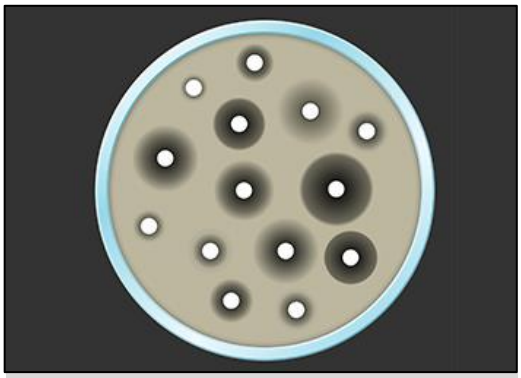
Antimicrobial Stewardship Strategy: Antibiograms

A summary of the cumulative susceptibility of bacterial isolates to formulary antibiotics in a given institution or region. Its main functions are to guide choice of empiric therapy and track resistance patterns.



@istock.com/Youst

Priority Level: **A**

Difficulty Level: **2**

Program Stage:

- ✓ Early
- Intermediate
- Advanced

For more information on these criteria and how they were developed, please see the Antimicrobial Stewardship Strategy Criteria Reference Guide.

Description

This is an overview and not intended to be an all-inclusive summary. As a general principle, patients must be monitored by the health care team after changes to therapy resulting from recommendations made by the antimicrobial stewardship team.

An antibiogram is a summary of the cumulative susceptibility of bacterial isolates to formulary antibiotics during a specified period. It represents the proportion of each bacterium that is susceptible to a given formulary antibiotic.

Antibiograms are frequently used to highlight local (e.g., institutional) susceptibility data. They are usually published annually. They can also reveal the frequency of isolation of certain organisms (e.g., whether there is a high prevalence of *Pseudomonas aeruginosa* in a region).

Antibiograms typically represent isolates from an entire institution, but more specific antibiograms may be created for areas within an institution, or for infections with different resistance patterns if enough isolates are available (e.g., specific to intensive care units [ICUs] or oncology wards, urinary isolates, respiratory isolates from patients with cystic fibrosis).

Antibiograms can vary from institution to institution, even within the same city, because of differences in populations, acuity etc. Regional antibiograms (combined data from a number of geographically close facilities) may be used if smaller institutions do not have enough isolates to make an antibiogram meaningful.

Institutions with outsourced microbiology services should inquire about the laboratory's ability to produce an antibiogram that meets their needs.

Clinical and Laboratory Standards Institute (CLSI) guidelines (see Tools/Resources, below) should be used to calculate and present susceptibility rates for antibiograms to ensure reliable reporting and standardize the presentation of data.

It may be difficult and labour-intensive to follow all CLSI recommendations (e.g., to eliminate duplicate isolates per patient). Clinicians should be informed of the sources and limitations of their institution's antibiogram (e.g., whether outpatient specimens are included or duplicates removed; changes in the definitions for susceptibility [minimum inhibitory concentration] breakpoints).

Institutional antibiograms should be widely distributed to clinicians (physicians, pharmacists, infection prevention and control practitioners etc.) using a range of methods, such as pocket cards, the hospital formulary or institutional antimicrobial handbook, posting on the institution's intranet or external website, posters on wards, email with updates, and/or displays during order entry.

Advantages

- Part of the checklist of the Centers for Disease Control and Prevention's Core Elements of Hospital Antimicrobial Stewardship Programs.
- Gives clinicians information about institution-specific resistance patterns and are the recommended way to track resistance.
- Multiple uses:
  - Monitoring resistance trends.
  - Comparing susceptibility rates between institutions (if similar methods used).
  - Helping in formulary decision-making.
  - Informing local/institutional recommendations for the selection of empiric therapy (instead of relying on recommendations from other institutions or from the United States, which generally has higher resistance rates than Canada).
  - Identifying stewardship initiatives and targets for education (e.g., observation of high resistance rates to fluoroquinolones in *Escherichia coli* can prompt education about the use of an alternate antibiotic class in seriously ill patients with urosepsis).

Disadvantages

- Challenging for smaller institutions, those without sufficient microbiology laboratory support and/or those that outsource microbiology services:
  - Insufficient resources/expertise.
  - Insufficient samples for meaningful interpretation of susceptibility rates (a minimum of 30 isolates is recommended by the CLSI).
  - Costs and limitations with outsourced services.
- Except for assessment of effects in a specific unit, antibiograms are not a reliable metric for the short-term effects of an antimicrobial stewardship program (due to the lag time for changes in resistance patterns to be reflected in an antibiogram and the multifactorial nature of resistance).
- They have a number of limitations:
  - Usually represent isolates from community and hospital-acquired infections; they may not be a good reflection of either alone.

- Useful only to guide choice of empiric therapy at the institutional level. Site and severity of infection, comorbidities and recent antimicrobial exposure must be considered when choosing therapy for a particular patient.
- Cannot identify increasing subclinical resistance or "MIC creep."
- Cannot identify the incidence of multi-drug-resistant organisms; susceptibility is provided only for individual antibiotics.
- Antibiograms reflecting cumulative hospital-wide data may dilute results and mask resistance trends for a particular ward or service (e.g., in the ICU or oncology wards). Conversely, when ICU data are included in an institution-wide antibiogram, susceptibility patterns can appear to show more resistance than if the ICU data is excluded and reported separately.

Requirements

- Knowledgeable personnel from microbiology to collate and interpret raw data.
  - Would require appropriate software in large institutions.
  - Should be updated at least annually.
- Individual (from microbiology or other) to summarize and present data.
- Individual to take responsibility for updating, publishing and disseminating a yearly update.

Useful References

Select articles to provide supplemental information and insight into the strategy described and/or examples of how the strategy was applied; not a comprehensive reference list. URLs are provided when materials are freely available on the Internet.

- Hindler JF, Stelling J. Analysis and presentation of cumulative antibiograms: a new consensus guideline from the Clinical and Laboratory Standards Institute. Clin Infect Dis. 2007;44(6):867–73. Available from: http://cid.oxfordjournals.org/content/44/6/867.long

  *This paper summarizes the background for the CLSI guideline and provides an appreciation of concepts for antibiogram development. Note that the paper relates to the recommendations in the **second edition** of the CLSI antibiogram guidelines.*

- Schulz LT, Fox BC, Polk RE. Can the antibiogram be used to assess microbiologic outcomes after antimicrobial stewardship interventions? A critical review of the literature. Pharmacotherapy. 2012;32(8):668–76.

- Pakyz AL. The utility of hospital antibiograms as tools for guiding empiric therapy and tracking resistance. Insights from the Society of Infectious Diseases Pharmacists. Pharmacotherapy. 2007;27(9):1306–12.

Tools and Resources

- Clinical and Laboratory Standards Institute. Analysis and presentation of cumulative antimicrobial susceptibility test data; approved guideline, fourth edition. Wayne, PA: Clinical and Laboratory Standards Institute; 2014.

  This document describes methods for recording and analysis of antimicrobial susceptibility test data, consisting of cumulative and ongoing summaries of susceptibility patterns of clinically significant microorganisms. Sample templates are included. The guideline must be purchased.

- Calgary Laboratory Services. Microbiology Newsletters: CLS 2013 Antibiograms [Internet]. Calgary, AB: Calgary Laboratory Services; c2013 [cited 2015 Nov 11]. Available from: http://www.calgarylabservices.com/education-research/publications/microbiology-newsletters.aspx

  Antibiograms from Calgary zone; provides examples by institution, unit and type of specimen.

Samples/Examples

- Example 1: Providence Healthcare - Pharmacy Newsletter October 2015
- Example 2: Cornwall Community Hospital - Antibiogram 2013-14
- Example 3: The Ottawa Hospital - Antibiogram 2014

These documents have been generously shared by various health care institutions to help others develop and build their antimicrobial stewardship programs. We recommend crediting an institution when adopting a specific tool/form/pathway in its original form.

Examples that contain clinical or therapeutic recommendations may not necessarily be consistent with published guidelines, or be appropriate or directly applicable to other institutions. All examples should be considered in the context of the institution's population, setting and local antibiogram.

The materials and information in this section are not owned by Public Health Ontario. Neither Public Health Ontario nor the institution sharing the document shall be responsible for the use of any tools and resources by a third party.

Links with Other Strategies

- Empiric antibiotic prescribing guidelines

Disclaimer

Citation

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For further information

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Example 1: Providence Healthcare - Pharmacy Newsletter October 2015

PROVIDENCE Healthcare

PHARMACY NEWS

OCTOBER 2015

2014 Antibiogram Update

Contributor: Annabelle Maliakkal PharmD RPh

Editor: Jeff Powis MD FRCPC MSc

Introduction

The Providence Healthcare antibiogram is a summary of the sensitivity of bacteria isolates to antibiotics. Until sensitivity results for a culture are available for a specific patient, clinicians rely on antibiograms to determine what initial empiric therapy may be most appropriate. It answers the question, "What is the likelihood that this antibiotic is effective against this bacterial strain?"

Information is organized into 3 tables: gram-negative organisms from all specimen types, gram-positive organisms from all specimen types, and most common urine isolates. This update of the antibiogram reflects the susceptibility of antibiotics for the most common organisms isolated from January 1 to December 31, 2014.

Accessing the antibiogram

The antibiogram is available via Medworxx for electronic access, as well as appended to this newsletter.

Interpretation of the antibiogram

The *% susceptible* is the percentage of isolates of a given bacterial organism that are sensitive to the given antibiotic treatment. The higher the % susceptibility, the more likely the organism will be sensitive to the antibiotic. Among many other patient-specific factors, this is one important consideration in the choice of an antibiotic.

Urinary-specific antibiogram

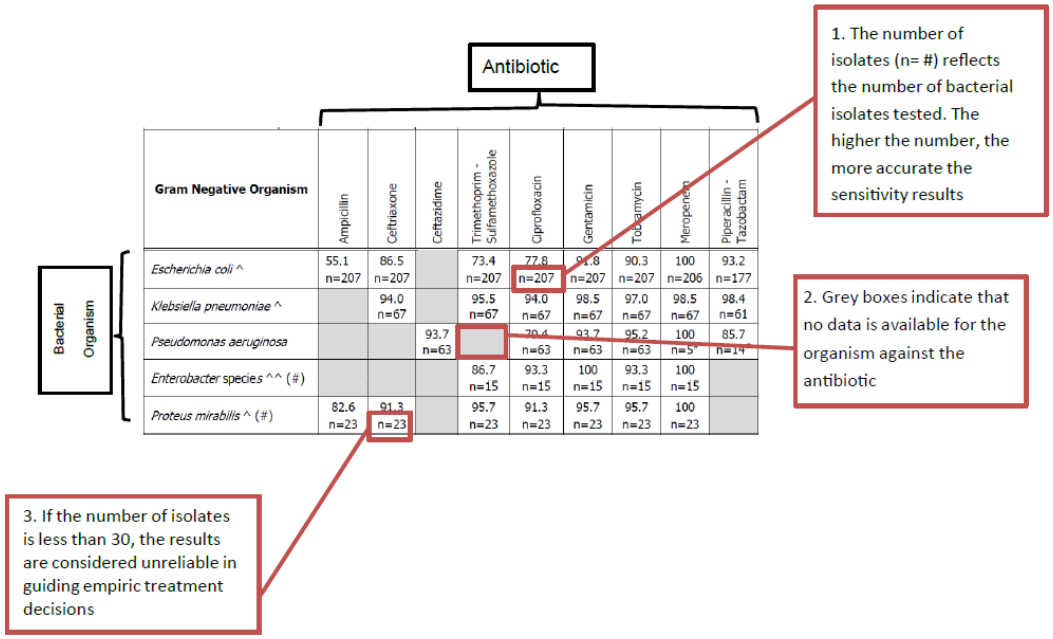
Urinary tract infections are one of the most common infections in our facility. Regular monitoring of the urinary-specific antibiogram is increasingly important because of multidrug resistance in bacterial uropathogens. Susceptibility of urinary antibiotics (e.g. nitrofurantoin) against these resistant organisms are included in the urinary-specific antibiogram but not the standard gram-positive and gram-negative antibiograms

How does the 2014 antibiogram differ from previous years?

To reflect the dynamic resistance patterns of antibiotic therapy, antibiograms are updated annually. With respect to sensitivity patterns, there are no significant updates to comment regarding the 2014 antibiogram.

One change in the reporting of urinary isolates this year is the removal of cefazolin from the antimicrobials reported. Cephalothin is now the only antimicrobial used to predict *E.coli* susceptibility. It is important to note that using cephalothin to predict *E.coli* susceptibility to cephalexin underestimates susceptibility (i.e. make the isolates look more resistant than they actually are). Methodology to test *E.coli* susceptibility to cephalexin will be changed in the upcoming year to reflect newer research. Cephalexin (Keflex) is still an appropriate empiric antimicrobial for lower urinary tract infections and will continue to be used in the Providence Lower Urinary Tract Care Pathway.

Three quick tips to using the antibiogram



LifeLabs—Antibiogram
Providence Healthcare
January 01—December 31, 2014

Table 1. All Isolates except Surveillance - % Susceptible

Gram Negative Organism	Ampicillin	Ceftriaxone	Ceftazidime	Trimethoprim - Sulfamethoxazole	Ciprofloxacin	Gentamicin	Tobramycin	Meropenem	Piperacillin - Tazobactam
Escherichia coli ^	55.1 n=207	86.5 n=207		73.4 n=207	77.8 n=207	91.8 n=207	90.3 n=207	100 n=206	93.2 n=177
Klebsiella pneumoniae ^		94.0 n=67		95.5 n=67	94.0 n=67	98.5 n=67	97.0 n=67	98.5 n=67	98.4 n=61
Pseudomonas aeruginosa			93.7 n=63		79.4 n=63	93.7 n=63	95.2 n=63	100 n=5#	85.7 n=14#
Enterobacter species ^^ (#)				86.7 n=15	93.3 n=15	100 n=15	93.3 n=15	100 n=15	
Proteus mirabilis ^ (#)	82.6 n=23	91.3 n=23		95.7 n=23	91.3 n=23	95.7 n=23	95.7 n=23	100 n=23	

General Notes:

Antibiogram results, patient risk factors for resistant organisms, and hospital epidemiology should be considered together to help guide empiric treatment of initial infections. Treatment should be re-evaluated as additional information from culture and sensitivity become available.

n = # of isolates tested

(#) = Analysis based on less than 30 isolates. Statistical comparison on results with less than 30 isolates is unreliable.

Calculation of results based on the first isolate per patient.

Organism-Specific Notes:

^ Includes ESBL and AMPC isolates

^^ *Enterobacter species* and other SPICE organisms (*Serratia, Providencia, Morganella, Citrobacter* species, and *Proteus vulgaris*) contain a chromosomal AmpC B-lactamase. Treatment with penicillins, cephalosporins, broad spectrum penicillins, and B-lactam/B-lactamase inhibitor combinations (i.e. piperacillin-tazobactam) is not recommended.

LifeLabs—Antibiogram
Providence Healthcare
January 01—December 31, 2014

Table 2. All Isolates except Surveillance - % Susceptible

Gram Positive Organism	Ampicillin	Cloxacillin	Cefazolin	Clindamycin	Erythromycin	Trimethoprim - Sulfamethoxazole	Tetracycline *	Rifampin **	Vancomycin
Staphylococcus aureus (all)		91.2 n=57	91.2 n=57	(see MSSA and MRSA)					
Methicillin Sensitive S.aureus (MSSA)		100 n=52	100 n=52	55.8 n=52	53.8 n=52	98.1 n=52			100 n=52
Methicillin Resistant S.aureus (MRSA) ^ (#)				60.0 n=5	40.0 n=5	100 n=5	100 n=5	100 n=5	100 n=5
Enterococcus species ^^	86.7 n=158								100 n=158

General Notes:

Antibiogram results, patient risk factors for resistant organisms, and hospital epidemiology should be considered together to help guide empiric treatment of initial infections. Treatment should be re-evaluated as additional information from culture and sensitivity become available.

n = # of isolates tested

(#) = Analysis based on less than 30 isolates. Statistical comparison on results with less than 30 isolates is unreliable.

Calculation of results based on the first isolate per patient.

Organism-Specific Notes:

^ *Methicillin Resistant S.aureus* (MRSA) are resistant to all B-Lactams (penicillins, cephalosporins, B-lactam/B- lactamase inhibitor combinations, and carbapenems).

^^ Includes *Vancomycin-Resistant Enterococcus* species

Clindamycin, Trimethoprim/Sulfamethoxazole and all Cephalosporins are ineffective against *Enterococcus* species.

Antibiotic - Specific Notes:

* Organisms that are susceptible to Tetracycline are also considered susceptible to Doxycycline.

** Rifampin should not be used alone for chemotherapy.

LifeLabs—Antibiogram
Providence Healthcare
January 01—December 31, 2014

Table 3. Urine Isolates - % Susceptible

	Ampicillin	Cephalothin *	Ciprofloxacin	Nitrofurantoin	Trimethoprim - Sulfamethoxazole	Gentamicin	Tobramycin	Ceftriaxone	Amoxicillin - Clavulanic Acid	Piperacillin - Tazobactam	Meropenem	Vancomycin
Gram Negative Organism												
Escherichia coli ^	54.7 n=203	34.0 n=203	78.3 n=203	88.7 n=203	73.9 n=203	91.6 n=203	90.1 n=203	86.7 n=203	89.2 n=176	93.1 n=175	100 n=202	
Klebsiella pneumoniae ^		85.2 n=61	93.4 n=61	26.2 n=61	95.1 n=61	98.4 n=61	96.7 n=61	93.4 n=61	100 n=57	100 n=57	100 n=61	
Gram Positive Organism												
Enterococcus species ^^	86.6 n=157		70.7 n=157	87.3 n=157								100 n=157

General Notes:

Antibiogram results, patient risk factors for resistant organisms, and hospital epidemiology should be considered together to help guide empiric treatment of initial infections. Treatment should be re-evaluated as additional information from culture and sensitivity become available.

n = # of isolates tested

Calculation of results based on the first isolate per patient.

Organism-Specific Notes:

^ Includes ESBL and AMPC isolates

^^ Includes *Vancomycin-Resistant Enterococcus* species

Antibiotic - Specific Notes:

* Cephalothin interpretative criteria may be used to predict results to Cephalexin.

Example 2: Cornwall Community Hospital - Antibiogram 2013-14

EORLA Microbiology Reference Laboratory

% Susceptible — **March 2013 to December 2014**

Number of isolates tested for each organism is indicated in brackets for each year(s)

GRAM-NEGATIVE	Ampicillin	Amox/Clav	Pip/Tazo	Cefazolin	Ceftriaxone	Meropenem	Ciprofloxacin	Septra	Nitrofurantoin	Gentamicin
Escherichia coli 2013 (n=660)	63	83	94	75	93	100	83	83	96	92
2014 (n=844)	62	86	94	76	94	100	85	80	98	93
Klebsiella pneumoniae 2013 (n=139)	0	97	97	89	98	100	98	92	61	100
2014 (n=123)	0	95	95	86	96	100	96	94	64	98
Proteus mirabilis 2013 (n=44)	88	97	97	32	97	100	86	88	0	93
2014 (n=41)	78	100	100	39	100	100	88	83	0	88
Enterobacter cloacae 2013 (n=35)	----	----	----	----	----	100	85	82	----	97
2014 (n=40)	----	----	----	----	----	100	100	95	----	95

Pseudomonas aeruginosa	Pip/Tazo	Ceftazidime	Meropenem	Ciprofloxacin	Tobramycin	Gentamicin
2013 (n=52)	100	98	92	94	98	96
2014 (n=85)	98	98	89	86	95	89

GRAM-POSITIVE	Cloxacillin	Cefazolin	Erythromycin	Clindamycin	Tetracycline	Septra	Vancomycin
Staphylococcus aureus **(methicillin-suscept.)** 2013 (n=161)	100	100	74	78	95	96	100
2014 (n=187)	100	100	68	73	99	99	100
Staphylococcus aureus **(MRSA)** 2013 (n=103)	0	0	14	36	97	97	100
2014 (n=97)	0	0	6	35	100	100	100

Streptococcus pneumoniae	Penicillin*	Erythromycin	Clindamycin	Levofloxacin	Vancomycin		
2013-2014 (n=22)	100	73	91	100	100		
***non-meningitis interpretation**			No isolates with Pen MIC > 1 mg/L				

	Penicillin	Erythromycin	Clindamycin	Vancomycin			
Group A Streptococcus 2013 (n=145)	100	84	84	100			
2014 (n=186)	100	91	91	100			
Group B Streptococcus 2013 (n=29)	100	55	55	100			
2014 (n=34)	100	50	50	100			

	Ampicillin	Nitrofurantoin	Vancomycin				
Enterococcus sp. 2013 (n=152)	88	86	100				
2014 (n=196)	91	93	99.5				

ATTENTION Caution is required for interpreting the significance of *ATTENTION *

ATTENTION susceptibilities when less than 50 organisms were tested *ATTENTION *

Example 2: Cornwall Community Hospital - Antibiogram 2013-14 (continued)

	% MRSA	% ESBL*
***S. aureus* bacteremia**		
2013 (n=18)	44%	----
2014 (n=31)	55%	----
***E. coli* bacteremia**		
2013 (n=31)	----	3.20%
2014 (n=43)	----	9.30%
***Klebsiella pneumoniae* bacteremia**		
2013-2014 (n=23)		0%

* ESBL: Extended-spectrum beta-lactamase

ESBLS are Gram-negative bacteria that produce a beta-lactamase enzyme that has the ability to break down commonly used antibiotics and **confers resistance to penicillins and cephalosporins**.

The **most common ESBL-producing** bacteria are some strains of ***Escherichia coli*** and ***Klebsiella pneumoniae***.

ANTIBIOGRAM
2013-2014

Cornwall Community Hospital
Hôpital communautaire de Cornwall

Developed by the
Antimicrobial Stewardship Committee

29/03/2016

Example 3: The Ottawa Hospital - Antibiogram 2014

GUIDELINES FOR EXTENDED INTERVAL AMINOGLYCOSIDE DOSING

Patient Eligibility

Extended interval (also referred to as single or once-daily) dosing of aminoglycosides may be considered for any adult patient ≤ 65 years of age who requires aminoglycoside therapy. However, due to a lack of supporting data, extended interval aminoglycoside dosing is not recommended in the following situations:

- Renal dysfunction (Creatinine clearance < 50 mL/min)
- Endocarditis (other than streptococcal)
- Pregnancy
- Septic shock
- Infections in neutropenic patients
- Infections in burn patients
- Presence of large fluid overload (e.g. ascites, third space accumulation)

Dosing

- Gentamicin or Tobramycin 4-6 mg/kg/day as a single dose.
- For uncomplicated UTI, 3-4 mg/kg/day is recommended.
- Dose can be mixed in 100 mL D5W and infused over 30-60 min.

Monitoring

- Measure trough level when clinically indicated.
- If trough level <1 mg/L, continue with once-daily dosing.
- If trough level >1 mg/L, switch to conventional dosing.

Guidelines for Empiric Vancomycin Dosing

Dose: 15-20 mg/kg

CrCl(mL/min)	>60	40-60	30-40	15-30	<15
Interval (hrs)	q8-12h	q12-24h	q24-36h	q48h	q72h*

*Q72H minimum; should be guided by serum measurements
See specific recommendations for dialysis patients.

Monitoring

Trough level immediately prior to fourth dose may be used to assess dosing when indicated.

ANTIBIOGRAM 2014

THE OTTAWA HOSPITAL
L'HÔPITAL D'OTTAWA

Developed by the
Antimicrobial Subcommittee
of the
Pharmacy & Therapeutics Committee

PHY 202 (REV 04/2014)

Meropenem (Restricted to ID/ICU/BMT)

1. Suspected or proven polymicrobial infection when combination therapy with other antibiotics or piperacillin-tazobactam monotherapy is not desirable because:
   - organism is documented or likely resistant to all alternatives, risk of toxicity with aminoglycosides, or clinical failure.
2. Infection involving an organism documented or likely resistant to all alternatives.

Piperacillin-Tazobactam

1. Suspected or proven polymicrobial infection when combination therapy with other antibiotics is not desirable because: organisms are documented or likely resistant to more narrow spectrum antibiotics or risk of toxicity with aminoglycosides.
2. Empiric therapy of febrile neutropenia ± aminoglycosides.
3. Suspected or proven severe nosocomial pneumonia where organisms are documented or likely resistant to more narrow spectrum antibiotics.

Vancomycin

1. Serious infections due to beta-lactam resistant gram-positive organisms.
2. Infections due to gram-positive organisms in patients with serious allergy to beta-lactam antibiotics.
3. Empiric treatment pending susceptibility for *Staphylococcus aureus* identified from a sterile site.
4. Empiric therapy for infections in which *Staphylococcus aureus* is suspected AND patient presents with severe disease (e.g. sepsis, necrotizing pneumonia, etc.)
5. Surgical prophylaxis in patients with life-threatening allergy to beta-lactam antibiotics or known MRSA colonization.
6. Empiric treatment of febrile neutropenic patients with evidence of gram-positive infection (e.g. inflamed IV site).
7. Cases of *severe C. difficile*-associated colitis, and those unresponsive to metronidazole (oral therapy).

STEPS TO PREVENT ANTIMICROBIAL RESISTANCE

Prevent Infection

- Promote vaccination
- Get the catheters out
- Practice hand hygiene

Diagnose and Treat Infection Effectively

- Target the Pathogen
  - Obtain appropriate cultures
  - Narrow spectrum when possible
  - Optimize dose & duration
  - Ensure adequate source control
- Access the Experts

Use Antimicrobials Wisely

- Use local susceptibility data
- Treat infection, not contamination or colonization
- Know when to say "no" to vanco and pip/tazo
- Stop antibiotic therapy when infection is unlikely or cured

Adapted from the CDC Campaign to Prevent Antimicrobial Resistance in Healthcare Settings

www.cdc.gov/drugresistance/healthcare

ANTIBIOGRAM 2014

Tables 1 and 2 summarize the percentage of bacterial strains susceptible in 2013 to Formulary antibiotics.

TABLE 1 Gram Positive Isolates Bacteria / Drug	Penicillin	Ampicillin	Cefazolin	Cloxacillin	Clindamycin	Erythromycin (Macrolides)	Cotrimoxazole	Vancomycin
Staph. aureus (not MRSA)[1]	–	–	100%	100%	75%	73%	97%	100%
Coag. Negative Staph.	–	–	–	35%	–	–	66%	100%
Enterococcus	–	82%	–	–	–	–	–	98%
Strep pneumoniae	100%*	–	–	–	76%	78%	–	100%
Group A streptococcus	100%	–	–	–	85%	85%	–	100%

[1] Approximately 15% of *S. aureus* bacteremias at TOH are resistant to beta-lactams (i.e. MRSA)
Approximately 22% of *S. aureus* skin and soft tissue infections seen through Emergency are MRSA.
* When treating non-meningitis infections. For meningitis, ceftriaxone with vancomycin is recommended for empiric therapy.

TABLE 2 Gram Negative Isolates Bacteria / Drug	Ampicillin	Amoxicillin/ Clavulanate	Cefazolin/ Cefuroxime	Ceftriaxone	Ceftazidime	Ciprofloxacin	Cotrimoxazole	Gentamicin	Meropenem	Pip-tazobactam	Tobramycin
Acinetobacter	–	–	–	–	88%	83%	82%	92%	98%	84%	92%
Citrobacter	–	–	–	–	–	94%	91%	94%	100%	–	95%
E. coli	54%	80%	68%	91%	91%	75%	75%	91%	99%	93%	–
Enterobacter	–	–	–	–	–	94%	93%	97%	99%	–	96%
Klebsiella	–	92%	70%	93%	93%	93%	91%	96%	99%	92%	–
Proteus mirabilis	83%	93%	38%	97%	97%	88%	80%	94%	100%	98%	–
Ps. aeruginosa (non-C.F.)	–	–	–	–	88%	76%	–	80%	81%	89%	88%
Serratia	–	–	–	–	–	91%	99%	100%	99%	–	92%

– Indicates antibiotic not usually tested or reported (other therapy would be more appropriate).
Resistance may develop on therapy if infections due to Citrobacter, Enterobacter or Serratia are treated with cephalosporins or pip/tazo.

ANTI-INFECTIVE DRUG COSTS

The following costs are rounded average costs of anti-infective agents within The Ottawa Hospital only. For IV medications, additional costs (eg. Minibags ($1.50 each), syringes, labour) are not included.

DRUG	DOSE	COST/DAY ($)
Amoxicillin	500 mg PO q8h	
Amoxicillin-clavulanate	500 mg PO q8h	
Amphotericin B	50 mg IV daily	
Amphotericin B – liposomal	300 mg IV daily	
Ampicillin	1 g IV q6h	
Azithromycin	500 mg PO daily	
	500 mg IV daily	
Caspofungin	50 mg IV daily	
Cefazolin	1 g IV q8h	
Ceftazidime	1 g IV q8h	
Ceftriaxone	1 g IV daily	
Cefuroxime	750 mg IV q8h	
	500 mg PO q12h	
Cephalexin	500 mg PO q6h	
Ciprofloxacin	500 mg PO q12h	
	400 mg IV q12h	
Clarithromycin XL	1000 mg PO daily	
Clindamycin	300 mg PO q8h	
	600 mg IV q8h	
Cloxacillin	500 mg PO q6h	
	2 g IV q6h	
Cotrimoxazole	160/800 mg (DS) PO q12h	
	160/800 mg IV q12h	
Fluconazole	400 mg PO daily	
	400 mg IV daily	
Gentamicin	120 mg IV q8h	
Levofloxacin	750 mg PO daily	
	750 mg IV daily	
Linezolid	600 mg PO q12h	
	600 mg IV q12h	
Meropenem	500 mg IV q6h	
Metronidazole	500 mg PO q8h	
	500 mg IV q8h	
Micafungin	100 mg IV daily	
Penicillin G	2 MU IV q6h	
Penicillin V	300 mg PO q6h	
Piperacillin-tazobactam	3.375 g IV q6h	
Tigecycline	50 mg IV q12h	
Tobramycin	120 mg IV q8h	
Vancomycin	1 g IV q12h	
Voriconazole	200 mg PO q12h	
	300 mg IV q12h	

PRESCRIBING CRITERIA FOR RESTRICTED ANTI-INFECTIVE AGENTS

(Use outside these criteria requires an Infectious Diseases consult.)

Ceftazidime

1. Treatment of proven or highly suspected pseudomonas infections (e.g. CF, bronchiectasis patients).
2. Empiric treatment of peritonitis in patients on CAPD.

Ciprofloxacin IV

Patients unable to take oral ciprofloxacin and one of:

1. Proven gram-negative infection due to an organism resistant to other antibiotics.
2. Proven gram-negative infection due to an organism susceptible to another antibiotic which is contraindicated.
3. Empiric treatment of respiratory infections in cystic fibrosis.
4. Empiric treatment of ventilator-associated pneumonia.

Fluconazole IV

Patients unable to take oral fluconazole and one of:

1. Documented or highly suspected candida infection.
2. Prophylaxis of allogeneic BMT patients.
3. Empiric treatment of symptomatic patients at high risk of disseminated candidiasis/candidemia AND having positive cultures from 3 sites.
4. Treatment of candidemia when susceptible.
5. Treatment of hepatosplenic candidiasis.
6. Alternative to nystatin for the treatment of mucocutaneous candidiasis, due to lack of efficacy or intolerance.
7. Treatment of candiduria in patients with symptoms of UTI.
8. Treatment of respiratory, cutaneous, or meningeal (following induction phase) cryptococcal infection.

Fluconazole is NOT indicated for positive single site culture in an asymptomatic patient (e.g. sputum culture, urine culture in a catheterized patient).