ANTIMICROBIAL RESISTANCE TRENDS IN NEW ZEALAND, 2005

Helen Heffernan, Senior Scientist, Antibiotic Reference Laboratory
Rosemary Woodhouse, Senior Technician, Antibiotic Reference Laboratory
and
Alokananda Maitra, Biostatistician

ESR
Porirua

December 2006

Client Report
FW06108

CONTENTS

SUMMARY

This report describes time-trends in antimicrobial resistance in New Zealand. It uses data routinely collected and generated as part of ESR's ongoing surveillance of antimicrobial resistance. Two data sources were used for the trend analyses in this report: (1) antimicrobial resistance data from hospital and community diagnostic laboratories, and (2) data generated at ESR from the ongoing surveillance of resistance among invasive pathogens and *Salmonella* referred to ESR.

ESR has collected and analysed antimicrobial resistance data from hospital and community diagnostic laboratories since 1988. The data collected is limited to specific organisms and antibiotics, and it is derived from the results of the laboratories' routine antimicrobial susceptibility testing. The diagnostic laboratories that have contributed data to this surveillance system have varied from year to year. For the trend analyses in this report that use data from diagnostic laboratories, changes in resistance over the 5-year period 2001 to 2005 were analysed. For each trend analysis, only data from laboratories that contributed data in each of the five years for that particular resistance (organism/antibiotic combination) was included.

Analysis of data from diagnostic laboratories identified several notable and significant changes between 2001 and 2005, including:

- A trend of decreasing ampicillin and amoxicillin/clavulanic acid resistance, but increasing second- and third-generation cephalosporin resistance, among urinary *Escherichia coli*.
- Increases in fluoroquinolone and gentamicin resistance among *E. coli*.
- Increase in fluoroquinolone resistance among *Neisseria gonorrhoeae*. By 2005, fluoroquinolone resistance was three times as common as penicillin resistance.
- Decreases in fluoroquinolone, gentamicin and imipenem/meropenem resistance among *Pseudomonas aeruginosa* isolated in hospital laboratories.
- Increases in resistance to almost all antibiotics, including oxacillin, among *Staphylococcus aureus* isolated in hospital, but not community, laboratories.
- Increases in penicillin, erythromycin, cotrimoxazole and tetracycline resistance among non-invasive isolates of *Streptococcus pneumoniae*.

ESR also monitors resistance among invasive isolates of *S. pneumoniae*, *Haemophilus influenzae* and *Neisseria meningitidis*. These isolates are referred to ESR as part of the laboratory-based surveillance of invasive disease. Similarly, resistance among *Salmonella* is monitored using isolates routinely referred to ESR for epidemiological typing. Trends in resistance among invasive pathogens over the 10 years 1996-2005 and trends in resistance among clinical isolates of non-typhoidal *Salmonella* over the six years 2000-2005 were analysed.

Overall, during the 10 years 1996 to 2005, there were highly significant trends of increasing penicillin and third-generation cephalosporin resistance and non-susceptibility among invasive pneumococci. Ampicillin resistance, but not β-lactamase production, increased

Continued

SUMMARY *continued*

among invasive *H. influenzae*. This effect was due to the increasing number of β-lactamase-negative ampicillin-resistant (BLNAR) isolates that have been identified since 2003. The prevalence of reduced penicillin susceptibility among invasive meningococci is increasing, however, these isolates are still susceptible to normal penicillin treatment regimens for meningococcal meningitis.

There have been no significant changes in resistance among clinical isolates of non-typhoidal *Salmonella* since 2000, and resistance remains low.

RECOMMENDATIONS

- Diagnostic laboratories should be encouraged, where possible, to record their antimicrobial susceptibility testing results according to the three standard susceptibility categories: susceptible, intermediate and resistant.

1 INTRODUCTION

This report describes time-trends in antimicrobial resistance in New Zealand.

Each year since 1988, ESR has collected and analysed antimicrobial resistance data from hospital and community diagnostic laboratories throughout New Zealand. The data collected is limited to specific organisms and antibiotics. The data is derived from the results of the laboratories' routine antimicrobial susceptibility testing and is used to produce annual national estimates of the prevalence of resistance among medically important bacteria to commonly used antimicrobials. Since 1999, the data has also been used to examine time-trends in resistance in New Zealand.

A second source of resistance data is used for the trend analyses included in this report. Invasive isolates of *Streptococcus pneumoniae*, *Haemophilus influenzae* and *Neisseria meningitidis* (ie, isolates from normally sterile sites) are routinely referred to ESR as part of the laboratory-based surveillance of invasive disease due to these three pathogens. Similarly, clinical *Salmonella* isolates are routinely referred to ESR for epidemiological typing. At ESR, the antimicrobial susceptibility of all the invasive isolates, a proportion of the non-typhoidal *Salmonella*, and all *S.* Typhi and *S.* Paratyphi are tested.

This is the fifth time-trends report.[1-4] For the analyses in this report that use antimicrobial resistance data from diagnostic laboratories, the time period covered is five years (2001-2005) to maximise the number of laboratories from which data can be included. The time period covered for the *S. pneumoniae*, *H. influenzae* and *N. meningitidis* invasive isolates is 10 years (1996-2005). Trends among non-typhoidal *Salmonella* are analysed over six years (2000-2005).

2 METHODOLOGY

2.1 Data Sources

Two data sources were used for the analyses included in this report:

1 Antimicrobial resistance data from hospital and community diagnostic laboratories

Antimicrobial resistance among *Campylobacter, Enterococcus, Escherichia coli* from bacteraemia, urinary *E. coli*, non-invasive *H. influenzae, Neisseria gonorrhoeae, Pseudomonas aeruginosa, Staphylococcus aureus*, coagulase-negative staphylococci from blood, non-invasive *S. pneumoniae* and *Streptococcus pyogenes* were analysed for trend over the 5-year period 2001-2005.

Susceptibility data was available from 20 laboratories for each of the five years 2001-2005 for at least some of the organisms and antibiotics included in the analyses. The 20 laboratories were the microbiology laboratories at Whangarei Hospital; North Shore Hospital; Auckland City and Children's Hospital; Diagnostic Medlab, Auckland; Waikato Hospital; Rotorua Hospital; Medlab Bay of Plenty, Tauranga; Gisborne Hospital; Whakatane Hospital; Taranaki Medlab; Wanganui Hospital; Wanganui Diagnostic Laboratory; Medlab Central, Palmerston North; Wellington Hospital; Wellington Medlab; Nelson Diagnostic Laboratory; Wairau Hospital, Blenheim; Christchurch Hospital (Canterbury Health Laboratories); and Southern Community Laboratories, Christchurch and Dunedin. These laboratories include 11 hospital laboratories, seven community laboratories, and two laboratories (Medlab Bay of Plenty and Medlab Central) that process specimens from both hospital and community patients. In addition, the seven community laboratories process specimens from private hospitals and residential-care facilities.

For each trend analysis, only data from laboratories that had supplied data in each of the five years for that particular resistance (organism/antibiotic combination) was included. In addition, with the exception of pneumococcal penicillin non-susceptibility, resistance data that included intermediate resistance was not used. Details of which laboratories' data were included in each trend analysis are shown in Appendix 1.

Where appropriate, data from hospital laboratories and community laboratories was analysed separately. When the data from hospital and community laboratories was analysed separately, the data from Medlab Bay of Plenty and Medlab Central was excluded. An organism qualified as 'hospital' indicates the data only includes that reported by hospital laboratories. Correspondingly, an organism qualified as 'community' indicates the data only includes that reported by community laboratories.

2 Antimicrobial resistance among invasive *S. pneumoniae*, *H. influenzae* and *N. meningitidis* isolates and non-typhoidal *Salmonella* referred to ESR

Antimicrobial resistance rates among *S. pneumoniae*, *H. influenzae*, and

N. meningitidis invasive isolates, referred to ESR during the 10-year period 1996-2005, and non-typhoidal *Salmonella* from clinical specimens, referred during the 6-year period 2000-2005, were analysed for trend.

2.2 Statistical Analysis

Resistance rates based on a sample of <10 isolates were not included in the trend analyses. Poisson regression analysis was used to determine the overall pattern of change in resistance to an antibiotic over the time period included in a trend analysis. An associated P value <0.05 indicated that the direction of the trend was significant at the 5% level of significance. Approximate 95% confidence intervals were calculated for some resistance rates to identify the precision of the rates. Statistical analyses were performed using the Statistical Analysis Software (SAS) version 9.1.[5]

2.3 Results Presentation

In the report, the term co-amoxiclav refers to the combination of amoxicillin and clavulanic acid, and the term cotrimoxazole refers to the combination of trimethoprim and sulphamethoxazole. Fluoroquinolone data represents ciprofloxacin, norfloxacin or any other fluoroquinolones tested.

In the charts presented in the results section, the level of any significant increase or decrease is indicated with * denoting the Poisson regression P value was 0.01 to <0.05, ** denoting the P value was 0.001 to <0.01 and *** denoting the P value was <0.001.

The annual resistance rates used to generate the charts and trend analyses based on data from diagnostic laboratories (section 3.1) are tabulated in Appendix 2. Annual resistance rates for the 10 years 1996-2005, based on data from all diagnostic laboratories that contributed data rather than just those laboratories whose data is included in the trend analyses, are tabulated in Appendix 5.

The annual resistance rates used to generate the charts and trend analyses presented in the results for the invasive *S. pneumoniae*, *H. influenzae*, and *N. meningitidis* isolates (section 3.2) are tabulated in Appendix 3. The annual resistance rates used to generate the charts and trend analyses presented in the results for the clinical non-typhoidal *Salmonella* (section 3.3) are tabulated in Appendix 4. This appendix also includes data on resistance among clinical *S.* Typhi and *S.* Paratyphi. However, this data was not analysed for trend.

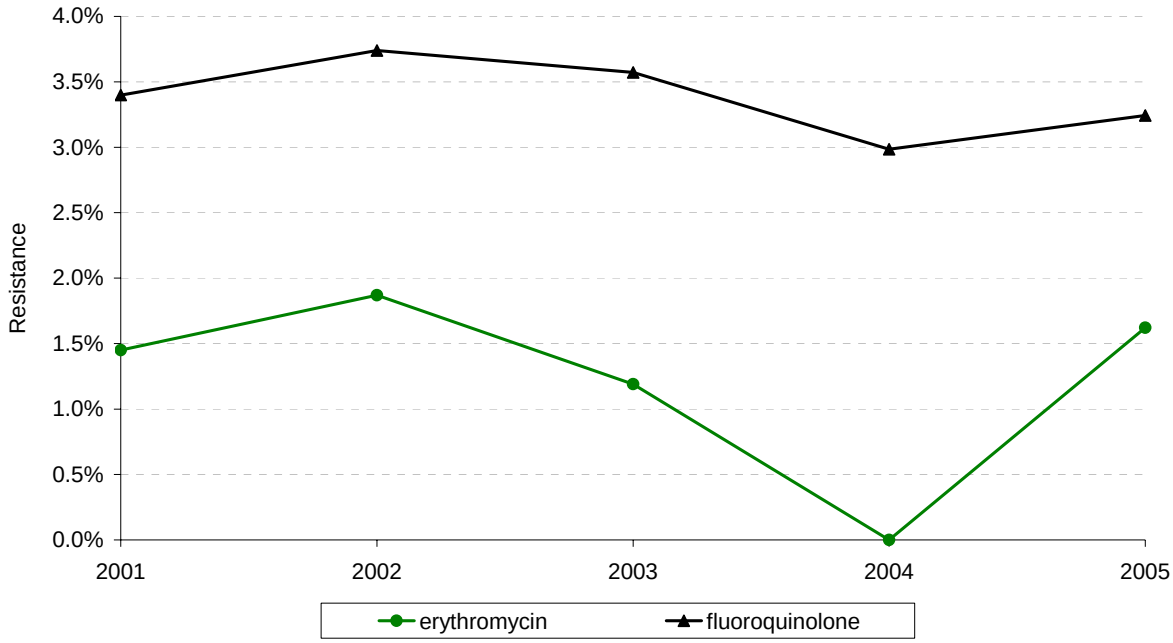
3 RESULTS

3.1 Trends in Antimicrobial Resistance Based on Data from Diagnostic Laboratories, 2001-2005

The number of isolates tested and the annual resistance rates used to generate the charts presented in this section are tabulated in Appendix 2.

3.1.1 *Campylobacter*

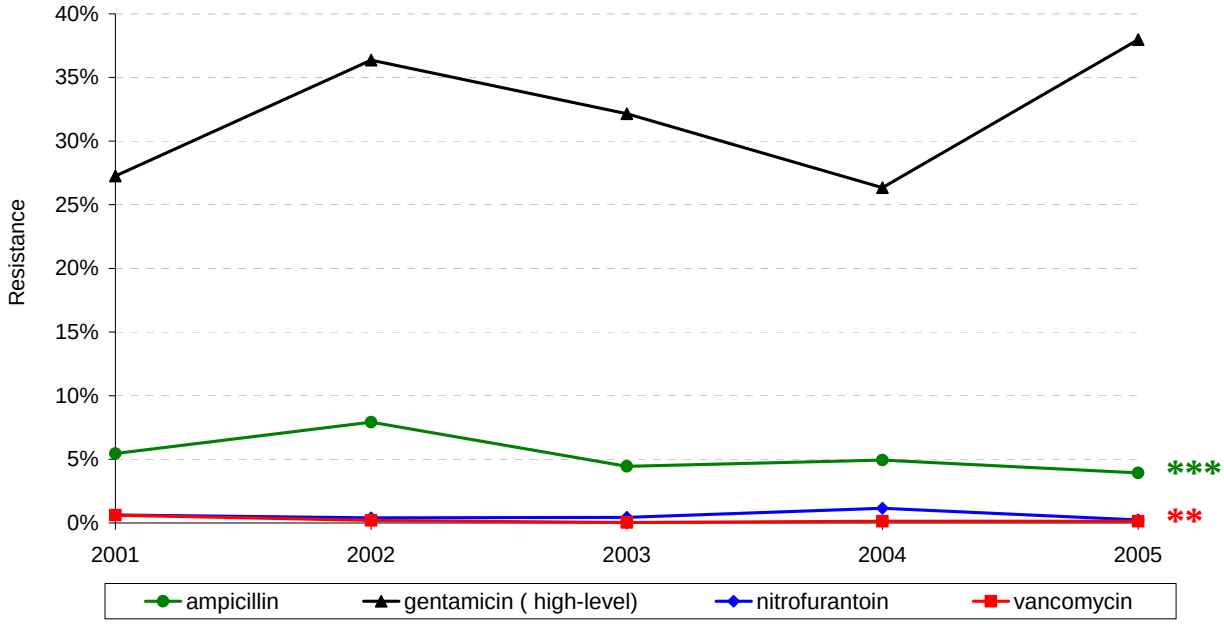
Figure 1. *Campylobacter*: erythromycin and fluoroquinolone resistance, 2001-2005



	Direction of the trend	Significance	P-value
erythromycin resistance	decrease	not significant	0.5076
fluoroquinolone resistance	decrease	not significant	0.7940

3.1.2 *Enterococcus* from Hospital Laboratories

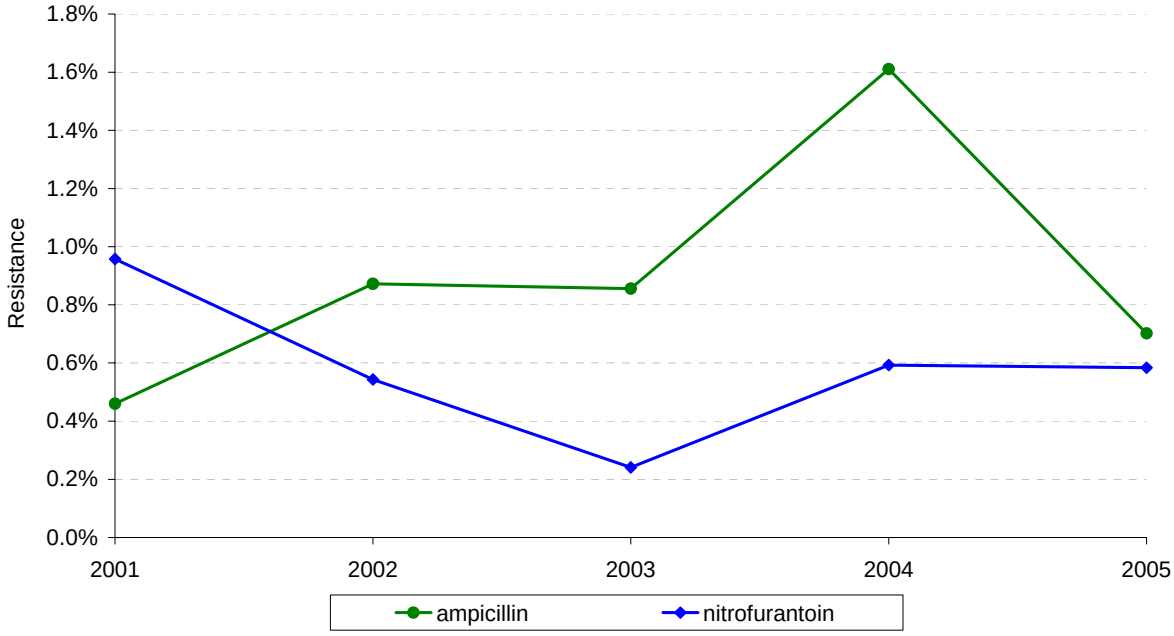
Figure 2. *Enterococcus*: ampicillin, high-level gentamicin, nitrofurantoin and vancomycin resistance among hospital isolates, 2001-2005



	Direction of the trend	Significance	P-value
ampicillin resistance	decrease	significant	<0.0001
high-level gentamicin resistance	increase	not significant	0.2274
nitrofurantoin resistance	decrease	not significant	0.9777
vancomycin resistance	decrease	significant	0.0067

3.1.3 *Enterococcus* from Community Laboratories

Figure 3. *Enterococcus*: ampicillin and nitrofurantoin resistance among community isolates, 2001-2005



	Direction of the trend	Significance	P-value
ampicillin resistance	increase	not significant	0.0958
nitrofurantoin resistance	decrease	not significant	0.2893

3.1.4 Comparison of Resistance Among *Enterococcus* from Hospital and Community Laboratories

	Percent resistance (2001 rate - 2005 rate)	
	Hospital	**Community**
ampicillin resistance	5.5 – 3.9	0.5 – 0.7
high-level gentamicin resistance	27.3 – 38.0	-
nitrofurantoin resistance	0.6 – 0.2	1.0 – 0.6
vancomycin resistance	0.6 – 0.1	-

3.1.5 *Escherichia coli* from Bacteraemia

Figure 4a. *Escherichia coli* from bacteraemia: β-lactam resistance, 2001-2005

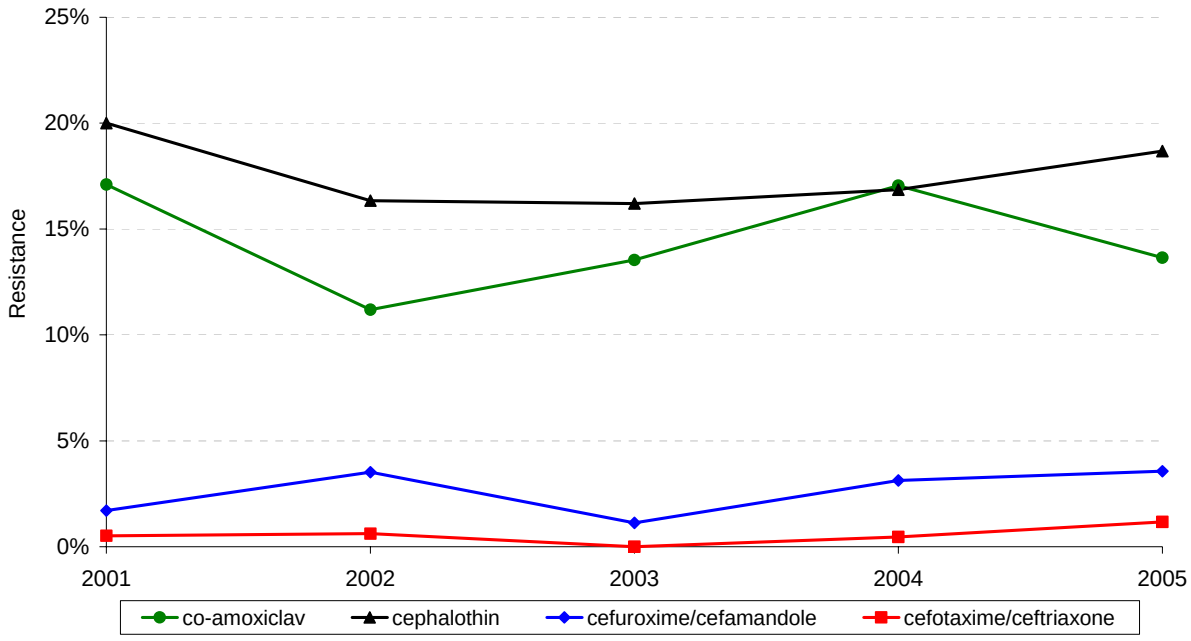
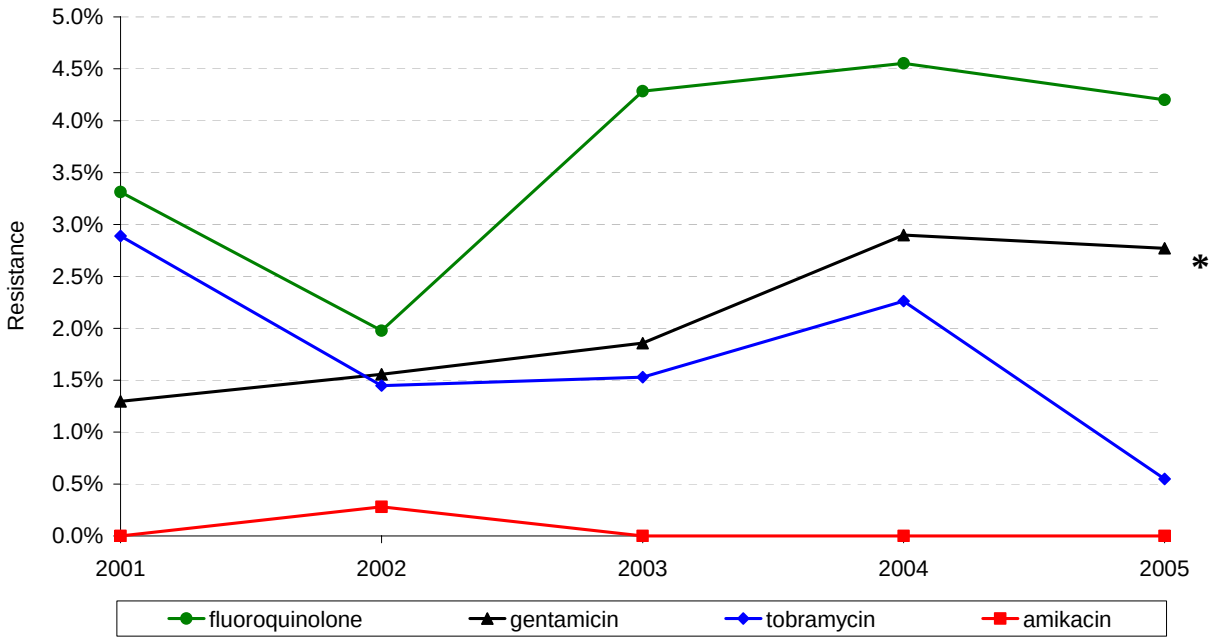


Figure 4b. *Escherichia coli* from bacteraemia: fluoroquinolone, gentamicin, tobramycin and amikacin resistance, 2001-2005



Note: The higher rate of tobramycin than gentamicin resistance recorded in 2001 is probably due to the inclusion of tobramycin susceptibility data based on second-line testing.

	Direction of the trend	Significance	P-value
co-amoxiclav resistance	decrease	not significant	0.9032
cephalothin resistance	decrease	not significant	0.7167
cefuroxime/cefamandole resistance	increase	not significant	0.1584
cefotaxime/ceftriaxone resistance	increase	not significant	0.3180
fluoroquinolone resistance	increase	not significant	0.0577
gentamicin resistance	increase	significant	0.0119
tobramycin resistance	decrease	not significant	0.2510
amikacin resistance	decrease	not significant	0.5351

Note: No resistance to imipenem/meropenem was reported

3.1.6 Urinary *Escherichia coli* from Hospital Laboratories

Figure 5a. Urinary *Escherichia coli*: β-lactam resistance among hospital isolates, 2001-2005

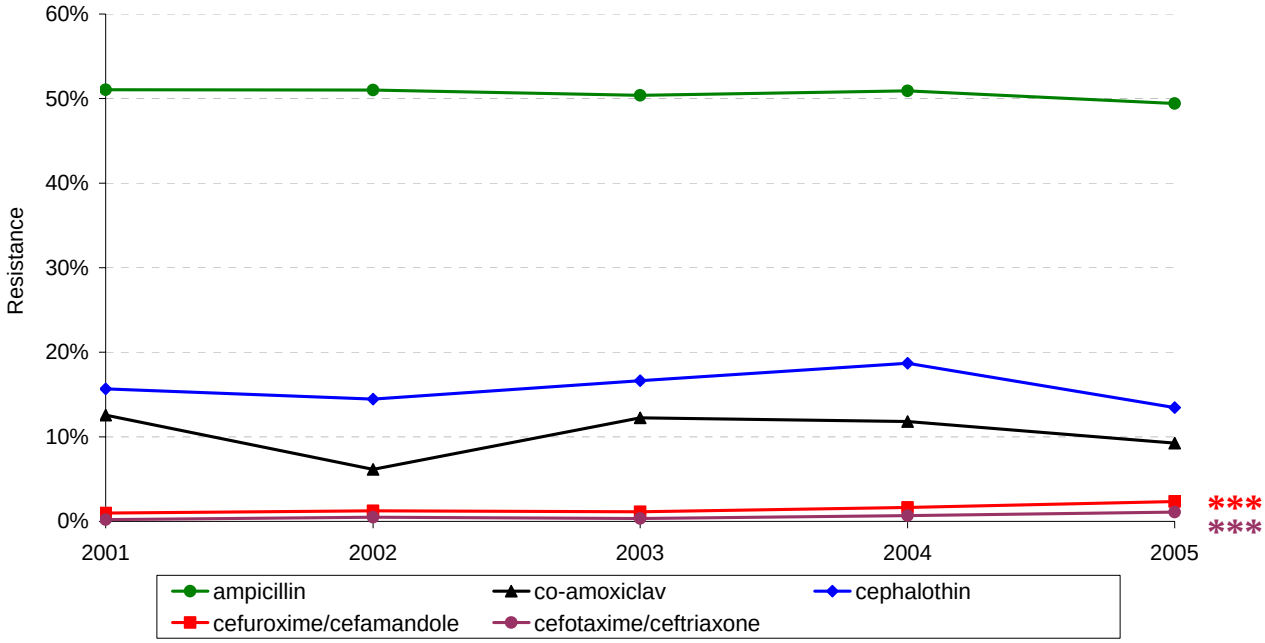
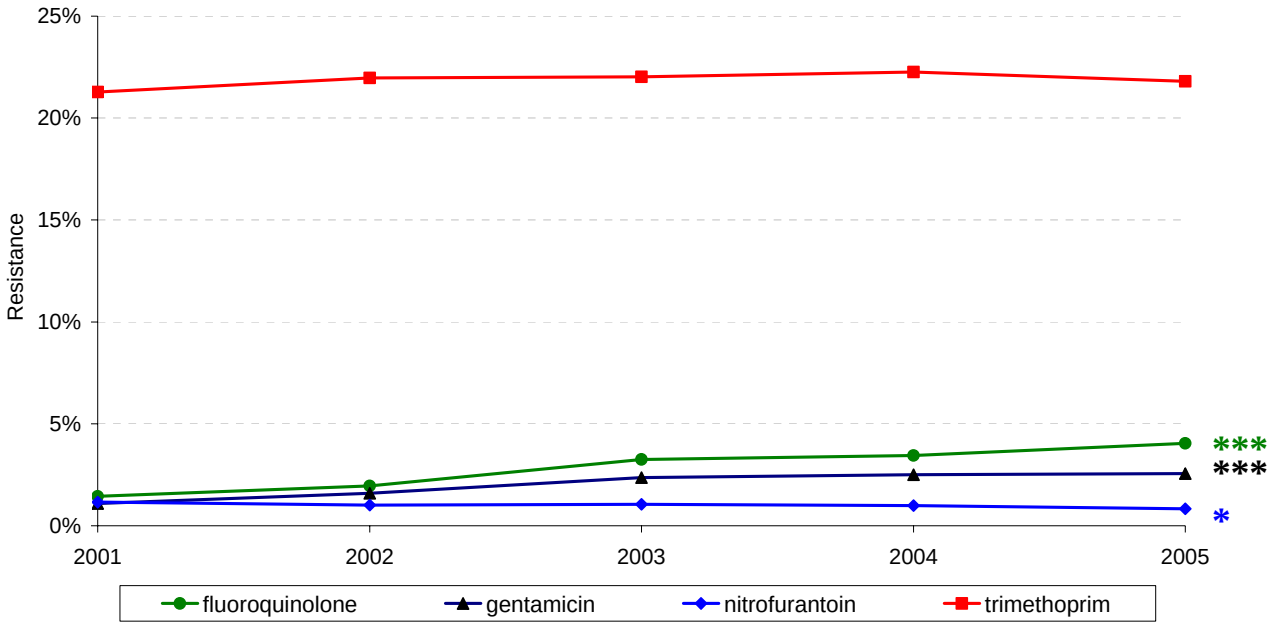


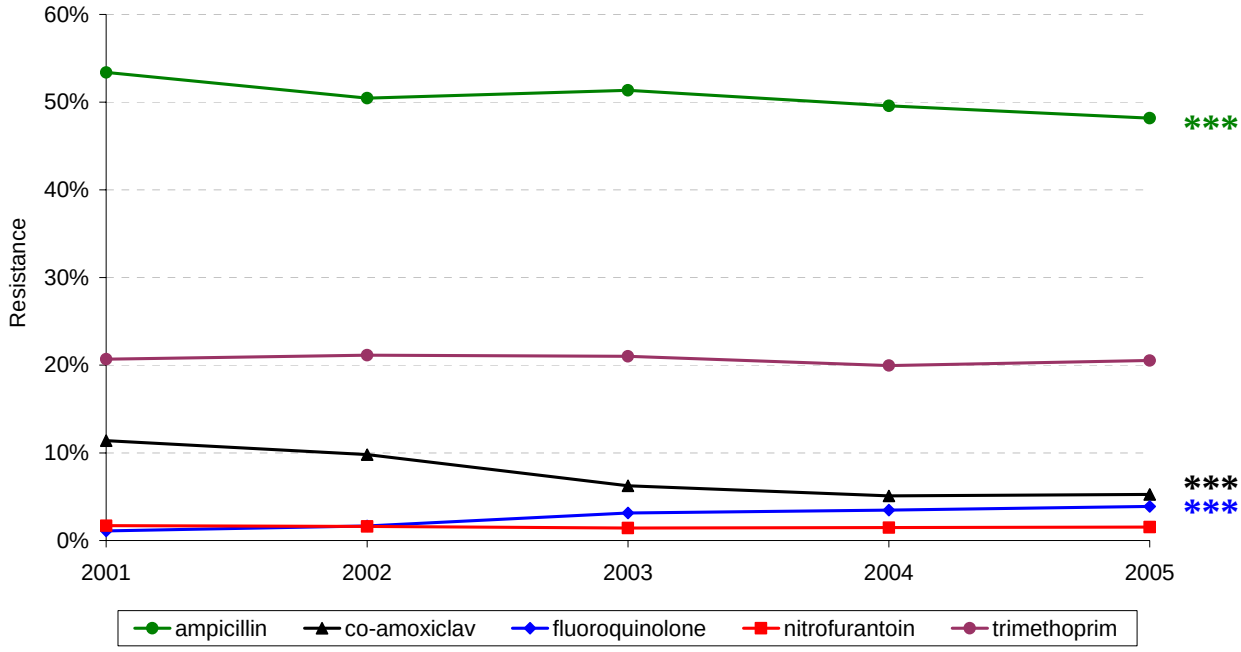
Figure 5b. Urinary *Escherichia coli*: fluoroquinolone, gentamicin, nitrofurantoin and trimethoprim resistance among hospital isolates, 2001-2005



	Direction of the trend	Significance	P-value
ampicillin resistance	decrease	not significant	0.1853
co-amoxiclav resistance	decrease	not significant	0.5177
cephalothin resistance	increase	not significant	0.6020
cefuroxime/cefamandole resistance	increase	significant	0.0002
cefotaxime/ceftriaxone resistance	increase	significant	0.0004
fluoroquinolone resistance	increase	significant	<0.0001
gentamicin resistance	increase	significant	<0.0001
nitrofurantoin resistance	decrease	significant	0.0496
trimethoprim resistance	increase	not significant	0.4349

3.1.7 Urinary *Escherichia coli* from Community Laboratories

Figure 6. Urinary *Escherichia coli*: ampicillin, co-amoxiclav, fluoroquinolone, nitrofurantoin and trimethoprim resistance among community isolates, 2001-2005



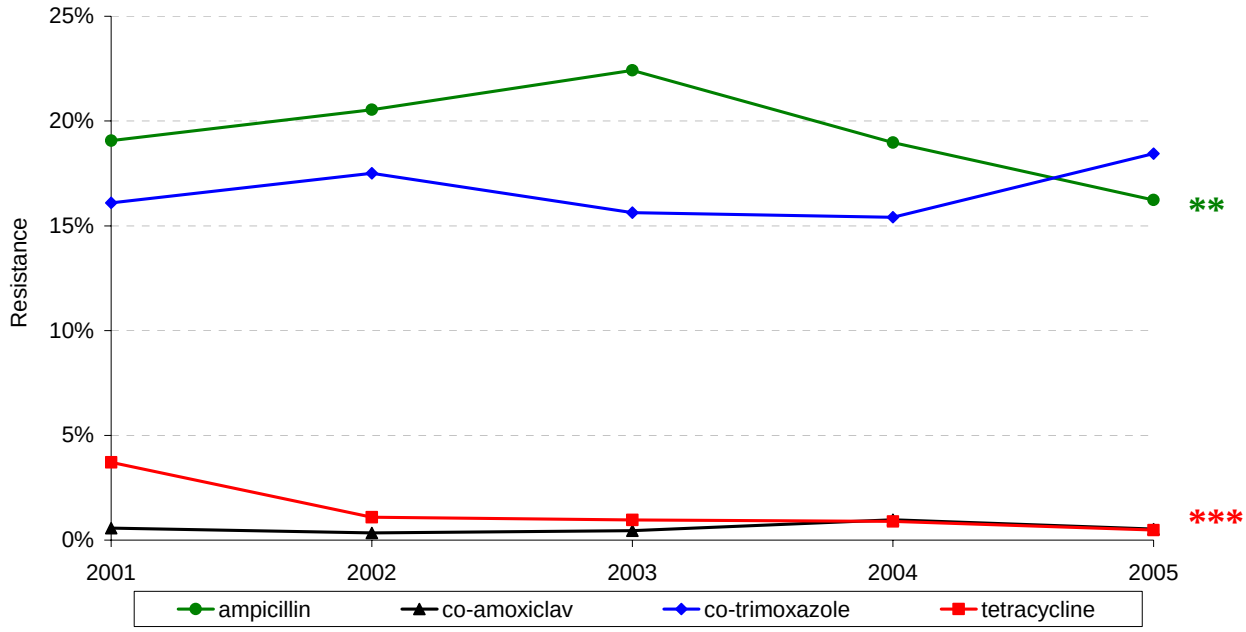
	Direction of the trend	Significance	P-value
ampicillin resistance	decrease	significant	<0.0001
co-amoxiclav resistance	decrease	significant	<0.0001
fluoroquinolone resistance	increase	significant	<0.0001
nitrofurantoin resistance	decrease	not significant	0.1440
trimethoprim resistance	decrease	not significant	0.1377

3.1.8 Comparison of Resistance Among Urinary *Escherichia coli* from Hospital and Community Laboratories

	Percent resistance (2001 rate - 2005 rate)	
	Hospital	**Community**
ampicillin	51.1 – 49.4	53.4 – 48.2
co-amoxiclav	12.6 – 9.3	11.4 – 5.3
cephalothin	15.7 – 13.5	-
cefuroxime	1.0 – 2.4	-
cefotaxime	0.2 – 1.1	-
fluoroquinolone	1.4 – 4.0	1.1 – 3.9
gentamicin	1.1 – 2.6	-
nitrofurantoin	1.2 – 0.8	1.7 – 1.5
trimethoprim	21.3 – 21.8	20.7 – 20.5

3.1.9 Non-invasive *Haemophilus influenzae*

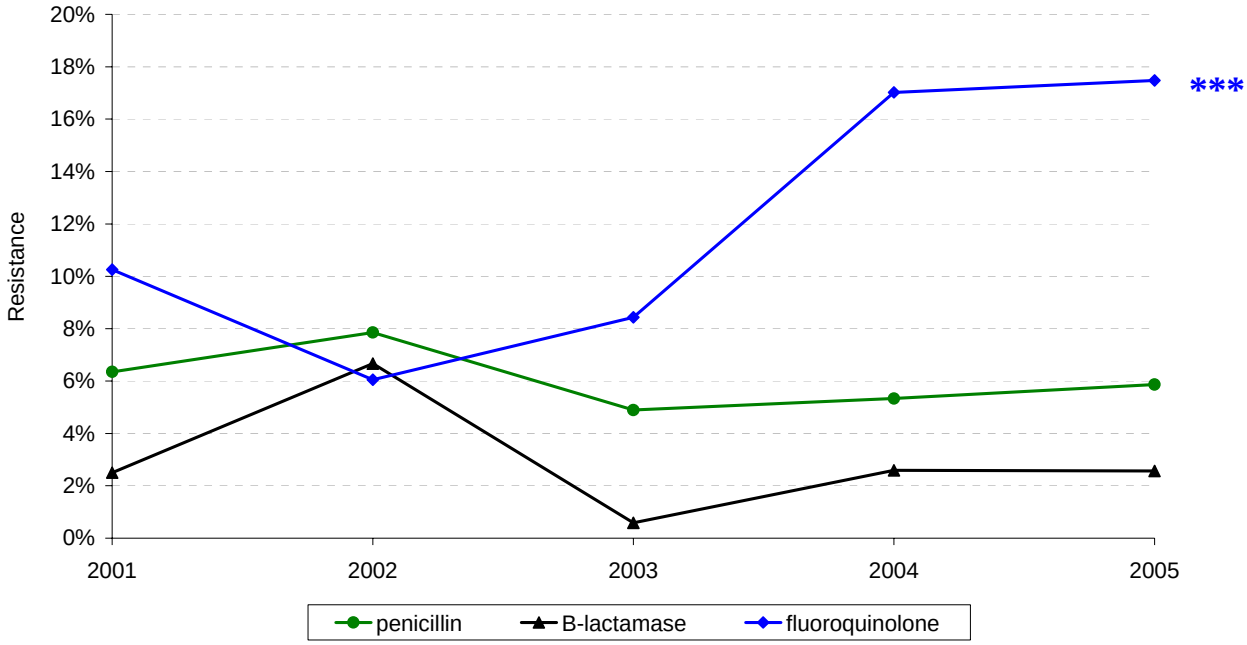
Figure 7. Non-invasive *Haemophilus influenzae*: ampicillin, co-amoxiclav, cotrimoxazole and tetracycline resistance, 2001-2005



	Direction of the trend	Significance	P-value
ampicillin resistance	decrease	significant	0.0035
co-amoxiclav resistance	increase	not significant	0.2116
cotrimoxazole resistance	increase	not significant	0.3544
tetracycline resistance	decrease	significant	<0.0001

3.1.10 *Neisseria gonorrhoeae*

Figure 8. *Neisseria gonorrhoeae*: penicillin, β-lactamase and fluoroquinolone resistance, 2001-2005



	Direction of the trend	Significance	P-value
penicillin resistance	decrease	not significant	0.1483
B-lactamase positive	decrease	not significant	0.1932
fluoroquinolone resistance	increase	significant	<0.0001

3.1.11 *Pseudomonas aeruginosa* from Hospital Laboratories

Figure 9a. *Pseudomonas aeruginosa*: β-lactam resistance among hospital isolates, 2001-2005

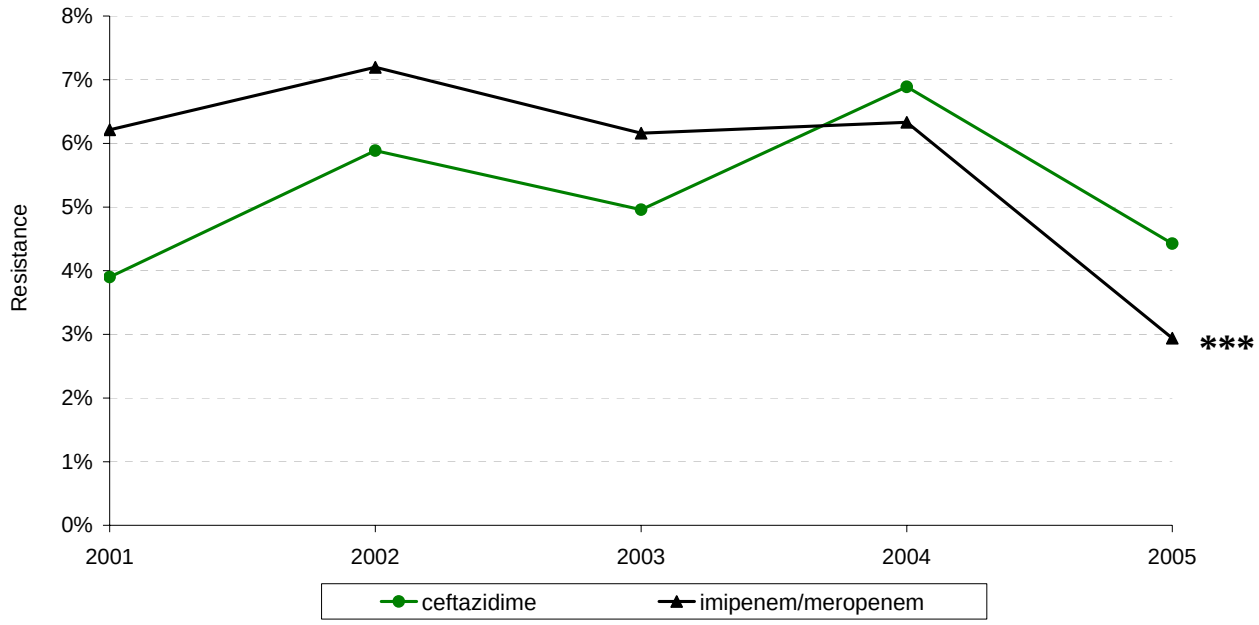
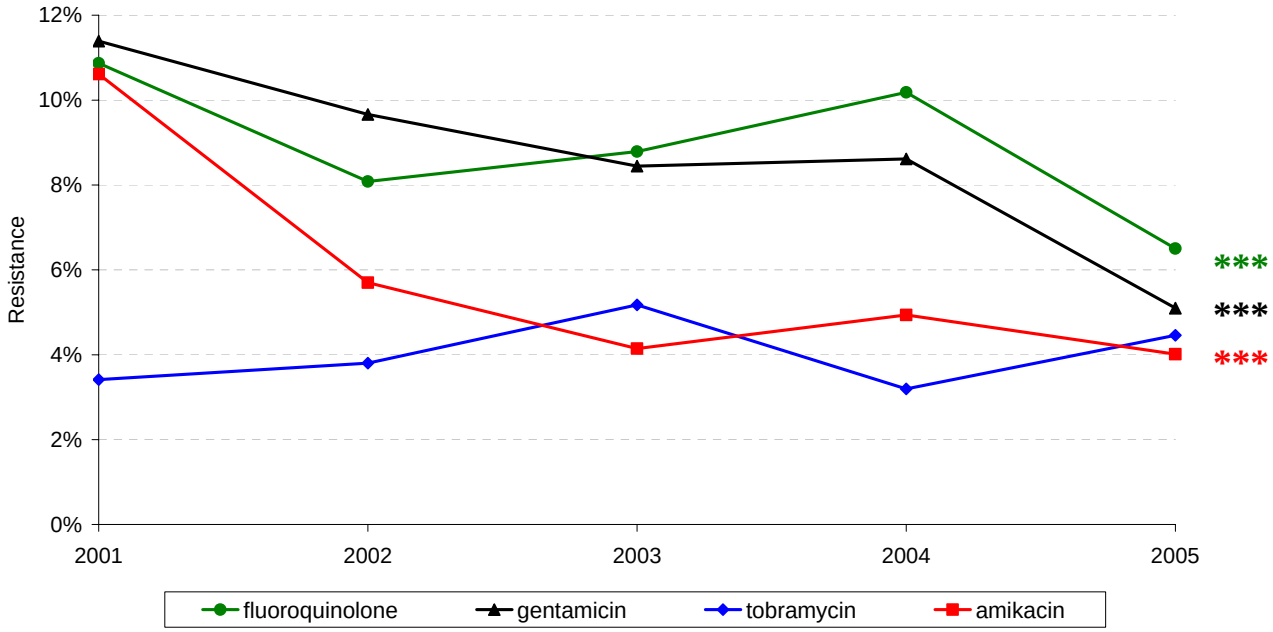


Figure 9b. *Pseudomonas aeruginosa*: fluoroquinolone, gentamicin, tobramycin and amikacin resistance among hospital isolates, 2001-2005

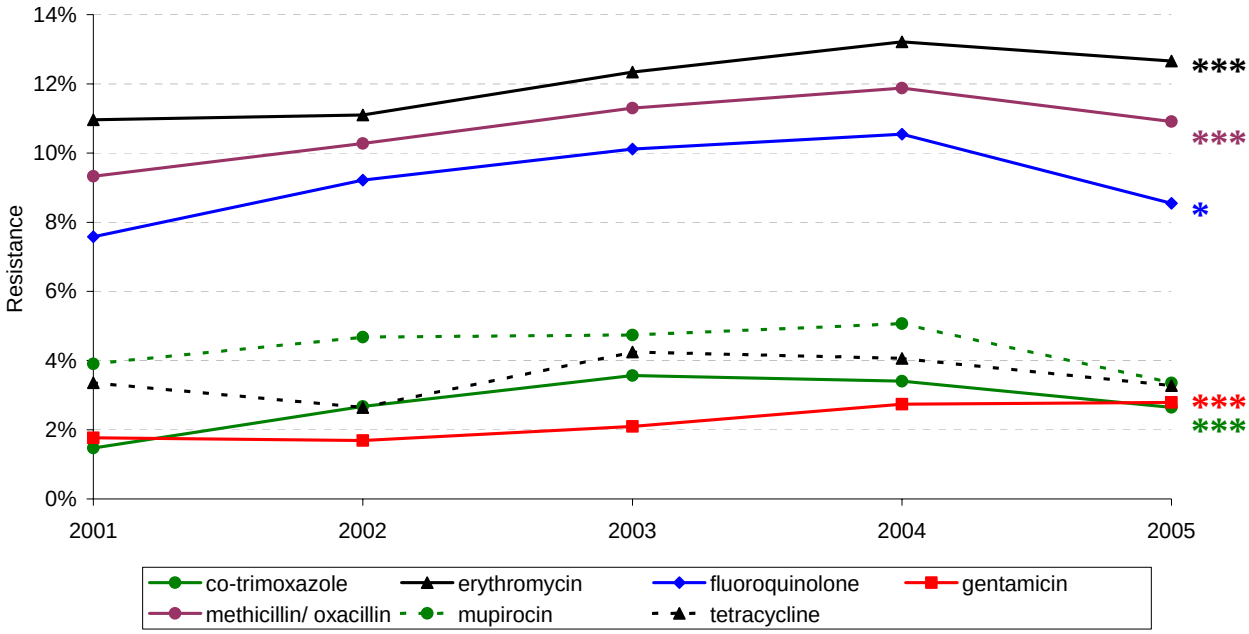


Note: The higher rate of amikacin than tobramycin resistance recorded in some years is probably due to the inclusion of amikacin susceptibility data based on second-line testing.

	Direction of the trend	Significance	P-value
ceftazidime resistance	increase	not significant	0.0758
imipenem/meropenem resistance	decrease	significant	0.0002
fluoroquinolone resistance	decrease	significant	<0.0001
gentamicin resistance	decrease	significant	<0.0001
tobramycin resistance	increase	not significant	0.2659
amikacin resistance	decrease	significant	<0.0001

3.1.12 *Staphylococcus aureus* from Hospital Laboratories

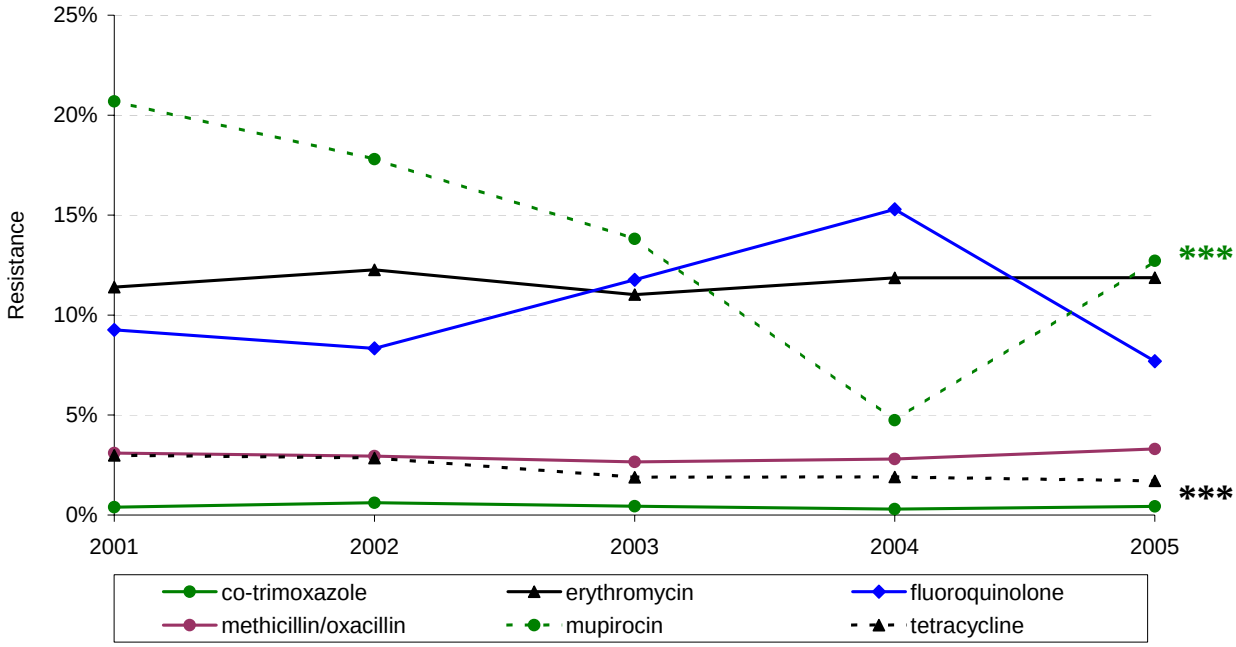
Figure 10. *Staphylococcus aureus*: cotrimoxazole, erythromycin, fluoroquinolone, gentamicin, methicillin/oxacillin, mupirocin and tetracycline resistance among hospital isolates, 2001-2005



	Direction of the trend	Significance	P-value
cotrimoxazole resistance	increase	significant	<0.0001
erythromycin resistance	increase	significant	<0.0001
fluoroquinolone resistance	increase	significant	0.0215
gentamicin resistance	increase	significant	<0.0001
methicillin/oxacillin resistance	increase	significant	<0.0001
mupirocin resistance	decrease	not significant	0.7365
tetracycline resistance	increase	not significant	0.1023

3.1.13 *Staphylococcus aureus* from Community Laboratories

Figure 11. *Staphylococcus aureus*: cotrimoxazole, erythromycin, fluoroquinolone, methicillin/oxacillin, mupirocin and tetracycline resistance among community isolates, 2001-2005



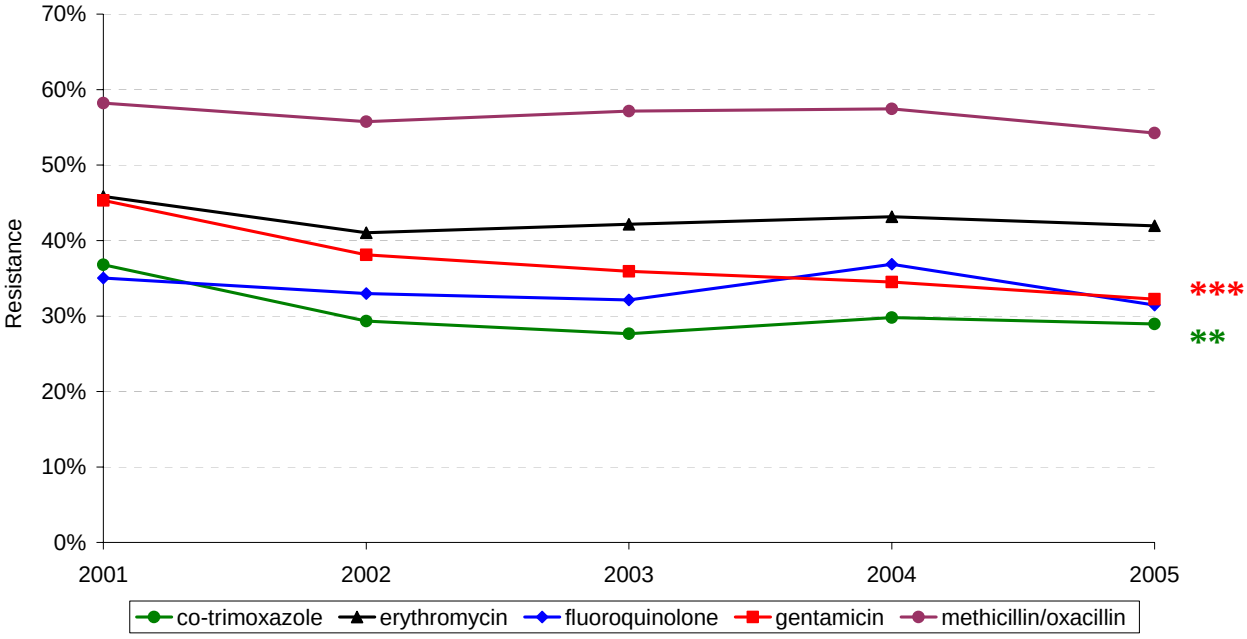
	Direction of the trend	Significance	P-value
cotrimoxazole resistance	decrease	not significant	0.1465
erythromycin resistance	increase	not significant	0.6846
fluoroquinolone resistance	increase	not significant	0.9816
methicillin/oxacillin resistance	increase	not significant	0.5123
mupirocin resistance	decrease	significant	0.0007
tetracycline resistance	decrease	significant	<0.0001

3.1.14 Comparison of Resistance Among *Staphylococcus aureus* from Hospital and Community Laboratories

	Percent resistance (2001 rate - 2005 rate)	
	Hospital	**Community**
cotrimoxazole	1.5 – 2.7	0.4 – 0.4
erythromycin	11.0 – 12.7	11.4 – 11.9
fluoroquinolone	7.6 – 8.6	9.3 – 7.7
gentamicin	1.8 – 2.8	-
methicillin/oxacillin	9.3 – 10.9	3.1 – 3.3
mupirocin	3.9 – 3.4	20.7 – 12.7
tetracycline	3.4 – 3.3	3.0 – 1.7

3.1.15 Coagulase-negative Staphylococci from Blood

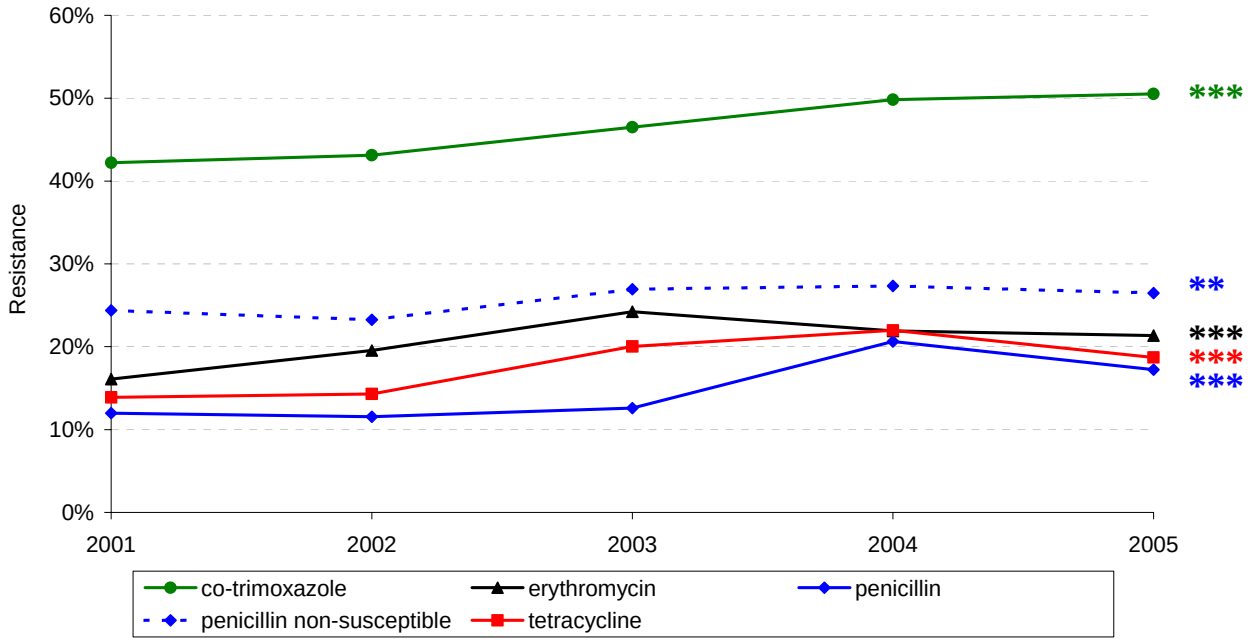
Figure 12. Coagulase-negative staphylococci from blood: cotrimoxazole, erythromycin, fluoroquinolone, gentamicin and methicillin/oxacillin resistance, 2001-2005



	Direction of the trend	Significance	P-value
cotrimoxazole resistance	decrease	significant	0.0075
erythromycin resistance	decrease	not significant	0.2653
fluoroquinolone resistance	decrease	not significant	0.5971
gentamicin resistance	decrease	significant	<0.0001
methicillin/oxacillin resistance	decrease	not significant	0.2531

3.1.16 Non-invasive *Streptococcus pneumoniae*

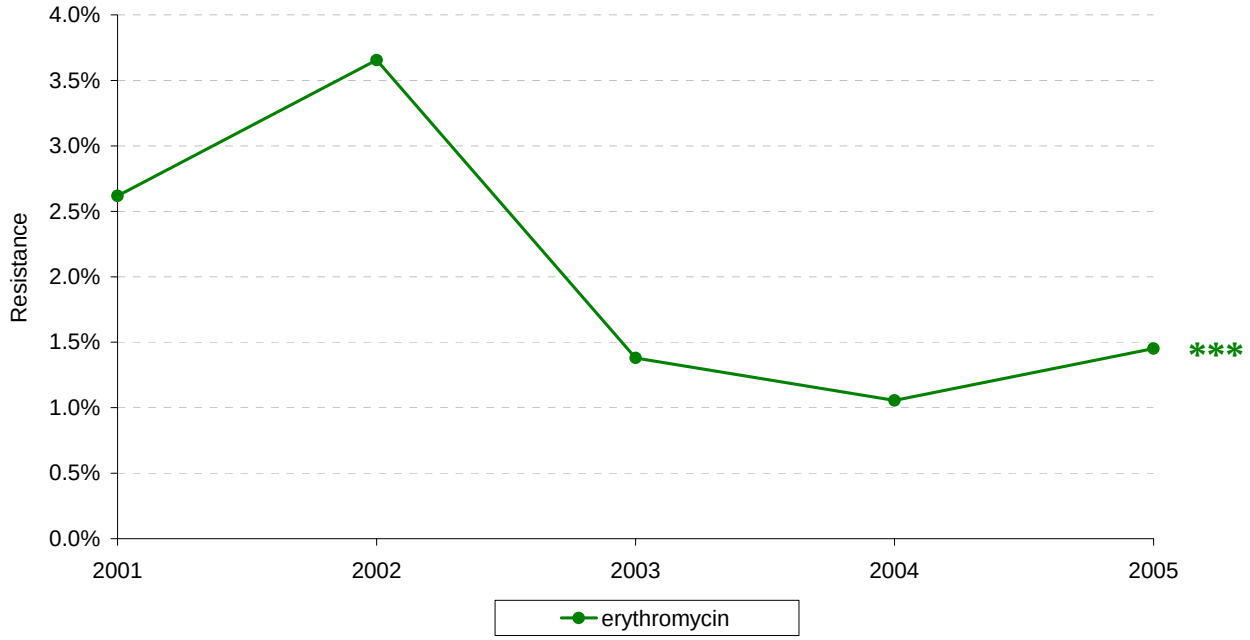
Figure 13. Non-invasive *Streptococcus pneumoniae*: cotrimoxazole, erythromycin, penicillin and tetracycline resistance, and penicillin non-susceptibility, 2001-2005



	Direction of the trend	Significance	P-value
cotrimoxazole resistance	increase	significant	0.0004
erythromycin resistance	increase	significant	0.0008
penicillin resistance	increase	significant	<0.0001
penicillin non-susceptibility	increase	significant	0.0035
tetracycline resistance	increase	significant	<0.0001

3.1.17 *Streptococcus pyogenes*

Figure 14. *Streptococcus pyogenes*: erythromycin resistance, 2001-2005



	Direction of the trend	Significance	P-value
erythromycin resistance	decrease	significant	<0.0001

3.2 Trends in Antimicrobial Resistance Among Invasive Disease Pathogens

The number of isolates tested and the annual resistance rates used to generate the charts presented in this section are tabulated in Appendix 3.

3.2.1 *Streptococcus pneumoniae*

Figure 15a. *Streptococcus pneumoniae* from invasive disease: penicillin resistance (MIC ≥2 mg/L) and non-susceptibility (MIC ≥0.12 mg/L), 1996-2005 [with 95% confidence interval bars]

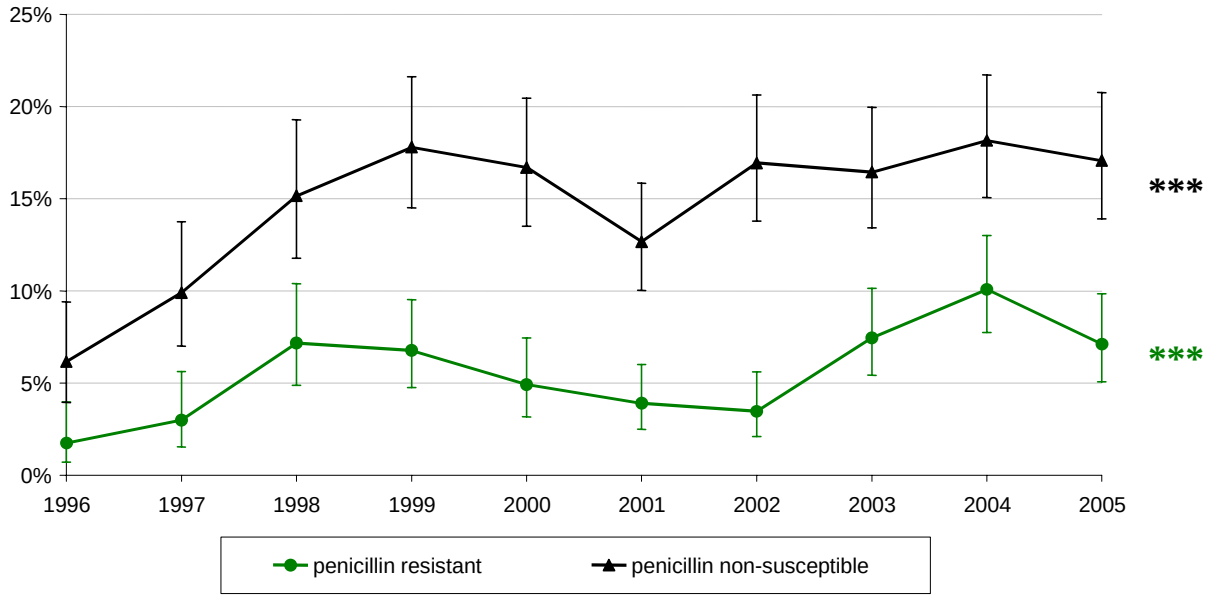


Figure 15b. *Streptococcus pneumoniae* from invasive disease: cefotaxime resistance (MIC ≥2 mg/L) and non-susceptibility (MIC ≥1 mg/L), meningitis interpretive standards, 1996-2005 [with 95% confidence interval bars]

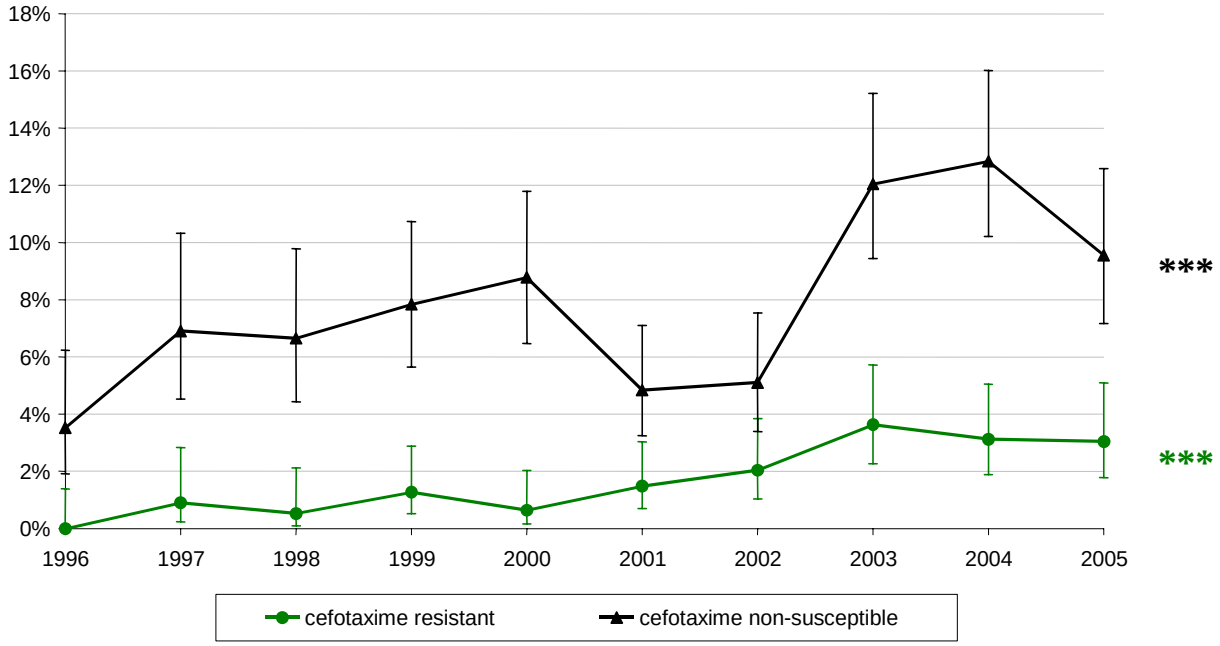


Figure 15c. *Streptococcus pneumoniae* from invasive disease: cefotaxime resistance (MIC≥4 mg/L) and non-susceptibility (≥2 mg/L), non-meningitis interpretive standards, 1996-2005 [with 95% confidence interval bars]

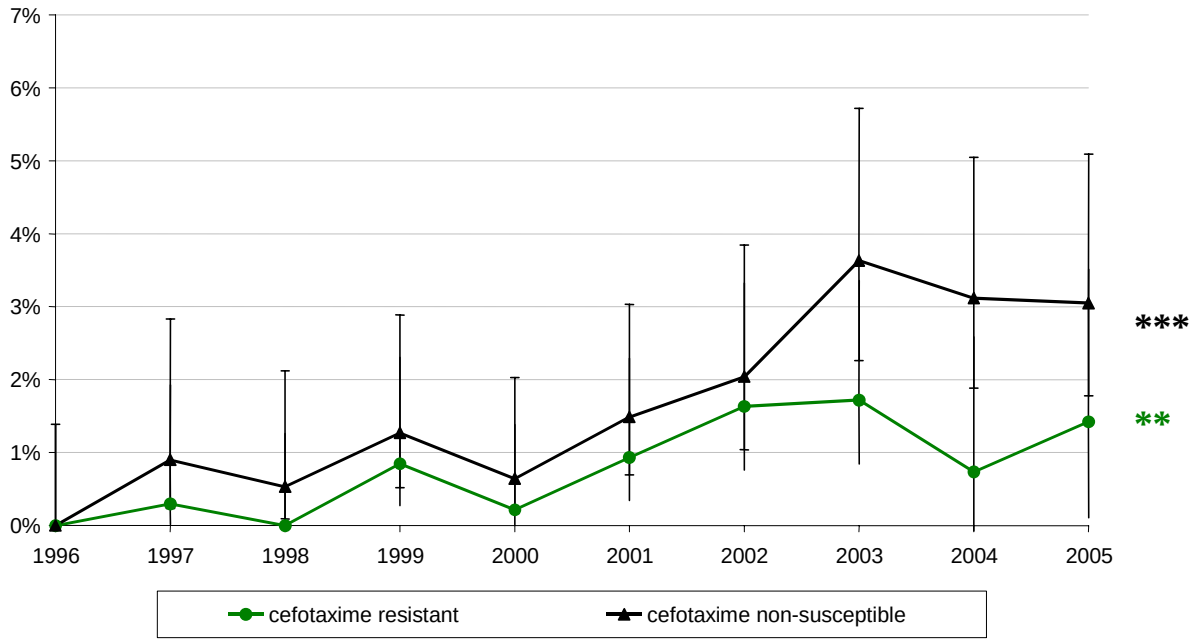
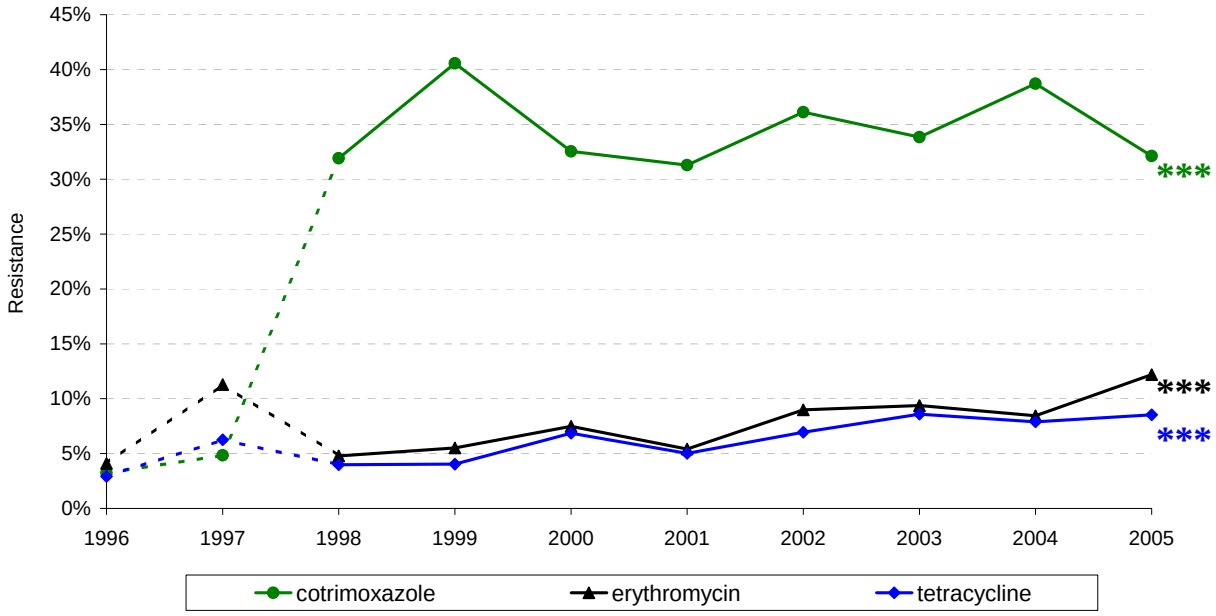


Figure 15d. *Streptococcus pneumoniae* from invasive disease: cotrimoxazole, erythromycin and tetracycline resistance, 1996-2005

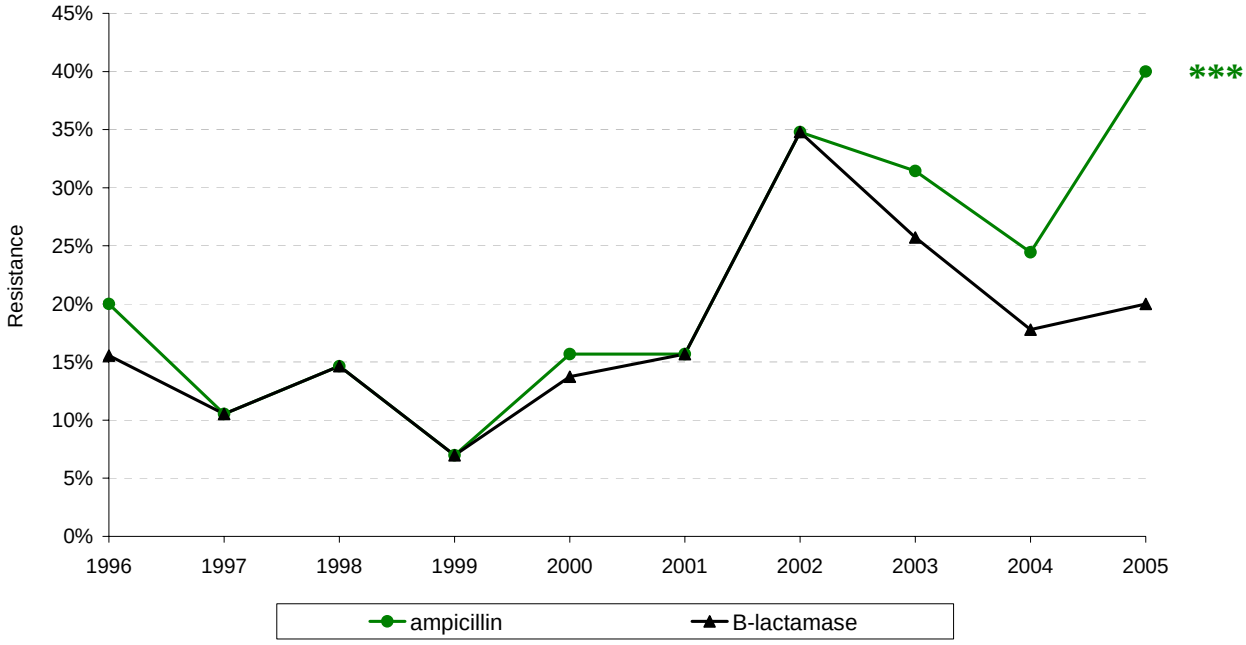


Note: In 1997 only a small number of the total isolates were tested for cotrimoxazole, erythromycin and tetracycline susceptibility (Appendix 3).

	Direction of the trend	Significance	P-value
penicillin resistance	increase	significant	<0.0001
penicillin non-susceptibility	increase	significant	<0.0001
meningitis interpretation			
cefotaxime resistance	increase	significant	<0.0001
cefotaxime non-susceptibility	increase	significant	<0.0001
non-meningitis interpretation			
cefotaxime resistance	increase	significant	0.0014
cefotaxime non-susceptibility	increase	significant	<0.0001
cotrimoxazole resistance	increase	significant	<0.0001
erythromycin resistance	increase	significant	<0.0001
tetracycline resistance	increase	significant	<0.0001

3.2.2 *Haemophilus influenzae*

Figure 16. *Haemophilus influenzae* from invasive disease: ampicillin resistance and β-lactamase production, 1996-2005

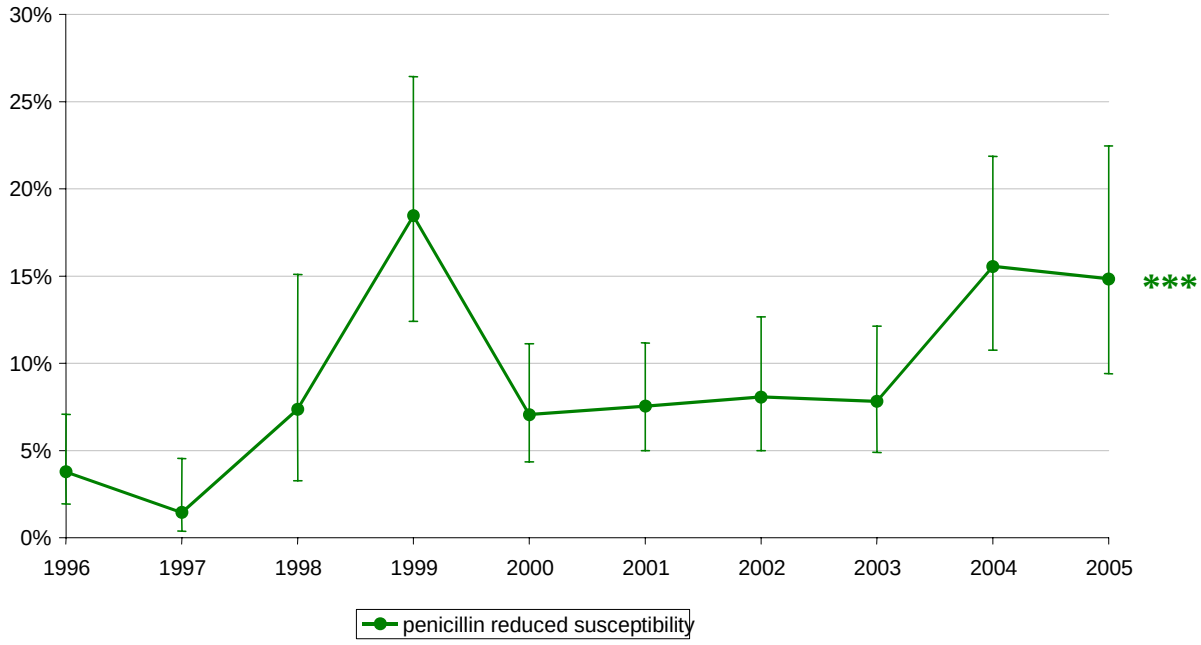


	Direction of the trend	Significance	P-value
ampicillin resistance	increase	significant	0.0008
β-lactamase positive	increase	not significant	0.0511

Note: *H. influenzae* invasive isolates in New Zealand remain universally susceptible to third-generation cephalosporins. Occasional rifampicin resistance has been identified, with just two rifampicin-resistant isolates being identified during the 10 years 1996-2005.

3.2.3 *Neisseria meningitidis*

Figure 17. *Neisseria meningitidis* from invasive disease: reduced penicillin susceptibility (MIC ≥0.12 mg/L), 1996-2005 [with 95% confidence interval bars]



	Direction of the trend	Significance	P-value
penicillin reduced susceptibility	increase	significant	<0.0001

Note: *N. meningitidis* invasive isolates in New Zealand remain universally susceptible to third-generation cephalosporins and ciprofloxacin. Occasional rifampicin resistance has been identified, with just two rifampicin-resistant isolates being identified during the 10 years 1996-2005.

3.3 Non-typhoidal *Salmonella*

The number of isolates tested and the annual resistance rates used to generate the charts presented in this section are tabulated in Appendix 4.

Figure 18a. Non-typhoidal *Salmonella*: ampicillin, cephalothin, chloramphenicol and ciprofloxacin resistance, 2000-2005

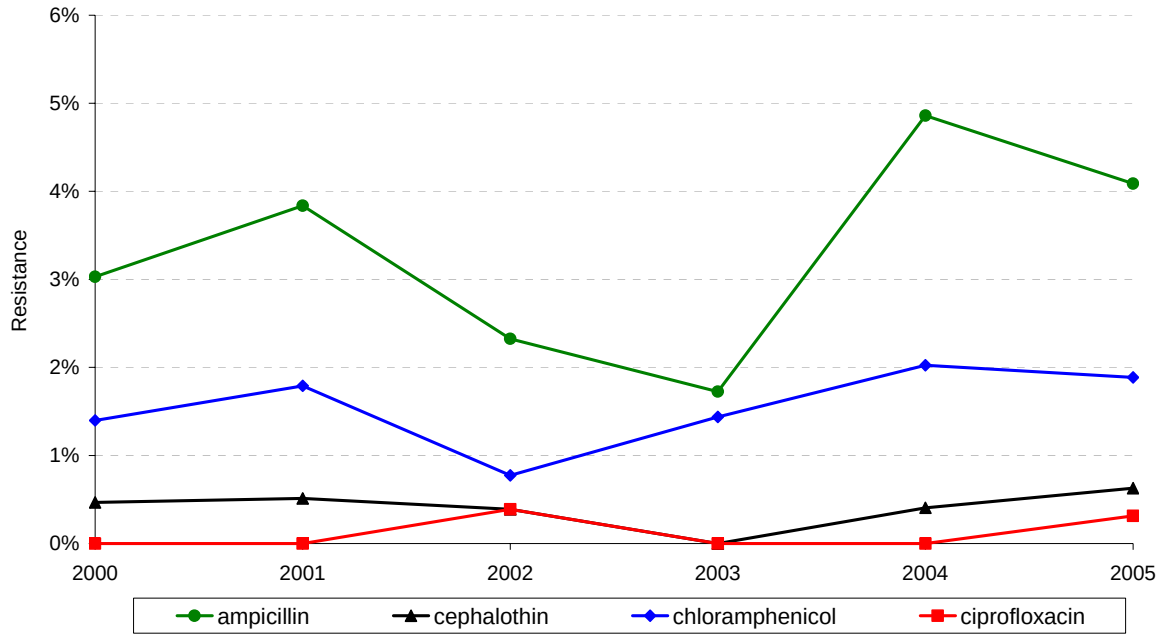
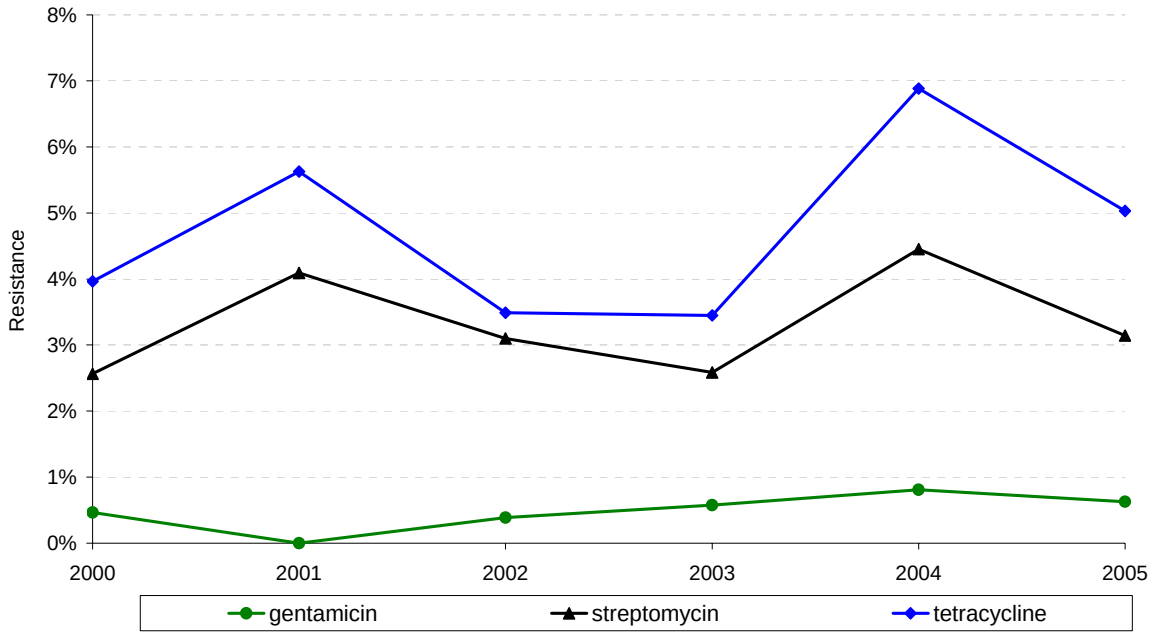


Figure 18b. Non-typhoidal *Salmonella*: gentamicin, streptomycin and tetracycline, 2000-2005



	Direction of the trend	Significance	P-value
ampicillin resistance	increase	not significant	0.4747
cephalothin resistance	decrease	not significant	0.9683
chloramphenicol resistance	increase	not significant	0.5758
ciprofloxacin resistance	increase	not significant	0.3524
gentamicin resistance	increase	not significant	0.3012
streptomycin resistance	increase	not significant	0.7168
tetracycline resistance	increase	not significant	0.4631

4 DISCUSSION

The trend analyses that are based on the antimicrobial resistance data collected from diagnostic laboratories have several limitations. The first of these limitations is that the analyses are often based on a relatively small proportion of the total available data. To avoid any year-to-year variations in resistance that could merely reflect differences between the contributing laboratories (eg, their geographical location or whether they process hospital or community patient specimens), for each particular resistance (organism/antibiotic combination) analysed, only data from laboratories that provided that particular resistance data in each of the five years analysed for trend was included. In addition, with the exception of pneumococcal penicillin non-susceptibility, only resistance data that did not include intermediate resistance was used. This approach limits the data available for inclusion in these time-trend analyses. Therefore while in these latest trend analyses, data from 20 laboratories was used, often the trend analysis for a particular resistance was based on data from far fewer laboratories (Appendix 1).

In addition to the limitation on the number of laboratories from which data is included, the trend analyses are potentially further limited by factors that may affect the validity of collating data from different laboratories, such as differences in protocols for which specimens are tested for antimicrobial susceptibility, differences in test methodologies, and differences in results interpretation.

Finally the trend analyses are also potentially limited by other factors that can limit the accuracy of any estimates of resistance rates, such as the inclusion of duplicate isolates from the same patient and not distinguishing between antibiotics tested as first-line and those tested as second-line against isolates demonstrating significant resistance.

Mindful of these limitations, there are still several noteworthy observations on the trends in antimicrobial resistance evident from the data collected from diagnostic laboratories for the five years 2001 to 2005:

- **Relatively low and stable levels of erythromycin and fluoroquinolone resistance in *Campylobacter***

  While the number of isolates tested was small and contributed by only one laboratory (LabPlus, Auckland), as most laboratories do not routinely test the susceptibility of *Campylobacter*, there has been no significant change in resistance to either erythromycin or fluoroquinolones and rates of resistance are low: erythromycin <2% and fluoroquinolones 3-4%.

- **Changes in resistance to β-lactams among urinary *E. coli***

  There was a trend of decreasing ampicillin and co-amoxiclav resistance, with these decreases significant among community urinary *E. coli*. Conversely, resistance to second and third-generation cephalosporins increased among hospital urinary *E. coli* (data not available for community urinary *E. coli*). These changes suggest that the prevalence of the broad-spectrum β-lactamases may be decreasing while extended-spectrum β-lactamases (ESBLs) are increasing, albeit to a lesser extent.

Data from other ESR surveillance certainly indicates that ESBLs are increasing among *E. coli* in New Zealand.[6,7]

- **Increases in fluoroquinolone and gentamicin resistance among *E. coli***

  Fluoroquinolone resistance increased among both hospital and community urinary *E. coli*, with rates in 2005 nearly three times those five years earlier. Similarly gentamicin resistance increased in hospital bacteraemic and urinary *E. coli* (data not available for community urinary *E. coli*).

  These increases in fluoroquinolone resistance and gentamicin resistance may be linked with the increases in third-generation cephalosporin resistance, as the majority of ESBL-producing *E. coli* are multiresistant, including fluoroquinolone and gentamicin resistant.[8]

- **Decrease in ampicillin resistance among *H. influenzae* from non-invasive infections**

  The decrease in ampicillin resistance among non-invasive *H. influenzae* contrasts with the trend of increasing resistance among invasive isolates. In 2005, ampicillin resistance was 16.2% among non-invasive isolates compared with 40% among invasive isolates tested at ESR, half of which was not β-lactamase-mediated. It is possible that non-β-lactamase-mediated ampicillin resistance is going undetected in many laboratories.

- **Increase in fluoroquinolone resistance among *N. gonorrhoeae***

  Fluoroquinolone resistance in gonococci reached 17.5% by 2005, almost three times higher than penicillin resistance (5.9%). However, there is considerable variation in resistance to both antibiotics in different parts of the country.[9]

- **Decreases in resistance among hospital *P. aeruginosa***

  All significant changes in resistance among hospital *P. aeruginosa* were decreases and included decreases in fluoroquinolone, gentamicin and imipenem/meropenem resistance.

- **Differences in resistance trends between hospital and community *S. aureus***

  There were significant increases in resistance to cotrimoxazole, erythromycin, fluoroquinolones, gentamicin and oxacillin among hospital, but not community, *S. aureus*. The increases in oxacillin, fluoroquinolone and erythromycin resistance is likely to be due to the increase in the prevalence of MRSA, particularly EMRSA-15, in hospitals since 2000. Conversely community MRSA, and particularly the WSPP MRSA, have decreased over the same time period.

- **Increase in resistance to several antibiotics among non-invasive isolates of *S. pneumoniae***

  There were significant increases in penicillin resistance and non-susceptibility, and

erythromycin, cotrimoxazole and tetracycline resistance among non-invasive pneumococci. The same increases were evident among invasive isolates tested at ESR during the same time period.

The referral of invasive isolates to ESR is either complete (in the case of *N. meningitidis*) or at least representative (*S. pneumoniae* and *H. influenzae*). Therefore, the trend analyses of antimicrobial resistance among these isolates should be an accurate representation of any changes in antimicrobial resistance among these pathogens in New Zealand. There were several notable changes in antimicrobial resistance during the 10 years 1996 to 2005, including:

- **Increases in resistance to penicillin, cefotaxime and erythromycin among invasive *S. pneumoniae***

  Overall, during the last 10 years, there were highly significant trends of increasing penicillin and third-generation cephalosporin resistance and non-susceptibility. However, during these years there have been three distinct phases in penicillin resistance, with a period of increasing resistance to a peak in 1998, followed by four years of declining resistance until 2003 when resistance increased again and reached the highest rate ever in 2004. Erythromycin resistance tripled over the 10 years to 12.2% in 2005.

- **Increase in ampicillin resistance among invasive *H. influenzae***

  Ampicillin resistance, but not β-lactamase production, increased among invasive *H. influenzae*. This was due to the increasing number of β-lactamase-negative, ampicillin-resistant (BLNAR) isolates that have been identified since 2003. In 2005, half of the 16 ampicillin-resistant isolates did not produce β-lactamase. Most of the BLNAR identified among invasive *H. influenzae* have had a relatively low level of ampicillin resistance (MICs 0.5-2.0 mg/L).

- **Increase in reduced penicillin susceptibility among invasive *N. meningitidis***

  The prevalence of reduced penicillin susceptibility (MICs 0.12-0.5 mg/L) among meningococci increased to reach 14.8% in 2005. These meningococci are still susceptible to normal penicillin treatment regimens for meningococcal meningitis.

The data available for analysis of antimicrobial resistance trends among non-typhoidal *Salmonella* is limited for two reasons. First, while ESR's surveillance of antimicrobial resistance among *Salmonella* began in 1972, between 1982 and 1997 only 5-yearly surveys were undertaken. Continuous surveillance resumed in 2000 and hence the period analysed for trends in this report was only 2000 to 2005. Second, the range of antimicrobials tested each year since 2000 is limited. Cotrimoxazole, sulphonamides and trimethoprim were not tested in 2000-01, and co-amoxiclav and nalidixic acid susceptibility testing did not commence until 2004.

Among the antibiotics tested each year since 2000 (ampicillin, cephalothin, chloramphenicol, ciprofloxacin, gentamicin, streptomycin and tetracycline) there were

no significant changes in resistance and resistance remains relatively low. Of particular note, only two ciprofloxacin-resistant *Salmonella* have been identified – one in 2002 and the other in 2005 – both infections were acquired overseas.

This is the fifth trend analysis that has been reported.[1-4] Currently, as mentioned above, the analyses based on data collected from diagnostic laboratories may not be wholly representative of resistance trends in New Zealand, as only a small proportion of the total available data is used. It is hoped that as more laboratories consistently contribute their annual data, more data will be available for the trend analyses. However, changes in district health board contracts for laboratory services may have a negative impact on the collection of this data in at least a couple of ways. First, if laboratories are working within tighter financial limitations, they may be less able or inclined to participate in ESR's surveillance systems. Second, if there is an increase in laboratories who are processing specimens from both hospital patients and community patients, there will be less data available for the resistance analyses that are split according to whether the data came from a 'hospital' or 'community' laboratory.

The need to exclude data from laboratories that categorise intermediate resistance with resistance also continues to limit the number of laboratories from whom data is available to estimate national rates of resistance and analyse trends. Therefore it is recommended that laboratories be encouraged, where possible, to record their antimicrobial susceptibility testing results according to the three standard susceptibility categories: susceptible, intermediate and resistant. This recommendation is in line with NCCLS's guideline for the analysis and presentation of cumulative antimicrobial susceptibility test data.[10] In addition, to maximise the amount of data available for surveillance purposes, laboratories should be encouraged to record in their databases the susceptibility test results for all antibiotics tested, rather than only those reported.

REFERENCES

1 Brett M, Garrett N. Trend analysis of antimicrobial resistance data collected in New Zealand between 1991 and 1999. Porirua: Institute of Environmental Science & Research Ltd; 2000.

2 Heffernan H, Garrett N. Antimicrobial resistance trends in New Zealand, 1991-2000. Porirua: Institute of Environmental Science & Research Ltd; 2001. Client Report No FW0165.

3 Heffernan H, Garrett N, Woodhouse R. Antimicrobial resistance trends in New Zealand, 2001. Porirua: Institute of Environmental Science & Research Ltd; 2002. Client Report No FW0270. Available at http://www.surv.esr.cri.nz/PDF_surveillance/Antimicrobial/AR_Trend_2001.pdf.

4 Heffernan H, Woodhouse R, Fernando D, Blackmore T. Antimicrobial resistance trends in New Zealand, 2003. Porirua: Institute of Environmental Science & Research Ltd; 2004. Client Report No FW04103. Available at http://www.surv.esr.cri.nz/PDF_surveillance/Antimicrobial/AR_Trend_2003.pdf.

5 SAS version 9.1. Cary (NC): SAS Institute.

6 Extended-spectrum β-lactamases (ESBLs) in Enterobacteriaceae confirmed in 2005. Porirua: Institute of Environmental Science & Research Ltd. Available at http://www.surv.esr.cri.nz/PDF_surveillance/Antimicrobial/ESBL_2005.pdf.

7 Heffernan H, Woodhouse R, Blackmore T. Prevalence of extended-spectrum β-lactamases among urinary *Escherichia coli* and *Klebsiella* in New Zealand in 2006. Porirua: Institute of Environmental Science & Research Ltd; 2006. Client Report No FW06107.

8 Heffernan H, Woodhouse R, Blackmore T. Methods used in New Zealand diagnostic laboratories to identify and report extended-spectrum β-lactamase-producing Enterobacteriaceae. Porirua: Institute of Environmental Science & Research Ltd; 2005. Client Report No. FW0598. Available at http://www.surv.esr.cri.nz/PDF_surveillance/Antimicrobial/ESBLMethods_2005.pdf.

9 Antimicrobial resistance among Neisseria gonorrhoeae; quarterly reports. Available at http://www.surv.esr.cri.nz/antimicrobial/neisseria_gonorrhoeae.php.

10 Analysis and presentation of cumulative antimicrobial susceptibility test data; approved guideline. Pennsylvania: NCCLS; 2002. NCCLS Document M39-A.

APPENDIX 1

Source of Data Used to Produce the Trend Analyses and Charts Included in Section 3.1 and the Data Presented in Appendix 2

Abbreviation used in this appendix	
Whangar Hosp	Whangarei Hospital
N Shore Hosp	North Shore Hospital
Ak City Hosp	LabPlus, Auckland City and Children's Hospital
Ak DML	Diagnostic Medlab, Auckland
Waikato Hosp	Waikato Hospital
Rotorua Hosp	Rotorua Hospital
Tauranga Medlab	Medlab Bay of Plenty, Tauranga
Gisborne Hosp	Gisborne Hospital
Whakata Hosp	Whakatane Hospital
Taranaki Medlab	Taranaki Medlab
Wangan Hosp	Wanganui Hospital
Wangan DiagLab	Wanganui Diagnostic Laboratory
Palm Nth Medlab	Medlab Central, Palmerston North
Wgtn Hosp	Wellington Hospital
Wgtn Medlab	Wellington Medlab
Nelson DiagLab	Nelson Diagnostic Laboratory
Blen Hosp	Wairau Hospital, Blenheim
Chch Hosp	Canterbury Health Laboratories, Christchurch Hospital
Chch SCL	Southern Community Laboratories, Christchurch
Dunedin SCL	Southern Community Laboratories, Dunedin

	Whangar Hosp	N Shore Hosp	Ak City Hosp	Ak DML	Waikato Hosp	Rotorua Hosp	Tauranga Medlab	Gisborne Hosp	Whakata Hosp	Taranaki Medlab	Wangan Hosp	Wangan DiagLab	Palm Nth Medlab	Wgtn Hosp	Wgtn Medlab	Nelson DiagLab	Blen Hosp	Chch Hosp	Chch SCL	Dunedin SCL
***Campylobacter* spp**																				
erythromycin																				
fluoroquinolone																				
***Enterococcus* spp**																				
Hospital																				
ampicillin																				
gentamicin (high-level)																				
nitrofurantoin																				
vancomycin																				
Community																				
ampicillin																				
nitrofurantoin																				
***E. coli* bacteraemia**																				
Hospital																				
amikacin																				
cefotaxime/ceftriaxone																				
cefuroxime/cefamandole																				
cephalothin																				
co-amoxiclav																				
fluoroquinolone																				
gentamicin																				
imipenem/meropenem																				
tobramycin																				

Indicates the laboratory's data was included.

	Whangar Hosp	N Shore Hosp	Ak City Hosp	Ak DML	Waikato Hosp	Rotorua Hosp	Tauranga Medlab	Gisborne Hosp	Whakata Hosp	Taranaki Medlab	Wangan Hosp	Wangan DiagLab	Palm Nth Medlab	Wgtn Hosp	Wgtn Medlab	Nelson DiagLab	Blen Hosp	Chch Hosp	Chch SCL	Dunedin SCL
***E. coli* urinary**																				
Hospital																				
ampicillin																				
cefotaxime/ceftriaxone																				
cefuroxime/cefamandole																				
cephalothin																				
co-amoxiclav																				
fluoroquinolone																				
gentamicin																				
nitrofurantoin																				
trimethoprim																				
Community																				
ampicillin																				
co-amoxiclav																				
fluoroquinolone																				
nitrofurantoin																				
trimethoprim																				
***Haemophilus influenzae* non-invasive**																				
ampicillin																				
co-amoxiclav																				
cotrimoxazole																				
tetracycline																				
Neisseria gonorrhoeae																				
B-lactamase positive																				
fluoroquinolone																				
penicillin																				

	Whangar Hosp	N Shore Hosp	Ak City Hosp	Ak DML	Waikato Hosp	Rotorua Hosp	Tauranga Medlab	Gisborne Hosp	Whakata Hosp	Taranaki Medlab	Wangan Hosp	Wangan DiagLab	Palm Nth Medlab	Wgtn Hosp	Wgtn Medlab	Nelson DiagLab	Blen Hosp	Chch Hosp	Chch SCL	Dunedin SCL
Pseudomonas aeruginosa																				
Hospital																				
amikacin																				
ceftazidime																				
fluoroquinolone																				
gentamicin																				
imipenem/meropenem																				
tobramycin																				
Staphylococcus aureus																				
Hospital																				
cotrimoxazole																				
erythromycin																				
fluoroquinolone																				
gentamicin																				
methicillin/oxacillin																				
mupirocin																				
tetracycline																				
Community																				
cotrimoxazole																				
erythromycin																				
fluoroquinolone																				
methicillin/oxacillin																				
mupirocin																				
tetracycline																				

	Whangar Hosp	N Shore Hosp	Ak City Hosp	Ak DML	Waikato Hosp	Rotorua Hosp	Tauranga Medlab	Gisborne Hosp	Whakata Hosp	Taranaki Medlab	Wangan Hosp	Wangan DiagLab	Palm Nth Medlab	Wgtn Hosp	Wgtn Medlab	Nelson DiagLab	Blen Hosp	Chch Hosp	Chch SCL	Dunedin SCL
Staphylococci (coagulase negative) from blood																				
cotrimoxazole																				
erythromycin																				
fluoroquinolone																				
gentamicin																				
methicillin/oxacillin																				
***Streptococcus pneumoniae* non-invasive**																				
cotrimoxazole																				
erythromycin																				
penicillin																				
penicillin non-susceptibility																				
tetracycline																				
Streptococcus pyogenes																				
erythromycin																				

APPENDIX 2

Data Used to Produce the Trend Analyses and Charts Included in Section 3.1 of the Results

	2001		2002		2003		2004		2005	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
***Campylobacter* spp**										
erythromycin	207	1.5	214	1.9	168	1.2	200	0	185	1.6
fluoroquinolone	206	3.4	214	3.7	168	3.6	201	3.0	185	3.2
Enterococcus										
Hospita1										
ampicillin	2656	5.5	2883	7.9	3663	4.5	2993	4.9	2871	3.9
gentamicin (high-level)	400	27.3	352	36.4	423	32.2	334	26.4	308	38.0
nitrofurantoin	1945	0.6	2290	0.4	2939	0.4	2250	1.2	2262	0.2
vancomycin	1653	0.6	2040	0.2	2779	0.04	2193	0.1	2160	0.1
Community										
ampicillin	1737	0.5	2179	0.9	2454	0.9	2484	1.6	2423	0.7
nitrofurantoin	1567	1.0	1473	0.5	2075	0.2	2024	0.6	2055	0.6
***E. coli* bacteraemia**										
Hospital										
amikacin	332	0	355	0.3	291	0	346	0	267	0
cefotaxime/ceftriaxone	389	0.5	486	0.6	424	0	433	0.5	428	1.2
cefuroxime/cefamandole	528	1.7	626	3.5	623	1.1	607	3.1	505	3.6
cephalothin	340	20.0	355	16.3	290	16.2	350	16.9	273	18.7
co-amoxiclav	532	17.1	563	11.2	554	13.5	610	17.0	579	13.6
fluoroquinolone	634	3.3	708	2.0	677	4.3	681	4.6	619	4.2
gentamicin	694	1.3	770	1.6	754	1.9	759	2.9	722	2.8
imipenem/meropenem	333	0	354	0	291	0	347	0	276	0
tobramycin	173	2.9	207	1.4	196	1.5	221	2.3	182	0.5
***E. coli* urinary**										
Hospital										
ampicillin	8099	51.1	8292	51.0	9289	50.4	8971	50.9	7987	49.4
cefotaxime/ceftriaxone	2015	0.2	1964	0.5	1983	0.4	2057	0.7	1911	1.1
cefuroxime/cefamandole	2262	1.0	2213	1.3	2266	1.2	2248	1.7	2128	2.4
cephalothin	3270	15.7	3214	14.5	3444	16.6	3395	18.7	2478	13.5
co-amoxiclav	6396	12.6	6321	6.2	6719	12.3	6458	11.8	5859	9.3
fluoroquinolone	8058	1.4	8274	2.0	9256	3.3	8912	3.4	7968	4.0
gentamicin	6989	1.1	7200	1.6	8299	2.4	7783	2.5	6862	2.6
nitrofurantoin	7665	1.2	8736	1.0	9695	1.1	9362	1.0	8424	0.8
trimethoprim	7370	21.3	7472	22.0	8236	22.1	8006	22.3	7853	21.8
Community										
ampicillin	8122	53.4	12053	50.4	12698	51.3	12403	49.6	12404	48.2
co-amoxiclav	15822	11.4	20126	9.8	19806	6.3	19301	5.1	18103	5.3
fluoroquinolone	15822	1.1	19381	1.7	19802	3.1	19426	3.5	18077	3.9
nitrofurantoin	15824	1.7	19443	1.6	19635	1.4	19082	1.5	18038	1.5
trimethoprim	15831	20.7	19405	21.1	19808	21.0	19394	20.0	18208	20.5
***Haemophilus influenzae* non-invasive**										
ampicillin	4731	19.1	4093	20.6	4415	22.4	3895	19.0	3696	16.2
co-amoxiclav	3002	0.6	2924	0.3	3337	0.5	2791	1.0	2483	0.5
cotrimoxazole	2689	16.1	2479	17.5	2495	15.6	2486	15.4	2310	18.4
tetracycline	1885	3.7	1562	1.1	1760	1.0	1798	0.9	1683	0.5

	2001		2002		2003		2004		2005	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
Neisseria gonorrhoeae										
β-lactamase positive	80	2.5	180	6.7	170	0.6	232	2.6	273	2.6
fluoroquinolone	429	10.3	562	6.0	640	8.4	1210	17.0	761	17.5
penicillin	834	6.4	891	7.9	1063	4.9	1613	5.3	1108	5.9
Pseudomonas aeruginosa										
Hospital										
amikacin	989	10.6	1912	5.7	1882	4.1	1843	4.9	1545	4.0
ceftazidime	3155	3.9	2447	5.9	3589	5.0	3034	6.9	3006	4.4
fluoroquinolone	3110	10.9	3365	8.1	3733	8.8	3330	10.2	3368	6.5
gentamicin	3459	11.4	3467	9.7	4026	8.5	3354	8.6	3395	5.1
imipenem/meropenem	1947	6.2	1654	7.2	1948	6.2	1911	6.3	1633	2.9
tobramycin	1728	3.4	1445	3.8	1777	5.2	1128	3.2	1390	4.5
Staphylococcus aureus										
Hospital										
cotrimoxazole	8378	1.5	8437	2.7	8726	3.6	9054	3.4	9218	2.7
erythromycin	15381	11.0	15586	11.1	17607	12.3	16249	13.2	17134	12.7
fluoroquinolone	4762	7.6	4296	9.2	5041	10.1	5367	10.6	5300	8.6
gentamicin	11708	1.8	11503	1.7	13828	2.1	12441	2.7	12831	2.8
methicillin/oxacillin	16257	9.3	15881	10.3	18407	11.3	16707	11.9	17434	10.9
mupirocin	717	3.9	663	4.7	1076	4.7	513	5.1	686	3.4
tetracycline	6436	3.4	7113	2.6	7459	4.2	8342	4.1	8912	3.3
Community										
cotrimoxazole	5321	0.4	9110	0.6	8694	0.4	9674	0.3	8830	0.4
erythromycin	10646	11.4	14901	12.3	14073	11,0	15418	11.9	13397	11.9
fluoroquinolone	54	9.3	36	8.3	51	11.8	85	15.3	104	7.7
methicillin/oxacillin	11169	3.1	15488	2.9	14646	2.7	15830	2.8	13799	3.3
mupirocin	87	20.7	191	17.8	210	13.8	485	4.7	354	12.7
tetracycline	5227	3.0	8940	2.9	8296	1.9	9300	1.9	8520	1.7
Staphylococci (coagulase negative) from blood										
cotrimoxazole	867	36.8	644	29.4	882	27.7	936	29.8	1367	29.0
erythromycin	1215	45.8	816	41.1	1105	42.2	1163	43.2	1509	42.0
fluoroquinolone	488	35.0	285	33.0	221	32.1	198	36.9	299	31.4
gentamicin	1015	45.3	648	38.1	910	35.9	962	34.5	1303	32.2
methicillin/oxacillin	1410	58.2	981	55.8	1260	57.1	1349	57.4	1668	54.3
***Streptococcus pneumoniae* non-invasive**										
cotrimoxazole	1021	42.2	1141	43.1	1161	46.5	1094	49.8	1079	50.5
erythromycin	1393	16.1	1443	19.5	1494	24.2	1406	21.9	1386	21.4
penicillin	1943	12.0	1810	11.6	1661	12.6	1609	20.6	1458	17.2
penicillin non-susceptibility	4925	26.2	4498	26.8	4046	29.1	3734	30.6	3432	27.9
tetracycline	1396	13.9	1455	14.3	1447	20.0	1320	22.0	1219	18.7
Streptococcus pyogenes										
erythromycin	2139	2.6	3255	3.7	3259	1.4	3316	1.1	2960	1.5

APPENDIX 3

Antimicrobial Susceptibility Data for Invasive Isolates of *Streptococcus pneumoniae, Haemophilus influenzae* and *Neisseria meningitidis*, 1996-2005

	1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
Streptococcus pneumoniae																				
penicillin MIC ≥2[1]	341	1.8	333	3.0	376	7.2	472	6.8	466	5.2	537	3.9	490	3.5	523	7.5	545	10.1	492	7.1
penicillin MIC ≥0.12[1]	341	6.2	333	9.9	376	15.2	472	17.8	466	16.5	537	12.7	490	16.9	523	16.4	545	18.2	492	17.1
cefotaxime MIC ≥4[2]	341	0	333	0.3	376	0	472	0.8	466	0.2	537	0.9	490	1.6	523	1.7	545	0.7	492	1.4
cefotaxime MIC ≥2[2]	341	0	333	0.9	376	0.5	472	1.3	466	0.6	537	1.5	490	2.0	523	3.6	545	3.1	492	3.0
cefotaxime MIC ≥1[2]	341	3.5	333	6.9	376	6.6	472	7.8	466	8.6	537	4.8	490	5.1	523	12.0	545	12.8	492	9.6
cotrimoxazole	341	3.2	62	4.8	376	31.9	471	40.6	465	32.7	537	31.3	490	36.1	523	33.8	545	38.7	492	32.1
erythromycin	341	4.1	62	11.3	376	4.8	472	5.5	465	7.5	537	5.4	490	9.0	523	9.4	545	8.4	492	12.2
tetracycline	341	2.9	32	6.3	376	4.0	471	4.0	466	6.9	537	5.0	490	6.9	523	8.6	545	7.9	492	8.5
1 MIC ≥2 mg/L = penicillin resistant, MIC ≥0.12 mg/L = penicillin non-susceptible 2 MIC ≥4 mg/L = cefotaxime resistant (non-meningitis interpretation), MIC ≥2 mg/L = cefotaxime resistant (meningitis interpretation) and cefotaxime non-susceptible (non-meningitis interpretation), MIC ≥1 mg/L = cefotaxime non-susceptible (meningitis interpretation)																				
Haemophilus influenzae																				
ampicillin	45	20.0	38	10.5	41	14.6	43	7.0	51	15.7	51	15.7	23	34.8	70	31.4	45	24.4	40	40.0
B-lactamase positive	45	15.6	38	10.5	41	14.6	43	7.0	51	13.7	51	15.7	23	34.8	70	25.7	45	17.8	40	20.0
cefotaxime	45	0	38	0	41	0	43	0	51	0	51	0	23	0	70	0	45	0	40	0
rifampicin	45	0	38	0	41	0	43	2.3	51	0	51	0	23	0	70	0	45	0	40	2.5
Neisseria meningitidis																				
penicillin MIC ≥0.12	264	3.8	206	1.5	95	7.4	130	18.5	255	7.1	318	7.5	223	8.1	243	7.8	180	15.6	128	14.8
rifampicin	264	0	206	0.5	95	0	130	0	255	0	318	0	223	0	243	0.4	180	0	128	0
ciprofloxacin	264	0	206	0	95	0	130	0	255	0	318	0	223	0	243	0	180	0	128	0
ceftriaxone	264	0	206	0	95	0	130	0	255	0	318	0	223	0	243	0	180	0	128	0

APPENDIX 4

Antimicrobial Susceptibility Data for *Salmonella*, 2000-2005

	2000		2001		2002		2003		2004		2005	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
Non-typhoidal *Salmonella*												
ampicillin	429	3.0	391	3.8	258	2.3	348	1.7	247	4.9	318	4.1
cephalothin	429	0.5	391	0.5	258	0.4	348	0	247	0.4	318	0.6
chloramphenicol	429	1.4	391	1.8	258	0.8	348	1.4	247	2.0	318	1.9
ciprofloxacin	429	0	391	0	258	0.4	348	0	247	0	318	0.3
co-amoxiclav									247	0.4	318	0.3
cotrimoxazole					258	0.8	348	1.4	247	3.6	318	1.9
gentamicin	429	0.5	391	0	258	0.4	348	0.6	247	0.8	318	0.6
nalidixic acid									247	6.1	318	5.7
streptomycin	429	2.6	391	4.1	258	3.1	348	2.6	247	4.5	318	3.1
sulphonamides					258	1.2	348	3.2	247	6.5	318	4.1
tetracycline	429	4.0	391	5.6	258	3.5	348	3.4	247	6.9	318	5.0
trimethoprim					258	0.8	348	1.4	247	3.6	318	1.9
***Salmonella* Typhi**												
ampicillin			26	3.9	23	0	18	5.6	34	2.9	28	14.3
cephalothin			26	0	23	0	18	5.6	34	0	28	0
chloramphenicol			26	3.9	23	0	18	11.1	34	2.9	28	10.7
ciprofloxacin			26	0	23	0	18	0	34	0	28	0
co-amoxiclav									34	0	28	0
cotrimoxazole			26		23	0	18	5.6	34	2.9	28	14.3
gentamicin			26	0	23	0	18	0	34	0	28	0
nalidixic acid									34	23.5	28	42.9
streptomycin			26	3.9	23	4.4	18	33.3	34	41.2	28	32.1
sulphonamides			26		23	0	18	5.6	34	2.9	28	14.3
tetracycline			26	3.9	23	0	18	5.6	34	2.9	28	14.3
trimethoprim			26		23	0	18	5.6	34	2.9	28	14.3
***Salmonella* Paratyphi A**												
ampicillin					3	0	10	0	9	0	8	0
cephalothin					3	0	10	0	9	0	8	0
chloramphenicol					3	0	10	0	9	0	8	0
ciprofloxacin					3	0	10	0	9	0	8	0
co-amoxiclav									9	0	8	0
cotrimoxazole					3	0	10	0	9	0	8	0
gentamicin					3	0	10	0	9	0	8	0
nalidixic acid									9	77.8	8	50
streptomycin					3	0	10	0	9	11.1	8	0
sulphonamides					3	0	10	0	9	0	8	0
tetracycline					3	0	10	0	9	0	8	0
trimethoprim					3	0	10	0	9	0	8	0

	2000		2001		2002		2003		2004		2005	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
***Salmonella* Paratyphi B**												
ampicillin					6	33.3	2	0	2	0	3	33.3
cephalothin					6	0	2	0	2	0	3	0
chloramphenicol					6	33.3	2	0	2	0	3	33.3
ciprofloxacin					6	0	2	0	2	0	3	0
co-amoxiclav					6				2	0	3	0
cotrimoxazole					6	0	2	0	2	0	3	0
gentamicin					6	0	2	0	2	0	3	0
nalidixic acid					6				2	0	3	33.3
streptomycin					6	33.3	2	0	2	0	3	33.3
sulphonamides					6	16.7	2	0	2	0	3	33.3
tetracycline					6	33.3	2	0	2	0	3	33.3
trimethoprim					6	0	2	0	2	0	3	0

APPENDIX 5

Collated Antimicrobial Susceptibility Data for all Contributing Laboratories, 1996-2005

	1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
***Acinetobacter* spp**																				
amikacin	99	3.0	76	3.9	101	4.0	163	6.7	144	2.8	133	9.0	100	6.0	92	3.3	190	8.9	107	5.6
ceftazidime	111	18.0	141	24.1	135	24.4	339	12.4	239	14.6	211	22.3	147	16.3	204	11.3	291	15.8	196	14.3
cotrimoxazole	297	37.7	337	31.2	511	19.6	610	21.0	507	14.0	600	18.0	335	12.2	389	10.5	389	15.9	300	12.7
fluoroquinolone	280	13.6	358	16.2	368	17.1	598	18.9	465	8.6	651	17.7	400	6.3	531	5.1	481	9.8	361	6.6
gentamicin	376	29.0	449	20.7	654	14.7	600	18.7	524	12.2	671	13.7	465	6.9	474	7.0	467	9.2	399	7.0
imipenem/meropenem							469	2.1	205	4.4	346	2.0	118	2.5	215	0.9	279	5.4	158	3.2
piperacillin-tazobactam																	98	4.1	69	5.8
ticarcillin-clavulanic acid																	156	16.0	147	10.2
tobramycin	56	10.7	109	6.4	65	21.5	250	5.2	175	10.9	155	9.7	123	13.0	121	6.6	192	12.0	106	4.7
***Campylobacter* spp**																				
erythromycin							121	3.3	175	2.9	342	1.2	303	2.0	367	1.1	392	0	351	1.1
fluoroquinolone							1	0	48	2.1	279	2.9	318	2.8	367	1.9	384	2.3	351	2.0
Citrobacter freundii																				
amikacin	32	0	44	0	76	0	82	1.2	126	0	96	0	60	21.7	80	0	200	0	75	0
cefotaxime/ceftriaxone	151	31.1	240	17.1	199	16.1	158	13.3	138	14.5	152	23.0	100	33.0	140	19.3	275	11.3	134	24.6
cotrimoxazole	177	5.6	267	4.1	345	11.3	221	8.1	184	6.0	348	10.9	256	9.0	202	6.4	310	3.5	232	10.8
fluoroquinolone	223	1.3	367	0.8	317	0.3	314	2.9	264	1.5	701	3.6	410	4.4	361	1.7	483	1.9	308	1.9
gentamicin	283	1.1	419	2.1	403	1.5	226	3.5	234	3.0	272	2.6	218	3.2	299	3.7	371	2.2	296	4.4
imipenem/meropenem							137	1.5	112	1.8	146	0	75	0	99	0	236	0	101	1.0
tobramycin	32	0	57	1.8	61	0	55	0	79	6.3	76	0	69	2.9	56	0	103	1.9	86	3.5

	1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
***Enterobacter* spp**																				
amikacin	320	0.6	360	1.4	475	0	532	0.2	591	0.2	733	0.1	546	0.7	564	0.4	750	0.5	594	1.0
cefotaxime/ceftriaxone	511	25.0	805	14.8	943	20.6	895	18.4	818	12.6	1039	20.9	843	21.7	1071	18.8	1246	20.3	991	17.8
cotrimoxazole	683	4.2	933	3.5	1252	6.8	1320	5.7	1144	6.4	1540	7.1	1428	8.5	1588	9.1	1513	9.1	1415	10.2
fluoroquinolone	631	2.4	917	2.6	1310	2.5	1311	3.2	1274	3.4	1641	4.6	1461	4.5	1818	4.7	1787	5.1	1646	3.8
gentamicin	868	2.2	1279	2.5	1503	3.5	1854	3.3	1293	3.9	1535	4.3	1337	6.4	1518	4.9	1583	7.4	1477	5.1
imipenem/meropenem							815	0.6	547	0.4	1027	0.5	565	0.5	831	0	1049	0.2	612	0.2
tobramycin	161	1.9	173	1.2	193	2.6	243	2.9	271	3.7	337	4.7	412	6.1	359	5.3	488	5.9	472	4.2
***Enterococcus* spp**																				
ampicillin	1713	1.5	6716	1.1	6147	1.4	5848	4.3	6487	2.1	8418	2.8	7661	4.0	8391	3.2	7899	3.2	10202	2.1
gentamicin (high-level)	7	14.3	67	25.4	376	2.4	232	26.3	313	30.4	739	17.6	634	21.9	1000	29.2	1001	27.2	858	36.4
nitrofurantoin	758	0.8	4186	1.2	2778	2.4	4391	5.3	5298	1.2	7028	1.1	6236	0.5	6887	0.5	6561	0.7	5974	0.4
tetracycline	210	50.0	505	58.4	1023	48.6	816	55.3	864	59.3	1478	62.6	1342	65.0	1333	67.5	978	67.3	715	74.5
vancomycin	298	0.3	1213	0.3	2116	0.4	1423	0.7	1807	0.3	2718	0.7	2980	0.3	3671	0.03	2931	0.1	3346	0.1
***E. coli* bacteraemia**																				
amikacin											352	0	371	0.3	340	0	512	0.2	328	0
ampicillin											1014	55.6	912	52.3	990	57.0	1101	53.0	872	51.5
cefepime																	103	0	119	4.2
cefotaxime/ceftriaxone											818	0.6	706	0.4	841	0.4	930	1.3	706	0.8
cefuroxime/cefamandole											823	2.8	713	3.4	941	1.5	860	2.8	528	3.4
cephalothin											554	28.9	451	19.5	489	11.7	675	23.3	355	18.9
co-amoxiclav											858	20.9	708	11.0	828	11.1	962	15.6	760	13.8
fluoroquinolone											969	2.7	869	2.0	1003	4.0	1012	5.0	844	4.4
gentamicin											1015	1.1	895	1.8	1034	1.9	1096	3.2	876	3.1
imipenem/meropenem											489	0	535	0	522	0	720	0	415	0
tobramycin											229	2.2	292	1.7	281	1.1	389	2.3	250	0.8

	1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
***E. coli* urinary**																				
amikacin	2073	0	2163	0.05	3127	0.03	3623	0.3	3647	0	4384	0.02	3218	0	4079	0.1	5392	0	3500	0
ampicillin	12631	58.9	59563	58.3	47657	55.5	46661	54.5	69909	55.2	77932	55.4	46958	51.3	38706	51.8	43628	51.3	34675	48.8
cefotaxime/ceftriaxone	3392	2.2	3281	0.2	5233	0.2	6069	0.3	5726	0.1	6228	0.6	4609	1.0	5905	0.9	9420	0.9	4218	0.8
cefuroxime/cefamandole	3555	2.7	3406	2.6	5791	3.2	5103	1.7	4624	1.0	4761	2.2	4642	8.3	6483	1.8	7320	2.7	3443	1.7
cephalothin	4428	39.8	3517	33.7	4486	35.6	7172	26.9	9369	18.1	10945	19.8	8153	13.6	7834	16.4	8552	20.9	5149	11.9
co-amoxiclav	10605	18.1	58178	11.4	48102	12.6	45219	10.6	67758	8.9	76164	10.0	51028	9.9	44848	9.4	46144	8.5	36758	7.3
cotrimoxazole	2392	20.4	4304	22.2	10342	19.9	13740	18.9	4534	23.1	6670	21.3	18263	20.8	7230	21.7	9096	23.0	6830	20.1
fluoroquinolone	8429	1.5	55851	0.4	47714	0.6	30502	0.9	65995	1.2	83600	1.6	51787	1.9	45217	3.1	50708	3.4	39878	3.7
gentamicin	7552	0.4	10119	0.4	8306	0.7	15770	0.9	15076	1.0	15726	1.0	8498	2.0	12149	2.3	13797	3.6	9304	2.8
nitrofurantoin	10173	3.2	58101	1.5	42746	1.8	38685	1.5	68650	1.5	83481	1.5	54018	1.5	46970	1.5	50610	1.3	42158	1.3
tobramycin	2659	15.9	757	1.2	1400	0.1	2490	0.8	1757	0.7	2109	1.0	2298	1.3	2975	0.7	5024	2.6	1613	0.9
trimethoprim	10677	21.1	57614	22.3	46035	22.5	23228	22.4	69465	22.5	84517	22.5	53855	21.7	46823	22.2	50242	21.9	41683	20.4
***Haemophilus influenzae* non-invasive**																				
ampicillin	2821	14.5	6859	15.8	5433	16.1	7798	23.3	10016	23.3	11624	21.0	6836	21.4	6407	23.4	5522	19.3	7600	17.3
B-lactamase positive	2366	14.2	2973	13.4	3099	15.5	2108	21.7	3111	17.7	4422	18.6	3665	22.3	7802	26.8	7075	20.5	6031	17.9
co-amoxiclav	1460	2.3	5060	0.4	4278	0.5	6644	0.5	4518	0.4	6179	0.6	5483	0.9	5760	0.8	4544	1.2	3786	1.0
cotrimoxazole	955	9.6	4613	13.3	3877	10.7	6608	17.1	8463	17.4	9098	17.0	4882	17.9	7868	19.2	4418	16.6	3653	17.8
tetracycline	1252	0.6	4958	1.7	2303	1.9	6381	1.0	4721	0.9	6196	1.5	4716	1.1	4876	0.7	4258	1.0	3649	0.7

	1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
***Klebsiella* bacteraemia**																				
amikacin																	156	0	93	0
cefepime																	37	2.7	20	0
cefotaxime/ceftriaxone																	246	2.8	185	1.6
cefuroxime/cefamandole																	206	3.9	148	6.1
cephalothin																	198	10.6	112	8.9
co-amoxiclav																	242	4.1	175	2.9
fluoroquinolone																	272	1.1	187	1.6
gentamicin																	277	1.4	199	2.0
imipenem/meropenem																	215	0	111	0
tobramycin																	109	0	37	0
Moraxella (Branhamella) catarrhalis																				
ampicillin	605	91.6	1391	89.6	1080	86.6	1205	92.2	1203	90.5	1415	93.6	1458	91.3	1209	91.6	1533	92.8	1051	91.9
B-lactamase positive	301	88.4	705	91.2	773	86.2	667	78.4	1130	77.3	1331	94.9	995	91.0	1346	90.0	824	91.5	933	91.4
erythromycin	413	0.7	1382	1.9	608	1.3	1479	2.6	1058	1.7	1011	2.4	966	1.2	439	3.2	388	1.5	309	1.6
tetracycline	442	0.5	1336	1.3	646	1.5	1413	0.6	1141	1.7	1217	2.4	1490	0.9	1106	0.7	1152	0.3	857	0.6
Morganella morganii																				
amikacin	88	4.5	109	0	152	0	123	0.8	145	2.1	152	1.3	132	0.8	153	0	206	0.5	145	1.4
cefotaxime/ceftriaxone	158	8.2	209	4.3	306	7.2	222	7.2	197	1.0	260	5.0	192	2.6	297	2.7	388	4.4	282	4.6
cotrimoxazole	190	8.4	190	7.9	411	11.4	367	9.0	369	12.2	403	12.9	396	15.2	366	15.3	421	15.4	399	12.8
fluoroquinolone	187	0	244	0.8	445	4.7	330	3.9	376	6.4	539	9.1	439	8.7	539	6.1	577	9.0	460	6.5
gentamicin	262	1.5	344	3.8	487	8.8	386	7.8	354	11.0	449	11.8	394	13.5	514	9.5	533	11.6	460	13.7
imipenem/meropenem							213	4.2	159	1.9	242	3.3	243	0	220	0	316	1.3	138	0
tobramycin	53	9.4	59	0	68	2.9	55	0	78	3.8	96	0	81	44.4	93	2.2	174	1.1	126	1.6

	1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
Neisseria gonorrhoeae																				
B-lactamase positive									830	3.0	328	4.0	694	3.7	984	3.2	1399	3.1	1299	3.0
fluoroquinolone									851	2.0	906	9.7	749	6.0	994	8.1	1685	16.0	1516	16.4
penicillin									935	7.0	990	6.4	1098	7.3	1426	5.1	1913	6.6	1361	5.2
tetracycline									900	4.7	509	19.4	680	17.1	658	16.6	837	16.2	585	9.1
***Proteus mirabilis* (indole negative)**																				
amikacin	493	3.0	477	0	535	1.5	626	0.8	697	1.0	565	0.2	547	0.2	570	0	856	0.4	572	0
ampicillin	1524	11.2	4364	14.9	4715	16.8	4240	13.6	5180	13.7	5815	13.6	4640	11.2	3969	12.4	4051	11.9	3418	13.8
cefotaxime/ceftriaxone	695	0.7	1069	0.4	1100	1.0	1024	0.6	1018	0.7	1147	0.3	973	0.1	1042	0.3	1308	0	875	0.3
cefuroxime/cefamandole	799	2.1	832	4.0	844	3.4	903	3.1	902	3.7	827	1.9	684	1.9	1118	2.5	1065	2.7	839	2.1
cephalothin	599	6.8	526	5.7	490	9.0	1077	7.8	1171	6.0	1387	5.1	1125	4.8	1126	6.4	1332	8.2	1152	5.6
co-amoxiclav	1221	3.0	4199	3.0	4273	3.6	4005	2.9	4920	2.7	5578	2.8	4615	2.2	4060	2.6	3786	2.7	3093	2.9
cotrimoxazole	816	9.3	1045	6.2	2550	5.1	1623	5.4	1711	12.6	2379	9.8	2501	8.7	1543	8.4	1713	5.4	1481	7.0
fluoroquinolone	1080	1.1	1552	0.5	3026	1.0	3397	1.4	4578	1.0	4822	0.9	4232	1.2	4239	1.1	3578	0.8	3094	1.0
gentamicin	1244	2.9	1903	0.8	2078	1.2	1973	0.8	2072	0.9	2100	1.3	1661	1.1	1968	1.4	2055	1.0	1681	1.1
imipenem/meropenem							943	1.7	785	3.2	869	0.2	798	0	803	0	1066	0.6	502	0.0
tobramycin	332	7.2	300	1.0	310	4.2	361	1.9	456	2.9	336	1.5	417	1.2	292	0	706	0.6	530	0.4
Pseudomonas aeruginosa																				
amikacin	1016	8.3	622	14.3	1623	7.3	2563	6.9	1678	6.4	953	6.5	1943	6.0	2156	5.4	2427	5.3	1993	5.2
ceftazidime	1409	7.2	3406	5.3	3671	4.2	4054	5.9	4384	3.8	5506	3.4	3358	5.0	6260	3.6	5319	5.1	4452	4.4
fluoroquinolone	2205	13.0	4429	10.3	5647	11.3	6566	8.3	6718	10.9	8717	8.9	7434	8.2	8902	7.5	7686	9.8	7173	7.6
gentamicin	2561	14.3	5825	7.6	7499	9.4	7309	11.0	8280	11.6	9337	11.9	7944	7.7	8881	6.4	7650	7.0	6617	4.8
imipenem/meropenem							3456	8.4	1737	5.2	2519	7.3	2046	6.2	3975	4.9	3506	5.2	2475	4.0
piperacillin-tazobactam																	2056	3.2	2872	3.9
ticarcillin-clavulanic acid																	1293	9.7	1474	10.8
tobramycin	1553	5.1	3375	2.5	3613	3.2	4127	2.8	3290	3.6	4063	3.3	2928	3.3	3100	3.7	2254	2.4	2262	3.6

	1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
Serratia spp																				
amikacin	89	1.1	95	0	152	0.7	162	0	303	4.3	367	0.8	156	0	282	0.4	390	0.8	331	0.9
cefotaxime/ceftriaxone	161	9.3	243	8.2	342	4.7	380	15.8	574	37.1	723	14.8	307	12.1	525	10.9	815	17.7	585	13.0
cotrimoxazole	259	9.3	317	13.2	425	10.8	564	8.7	796	21.1	1230	10.2	795	9.8	833	8.2	1036	5.3	886	7.4
fluoroquinolone	229	5.2	453	25.8	503	12.5	540	22.0	789	23.2	1298	14.9	855	17.0	968	13.4	1188	16.3	1054	12.9
gentamicin	312	5.4	516	2.7	572	2.3	626	1.0	915	2.7	1205	3.2	760	1.4	1115	0.4	1105	2.0	994	0.6
imipenem/meropenem							351	2.0	388	0.3	625	0.2	302	0	390	0.3	607	0.8	411	0.2
tobramycin	70	8.6	48	0	42	2.4	57	10.5	255	9.8	248	2.4	227	1.3	138	1.4	411	2.4	341	3.5
Staphylococcus aureus																				
clindamycin	1103	6.9	813	1.2	3429	2.6	4066	3.0	2843	4.1	6006	2.4	5770	3.0	12883	2.2	13106	2.8	19736	4.1
cotrimoxazole	8973	1.0	36126	0.5	29404	0.4	38229	0.8	29944	1.5	55969	0.8	63253	1.3	42028	2.2	43180	2.7	41632	1.2
erythromycin	13100	8.2	48035	9.9	46179	10.3	52424	11.9	67962	11.8	75491	12.2	77941	11.9	60633	12.2	52315	12.0	51272	11.9
fluoroquinolone	4684	2.1	19392	1.6	6805	4.6	16254	4.3	10362	5.2	13625	9.7	11189	14.7	14771	9.3	15001	8.3	17344	4.9
fusidic acid																	15416	22.3	10193	15.7
gentamicin	8174	2.0	7653	1.1	14210	1.6	19796	2.5	16294	2.6	22178	1.7	19031	1.6	16828	2.3	17170	2.7	16271	2.3
methicillin/oxacillin	14436	3.8	50395	4.3	47833	4.7	51470	5.8	74415	6.9	82600	6.8	94433	7.7	62782	7.5	79477	7.8	77104	6.9
mupirocin	785	2.5	19631	17.1	11645	18.5	14906	19.3	32183	21.5	28033	19.7	31339	18.8	14032	17.5	10627	15.9	23764	16.6
penicillin	14328	87.4	49144	90.5	41939	90.7	53223	86.0	66818	89.4	75771	88.1	77291	87.3	61221	87.2	83901	87.1	73785	86.6
tetracycline	5080	3.2	34757	3.0	26498	2.7	42677	2.9	22555	2.5	56548	2.8	54271	2.9	32313	2.6	36722	2.6	28984	2.1

	1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
Staphylococci (coagulase negative) from blood																				
clindamycin	64	28.1	17	5.9	221	15.4	302	15.6	302	24.8	905	22.5	628	15.4	488	22.7	1350	25.6	713	27.8
cotrimoxazole	689	12.5	505	22.2	735	21.8	505	24.2	850	22.7	1159	33.1	990	26.3	1213	26.0	2234	28.1	1711	27.7
erythromycin	1139	36.2	918	39.3	1555	39.4	1356	41.0	1718	41.2	2056	42.1	1446	36.8	1650	40.9	2469	41.3	2076	41.3
fluoroquinolone	192	8.9	282	8.2	873	15.0	650	10.8	631	17.7	1172	22.9	763	18.5	621	18.8	1319	19.2	838	19.2
gentamicin	953	23.3	691	20.7	1180	28.3	1166	30.3	1212	28.5	1588	38.0	1129	31.2	1391	29.8	2176	31.5	1928	27.0
methicillin/oxacillin	1191	44.7	784	36.4	1663	43.1	1436	47.2	1720	49.0	2067	54.5	1710	51.0	1668	54.0	2648	56.5	2099	52.4
penicillin	1223	79.2	774	78.3	1732	82.4	1555	81.4	1362	83.5	2019	84.7	1676	82.2	1630	85.7	2413	84.1	2071	85.6
tetracycline	56	14.3	126	11.9	708	5.5	384	19.0	399	14.0	1159	9.6	847	15.5	527	12.1	2034	9.5	1600	8.8
vancomycin	977	0	545	0.4	589	0.2	458	0	1232	0	1378	0	1339	0.1	1389	0.1	2197	0	1967	0.1
***Streptococcus pneumoniae* non-invasive**																				
cefotaxime/ceftriaxone					331	6.3	194	6.7	82	2.4	1074	10.8	771	10.9	736	6.1	775	4.3	551	2.7
chloramphenicol	298	10.1	1618	3.6	857	2.2	1762	4.5	2922	5.2	3398	4.1	2007	2.1	1239	1.9	926	1.5	661	0.3
cotrimoxazole	503	23.5	2969	38.7	1041	26.6	1265	42.8	4273	46.5	3765	40.2	2652	40.8	4361	43.7	2416	44.6	1597	47.5
erythromycin	1345	7.0	4353	12.6	2826	10.0	4632	18.2	5780	18.4	4875	18.2	3749	19.3	5118	20.6	2970	18.9	2134	20.0
penicillin											2542	11.2	2717	10.0	2880	15.7	2593	20.5	2177	18.5
penicillin non-susceptibility	1359	7.9	4381	17.6	2350	11.7	4844	22.6	5830	25.7	3354	28.3	3675	26.2	5792	26.9	5163	27.3	4082	26.8
tetracycline	814	6.3	3458	11.6	1046	7.6	1643	12.2	2446	15.5	2535	13.6	4495	16.4	2761	18.9	2350	17.7	1685	17.3
Streptococcus pyogenes																				
erythromycin					7898	0.9	11418	1.3	10710	1.5	15433	1.3	17301	1.4	11807	1.1	6721	0.9	4560	1.4
penicillin					8442	0.1	11434	0.02	10754	0	15504	0	19829	0	10029	0	12492	0	4160	0