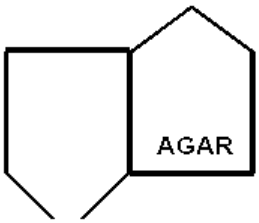

The Australian Group on Antimicrobial Resistance

Gram-negative Survey

2008 Antimicrobial Susceptibility Report

Prepared by

Professor John Turnidge
SA Pathology (Women's and Children's Hospital)
Adelaide

A/Professor Thomas Gottlieb
Concord Hospital
Sydney

Dr David Mitchell
Westmead Hospital
Sydney

Julie Pearson
PathWest Laboratory Medicine WA, Royal Perth Hospital
Perth

Jan Bell
SA Pathology (Women's and Children's Hospital)
Adelaide

On behalf of the Australian Group for Antimicrobial Resistance (AGAR)

Funded by
Commonwealth of Australia
Department of Health and Ageing

1 TABLE OF CONTENTS

2 EXECUTIVE SUMMARY

The Australian Group on Antimicrobial Resistance (AGAR) performs regular period-prevalence studies to monitor changes in antimicrobial resistance. In 2008, AGAR moved to performing annual surveys of resistance in sentinel Gram-negative pathogens, alternating between pathogens causing community-onset infections and those causing hospital-onset infections, having previously conducted biennial surveys of all isolates regardless of infection onset. The 2008 survey focussed on community-onset infections, examining isolates from urinary tract infections from patients presenting to outpatient clinics, emergency departments or to community practitioners. In all, 31 laboratories covering each state and mainland territory of Australia participated in the 2008 surveillance program. Two thousand one hundred and fifty five *E. coli*, 592 *Klebsiella* species and 263 *Enterobacter* species were tested using a commercial automated method (Vitek 2, BioMerieux). Results were analysed using CLSI breakpoints from January 2011.

Moderately high levels of resistance to ampicillin (and therefore amoxycillin) were observed in *E. coli* (44%), with lower rates for amoxycillin-clavulanate (13% intermediate, 3% resistant). Resistance to third-generation cephalosporins is low (ceftriaxone 2%, ceftazidime 1%). In line with international trends among community strains of *E. coli*, most of the strains examined for extended-spectrum β-lactamase (ESBL) production harboured genes of the CTX-M type (36/45 = 80%). Moderate levels of resistance were detected to cefazolin (12%) and trimethoprim (18%). Ciprofloxacin resistance was found in 4% of *E. coli* isolates, higher than that of the other Gram-negative species examined. Resistance to ticarcillin-clavulanate, piperacillin-tazobactam, cefepime, and gentamicin were below 4%. Two isolates had evelated meropenem MICs, but neither possessed any carbapenemase gene known to be prevalent internationally.

Compared to *E. coli*, *Klebsiella* species showed higher levels of resistance to cefazolin, ceftriaxone, ceftazidime, cefepime, ticarcicllin-clavulanate, and piperacillin-tazobactam, but lower rates of resistance to amoxycillin-clavulanate, ciprofloxacin, gentamicin, and trimethoprim. ESBLs were present in 16 of 17 presumptively ESBL-positive isolates of *K. pneumoniae*, 13 of which also proved to be of the CTX-M type. No strains had elevated meropenem MICs.

Acquired resistance in *Enterobacter* species was common to ticarcillin-clavulanate (16%), ceftriaxone (23%), ceftazidime (17%) and trimethoprim (10%). Rates of resistance to piperacillin-tazobactam, cefepime, ciprofloxacin, and gentamicin were all less than 5%. No strains had elevated meropenem MICs.

There are worrying trends in the emergence of CTX-M-producing *E. coli* and *Klebsiella* species and ciprofloxacin-resistant *E. coli* now presenting in or from the community. Other resistance patterns appear stable. There were no striking differences in resistance rates between the states/territories.

3 BACKGROUND

3.1 OBJECTIVES OF THE PROGRAM

AGAR commenced surveillance of key Gram-negative pathogens, *Escherichia coli* and *Klebsiella* species in 1992. Surveys have been conducted biennially since then. In 2004, another genus of Gram-negative pathogens in which resistance can be of clinical importance, *Enterobacter* species, was added. In 2008, AGAR moved to performing annual surveys of resistance in sentinel Gram-negative pathogens, have previously conducted biennial surveys. Annual surveys alternate each year between pathogens causing community-onset infections and those causing hospital-onset infections. The objectives of the 2008 surveillance program were:

1. Determine proportions of resistance to the main therapeutic agents in *E. coli*, *Klebsiella* species, and *Enterobacter* species isolated from outpatients and the community with urinary tract infections
2. Examine the extent of co-resistance and multi-resistance in these species
3. Detect emerging resistance to extended-spectrum cephalosporins and newer last-line agents such as carbapenems

3.2 IMPORTANCE OF SPECIES SURVEYED

All species surveyed are members of the family Enterobacteriaceae. This family contains the most important Gram-negative pathogens in a wide range of common conditions in both the community and in hospitals. The three groups surveyed are considered to be valuable sentinels for multi-resistance and emerging resistance.

E. coli is the commonest cause of upper and lower urinary tract infection, and is prominent in a number of other conditions including intra-abdominal sepsis, post-operative wound infections and neonatal sepsis, cholangitis and septicaemia in the profoundly neutropenic patient. It is one of the commonest isolates in the routine microbiology laboratory.

Klebsiella species are associated with similar conditions to those of *E. coli* but occur less frequently. They are more likely than *E. coli* to acquire and transmit resistance determinants. They are in addition an important cause of pneumonia. This genus is usually intrinsically resistant to aminopenicillins through the possession of one of a small number of natural ß-lactamases.

Enterobacter species are predominantly hospital-acquired pathogens. They are intrinsically resistant to aminopenicillins, first and second generation cephalosporins including cefamycins. Hence, they are naturally multi-resistant. They acquire resistance to important Gram-negative agents relatively easily.

3.3 RELEVANCE OF ANTIMICROBIALS TESTED

3.3.1 B-LACTAMS

This group of agents are the **mainstay of treatment** for Gram-negative infections in all settings, being the drugs of choice for both minor outpatient infections (e.g. lower UTI), and serious community-acquired infections (e.g. septicaemia)

Ampicillin: an aminopenicillin, used to predict resistance to ampicillin and amoxycillin. Considered the drugs of choice for susceptible *E. coli.* [Parenteral, oral; widespread community, mainly as amoxycillin, and hospital use]

Amoxycillin-clavulanate: a ß-lactamase inhibitor combination. Multiple uses including infections caused by ampicillin-resistant strains of *E. coli* and *Klebsiella* species. [Oral, widespread hospital and community use]

Piperacillin-tazobactam: a ß-lactamase inhibitor combination. Broad spectrum agent with multiple uses including against Gram-negative bacteria resistant to other agents. Similar activity to ticarcillin-clavulanate, another widely used ß-lactamase inhibitor combination. [Parenteral, limited hospital use]

Cefazolin: first-generation cephalosporin used for treating common Gram-negative and Gram-positive pathogens. Cefazolin is an important agent for surgical prophylaxis and penicillin-allergic patients. [Parenteral, cephalexin is the nearest oral equivalent, widespread community and hospital use]

Cefoxitin: second-generation cephalosporin, although better described as a cephamycin due to its unique spectrum. Very limited clinical use in surgical prophylaxis. Used in this study to screen for potential AmpC ß-lactamases. [Parenteral, very limited hospital use]

Ceftriaxone: a third-generation cephalosporin. For Enterobacteriaceae, testing results predict cefotaxime. Multiple specialised clinical uses. [Parenteral, extensive hospital use, strictly avoided in some hospitals]

Ceftazidime: a third-generation cephalosporin but with additional antipseudomonal activity. Most susceptible to extended-spectrum ß-lactamases and included in this study for that reason. Main role in Australia as an antipseudomonal agent. [Parenteral, modest hospital use in specialized units]

Cefepime: a fourth generation cephalosporin, but with activity against organisms producing AmpC ß-lactamases, both natural (chromosomal cephalosporinases) and acquired. [Parenteral, modest hospital use in specialized units]

Meropenem: a carbapenem. Predicts activity of most of the other carbapenems, imipenem and doripenem, against Enterobacteriaceae. Last-line agent used for multi-resistant Gram-negative infections, presumptive and proven. [Parenteral, modest restricted hospital use]

3.3.2 OTHER ANTIMICROBIAL CLASSES

Ciprofloxacin: a fluoroquinolone. Predicts resistance in Gram-negatives to other fluoroquinolones, ofloxacin, moxifloxacin. Resistance to ciprofloxacin confirms resistance to norfloxacin. Valuable oral agent reserved for infections caused by Gram-negatives resistant to other antibacterials, and as an antipseudomonal. [Oral, IV, restricted community and hospital use]

Gentamicin: an aminoglycoside. Generally predicts resistance in Gram-negatives to tobramycin (but not Amikacin). Valuable first line agent for presumptive Gram-negative sepsis. [IV, high first line hospital use].

Amikacin: an aminoglycoside. It is unaffected by the common aminoglycoside-modifying enzymes that cause Gram-negative bacteria to become resistant to gentamicin and tobramycin.

Trimethoprim: a folate synthesis (dihydrofolate reductase) inhibitor. Standard treatment for uncomplicated urinary tract infection. [Oral, moderate community use, limited hospital use, both mainly as cotrimoxazole]

Nitrofurantoin: a nitrofuran. A unique mechanism of action but its role, based on its pharmacology, is restricted to the treatment and prevention of urinary tract infection.

Tigecycline: a glycylcycline. A new class of antibiotics derived from tetracycline. These tetracycline analogues are specifically designed to overcome two common mechanisms of tetracycline resistance, namely resistance mediated by acquired efflux pumps and/or ribosomal protection. Used as a reserve agent for multi-resistant organisms.

3.4 RESISTANCES OF CONCERN

3.4.1 B-LACTAMASES

ß-lactamases are the principal resistance mechanism to ß-lactams in Gram-negative bacteria. There is an enormous range of these enzymes now described. Like antibiotics themselves, each ß-lactamase has a "spectrum" of ß-lactams that it can hydrolyze and inactivate. The ß-lactamases of worldwide importance are listed in Table 1.

Table 1 Important ß-lactamases in Enterobacteriaceae

ß-lactamase	Mainly found in	ß-lactams affected or usual co-resistances	Comments
TEM-1,2	*E. coli*	Ampicillin, amoxycillin, piperacillin, (cephalothin)	Very common
TEM-1 hyperproduction	*E. coli*	Amoxycillin-clavulanate (piperacillin-tazobactam)	Increased prevalence in recent years
TEM, SHV and CTX-M extended spectrum ß-lactamases (ESBLs)	*E. coli*, *K. pneumoniae*, *Enterobacter* spp.	Ampicillin, amoxycillin, piperacillin, first-, second- (excluding cephamycins [cefoxitin]) and third generation cephalosporins, monobactam	Mainly hospital-associated until recent emergence in community practice overseas

K1 hyperproduction	*K. oxytoca*	Ampicillin, amoxycillin, piperacillin, first- and second-generation cephalosporins, aztreonam, ceftriaxone > cefotaxime	Natural enzyme selected to hyperproduction
Chromosomal cephalosporinases	ESCaPPM*	Ampicillin, amoxycillin, first-, second-generation cephalosporins, third generation cephalosporins in de-repressed mutants.	Natural enzymes. Selection for stably de-repressed mutants can occur during treatment and strains with this are common
Plasmid-borne AmpC ß-lactamases	*E. coli, K. pneumoniae*	Ampicillin, amoxycillin, first, second and third-generation cephalosporins, including cephamycin	Emerging overseas as a significant problem
Carbapenemases	Rare, but increasing	Ampicillin, amoxycillin, first-, second and third-generation cephalosporins +/-aztreonam	Have been rare in Enterobacteriaceae but now being seen for the first time in Australia and overseas

* ***E****nterobacter* species, ***S****erratia* species, ***C****itrob****a****cter freundii*, ***P****roteus vulgaris* and *penneri*, ***P****rovidencia* species and ***M****organella morganii*.

3.4.2 NON-BETA-LACTAM ANTIBIOTICS

In Enterobacteriaceae, resistance to fluoroquinolones such as ciprofloxacin is generally the result of mutations in the *gyrA* gene, leading to amino acid changes in the target protein DNA gyrase. Two or three mutation and amino acid changes are required to develop full resistance to ciprofloxacin. Occasionally resistance can be brought about through efflux, usually in combination with DNA gyrase mutations.

Resistance to gentamicin and other aminoglycosides is most commonly the result of aminoglycoside modifying enzymes. The types prevalent in Enterobacteriaceae can vary widely by hospital, region and country.

Trimethoprim resistance is most commonly the result of mutations in the gene encoding the dihydrofolate reductase.

4 STUDY DESIGN

Thirty one institutions from each State and mainland Territories of Australia participated in the Gram-negative 2008 AGAR survey. Each institution collected up to 70 *E. coli*, 20 *Klebsiella* species and 10 *Enterobacter* species from different outpatient urinary tract infections.

Table 2. Isolates Tested

Region	Number of Institutions	*E. coli*	*Enterobacter* species	*Klebsiella* species	Total
Australian Capital Territory (ACT)	1	70	10	20	100
New South Wales (NSW)	8	558	72	158	788
Northern Territory (NT)	1	70	4	20	94
Queensland (QLD)	6	420	55	120	595
South Australia (SA)	3	210	26	59	295
Tasmania (TAS)	2	130	6	26	162
Victoria (VIC)	6	417	52	109	578
Western Australia (WA)	4	280	38	80	398
Total	**31**	**2,155**	**263**	**592**	**3010**

4.1 PARTICIPITATING INSTITUTIONS

ACT (1)
The Canberra Hospital

NSW (8)
Concord Hospital
Douglass Hanly Moir
John Hunter Hospital
Nepean Hospital
Royal North Shore Hospital
Royal Prince Alfred Hospital
Sydney South West Pathology Service
Westmead Hospital

NT (1)
Royal Darwin Hospital

QLD (6)
Pathology Queensland, Cairns Base Hospital
Pathology Queensland, Gold Coast Hospital
Pathology Queensland, Prince Charles Hospital
Pathology Queensland, Princess Alexandra Hospital
Pathology Queensland, Central Laboratory
Sullivan Nicolaides Pathology

SA (3)
SA Pathology (Flinders Medical Centre)
SA Pathology (Royal Adelaide Hospital)
SA Pathology (Women's and Children's Hospital)

TAS (2)
Launceston General Hospital
Royal Hobart Hospital

VIC (6)

Alfred Hospital
Austin Health
Gribbles Pathology (Healthscope Pathology)
Monash Medical Centre
Royal Children's Hospital
St Vincent's Hospital

WA (4)

PathWest Laboratory Medicine - WA, Fremantle Hospital
PathWest Laboratory Medicine - WA, QEII Medical Centre
PathWest Laboratory Medicine - WA, Royal Perth Hospital
St John of God Pathology

4.2 METHODS

4.2.1 SPECIES IDENTIFICATION

E. coli isolates were identified by one of the following methods:

Vitek®, Phoenix™ Automated Microbiology System, MicroScan®, Microbact, or ATB®
Chromogenic agar plus spot indole (DMACA)
Agar replication
Minimum tests: BGA or citrate, indole and lactose fermentation.

Klebsiella species and *Enterobacter* species were identified by one of the following methods:

API20E, MicroScan®, Vitek® (plus indole), Phoenix™ Automated Microbiology System, or ATB®
Chromogenic agar plus spot indole (DMACA)
Agar replication

4.2.2 SPECIES INCLUDED IN STUDY

Table 3. Species included

Group	Organism		Total
E. coli	*E. coli*		2,155
Klebsiella	*K. pneumoniae*		475
	K. oxytoca		113
	K. pneumoniae subsp *ozaenae*		2
	Klebsiella not speciated.		2
		Total	592
Enterobacter	*E. cloacae*		158
	E. aerogenes		99
	E. asburiae		4
	E. cancerogenus		1
	Enterobacter not speciated.		1
		Total	263

4.3 SUSCEPTIBILITY TESTING

4.3.1 METHOD

Testing was performed by a commercial semi-automated method, Vitek 2 (BioMerieux) which is calibrated to the ISO reference standard method of broth microdilution. Commercially available Vitek AST-N083 cards were utilized by all participants throughout the survey period. The most recent CLSI breakpoints from Janurary 2011 have been employed in the analysis.

4.3.2 ANTIBIOTICS TESTED

Table 4. Antimicrobials Tested

Antimicrobial Agent	AST N083 card Concentration range	CLSI Breakpoints (mg/L)[a]		
Ampicillin	≤2, 4, 8, 16, ≥32	≤8	16	≥32
Co-amoxyclav	≤2/1, 4/2, 8/4, 16/8, ≥32/16	≤8/4	16/8	≥32/16
Piperacillin/tazobactam	≤4/4, 8/4, 16/4, 32/4, 64/4, ≥128/4	≤16/4	32/4-64/4	≥128/4
Ticarcillin/clavulanate	≤8/2, 16/2, 32/2, 64/2, ≥128/2	≤16/2	32/2-64/2	≥128/2
Cefazolin[b]	≤4, 8, 16, 32, ≥64	≤2	4	≥8
Cefepime	≤1, 2, 4, 8, 16, 32, ≥64	≤8	16	≥32
Ceftriaxone	≤1, 2, 4, 8, 16, 32, ≥64	≤1	2	≥4
Cefoxitin	≤4, 8, 16, 32, ≥64	≤8	16	≥32
Ceftazidime	≤1, 2, 4, 8, 16, 32, ≥64	≤4	8	≥16
Meropenem	≤0.25, 0.5, 1, 2, 4, 8, ≥16	≤1	2	≥4
Gentamicin	≤1, 2, 4, 8, ≥16	≤4	8	≥16
Tobramycin	≤1, 2, 4, 8, ≥16	≤4	8	≥16
Amikacin	≤2, 4, 8, 16, 32, ≥64	≤16	32	≥64
Ciprofloxacin	≤0.25, 0.5, 1, 2, ≥4	≤1	2	≥4
Norfloxacin	≤0.5, 1, 2, 4, 8, ≥16	≤4	8	≥16
Nitrofurantoin	≤16, 32, 64, 128, 256, ≥512	≤32	64	≥128
Nalidixic Acid	≤2, 4, 8, 16, ≥32	≤16	-	≥32
Trimethoprim/sulphamethoxazole	≤1/19, 2/38, 4/76, 8/152, ≥16/304	≤2/38	-	≥4/76
Trimethoprim	≤0.5, 1, 2, 4, 8, ≥16	≤8	-	≥16
Tigecycline[c]	≤0.5, 1, 2, 4, ≥8	≤2	4	≥8

[a] The breakpoints selected to determine resistance are described in Performance Standards for Antimicrobial Susceptibility Testing: Twentieth Information Supplement, CLSI document M100-S21, January 2011.

[b] For analysis, breakpoints of ≤4, ≥8 were appied due to the MIC range available on the Vitek card, recognising that the January 2011 breakpoint is actually susceptible ≤ 2 mg/L

[c] For tigecycline, FDA breakponts were employed as none are provided by CLSI

4.4 QUALITY CONTROL

E. coli ATCC 25922 and *E. coli* ATCC 35218 were the quality control strains for this survey

5 SOURCE OF ISOLATES

All of isolates were collected from non-hospitalised patients with urinary tract infections, including those presenting to emergency departments, outpatient departments or to community practitioners

6 SUSCEPTIBILITY TESTING RESULTS

Overall percentages of resistance or non-susceptibility are shown in Section 6.1 and the Appendix. Appendix 1 shows the details of percentages susceptible, intermediate and resistant for blood culture isolates and isolates from other specimen sources for each antibiotic. For some antibiotics, the concentration range tested did not distinguish between intermediate susceptibility (I) and resistant (R), and the term non-susceptible (NS) was used to describe these strains.

6.1 PERCENTAGES RESISTANT/NON-SUSCEPTIBLE

Table 6. Ampicillin

Species		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
E. coli	%R	44.3%	44.4%	45.7%	43.6%	47.6%	41.5%	46.5%	40.7%	44.4%

Comments: Resistance to ampicillin is intrinsic in *Klebsiella* and *Enterobacter* species, due to natural ß-lactamases, and hence resistance rates not reported here. Some strains may test as susceptible in vitro, but are generally reported as resistant

Table 7. Amoxycillin-clavulanate

Species		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
E. coli	%I	8.6%	16.1%	18.6%	12.9%	9.5%	10.8%	12.9%	12.9%	13.3%
	%R	4.3%	2.3%	0.0%	3.8%	3.8%	1.5%	2.4%	3.6%	2.9%
***Klebsiella* spp.**	%I	10.0%	3.8%	0.0%	3.3%	3.4%	0.0%	3.7%	2.5%	3.4%
	%R	5.0%	8.9%	0.0%	1.7%	1.7%	0.0%	3.7%	1.3%	3.9%
K. oxytoca	%I	33.3%	2.5%	0.0%	5.6%	9.1%	0.0%	3.7%	0.0%	5.3%
	%R	16.7%	10.0%	0.0%	5.6%	0.0%	0.0%	0.0%	0.0%	5.3%
K. pneumoniae	%I	0.0%	4.3%	0.0%	3.0%	2.1%	0.0%	3.7%	2.7%	2.9%
	%R	0.0%	8.5%	0.0%	1.0%	2.1%	0.0%	4.9%	1.4%	3.6%

Comments: Intermediate susceptibility or resistance to amoxycillin-clavulanate is intrinsic in *Enterobacter* species, due to natural ß-lactamases. and hence resistance rates not reported here. Some strains may test as susceptible in vitro, but are generally reported as resistant. Intermediate susceptibility is common in *E. coli* due to hyperproduction of acquired narrow-spectrum ß-lactamases, and in *Klebsiella* species due to higher levels of natural ß-lactamases.

Table 8. Ticarcillin-clavulanate

Species		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
E. coli	%R	1.4%	2.9%	4.3%	4.3%	2.9%	2.3%	2.9%	3.6%	3.2%
***Enterobacter* spp.**	%R	30.0%	20.8%	50.0%	9.1%	11.5%	0.0%	15.4%	15.8%	16.0%
E. aerogenes	%R	16.7%	14.3%	50.0%	14.3%	0.0%	0.0%	12.5%	0.0%	11.1%
E. cloacae	%R	66.7%	25.6%	50.0%	7.5%	21.4%	0.0%	19.2%	21.4%	19.6%
***Klebsiella* spp.**	%R	5.0%	8.9%	0.0%	2.5%	1.7%	0.0%	3.7%	2.5%	4.2%
K. oxytoca	%R	16.7%	7.5%	0.0%	11.1%	9.1%	0.0%	0.0%	0.0%	6.2%
K. pneumoniae	%R	0.0%	9.4%	0.0%	1.0%	0.0%	0.0%	4.9%	2.7%	3.8%

Comments: Resistance to ticarcillin-clavulanate in *E. coli* and *Klebsiella* species may indicate the presence of acquired plasmid-borne AmpC ß-lactamases.

Table 9. Piperacillin-tazobactam

Species		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
E. coli	%R	0.0%	0.4%	1.4%	0.2%	0.0%	0.0%	0.2%	0.4%	0.3%
***Enterobacter* spp.**	%R	0.0%	5.6%	25.0%	1.8%	0.0%	0.0%	1.9%	2.6%	3.0%
E. aerogenes	%R	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
E. cloacae	%R	0.0%	9.3%	0.0%	2.5%	0.0%	0.0%	3.8%	3.6%	4.4%
***Klebsiella* spp.**	%R	5.0%	2.5%	0.0%	0.8%	1.7%	0.0%	0.9%	0.0%	1.4%
K. oxytoca	%R	16.7%	7.5%	0.0%	5.6%	9.1%	0.0%	0.0%	0.0%	5.3%
K. pneumoniae	%R	0.0%	0.9%	0.0%	0.0%	0.0%	0.0%	1.2%	0.0%	0.4%

Comments: Resistance to piperacillin-tazobactam in *E. coli* and *Klebsiella* species may indicate the presence of acquired plasmid-borne AmpC ß-lactamases.

Table 10. Cefazolin

Species		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
E. coli	%R	11.4%	14.2%	20.0%	10.0%	11.0%	11.5%	12.9%	11.1%	12.3%
***Enterobacter* spp.**	%R	100%	95.8%	100%	96.4%	88.5%	66.7%	84.6%	92.1%	92.0%
E. aerogenes	%R	100%	89.3%	100%	92.9%	72.7%	75.0%	70.8%	80.0%	82.8%
E. cloacae	%R	100%	100%	100%	97.5%	100%	50.0%	100%	96.4%	98.1%
***Klebsiella* spp.**	%R	10.0%	31.0%	5.0%	10.8%	22.0%	15.4%	22.9%	8.8%	19.3%
K. oxytoca	%R	33.3%	77.5%	100%	61.1%	81.8%	50.0%	63.0%	66.7%	68.1%
K. pneumoniae	%R	0.0%	14.5%	0.0%	2.0%	8.3%	9.1%	9.9%	4.1%	7.6%

Comments:
Interpretation based on MIC range available on Vitek card, which currently do not match those of the new CLSI breakpoints published in 2011.
Resistance to cefazolin, representative of first generation cephalosporins, is common in *E. coli* and *Klebsiella* species. *Enterobacter* species are intrinsically resistant due to natural ß-lactamases.

Table 11. Ceftriaxone

Species		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
E. coli	%NS	1.4%	2.2%	2.9%	0.5%	1.4%	1.5%	2.4%	4.6%	2.1%
***Enterobacter* spp.**	%NS	30.0%	23.6%	50.0%	14.5%	19.2%	33.3%	25.0%	28.9%	23.2%
E. aerogenes	%NS	33.3%	14.3%	50.0%	21.4%	9.1%	50.0%	25.0%	10.0%	20.2%
E. cloacae	%NS	33.3%	30.2%	50.0%	12.5%	28.6%	0.0%	26.9%	35.7%	25.9%
***Klebsiella* spp.**	%NS	5.0%	8.2%	0.0%	1.7%	3.4%	0.0%	4.6%	2.5%	4.2%
K. oxytoca	%NS	16.7%	10.0%	0.0%	5.6%	0.0%	0.0%	7.4%	0.0%	7.1%
K. pneumoniae	%NS	0.0%	7.7%	0.0%	1.0%	4.2%	0.0%	3.7%	2.7%	3.6%

Comments: In *E. coli* and *Klebsiella* species non-susceptibility to ceftriaxone is indicative of extended-spectrum ß-lactamase production. In *Enterobacter* species resistance is indicative of stable de-repression of natural chromosomal cephalosporinase.

Table 12. Ceftazidime

Species		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
E. coli	%NS	1.4%	0.7%	1.4%	0.5%	1.0%	0.0%	1.0%	2.9%	1.0%
***Enterobacter* spp.**	%NS	20.0%	20.8%	50.0%	12.7%	7.7%	16.7%	15.4%	18.4%	16.7%
E. aerogenes	%NS	16.7%	14.3%	50.0%	21.4%	0.0%	25.0%	16.7%	0.0%	14.1%
E. cloacae	%NS	33.3%	25.6%	50.0%	10.0%	14.3%	0.0%	15.4%	25.0%	19.0%
***Klebsiella* spp.**	%NS	0.0%	6.3%	0.0%	0.8%	1.7%	0.0%	2.8%	1.3%	2.7%
K. oxytoca	%NS	0.0%	5.0%	0.0%	0.0%	0.0%	0.0%	3.7%	0.0%	2.7%
K. pneumoniae	%NS	0.0%	6.8%	0.0%	1.0%	2.1%	0.0%	2.5%	1.4%	2.7%

Comments: In *E. coli* and *Klebsiella* species non-susceptibility to ceftazidime is indicative of extended-spectrum ß-lactamase production. In *Enterobacter* species resistance is indicative of stable de-repression of natural chromosomal cephalosporinase.

Table 13. Cefepime

Species		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
E. coli	%NS	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	0.2%	1.4%	0.3%
***Enterobacter* spp.**	%NS	0.0%	0.0%	25.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
E. aerogenes	%NS	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
E. cloacae	%NS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
***Klebsiella* spp.**	%NS	0.0%	3.2%	0.0%	0.0%	0.0%	0.0%	1.8%	0.0%	1.2%
K. oxytoca	%NS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
K. pneumoniae	%NS	0.0%	4.3%	0.0%	0.0%	0.0%	0.0%	2.5%	0.0%	1.5%

Comments: In *E. coli* and *Klebsiella* species non-susceptibility to cefepime is suggestive of mixed or hyperproduction of extended-spectrum ß-lactamases. In *Enterobacter* species non-susceptibility is suggestive of the presence of extended-spectrum ß-lactamases.

Table 14. Meropenem

Species		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
E. coli	%NS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.4%	0.1%
***Enterobacter* spp.**	%NS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
***Klebsiella* spp.**	%NS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Comments: Non-susceptibility in Enterobacteriaceae suggests the presence of carbapenemases.

Table 15. Ciprofloxacin

Species		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
E. coli	%NS	2.9%	4.8%	7.1%	3.6%	3.3%	1.5%	4.1%	5.7%	4.2%
***Enterobacter* spp.**	%NS	0.0%	1.4%	25.0%	0.0%	7.7%	0.0%	0.0%	2.6%	1.9%
E. aerogenes	%NS	0.0%	0.0%	50.0%	0.0%	9.1%	0.0%	0.0%	0.0%	2.0%
E. cloacae	%NS	0.0%	2.3%	0.0%	0.0%	7.1%	0.0%	0.0%	3.6%	1.9%
***Klebsiella* spp.**	%NS	0.0%	3.8%	0.0%	1.7%	3.4%	0.0%	3.7%	1.3%	2.5%
K. oxytoca	%NS	0.0%	2.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%
K. pneumoniae	%NS	0.0%	4.3%	0.0%	2.0%	4.2%	0.0%	4.9%	1.4%	2.9%

Comments: Ciprofloxacin non-susceptibility indicates at least mutations in *gyrA*, the gene encoding the target enzyme, DNA gyrase and, and more recently, the possibility of plasmid-mediated quinolone-resistance genes

Table 16. Norfloxacin

Species		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
E. coli	%NS	1.4%	4.7%	7.1%	3.3%	3.3%	1.5%	4.1%	5.7%	4.1%
***Enterobacter* spp.**	%NS	0.0%	1.4%	0.0%	0.0%	7.7%	0.0%	0.0%	2.6%	1.5%
E. aerogenes	%NS	0.0%	0.0%	0.0%	0.0%	9.1%	0.0%	0.0%	0.0%	1.0%
E. cloacae	%NS	0.0%	2.3%	0.0%	0.0%	7.1%	0.0%	0.0%	3.6%	1.9%
***Klebsiella* spp.**	%NS	0.0%	3.2%	0.0%	0.8%	3.4%	0.0%	2.8%	1.3%	2.0%
K. oxytoca	%NS	0.0%	2.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%
K. pneumoniae	%NS	0.0%	3.4%	0.0%	1.0%	4.2%	0.0%	3.7%	1.4%	2.3%

Comments: Norfloxacin non-susceptibility indicates mutations in *gyrA*, the gene encoding the target enzyme, DNA gyrase and/or more recently, the possibility of plasmid-mediated quinolone-resistance genes

Table 17. Gentamicin

Species		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
E. coli	%R	2.9%	3.6%	4.3%	2.4%	2.9%	2.3%	4.1%	5.4%	3.5%
***Enterobacter* spp.**	%R	0.0%	6.9%	25.0%	3.6%	7.7%	0.0%	0.0%	0.0%	3.8%
E. aerogenes	%R	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
E. cloacae	%R	0.0%	11.6%	0.0%	5.0%	14.3%	0.0%	0.0%	0.0%	5.7%
***Klebsiella* spp.**	%R	0.0%	5.7%	0.0%	0.8%	0.0%	0.0%	3.7%	2.5%	2.7%
K. oxytoca	%R	0.0%	5.0%	0.0%	0.0%	0.0%	0.0%	3.7%	16.7%	3.5%
K. pneumoniae	%R	0.0%	6.0%	0.0%	1.0%	0.0%	0.0%	3.7%	1.4%	2.5%

Comments: Gentamicin resistance indicates the presence of at least one of a range of aminoglycoside modifying enzymes

Table 18. Trimethoprim

Species		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
E. coli	%R	22.9%	21.0%	20.0%	14.5%	16.7%	13.8%	23.3%	13.6%	18.4%
***Enterobacter* spp.**	%R	10.0%	12.5%	25.0%	7.3%	19.2%	0.0%	5.8%	5.3%	9.5%
E. aerogenes	%R	0.0%	7.1%	50.0%	0.0%	9.1%	0.0%	0.0%	0.0%	4.0%
E. cloacae	%R	33.3%	16.3%	0.0%	10.0%	28.6%	0.0%	11.5%	7.1%	13.3%
***Klebsiella* spp.**	%R	10.0%	12.7%	15.0%	5.8%	11.9%	7.7%	11.9%	12.5%	10.8%
K. oxytoca	%R	0.0%	5.0%	0.0%	5.6%	9.1%	0.0%	7.4%	16.7%	6.2%
K. pneumoniae	%R	14.3%	15.4%	15.8%	6.0%	12.5%	9.1%	13.6%	12.2%	12.0%

Comments: Trimethoprim resistance is the result of mutations in the gene encoding dihydrofolate reductase.

Table 19. Tigecycline

Species		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
E. coli	%NS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
***Enterobacter* spp.**	%NS	0.0%	4.2%	0.0%	1.8%	3.8%	0.0%	1.9%	2.6%	2.7%
E. aerogenes	%NS	0.0%	3.6%	0.0%	0.0%	9.1%	0.0%	0.0%	0.0%	2.0%
E. cloacae	%NS	0.0%	4.7%	0.0%	2.5%	0.0%	0.0%	3.8%	3.6%	3.2%
***Klebsiella* spp.**	%NS	10.0%	3.2%	0.0%	2.5%	0.0%	0.0%	0.0%	3.8%	2.2%
K. oxytoca	%NS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
K. pneumoniae	%NS	14.3%	4.3%	0.0%	3.0%	0.0%	0.0%	0.0%	4.1%	2.7%

Comments: Tigecycline resistance usually indicates the overexpression of AcrAB, a member of the RND multidrug efflux family.

6.2 SUMMARY

The following summarizes the resistance issues in the three groups of Enterobacteriaceae, except for extended-spectrum ß-lactamases (Section 6.3.1) and carbapenemases (Section 6.3.2). There are no striking differences between the states, although NSW/ACT has higher percentages of acquired resistance to many older drug classes in *Enterobacter* species compared to the other states.

E. coli

Ampicillin resistance proportions have been moderately high for more than a decade, and approximately stable at around 45% in the Australian community. Amoxycillin-clavulanate intermediate and resistant strains have been around for some time but remain in relatively low proportion. Percentages of resistance to ticarcillin-clavulanate and piperacillin-tazobactam remain low for *E. coli* and *Klebsiella* spp. Cefazolin maintains modest levels of resistance. Ciprofloxacin resistance appears to be increasing despite controlled usage in both the community and in hospitals. Gentamicin resistance remains fairly low despite more three decades of use in mostly hospital practice. Trimethoprim, especially as cotrimoxazole, use has been high in the community and this is reflected in the resistance percentages.

***Klebsiella* species**

Acquired resistances of interest include those of ß-lactamase inhibitor combinations; percentage of resistance to amoxycillin-clavulanate and piperacillin-tazobactam are still low. Percentages are substantially higher for cefazolin, a first generation cephalosporin. Resistance to gentamicin is still low. Resistance to ciprofloxacin and trimethoprim is less common than in *E. coli*.

***Enterobacter* species**

Ampicillin, amoxycillin-clavulanate and first-generation cephalosporins are generally considered inactive against *Enterobacter* species. Resistance to gentamicin is similar to that seen in *E. coli* and commoner than seen in *Klebsiella* species. Levels of resistance to ciprofloxacin and trimethoprim are less than in *E. coli* and *Klebsiella* species.

6.3 MAJOR RESISTANCES

6.3.1 ESBLS

Extended-spectrum ß-lactamases are important problem resistances internationally. They have been predominantly a problem in hospital practice, and initially were more common in *Klebsiella* species than in *E. coli*. Recently, two new trends have emerged: the presence of ESBLs in *Enterobacter* species, and the emergence of specific types of ESBLs (so-called CTX-M enzymes). ESBLs are important as they compromise the efficacy of third-generation cephalosporins which have been such a useful therapeutic alternative in hospital practice. Outbreaks of ESBLs producing *Klebsiella* species and *E. coli* have led some hospitals in Australia to severely restrict or abandon third-generation cephalosporin use. ESBLs, particularly those of the CTX-M type, are starting to emerge in community isolates of *E. coli*.

Most ESBL-producing strains will be captured/recognised using the new CLSI ceftriaxone “susceptible” breakpoints of 1 mg/L. The “susceptible”breakpoint of 4 mg/L for ceftazidime is less sensitive for ESBL detection, but an MIC > 1mg/L (which is present on the Vitek 2 card) is more sensitive. Isolates with either ceftriaxone or ceftazidime MICs above 1 mg/L were selected for ESBL phenotypic confirmation and molecular testing.

Neither of ceftriaxone nor ceftazidime testing will identify ESBL production in *Enterobacter* species because of their chromosomal AmpC β-lactamase. In that species, cefepime at 1 mg/L is suggestive that an isolate of this genus habours an ESBL. Isolates with a cefepime MIC > 1mg/L were selected for ESBL phenotypic confirmation and molecular testing.

Molecular testing involved multiplex screening for TEM, SHV, CTX-M and plasmid-borne AmpC genes. TEM screening does not accurately discriminiate between TEM-1/2 genes, which encode narrow-spectrum β-lactamases, and TEM genes that encode ESBLs. Similarly, SHV screening does not discriminate between SHV-1/11, which are narrow-spectrum β-lactamases, and SHV genes that encode ESBLs. SHV-1 is the natural chromosomal enzyme of *Klebsiella pneumoniae* enzyme leading to natural ampicillin/amoxycillin resistance. CTX-M genes all encode ESBLs, as do plasmid-borne AmpC genes effectively.

Table 20. Presumptive and Confirmed Extended-spectrum β-lactamase Production

Species	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
Escherichia coli	1	13	2	3	3	2	10	14	48
Ceftriaxone > 1 mg/L	1.4%	2.2%	2.9%	0.5%	1.4%	1.5%	2.4%	4.6%	2.1%
Ceftazidime > 1 mg/L	1.4%	1.3%	2.9%	0.7%	1.0%	0.8%	1.7%	3.6%	1.5%
Either of above	1.4%	2.3%	2.9%	0.7%	1.4%	1.5%	2.4%	5.0%	2.2%
Confirmed									
any ESBL (No. received)	1/1	10/11	2/2	2/3	3/3	2/2	9/9	11/14	40/45
CTX-M types	0	10	2	0	3	2	8	11	36
plasmid-borne AmpC	1	0	0	2	0	0	1	0	4
Klebsiella pneumoniae	0	9	0	1	2	0	3	2	17
Ceftriaxone > 1 mg/L		7.7%		1.0%	4.2%		3.7%	2.7%	3.6%
Ceftazidime > 1 mg/L		6.8%		1.0%	2.1%		2.5%	1.4%	2.7%
Either of above		7.7%		1.0%	4.2%		3.7%	2.7%	3.6%
Confirmed									
any ESBL (No. received)		9/9		1/1	1/2		3/3	2/2	16/17
CTX-M types		9		0	0		2	2	13
plasmid-borne AmpC		0		1	0		0	0	1
Klebsiella oxytoca	1	4	0	1	0	0	2	0	8
Ceftriaxone > 1 mg/L	16.7%	10.0%		5.6%			7.4%		7.1%
Ceftazidime > 1 mg/L	0.0%	5.0%		0.0%			3.7%		2.7%
Either of above	16.7%	10.0%		5.6%			7.4%		7.1%
Confirmed									
any ESBL (No. received)	0/1	2/4		0/1			1/2		3/8
CTX-M types	0	1		0			0		1
plasmid-borne AmpC	0	0		0			0		0
***Enterobacter* species**	0	5	1	1	1	0	2	0	10
Cefepime > 1 mg/L		6.9%	25.0%	1.8%	3.8%		3.8%		3.8%
Confirmed									
any ESBL (No. received)		2/4	1/1	0/1	0/1		0/2	0	3/9
CTX-M types		0	1	0	0		0	0	1

ESBLs are more common in *Klebsiella* species (3.9% confirmed; range 0.0% to 7.0%) than in *E. coli* (1.9% confirmed; range 0.5% to 3.9%), a situation that has prevailed in Australia since their original emergence here. For the *Enterobacter* species 1.1% of isolates contained an ESBL. There was a notable presence of CTX-M enzymes in *E. coli* (36/45 tested), mimicking the early stages of the spread of these enzymes in this species around the world.

Many of the *K. oxytoca* isolates with an ESBL phenotype were hyperproducers of K1 β-lactamase, the natural chromosomal enzyme in these species, rather than ESBL producers. Hyperproducers of K1 β-lactamase are consistently resistant to piperacillin-tazobactam, having borderline resistance to cefepime, but remain susceptible to ceftazidime. This pattern is not typical of a true ESBL producer.

6.3.2 PLASMID-BORNE AmpC β-LACTAMASES

Plasmid-borne AmpC ß-lactamases have recently emerged internationally as a growing Gram-negative resistance problem. They are the result of mobilization of natural chromosomally located genes from common and uncommon species of Enterobacteriaceae onto transmissible plasmids and into the common pathogens. There are currently 6 separate classes. Like ESBLs these enzymes confer resistance to the important third-generation cephalosporins such as ceftriaxone and ceftazidime. Routine phenotypic detection methods have not yet been effectively developed. Nevertheless it is possible to exploit a special feature of these enzymes, their ability to inactivate the cephamycins, represented by cefoxitin. *Enterobacter* species already naturally possess chromosomally-encoded AmpC enzymes.

Table 21. Presumptive plasmid-borne AmpC ß-lactamase Production

Species	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
Escherichia coli	1	1	0	4	0	0	5	5	16
Cefoxitin ≥ 32 mg/L	1.4%	0.2%		1.0%			1.2%	1.8%	0.7%
***Klebsiella* species**	1	5	0	3	1	0	1	1	12
Cefoxitin ≥ 32 mg/L	5.0%	3.2%		2.5%	1.7%		0.9%	1.3%	2.0%

The proportions of *E. coli* and *Klebsiella* species with elevated cefoxitin MICs were low. Only 25% of cefoxitin-resistant *E. coli* and 10% of *Klebsiella* spp. that were available for molecular confirmation were confirmed to contain plasmid-borne AmpC; with CMY-2 (n=4) in *E. coli,* and CMY-2 detected in one *K. pneumoniae*.

6.3.3 CARBAPENEMASES

Acquired carbapenemases, in particular metallo-ß-lactamases, were first described in *Pseudomonas aeruginosa* and *Acinetobacter baumannii*. They are now being seen more commonly among members of the Enterobacteriaceae. Two strains of *E. coli* in the survey were not susceptible to meropenem. Neither contained a plasmid mediated carbapenemase by molecular testing for IMP, VIM, NDM, OXA-48-like and KPC genes.

6.4 IMPORTANT CO-RESISTANCES

Strains harbouring extended-spectrum ß-lactamases are much more likely to harbour resistances to unrelated drug classes. The proportion of strains with elevated MICs to ceftriaxone or ceftazidime (>1 mg/L), and confirmed to contain an extended-spectrum ß-lactamase, which were resistant to other drug classes is shown in Table 21:

Table 22. Co-resistance percentages in strains with confirmed ESBLs

Species	Category	Ciprofloxacin	Gentamicin	Trimethoprim*
E. coli (n=40)	%I	2.8%	0.0%	-
	%R	72.2%	47.2%	72.2%
Klebsiella pneumoniae (n=16)	%I	25.0%	0.0%	-
	%R	25.0%	56.3%	81.3%

* There is no intermediate category for trimethoprim

Further detail on co-resistances is contained in Appendix 2.

6.5 MULTI-RESISTANCE

The most problematic Gram-negative pathogens are those with multiple acquired resistances. Although there is no agreed benchmark for the definition of multi-resistance in Enterobacteriaceae, we have chosen acquired resistance to more than 3 agents to define multi-resistance in our survey. For each species, antibiotics were excluded from the count if they were affected by natural resistance mechanisms, so that only true acquired resistances were included. For the purposes of this analysis, resistance included Intermediate susceptibility when the tested range did not go beyond the susceptible category.

Table 23. Mutli-resistance in Escherichia coli

		Non-multi-resistant					Multi-resistant										
Region	**Total**	**0**	**1**	**2**	**3**	**%**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**%**
ACT	70	33	19	13	3	97.1%	1			1								2.9%
NSW	558	281	122	99	35	96.2%	11	6	2	2								3.8%
NT	70	36	13	10	8	95.7%	2			1								4.3%
QLD	420	223	112	51	22	97.1%	7	3	2									2.9%
SA	210	99	67	30	7	96.7%	2	3		1	1							3.3%
TAS	130	71	35	17	4	97.7%	1	1	1									2.3%
VIC	417	203	98	73	21	94.7%	13	3	5		1							5.3%
WA	280	160	59	33	12	94.3%	6		3	5	1	1						5.7%
Total	*2155*	*1106*	*525*	*326*	*112*	*96.0%*	*43*	*16*	*13*	*10*	*3*	*1*						*4.5%*

Antibiotics included: ampicillin, amoxycillin-clavulanate, piperacillin-tazobactam, cefazolin, cefoxitin, ceftriaxone, ceftazidime, cefepime, gentamicin, amikacin, ciprofloxacin, nitrofurantoin, trimethoprim, meropenem

Antibiotics excluded: ticarcillin-clavulanate, tobramycin, norfloxacin, nalidixic acid, sulfamethoxazole-trimethoprim

Table 24. Mutli-resistance in Klebsiella species

		Non-multi-resistant					Multi-resistant										
Region	**Total**	**0**	**1**	**2**	**3**	**%**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**%**
ACT	20	14	4		1	95.0%	1										5.0%
NSW	158	79	52	8	5	91.1%	3	4	4	1		1	1				8.9%
NT	20	15	4	1		100%											
QLD	120	76	37	4	1	98.3%		2									1.7%
SA	59	35	19	2	1	96.6%		1	1								3.4%
TAS	26	18	7	1		100%											
VIC	109	66	32	5	1	95.4%	2	1	1			1					4.6%
WA	80	54	19	4	1	97.5%	1	1									2.5%
Total	*592*	*357*	*174*	*25*	*10*	*95.6%*	*7*	*9*	*6*	*1*		*2*	*1*				*4.4%*

Antibiotics included: amoxycillin-clavulanate, piperacillin-tazobactam, cefazolin, cefoxitin, ceftriaxone, ceftazidime, cefepime, gentamicin, amikacin, ciprofloxacin, nitrofurantoin, trimethoprim, meropenem

Antibiotics excluded: ampicillin, cephalothin, ticarcillin-clavulanate, tobramycin, norfloxacin, nalidixic acid, sulfamethoxazole-trimethoprim

Table 25. Mutli-resistance in Enterobacter species

		Non-multi-resistant					Multi-resistant							
Region	**Total**	**0**	**1**	**2**	**3**	**%**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**%**
ACT	10	4	4	1	1	100%								
NSW	72	34	18	9	4	90.3%	6			1				9.7%
NT	4	2		1		75.0%			1					25.0%
QLD	55	34	13	4	2	96.4%	2							3.6%
SA	26	12	9	2	2	96.2%	1							3.8%
TAS	6	3	3			100%								
VIC	52	26	17	4	5	100%								
WA	38	25	6	3	4	100%								
Total	*263*	*140*	*70*	*24*	*18*	*95.8%*	*9*		*1*	*1*				*4.2%*

Antibiotics included: piperacillin-tazobactam, ceftriaxone, ceftazidime, cefepime, gentamicin, amikacin, ciprofloxacin, nitrofurantoin, trimethoprim, meropenem

Antibiotics excluded: ampicillin, amoxycillin-clavulanate, cefazolin, cefoxitin, ticarcillin-clavulanate, tobramycin, norfloxacin, nalidixic acid, sulfamethoxazole-trimethoprim

6.6 LIMITATIONS OF THE STUDY

Although this study is comprehensive in its coverage of Australia, and the methodology follows international standards, there are a small number of limitations to the data and its interpretation.

1. The data are not denominator controlled. There is currently no consensus on an appropriate denominator for such surveys. Institution size, throughput, patient complexity and local antibiotic use patterns very much determine the types of resistance likely to be observed.

2. Every attempt has been made by the participating laboratories to ascertain the clinical significance of isolates; however, the laboratories are dependent on (sometimes very limited) clinical information supplied on request forms. Gathering detailed clinical information sufficient to make a judgment on significance would require much greater resources than were available for this survey. Nevertheless, isolates were included only if there was laboratory evidence of urinary tract infection, although some cases of asymptomatic bacteriuria were likely included.

7 STANDARDS AND INFORMATION RESOURCES

1. Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing. Twenty-first informational supplement. M100-S21. CLSI, Wayne, Pa, 2011.

2. Clinical and Laboratory Standards Institute. Methods for Dilution Antimicrobial Susceptibility Tests for Bacteria That Grow Aerobically; Approved Standard - Eighth Edition. M07-A8. CLSI, Wayne, Pa, 2009

3. Bell JM, Turnidge JD, Jones RN; SENTRY Asia-Pacific Participants. Prevalence of extended-spectrum beta-lactamase- producing *Enterobacter cloacae* in the Asia-Pacific region: results from the SENTRY Antimicrobial Surveillance Program, 1998 to 2001. *Antimicrob Agents Chemother*. 2003 Dec;47(12):3989-93.

4. Tigecycline USA package insert; www.wyeth.com/hcp/tygacil/moa

8 ACKNOWLEDGEMENTS

Alfred Hospital, VIC	Denis Spelman and Michael Huysmans
Austin Health, VIC	Barrie Mayall and Peter Ward
Concord Hospital, NSW	Tom Gottlieb and Glenn Funnell
Douglass Hanly Moir Pathology, NSW	Miriam Paul and Richard Jones
Gribbles Pathology, VIC	John Andrew and Di Olden
John Hunter Hospital, NSW	John Ferguson and Jo Anderson
Launceston General Hospital, TAS	Kathy Wilcox
Southern Health, (Monash Medical Centre), VIC	Tony Korman and Despina Kotsanas
Nepean Hospital, NSW	James Branley and Donna Barbaro
PathWest Laboratory Medicine-WA, Fremantle Hospital, WA	David McGechie and Graham Frances
PathWest Laboratory Medicine-WA, QEII Medical Centre, WA	Clay Golledge and Barbara Henderson
PathWest Laboratory Medicine-WA, Royal Perth Hospital, WA	Keryn Christiansen and Geoffrey Coombs
Pathology Queensland, Cairns Base Hospital, QLD	Enzo Binotto and Bronwyn Thomsett
Pathology Queensland, Gold Coast Hospital, QLD	Petra Derrington and Dale Thorley
Pathology Queensland, Princess Alexandra Hospital, QLD	Joan Faoagali and Gwen Lye
Pathology Queensland, Prince Charles Hospital, QLD	Chris Coulter and Sonali Coulter
Pathology Queensland, Central Laboratory, QLD	Graeme Nimmo and Narelle George
Royal Children's Hospital, VIC	Suzanne Garland and Gena Gonis
Royal Darwin Hospital, NT	Jann Hennessy
Royal Hobart Hospital, TAS	Alistair McGregor and Rob Peterson
Royal North Shore Hospital, NSW	George Kotsiou and Clarence Fernandes
Royal Prince Alfred Hospital, NSW	Richard Benn and Bradley Watson
SA Pathology (Flinders Medical Centre), SA	David Gordon and Hendrik Pruul
SA Pathology (Royal Adelaide Hospital), SA	Morgyn Warner and Rachael Pratt
SA Pathology (Women's and Children's Hospital), SA	John Turnidge and Jan Bell
Sydney South West Pathology Service, NSW	Ann Hofmeyr and Helen Ziochos
St John of God Pathology, WA	Sasha Jaksic and Dawn Arklie
St Vincent's Hospital, VIC	Mary Jo Waters and Linda Joyce
Sullivan Nicolaides Pathology, QLD	Jenny Robson and Marianne Allen
The Canberra Hospital, ACT	Peter Collignon and Susan Bradbury
Westmead Hospital, NSW	David Mitchell and Lee Thomas

APPENDIX 1. SUSCEPTIBILITY RESULTS BY STATE

Ampicillin

Genus	State	Total	%S	%I	%R
Escherichia coli	ACT	70	54.3%	1.4%	44.3%
	NSW	558	55.6%	0.0%	44.4%
	NT	70	54.3%	0.0%	45.7%
	QLD	420	55.7%	0.7%	43.6%
	SA	210	52.4%	0.0%	47.6%
	TAS	130	58.5%	0.0%	41.5%
	VIC	417	52.8%	0.7%	46.5%
	WA	280	59.3%	0.0%	40.7%
	National	2155	1192	7	956
			55.3%	0.3%	44.4%

Amoxycillin-clavulanate

Genus	State	Total	%S	%I	%R
Escherichia coli	ACT	70	87.1%	8.6%	4.3%
	NSW	558	81.5%	16.1%	2.3%
	NT	70	81.4%	18.6%	0.0%
	QLD	420	83.3%	12.9%	3.8%
	SA	210	86.7%	9.5%	3.8%
	TAS	130	87.7%	10.8%	1.5%
	VIC	417	84.7%	12.9%	2.4%
	WA	280	83.6%	12.9%	3.6%
	National	2155	1806	287	62
			83.8%	13.3%	2.9%
Klebsiella species	ACT	20	85.0%	10.0%	5.0%
	NSW	158	87.3%	3.8%	8.9%
	NT	20	100%		
	QLD	120	95.0%	3.3%	1.7%
	SA	59	94.9%	3.4%	1.7%
	TAS	26	100%		
	VIC	109	92.7%	3.7%	3.7%
	WA	80	96.3%	2.5%	1.3%
	National	592	549	20	23
			92.7%	3.4%	3.9%

Ticarcillin-clavulanate

Genus	Region	Total	%S	%I	%R
Enterobacter species	ACT	10	70.0%	0.0%	30.0%
	NSW	72	68.1%	11.1%	20.8%
	NT	4	50.0%	0.0%	50.0%
	QLD	55	87.3%	3.6%	9.1%
	SA	26	84.6%	3.8%	11.5%
	TAS	6	66.7%	33.3%	0.0%
	VIC	52	76.9%	7.7%	15.4%
	WA	38	76.3%	7.9%	15.8%
	National	263	201	20	42
			76.4%	7.6%	16.0%
Escherichia coli	ACT	70	92.9%	5.7%	1.4%
	NSW	558	89.2%	7.9%	2.9%
	NT	70	88.6%	7.1%	4.3%
	QLD	420	90.7%	5.0%	4.3%
	SA	210	95.2%	1.9%	2.9%
	TAS	130	94.6%	3.1%	2.3%
	VIC	417	91.4%	5.8%	2.9%
	WA	280	91.8%	4.6%	3.6%
	National	2155	1967	119	69
			91.3%	5.5%	3.2%
Klebsiella species	ACT	20	95.0%	0.0%	5.0%
	NSW	158	88.0%	3.2%	8.9%
	NT	20	100%		
	QLD	120	95.0%	2.5%	2.5%
	SA	59	96.6%	1.7%	1.7%
	TAS	26	100%		
	VIC	109	95.4%	0.9%	3.7%
	WA	80	96.3%	1.3%	2.5%
	National	592	556	11	25
			93.9%	1.9%	4.2%

Piperacillin-tazobactam

Genus	Region	Total	%S	%I	%R
Enterobacter species	ACT	10	80.0%	20.0%	0.0%
	NSW	72	87.5%	6.9%	5.6%
	NT	4	75.0%	0.0%	25.0%
	QLD	55	90.9%	7.3%	1.8%
	SA	26	96.2%	3.8%	0.0%
	TAS	6	100%		
	VIC	52	88.5%	9.6%	1.9%
	WA	38	84.2%	13.2%	2.6%
	National	263	233	22	8
			88.6%	8.4%	3.0%
Escherichia coli	ACT	70	100%		
	NSW	558	99.5%	0.2%	0.4%
	NT	70	98.6%	0.0%	1.4%
	QLD	420	99.8%	0.0%	0.2%
	SA	210	100%		

	TAS	130	100%		
	VIC	417	99.5%	0.2%	0.2%
	WA	280	99.6%	0.0%	0.4%
	National	2155	2147	2	6
			99.6%	0.1%	0.3%
Klebsiella species	ACT	20	95.0%	0.0%	5.0%
	NSW	158	96.2%	1.3%	2.5%
	NT	20	100%		
	QLD	120	98.3%	0.8%	0.8%
	SA	59	98.3%	0.0%	1.7%
	TAS	26	100%		
	VIC	109	97.2%	1.8%	0.9%
	WA	80	97.5%	2.5%	0.0%
	National	592	577	7	8
			97.5%	1.2%	1.4%

Cefazolin

Genus	Region	Total	%S+I		%R
Enterobacter species	ACT	10			100%
	NSW	72	4.2%		95.8%
	NT	4			100%
	QLD	55	5.5%		94.5%
	SA	26	11.5%		88.5%
	TAS	6	33.3%		66.7%
	VIC	52	15.4%		84.6%
	WA	38	7.9%		92.1%
	National	263	22		241
			8.4%		91.6%
Escherichia coli	ACT	70	88.6%		11.4%
	NSW	558	85.8%		14.2%
	NT	70	80.0%		20.0%
	QLD	420	90.0%		10.0%
	SA	210	89.0%		11.0%
	TAS	130	88.5%		11.5%
	VIC	417	87.1%		12.9%
	WA	280	88.9%		11.1%
	National	2155	1889		266
			87.7%		12.3%
Klebsiella species	ACT	20	90.0%		10.0%
	NSW	158	69.0%		31.0%
	NT	20	95.0%		5.0%
	QLD	120	89.2%		10.8%
	SA	59	78.0%		22.0%
	TAS	26	84.6%		15.4%
	VIC	109	77.1%		22.9%
	WA	80	91.3%		8.8%
	National	592	478		114
			80.7%		19.3%

Cefoxitin

Genus	Region	Total	%S	%I	%R
Enterobacter species	ACT	10	0.0%	10.0%	90.0%
	NSW	72	0.0%	2.8%	97.2%
	NT	4			100%
	QLD	55	5.5%	0.0%	94.5%
	SA	26	3.8%	0.0%	96.2%
	TAS	6	16.7%	0.0%	83.3%
	VIC	52	5.8%	5.8%	88.5%
	WA	38	7.9%	0.0%	92.1%
	National	263	11	6	246
			4.2%	2.3%	93.5%
Escherichia coli	ACT	70	97.1%	1.4%	1.4%
	NSW	558	98.0%	1.8%	0.2%
	NT	70	100%		
	QLD	420	97.9%	1.2%	1.0%
	SA	210	99.5%	0.5%	0.0%
	TAS	130	97.7%	2.3%	0.0%
	VIC	417	98.6%	0.2%	1.2%
	WA	280	96.8%	1.4%	1.8%
	National	2155	2114	25	16
			98.1%	1.2%	0.7%
Klebsiella species	ACT	20	90.0%	5.0%	5.0%
	NSW	158	94.9%	1.9%	3.2%
	NT	20	100%		
	QLD	120	97.5%	0.0%	2.5%
	SA	59	96.6%	1.7%	1.7%
	TAS	26	100%		
	VIC	109	99.1%	0.0%	0.9%
	WA	80	96.3%	2.5%	1.3%
	National	592	573	7	12
			96.8%	1.2%	2.0%

Ceftriaxone

Genus	Region	Total	%S	%I	%R
Enterobacter species	ACT	10	70.0%	0.0%	30.0%
	NSW	72	76.4%	0.0%	23.6%
	NT	4	50.0%	0.0%	50.0%
	QLD	55	85.5%	0.0%	14.5%
	SA	26	80.8%	3.8%	15.4%
	TAS	6	66.7%	0.0%	33.3%
	VIC	52	75.0%	3.8%	21.2%
	WA	38	71.1%	10.5%	18.4%
	National	263	202	7	54
			76.8%	2.7%	20.5%
Escherichia coli	ACT	70	98.6%	0.0%	1.4%
	NSW	558	97.8%	0.0%	2.2%
	NT	70	97.1%	0.0%	2.9%
	QLD	420	99.5%	0.0%	0.5%
	SA	210	98.6%	0.0%	1.4%
	TAS	130	98.5%	0.0%	1.5%

	VIC	417	97.6%	0.0%	2.4%
	WA	280	95.4%	0.0%	4.6%
	National	2155	2110	0	45
			97.9%	0.0%	2.1%
Klebsiella species	ACT	20	95.0%	0.0%	5.0%
	NSW	158	91.8%	0.0%	8.2%
	NT	20	100%		
	QLD	120	98.3%	0.0%	1.7%
	SA	59	96.6%	1.7%	1.7%
	TAS	26	100%		
	VIC	109	95.4%	0.0%	4.6%
	WA	80	97.5%	0.0%	2.5%
	National	592	567	1	24
			95.8%	0.2%	4.1%

Ceftazidime

Genus	Region	Total	%S	%I	%R
Enterobacter species	ACT	10	80.0%	0.0%	20.0%
	NSW	72	79.2%	0.0%	20.8%
	NT	4	50.0%	0.0%	50.0%
	QLD	55	87.3%	0.0%	12.7%
	SA	26	92.3%	0.0%	7.7%
	TAS	6	83.3%	16.7%	0.0%
	VIC	52	84.6%	0.0%	15.4%
	WA	38	81.6%	2.6%	15.8%
	National	263	219	2	42
			83.3%	0.8%	16.0%
Escherichia coli	ACT	70	98.6%	0.0%	1.4%
	NSW	558	99.3%	0.0%	0.7%
	NT	70	98.6%	0.0%	1.4%
	QLD	420	99.5%	0.0%	0.5%
	SA	210	99.0%	0.0%	1.0%
	TAS	130	100%		
	VIC	417	99.0%	0.0%	1.0%
	WA	280	97.1%	0.0%	2.9%
	National	2155	2133	0	22
			99.0%	0.0%	1.0%
Klebsiella species	ACT	20	100%		
	NSW	158	93.7%	0.0%	6.3%
	NT	20	100%		
	QLD	120	99.2%	0.0%	0.8%
	SA	59	98.3%	0.0%	1.7%
	TAS	26	100%		
	VIC	109	97.2%	0.0%	2.8%
	WA	80	98.8%	0.0%	1.3%
	National	592	576	0	16
			97.3%	0.0%	2.7%

Cefepime

Genus	Region	Total	%S	%I	%R
Enterobacter species	ACT	10	100%		
	NSW	72	100%		
	NT	4	75.0%	0.0%	25.0%
	QLD	55	100%		
	SA	26	100%		
	TAS	6	100%		
	VIC	52	100%		
	WA	38	100%		
	National	263	262	0	1
			99.6%	(0.0)	0.4%
Escherichia coli	ACT	70	100%		
	NSW	558	100%		
	NT	70	100%		
	QLD	420	100%		
	SA	210	99.5%	0.0%	0.5%
	TAS	130	100%		
	VIC	417	99.8%	0.0%	0.2%
	WA	280	98.6%	0.4%	1.1%
	National	2155	2149	1	5
			99.7%	0.0%	0.2%
Klebsiella species	ACT	20	100%		
	NSW	158	96.8%	0.6%	2.5%
	NT	20	100%		
	QLD	120	100%		
	SA	59	100%		
	TAS	26	100%		
	VIC	109	98.2%	0.0%	1.8%
	WA	80	100%		
	National	592	585	1	6
			98.8%	0.2%	1.0%

Meropenem

Genus	Region	Total	%S	%I	%R
Enterobacter species	ACT	10	100%		
	NSW	72	100%		
	NT	4	100%		
	QLD	55	100%		
	SA	26	100%		
	TAS	6	100%		
	VIC	52	100%		
	WA	38	100%		
	National	263	263		
			100%		
Escherichia coli	ACT	70	100%		
	NSW	558	100%		
	NT	70	100%		
	QLD	420	100%		
	SA	210	100%		

	TAS	130	100%		
	VIC	417	99.8%	0.2%	0.0%
	WA	280	99.6%	0.4%	0.0%
	National	2155	2153	2	0
			99.9%	0.1%	0.0%
Klebsiella species	ACT	20	100%		
	NSW	158	100%		
	NT	20	100%		
	QLD	120	100%		
	SA	59	100%		
	TAS	26	100%		
	VIC	109	100%		
	WA	80	100%		
	National	592	592		
			100%		

Ciprofloxacin

Genus	Region	Total	%S	%I	%R
Enterobacter species	ACT	10	100%		
	NSW	72	98.6%	0.0%	1.4%
	NT	4	75.0%	25.0%	0.0%
	QLD	55	100%		
	SA	26	92.3%	3.8%	3.8%
	TAS	6	100%		
	VIC	52	100%		
	WA	38	97.4%	0.0%	2.6%
	National	263	258	2	3
			98.1%	0.8%	1.1%
Escherichia coli	ACT	70	97.1%	0.0%	2.9%
	NSW	558	95.2%	0.2%	4.7%
	NT	70	92.9%	0.0%	7.1%
	QLD	420	96.4%	0.2%	3.3%
	SA	210	96.7%	0.0%	3.3%
	TAS	130	98.5%	0.0%	1.5%
	VIC	417	95.9%	0.0%	4.1%
	WA	280	94.3%	0.0%	5.7%
	National	2155	2064	2	89
			98.8%	0.1%	4.1%
Klebsiella species	ACT	20	100%		
	NSW	158	96.2%	1.3%	2.5%
	NT	20	100%		
	QLD	120	98.3%	0.8%	0.8%
	SA	59	96.6%	0.0%	3.4%
	TAS	26	100%		
	VIC	109	96.3%	2.8%	0.9%
	WA	80	98.8%	0.0%	1.3%
	National	592	577	6	9
			97.5%	1.0%	1.5%

Norfloxacin

Genus	Region	Total	%S	%I	%R
Enterobacter species	ACT	10	100%		
	NSW	72	98.6%	0.0%	1.4%
	NT	4	100%		
	QLD	55	100%		
	SA	26	92.3%	3.8%	3.8%
	TAS	6	100%		
	VIC	52	100%		
	WA	38	97.4%	2.6%	0.0%
	National	263	259	2	2
			98.5%	0.8%	0.8 %
Escherichia coli	ACT	70	98.6%	0.0%	1.4%
	NSW	558	95.3%	0.2%	4.5%
	NT	70	92.9%	1.4%	5.7%
	QLD	420	96.7%	0.5%	2.9%
	SA	210	96.7%	0.5%	2.9%
	TAS	130	98.5%	0.0%	1.5%
	VIC	417	95.9%	0.0%	4.1%
	WA	280	94.3%	0.0%	5.7%
	National	2155	2067	5	83
			95.9%	0.2%	3.9%
Klebsiella species	ACT	20	100%		
	NSW	158	96.8%	1.3%	1.9%
	NT	20	100%		
	QLD	120	99.2%	0.0%	0.8%
	SA	59	96.6%	1.7%	1.7%
	TAS	26	100%		
	VIC	109	97.2%	1.8%	0.9%
	WA	80	98.8%	0.0%	1.3%
	National	592	580	5	7
			98.0%	0.8%	1.2%

Gentamicin

Genus	Region	Total	%S	%I	%R
Enterobacter species	ACT	10	90.0%	10.0%	0.0%
	NSW	72	93.1%	0.0%	6.9%
	NT	4	75.0%	0.0%	25.0%
	QLD	55	96.4%	0.0%	3.6%
	SA	26	92.3%	0.0%	7.7%
	TAS	6	100%		
	VIC	52	100%		
	WA	38	100%		
	National	263	252	1	10
			95.8%	0.4%	3.8%
Escherichia coli	ACT	70	97.1%	0.0%	2.9%
	NSW	558	96.2%	0.2%	3.6%
	NT	70	95.7%	0.0%	4.3%
	QLD	420	97.6%	0.0%	2.4%
	SA	210	97.1%	0.0%	2.9%
	TAS	130	97.7%	0.0%	2.3%

	VIC	417	95.9%	0.0%	4.1%
	WA	280	94.6%	0.0%	5.4%
	National	2155	2078	1	76
			96.4%	0.0%	3.5%
Klebsiella species	ACT	20	100%		
	NSW	158	94.3%	0.0%	5.7%
	NT	20	100%		
	QLD	120	99.2%	0.0%	0.8%
	SA	59	100%		
	TAS	26	100%		
	VIC	109	96.3%	0.0%	3.7%
	WA	80	97.5%	0.0%	2.5%
	National	592	576	0	16
			97.3%	0.0%	2.7%

Trimethoprim

Genus	Region	Total	%S		%R
Enterobacter species	ACT	10	90.0%		10.0%
	NSW	72	87.5%		12.5%
	NT	4	75.0%		25.0%
	QLD	55	92.7%		7.3%
	SA	26	80.8%		19.2%
	TAS	6	100%		
	VIC	52	94.2%		5.8%
	WA	38	94.7%		5.3%
	National	263	238		25
			90.5%		9.5%
Escherichia coli	ACT	70	77.1%		22.9%
	NSW	558	79.0%		21.0%
	NT	70	80.0%		20.0%
	QLD	420	85.5%		14.5%
	SA	210	83.3%		16.7%
	TAS	130	86.2%		13.8%
	VIC	417	76.7%		23.3%
	WA	280	86.4%		13.6%
	National	2155	1759		396
			81.6%		18.4%
Klebsiella species	ACT	20	90.0%		10.0%
	NSW	158	87.3%		12.7%
	NT	20	85.0%		15.0%
	QLD	120	94.2%		5.8%
	SA	59	88.1%		11.9%
	TAS	26	92.3%		7.7%
	VIC	109	88.1%		11.9%
	WA	80	87.5%		12.5%
	National	592	528		64
			89.2%		10.8%

Tigecycline

Genus	Region	Total	%S	%I	%R
Enterobacter species	ACT	10	100%		
	NSW	72	95.8%	2.8%	1.4%
	NT	4	100%		
	QLD	55	98.2%	0.0%	1.8%
	SA	26	96.2%	3.8%	0.0%
	TAS	6	100%		
	VIC	52	98.1%	1.9%	0.0%
	WA	38	97.4%	2.6%	0.0%
	National	263	256	5	2
			97.3%	1.9%	0.8%
Escherichia coli	ACT	70	100%		
	NSW	558	100%		
	NT	70	100%		
	QLD	420	100%		
	SA	210	100%		
	TAS	130	100%		
	VIC	417	100%		
	WA	280	100%		
	National	2155	2155	0	0
			100%	0.0%	0.0%
Klebsiella species	ACT	20	90.0%	5.0%	5.0%
	NSW	158	96.8%	2.5%	0.6%
	NT	20	100%		
	QLD	120	97.5%	0.8%	1.7%
	SA	59	100%		
	TAS	26	100%		
	VIC	109	100%		
	WA	80	96.3%	1.3%	2.5%
	National	592	579	7	6
			97.8%	1.2%	1.0%

APPENDIX 2. ANTIBIOTIC PROFILES BY FREQUENCY

Enterobacter species (n = 263)

Antibiotic Profile			State							
PtzCtrCazCpmGenAmkTmpNitCipMer			AUS	QLD	NSW	ACT	VIC	TAS	SA	WA	NT
		Nit	136	29	38	3	34	2	12	17	1
			50	16	13	2	3	2	4	9	1
PtzCtrCaz		Nit	22	5	5	1	6		1	4	
Ctr		Nit	11	1	1		3		2	4	
		TmpNit	9	2	3	1	1		2		
CtrCaz		Nit	8		3	1	2	1		1	
PtzCtrCaz			4		3					1	
Ctr			3				1	1	1		
CtrCaz	Gen	TmpNit	3	1	2						
		TmpNitCip	2						1	1	
	Gen	TmpNit	2		1				1		
CtrCaz	Gen	Tmp	2	1					1		
		NitCip	1						1		
		Tmp	1				1				
	Gen	Nit	1			1					
Ctr		TmpNit	1				1				
Ctr	Gen	TmpNit	1		1						
CtrCaz			1								1
CtrCaz		TmpNit	1		1						
PtzCtr		Nit	1			1					
PtzCtrCaz		TmpNit	1							1	
PtzCtrCaz	Gen	TmpNitCip	1		1						
PtzCtrCazCpmGen		TmpNitCip	1								1

Ptz = piperacillin-tazobactam, Ctr = ceftriaxone, Caz = ceftazidime, Cpm = cefepime, Gen = gentamicin, Amk = amikacin, Tmp = trimethoprim, Nit = nitrofurantoin, Cip = ciprofloxacin, Mer = meropenem

Escherichia coli (n = 2,155)

Antibiotic Profile	State								
AmpAmcPtzCzlCftCtrCazCpmGenAmkTmpNitCipMer	AUS	QLD	NSW	ACT	VIC	TAS	SA	WA	NT
	1077	216	272	32	198	68	98	157	36
Amp	357	76	69	12	72	26	47	45	10
Amp Tmp	140	24	47	6	32	8	11	9	3
AmpAmc Czl	105	25	29	3	17	6	9	9	7
AmpAmc	101	22	31	2	14	4	14	13	1
Tmp	69	11	16	3	18	5	10	4	2
AmpAmc Czl Tmp	47	7	19	1	10	2	2	3	3
Amp Czl	17		4	1	5	3	3	1	
AmpAmc Tmp	17	5	1	1	7			3	
Nit	16	3	7		2	3	1		
Amp Gen Tmp	12	1	5	1	3			2	
Amp Gen Tmp Cip	12	3	2		3	1	1	1	1
Amp Cip	8	1	2		3		1	1	
Amp Nit	8	2	1	1	2			2	
Amp Tmp Cip	8	3	2		1			1	1
Amp TmpNit	8		2	1	2		2	1	
Amp Czl Tmp	8	1	2		2		2		1
Cfx	7	2	3					2	
AmpAmc CzlCfx	7	1			1	2		3	
Amp Gen Cip	6	3			1		1	1	
Cip	5	1	4						
AmpAmc Czl TmpNit	5	1	1	1	1		1		
TmpNit	4	1	1	1	1				
AmpAmc Czl Ctr Gen Tmp Cip	4		1		2			1	
Gen Tmp	3		1		1			1	
Amp TmpNitCip	3						1	1	1
Amp Czl Ctr	3		2					1	
AmpAmc Cfx	3	1	2						
AmpAmc Czl Tmp Cip	3		1		1			1	
AmpAmc Czl Gen Tmp	3	1			1		1		
AmpAmc CzlCfx Tmp	3	1			2				
AmpAmc CzlCfxCtrCaz	3	2			1				
Cfx Tmp	2		1	1					
Amp Gen	2		1					1	
Amp Gen TmpNit	2		1		1				
Amp Czl Nit	2		1					1	
Amp Czl Ctr Gen Tmp Cip	2		1		1				
AmpAmc Cip	2	1	1						
AmpAmc Tmp Cip	2		2						
AmpAmc Gen Cip	2		1						1
AmpAmc Gen Tmp	2				1			1	
AmpAmc Czl Ctr Gen	2		1					1	
AmpAmc Czl Ctr Gen Tmp	2		1			1			
AmpAmc Czl CtrCaz Gen Tmp Cip	2							2	
AmpAmc CzlCfx Cip	2		2						
AmpAmcPtzCzl	2		2						
AmpAmcPtzCzl Tmp	2	1			1				

Antibiotic Profile												State								
Amp	Amc	Ptz	Czl	Cft	Ctr	Caz	Cpm	Gen	Amk	Tmp	Nit	Cip	Mer	AUS	QLD	NSW	ACT	VIC	TAS	SA	WA	NT
											Nit	Cip		1		1						
								Gen						1			1					
								Gen	Amk					1		1						
			Czl											1						1		
			Czl							Tmp				1		1						
			Czl	Cfx							Nit			1							1	
	Amc													1							1	
	Amc		Czl								Nit			1		1						
	Amc		Czl					Gen		Tmp				1		1						
Amp				Cfx										1	1							
Amp				Cfx								Cip		1	1							
Amp				Cfx						Tmp				1		1						
Amp			Czl									Cip		1			1					
Amp			Czl							Tmp		Cip		1		1						
Amp			Czl					Gen		Tmp		Cip		1		1						
Amp			Czl					Gen		TmpNit		Cip		1				1				
Amp			Czl		Ctr							Cip		1				1				
Amp			Czl		Ctr					Tmp				1								1
Amp			Czl		Ctr			Gen						1		1						
Amp			Czl		Ctr			Gen			Nit	Cip		1				1				
Amp			Czl		Ctr			Gen		Tmp				1						1		
Amp			Czl		CtrCaz					Tmp				1				1				
Amp			Czl		CtrCaz					Tmp		Cip		1		1						
Amp			Czl		CtrCaz			Gen		Tmp		Cip		1						1		
Amp			Czl		CtrCaz			Gen		TmpNit		Cip		1								1
Amp			Czl	Cfx						Tmp				1				1				
Amp			Czl	Cfx				Gen		Tmp		Cip		1						1		
Amp			Czl	Cfx	Ctr	Caz				Tmp		Cip		1							1	
Amp	Amc							Gen						1		1						
Amp	Amc				Ctr									1							1	
Amp	Amc		Czl					Gen				Cip		1	1							
Amp	Amc		Czl					Gen		Tmp		Cip		1	1							
Amp	Amc		Czl					Gen		TmpNit				1				1				
Amp	Amc		Czl		Ctr									1				1				
Amp	Amc		Czl		Ctr					Tmp		Cip		1		1						
Amp	Amc		Czl		Ctr		Cpm	Gen				Cip		1							1	
Amp	Amc		Czl		CtrCaz							Cip		1		1						
Amp	Amc		Czl		CtrCaz					Tmp		Cip		1				1				
Amp	Amc		Czl		CtrCaz			Gen		Tmp				1		1						
Amp	Amc		Czl		CtrCaz			Gen		TmpNit		Cip		1							1	
Amp	Amc		Czl		CtrCaz		Cpm			Tmp		Cip		1						1		
Amp	Amc		Czl		CtrCaz		Cpm			TmpNit		Cip		1							1	
Amp	Amc		Czl		CtrCaz		Cpm	Gen		TmpNit		Cip		1							1	
Amp	Amc		Czl	Cfx						Tmp		Cip		1		1						
Amp	Amc		Czl	Cfx	Ctr			Gen		Tmp		Cip		1					1			
Amp	Amc		Czl	Cfx	Ctr	Caz						Cip		1			1					
Amp	Amc		Czl	Cfx	Ctr	Caz				TmpNit		Cip		1							1	

Antibiotic Profile	State								
AmpAmcPtzCzlCftCtrCazCpmGenAmkTmpNitCipMer	AUS	QLD	NSW	ACT	VIC	TAS	SA	WA	NT
AmpAmc CzlCfxCtrCazCpm Tmp Cip	1				1				
AmpAmc CzlCfxCtrCazCpmGen Tmp Cip	1							1	
AmpAmcPtz Nit Mer	1				1				
AmpAmcPtz TmpNit Mer	1							1	
AmpAmcPtzCzl Nit	1								1
AmpAmcPtzCzlCfxCtrCaz Tmp Cip	1		1						

Amp = ampicillin, Amc = amoxycillin-calvulanate, Ptz = piperacillin-tazobactam, Czl = cefazolin, Cft = cefoxitin, Ctr = ceftriaxone, Caz = ceftazidime, Cpm = cefepime, Gen = gentamicin, Amk = amikacin, Tmp = trimethoprim, Nit = nitrofurantoin, Cip = ciprofloxacin, Mer = meropenem

Klebsiella species (n = 592)

Antibiotic Profile	State								
AmcPtzCzlCftCtrCazCpmGenAmkTmpNitCipMer	AUS	QLD	NSW	ACT	VIC	TAS	SA	WA	NT
Nit	286	64	72	7	47	10	29	49	8
	143	33	30	6	28	10	13	15	8
Czl	44	4	12	1	12	4	7	3	1
Czl Nit	25	4	16		4		1		
TmpNit	20	3	2	1	4	2	2	3	3
Tmp	8	2			1		2	3	
Cfx Nit	4	1		1				2	
Amc	4	1		2	1				
Amc Czl TmpNit	4		2		1		1		
Cfx TmpNit	3		2	1					
Amc TmpNit	3		2		1				
Amc CzlCfx Nit	3		2				1		
AmcPtzCzl Ctr Nit	3	1	1	1					
Cfx TmpNitCip	2	1	1						
Czl TmpNit	2	1						1	
Amc Czl	2	1			1				
Amc Czl Nit	2		2						
Amc Czl CtrCaz Gen Tmp Cip	2		2						
AmcPtzCzl	2	1					1		
AmcPtzCzl Ctr	2		1		1				
AmcPtzCzlCfxCtrCazCpmGen TmpNitCip	2		2						
NitCip	1				1				
TmpNitCip	1				1				
Gen Nit	1	1							
Czl Tmp	1				1				
Czl Gen Tmp	1							1	
Czl Ctr TmpNit	1		1						
Czl CtrCaz TmpNitCip	1						1		
Czl CtrCaz Gen Tmp	1		1						
Czl CtrCaz Gen TmpNit	1				1				
Czl CtrCazCpm Tmp	1		1						
CzlCfx TmpNit	1				1				
CzlCfxCtr TmpNitCip	1						1		
Amc Cip	1	1							
Amc Czl Ctr	1							1	
Amc Czl Ctr Gen TmpNit	1				1				
Amc Czl CtrCaz Gen Tmp	1		1						
Amc Czl CtrCaz Gen TmpNitCip	1		1						
Amc Czl CtrCazCpmGen Tmp	1		1						
Amc Czl CtrCazCpmGen TmpNit	1		1						
Amc CzlCfxCtrCaz	1	1							
AmcPtz Cfx TmpNitCip	1							1	
AmcPtzCzl Nit	1		1						
AmcPtzCzl CtrCaz Gen TmpNit	1							1	
AmcPtzCzl CtrCazCpmGen NitCip	1				1				
AmcPtzCzl CtrCazCpmGen TmpNitCip	1				1				
AmcPtzCzlCfx Nit	1		1						

Amp = ampicillin, Ptz = piperacillin-tazobactam, Czl = cefazolin, Cft = cefoxitin, Ctr = ceftriaxone, Caz = ceftazidime, Cpm = cefepime, Gen = gentamicin, Amk = amikacin, Tmp = trimethoprim, Nit = nitrofurantoin, Cip = ciprofloxacin, Mer = meropenem

APPENDIX 3. MIC DISTRIBUTIONS

Enterobacter aerogenes

Drug	Number (percentage) of Minimum Inhibitory Concentrations (mg/L) at: [a]															Total	%S	%IR
	0.016	0.03	0.06	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256			
ampicillin								13 (13.1)	20 (20.2)	13 (13.1)	22 (22.2)	31 (31.3)				99	46.5%	53.5%
co-amoxyclav								2 (2.0)	5 (5.1)	3 (3.0)	19 (19.2	70 (70.7)				99	10.1%	89.9%
Ticarcillin/clavulanate										78 (78.8)	2 (2.0)	3 (3.0)	5 (5.1)	11 (11.1)		99	80.8%	19.2%
piperacillin/tazobactam									82 (82.8)	9 (9.1)		3 (3.0)	4 (4.0)	1 (1.0)		99	91.9%	8.1%
cefazolin									17 (17.2)		2 (2.0)	1 (1.0)	79 (79.8)			99	17.2%	82.8%
cefoxitin									4 (4.0)	2 (2.0)	2 (2.0)	6 (6.1)	85 (85.9)			99	6.1%	93.9%
ceftriaxone							79 (79.8)	3 (3.0)	2 (2.0)	1 (1.0)	9 (9.1)	2 (2.0)	3 (3.0)			99	79.8%	20.2%
ceftazidime							80 (80.8)	2 (2.0)	3 (3.0)	1 (1.0)	4 (4.0)	2 (2.0)	7 (7.1)			99	85.9%	14.1%
cefepime							98 (99.0)						1 (1.0)			99	99.0%	1.0%
gentamicin							97 (98.0)			1 (1.0)	1 (1.0)					99	98.0%	2.0%
tobramycin							98 (99.0)				1 (1.0)					99	99.0%	1.0%
amikacin								96 (97.0)	2 (2.0)		1 (1.0)					99	100%	
nalidixic acid								42 (42.4)	45 (45.5)	1 (1.0)	3 (3.0)	8 (8.1)				99	91.9%	8.1%
ciprofloxacin					94 (94.9)	1 (1.0)	2 (2.0)	1 (1.0)	1 (1.0)							99	98.0%	2.0%

Drug	Number (percentage) of Minimum Inhibitory Concentrations (mg/L) at: [a]															Total	%S	%IR
	0.016	0.03	0.06	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256			
norfloxacin						90	1	7			1					99		
						(90.9)	(1.0)	(7.1)			(1.0)						99.0%	1.0%
trimethoprim						76	15	3	1		4					99		
						(76.8)	(15.2)	(3.0)	(1.0)		(4.0)						96.0%	4.0%
Trimethoprim/s							95				4					99		
							(96.0)				(4.0)						96.0%	4.0%
meropenem					99											99		
					(100)												100%	
tigecycline						51	44	2	2							99		
						(51.5)	(44.4)	(2.0)	(2.0)								98.0%	2.0%

[a] Shaded areas indicate ≤ and ≥ MIC values available on the Vitek ASTN083 card; vertical lines indicate CLSI M100-S21 susceptible (blue) and resistant (red) breakpoints.

Enterobacter cloacae

Drug	Number (percentage) of Minimum Inhibitory Concentrations (mg/L) at: [a]															Total	%S	%IR
	0.016	0.03	0.06	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256			
ampicillin								3 (1.9)	4 (2.5)	16 (10.1)	43 (27.2)	92 (58.2)				158	14.6%	85.4%
co-amoxyclav								3 (1.9)	6 (3.8)	5 (3.2)	10 (6.3	134 (84.8)				158	8.9%	91.1%
Ticarcillin/clavulanate										103 (65.2)	12 (7.6)	6 (3.8)	6 (3.8)	31 (19.6)		158	72.8%	27.2%
piperacillin/tazobactam									126 (79.7)	7 (4.4)	3 (1.9)	2 (1.3)	13 (8.2)	7 (4.4)		158	86.1%	13.9%
cefazolin									3 (1.9)	6 (3.8)	1 (0.6)		148 (93.7)			158	1.9%	98.1%
cefoxitin									2 (1.3)	2 (1.3)	4 (2.5)	4 (2.5)	146 (92.4)			158	2.5%	97.5%
ceftriaxone							117 (74.1)	4 (2.5)		2 (1.3)	5 (3.2)	4 (2.5)	26 (16.5)			158	74.1%	25.9%
ceftazidime							123 (77.8)	1 (0.6)	4 (2.5)	1 (0.6)	2 (1.3)	2 (1.3)	25 (15.8)			158	81.0%	19.0%
cefepime							149 (94.3)	4 (2.5)	4 (2.5)	1 (0.6)						158	100%	
gentamicin							146 (92.4)	1 (0.6)	2 (1.3)		9 (5.7)					158	94.3%	5.7%
tobramycin							148 (93.7)	1 (0.6)		7 (4.4)	2 (1.3)					158	94.3%	5.7%
amikacin								154 (97.5)	2 (1.3)	1 (0.6)	1 (0.6)					158	100%	
nalidixic acid								91 (57.6)	39 (24.7)	9 (5.7)	7 (4.4)	12 (7.6)				158	92.4%	7.6%
ciprofloxacin					150 (94.9)	3 (1.9)	2 (1.3)	1 (0.6)	2 (1.3)							158	98.1%	1.9%

Drug	Number (percentage) of Minimum Inhibitory Concentrations (mg/L) at: [a]															Total	%S	%IR
	0.016	0.03	0.06	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256			
norfloxacin						142	3	10		2	1					158		
						(89.9)	(1.9)	(6.3)		(1.3)	(0.6)						98.1%	1.9%
trimethoprim						63	59	9	3	3	21					158		
						(39.9)	(37.3)	(5.7)	(1.9)	(1.9)	(13.3)						86.7%	13.3%
Trimethoprim/s							138	2			18					158		
							(87.3)	(1.3)			(11.4)						88.6%	11.4%
meropenem					156	1	1									158		
					(98.7)	(0.6)	(0.6)										100%	
tigecycline						63	72	18	3	2						158		
						(39.9)	(45.6)	(11.4)	(1.9)	(1.3)							96.8%	3.2%

[a] Shaded areas indicate ≤ and ≥ MIC values available on the Vitek ASTN083 card; vertical lines indicate CLSI M100-S21 susceptible (blue) and resistant (red) breakpoints.

Escherichia coli

Drug	Number (percentage) of Minimum Inhibitory Concentrations (mg/L) at: [a]															Total	%S	%IR
	0.016	0.03	0.06	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256			
ampicillin								1005 (46.6)	107 (5.0)	80 (3.7)	7 (0.3)	956 (44.4)				2155	55.3%	44.7%
co-amoxyclav								774 (35.9)	666 (30.9)	366 (17.0)	287 (13.3	62 (2.9)				2155	83.8%	16.2%
Ticarcillin/clavulanate										1545 (71.7)	422 (19.6)	75 (3.5)	44 (2.0)	69 (3.2)		2155	91.3%	8.7%
piperacillin/tazobactam									2129 (98.8)	18 (0.8)			2 (0.1)	6 (0.3)		2155	99.6%	0.4%
cefazolin									1889 (87.7)	43 (2.0)	107 (5.0)	4 (0.2)	112 (5.2)			2155	87.7%	12.3%
cefoxitin									2062 (95.7)	52 (2.4)	25 (1.2)	10 (0.5)	6 (0.3)			2155	98.1%	1.9%
ceftriaxone							2110 (97.9)		1 (0.0)		4 (0.2)	4 (0.2)	36 (1.7)			2155	97.9%	2.1%
ceftazidime							2122 (98.5)	2 (0.1)	9 (0.4)		21 (1.0)		1 (0.0)			2155	99.0%	1.0%
cefepime							2122 (98.5)	16 (0.7)	4 (0.2)	7 (0.3)	1 (0.0)	1 (0.0)	4 (0.2)			2155	99.7%	0.3%
gentamicin							2000 (92.8)	67 (3.1)	11 (0.5)	1 (0.0)	76 (3.5)					2155	96.4%	3.6%
tobramycin							2058 (95.5)	13 (0.6)	10 (0.5)	57 (2.6)	17 (0.8)					2155	96.6%	3.4%
amikacin								1622 (75.3)	498 (23.1)	23 (1.1)	11 (0.5)		1 (0.0)			2155	100%	
nalidixic acid								1777 (82.5)	181 (8.4)	18 (0.8)	7 (0.3)	172 (8.0)				2155	92.0%	8.0%
ciprofloxacin					2017 (93.6)	33 (1.5)	14 (0.6)	2 (0.1)	89 (4.1)							2155	95.8%	4.2%

Drug	Number (percentage) of Minimum Inhibitory Concentrations (mg/L) at: [a]															Total	%S	%IR
	0.016	0.03	0.06	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256			
norfloxacin						1991	11	65		5	83					2155		
						(92.4)	(0.5)	(3.0)		(0.2)	(3.9)						95.9%	4.1%
trimethoprim						1549	180	14	7	9	396					2155		
						(71.9)	(8.4)	(0.3)	(0.3)	(0.4)	(18.4)						81.6%	18.4%
Trimethoprim/s							1777	17	7	2	352					2155		
							(82.5)	(0.8)	(0.3)	(0.1)	(16.3)						83.2%	16.8%
meropenem					2152		1	2								2155		
					(99.9)		(0.0)	(0.1)									99.9%	0.1%
tigecycline						2149	13	1								2155		
						(99.4)	(0.6)	(0.0)									100%	

[a] Shaded areas indicate ≤ and ≥ MIC values available on the Vitek ASTN083 card; vertical lines indicate CLSI M100-S21 susceptible (blue) and resistant (red) breakpoints.

Klebsiella oxytoca

Drug	Number (percentage) of Minimum Inhibitory Concentrations (mg/L) at: [a]															Total	%S	%IR
	0.016	0.03	0.06	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256			
ampicillin								2 (1.8)			25 (22.1)	86 (76.1)				113	1.8%	98.2%
co-amoxyclav								78 (69.0)	20 (17.7)	3 (2.7)	6 (5.3)	6 (5.3)				113	89.4%	10.6%
Ticarcillin/clavulanate										99 (87.6)	4 (3.5)		3 (2.7)	7 (6.2)		113	91.2%	8.8%
piperacillin/tazobactam									104 (92.0)	1 (0.9)			2 (1.8)	6 (5.3)		113	92.9%	7.1%
cefazolin									36 (31.9)	32 (28.3)	14 (12.4)	3 (2.7)	28 (24.8)			113	31.9%	68.1%
cefoxitin									110 (97.3)	2 (1.8)		1 (0.9)				113	99.1%	0.9%
ceftriaxone							105 (92.9)		1 (0.9)	5 (4.4)	1 (0.9)		1 (0.9)			113	92.9%	7.1%
ceftazidime							110 (97.3)				3 (2.7)					113	97.3%	2.7%
cefepime							111 (98.2)	1 (0.9)		1 (0.9)						113	100%	
gentamicin							109 (96.5)				4 (3.5)					113	96.5%	3.5%
tobramycin							109 (96.5)			3 (2.7)	1 (0.9)					113	96.5%	3.5%
amikacin								111 (98.2)	1 (0.9)		1 (0.9)					113	100%	
nalidixic acid								91 (80.5	17 (15.0)	1 (0.9)	2 (1.8)	2 (1.8)				113	98.2%	1.8%
ciprofloxacin					112 (99.1)				1 (0.9)							113	99.1%	0.9%

Drug	Number (percentage) of Minimum Inhibitory Concentrations (mg/L) at: [a]															Total	%S	%IR
	0.016	0.03	0.06	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256			
norfloxacin						109	1	2			1					113		
						(96.5)	(0.9)	(1.8)			(0.9)						99.1%	0.9%
trimethoprim						80	23	3			7					113		
						(70.8)	(20.4)	(2.7)			(6.2)						93.8%	6.2%
Trimethoprim/s							106		1		6					113		
							(93.8)		(0.9)		(5.3)						93.8%	6.2%
meropenem					113											113		
					(100)												100%	
tigecycline						111	1	1								113		
						(98.3	(0.9)	(0.9)									100%	

[a] Shaded areas indicate ≤ and ≥ MIC values available on the Vitek ASTN083 card; vertical lines indicate CLSI M100-S21 susceptible (blue) and resistant (red) breakpoints.

Klebsiella pneumoniae

Drug	Number (percentage) of Minimum Inhibitory Concentrations (mg/L) at: [a]															Total	%S	%IR
	0.016	0.03	0.06	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256			
ampicillin								12 (2.5)	1 (0.2)	10 (2.1)	162 (34.1)	290 (61.1)				475	4.8%	95.2%
co-amoxyclav								371 (78.1)	40 (8.4)	33 (6.9)	14 (2.9)	17 (3.6)				475	93.5%	6.5%
Ticarcillin/clavulanate										430 (90.5)	19 (4.0)	3 (0.6)	5 (1.1)	18 (3.8)		475	94.5%	5.5%
piperacillin/tazobactam									443 (93.3)	25 (5.3)		1 (0.2)	4 (0.8)	1 (0.4)		475	98.5%	1.5%
cefazolin									439 (92.4)	2 (0.4)	6 (1.3)		28 (5.9)			475	92.4%	7.6%
cefoxitin									442 (93.1)	15 (3.2)	7 (1.5)	4 (0.8)	7 (1.5)			475	96.2%	3.8%
ceftriaxone							458 (96.4)	1 (0.2)		1 (0.2)	2 (0.4)		13 (2.7)			475	96.4%	3.6%
ceftazidime							462 (97.3)				4 (0.8)		9 (1.9)			475	97.3%	2.7%
cefepime							462 (97.3)	3 (0.6)	1 (0.2)	2 (0.4)	1 (0.2)	2 (0.4)	4 (0.8)			475	98.5%	1.5%
gentamicin							462 (97.3)	1 (0.2)			12 (2.5)					475	97.5%	2.5%
tobramycin							459 (96.6)	2 (0.4)	2 (0.4)	8 (1.7)	4 (0.8)					475	97.5%	2.5%
amikacin								464 (97.7)	7 (1.5)	2 (0.4)	2 (0.4)					475	100%	
nalidixic acid								313 (65.9)	101 (21.3)	18 (3.8)	9 (1.9)	34 (7.2)				475	92.8%	7.2%
ciprofloxacin					435 (91.6)	7 (1.5)	19 (4.0)	6 (1.3)	8 (1.7)							475	97.1%	2.9%

Drug	Number (percentage) of Minimum Inhibitory Concentrations (mg/L) at: [a]															Total	%S	%IR
	0.016	0.03	0.06	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256			
norfloxacin						429	3	28	4	5	6					475		
						(90.3)	(0.6)	(5.9)	(0.8)	(1.1)	(1.3)						97.7%	2.3%
trimethoprim						360	25	9	13	11	57					475		
						(75.8)	(5.3)	(1.9)	(2.7)	(2.3)	(12.0)						88.0%	12.0%
Trimethoprim/s							425	6	4	1	39					475		
							(89.5)	(1.3)	(0.8)	(0.2)	(8.2)						90.7%	9.3%
meropenem					475											475		
					(100)												100%	
tigecycline						348	96	18	7	6						475		
						(73.3)	(20.2)	(3.8)	(1.5)	(1.3)							97.3%	2.7%

[a] Shaded areas indicate ≤ and ≥ MIC values available on the Vitek ASTN083 card; vertical lines indicate CLSI M100-S21 susceptible (blue) and resistant (red) breakpoints.