

**Table 1:** Antimicrobial stewardship audit standards.

Definition		Inclusions/exclusions
<b>Standards 1–3: diagnostic stewardship</b>		
1	Blood cultures are taken before IV antibiotics are administered in hospital for essential diagnoses*	<b>Inclusions:</b> non-neutropenic sepsis, neutropenic sepsis, meningitis, encephalitis, endocarditis, osteomyelitis, septic arthritis, necrotising soft tissue infections, pyelonephritis, urinary tract infection receiving IV antibiotics and IV catheter-related infection
2	Urine culture is taken before IV antibiotics are administered in hospital when a urine infection is suspected	<b>Inclusions:</b> pyelonephritis, urinary tract infection receiving IV antibiotics and urinary sepsis (“urosepsis”) <b>Exclusions:</b> sepsis where the clinician did not document a possible urinary tract source
3	Cerebrospinal fluid (CSF) is taken before IV antibiotics are administered in hospital, or up to 4 hours after antibiotics	<b>Inclusions:</b> meningitis and encephalitis
<b>Standards 4–7: antimicrobial stewardship—indication and antimicrobial choice</b>		
4	The indication is written in the notes and on the medication chart within 24 to 48 hours of prescribing antibiotics	<b>Inclusions:</b> all patients
5	A planned duration or review date is written in the notes and medication chart	<b>Inclusions:</b> all patients
6	Antibiotic choices should be consistent with MicroGuide™	<b>Exclusions:</b> a guideline is not available for the condition, ID specialist advice was given, significant antibiotic allergy or intolerances exist that are not covered by MicroGuide™, there is known causative microbiology within the prior 7 days, the patient is failing treatment despite taking the recommended antibiotic already and known MRSA/ESBL carriage not covered by the guideline†
7	Patients on selected restricted IV antibiotics require discussion with ID within 48 to 72 hours‡	<b>Inclusions:</b> all patients receiving piperacillin/tazobactam, ertapenem or meropenem <b>Exclusions:</b> all other restricted antimicrobials

**Table 1 (continued):** Antimicrobial stewardship audit standards.

Standards 8–10: antimicrobial review—duration, IV-oral switch and de-escalation		
8	IV antibiotics are reviewed within 48 to 72 hours of the start date of IV antibiotics	<b>Inclusions:</b> all patients
9	Patients who meet IV-oral SWITCH criteria should be changed to oral antibiotics§	<b>Inclusions:</b> all patients meeting IV-oral SWITCH criteria†
10	Patients should change to a targeted, narrow-spectrum antibiotic to complete therapy when a suitable antibiotic can be identified from microbiology results	<b>Inclusions:</b> all patients where microbiology results are available demonstrating safe, narrower spectrum antibiotic options

\*Waikato MicroGuide™ recommended at least one set of blood cultures as being acceptable for standard 1.

†MRSA: methicillin-resistant Staphylococcus aureus, ESBL: extended spectrum beta-lactamase.

‡Restriction criteria were defined by the Pharmac Section H (Hospital Medicines List).

§IV-oral SWITCH criteria, Waikato Hospital adult antimicrobial guide:

**Suitable oral option**—an oral antibiotic is listed in the susceptibilities, or there is an oral formulation of the IV antibiotic.

**When afebrile for >24 hours**, defined as a tympanic temperature of 37.9C or less for 24 hours.

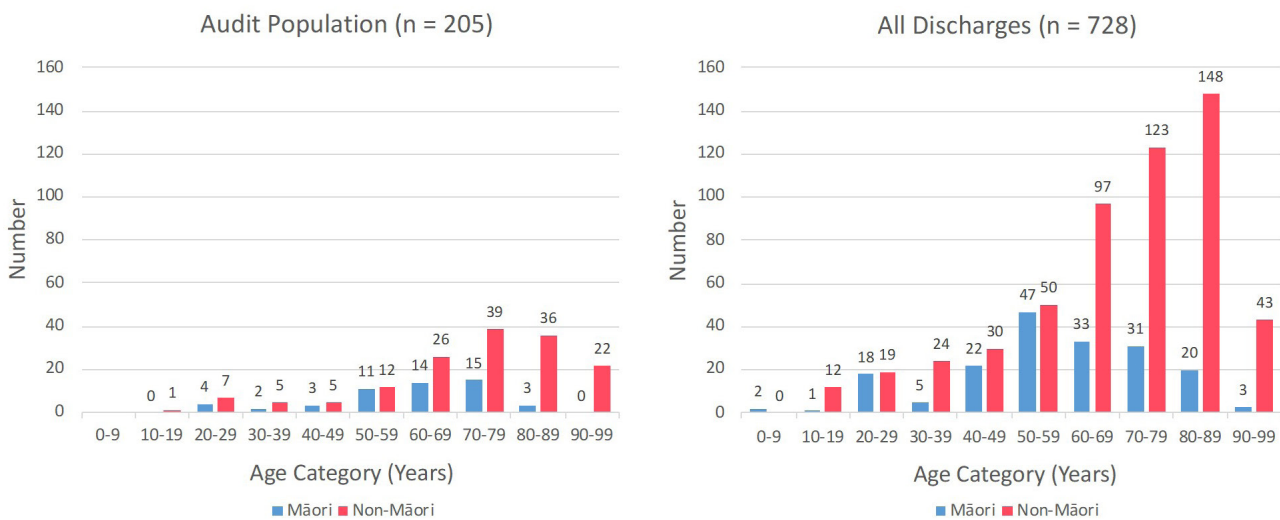
**Infection suitable for oral**—excluding meningitis, endocarditis, neutropenic fever and necrotising skin/soft tissue infection.

**Tolerating oral or nasogastric food and fluid.**

**Clinical and laboratory improvement**—patient documented as clinically improved and a neutrophil count improving towards normal values.

**Haematology and oncology patients excluded.**

**Figure 1:** Age distributions of Māori and non-Māori.



**Table 2:** Baseline characteristics.

Audit population		Total n=205 (%)*	Māori n=52 (%)*	Non-Māori n=153 (%)*	p-value for Māori compared to non-Māori
<b>Ethnicity</b>					
Māori		52 (25.4)	52	-	-
European		139 (67.8)	-	139	
Asian		5 (2.4)	-	5	
Pacific		4 (2.0)	-	4	
Not stated		4 (2.0)	-	4	
Other ethnicity		1 (0.5)	-	1	
<b>Age</b>					
Mean, years (SD)		68.7 (18.2)	61.1 (16.1)	71.2 (18.2)	p=0.001
<b>Sex</b>					
Male		98 (47.8)	26 (50.0)	72 (47.1)	p=0.714
Female		107 (52.2)	26 (50.0)	81 (52.9)	
<b>Known multidrug-resistant organism colonisation†</b>					
None known		184 (89.8)	44 (84.6)	140 (91.5)	p=0.157
MRSA alert		11 (5.4)	6 (11.5)	5 (3.3)	p=0.022
ESBL alert		9 (4.4)	2 (3.8)	7 (4.6)	p=0.825
MRSA and ESBL alerts		1 (0.5)	0 (0.0)	1 (0.7)	p=0.559
<b>Ward location</b>					
Waikato Hospital n=175	General medicine	135 (65.9)	36 (69.2)	99 (64.7)	p=0.552
	Respiratory	34 (16.6)	14 (26.9)	20 (13.1)	p=0.020
	Stroke	6 (2.9)	1 (1.9)	5 (3.3)	p=0.619
Thames inpatient unit		30 (14.6)	1 (1.9)	29 (19.0)	p=0.003
<b>All discharges</b>		<b>Total n=728 (%)*</b>	<b>Māori n=182 (%)*</b>	<b>Non-Māori n=546 (%)*</b>	<b>p-value for Māori compared to non-Māori</b>
<b>Ward location</b>					
Waikato Hospital n=578	General medicine	436 (59.9)	105 (57.7)	331 (60.6)	p=0.485
	Respiratory	93 (12.8)	38 (20.9)	55 (10.1)	p <0.001
	Stroke	49 (6.7)	18 (9.9)	31 (5.7)	p=0.049
Thames inpatient unit		150 (20.6)	21 (11.5)	129 (23.6)	p <0.001

\*Percentages may not add to 100% due to rounding.

†MRSA: methicillin-resistant *Staphylococcus aureus*, ESBL: extended spectrum beta-lactamase from electronic record alerts.

**Table 3:** Clinician-documented indications and initial antibiotic.

	<b>Total n=205 (%)*</b>	<b>Māori n=52 (%)*</b>	<b>Non-Māori n=153 (%)*</b>	<b>p-value for Māori compared to non-Māori</b>
<b>Clinician-documented indications</b>				
Respiratory	70 (34.1)	24 (46.2)	46 (30.1)	p=0.035
Genitourinary	34 (16.6)	8 (15.4)	26 (17.0)	p=0.788
Skin and soft tissue	33 (16.1)	7 (13.5)	26 (17.0)	p=0.549
Sepsis, unknown source†	19 (9.3)	2 (3.8)	17 (11.1)	p=0.119
Gastrointestinal	19 (9.3)	4 (7.7)	15 (9.8)	p=0.650
Not documented	12 (5.9)	2 (3.8)	10 (6.5)	p=0.475
Other‡	18 (8.8)	5 (9.6)	13 (8.5)	p=0.806
<b>Initial antibiotic</b>				
Ceftriaxone	80 (39.0)	18 (34.6)	62 (40.5)	p=0.451
Amoxicillin/clavulanate	69 (33.7)	24 (46.2)	45 (29.4)	p=0.027
Flucloxacillin	20 (9.8)	3 (5.8)	17 (11.1)	p=0.262
Piperacillin/tazobactam	8 (3.9)	2 (3.8)	6 (3.9)	p=0.981
Cefuroxime	7 (3.4)	0 (0.0)	7 (4.6)	p=0.117
Cefazolin	5 (2.4)	1 (1.9)	4 (2.6)	p=0.780
Other§	16 (7.8)	4 (7.7)	12 (7.8)	p=0.972

\*Percentages may not add to 100% due to rounding.

†Fifty-five patients had sepsis documented: respiratory (7), genitourinary (14), skin and soft tissue (7), unknown source (19), gastrointestinal (5), neutropenic sepsis (3).

‡Other indications: head and neck (5), central nervous system (5), bone and joint (4), neutropenic sepsis (3), infective endocarditis (1).

§Other antibiotics: gentamicin (3), metronidazole (3), ertapenem (2), meropenem (2), ciprofloxacin (2), penicillin (1), amoxicillin (1), ceftazidime (1), clarithromycin (1).

**Table 4:** Antimicrobial stewardship audit results.

Audit standards		Total n/N (%)*	Māori n/N (%)*	Non-Māori n/N (%)*	
<b>Standards 1–3: diagnostic stewardship</b>					
1	Blood cultures are taken before IV antibiotics are administered in hospital for essential diagnoses†	<b>57/86 (66.3)</b>	8/18 (44.4)	49/68 (72.1)	
2	Urine culture is taken before IV antibiotics are administered in hospital when a urine infection is suspected	<b>27/34 (79.4)</b>	6/8 (75.0)	21/26 (80.8)	
3	Cerebrospinal fluid (CSF) is taken before IV antibiotics are administered in hospital, or up to 4 hours after antibiotics	<b>3/6 (50.0)</b>	1/2 (50.0)	2/4 (50.0)	
	All microbiological sampling events combined	<b>87/126 (69.0)</b>	15/28 (53.6)	72/98 (73.5)	
<b>Standards 4–7: antimicrobial stewardship—indication and antimicrobial choice</b>					
4	The indication is written in the notes and on the medication chart within 24 to 48 hours of prescribing antibiotics	Notes	<b>193/205 (94.1)</b>	50/52 (96.2)	143/153 (93.5)
		Medication chart	<b>23/205 (11.2)</b>	5/52 (9.6)	18/153 (11.8)
5	A planned duration or review date is written in the notes and medication chart	Notes	<b>87/205 (42.4)</b>	23/52 (44.2)	64/153 (41.8)
		Medication chart	<b>25/205 (12.2)</b>	8/52 (15.4)	17/153 (11.1)
6	Antibiotic choices should be consistent with MicroGuide™‡	<b>91/167 (54.5)</b>	25/44 (56.8)	66/123 (53.7)	
7	Patients on selected restricted IV antibiotics require discussion with ID within 48 to 72 hours	<b>2/13 (15.4)</b>	1/4 (25.0)	1/9 (11.1)	
<b>Standards 8–10: antimicrobial review—duration, IV-oral switch and de-escalation</b>					
8	IV antibiotics are reviewed within 48 to 72 hours of the start date of IV antibiotics	<b>186/205 (90.7)</b>	47/52 (90.4)	139/153 (90.8)	
9	Patients who meet IV-oral SWITCH criteria should be changed to oral antibiotics	<b>124/140 (88.6)</b>	32/37 (86.5)	92/103 (89.3)	
10	Patients should change to a targeted, narrow-spectrum antibiotic to complete therapy when a suitable antibiotic can be identified from microbiology results	<b>122/132 (92.4)</b>	35/36 (97.2)	87/96 (90.6)	

\*n = number meeting audit standard, N = number remaining after inclusions/exclusions. Audit targets were 100% after applying inclusion/exclusion criteria. The audit was not designed to compare Māori and non-Māori outcomes.

†Waikato MicroGuide™ recommended at least one set of blood cultures as being acceptable for standard 1.

‡No MicroGuide™ guideline was available for 21 patients: unclear indications (8), two or more simultaneous infections (3), infective exacerbations of bronchiectasis or cystic fibrosis (3), cirrhosis-related conditions (2), cancer-related pneumonia (1), empyema (1), parotitis (1), prosthetic valve infective endocarditis (1), diverticulitis (1).