National Public Health Service for Wales

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Antimicrobial Resistance in Wales (2006/2007)

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Section 1: Introduction

Antimicrobial resistance is an increasing problem that can result in difficulty in treating infections, leading to failed therapy and potential complications. Treatment for most infections is started empirically before antimicrobial susceptibilities are known. A particular problem with the spread of antimicrobial resistance is that it becomes more difficult to select empirical therapy that will have reliable activity. This, the second report from the Welsh Antimicrobial Resistance Programme Surveillance Unit, provides data that can be used to design empirical therapy guidance, and tracks antimicrobial resistance trends in Wales between 2006 and 2007.

Section 2: Key points of interest

- Antimicrobial resistance in Wales has increased over the last year for some of the major pathogens. In some cases there is considerable variability in resistance rates between different areas and hospitals. This is likely to reflect different antimicrobial usage and the spread of particular bacterial strains.

- **E. coli and "coliforms"**

  Resistance to multiple antimicrobials in *E. coli* from blood cultures is increasing (page 10); co-amoxiclav - 28.9%, fluoroquinolones - 20.9%, 3rd generation cephalosporins - 12.6%.

  A significant amount of the increasing resistance to 3rd generation cephalosporins (and fluoroquinolones) is due to the spread of CTX-M-type ESBLs (Extended Spectrum Beta-lactamases) (page 12).

  Resistance in other coliforms (*Klebsiella* spp., *Serratia* spp. *Enterobacter* spp.) from blood cultures remains high. Collated resistance rates for all coliforms (including *E. coli*) that could guide empirical therapy are co-amoxiclav – 38.1%, fluoroquinolones – 22.4%, 3rd generation cephalosporins – 19.3%, gentamicin – 6.6%, and carbapenems – 0.2% (page 19).

  Resistance rates for coliforms isolated from urinary specimens are lower than for blood culture isolates, but also continue to rise (page 28). It is notable that resistance to trimethoprim in community urinary coliforms is 30.9%. This high rate reflects selective testing in the community, and trimethoprim continues to be the first-line empirical therapy for uncomplicated UTI in the community.

- ***Streptococcus pneumoniae***

  Penicillin resistance in *S. pneumoniae* remains stable at 4.2% (page 36) which is similar to other areas of the UK.

- ***Campylobacter* spp.**

  Resistance to ciprofloxacin remains high at 28.1% with wide local variability and rates up to 69.8% in some areas (page 39). Resistance to erythromycin (recommended therapy) remains modest at 3.4%.

Section 3: Methods

Data presented
Antimicrobial resistance data is provided for the following selected areas and specific pathogens:

- Top ten bacteraemia pathogens
- Urinary coliforms (community & hospital)
- Wound swab isolates
    - *Staphylococcus aureus* including MRSA from wound swabs (community)
- All specimens (community & hospital)
    - *Streptococcus pneumoniae*
    - *Streptococcus pyogenes*
    - *Haemophilus influenzae*
    - *Campylobacter spp.*

"Community" data is from samples referred from a general practice and hospital data is from samples submitted from hospital in-patients.

Data sources
Antimicrobial susceptibility testing (AST) data was extracted from the Laboratory Information Management Systems (LIMS) via the regional DataStore systems. DataStore collects all data stored on the LIMS and maps information into a pseudo-anonymised standardized format.

Data from Prince Charles Hospital and the general practices served by the Merthyr laboratory is not included in this report as their LIMS were not linked to DataStore at the time of data extraction. It is intended that this data will be included in future reports.

The laboratories and hospitals with their code included in this report comprise:

Laboratory	Hospital	Code
Abergavenny	Nevill Hall Hospital	M
NPHS - Aberystwyth	Bronglais General Hospital	A
NPHS - Bangor	Ysbyty Gwynedd	K
NPHS - Bridgend	Princess of Wales Hospital	B
NPHS - Cardiff	Llandough Hospital	P
	University Hospital of Wales	F
	Velindre Hospital	Q
NPHS - Carmarthen	West Wales General Hospital	J
	Prince Philip Hospital	R
Haverfordwest	Withybush General Hospital	G
Newport	Royal Gwent Hospital	D
Pontypridd	Royal Glamorgan Hospital	C
NPHS - Rhyl	Ysbyty Glan Clwyd	L
NPHS - Swansea	Neath General Hospital	T
	Morriston Hospital	E

	Singleton Hospital	S
Wrexham	Wrexham Maelor Hospital	H
All Wales		Z

Data interpretation

As with all surveillance schemes, appropriate interpretation of the data, with an appreciation of the potential biases, is key. The main potential biases which should be considered in the data presented herein are:

- Sampling bias
    - This occurs if the submission of samples to the microbiology laboratory does not represent all patients presenting with that infection, but is selective in some way. If this is the case, the published resistance rate may be skewed, and not representative of the true rate in patients presenting with uncomplicated infection. This effect is likely to be more of an issue with certain sample types. For example bacteraemia data is felt to be fairly representative, since most patients presenting with sepsis will have a blood culture sent. However if general practitioners only submit urine samples from patients who have failed initial therapy, the published rates of resistance will be falsely high.

- Selective testing
    - This occurs if a laboratory only tests susceptibility to a certain agent against selected organisms. For example, a laboratory might only test some agents when an organism is resistant to first-line drugs. This would result in falsely high published rates of resistance. In order to reduce the effect of selective testing on the published rates, data is only included if >80% of a given isolate from a given specimen is tested against the agent.

- Methodological variability
    - There are many methods available for antimicrobial susceptibility testing which may give inconsistent results. In order to reduce this effect on the published rates the Welsh Antimicrobial Chemotherapy Group is working to standardize testing across Wales. All but one laboratory use a combination of the BSAC (British Society for Antimicrobial Chemotherapy) standardized disc sensitivity method, and the BD Phoenix automated AST/ID system.

- Duplicate testing
    - This occurs if a patient has multiple specimens tested from a single infection episode. Potentially this can skew the resistance data. In order reduce the effect of this; duplicate isolates are removed from analysis by a sub-routine in DataStore. Isolates are deemed to be duplicates if the same organism with the same antibiogram is grown form the same sample type within 14 days (for hospital in-patients) or 90 days (for community patients).

All Wales data

The All-Wales resistance rates for each antimicrobial comprise an aggregate of data from a number of different laboratories. All-Wales resistance rates are only presented for organisms where ≥80% of such isolates from the given sample type was tested.

Individual Hospital/Laboratory data

Individual hospital or laboratory resistance rates are only presented for organisms where ≥80% of such isolates from the given sample type was tested and where the number of isolates tested exceeds 10.

Duplicates

Data from duplicate isolates was removed prior to analysis. For community data, organisms from the same patient, with the same identification and susceptibility pattern isolated ≤ 90 days from the date of the initial isolate were excluded, and for hospital data the cut-off was ≤ 14 days.

Antimicrobial Groups

Although there has been a move towards standardization of antimicrobials used for AST, some variation between laboratories remains (e.g. differences in choice and number of third generation cephalosporins tested). In such cases data is aggregated and resistance rates are expressed at group level.

Generally, laboratories test a single fluoroquinolone and carbapenem where appropriate, but the choice of agent varies between laboratories. The antimicrobial groups included in this report comprise of the following aggregated susceptibility data:

- **Quinolones** – ciprofloxacin &/or levofloxacin, norfloxacin
- **Third generation cephalosporins** (3GC) – ceftazidime &/or cefotaxime, ceftriaxone, cefpodoxime.
- **Carbapenems** – imipenem &/or meropenem

Susceptibility results

Throughout data is presented in tables and on graphs as resistance rates with 95% confidence intervals (95% CI). [1] For the purpose of this report susceptibility results recorded as 'intermediate' are included in the category 'resistant', and in the case of penicillin susceptibility results for *S. pneumoniae* results recorded as intermediate, low- level or high-level resistance are included in the category 'resistant'.

1. Newcombe, Robert G. "Two-Sided Confidence Intervals for the Single Proportion: Comparison of Seven Methods," *Statistics in Medicine,* **17**, 857-872 (1998).

Other surveillance schemes

This report focuses on comparisons of data collected for Wales in the calendar years 2006 and 2007. To provide some external context to the data presented, it has been also been compared to surveillance data from other sources:

- Health Protection Agency (HPA)
  Website: http://www.hpa.org.uk/
  Publication: 'Trends in Antimicrobial Resistance in England, Wales and Northern Ireland 2008'
  This publication includes data derived from voluntary and mandatory reporting schemes lead by the HPA.
  Publication: GRASP the Gonococcal Resistance to Antimicrobials Surveillance Programme Annual Report 2007'
- European Antimicrobial Surveillance Scheme (EARSS)
  Website: http://www.rivm.nl/earss/
  Interactive database: http://www.rivm.nl/earss/database/
  A European wide network of national surveillance systems, providing reference data on antimicrobial resistance for public health purposes.

All of the above surveillance schemes are also susceptible to potential biases, particularly selective coverage and selective reporting. Thus comparisons with the presented data should be treated with caution.

NB. Throughout this document all resistance rates quoted from the HPA publication 'Antimicrobial resistance and prescribing in England, Wales and Northern Ireland,' relate to the calendar year **2007**, and data quoted from EARSS website database relate to the United Kingdom (UK) and the calendar year **2007**.

Section 4: Antimicrobial resistance rates for the most common organisms causing bacteraemia

Background

The 2007 top ten bacteraemia report for Wales comprises the commonest organisms isolated from blood cultures in Wales
http://www.wales.nhs.uk/sites3/page.cfm?orgid=379&pid=23019

Rank	Organism	Rate per 100,000 bed days
1	*Escherichia coli (E. coli)*	44
2	*Staphylococcus aureus* (MSSA)	17
3	*Enterococcus* species	13
=4	*Streptococcus pneumoniae*	11
=4	*Klebsiella* species	10
6	*Staphylococcus aureus* (MRSA)	9
7	Coagulase negative *staphylococci*	9
=8	*Pseudomonas aeruginosa*	5
=8	*Serratia* species	5
=8	*Enterobacter* species	4

The datasets include infections originating from community and hospital sources, and so may be affected by local clonal strains which can result in marked variability in resistance rates between hospitals/regions; results should be interpreted with caution.

Since coagulase negative staphylococci are frequently contaminants when isolated from blood cultures, data on susceptibility are not presented here.

The data in this report is not presented in rank order, but rather an order to allow easy comparison of resistances for related bacteria.

Table 1: Escherichia coli

TABLE 1: *Escherichia coli* from blood cultures

Resistance rates including (95% Confidence Intervals)

Duplicate Cut Off: ≤14 days

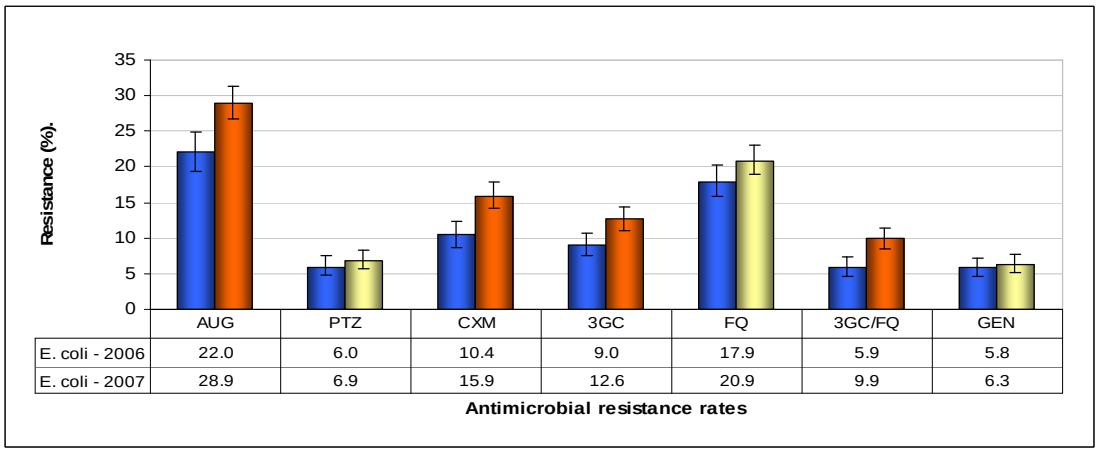
Time period: 1 January - 31 December 2007

Location Code	AMO	AUG	PTZ	CXM	3GC	CARB	FQ	3GC/FQ	GEN
A	63.6 (48.9, 76.2)	36.4 (23.8, 51.1)	18.6 (9.7, 32.6)	6.8 (2.3, 18.2)	9.1 (3.6, 21.2)	0.0 (0.0, 8.2)	11.4 (5.0, 24)	6.8 (2.3, 18.2)	9.5 (3.8, 22.1)
B	56.5 (46.3, 66.2)	25.8 (17.9, 35.8)	3.3 (1.1, 9.2)		7.6 (3.7, 14.9)	0.0 (0.0, 4.1)	20.9 (13.8, 30.3)	7.7 (3.8, 15)	4.4 (1.7, 10.8)
C	68.8 (57.9, 77.8)	33.8 (24.3, 44.6)	12.8 (7.1, 22.0)	19.0 (11.9, 29)	13.8 (7.9, 23)	0.0 (0.0, 4.6)	23.8 (15.8, 34.1)	10.0 (5.2, 18.5)	7.5 (3.5, 15.4)
D	53.6 (46.3, 60.8)	26.3 (20.4, 33.2)	2.8 (1.2, 6.4)	6.2 (3.5, 10.7)	3.9 (1.9, 7.9)	0.0 (0.0, 2.1)	17.3 (12.5, 23.5)	2.8 (1.2, 6.4)	6.7 (3.9, 11.4)
E	55.7 (47.2, 63.9)	18.3 (12.6, 25.8)	6.2 (3.2, 11.8)	13.0 (8.3, 19.8)	8.4 (4.8, 14.4)	0.0 (0.0, 3.0)	24.4 (17.9, 32.4)	7.6 (4.2, 13.5)	6.9 (3.7, 12.5)
F	60.6 (54.4, 66.4)	29.9 (24.6, 35.8)	9.2 (6.2, 13.4)	18.4 (14.1, 23.7)	13.5 (9.9, 18.3)	0.0 (0.0, 1.5)	25.1 (20.1, 30.8)	11.2 (7.8, 15.7)	11.2 (7.8, 15.7)
G	80.8 (62.1, 91.5)	61.5 (42.5, 77.6)	13.0 (4.5, 32.1)	26.9 (13.7, 46.1)	7.7 (2.1, 24.1)	0.0 (0.0, 14.3)	15.4 (6.1, 33.5)	3.8 (0.7, 18.9)	7.7 (2.1, 24.1)
H	59.8 (50.6, 68.4)				12.5 (7.6, 19.9)		19.6 (13.3, 28.0)	10.7 (6.2, 17.8)	2.7 (0.9, 7.6)
J	49.4 (39.3, 59.6)	23.9 (16.2, 33.7)	6.8 (3.2, 14.1)	15.7 (9.6, 24.7)		0.0 (0.0, 4.1)	14.6 (8.7, 23.4)		1.1 (0.2, 6.1)
K	56.7 (47.1, 65.8)	29.5 (21.0, 39.8)	5.8 (2.7, 12.1)	14.4 (8.9, 22.4)	18.4 (11.6, 27.8)	0.0 (0.0, 4.1)	16.3 (10.5, 24.6)	14.9 (8.9, 23.9)	2.9 (1, 8.1)
L	60.0 (49.9, 69.3)	34.7 (25.9, 44.7)	6.4 (3.0, 13.2)	21.1 (14.1, 30.3)	17.9 (11.5, 26.8)	0.0 (0.0, 3.9)	18.9 (12.3, 28)	15.8 (9.8, 24.4)	4.2 (1.6, 10.3)
M	60.2 (49.5, 70.1)	35.8 (26.2, 46.7)	6.2 (2.7, 13.8)	14.8 (8.7, 24.1)	11.2 (6.0, 20)	1.2 (0.2, 6.7)	12.0 (6.7, 20.8)	7.5 (3.5, 15.4)	9.6 (5, 17.9)
P	74.3 (63.3, 82.9)	43.2 (32.6, 54.6)	8.1 (3.8, 16.6)	32.4 (22.9, 43.7)	27.0 (18.2, 38.1)	0.0 (0.0, 4.9)	31.1 (21.7, 42.3)	18.9 (11.6, 29.3)	8.1 (3.8, 16.6)
Q	47.1 (26.2, 69)	23.5 (9.6, 47.3)	0.0 (0.0, 18.4)	23.5 (9.6, 47.3)	23.5 (9.6, 47.3)	0.0 (0.0, 18.4)	17.6 (6.2, 41.0)	11.8 (3.3, 34.3)	11.8 (3.3, 34.3)
R	54.0 (40.4, 67)	14.0 (7.0, 26.2)	6.1 (2.1, 16.5)	6.1 (2.1, 16.5)	6.1 (2.1, 16.5)	0.0 (0.0, 7.3)	8.0 (3.2, 18.8)	6.1 (2.1, 16.5)	4.0 (1.1, 13.5)
S	62.9 (54.1, 70.9)	27.4 (20.3, 35.9)	7.4 (3.9, 13.4)	24.2 (17.5, 32.4)	23.5 (16.8, 31.9)	0.0 (0.0, 3.1)	33.9 (26.1, 42.6)	19.3 (13.2, 27.3)	3.2 (1.3, 8)
T	43.2 (29.7, 57.8)	18.2 (9.5, 32)	0.0 (0.0, 8.0)	2.3 (0.4, 11.8)	2.3 (0.4, 11.8)	0.0 (0.0, 8.4)	18.2 (9.5, 32)	0.0 (0.0, 8.0)	6.8 (2.3, 18.2)
All-Wales: Resistance rates	**59.0** (56.6, 61.4)	**28.9** (26.7, 31.3)	**6.9** (5.7, 8.3)	**15.9** (14.1, 17.9)	**12.6** (11.1, 14.4)	**0.1** (0.0, 0.4)	**20.9** (19.0, 23.0)	**9.9** (8.5, 11.5)	**6.3** (5.2, 7.6)
All-Wales: Number of isolates	**1595**	**1466**	**1469**	**1438**	**1545**	**1472**	**1594**	**1544**	**1592**

Key: **AMO** = amoxicillin &/or ampicillin, **AUG** = co-amoxiclav, **PTZ** = piperacillin/tazobactam, **CXM** = cefuroxime, **CARB** = imipenem &/or meropenem, **FQ** = ciprofloxacin &/or levofloxacin, **3GC** = resistance to ceftazidime &/or cefotaxime, ceftriaxone , cefpodoxime, **3GC/FQ** = resistance to any third generation cephalosporin & any quinolone, **GEN** = gentamicin

Escherichia coli

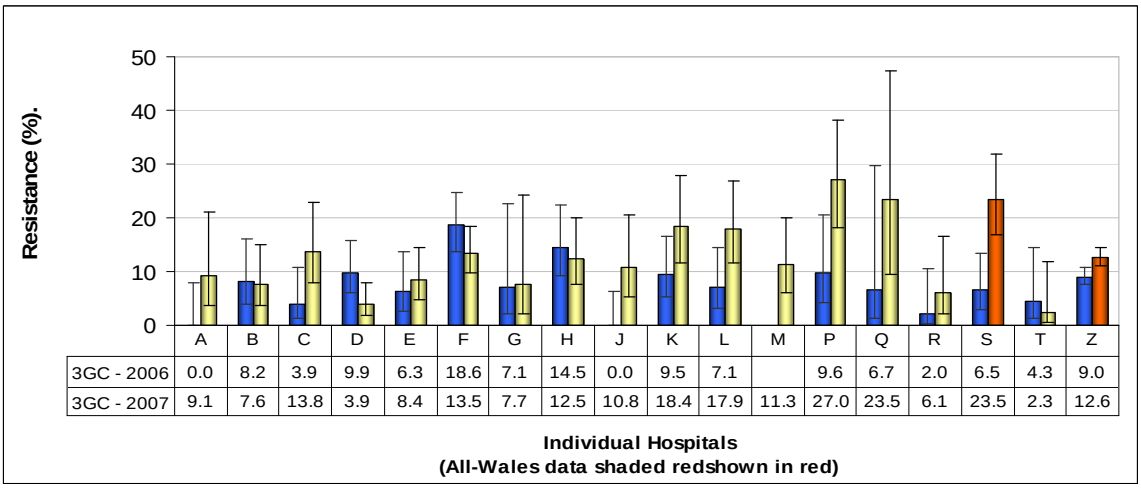
E. coli is the commonest organism grown from blood cultures in Wales. The All-Wales patterns of antimicrobial resistance for 2006 and 2007 are shown in Figure 1 & Table 1.



	AUG	PTZ	CXM	3GC	FQ	3GC/FQ	GEN
E. coli - 2006	22.0	6.0	10.4	9.0	17.9	5.9	5.8
E. coli - 2007	28.9	6.9	15.9	12.6	20.9	9.9	6.3

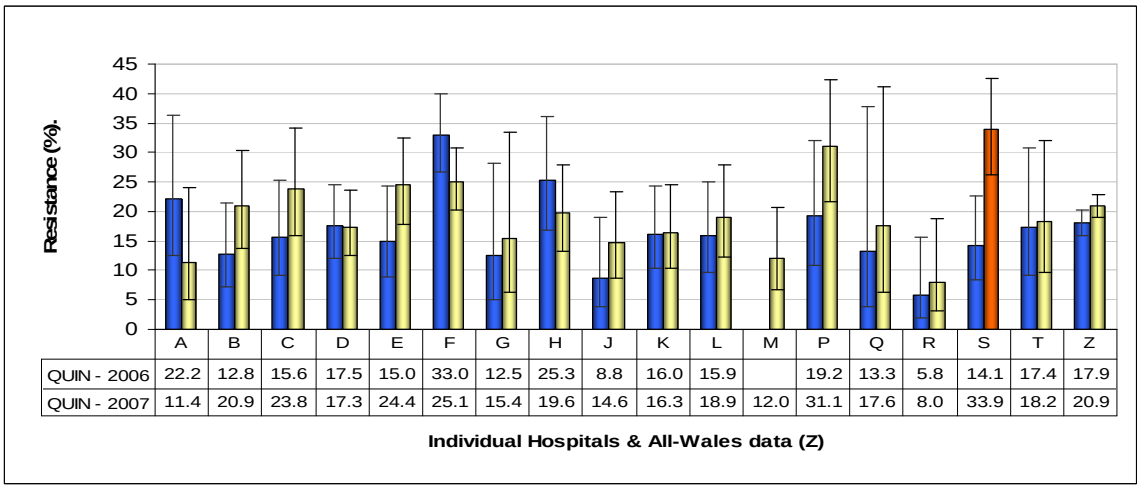
Figure 1: All-Wales antimicrobial resistance rates for *E. coli;* isolated from blood culture (2006 & 2007)

There is a general trend to increasing resistance to all agents with statistically significant increases for co-amoxiclav and cephalosporins. There was wide variability between laboratories (see Figures 2 and 3), with notable increases in resistance in Llandough (P), Singleton (S) and Velindre (Q) hospitals.



	A	B	C	D	E	F	G	H	J	K	L	M	P	Q	R	S	T	Z
3GC - 2006	0.0	8.2	3.9	9.9	6.3	18.6	7.1	14.5	0.0	9.5	7.1		9.6	6.7	2.0	6.5	4.3	9.0
3GC - 2007	9.1	7.6	13.8	3.9	8.4	13.5	7.7	12.5	10.8	18.4	17.9	11.3	27.0	23.5	6.1	23.5	2.3	12.6

Figure 2: Third generation cephalosporin resistance in *E. coli*; individual hospital data (2006 & 2007).



	A	B	C	D	E	F	G	H	J	K	L	M	P	Q	R	S	T	Z
QUIN - 2006	22.2	12.8	15.6	17.5	15.0	33.0	12.5	25.3	8.8	16.0	15.9		19.2	13.3	5.8	14.1	17.4	17.9
QUIN - 2007	11.4	20.9	23.8	17.3	24.4	25.1	15.4	19.6	14.6	16.3	18.9	12.0	31.1	17.6	8.0	33.9	18.2	20.9

Figure 3: Fluoroquinolone resistance in *E. coli*; individual hospital data (2006 & 2007).

The continuing increase in resistance to third generation cephalosporins in Wales is in-line with the 2007 HPA data for Wales and with the UK rates published by EARSS (sees Figure 4). The increasing resistance to 3rd generation cephalosporins that has been observed across Europe over the last few years has been attributed to the spread of CTX-M-type beta-lactamases. Please see the box below for further information on the situation in Wales.

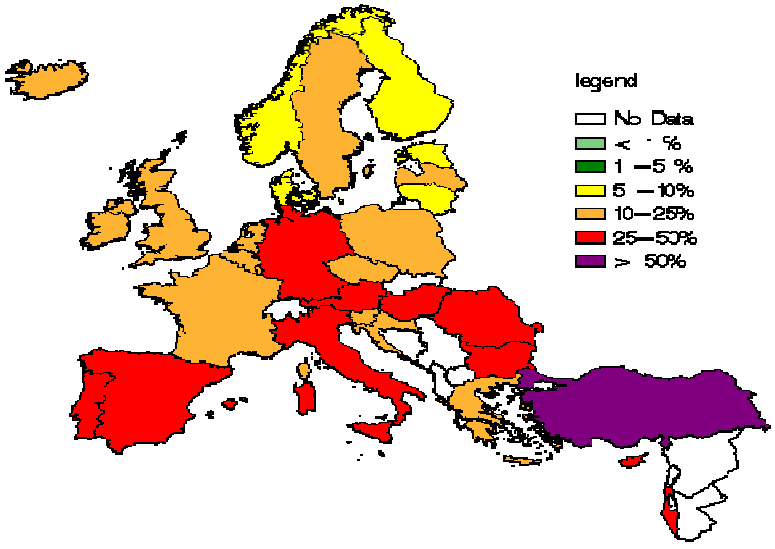


Figure 4: Proportion of *E. coli* from bacteraemia resistant fluoroquinolones in the different European countries in 2007: Data from EARSS
(Available at www.earss.rivm.nl)

Targeted surveillance for mechanisms of resistance to 3rd generation cephalosporins

The underlying mechanisms responsible for the increased resistance to 3rd generation cephalosporins observed in *E. coli* was studied in more detail by a targeted surveillance scheme coordinated by the Specialist Antimicrobial Chemothehrapy Unit (SACU) in Cardiff NPHS. From September 2007, all laboratories across Wales were requested to collect and submit 1/6 of the *E. coli* or other coliforms resistant to 3rd generation cephalosporins isolated from community or hospital samples. To date 546 isolates have been received and analysed.
Preliminary data for *E. coli* are shown in the table.

	Percent of isolates with given resistance mechanism	
	Community (n=205)	**Hospital (n=136)**
CTX-M	59.5	69.9
Plasmid AmpC	5.4	2.2
Other mechanism	35.1	27.9

The major resistance mechanism found was CTX-M type ESBLs (Extended Spectrum Beta-lactamases) with more than 90% being CTX-M15, the predominant enzyme found elsewhere in the UK. However it should be noted that 30-40% of isolates had an alternative mechanism.

Of the isolates, resistant to 3rd generation cephalosporins, 82.8% were also resistant to fluoroquinolones (i.e. ciprofloxacin). This cross-resistance explains why resistance to both classes of antimicrobials is increasing in tandem (see Figure 5).

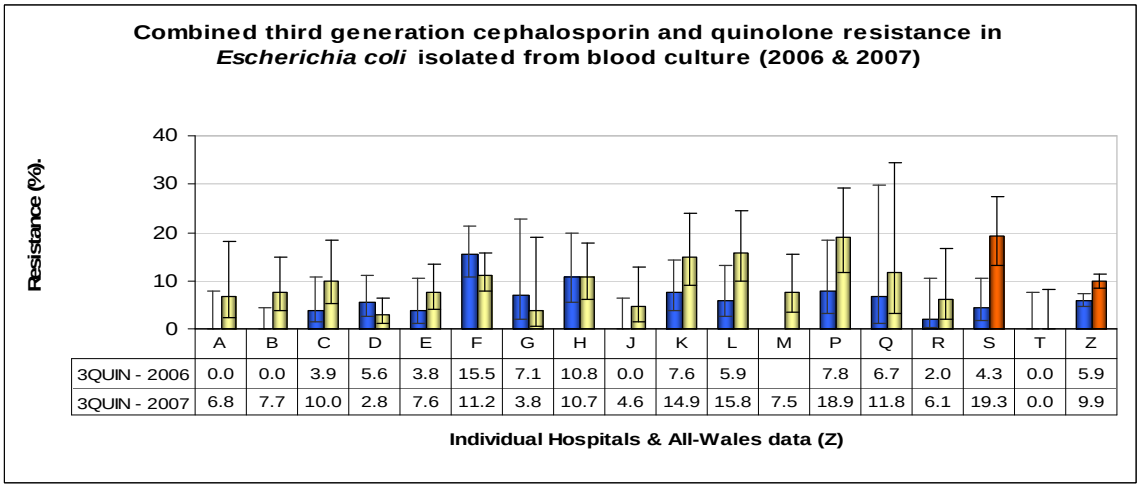


Figure 5: Combined third generation cephalosporin and fluoroquinolone resistance in *E. coli*; individual hospital data (2006 & 2007).

Table 2: Enterobacteriaceae (coliforms) and *Pseudomonas aeruginosa*

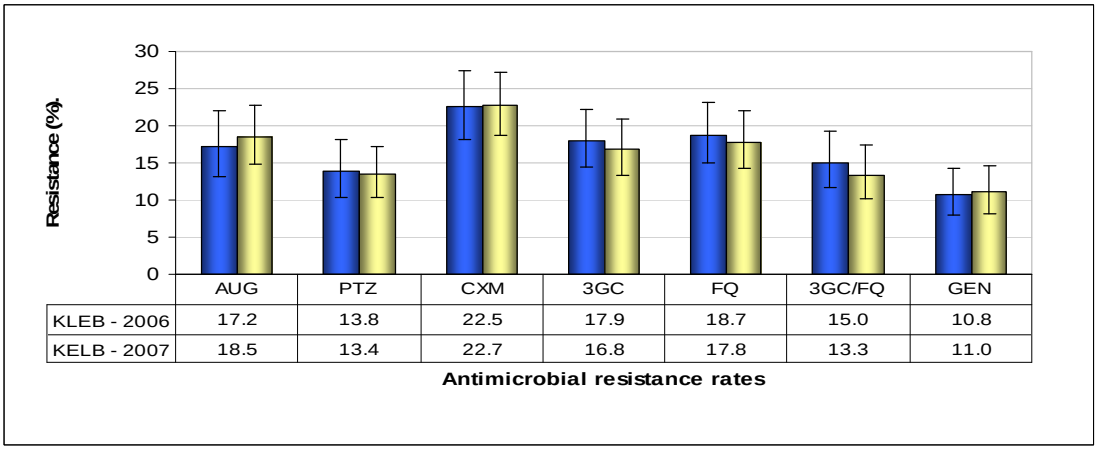
TABLE 2: Enterobacteriaceae and *Pseudomonas aerouginosa* from blood cultures
Resistance rates including (95% Confidence Intervals)
Duplicate Cut Off: ≤14 days
Time period: 1 January 2006 - 31 December 2007

Organism & Year	AMO		AUG		PTZ		CXM		3GC		CARB		FQ		3GC/FQ		GEN	
Klebsiella spp. 2007	98.9	(97.3, 99.6)	18.5	(14.8, 22.9)	13.4	(10.3, 17.3)	22.7	(18.7, 27.2)	16.8	(13.4, 21.0)	0.0	(0.0, 1.1)	17.8	(14.2, 22.0)	13.3	(10.1, 17.3)	11.0	(8.2, 14.7)
All-Wales: Number of isolates	376		352		372		370		371		349		377		344		362	
Klebsiella spp. 2006	97.0	(94.7, 98.3)	17.2	(13.2, 22.1)	13.8	(10.4, 18.1)	22.5	(18.2, 27.5)	17.9	(14.4, 22.2)	0.3	(0.1, 1.7)	18.7	(14.9, 23.2)	15.0	(11.6, 19.3)	10.8	(8.0, 14.4)
All-Wales: Number of isolates	371		278		322		342		371		344		344		344		371	
Serratia spp. 2007	98.4	(95.5, 99.5)	97.3	(93.8, 98.8)	29.6	(23.5, 36.5)	96.7	(93, 98.5)	63.8	(56.7, 70.4)	2.1	(0.8, 5.3)	54.9	(47.9, 61.8)	52.4	(45.3, 59.5)	0.5	(0.1, 2.9)
All-Wales: Number of isolates	190		184		186		182		188				193		185		193	
Serratia spp. 2006	97.3	(93.3, 99.0)	97.0	(92.6, 98.8)	25.9	(19.4, 33.6)	96.9	(92.4, 98.8)	62.1	(54.0, 69.6)	0.0	(0.0, 2.6)	55.7	(47.7, 63.4)	52.8	(44.7, 60.8)	2.7	(1.1, 6.7)
All-Wales: Number of isolates	150		134		143		130		145		146		149		144		149	
Enterobacter spp. 2007	100	(97.8, 100)	100	(97.7, 100)	19.8	(14.4, 26.6)			36.0	(29.2, 43.5)	0.0	(0.0, 2.3)	9.8	(6.2, 15.2)			6.9	(4.0, 11.7)
All-Wales: Number of isolates	173		166		162				172		166		173				173	
Enterobacter spp. 2006	95.0	(90.4, 97.4)	86.7	(80.2, 91.3)	17.4	(12.0, 24.6)			48.0	(40.2, 55.9)	0.8	(0.1, 4.2)	15.5	(10.6, 22.2)			10.1	(6.3, 15.7.7)
All-Wales: Number of isolates	159		143		138				148		132		148				159	
***Pseudomonas aueruginosa* 2007**					3.9	(1.9, 7.8)			4.8	(2.6, 8.9) [a]	5.8	(3.3, 10.1)	13.6	(9.5, 19.2)			8.4	(5.2, 13.2)
All-Wales: Number of isolates					181				187		189		191				191	
***Pseudomonas aueruginosa* 2006**					2.1	(0.6, 7.4)			0.0	(0.0, 3.4) [a]	12.4	(7.5, 19.7)	18.7	(12.8, 26.5)			8.9	(5.0, 15.2)
All-Wales: Number of isolates					95				109		113		123				124	

Key: **AMO** = amoxicillin &/or ampicillin, **AUG** = co-amoxiclav, **PTZ** = piperacillin/tazobactam, **CXM** = cefuroxime, **CARB** = imipenem &/or meropenem, **FQ** = ciprofloxacin &/or levofloxacin, **3GC** = resistance to ceftazidime &/or cefotaxime, ceftriaxone , cefpodoxime, **3GC/FQ** = resistance to any third generation cephalosporin & any quinolone, **GEN** = gentamicin, [a] = rate is for ceftazidime only

Klebsiella spp.

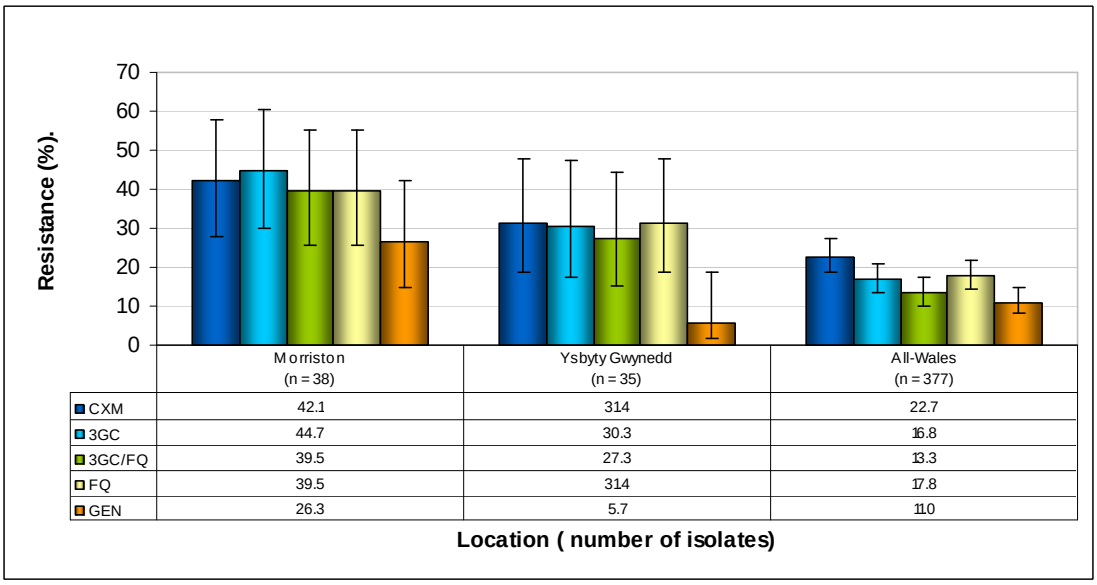
The All-Wales patterns of antimicrobial resistance in *Klebsiella* spp. are shown in Figure 6 & Table 2; with no significant changes between 2006 and 2007. Resistance to third generation cephalosporins (16.8%) and quinolones (17.8%) remains high, in-line with the 2007 HPA data, for Wales, which show an increase in third generation cephalosporin resistance from ≈14% to ≈16%, and the highest fluoroquinolone resistance in E&W ≈23% (95% CI ≈17-30%).



	AUG	PTZ	CXM	3GC	FQ	3GC/FQ	GEN
KLEB - 2006	17.2	13.8	22.5	17.9	18.7	15.0	10.8
KELB - 2007	18.5	13.4	22.7	16.8	17.8	13.3	11.0

Figure 6: All-Wales antimicrobial resistance rates for *Klebsiella* spp., isolated from blood culture (2006 & 2007).

As in 2006, there was wide local variability in resistance rates within Wales; with notably high rates of resistance to multiple agents seen at Morriston and Ysbyty Gwynedd (Figure 7). Resistance to fluoroquinolones at Morriston was significantly higher than those reported for the UK (10-25%) by EARSS (see figure 8). Resistance to carbapenems was undetected.



	Morriston (n = 38)	Ysbyty Gwynedd (n = 35)	All-Wales (n = 377)
CXM	42.1	31.4	22.7
3GC	44.7	30.3	16.8
3GC/FQ	39.5	27.3	13.3
FQ	39.5	31.4	17.8
GEN	26.3	5.7	11.0

Figure 7: Resistance rates to multiple agents in Klebsiella spp. for Morriston, Ysbyty Gwynedd and All-Wales.

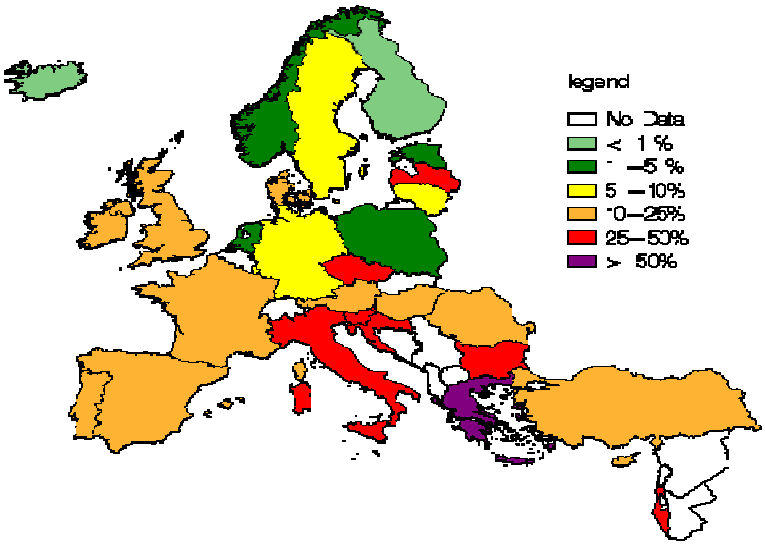
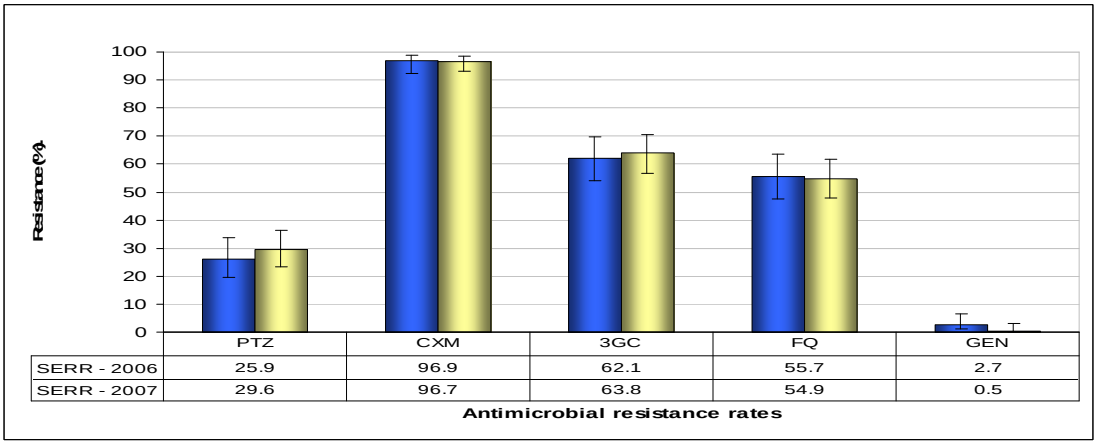


Figure 8: Proportion of *Klebsiella pneumoniae* from bacteraemia resistant fluoroquinolones in the different European countries in 2007: Data from EARSS (Available at www.earss.rivm.nl)

Serratia spp.

The All-Wales patterns of antimicrobial resistance in Serratia spp. are shown in Figure 9 & Table 2, with no significant changes between 2006 and 2007. Resistance to third generation cephalosporins and fluoroquinolones remains high in Wales (63.8%) and is significantly higher than that reported by the HPA for the single agents: cefotaxime (27%) and ceftazidime (12%). These high rates of resistance were observed in many hospitals, the lowest rate was 33.3% (13.8, 60.9) but all of the others ranged between 62.2% (47.6, 74.9) and 77.3% (56.6, 89.9).



	PTZ	CXM	3GC	FQ	GEN
SERR - 2006	25.9	96.9	62.1	55.7	2.7
SERR - 2007	29.6	96.7	63.8	54.9	0.5

Figure 9: All-Wales antimicrobial resistance rates for *Serratia* spp. isolated from blood culture (2006 & 2007).

The All-Wales resistance rate for fluoroquinolones was 54.9%; higher than the ciprofloxacin rate for E&W published by the HPA which has decreased from 27% in 2006 to 18% in 2007. Locally, there was wide variability in resistance rates within Wales 38.5% (17.7, 64.5) to 77.3% (56.6, 89.9); with notably high rates in Nevill Hall, Morriston, Royal Glamorgan and Royal Gwent hospitals (>60%). Carbapenem resistance was reported in one isolate from Nevill Hall hospital.

Enterobacter spp.

The All-Wales patterns of antimicrobial resistance in *Enterobacter* spp. are shown in Figure 10 & Table 2, with no statistically significant changes between 2006 and 2007.

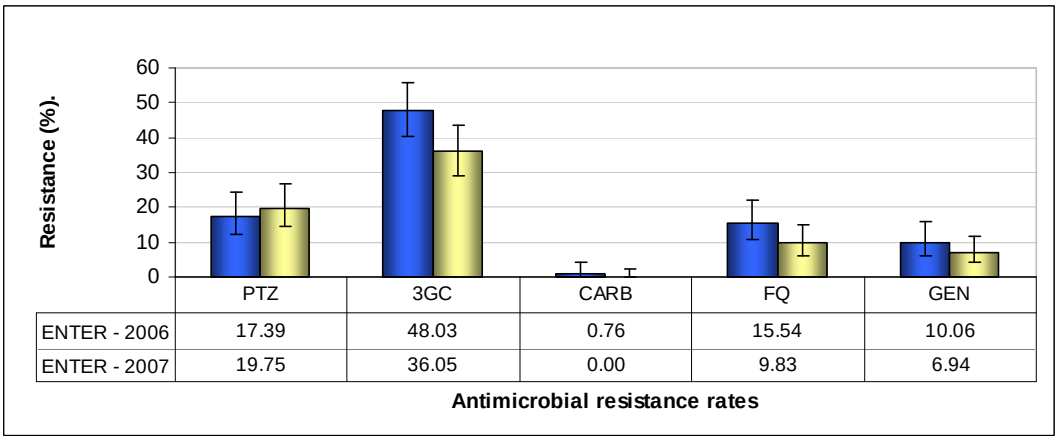


Figure 10: All-Wales antimicrobial resistance rates for *Enterobacter* spp., isolated from blood culture (2006 & 2007).

Resistance to third generation cephalosporins in *Enterobacter* spp. decreased during 2007 and are comparable with the rate for ceftazidime (≈ 32 %) published by the HPA for E&W. Locally, there was wide variability in third generation cephalosporin resistance rates within Wales 13.3% to 75%; with a notably high rate of resistance in the Royal Glamorgan hospital of 75% (46.8, 91.1). Resistance to carbapenems was not detected.

Pseudomonas aeruginosa

The All-Wales patterns of antimicrobial resistance in *Pseudomonas aeruginosa* are shown in Figure 11 & Table 2; with no statistically significant changes between 2006 and 2007.

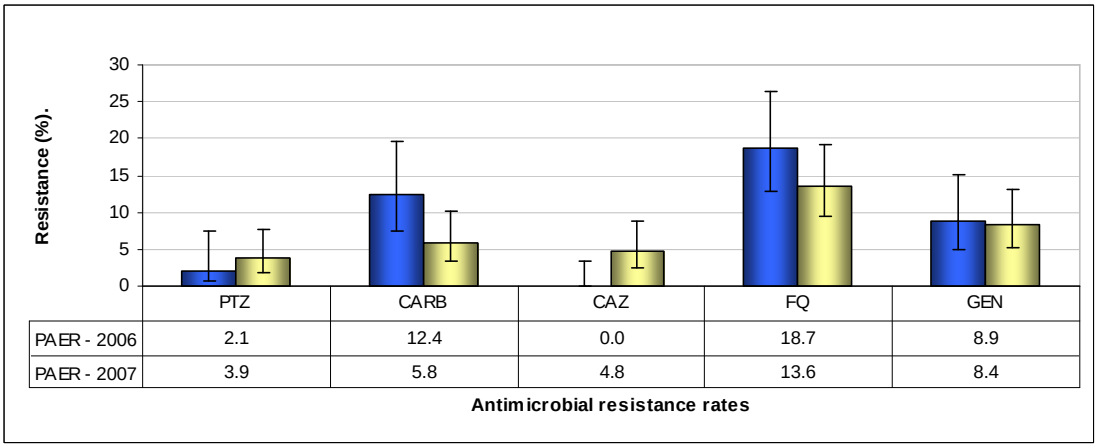
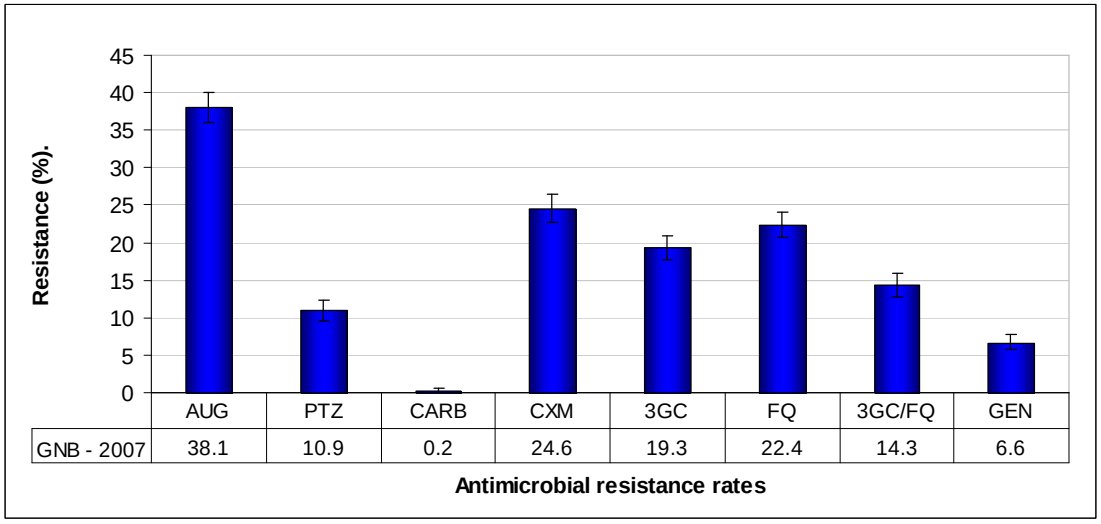


Figure 11: All-Wales antimicrobial resistance rates for *Ps. aeruginosa* isolated from blood culture (2006 & 2007).

In 2007, carbapenem and fluoroquinolone resistance rates decreased, making the rates comparable with those published by the HPA for E&W (ciprofloxacin ≈12%, imipenem ≈ 9%, meropenem ≈ 4%).

"Coliforms" (E. coli, Klebsiella spp.*, Serratia* spp. *, and Enterobacter* spp.*, but excluding Pseudomonas aeruginosa)*

To aid treatment decisions when a patient is initially identified as having a Gram negative bacteraemia, the collated data for coliforms is given in Figure 12. It is notable that resistance to "workhorse" antimicrobials such as co-amoxiclav, cephalosporins and fluoroquinolones is now 20% or more in these organisms. Only carbapenems have reliable activity.



	AUG	PTZ	CARB	CXM	3GC	FQ	3GC/FQ	GEN
GNB - 2007	38.1	10.9	0.2	24.6	19.3	22.4	14.3	6.6

Figure 12: All-Wales antimicrobial resistance rates for all coliforms isolated from blood culture (2007).

Table 3: *Staphylococcus aureus* (MSSA & MRSA)

TABLE 3: *Staphylococcus aureus* (MSSA & MRSA) from blood cultures
Resistance rates including (95% Confidence Intervals)
Duplicate Cut Off: ≤14 days
Time period: 1 January 2006 - 31 December 2007

Organism & Year	CIP	ERY	FUS	GEN	LZD	PEN	RIF	TET	VAN
MSSA - 2007		9.1 (7.0, 11.6)	12.3 (10.0, 15.1)	3.3 (2.1, 5.2)	0.2 (0.0, 1.2)	84.5 (81.1, 87.3)		2.3 (1.2, 4.3)	
All-Wales: Number of isolates		618	617	621	476	528		392	
MSSA - 2006		8.8 (6.8, 11.3)	12.1 (9.7, 14.9)	2.3 (1.4, 3.8)	0.0 (0.0, 1.0)	86.6 (83.4, 89.2)		3.3 (1.9, 5.7)	
All-Wales: Number of isolates		614	614	621	383	543		362	
MRSA - 2007	98.3 (95.1, 99.49)	75.2 (69.6, 79.8)	9.8 (6.9, 13.7)	0.4 (0.1, 2.0)	0.0 (0.0, 1.5)		1.5 (0.6, 3.8)	2.3 (1.0, 5.3)	0.0 (0.0, 1.5)
All-Wales: Number of isolates	177	294	296	275	255		263	216	252
MRSA - 2006	97.7 (93.5, 99.2)	76.7 (71.3, 81.3)	11.5 (8.4, 15.7)	3.4 (1.9, 6.2)	0.0 (0.0, 2.4)		2.2 (0.9, 5.0)	5.8 (3.2, 10.4)	0.0 (0.0, 2.1)
All-Wales: Number of isolates	131	274	295	293	158		231	171	177

Key: **CIP** = ciprofloxacin &/or levofloxacin, **ERY** = erythromycin, **FUS** = fusidic acid, **GEN** = gentamicin, **LZD** = linezolid, **PEN** = pencillin, RIF = rifampicin, **TET** = tetracycline, **VAN** = vancomycin

Meticillin Sensitive Staphylococcus aureus (MSSA)

The All-Wales pattern of antimicrobial resistance in MSSA is shown in Figure 13 & Table 3; with no statistically significant changes between 2006 and 2007.

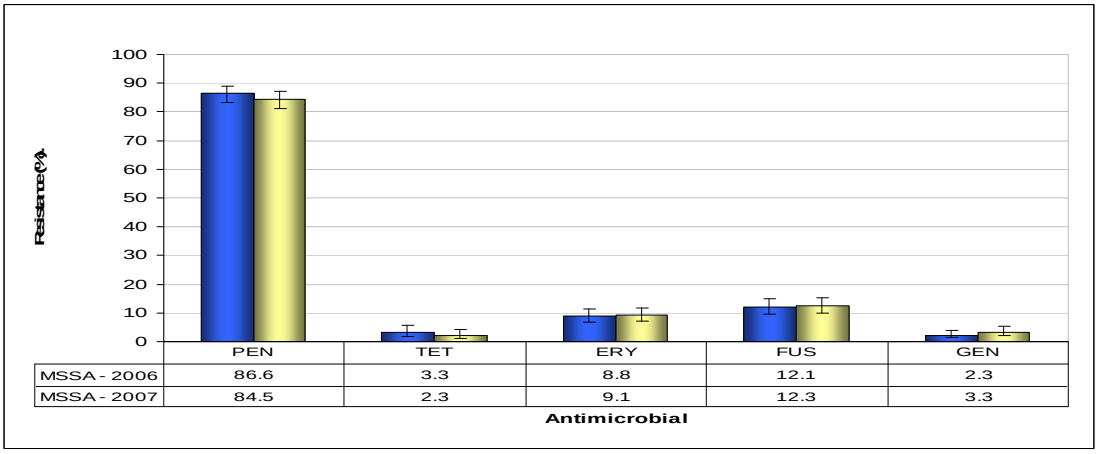


Figure 13: All-Wales antimicrobial resistance rates for Meticillin Sensitive *Staphylococcus aureus* (MSSA) isolated from blood culture (2006 & 2007).

The All-Wales antimicrobial resistance rates for MSSA are largely comparable to those published by the HPA for E&W, apart from gentamicin which is higher (3.3%) in comparison (1.1%). The increased rate was due to high rates locally in Royal Gwent (10.8%) and Royal Glamorgan (13.0%), which reflect varying presence of epidemic strains. This may also be true of fusidic acid resistant strains that predominate in Morriston (23.5%) and Singleton (26.1%) hospitals.

Meticillin Resistant Staphylococcus aureus (MRSA)

The All-Wales pattern of antimicrobial resistance in MRSA is shown in Figure 14 & Table 3; with no statistically significant changes between 2006 and 2007.

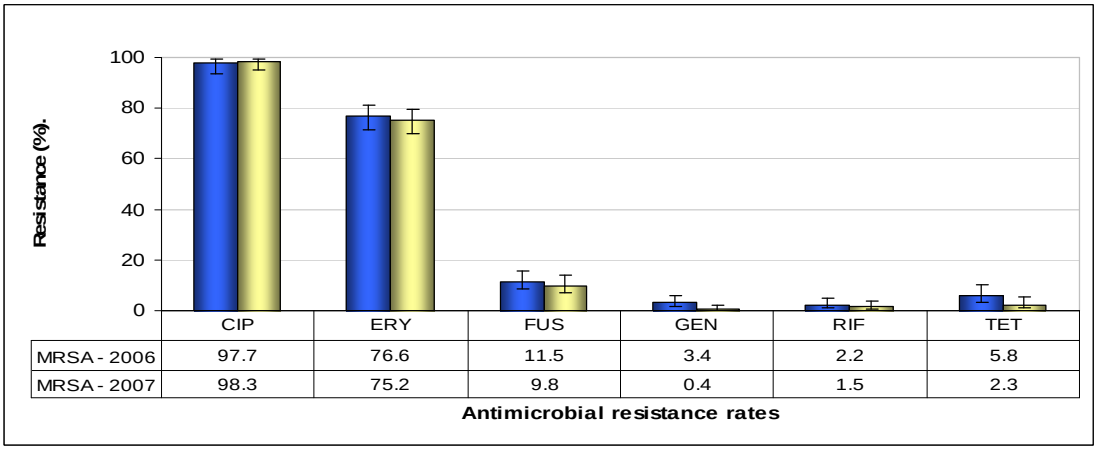


Figure 14: All-Wales antimicrobial resistance rates for Meticillin Resistant *Staphylococcus aureus* (MRSA) isolated from blood culture (2006 & 2007).

The All-Wales antimicrobial resistance rates for MRSA are largely comparable to those published by the HPA for E&W. The All-Wales rate for gentamicin resistance (0.36%) was lower than E&W rate (5.9%), however, in 2007 only Nevill Hall hospital reported any gentamicin resistance (12.5%) with all other hospitals having 0%. Resistance to vancomycin and linezolid remained undetected.

Enterococcus spp.

The All-Wales pattern of antimicrobial resistance in *Enterococcus* spp. is shown Table 4, with no statistically significant changes between 2006 and 2007.

Table 4: Enterococci

TABLE 4: Enterococci from blood cultures **Resistance rates including (95% Confidence Intervals)** **Duplicate Cut Off: ≤14 days** **Time period: 1 January 2006 - 31 December 2007**				
Organism & Year	**AMO**		**VAN**	
ENTEC - 2007	31.6	(27.8, 35.7)	13.9	(10.9, 17.4)
All-Wales: Number of isolates	534		433	
ENTEC - 2006	36.5	(32.8, 40.4)	15.5	(12.9, 18.7)
All-Wales: Number of isolates	608		592	
Key: **AMO** = amoxicillin, **VAN** = vancomycin				

The All-Wales resistance rate for amoxicillin/ampicillin was 31.6% (32. 8, 40.4); susceptibility to amoxicillin/ampicillin is a guide to the identification of the organism as *E. faecalis*; and suggests that in 2007 68.4% of entercoccal bacteraemias were due to *E. faecalis.* This proportion is slightly higher than the 2007 rate of *E. faecalis* bacteraemias published by the HPA for England & Wales (61.7%).

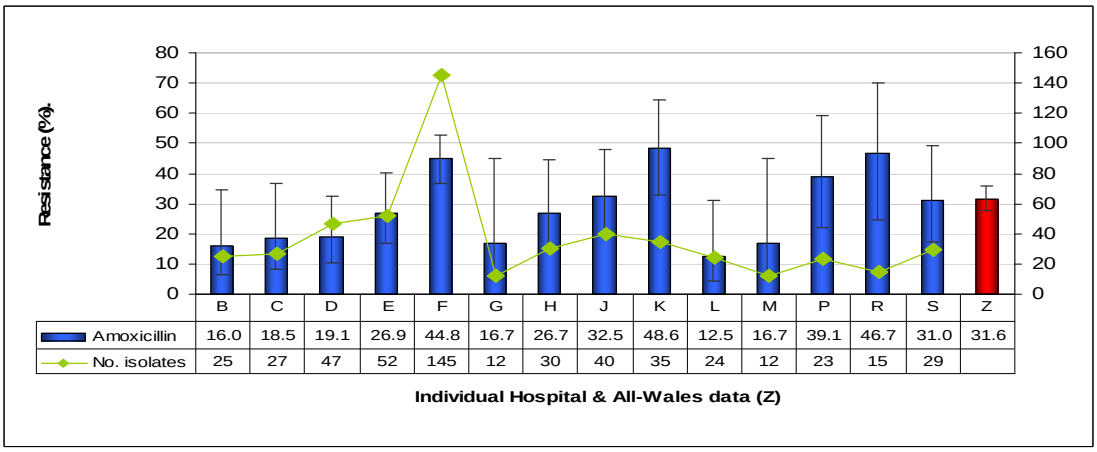


Figure 15: Amoxicillin resistance in *Enterococcus* spp.; individual hospital data (2006)

Of the isolates that were susceptible to amoxicillin/ampicillin, 3.6% were resistant to vancomycin. This rate is consistent with the 2007 rate for *E. faecalis* bacteraemias, published by the HPA for E&W (3%). Of the isolates that were resistant to amoxicillin/ampicillin, 32.0% were resistant to vancomycin. This rate is higher than the rate for *E. faecium* bacteraemias, published by the HPA for E&W (≈ 24%). The rate for Wales may be skewed by the inclusion of a large number of isolates from the University Hospital of Wales.

Streptococcus pneumoniae

The All-Wales pattern of antimicrobial resistance is shown in Figure 16 & Table 5; with no statistically significant changes between 2006 and 2007.

Table 5: *Streptococcus pneumoniae*

TABLE 5: *Streptococcus pneumoniae* from blood cultures
Resistance rates including (95% Confidence Intervals)
Duplicate Cut Off: ≤14 days
Time period: 1 January 2006 - 31 December 2007

Organism & Year	PEN	TET	ERY
SPNE - 2007	2.7 (1.5, 4.9)	2.1 (1.0, 4.4)	8.0 (5.5, 11.5)
All-Wales: Number of isolates	367	290	324
SPNE - 2006	4.1 (2.6, 6.6)	3.3 (1.7, 6.4)	8.9 (6.4, 12.3)
All-Wales: Number of isolates	389	240	360

Key: **PEN** = pencillin, **TET** = tetracycline, **ERY** = erythromycin

The 2007 All-Wales resistance rate for penicillin was not significantly different to the range published by the HPA for England & Wales (2.3 – 4.0%), and within the 1-5% range for non-susceptibility to penicillin published by EARSS (see Figure 15). Locally, there was variability in penicillin resistance rates within Wales 0% to 11.11%; with notably high resistance in Withybush General Hospital.

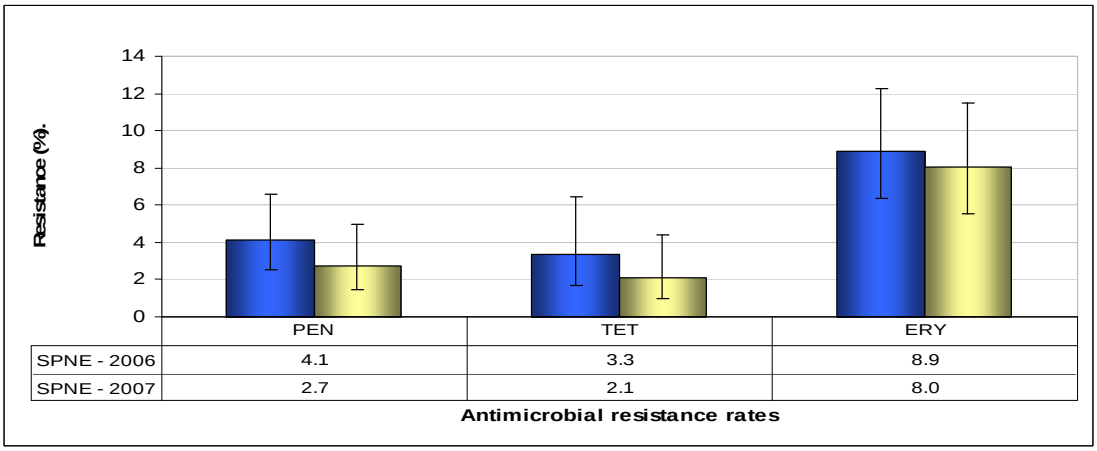


Figure 16: All-Wales antimicrobial resistance rates for *Streptococcus pneumoniae* isolated from blood culture (2006 & 2007).

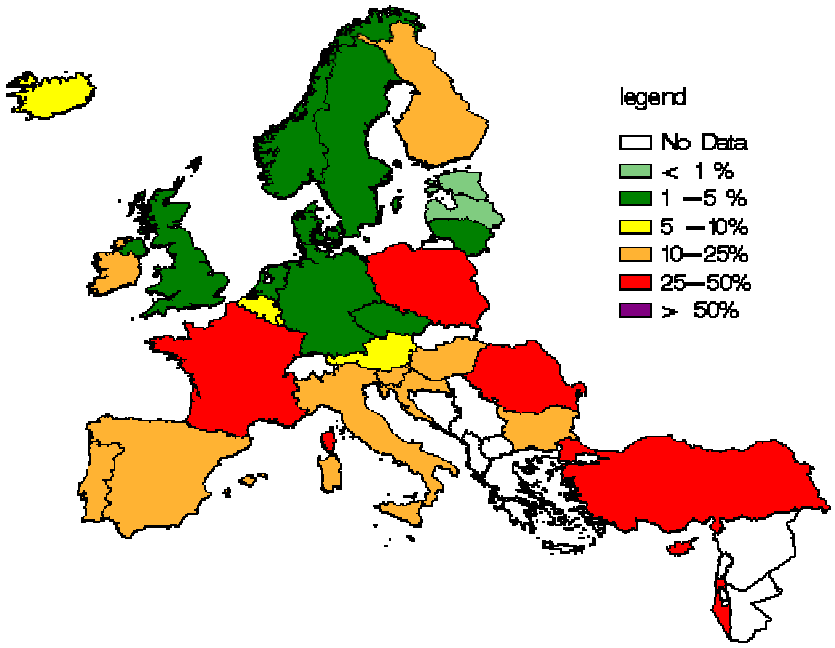


Figure 17: Proportion of Penicillin non-susceptible *S. pneumoniae* from the different European countries in 2007: Data from EARSS (Available at www.earss.rivm.nl)

Section 6: Antimicrobial resistance rates for urinary coliforms

For the purposes of this report the term coliform refers to organisms that were reported as a 'coliform' by the laboratory, or when identified further, were reported as one of the genera belonging to the family *Enterobacteriaceae*.

The genera included in this section of the report comprise: *Citrobacter, Edwardsiella, Enterobacter, Escherichia, Hafnia, Klebsiella, Kluyvera, Morganella, Pantoea, Proteus, Providencia, Rahnella, Salmonella, Serratia* and *Yersinia.*

It should be noted that data from routinely-submitted urine specimens is more prone to bias than data from blood culture isolates due to variable sampling by clinicians. Thus resistance rates quoted here are likely to be higher due to increased sampling from patients who are more likely to have resistant organisms (e.g. patients with recurrent infections or infections that have failed to respond to initial therapy). This should be factored into any use of the data presented for the design of empiric treatment guidance.

The generation of more specific data reports (e.g. different patient age groups) can be discussed with the Welsh AR Programme.

Table 6: Community Urinary Coliforms

TABLE 6: Community urinary coliforms (including *E. coli* & *Proteus* spp.)
Resistance rates including (95% Confidence Intervals)
Duplicate Cut Off: ≤91 days
Time period: 1 January - 31 December 2007

Location Code	AMO	AUG	1GC	TRI	AMO/TRI	FQ	AMO/TRI/FQ	NIT
A	51.1 (49.0, 53.2)	10.8 (9.6, 12.2)	11.3 (10.0, 12.7)	28.2 (26.4, 30.2)	22.3 (20.6, 24.2)	7.6 (6.5, 8.7)	6.6 (5.7, 7.8)	9.8 (8.6, 11.1)
B	51.2 (49.5, 52.9)	4.9 (4.2, 5.7)	6.2 (5.4, 7.1)	28.7 (27.2, 30.3)	22.3 (20.9, 23.8)	5.8 (5.1, 6.7)	4.3 (3.6, 5)	9.7 (8.7, 10.7)
C	56.3 (54.4, 58.1)	28.8 (27.1, 30.5)	22.5 (21.0, 24.1)	33.4 (31.7, 35.2)	27.1 (25.4, 28.7)	9.2 (8.2, 10.3)	6.9 (6, 7.9)	12.8 (11.6, 14.1)
D	55.1 (54.0, 56.2)	8.0 (7.5, 8.6)	6.6 (6.1, 7.1)	28.7 (27.7, 29.7)	23.0 (22.1, 24)	6.0 (5.5, 6.5)	4.2 (3.7, 4.6)	8.5 (7.8, 9.1)
E	47.8 (46.8, 48.8)	8.8 (8.3, 9.4)	10.6 (10.0, 11.2)	33.4 (32.5, 34.3)	23.6 (22.8, 24.5)	10.9 (10.3, 11.5)	7.8 (7.3, 8.3)	11.4 (10.8, 12.1)
F	54.5 (53.5, 55.5)	13.2 (12.6, 13.9)	7.6 (7.1, 8.1)	32.4 (31.5, 33.4)	26.3 (25.5, 27.2)	9.2 (8.6, 9.7)	7.1 (6.6, 7.6)	13.9 (13.2, 14.6)
G	49.1 (47.0, 51.1)	18.9 (17.4, 20.5)	13.6 (12.3, 15.1)	30.7 (28.8, 32.6)	22.6 (21, 24.4)	7.9 (6.9, 9.1)	5.7 (4.8, 6.7)	12.0 (10.8, 13.4)
H	52.7 (51.2, 54.2)	6.9 (6.2, 7.7)	8.2 (7.4, 9)	32.4 (31, 33.8)	26.0 (24.8, 27.4)	8.8 (8.0, 9.7)	6.3 (5.6, 7.0)	9.3 (8.4, 10.2)
J	52.4 (51.0, 53.9)	6.9 (6.2, 7.7)	6.3 (5.7, 7.1)	27.1 (25.9, 28.4)	21.6 (20.4, 22.8)	4.9 (4.3, 5.5)	3.3 (2.8, 3.9)	10.1 (9.3, 11)
K	55.3 (54.0, 56.6)		11.8 (11.0, 12.7)	31.8 (30.6, 33.1)	26.4 (25.3, 27.6)	10.8 (10.0, 11.7)	7.8 (7.1, 8.5)	13.8 (12.9, 14.7)
L	54.5 (53.1, 56.0)		8.5 (7.7, 9.3)	31.0 (29.8, 32.3)	25.1 (23.9, 26.4)	9.1 (8.3, 9.9)	6.8 (6.1, 7.5)	12.1 (11.2, 13)
M	51.7 (50.0, 53.5)	7.1 (6.2, 8)	7.5 (6.6, 8.4)	26.8 (25.3, 28.3)	20.8 (19.5, 22.3)	5.4 (4.7, 6.2)	3.5 (3.0, 4.2)	12.0 (10.9, 13.2)
N	58.6 (55.8, 61.2)	23.1 (20.8, 25.5)	19.1 (17.0, 21.4)	33.9 (31.4, 36.6)	27.5 (25.2, 30.1)	7.0 (5.7, 8.6)	4.4 (3.4, 5.7)	14.3 (12.5, 16.4)
All-Wales: Resistance rates	**52.8** (52.4, 53.2)	**11.8** (11.5, 12.1)	**9.5** (9.3, 9.7)	**30.9** (30.5, 31.3)	**24.3** (24, 24.6)	**8.3** (8.1, 8.5)	**6.0** (5.9, 6.2)	**11.5** (11.3, 11.8)
All-Wales: Number of isolates	**62119**	**52667**	**62317**	**62289**	**62047**	**62411**	**62008**	**60956**

Key: **AMO** = amoxicillin &/or ampicillin, **AUG** = co-amoxiclav, **1GC** = resistance to any first generation cephalosporin, **TRI** = trimethoprim, **AMO/TRI** = co-resistance to amoxicillin & trimethoprim, **FQ** = ciprofloxacin &/or levofloxacin or norfloxacin, **AMO/TRI/FQ** = co-resisatnce to amoxicillin, trimethoprim & fluoroquinolone, **NIT** = nitrofurantoin

Table 7: Hospital In-Patient Urinary Coliforms

TABLE 7: Hospital in-patient urinary coliforms (including *E. coli* & *Proteus* spp.)
Resistance rates including (95% Confidence Intervals)
Duplicate Cut Off: ≤91 days
Time period: 1 January - 31 December 2007

Location Code	AMO	AUG	1GC	TRI	AMO/TRI	FQ	AMO/TRI/FQ	NIT
A	59.9 (53.5, 64.2)	18.8 (14.9, 23.4)	20.4 (16.3, 25.1)	36.4 (31.4, 41.8)	30.2 (25.5, 35.5)	14.8 (11.4, 19.1)	12.3 (9.2, 16.4)	13.3 (10.0, 17.4)
B	54.0 (50.8, 57.2)	9.0 (7.3, 11)	10.3 (8.5, 12.4)	32.5 (29.5, 35.5)	25.3 (22.6, 28.2)	10.6 (8.8, 12.8)	8.0 (6.5, 10)	17.9 (15.6, 20.5)
C	64.9 (61.4, 68.2)	40.4 (37.0, 43.9)	33.9 (30.7, 37.4)	41.4 (38.0, 45.0)	35.9 (32.6, 39.4)	16.1 (13.6, 18.9)	14.1 (11.8, 16.8)	17.0 (14.5, 19.8)
D	61.9 (59.8, 64)	15.6 (14.1, 17.2)	13.3 (11.9, 14.9)	27.8 (25.9, 29.8)	22.9 (21.1, 24.8)	10.1 (8.9, 11.5)	7.0 (6.0, 8.2)	12.5 (6.7, 22.1)
E	54.6 (51.3, 57.8)	13.8 (11.7, 16.2)	18.7 (16.3, 21.4)	36.6 (33.5, 39.8)	29.9 (27.0, 33.0)	19.8 (17.3, 22.6)	14.7 (12.5, 17.2)	16.4 (14.1, 18.9)
F	68.6 (66.3, 70.9)	32.0 (29.7, 34.3)		43.5 (41.0, 45.9)	39.1 (36.7, 41.5)	25.8 (23.7, 28)	20.7 (18.8, 22.8)	24.7 (22.6, 26.9)
G	54.8 (50.9, 58.6)	29.4 (26.0, 33.0)	24.1 (21, 27.6)	33.0 (29.5, 36.7)	24.6 (21.4, 28.1)	15.2 (12.6, 18.1)	11.0 (8.8, 13.6)	18.1 (15.3, 21.3)
H	59.8 (57.5, 62.2)	16.5 (14.8, 18.3)	17.4 (15.7, 19.3)	37.7 (35.4, 40.1)	30.5 (28.3, 32.8)	16.7 (14.9, 18.5)	12.5 (11.0, 14.2)	15.5 (13.8, 17.3)
J	60.5 (57.6, 63.4)	11.4 (9.6, 13.4)	11.1 (9.4, 13.1)	27.2 (24.6, 29.9)	23.1 (20.7, 25.7)	7.9 (6.4, 9.6)	6.5 (5.2, 8.2)	14.6 (12.6, 16.8)
K	64.9 (62.1, 67.7)		22.8 (20.4, 25.4)	35.6 (32.9, 38.5)	32.2 (29.5, 35.0)	19.4 (17.2, 21.8)	16.5 (14.5, 18.9)	18.0 (15.9, 20.4)
L			11.2 (9.6, 13)	34.6 (32.1, 37.2)		13.9 (12.2, 15.9)		13.9 (12.2, 15.8)
M	58.8 (55.8, 61.8)	10.4 (8.7, 12.4)	11.1 (9.3, 13.2)	27.1 (24.4, 29.9)	22.6 (20.1, 25.2)	8.4 (6.8, 10.2)	4.7 (3.6, 6.2)	
N	68.3 (64.5, 71.8)	36.5 (32.8, 40.3)	29.2 (25.7, 32.9)	35.9 (32.3, 39.8)	32.0 (28.4, 35.7)	11.9 (9.6, 14.7)	8.1 (6.2, 10.5)	17.5 (14.7, 20.8)
P	71.4 (68, 74.6)	35.4 (32.0, 38.9)		46.8 (43.2, 50.4)	41.1 (37.6, 44.7)	34.0 (30.7, 37.5)	28.1 (25.0, 31.5)	16.2 (13.7, 19.1)
R	68.6 (62.7, 73.9)	19.9 (15.5, 25.2)	19.2 (14.8, 24.4)	35.2 (29.7, 41.2)	29.9 (24.7, 35.7)	19.2 (14.8, 24.4)	14.6 (10.8, 19.4)	23.6 (18.8, 29.1)
S	52.5 (48.6, 56.3)	13.4 (10.9, 16.2)	17.4 (14.6, 20.5)	31.8 (28.3, 35.6)	26.0 (22.7, 29.5)	17.0 (14.3, 20.1)	12.9 (10.5, 15.7)	12.6 (10.2, 15.4)
T	55.3 (50.4, 60.0)	11.5 (8.8, 14.9)	12.5 (9.6, 16.1)	31.6 (27.3, 36.3)	24.0 (20.1, 28.3)	12.0 (9.2, 15.6)	7.4 (5.2, 10.4)	12.0 (9.2, 15.5)
All-Wales: Resistance rates	**61.7** (60.9, 62.5)	**21.7** (21.1, 22.4)	**16.9** (16.3, 17.6)	**34.7** (34, 35.5)	**29.6** (28.9, 30.4)	**15.8** (15.2, 16.4)	**12.8** (12.2, 13.3)	**17.2** (16.6, 17.9)
All-Wales: Number of isolates	**14910**	**13967**	**14059**	**16018**	**14851**	**16097**	**14840**	**13143**

Key: **AMO** = amoxicillin &/or ampicillin, **AUG** = co-amoxiclav, **1GC** = resistance to any first generation cephalosporin, **TRI** = trimethoprim, **AMO/TRI** = co-resistance to amoxicillin & trimethoprim, **FQ** = ciprofloxacin &/or levofloxacin or norfloxacin, **AMO/TRI/FQ** = co-resisatnce to amoxicillin, trimethoprim & fluoroquinolone, **NIT** = nitrofurantoin

Community Urinary Coliforms

The All-Wales pattern of antimicrobial resistance is shown in Figures 18 & Table 6, with statistically significant increases in the resistance rates for antimicrobials other than nitrofurantoin between 2006 and 2007. The high rates of resistance, notably for trimethoprim, reflect an element of selective testing within the community. The true rate of resistance to trimethoprim in patients presenting with uncomplicated UTI in the community is likely to be considerably lower, and trimethoprim remains the suggested first-line empirical therapy for these patients.

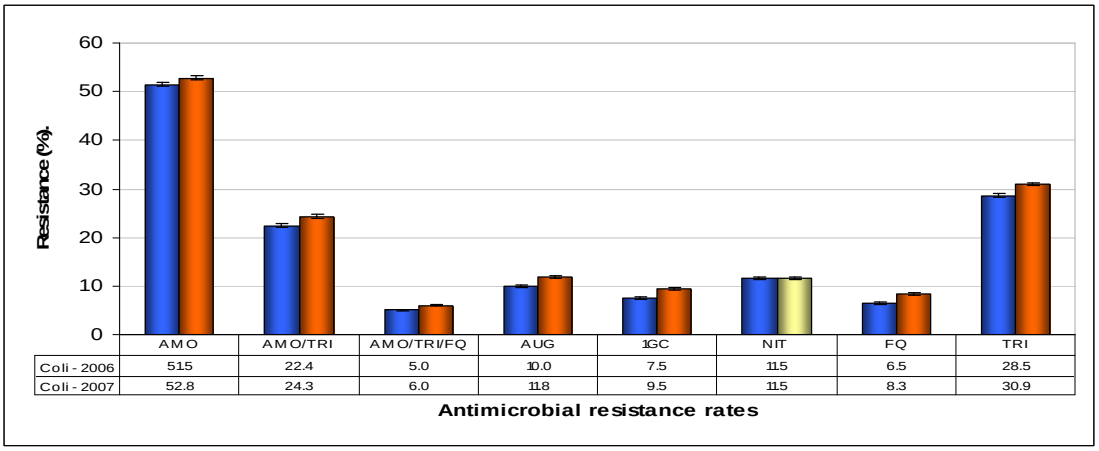


Figure 18: All-Wales antimicrobial resistance rates for coliforms from community urine samples (2006 & 2007).

The rates of resistance to both 1st generation cephalosporins and co-amoxiclav (see Figure 19) were particularly high in the communities served by the laboratories at the Royal Glamorgan Hospital (C) and Prince Charles Hospital (N).

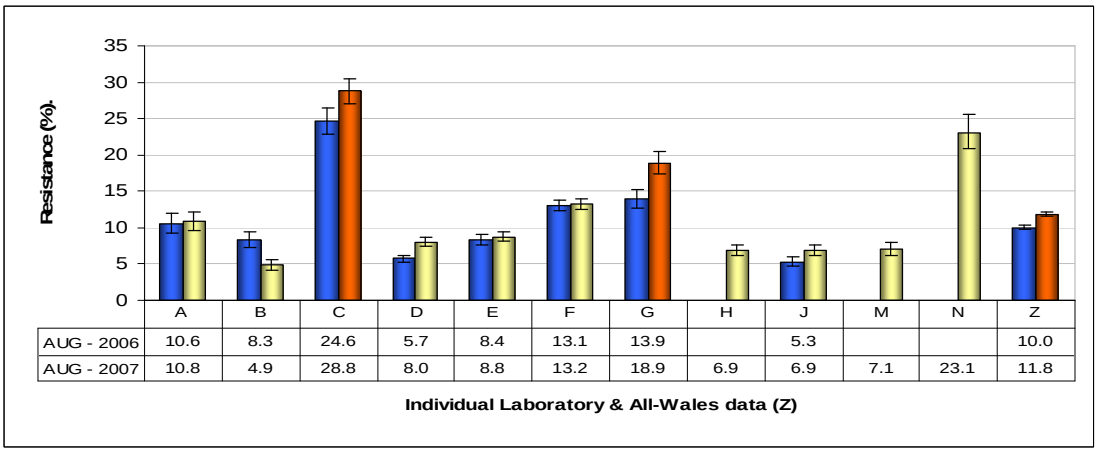


Figure 19: Co-amoxiclav resistance in community urinary coliforms; individual laboratory data (2006 & 2007).

Locally, there was variability in fluoroquinolone resistance rates within Wales 4.9% to 10.9% (see Figure 20); with notable increases in the rates for Bangor (K), Royal Glamorgan (C) and Swansea (E) community isolates. Note: For four laboratories there was no 2006 data for comparison.

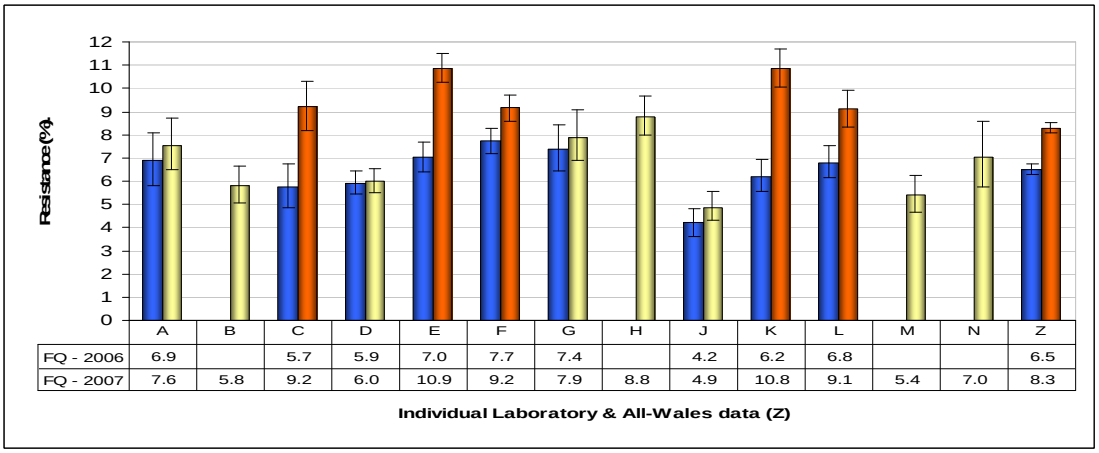


Figure 20: Fluoroquinolone resistance in community urinary coliforms; individual laboratory data (2006 & 2007).

The All-Wales resistance rate for nitrofurantoin was 11.5% (11.3, 11.8); the inclusion of *Proteus* species in the coliform group undoubtedly inflates the nitrofurantoin resistance rates. When *Proteus* species were excluded from the analysis the All-Wales resistance rate was 7.8% (7.6, 8.1).

In-patient Urinary Coliforms

The All-Wales pattern of antimicrobial resistance is shown in Figures 21 & Table 7, with statistically significant increases in the resistance rates for antimicrobials other than nitrofurantoin between 2006 and 2007.

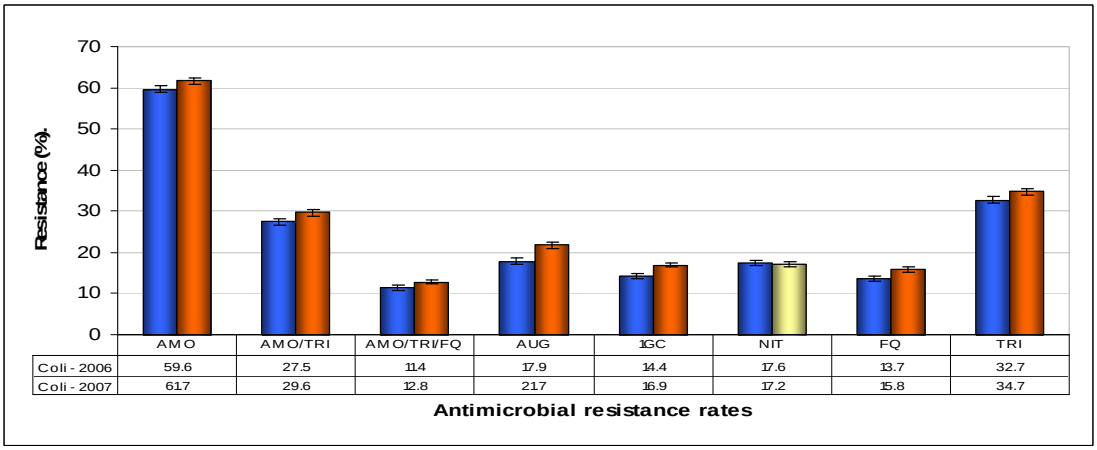


Figure 21: All-Wales antimicrobial resistance rates for coliforms from hospital in-patient urine samples (2006 & 2007).

Locally, there was wide variability in resistance rates within Wales; with notably high rates in some hospitals e.g. co-amoxiclav resistance in Royal Glamorgan (C) was 40.4% (see Figure 22) and fluoroquinolone resistance in Llandough Hospital (P) was 34.0% (see Figure 23).

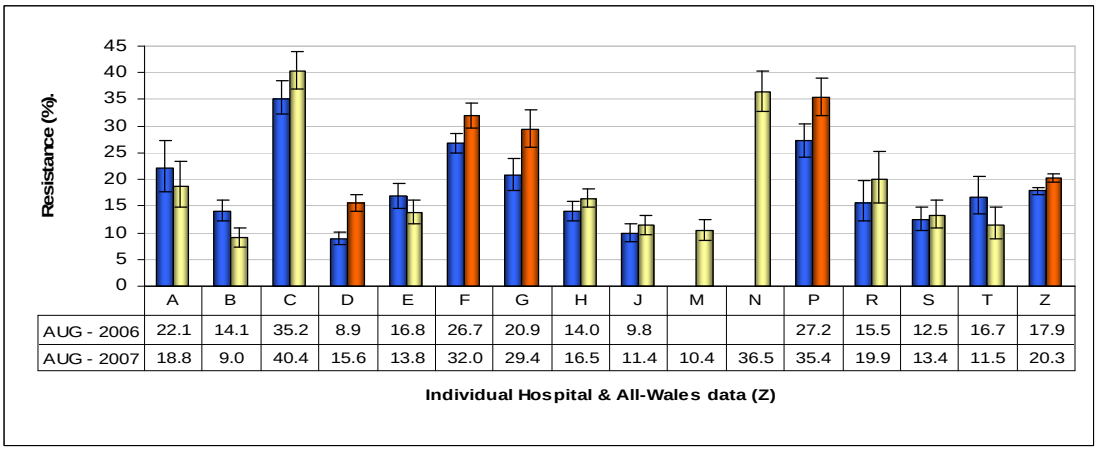


Figure 22: Co-amoxiclav resistance in hospital in-patient urinary coliforms; individual hospital data (2006 & 2007).

The high rates of resistance to both co-amoxiclav and first generation cephalosporins reported from in-patient isolates in the Royal Glamorgan Hospital (C) and Prince Charles Hospital (N) correlates with the high rates observed in their community isolates.

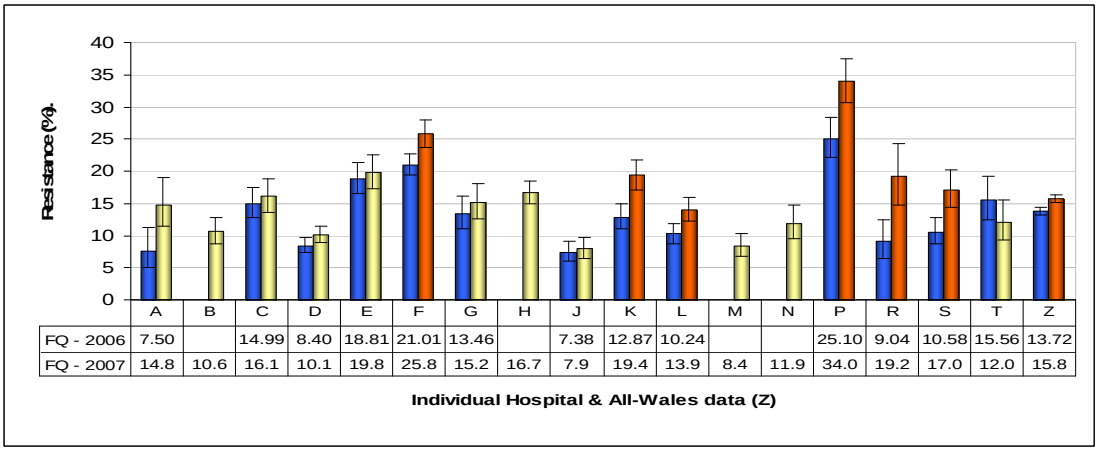


Figure 23: Fluoroquinolone resistance in hospital in-patient urinary coliforms; individual hospital data (2006 & 2007).

The All-Wales resistance rate for nitrofurantoin was 17.2%; when *Proteus* species were excluded from the analysis the resistance rate was 12.8% (12.2, 13.4).

Section 7: Antimicrobial resistance rates for *S. aureus* from general practice wound swabs

The data in this section is presented to reflect the antimicrobial susceptibility of organisms causing skin and soft tissue infections occurring in the community. However, it should be noted that there is a significant sampling bias in this data. Thus the fact that 16% of *S. aureus* isolates are resistant to Meticillin should not be interpreted to mean that this rate of resistance pertains to infection in the majority of patients in the community.

MSSA

The All-Wales pattern of antimicrobial resistance is shown in Figures 24 & Table 8, with no statistically significant difference in the resistance rates for antimicrobials other than erythromycin between 2006 and 2007.

Table 8: Community Meticillin sensitive *Staphylococcus aureus* (MSSA)

TABLE 8: Meticillin Sensitive *Staphylococcus aureus* (MSSA) from community wound swabs
Resistance rates including (95% Confidence Intervals)
Duplicate Cut Off: ≤14 days
Time period: 1 January 2006 - 31 December 2007

Organism & Year	PEN	TET	ERY	FUS	GEN
MSSA - 2007	**85.0** (84.4, 85.64)	**3.4** (3.1, 3.8)	**9.9** (9.4, 10.4)	**13.8** (13.2, 14.5)	**0.7** (0.5, 0.8)
All-Wales: Number of isolates	**12498**	**9086**	**14253**	**10588**	**12512**
MSSA - 2006	**86.6** (85.9, 87.4)	**4.1** (3.4, 4.9)	**11.5** (10.9, 12.2)	**13.6** (12.9, 14.4)	**0.5** (0.4, 0.7)
All-Wales: Number of isolates	**7624**	**2795**	**9275**	**8498**	**8498**

Key: **PEN = pencillin**, **TET** = tetracycline, **ERY** = erythromycin, **FUS** = fusidic acid, **GEN** = gentamicin

Erythromycin rates decreased from 11.5% (10.9, 12.2) to 9.9% (9.4, 10.4). Locally, there was some variability in gentamicin resistance rates within Wales 0.0 - 4.7%, with the higher rate in the community served by Royal Glamorgan (this is consistent with the high rate of gentamicin resistance seen in MSSA in blood cultures from the same hospital).

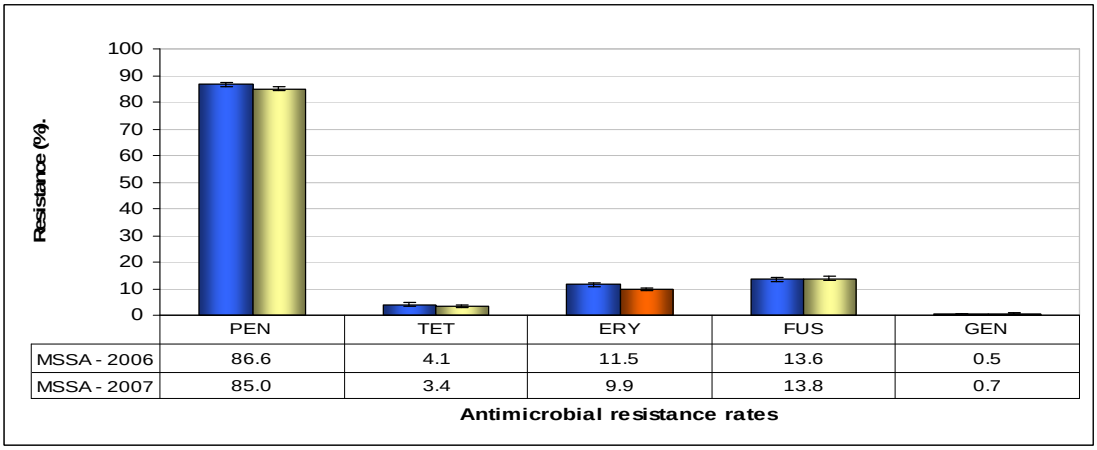


Figure 24: All-Wales antimicrobial resistance rates for MSSA isolated from wound swabs referred from general practice (2006 & 2007).

Table 9: Community Meticillin resistant *Staphylococcus aureus* (MRSA)

TABLE 9: Meticillin Resistant *Staphylococcus aureus* (MRSA) from community wound swabs
Resistance rates including (95% Confidence Intervals)
Duplicate Cut Off: ≤14 days
Time period: 1 January 2006 - 31 December 2007

Organism & Year	CIP	ERY	FUS	GEN	LZD	MUP	RIF	TET	VAN
MRSA - 2007	**95.4** (94.3, 96.3)	**68.0** (66.2, 69.7)	**14.6** (13.2, 16.0)	**1.1** (0.8, 1.6)	**0.0** (0.0, 0.3)	**4.0** (3.3, 5.0)	**0.7** (0.4, 1.2)	**7.2** (6.2, 8.4)	**0.00** (0.0, 0.3)
All-Wales: Number of isolates	**1630**	**2629**	**2492**	**2555**	**1268**	**2153**	**1816**	**2127**	**1482**
MRSA - 2006	**96.4** (95.1, 97.4)	**71.2** (69.0, 73.3)	**13.5** (12.1, 15.1)	**1.3** (0.9, 2.0)	**0.0** (0.0, 0.6)	**3.4** (2.5, 4.5)	**0.5** (0.2, 1.2)	**6.7** (5.5, 8.1)	**0.00** (0.0, 0.2)
All-Wales: Number of isolates	**956**	**1781**	**1974**	**1943**	**590**	**1329**	**962**	**1424**	**2274**

Key: **CIP** = ciprofloxacin &/or levofloxacin, **ERY** = erythromycin, **FUS** = fusidic acid, **GEN** = gentamicin, **LZD** = linezolid, **MUP** = mupirocin, RIF = rifampicin, **TET** = tetracycline, **VAN** = vancomycin

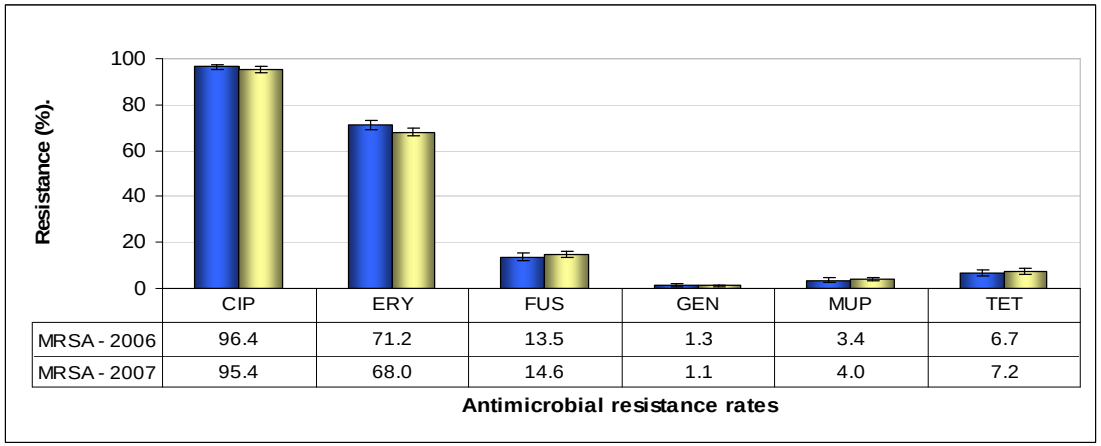


Figure 25: All-Wales antimicrobial resistance rates for MRSA isolated from wound swabs referred from general practice (2006 & 2007).

MRSA

The All-Wales pattern of antimicrobial resistance is shown in Figure 25 & Table 9, with no statistically significant difference in the resistance rates between 2006 and 2007. Locally, there was some variability in gentamicin resistance rates within Wales 0.0 – 6.1%, with the higher rates in the communities served by Royal Glamorgan (5.3%) and Withybush Hospital (6.1%).

As for 2006, resistance to linezolid and vancomycin remained undetected.

Section 8: Antimicrobial resistance rates for other pathogens (all-specimens, community & hospital).

The data in this section of the report comprises other pathogens which may commonly cause important infections other than bacteraemia.

- *Streptococcus pneumoniae*
- *Streptococcus pyogenes*
- *Haemophilus influenzae*
- *Campylobacter species*
- *Neisseria gonorrhoeae*

S. pneumoniae

The All-Wales pattern of antimicrobial resistance is shown in Figures 26 & Table 10, with no statistically significant difference in resistance rates between 2006 & 2007.

Table 10: *Streptococcus pneumoniae* (all specimens and all locations)

TABLE 10: *Streptococcus pneumoniae* - all specimens & locations
Resistance rates including (95% Confidence Intervals)
Duplicate Cut Off: ≤90 days
Time period: 1 January 2006 - 31 December 2007

Organism & Year	PEN	TET	ERY
SPNE - 2007	**4.2** (3.6, 4.8)	**5.2** (4.5, 5.9)	**9.8** (9.0, 10.7)
All-Wales: Number of isolates	**4458**	**3883**	**4538**
SPNE - 2006	**4.5** (3.8, 5.3)	**4.9** (4.1, 5.9)	**11.9** (10.7, 13.1)
All-Wales: Number of isolates	**3048**	**2100**	**2786**

Key: **PEN** = pencillin, **TET** = tetracycline, **ERY** = erythromycin

Locally, there was variability in penicillin resistance rates within Wales 0% to 6.6%; with notably high resistance (>6%) in the communities served by the laboratories at the Princess of Wales, UHW and Withybush General hospitals.

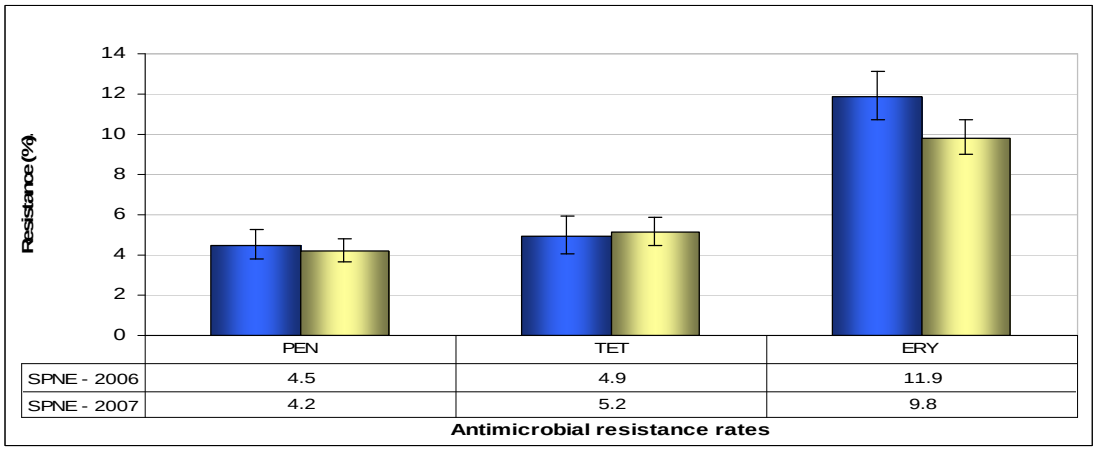


Figure 26: All-Wales antimicrobial resistance rates *S. pneumoniae*: All specimens, both hospital & community (2006 & 2007).

Streptococcus pyogenes

The All-Wales pattern of antimicrobial resistance is shown in Figures 27 & Table 11, with no statistically significant difference in resistance rates between 2006 & 2007.

Table 11: *Streptococcus pyogenes* (all specimens and all locations)

TABLE 11: *Streptococcus pyogenes* - all specimens & locations
Resistance rates including (95% Confidence Intervals)
Duplicate Cut Off: ≤90 days
Time period: 1 January 2006 - 31 December 2007

Organism & Year	PEN	TET	ERY
SPYO - 2007	**0.0** (0.0, 0.1)	**10.2** (9.2, 11.2)	**4.8** (4.2, 5.5)
All-Wales: Number of isolates	**4436**	**3521**	**4402**
SPYO - 2006	**0.0** (0.0, 0.2)	**11.4** (9.7, 13.4)	**3.5** (2.9, 4.3)
All-Wales: Number of isolates	**2206**	**1162**	**2676**

Key: **PEN** = pencillin, **TET** = tetracycline, **ERY** = erythromycin

Locally, there was variability in erythromycin resistance rates within Wales 0% to 10.3%; with the highest resistance reported in the community served by the laboratory at UHW in Cardiff.

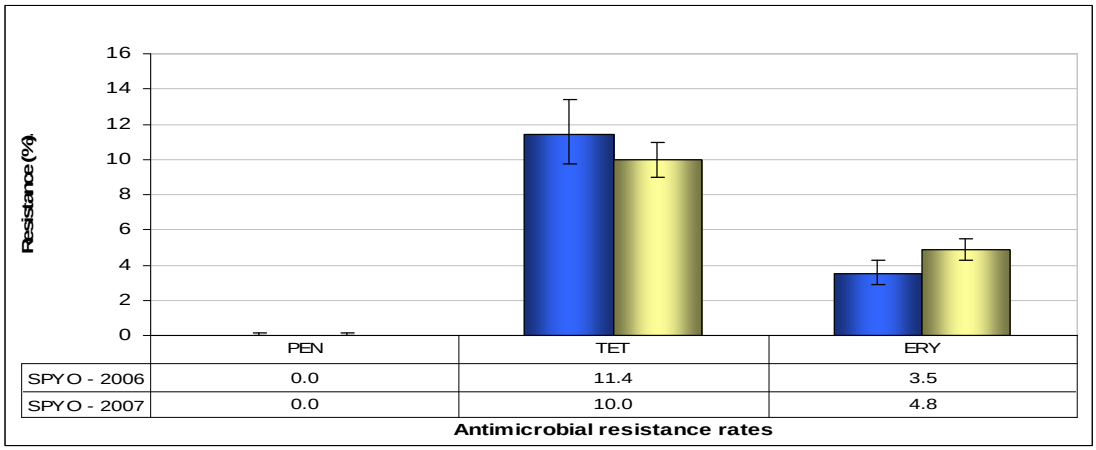


Figure 27: All-Wales antimicrobial resistance rates *S. pyogenes*: All specimens both hospital & community (2006 & 2007).

Haemophilus influenzae

The All-Wales pattern of antimicrobial resistance is shown in Figures 28 & Table 12, with no statistically significant difference in resistance rates between 2006 & 2007.

Table 12: *Haemophilus influenzae* (all specimens and all locations)

TABLE 12: *Haemophilus influenzae* - all specimens & locations
Resistance rates including (95% Confidence Intervals)
Duplicate Cut Off: ≤90 days
Time period: 1 January 2006 - 31 December 2007

Organism & Year	AM0	AUG	TET
HINF - 2007	**21.9** (21.0, 22.8)	**7.1** (6.6, 7.7)	**1.4** (1.1, 1.9)
All-Wales: Number of isolates	**8566**	**8068**	**3762**
HINF - 2006	**20.1** (19.0, 21.2)	**6.2** (5.5, 7.0)	**2.4** (1.8, 3.2)
All-Wales: Number of isolates	**5186**	**4257**	**1894**

Key: **AMO** = amoxicillin &/or ampicillin, **AUG** = co-amoxiclav, **TET** = tetracycline

Locally, there was variability in co-amoxiclav resistance rates within Wales 2.6 – 19.5%, with higher rate reported in the community served by the laboratory at Ysbyty Glan Clwyd. However, all rates were either lower or comparable to the rate published by BSAC for respiratory isolates of 17.4% (14.9, 20.2).

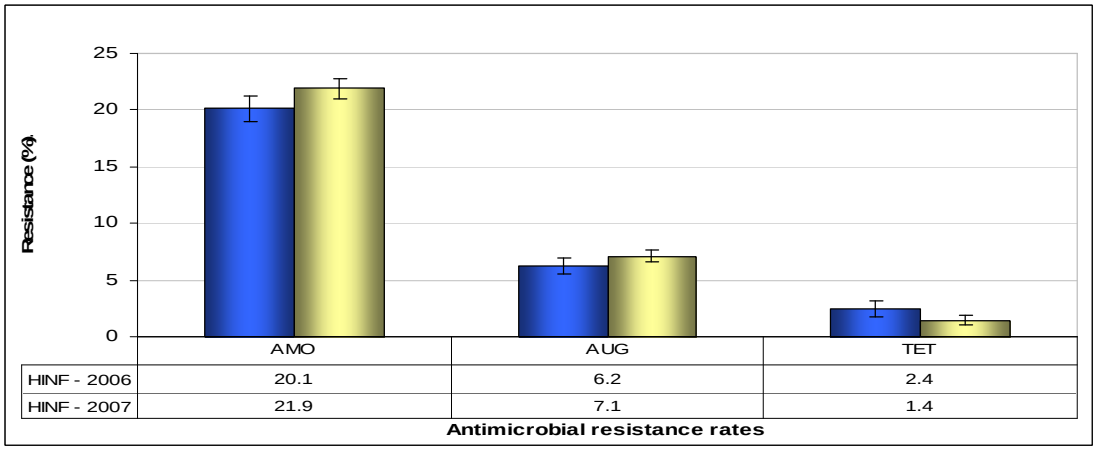


Figure 28: All-Wales antimicrobial resistance rates *H. influenzae*: All specimens, both hospital & community (2006 & 2007).

Campylobacter species

The All-Wales pattern of antimicrobial resistance is shown in Table 13; although there is an increase in resistance rates it should be noted that the 2006 rates did not include data for UHW and Nevill Hall.

Table 13: *Campylobacter* spp. (Community & hospital)

TABLE 13: *Campylobacter* spp. - all specimens & locations **Resistance rates including (95% Confidence Intervals)** **Duplicate Cut Off: ≤90 days** **Time period: 1 January 2006 - 31 December 2007**		
Organism & Year	**CIP**	**ERY**
CAMP - 2007 All-Wales: Number of isolates	**28.1** (26.5, 29.7) **3041**	**3.4** (2.8, 4.1) **3202**
CAMP - 2006 All-Wales: Number of isolates	**24.9** (23.1, 26.8) **2044**	**2.1** (1.5, 2.8) **2497**
Key: **CIP** = ciprofloxacin (includes levofloxacin results for one labroatory), **ERY** = erythromycin		

In 2007, the All-Wales rate for ciprofloxacin resistance was 28.1% and for erythromycin resistance was 3.4%. Locally, there was variability in ciprofloxacin resistance rates within Wales 11.8% - 69.8%, with the notably high resistance in the communities served by the laboratory at the Princess of Wales hospital (69.8%). Also, variability in erythromycin resistance rates 0.0 % – 39.1%, with notably high resistance in the communities served by the laboratory at the Royal Glamorgan hospital (39.1%).

Generally campylobacter isolates were not identified to species level, and so resistance rates are not comparable to other surveillance scheme data. The following rates were published by the HPA for England and Wales:

- Ciprofloxacin: *C. jejuni* (46%), *C. coli* (36%).
- Erythromycin: *C. jejuni* (9%), *C. coli* (54%).

Neisseria gonorrhoeae

The All-Wales pattern of antimicrobial resistance in N. gonorrhoeae for the year 2007 is shown in Figure 29. It is compared below to data published by the HPA GRASP (Gonococcal Resistance to Antimicrobials Surveillance) scheme which samples approximately 10% of gonococci and tests susceptibility centrally.

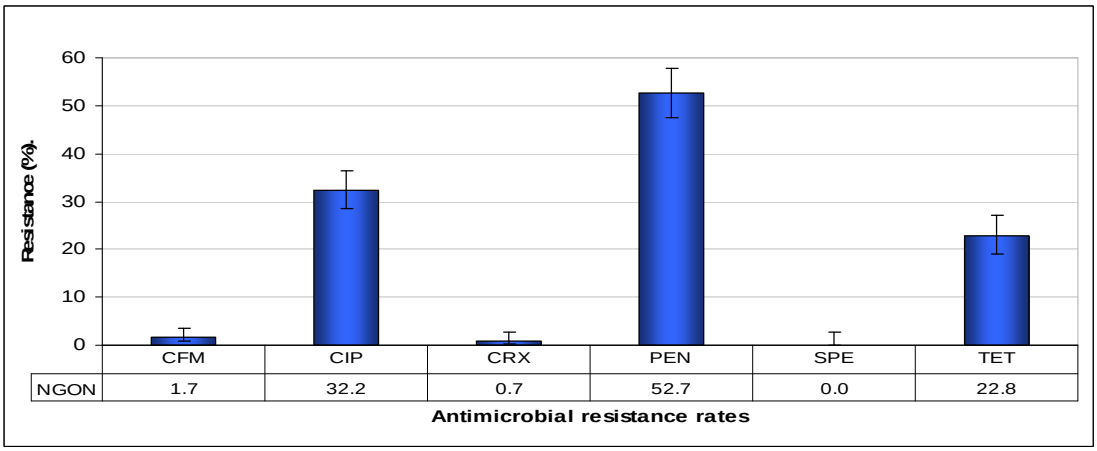


Figure 29: All-Wales antimicrobial resistance rates *N. gonorrhoeae* for 2007

Resistance to β-lactams

- The All-Wales resistance rate for cefixime (CFM) was 1.7% (0.8, 3.5), and is higher than the rate published in the HPA GRASP report for E&W of 0.2% (0.0, 0.6).
- The All-Wales resistance rate for ceftriaxone (CRX) was 0.7%, and is higher than the rate published in the HPA GRASP report of 0% (0.0, 0.0).
- The All-Wales resistance rate for penicillin (PEN) was 52.7%. This figure includes isolates that were intermediate as well as fully resistant, and is therefore higher than the rate published in the HPA GRASP report of 24% (18.3, 30.1) which includes only fully resistant isolates.

Resistance to spectinomycin

- Resistance to spectinomycin was not detected, and was not reported in the GRASP data.

Resistance to ciprofloxacin

- The All-Wales resistance rate for ciprofloxacin (CIP) was 32.2% (28.4, 36.3), and is comparable to the rate published in the HPA GRASP report of 28% (20.9, 35.6).

Resistance to tetracycline

- The All-Wales resistance rate for tetracycline (TET) was 22.8% (19.0, 27.1), and is lower than the rate published in the HPA GRASP report of 60% (51.2, 67.5).

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Dr Elizabeth Kubiak and colleagues, Royal Gwent Hospital, Newport
Dr Milada Tavodova and colleagues, Prince Charles Hospital, Merthyr
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