Part 2

Resources required for antimicrobial stewardship
7 The role of the clinical microbiology service

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7.1 Key points

- The clinical microbiology service is an essential and integral part of organisational initiatives that underpin antimicrobial stewardship efforts.

- The establishment of best practice procedures for rapid microbiological evaluation is critical to delivering timely and accurate information.

- Intensive care units are an area of particular importance, as the control of resistance in these units can affect other areas of the hospital. The clinical microbiology service should therefore pay particular attention to services provided to these areas.

- Reports to the clinician from the clinical microbiology service can provide comments that interpret isolate significance, provide antimicrobial susceptibility interpretation and provide antimicrobial management advice.

- The clinical microbiology service also has a critical role to play in improving overall antimicrobial use through providing information, establishing guidelines and educating other hospital staff. One key strategy is the production of annual cumulative antibiograms to indicate susceptibility patterns for key pathogens.

- The clinical microbiology service provides surveillance data on resistant organisms for infection control purposes.
7.2 **Recommendations**

7.2.1 Hospitals have access to a clinical microbiology service that provides:

- best practice diagnostic testing for infection, including relevant rapid tests for common viral, fungal or bacterial pathogens that are reported to clinicians

- consultation on choice, nature, handling and testing of specimens for detection of infection, especially when there is a broad infectious differential diagnosis under consideration

- direct advice from a specialist consultant or supervised registrar to clinicians at the time when bloodstream, meningeal or other critical infection is detected (this should occur seven days per week)

- regular patient-specific liaison with clinicians (including infectious diseases physicians if they are not integrated with the clinical microbiology service) who care for patients at a high risk of infection (e.g. patients in intensive care, haematology and oncology units).

7.2.2 Regular analyses of antimicrobial resistance are provided to groups with responsibility for local antimicrobial guidelines (e.g. antimicrobial stewardship committee, drug and therapeutics committee) to inform local empirical therapy recommendations and formulary management.

7.2.3 Cascade reporting of antimicrobial susceptibility is consistent with the *Therapeutic Guidelines: Antibiotic*.19

7.2.4 A national standard approach to antimicrobial susceptibility testing and cumulative analysis and reporting of antibiograms is developed, agreed and implemented by clinical microbiology services.
7.3 Clinical microbiology services’ involvement in antimicrobial stewardship

The clinical microbiology service (CMS) is an essential and integral part of a wide range of organisational initiatives that underpin antimicrobial stewardship (AMS) efforts. At some sites, many of these activities are done in conjunction with infectious diseases consultants and registrars. The CMS supports the clinician with data to inform individual patient diagnosis and treatment decisions, and should provide leadership in developing and maintaining best practice in the organisation’s antimicrobial use.

The CMS participates in a range of organisational AMS activities. These include:

- preparation of antimicrobial susceptibility reports (see Section 7.5)
- participation in
  - quality use of medicine, and drug and therapeutics committees (formulary controls, reporting on antimicrobial use)
  - evaluation and reporting of hospital antimicrobial use in conjunction with pharmacists
  - development, review and audit of clinical pathways or guidelines for common disorders (e.g. pneumonia) to ensure that optimal practices of investigation are specified
  - surveillance of healthcare associated infections, especially facilitating classification of the healthcare association status of bloodstream infections
- liaison with infection prevention and control staff and, where possible, promoting and supporting their safe practice agenda
- conducting antimicrobial education of medical staff, pharmacists and other clinical staff.

For a more detailed summary of clinical microbiology roles and the recommended processes, see the Healthcare Infection Control Special Interest Group web site.

7.4 Diagnostic testing practice

A specific microbiological diagnosis enables effective targeting of antimicrobial therapy against demonstrated pathogens. Microbiological results may allow an early decision to shift to directed treatment or cessation of antimicrobials, reducing unnecessary exposure.

7.4.1 Specimen collection

The CMS should promote the optimal microbiological evaluation of patients prior to commencing antimicrobials. The service should establish procedures for microbiological and related specimen collection according to best practice.
The clinical microbiology laboratory plays a critical role in antimicrobial stewardship by providing patient specific culture and susceptibility data to optimize individual antimicrobial management and by assisting infection control efforts in the surveillance of resistant organisms and in the molecular epidemiologic investigation of outbreaks.

Some of the more important issues are outlined below:

- Blood culture collection techniques that avoid contamination and ensure adequate sensitivity of detection, such as
  - avoiding contamination through use of appropriate antisepsis during collection (see Table 7.1)
  - avoiding collecting cultures via pre-existing central or peripheral lines — use of pre-existing lines reduces the specificity of a positive result and places the line at risk of contamination, which may cause subsequent line-related healthcare associated infection
  - collecting at least two blood culture sets in an adult from separate venipunctures — this helps to achieve acceptable sensitivity and enables confirmation of infection due to organisms that may potentially contaminate blood cultures.

- Urine specimen collection that avoids contamination or nonspecific results. Common problems that reduce specificity of the result include collection of urine
  - via old indwelling catheters
  - from asymptomatic patients (unless required for pre-operative or antenatal demonstration of significant bacteriuria).

- Collection of specimens for demonstration of viral infection when relevant.

- Performance of additional tests relevant to particular clinical syndromes (e.g. Legionella pneumophila urinary antigen testing or nucleic acid amplification test for Neisseria meningitidis from blood or cerebrospinal fluid, Legionella species from sputum).

- Appropriate use of acute-phase reactants (e.g. C-reactive protein, procalcitonin) to help rule in or rule out microbial sepsis.

The CMS needs to provide education to clinicians about specimen collection and laboratory testing procedures. Periodic summaries of blood culture contamination rates and analyses of organisms detected in particular specimen types provide useful feedback that can help modify practice.

### 7.4.2 Microbiology testing practice

The CMS should implement best practice methods for organism identification and determination of antimicrobial susceptibility.

Adequate analytical performance (e.g. for detection of susceptibility) should be demonstrated through performance in external quality-assurance programs.
7.4.3 Rapid testing
Many technologies are now available to enable rapid (same-day) analysis of specimens to either rule out or rule in infection. The availability of valid rapid results enables quicker streamlining of antimicrobial therapy. Examples of useful rapid tests include:

- direct nucleic acid amplification tests for
  - viruses (e.g. influenza from respiratory samples, cytomegalovirus from blood)
  - bacteria (e.g. Neisseria meningitidis from blood or cerebrospinal fluid)
  - methicillin-resistant Staphylococcus aureus from infection control screening swabs
  - fungi or bacteria (e.g. from sterile site tissue samples)
- direct antigen detection tests from
  - blood (e.g. Cryptococcus neoformans)
  - respiratory samples (e.g. respiratory syncytial virus, influenza)
  - faeces (e.g. Clostridium difficile, rotavirus, norovirus)
  - urine (e.g. L. pneumophila, Streptococcus pneumoniae)
  - cerebrospinal fluid (e.g. C. neoformans, S. pneumoniae)
- acute serological tests to demonstrate organism-specific IgM (e.g. measles, rubella diagnosis)
- secondary rapid tests performed on
  - positive blood culture broth samples (e.g. Gram staining, direct coagulase testing to demonstrate presence of S. aureus, nucleic acid amplification to demonstrate S. aureus and methicillin resistance, other modalities (e.g. protein–nucleic acid fluorescent in situ hybridisation probes)
  - bacterial or viral isolates from samples to confirm identification.

7.5 Microbiology reporting practice
The CMS should use cascade (also known as selective) reporting of antimicrobial susceptibilities. Cascade reporting involves a process of reporting antimicrobial susceptibility test results whereby secondary agents (i.e. those that are more broad spectrum) may only be reported if an organism is resistant to primary agents within a particular drug class. Routine reporting of susceptibility to nonformulary or restricted antimicrobial agents should be avoided.

Microbiology reports should also include a range of comments to help clinicians distinguish infection from contamination or colonisation (i.e. antimicrobial therapy is therefore not required). Example comments are provided in Table 7.1.
Table 7.1  Example microbiology report comments that interpret isolate significance

<table>
<thead>
<tr>
<th>Specimen type</th>
<th>Indication</th>
<th>Reporting comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood</td>
<td>Isolate of CoNS from ICU patient — mixed or isolated after prolonged incubation (&gt; 1 day), only one set taken</td>
<td>For optimal sensitivity and specificity, at least two separate blood culture sets (adult, 20 mL each) should be collected from separate venipuncture sites prior to beginning antimicrobial treatment. This patient had one set collected and has an isolated CoNS. This result is consistent with either infection or contamination — clinical correlation is required.</td>
</tr>
</tbody>
</table>
| Blood         | Isolate of potential contaminant organism(s) from non-ICU patient — mixed or isolated after prolonged incubation (> 1 day), not present in multiple sets | This isolate most likely represents contamination. To avoid contamination during blood culture collection, ensure:  
• collection is not done through pre-existing or new intravascular lines  
• hand hygiene is performed with alcohol-based hand rub prior to procedure, and wear protective eyewear  
• the skin site and blood culture bottle caps are disinfected with alcohol (applied for at least 1 minute)  
• sterile gloves and the no-touch technique for venipuncture are used  
• needle exchange prior to inoculation of bottle(s) is avoided. |
| Faeces        | Isolate of *Campylobacter* | *Campylobacter* gastroenteritis does not normally require antimicrobial treatment. However, in severe or prolonged cases and during pregnancy, erythromycin is recommended. |
| Mucosal or skin site swab | Gram stain or culture (or both) shows presence of nonpathogenic micro-organisms | Gram stain or culture (or both) result is consistent with normal flora. |
| Nonsterile site isolate | Antimicrobial susceptibility reported for information rather than to recommend treatment | The reporting of antimicrobial susceptibility does not imply that treatment with antimicrobials is necessary. Colonisation (as opposed to infection) does not require antimicrobial treatment. |

CoNS = coagulase-negative staphylococci; ICU = intensive care unit

*Laboratories should make local sensitivity patterns widely known and routinely should only report on those agents which appear in their formulary and policy.*

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Comments that assist the interpretation of antimicrobial susceptibility should also be included. Example comments of this type are in Table 7.2.

Table 7.2 Example microbiology report comments that provide antimicrobial susceptibility interpretation

<table>
<thead>
<tr>
<th>Specimen type</th>
<th>Indication</th>
<th>Reporting comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any site</td>
<td>Penicillin-resistant, methicillin-sensitive <em>Staphylococcus aureus</em> OR Beta-lactamase-negative <em>S. aureus</em></td>
<td><em>S. aureus</em> susceptible to flucloxacillin or dicloxacillin is also susceptible to cephalozin, cephalexin, and amoxycillin with clavulanate. Penicillin-susceptible strains can be treated with benzylpenicillin or amoxycillin. Cephalozin or cephalothin are suitable alternatives in the penicillin-allergic patient, unless the penicillin allergy is of the severe immediate type, in which case all beta-lactams should be avoided.</td>
</tr>
<tr>
<td>Any site</td>
<td><em>S. aureus</em> sensitive to erythromycin</td>
<td>The erythromycin result can be used to predict clindamycin and lincomycin susceptibility.</td>
</tr>
<tr>
<td>Any site</td>
<td><em>Eikenella corrodens</em> isolate</td>
<td><em>Eikenella corrodens</em> is an aerobic, oral, gram-negative organism. Most isolates are susceptible to benzylpenicillin, amoxycillin and tetracyclines. They are resistant to di/flucloxacillin, erythromycin and aminoglycosides.*</td>
</tr>
<tr>
<td>Respiratory tract</td>
<td><em>Streptococcus pneumoniae</em> with penicillin minimum inhibitory concentration of ≤ 2 mg/L</td>
<td>Penicillin-susceptible isolates of <em>S. pneumoniae</em> are susceptible to amoxycillin.</td>
</tr>
</tbody>
</table>

* This is an example of an organism that is not tested routinely. The CMS provides advice based on published literature to guide the clinician’s choice of therapy.

Comments that provide specific directed treatment advice are an important way of helping clinicians to direct antimicrobial therapy appropriately and to advise them of relevant treatment guidelines (national and local). Reporting and telephone liaison should promote compliance with *Therapeutic Guidelines: Antibiotic* wherever possible. Table 7.3 provides examples of this sort.

Reporting of microbiology susceptibility test results should be timely and accurate. This allows selection of more appropriate and focused therapy, and may help reduce broad-spectrum antimicrobial use.\(^{12,20}\)

For critical microbiology results (e.g. a penicillin-resistant isolate of *S. pneumoniae* in a patient with meningitis), it is essential that urgent discussion with the clinician takes place so that appropriate treatment is not delayed.
### Table 7.3  Example microbiology report comments that provide antimicrobial management advice

<table>
<thead>
<tr>
<th>Specimen type</th>
<th>Indication</th>
<th>Reporting comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSF or blood in meningitis patient</td>
<td><em>Streptococcus pneumoniae</em> (MIC PEN ≥ 0.12 mg/L)</td>
<td>Significant level of penicillin resistance is present. Alternative therapy needs to be considered. Please discuss with the clinical microbiologist [in reality, such a result should prompt an urgent telephone consultation]. (This is a CLSI-based MIC interpretation — some laboratories use other methods and resistance breakpoints.)</td>
</tr>
<tr>
<td>Blood</td>
<td><em>Staphylococcus aureus</em> isolate</td>
<td>Prolonged IV treatment is indicated, preferably via a peripherally inserted central line. Relapse of <em>S. aureus</em> bacteraemia occurs in up to 5% of patients and may present up to 3 months following the event. Patients should receive education to this effect.</td>
</tr>
<tr>
<td>Blood</td>
<td><em>S. pneumoniae</em> (MIC PEN &gt; 2 mg/L, ≤ 4 mg/L)</td>
<td>This isolate demonstrates reduced susceptibility to penicillin. Benzylpenicillin at a dose of 50 mg/kg up to 1.8 g IV 4-hourly remains satisfactory therapy for infections other than meningitis due to this organism. (This is a CLSI-based MIC interpretation — some laboratories use other methods and breakpoints.)</td>
</tr>
<tr>
<td>Pus or wound swab</td>
<td><em>S. aureus</em> isolate from patient with history of boils</td>
<td>If an undrained skin or soft tissue infection is present, early incision/drainage may be curative. If lesion is larger than 5 cm in diameter, also treat with one of the indicated oral antibiotics. AVOID monotherapy with rifampicin. If systemic sepsis is present, collect blood cultures and either use IV flucloxacillin (for MSSA) or vancomycin (for MRSA) for initial treatment. For recurrent staphylococcal infections, refer to [insert information resource link].</td>
</tr>
<tr>
<td>Pus or wound swab</td>
<td>Cellulitis patient with isolates of <em>Streptococcus pyogenes</em> or other beta-haemolytic streptococci, or MSSA</td>
<td>Monotherapy for cellulitis with flucloxacillin or dicloxacillin is effective in most patients. For a more complete discussion of this topic, refer to [insert information resource link].</td>
</tr>
</tbody>
</table>

**Susceptibility and culture results should be reported to clinicians with minimum of delay to allow them to streamline or stop antibiotic therapy as appropriate.**

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### Table 7.3 Example microbiology report comments that provide antimicrobial management advice continued

<table>
<thead>
<tr>
<th>Specimen type</th>
<th>Indication</th>
<th>Reporting comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pus or sterile site aspirate, or tissue culture</td>
<td>Anaerobic isolates</td>
<td>Agents that are predictably active against gram-negative anaerobes (such as <em>Bacteroides</em> and <em>Prevotella</em> spp.) include metronidazole (12-hourly dosage recommended), lincomycin, clindamycin, amoxicillin/clavulanate, piperacillin/tazobactam, or ticarcillin/clavulanate. [modify as per local formulary]</td>
</tr>
<tr>
<td>Any site other than urine</td>
<td>MRSA</td>
<td>If initial systemic treatment is required, use IV vancomycin (see <em>Therapeutic Guidelines: Antibiotic</em> for dosing advice). For uncomplicated skin or soft tissue infection, use one of the indicated oral antibiotics. AVOID monotherapy with rifampicin. For complicated or bone and joint infection, consult ID service.</td>
</tr>
</tbody>
</table>

CLSI = Clinical and Laboratory Standards Institute; CSF = cerebrospinal fluid; ESBL = extended spectrum beta-lactamase; ID = infectious diseases; IV = intravenous; MIC = minimum inhibitory concentration; MRSA = methicillin-resistant *Staphylococcus aureus*; MSSA = methicillin-sensitive *Staphylococcus aureus*; PEN = penicillin

### 7.6 Clinician liaison

The CMS provides key patient-specific information to the clinician. Liaison about results enables timely advice about appropriate empirical therapy (e.g. choice of agent, dose, route and duration). For critical results (e.g. blood or sterile site isolates), such liaison is best performed directly by telephone contact from a clinical microbiologist who may be located off-site.\(^a\)

#### 7.6.1 Intensive care antimicrobial liaison

A particular area of importance for effective AMS is the intensive care unit (ICU). Controlling resistance selection within intensive care has spillover effects for non-ICU patients.

Clinicians and ICU managers, in consultation with the microbiology service, need to regularly review antimicrobial use, changes in the ICU antibiograms (see Section 7.8) and multiresistant organism reports for the unit. This can provide the impetus to change local antimicrobial recommendations, with reference to *Therapeutic Guidelines: Antibiotic*, and promotes adherence to relevant infection prevention and control measures.

A representative of the CMS should attend intensive care liaison rounds, which may be on a daily, twice-weekly or weekly basis, dependent on the size and case load.

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\(^a\) It is acknowledged that some rural microbiology services in Australia are not directly supervised by a clinical microbiologist. In that case, it is essential that microbiology diagnostic processes and reporting are regularly reviewed by an external clinical microbiology consultant.
of the particular unit. Most locations conduct these rounds in conjunction with an infectious diseases physician. Prior to or during the round, the CMS should review all recent microbiology from all current ICU patients. Liaison rounds involve:

- discussing each patient (appraising clinical presentation, prior treatment, current status)
- determining the function of treatment — whether prophylaxis, empirical or directed treatment
- interpreting existing microbiological results and recommending additional investigations if required to clarify the infection status
- recommending changes (in the light of patient situation, microbiology and guidelines) to
  - documented diagnosis
  - switch to directed treatment
  - defined or agreed duration of treatment, or later date for further review.

### 7.6.2 Haematology and oncology liaison

The CMS should provide a similar (weekly) liaison service to haematology and oncology departments. This will facilitate more effective use of microbiological testing, interpretation of test results and antimicrobial use in the high-risk inpatients managed by these services.

### 7.7 Antimicrobial level monitoring and review

The CMS should cooperate with clinical chemistry and pharmacy units to monitor submitted antimicrobial levels for results that are either above or below targets (e.g. aminoglycosides, vancomycin, antifungal agents).

Interpretative comments consistent with *Therapeutic Guidelines: Antibiotic* should be appended to these reports. Where necessary, antimicrobial-level results may prompt contact with the clinician to discuss antimicrobial management. The CMS should facilitate access to antimicrobial-level data by pharmacy and other auditors to enable assessment of indicators that evaluate quality of use (see Chapter 5). Examples of quality indicators that are relevant for aminoglycosides and glycopeptides have been published and should be considered for adoption.

### 7.8 Antimicrobial resistance analysis and reporting

Most CMSs produce antimicrobial susceptibility tables (antibiograms), which are used by clinicians to inform empirical antimicrobial choice (Figure 7.1). These may be made available on the hospital’s intranet or on printed cards. Ideally, all CMSs should provide analyses (at least annually) of antimicrobial resistance to both individual clinicians and to groups with responsibility for local antimicrobial therapy guidelines (e.g. the AMS committee, drug and therapeutics committee, or quality
use of medicines committee) to inform local empirical therapy recommendations and formulary management. A clinical microbiologist needs to interpret the antibiograms to recognise at which point an antimicrobial is no longer a reliable empirical agent against an organism or group of organisms.

The Clinical and Laboratory Standards Institute guideline M39-A2 is an accepted international standard for analysis and presentation of antibiograms. The methods in this document have not received full discussion in Australia and it has not yet been widely accepted as a local standard. As a matter of priority, a national standard approach to analysis and reporting of cumulative antibiograms should be developed, agreed and implemented across CMSs.

WHONET software is one product that can process antimicrobial resistance data uploads from pathology information technology systems and produce cumulative antibiograms. This is often a challenging area for pathology organisations and warrants a national process to facilitate the information technology aspects of cumulative data analysis. CMSs that are struggling with unfriendly epidemiological data systems should focus on producing cumulative antibiograms for clinical areas such as emergency, intensive care, oncology or haematology in the first instance, as failure of empirical antimicrobial choice incurs the highest patient risk in these settings.

Trends in resistance for different organisms should be graphically visualised. Time series data on antimicrobial resistance are valuable for statistical correlation with antimicrobial use time series data. These analyses can identify significant antimicrobial use factors that are responsible for driving subsequent changes in the incidence of antimicrobial-resistant isolates within the hospital. Such data then can inform formulary decisions and antimicrobial use recommendations for particular clinical units (see Chapter 5 and Appendix 1 for more detailed information on use of time series analysis).

Analysis and reporting of relevant molecular resistance mechanisms (e.g. presence of carbapenemase or extended spectrum beta-lactamase enzymes within gram-negative organisms) or epidemiological markers (e.g. using one of many typing systems that are able to demonstrate significant clonality) provides additional descriptions of important endemic or emerging resistant pathogen epidemiology. These data can further inform AMS, and infection prevention and control strategies by identifying outbreaks and the dynamics of clonal pathogen transmission. Where relevant, participation of the CMS in existing targeted national surveillance programs (e.g. National Neisseria Reference network, Australian Group on Antimicrobial Resistance) may complement this process, providing access to detailed typing and molecular analysis of local microbial isolates.

\[a\] www.clsi.org

\[b\] www.who.int/drugresistance/whonetsoftware/en/index.html

\[c\] j.tapsall@unsw.edu.au

\[d\] www.agargroup.org
<table>
<thead>
<tr>
<th>Gram-positive</th>
<th>No. of isolates</th>
<th>Penicillin</th>
<th>Ampicillin*</th>
<th>Erythromycin</th>
<th>Methicillin*</th>
<th>Vancomycin</th>
<th>Ceftriaxone</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>322</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>▲</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coagulase negative staph</td>
<td>107</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Enterococcus</em></td>
<td>172</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>▲</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strep pneumonia#</td>
<td>12</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gram-negative</th>
<th>No. of isolates</th>
<th>Ampicillin*</th>
<th>Gentamycin</th>
<th>Cephalothin**</th>
<th>Ceftriaxone***</th>
<th>Ceftazidime</th>
<th>Piperacillin-tazo</th>
<th>Cotrimoxazole</th>
<th>Imipenem *</th>
<th>Ciprofloxacin</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Escherichia coli</em></td>
<td>456</td>
<td>●</td>
<td>▲</td>
<td>●</td>
<td>●</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Klebsiella spp.</td>
<td>127</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Haemophilus influenzae</em></td>
<td>42</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Stenotrophomonas maltophilia</em></td>
<td>21</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pseudomonas spp.</em></td>
<td>124</td>
<td>●</td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acinetobacter spp.◊</td>
<td>17</td>
<td>●</td>
<td></td>
<td></td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enterobacter spp.◊</td>
<td>86</td>
<td>●</td>
<td></td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Proteus mirabilis</em></td>
<td>55</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serratia spp.◊</td>
<td>22</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citrobacter spp.◊</td>
<td>33</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Morganella morganii</em></td>
<td>30</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

▲ > 90% effective
● 70–89% sensitive
● < 70% effective
blank cells = not reported

# Strep pneumonia 73% fully sensitive, 18% intermediate
* Amoxycillin provides similar cover
*** Cefotaxime provides similar cover
** Cephalothin provides similar cover
● Meropenem provides similar cover
◊ Don’t use cephalosporins, even if reported sensitive

XXX Hospital
Antibiotic sensitivity profile
Data from 1/1/200X to 31/3/200X
Whole Hospital

Figure 7.1  Example of a hospital antibiogram