The following antibiogram tables have been created using 2012 data derived from routine susceptibility tests performed by VIHA Microbiology laboratories. Data includes both inpatient and outpatient results. Data is listed according to organism grouping and antibiotic. Data may be selected by location: either all of VIHA or by geographic site (SI, CDH, CI or NI). The number of isolates used to generate the percent sensitive is listed for each organism. In order to be statistically valid, only those species with at least 30 isolates are included in the antibiogram. If an organism is not found on the antibiogram for your site, go to the VIHA wide antibiogram, as there were insufficient isolates from that site to be validated. Only the first isolate of the specific organism per patient per year is included in the antibiogram. Duplicate organisms from the same patient (all sources) will only be included if the organism’s susceptibility profile has significantly changed. Organisms recovered from Infection Control surveillance (ARO screening) and from cystic fibrosis patients are not included.

Additional antibiogram information is available by contacting Dr. P. Kibsey or the Medical Microbiologist on call in VIHA.

The percentage (%) reported reflects the total number of isolates sensitive to the antibiotic. Please refer to the diagram below. The footnotes associated with some microorganisms are explained in the accompanying document.

Antibiogram Table Format (sample)
FOOTNOTES: GRAM POSITIVE

1 **Corynebacterium species:**
- Include *C. jejueium, C. pseudodiphtheriticum, C. urealyticum,* and many other species.
- These organisms are included in the descriptive term “diphtheroids” or “coryneforms” when they are isolated as part of the normal skin flora.
- They can become opportunists associated with indwelling devices and implants and are often multi resistant, only sensitive to vancomycin.
- Significant infections include line sepsis, peritonitis, bacteremia, pneumonia and urinary tract infections.
- Susceptibility testing is performed on clinically significant isolates.

2 **Enterococcus species (E. faecalis, E. faecium):**
- When recovered from serious infections such as sepsis and endocarditis, are sensitive to either ampicillin/penicillin or vancomycin. These antibiotics are only static when used alone against this organism, hence the addition of an aminoglycoside for synergy (cidal action) is highly recommended. Other less serious infections, e.g. wounds, urinary tract infections, etc. can be treated with a single agent, according to the antibiogram reported for the isolate.
- Synergy testing results for gentamicin also applies to tobramycin and amikacin. When synergy between ampicillin, penicillin or vancomycin and an aminoglycosides is not detected, combination with ceftriaxone is suggested. Ciprofloxacin, nitrofurantoin and tetracycline are only appropriate for enterococci from urinary sites.
- Ampicillin results predict amoxicillin, amoxicillin/clavulanate, piperacillin/tazobactam, imipenem, and meropenem results.
- Ampicillin is slightly more active than penicillin for *E. faecalis*.

3 **Enterococcus faecium VRE (vancomycin resistant *Enterococcus*):**
- These strains are multi resistant to vancomycin, penicillin/ampicillin, ciprofloxacin and tetracycline.
- Linezolid is reliably sensitive but resistance may develop on treatment.
- All VRE isolates are confirmed for Van A and Van B genes by PCR molecular testing. Fortunately infections due to VRE are very rare in our region. VRE screening has been discontinued except for inpatients on renal units.
- *Enterococcus casseliflavus* and *E. gallinarum* are species that are intrinsically resistant to vancomycin and are not considered classical VRE. They are of low virulence and considered to be part of the normal bowel flora. There are no additional infection control precautions for these two organisms.

4 **Staphylococcus aureus:**
- Cloxacillin (or a first generation cephalosporin-ceFAZolin is reported) is the treatment of choice for *Staphylococcus aureus*.
- Aminoglycosides and rifampin are not used as single agents as resistance develops quickly but may be indicated for synergy in infections involving prosthetic devices.

5 **MRSA** (methicillin resistant *Staphylococcus aureus*):
- MRSA is resistant to cloxacillin.
- **Cloxacillin resistance implies that ALL cephalosporins, amoxicillin/clavulanate, piperacillin/tazobactam, imipenem, and meropenem are resistant.**
- In addition, hospital acquired MRSA are frequently multi-resistant, demonstrating resistance to erythromycin, clindamycin, gentamicin, tetracycline, trimethoprim-sulfamethoxazole and ciprofloxacin/moxifloxacin.
- Increasing sensitivity to clindamycin and trimethoprim-sulfamethoxazole over the past few years correlates with the replacement of the multi-resistant “hospital strain” with more virulent but less multi-resistant “community strains” of MRSA (CA-MRSA). In VIHA, CA-MRSA is the most predominant strain transmitted in the hospital setting.
- The MIC for Vancomycin is reported on all invasive isolates to assist with patient management.
- Approximately 40-60% of hospital strains in the USA are MRSA. In our region, the percentage of MRSA/all *Staphylococcus aureus* laboratory isolates is 19.8% (decreased from 29% in 2005). The provincial trend % MRSA/MSSA demonstrates a reduction of 32% from 2007 to 2011. The 2011 incidence rate in VIHA of MRSA in new patients with the disease per 1000 patients is 5%.
# FOOTNOTES: GRAM POSITIVE

## Staphylococcus lugdunensis:
- *Staphylococcus lugdunensis* is a type of coagulase negative *Staphylococcus*.
- This species is normal flora of the skin and has been implicated in foreign body infections, endophthalmitis, catheter related infections, UTI and wound infections.
- In clinical presentation it resembles infections caused by *Staphylococcus aureus*.
- Most often the patients have had some contact with health care facilities.
- According to the VIHA 2012 Antibiogram, 100% of strains were sensitive to cloxacillin/ceFAZolin but resistance to these antibiotics has been documented.

## Staphylococcus saprophyticus:
- *Staphylococcus saprophyticus* susceptibility testing is not routinely performed on most urinary isolates as the antibiogram is predictable.
- Antibiotics of choice are nitrofurantoin, trimethoprim-sulfamethoxazole or ciprofloxacin.
- As with other species of coagulase negative *Staphylococcus* approximately 50% of strains are sensitive to cloxacin/ceFAZolin. Sensitivity testing is performed on all invasive isolates.

## Streptococcus agalactiae (Group B Streptococcus):
- Are universally sensitive to penicillin, ampicillin, cephalosporins and vancomycin.
- For penicillin allergic patients, a cephalosporin or vancomycin should be used until clindamycin results are available.
- In penicillin allergic patients, erythromycin and clindamycin are alternate choices and susceptibility testing must be performed including inducible clindamycin testing. In VIHA, as elsewhere, increasing resistance to these antibiotics has been observed:

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<tbody>
<tr>
<td>Erythromycin:</td>
<td>85% S</td>
<td>75% S</td>
<td>77% S</td>
<td>56% S</td>
<td>60% S</td>
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<tr>
<td>Clindamycin:</td>
<td>75% S</td>
<td>71% S</td>
<td>71% S</td>
<td>68%</td>
<td>65% S</td>
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## Streptococcus anginosus group:
- Includes *S. anginosus*, *S. constellatus* and *S. intermedius*.
- This group of viridans streptococcus are isolated from the respiratory, genital and gastrointestinal tracts.
- These organisms are implicated in abscesses, empyema, peritonitis and brain infections.
- They have variable susceptibilities to macrolides and clindamycin but are always sensitive to penicillin, 3rd generation cephalosporins, and vancomycin.

## Streptococcus pyogenes (Group A Streptococcus):
- Are still universally sensitive to penicillin and cephalosporins.
- In penicillin allergic patients, susceptibility testing is advised when a macrolide or clindamycin is used, as not all strains are sensitive.
- Local strains are demonstrating slight resistance to both erythromycin and clindamycin, especially in the IVDU population.

## Viridans group Streptococcus species:
- Includes oral streptococci and nutritionally variant streptococci.
- These organisms are becoming less sensitive to penicillin and are the source of resistant plasmids for *S. pneumoniae*.
- The treatment of choice for serious infections is high dose penicillin, with or without an aminoglycoside (according to site of infection and penicillin MIC).
**FOOTNOTES: GRAM POSITIVE**

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<tr>
<td>Penicillin:</td>
<td>86% S</td>
<td>89% S</td>
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- *Streptococcus pneumoniae*: Are becoming increasingly resistant to several antibiotics.
- However penicillin susceptibilities for *S. pneumoniae* have been stable over the last 5 years:

Penicillin breakpoints have changed to reflect po, iv meningitis, and iv nonmeningitis as routes of administration. High level resistance to penicillin (MIC >2µg/mL) is rare (2% in VIHA in 2012).
- As stepwise resistance to penicillin increases resistance to cephalosporins including 2nd and 3rd generation cephalosporins increases even faster.
- Penicillin/cephalosporin resistant strains may be cross resistant to cefuroxime, erythromycin, tetracycline and trimethoprim-sulfamethoxazole.
- Penicillin sensitive strains can be treated with ampicillin, amoxicillin +/- clavulanate or a 2nd and 3rd generation cephalosporin without further testing.

**NOTE:** CeFAZolin or cephalexin are not appropriate antibiotics for treating *S. pneumoniae*.
- Penicillin intermediate strains will usually respond to high dose penicillin, ampicillin, or amoxicillin if the infection originates in the respiratory tract. However intermediate level penicillin resistant strains in the CSF will not respond to penicillin or ampicillin. These strains and high level resistant strains require combination treatment with a third generation cephalosporin and vancomycin. The laboratory will report intermediate or high level resistant strains to the physician by phone.
- Macrolides are no longer indicated as first line empiric treatment of *S. pneumoniae*, as only 77% of isolates are susceptible.
- Strains resistant to fluoroquinolones are rare in our region. Patients previously receiving this class of antibiotic for any indication in the previous 3 months should be treated with alternate antibiotics for empiric treatment of community acquired pneumonia.

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### Acinetobacter baumannii complex:
- Are environmental organisms from a similar habitat as *Pseudomonas* species.
- They are opportunists, have an antibiogram like *Pseudomonas* and cause serious bacteremias, pneumonias and wound infections.
- Some strains are multi-resistant, most frequently to aminoglycosides and cefTAZidime. These particular strains are often acquired in non Canadian hospitals or overseas in military situations.

### Enterobacter, Pantoea, Citrobacter, Hafnia, Morganella, Proteus (not *P. mirabilis*), Providencia & Serratia:
- These organisms possess an “inducible beta-lactamase” (IBL or AmpC). They have the “resistance potential” on a chromosome that confers resistance to all cephalosporins.
- When exposed to a cephalosporin, they will derepress (turn on) the gene and quickly express resistance across all cephalosporins.
- Recommended treatment is to discontinue all cephalosporins.
- Alternative treatment includes ciprofloxacin, aminoglycoside, trimethoprim-sulfamethoxazole or imipenem.
- The enzyme is not reversed with amoxicillin/clavulanate or piperacillin/tazobactam.
- This group of organisms is also known by the acronym “Spice Group”.
- *Citrobacter freundii* complex includes *C. freundii, C. braakii, C. gillenii, C. murliniae, C. sedlakii, C. werkmanii,* and *C. youngae.*

### E. coli:
- May show variable susceptibility to the first generation cephalosporins.
- For wound, urine, other non-sterile body fluids isolates, both cefAZolin and cephalaxin are reported as the results may be different.
- Some strains of *E. coli* have acquired the chromosomai AmpC on a plasmid from the “Spice Group”. These strains of *E. coli* will then have the identical antibiogram to an IBL organism.

### ESBL isolates:
- Some strains of *E. coli, Klebsiella pneumoniae* and *K. oxytoca* (rare other coliforms) have acquired a plasmid that renders them resistant to all cephalosporins including the 3rd generation cephalosporins and cefTAZidime.
- This enzyme is called an “extended spectrum beta-lactamase” (ESBL).
- Strains possessing these traits are mostly community acquired in our region and can be serious nosocomial pathogens in some hospital units.
- These organisms may also be multi resistant to quinolones, aminoglycosides and trimethoprim-sulfamethoxazole.
- The antibiotic of choice is imipenem for serious infections.
- Piperacillin/tazobactam and amoxicillin/clavulanate may also be effective for some strains of ESBL.
- CRE: Carbapenem Resistant Enterobacteriaceae can be due either to porin mutations in the presence of cephalosporinase (eg. AmpC or ESBL) or the acquisition of a plasmid. CR enzymes are associated with travel, medical tourism or hospitalization in high risk countries such as the Indian sub continent, Greece, Israel, Brazil and USA. Alternate antibiotic choices are extremely limited, if any.

### Haemophilus influenzae:
- Are initially reported as beta lactamase positive (ampicillin R) or negative (ampicillin S).
- IF β-lactamase (-) and ampicillin resistant (BLNAR), the organism should be considered resistant to amoxicillin/clavulanic acid, cefaclor and cefuroxime.
- 1st generation cephalosporins have no activity.
- There is rare documented resistance for 2nd or 3rd generation cephalosporins, ciprofloxacin or amoxicillin/clavulanate.
- Erythromycin has very poor activity against *Haemophilus*, but the newer macrolides claim to have better activity.
- Literature states that the clarithromycin in vitro result may not reflect clinical outcomes due to synergistic effect of the antibiotic metabolite.
- Trimethoprim-sulfamethoxazole can be used for most strains.

### Haemophilus parainfluenzae:
- Are recovered from older COPD patients experiencing respiratory exacerbations.
- *H. parainfluenzae* are notably more resistant to macrolides than *H. influenzae.*
### FOOTNOTES: GRAM NEGATIVE

#### 7 *Pseudomonas aeruginosa:*
- Piperacillin/tazobactam, aminoglycosides, imipenem and cefTAZidime are still very effective antibiotics for *Pseudomonas aeruginosa*.
- Tobramycin is the empiric choice when choosing an aminoglycoside to treat *Pseudomonas aeruginosa*.
- Only 88% of strains are sensitive to ciprofloxacin therefore it should not be considered as monotherapy for empiric treatment in serious infections.
- There are no longer recommendations to treat serious *Pseudomonas aeruginosa* infections with two antibiotics.
- *Pseudomonas aeruginosa* infections in febrile neutropenic or immunocompromised patients may be treated with mono or combined therapy.

#### 8 *Stenotrophomonas maltophilia:*
- Are opportunistic organisms with similar habitat to *Pseudomonas* species and are hospital associated.
- *S. maltophilia* are resistant to aminoglycosides, all cephalosporins, carbapenems, and piperacillin/tazobactam.
- Antibiotics of choice include trimethoprim-sulfamethoxazole (treatment of choice) or minocycline.
- Ticarcillin/clavulanic acid has modest activity.
- Ciprofloxacin is effective for only 50% of isolates.
- Serious infections should be treated with two antibiotics.