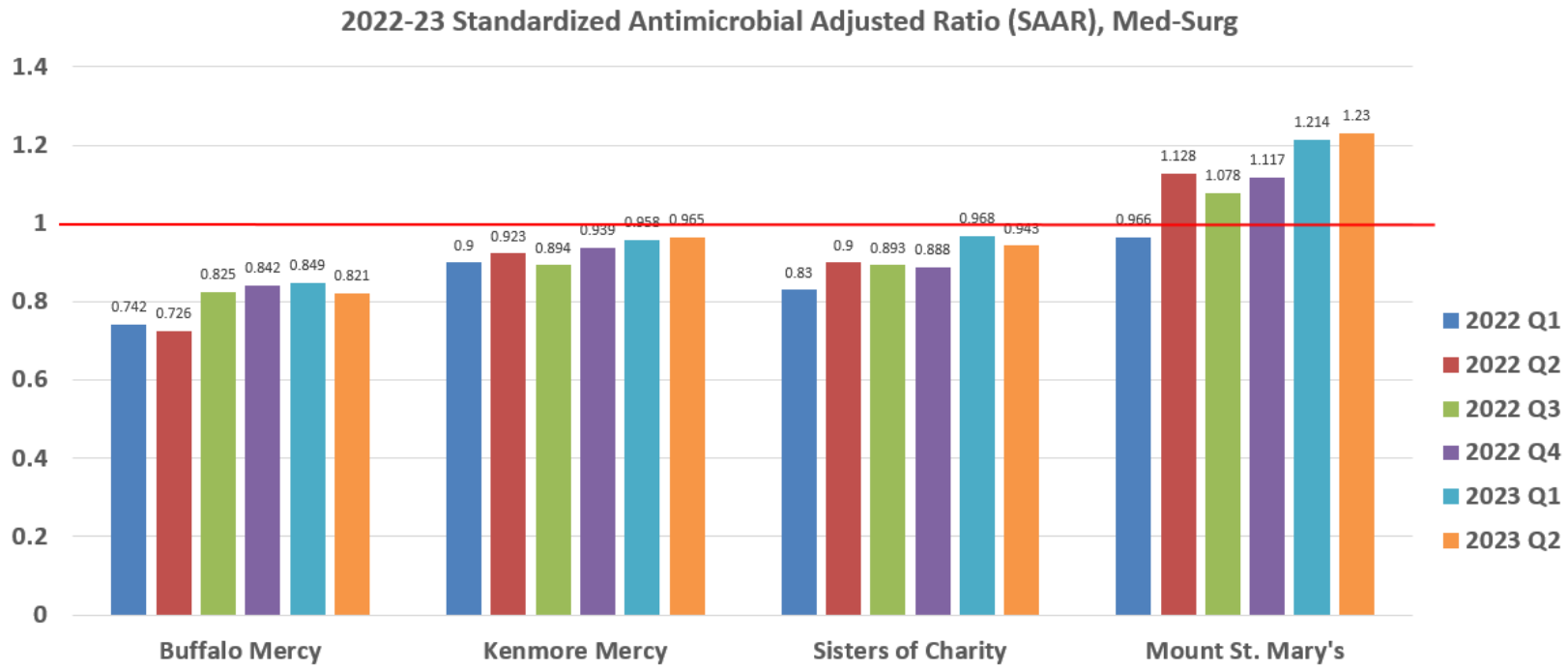
*Default diluent is highly variable

**Dose is highly variable

SECTION 3.
Antimicrobial Utilization Data

3.1 Figure 6. Antimicrobial Use

The Catholic Health Antimicrobial Stewardship committee tracks antimicrobial use and antimicrobial resistance trends across sites.



Using data submitted to the NHSN, the SAAR is a risk-adjusted summary measure of antimicrobial use, and compares observed antimicrobial days to predicted antimicrobial days for groups of antimicrobial agents used in specified patient care locations. A SAAR greater than 1.0 indicates more antimicrobial days were observed than predicted; conversely, a SAAR less than 1.0 indicates fewer antimicrobial days were observed than predicted.

SECTION 4.
Infection Prevention and Control Guide

Many healthcare associated infections are preventable with close adherence to basic infection prevention and control recommendations. The subject matter outlined below is a basic primer on infection prevention standards for Catholic Health facilities. The full policies behind many of the recommendations listed below are found under the M-Files tab on the Catholic Health intranet page.

Additional resources for infection prevention are found on the Catholic Health intranet's "Click on the Bug" website (https://my.chsbuffalo.org/edu/infection-control) or by contacting your facility's infection preventionist.

4.1 Hand Hygiene[70]

Hand hygiene is the cornerstone of infection prevention within healthcare settings. The routine utilization of hand hygiene by healthcare workers is an established and highly effective means of infection prevention for patients and associates.

When to preform hand hygiene

- Before touching a patient (even if planning to wear gloves)
- After touching a patient (even if gloves were worn)
- After touching anything within the patient's care area (e.g. light switch, bed, IV pump, call bell, etc.) even if gloves were worn.
- Before any aseptic task (e.g. placing a urinary catheter)
- Anytime one's hands become visibly soiled

Hand hygiene should also be performed after going to the bathroom, before eating or if one suspects significant contamination (e.g. after coughing into one's hand)

What to sanitize hands with

In most instances, alcohol based hand rub is suitable for hand hygiene. Soap and water must be used in situations where the hands are visibly soiled or when exiting a *Clostridium difficile* isolation room. Soap and water can also be used in lieu of alcohol based hand sanitizer at any time if preferred.

How to sanitize hands

Alcohol-based hand rub: The dispensed solution should be rubbed on the hands, between fingers and onto the wrists until no longer moist.

Soap and water: First wet hands under faucet. The water does not need to be hot. Next, apply soap to the hands, rubbing together to produce lather. Rub the lather onto the fingertips, between the fingers and onto the backs of hands and wrists. The entire process should take about twenty seconds. Dry hands with a clean paper towel.

4.2 Standard Precautions

Standard precautions apply to all patients regardless of suspected or confirmed infection status in any healthcare setting.

In addition to hand hygiene, additional Personal Protective Equipment (PPE) may be required to prevent contamination of healthcare personnel. Wear PPE when the anticipated patient interaction indicates that contact with blood or body fluids may occur. Hand hygiene must always occur, even if gloves and other PPE were used.

- Gloves should be worn to reduce the likelihood of blood or body fluid contamination for:
  - Touching blood, body fluids, mucous membranes or non-intact skin of all patients.
  - Handling items and surfaces soiled with blood or body fluids.
  - Performing venipuncture, phlebotomy or other vascular procedures
  - When the health care worker has cuts, scratches or other breaks in the skin.
  - Gloves should be changed after each patient contact and during procedures if they become torn or damaged or have been in contact with a contaminated body site.

- Wear a gown when contact with blood, body fluids, secretions, or excretions is anticipated.
- Wear a mask and eye protection to protect the eye, nose and mouth when procedures and activities are likely to generate splashes or sprays of blood and/or body fluids.
- Wear a mask for the insertion of catheters or material into spinal or epidural spaces.
- Patient resuscitation should be done using a mouthpiece, resuscitation bag or other ventilation device to prevent contact with mouth and oral secretions.
- Wear mask to prevent transmission of respiratory pathogens when evaluating patients with significant respiratory symptoms. Instruct symptomatic patients to cover mouth/nose when sneezing/coughing, use tissues and dispose of appropriately.
- Specimens of blood and body fluid from all patients are considered infective. Specimen containers should be placed in clear, sealed bags for transport.
- Per OSHA guidelines, healthcare workers should refrain from eating and drinking in patient care areas where blood and body fluid may have contaminated surfaces.

4.3 Transmission-Based Guidelines

In addition to Standard Precautions, use of Transmission-Based Precautions is necessary for patients with infections from highly transmissible and/or epidemiologically important pathogens. In these instances, additional control measures are needed to prevent transmission within the facility.

There are five types of isolation precautions: Contact, Enteric Contact, Droplet, Airborne and Enhanced. Each type of precaution is designed to prevent transmission by a particular route.

Contact Precautions: Prevent spread of organisms by direct physical contact. Healthcare workers must wear a gown and gloves upon room entry. Dedicated stethoscopes, blood pressure cuffs and disposable thermometers should be used. Equipment taken out of a contact isolation room should be thoroughly cleaned before coming into contact with another patient. All people exiting the room must perform hand hygiene.

Enteric Contact Precautions: Prevent spread of contagious organisms found in feces by direct physical contact. Healthcare workers must wear a gown and gloves upon room entry. Dedicated stethoscopes, blood pressure cuffs and disposable thermometers should be used. Equipment taken out of a contact isolation room should be thoroughly cleaned before coming into contact with another patient. **All people exiting the room must wash hands with soap and water.**

Droplet Precautions: Prevent spread of organisms by large droplets from the respiratory route. Healthcare workers must wear a surgical mask within six feet of a person on droplet precautions. All people exiting the room must perform hand hygiene.

Airborne Precautions: Prevent spread of organisms by aerosolized particles from the respiratory route. Healthcare workers must wear an N95 respirator or Powered Air Purifying Respirator (PAPR) when entering the room of a person on airborne precautions. Aerosolized organisms may remain suspended in the air for several minutes to hours. Therefore, all patients on airborne isolation must be placed in a negative pressure room to prevent infectious organisms from escaping the room via air currents. All people exiting the room must perform hand hygiene.

Enhanced Precautions: Prevent the spread of highly transmissible, epidemiologically relevant pathogens including emerging/novel pathogens with unknown transmission dynamics. Healthcare workers must wear an N95 or equivalent respirator, eye protection, gown, and gloves upon room entry. Dedicated stethoscopes, blood pressure cuffs and disposable thermometers should be used. The door to the room should be closed. Equipment taken out of an enteric isolation room should be thoroughly cleaned before encountering another patient. All people exiting the room must perform hand hygiene.

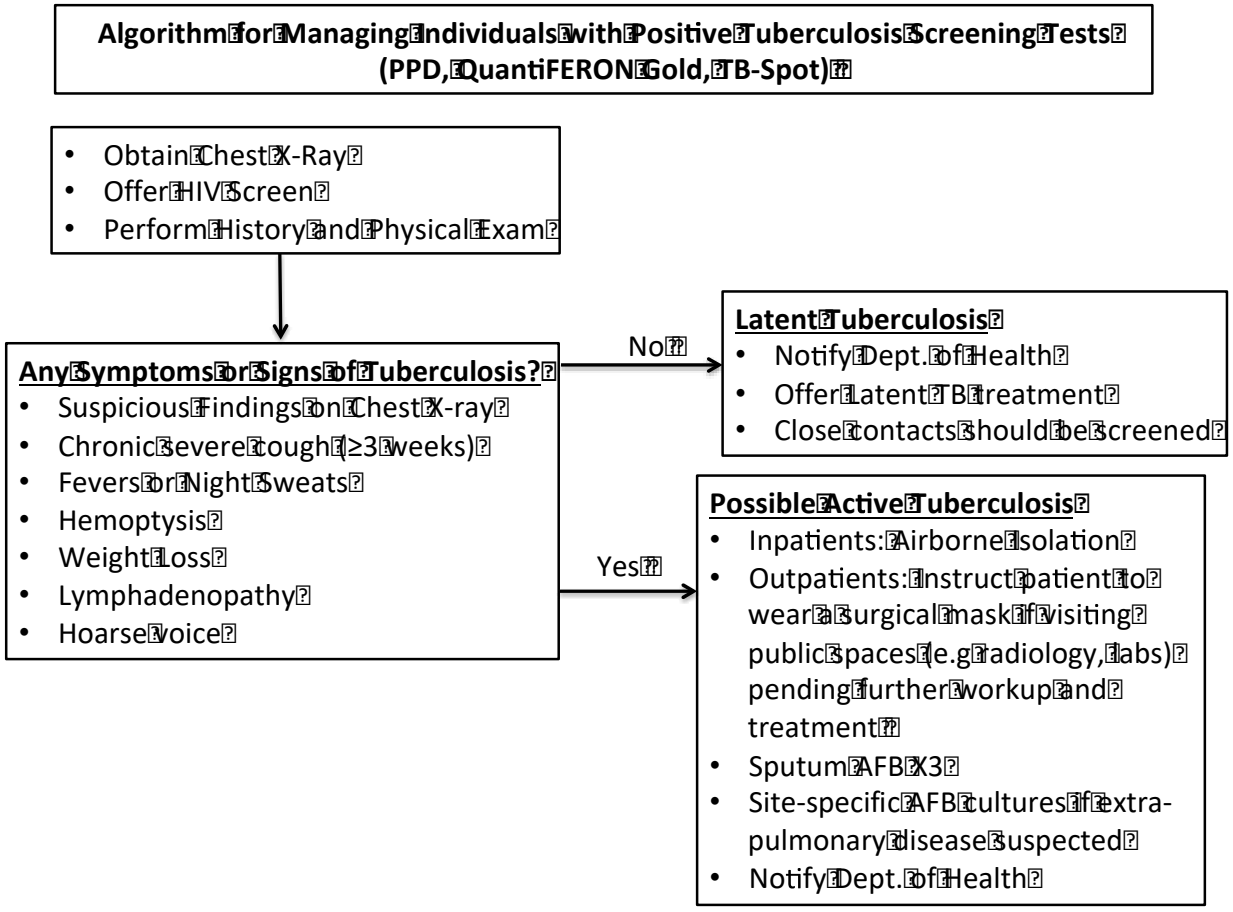
The table listed on the following page highlights some important syndromes and organisms where transmission-based precautions are necessary. A full listing can be found under Catholic Health Policy IC. 103.
https://secure5.compliance360.com/DMZ/Policy/PolicySearch.aspx?PD=O8WBP3JVW9br7RsJgeziB5OVmAaK7JLONj8bXJ7IjAdslr1izgnoqgunJpCukIEW2Y1c4gLlmdgzFADESUwO8KfNDuO4g1PT%2bl15eGb8XSJHyqgjzSnvszOXePe4vRSN

Frequently Encountered Conditions requiring Transmission-Based Precautions

Disease/Syndrome	Isolation Type	Duration of Isolation	Notes
Cavitary Lung Lesion or Chronic Pneumonia (≥3 weeks symptoms)	Airborne –possible tuberculosis	Until 3 sputum AFB collected at least 8h apart are smear negative AND no ongoing suspicion for pulmonary tuberculosis	Consider tuberculosis in any patient presenting with cavitary lung lesions or chronic cough with infiltrates of unknown etiology
Clostridioides (Clostridium) difficile	Enteric Contact	Isolation must begin when C. difficile test ordered. Precautions must remain in place for the remainder of hospitalization if positive test (DNA+ or Toxin+)	Soap and water hand washing when leaving the room. A negative test after treatment does not qualify for removal from precautions.
Draining Wounds - Uncontrolled	Contact	Until drainage can be controlled with local dressings	Any large draining wound that cannot be contained with dressings
Influenza	Droplet	Minimum seven days from symptom onset or 24 from last fever –whichever is longer. Symptoms beginning days prior to admission count toward this calculation.	Antiviral therapy does not alter precaution duration.
COVID-19	Enhanced	Minimum 10 days from symptom onset. Symptoms beginning days prior to admission count toward this calculation. In cases of critical illness or severe immunocompromise isolation can last up to 20 days	Patients do not need to remain hospitalized to complete isolation if healthy enough for discharge
Measles	Airborne	Contagious 4 days prior through 4 days after rash onset	Suspect if *Cough, Conjunctivitis Coryza, Morbilliform Rash*
Meningitis -Community Acquired (*N. meningitidis* and *H. influenzae*)	Droplet	24 hours from antibiotic start	Post exposure prophylaxis may be warranted for close contacts of N. meningitidis cases that did not use droplet isolation.
Methicillin Resistant *S. aureus* (MRSA), wounds and uncontrolled drainage	Contact	Until therapy complete AND no further signs of drainage/pus from source.	Empiric contact precautions can be instituted in cases with prior resistant organism history and associated draining wounds or heavy secretions
Vancomycin Resistant *Enterococcus* (VRE) wounds and uncontrolled drainage			
ESBL+ E. coli & Klebisella wounds and uncontrolled drainage			

Multi Drug Resistant Gram-Negative Rods (CRE, MDR Pseudomonas, MDR Acinetobacter)	Contact	Through hospitalization and on future admissions	Can persist in/on patients and can survive on surfaces for long periods
Tuberculosis, Pulmonary - confirmed	Airborne	Contact Infection Prevention for guidance	Precautions typically remain in place until improvement in symptoms while on therapy
Vesicular Rash in multiple dermatomes - Possible disseminated Zoster	Airborne and Contact	Until lesions crusted	Visitors and staff without prior chickenpox or vaccination should avoid entering the room.

Figure 7. Guidance for Evaluating Individuals with positive Tuberculosis Screening Tests



4.4 Preventing Device-Associated Infections

Indwelling medical devises are a major cause of healthcare associated infections. Central venous catheters and indwelling urinary (Foley) catheters are collectively responsible for the majority of device-associated infections within acute care settings. **The best way to avoid device-associated infections is to avoid their use whenever possible.**

Central Lines (e.g. PICC, Triple Lumen, Hemodialysis, Cordis, Mediport, Hickman, Hohn)

Indications for Central Lines:

- CVP monitoring or prolonged vasopressor use in a critically ill patients
- Infusion of vesicants (e.g. chemotherapy) and hyperosmolar solutions (e.g. TPN)
- Planned long term antimicrobial therapy
- Planned long term outpatient infusion therapy
- Hemodialysis

Central lines should be removed as soon as the indication for placement is no longer present (assuming no new indication has developed). Lines should never be left in for convenience except in cases of hospice/end of life care.

Midline Catheters should be used if vascular access cannot be achieved with a PIV unless another indication for central access is also identified as listed above.

Central line insertion bundle

- Use an alternative method of venous access whenever possible (peripheral IV or midline catheter)
- Avoid the femoral location
- Participants must wash hands before procedure
- Use chlorhexidine-alcohol to prep skin and allow to completely dry before proceeding
- Participants must wear a mask, cap, sterile gloves and sterile gown.
- The patient must be covered from head to toe under a sterile drape leaving only the prepped insertion area exposed.
- Ultrasound probes used in any central line insertion must be covered with a sterile sheath and only sterile ultrasound gel should be used during the procedure.
- The insertion site should be covered with a chlorhexidine patch and sterile dressing that is signed and dated.

Central line care and maintenance

- The indication for a central line should be reviewed and documented daily. It should be removed promptly if no longer indicated.
- Hand hygiene should be performed before accessing any central line.
- An alcohol swab should be used to scrub the access port for 15 seconds before any access procedure occurs.
- Dressings should be changed weekly and whenever soiled or falling off.
- Lines placed under non-sterile (emergent) conditions should be removed and replaced (if central access still required) as soon as possible.

Indwelling Urinary Catheters (Foley Catheters)

The indication for a Foley catheter should be reviewed and documented daily. It should be removed promptly when no longer indicated.

Urine cultures should not be sent from urinary catheters unless clinical signs or symptoms of UTI are present. See pp. 19-20 for additional details on indications and protocol for urine cultures in catheterized patients.

Appropriate indications for urinary catheters

- Management of acute urinary retention or urinary obstruction
- Neurogenic bladder dysfunction/chronic indwelling urinary catheter
- Patients requiring accurate assessment of urinary output (strict I&O) when other means are not possible
- Recent surgery involving bladder or urinary tract
- Assistance in sacral wound healing for Stage III and IV pressure ulcers for incontinent patients
- Patients with epidural catheters in place
- Hospice/end of life care

Inappropriate use of urinary catheters include:

- Continued use of urinary catheter when no longer needed
- Urinary incontinence without stage III/IV sacral wounds
- Nursing convenience
- Patient/family request

4.5 Infection Control Emergencies

Occasionally, patients may present with syndromes or diagnoses that present a critical hazard to associates, other patients and the public. In such instances, early recognition, communication and control measures can prevent a larger public health crisis.

In conjunction with public health authorities, the infection prevention department will periodically send communications to front line providers regarding emerging infection threats. Additionally, it is all providers' responsibility to maintain a level of suspicion for highly transmissible infections in patients presenting with unusual syndromes, particularly with recent travel history.

Whenever concern arises, the infection preventionist on call should be notified and the patient should be kept in a single room with the door closed pending an infection prevention and control consultation. Infection prevention will coordinate with public health authorities when concern for serious transmissible infection persists. The table below lists some examples when infection prevention should be called immediately.

The table below is not exhaustive. When in doubt: call. It is always better to contact Infection Prevention whenever there is concern about a potential highly transmissible infection.

Syndrome (Diseases of concern)	**Clues**	**Control Measures**
Cough, Conjunctivitis Coryza, Morbilliform Rash (Measles)	• Upper respiratory illness • High Fever • Lack of Childhood Vaccines • Known measles exposure • Morbilliform rash starting on face • Bluish-white raised lesions on buccal mucosa (Koplik's spots) • Conjunctival injection	Airborne Precautions
Sepsis in a returning traveler from region with viral hemorrhagic illness outbreak (Ebola, Marburg, Crimean-Congo)	• Fever • Nausea, vomiting • Diarrhea • Hemorrhage • Maculopapular rash	Enhanced Precautions
Severe Respiratory Illness in returning traveler from region with novel respiratory virus outbreak (e.g. MERS, avian influenza, SARS)	• Fever • Cough • Upper respiratory symptoms • Respiratory Distress -Severe • Recent travel from outbreak area	Enhanced Precautions
Vesicular Rash over body with lesions all at same stage (Smallpox, Mpox)	• Oral lesions precede body rash • High fever • Umbilicated vesicular rash starting on face and limbs • Lesions all at same stage • Myalgias, back pain	Enhanced Precautions

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