9.2 Antimicrobial Resistance

Summary

Key Points

- There were 1,309 reports of *S. aureus* bacteraemia submitted to the European Antimicrobial Resistance Surveillance Network (EARS-Net), of which 355 (27.1%) were meticillin-resistant *S. aureus* (MRSA). This represents a significant decrease from 33.7% reported in 2008. Overall, the number of MRSA reports was down by 19% from 439 in 2008

  For acute hospitals, the rate of MRSA bacteraemia was 0.089 cases per 1,000 patient bed days used, a decrease from 0.111 in 2008. Over the same period, the rate of meticillin-susceptible *S. aureus* (MSSA) increased from 0.216 to 0.237

- There were 356 reports of invasive *S. pneumoniae* infection compared to 447 in 2008, a decrease of 20%. The national rate of invasive infection was 8.6 compared to 10.8 per 100,000 population in 2008. The biggest reductions in numbers of reports and rates of infection were seen in children <2 years, the target population for the 7-valent conjugate (PCV-7) introduced in September 2008

  The proportion of penicillin-non-susceptible *S. pneumoniae* (PNSP) decreased from 23.1% in 2008 to 20.2% in 2009; the proportion of isolates with high-level resistance to penicillin decreased marginally from 6.1% in 2008 to 5.6% in 2009 while intermediate level resistance decreased significantly from 16.9% to 13.3%

  Serotype data were available on 302 of 356 isolates (85%) and results indicate good coverage for both the 23-valent polysaccharide (PPV23) and PCV7 vaccines in their target populations: 87% (adults ≥65 years) and 56% (children <2 years), respectively

- There were 397 reports of *E. faecium* bacteraemia compared with 406 in 2008. The proportion that was vancomycin-resistant *E. faecium* (VREfm) increased from 35.7% in 2008 to 38.3% in 2009. Multi-drug resistant (MDR) *E. faecium* increased from 16.2% to 26.7%

- There were 2,064 reports of invasive *E. coli* infection, an increase of 7% from 1,924 reports in 2008. Resistance to third-generation cephalosporins (3GCs) remained stable at 7.5% but extended-spectrum beta-lactamase (ESBL)-production increased from 5.0% to 5.8% in 2009. Ciprofloxacin resistance decreased slightly from 23.3% to 22.3%, the first decrease since surveillance began in 2002. MDR *E. coli* also decreased from 12.1% in 2008 to 10.4% in 2009

- There were 323 reports of invasive *K. pneumoniae* infections compared to 311 in 2008

- There were 248 reports of invasive *P. aeruginosa* infections compared to 199 in 2008, an increase of 25%

- For the 14 laboratories participating in enhanced bacteraemia surveillance, the rate of clinically-significant MRSA bloodstream infection decreased from 0.065 cases per 1,000 patient bed days used in 2008 to 0.058 in 2009, while the rate for MSSA increased from 0.080 in 2008 to 0.122 in 2009

- See http://www.hpsc.ie for further details of EARS-Net, antimicrobial resistance and enhanced bacteraemia surveillance in Ireland

- European data are available at http://ecdc.europa.eu/en/activities/surveillance/EARS-Net/Pages/Database.aspx

Introduction

The European Antimicrobial Resistance Surveillance Network (EARS-Net), previously the European Antimicrobial Resistance Surveillance System (EARSS), in Ireland collects routinely-generated antimicrobial susceptibility testing data on seven important bacterial pathogens using the EARS-Net case definition. Participating laboratories submit data on the "primary" or first isolate from blood or cerebrospinal fluid (CSF) per patient per quarter. EARS-Net does not distinguish clinically significant isolates from contaminants and primarily serves as a surveillance system to measure national levels of antimicrobial resistance (AMR). In 2009, all 44 microbiology laboratories (43 by year-end) participated in EARS-Net resulting in complete coverage of the Irish population.

Staphylococcus aureus

There were 1,309 reports of *S. aureus* bacteraemia from 1,262 patients, of which 355 (27.1%) were meticillin-resistant *S. aureus* (MRSA) (table 1). This represents the lowest annual proportion since surveillance began in 1999. In 2008, the proportion was 33.7%. The decrease observed in 2008 was highly significant (Chi^2=13.3, P=0.0003). This is the third successive year in which a decrease has been observed and this downward trend is also highly significant (Chi^2_{trend}=71.4, P<0.0001) (figure 1). Overall, there was a 19.1% reduction in the number of MRSA bacteraemia reports compared with 2008 (355 vs. 439). The total number of meticillin-susceptible *S. aureus* (MSSA) bacteraemia reports increased by 10.4% from 864 in 2008 to 954 in 2009. The reason for this increase is unclear, but may be related to differences in the epidemiology of MSSA versus MRSA, or to infection control interventions that selectively target MRSA. Greater participation of laboratories in enhanced bacteraemia surveillance would go some way to elucidate the key risk factors for acquisition and infection by MSSA strains, thereby allowing appropriate measures to be implemented to help reduce the burden of infection associated with these organisms. One key factor to consider is that MRSA tends to be clonal (i.e. one or two strains may be responsible for the majority of infections in a healthcare setting) while MSSA is generally much more heterogeneous in nature (i.e. many different strains are present) and often acquisition is from the patient's own normal bacterial flora, although clonal spread of MSSA in healthcare settings is increasingly recognised. Despite the decrease in numbers and proportion of MRSA, Ireland still had one of the higher proportions of MRSA in Europe in 2009 (see http://ecdc.europa.eu/en/activities/surveillance/EARS-Net/Pages/Database.aspx for European data, including EARS-Net tables, charts and maps).

No MRSA isolates with reduced susceptibility to vancomycin were detected at the National MRSA Reference Laboratory by the Etest® macromethod. The MRSA rate for all acute hospitals in 2009 was 0.089 cases per 1,000 patient bed days used, representing a decrease from 0.111 in 2008, while the MSSA rate increased from 0.216 to 0.237 [Note: the rates are now calculated taking into account the denominator data (bed days used) obtained from the Business Intelligence Unit at the Health Services Executive for all acute public hospitals; and directly from the hospitals for private hospitals where available, where both numerator (MRSA numbers) and denominator data have been provided. This contrasts with previous reports when only data from acute public hospitals were considered].

In patients with laboratory-confirmed *S. aureus* bacteraemia, the probability that the infecting organism was MRSA as compared to MSSA was over 1.7-times greater in patients aged ≥65years than in those aged <65 years (RR=1.66, Chi^2=29.5, P<0.0001).

Males were approximately 1.8-times more likely to get an invasive *S. aureus* infection (2.1-times for MRSA, z=7.0, P<0.0001; 1.7-times for MSSA, z=8.7, P<0.0001) than females (z=11.0, P<0.0001). The frequency of

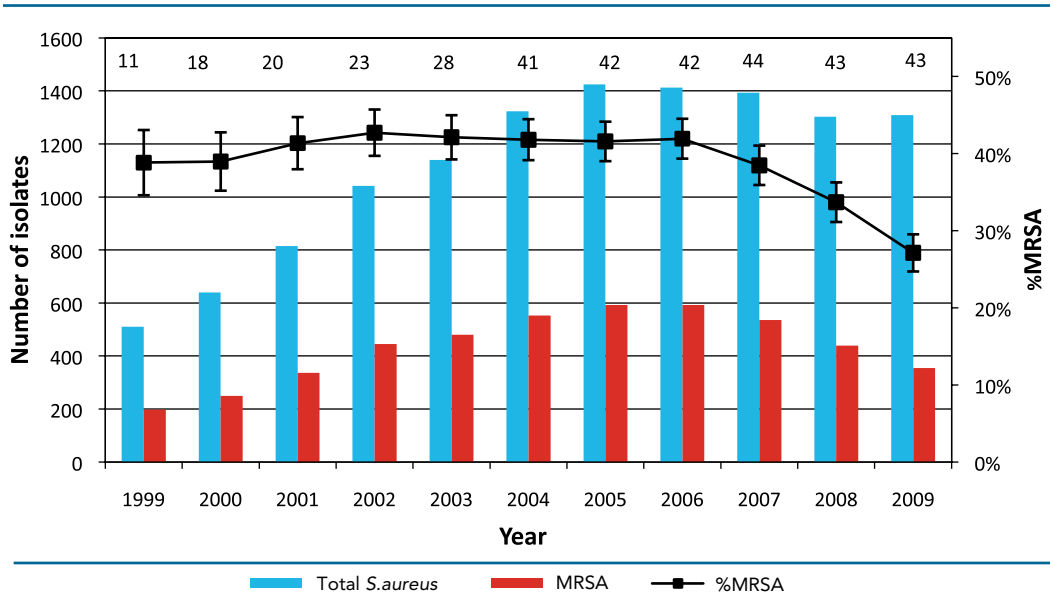

Figure 1. Trends for S. aureus – total numbers of S. aureus/MRSA and percentage MRSA with 95% confidence intervals The numbers of participating laboratories by year-end are indicated above the bars

Table 1. Summary of EARSS data by pathogen and year, 1999-2009

Pathogen	Year										
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Number laboratories by year-end	**12**	**19**	**20**	**23**	**28**	**41**	**42**	**42**	**44**	43	**43**
S. aureus											
Number of isolates	510	639	815	1042	1140	1323	1424	1412	1393	1303	1309
Number Meticillin-R (or MRSA)	198	249	337	445	480	553	592	592	536	439	355
Meticillin-R (or MRSA)	38.8%	39.0%	41.3%	42.7%	42.1%	41.8%	41.6%	41.9%	38.5%	33.7%	27.1%
Number VISA	0	0	0	0	0	0	0	2	1	0	0
VISA*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%
Number laboratories by year-end	**12**	**19**	**20**	**23**	**28**	**41**	**42**	**42**	**44**	**42**	**43**
S. pneumoniae											
Number of isolates	157	201	245	278	364	400	401	407	438	447	356
Penicillin-NS*	19.1%	13.4%	12.2%	11.5%	11.8%	10.3%	11.7%	15.7%	17.4%	23.1%	20.2%
of which: HLR	0.0%	3.5%	1.6%	1.4%	2.2%	1.8%	3.0%	2.9%	5.7%	6.1%	5.6%
Int	16.6%	8.5%	10.6%	9.7%	8.8%	7.0%	8.7%	12.5%	11.0%	16.9%	13.8%
Erythromycin-R*	14.0%	12.0%	12.5%	12.7%	11.6%	14.4%	12.1%	16.1%	16.4%	16.7%	17.3%
E. faecalis											
Number of isolates				168	218	242	290	294	281	301	289
Ampicillin-R*	No data	No data	No data	8.1%	5.1%	0.8%	3.5%	4.5%	2.2%	0.7%	2.1%
Vancomycin-R				2.4%	1.4%	1.3%	2.5%	3.7%	2.8%	3.7%	0.7%
HLG-R*				38.5%	33.9%	41.3%	43.1%	42.4%	37.2%	30.5%	36.7%
E. faecium											
Number of isolates				85	135	187	224	265	332	406	397
Ampicillin-R*	No data	No data	No data	88.9%	91.0%	95.7%	92.3%	93.9%	93.1%	95.1%	92.9%
Vancomycin-R				11.1%	19.4%	23.2%	31.7%	37.1%	33.5%	35.7%	38.3%
HLG-R*				16.7%	53.8%	58.0%	51.4%	44.3%	34.9%	28.1%	39.1%
MDR*				3.7%	11.4%	18.5%	25.6%	25.6%	22.3%	16.2%	26.7%
E. coli											
Number of isolates				741	991	1256	1445	1656	1784	1924	2064
Ampicillin-R*				62.2%	61.9%	65.0%	67.6%	70.7%	68.3%	70.3%	68.7%
3GC-R*				3.0%	2.4%	2.4%	4.1%	4.1%	6.7%	7.5%	7.5%
Ciprofloxacin-R*	No data	No data	No data	5.4%	9.5%	12.6%	17.3%	21.5%	22.1%	23.3%	22.3%
Gentamicin-R*				2.7%	3.9%	5.7%	8.5%	7.7%	9.9%	10.2%	7.7%
Gentamicin/Tobramycin/Amikacin-R*				2.9%	4.3%	6.1%	8.6%	8.6%	10.6%	11.0%	9.3%
ESBL-producers*				1.2%	1.3%	1.1%	2.4%	2.5%	4.1%	5.0%	5.8%
MDR*				2.4%	3.8%	5.6%	7.7%	9.0%	11.4%	12.1%	10.4%
Number laboratories by year-end								**36**	**39**	**41**	**42**
K. pneumoniae											
Number of isolates								217	244	311	323
Ampicillin-R*								97.7%	99.2%	99.7%	99.7%
3GC-R*								10.2%	9.9%	11.3%	11.2%
Ciprofloxacin-R*	No data	No data	No data	No data	No data	No data	No data	15.3%	18.1%	12.7%	13.0%
Gentamicin-R*								7.8%	9.9%	10.6%	11.1%
Imipenem/meropenem-R*								0.0%	0.6%	0.0%	0.0%
ESBL-producers*								8.6%	3.7%	7.7%	8.2%
MDR*								11.2%	11.9%	9.9%	11.9%
P. aeruginosa											
Number of isolates								128	177	199	248
Pipericillin/tazobactam-R*								9.4%	12.6%	9.7%	8.9%
Ceftazidime-R*	No data	No data	No data	No data	No data	No data	No data	10.6%	11.8%	8.7%	11.8%
Imipenem/meropenem-R*								11.8%	12.2%	9.3%	9.7%
Ciprofloxacin-R*								18.0%	22.9%	21.8%	12.1%
Gentamicin-R*								10.2%	13.3%	9.0%	7.7%
MDR*								9.5%	12.5%	11.1%	6.4%

R, Resistant; NS, Non-Susceptible [includes isolates with intermediate (Int) and high-level resistance (HLR)]
MRSA, Meticillin-Resistant *S. aureus*; VISA, Vancomycin-Intermediate *S. aureus*
HLG, High-Level Gentamicin; 3GC, 3rd-Generation Cephalosporin (includes cefotaxime, ceftriaxone, ceftazidime and cefpodoxime);
ESBL, Extended-Spectrum Beta-Lactamase; MDR, Multi-Drug Resistant
* Not all isolates tested
Changes to the data presented in previous reports are highlighted in red

invasive *S. aureus* infection increased with age, with the majority of infections (n=775; 59%) occurring in adults over 60 years. The median age for patients with an MRSA infection was 72 years (95%CI, 70-73) while the median age for patients with MSSA was 62 years (95%CI, 60-64). This was considered to be a significant difference as the confidence intervals did not overlap.

Streptococcus pneumoniae

There were 356 reports of invasive *S. pneumoniae* infection (350 from blood and six from CSF) from 356 patients, a decrease of 20.4% from 447 reports in 2008. See table 1 for the annual proportions of *S. pneumoniae* isolates non-susceptible/resistant to penicillin and erythromycin by year since 1999 when surveillance began. Penicillin-non-susceptible *S. pneumoniae* (PNSP) accounted for 20.2% (n=72) of all isolates tested against penicillin (n=356) in 2009 (table 1). Of the 72 PNSP isolates, 49 were intermediately-resistant (Int; MIC=0.1-1.0mg/L) and 20 were HLR (MIC >1.0mg/L) to penicillin. No penicillin MICs were available for three non-susceptible (NS) isolates. The proportion of PNSP in Ireland increased significantly over the four years from 10.3% in 2004 to 23.1% in 2008 (Chi^2_{trend}=31.5, P<0.0001) but shows signs of a decrease in 2009 (figure 2). The proportion of isolates with high-level resistance (HLR) to penicillin decreased slightly from 6.1% in 2008 to 5.6% in 2009. Fifty-eight (17.3%) of 336 isolates were resistant to erythromycin, a slight increase from 16.7% in 2008.

In 2009, Ireland had one of the highest proportions of PNSP, and HLR to penicillin among *S. pneumoniae*, in countries reporting to EARS-Net, although comparisons with other EARS-Net countries is problematic due to the possibility of different interpretive criteria being applied to the data. [Note: The Clinical Laboratory Standards Institute (CLSI) now provides three sets of breakpoints for interpreting penicillin susceptibility of *S. pneumoniae* isolates: meningitis, non-meningitis and oral. In Ireland, EARS-Net data are reported using the "oral" breakpoints (which correspond to the original CLSI breakpoints) for epidemiological purposes, and thus consistency].

Moderately high levels of erythromycin resistance were seen, similar to the situation observed in much of Southern and Central Europe. Of isolates tested against both penicillin and erythromycin (n=336), 40 (11.9%) were simultaneously PNSP (29 Int, 10 HLR) and erythromycin-resistant in 2008 compared with 10.2% in 2008.

Prior to the introduction of the 7-valent pneumococcal conjugate vaccine (PCV7) into the childhood immunisation schedule in September 2008, a national pilot project was established early in 2007 as a result of a collaborative initiative between RCSI/Beaumont Hospital, Children's University Hospital, Temple St and HPSC with the aim of providing baseline serotyping data on invasive *S. pneumoniae* isolates. Serotype data were available on 302 pneumococcal isolates from 30 laboratories (of 34 that reported pneumococcal isolates to EARS-Net in 2009) representing 85% of all pneumococcal isolates reported in 2009. Overall, 272 (90%) and 124 (41%) isolates belonged to serotypes covered by the pneumococcal polysaccharide (PPV23; target population: adults ≥65 years and at risk groups) and conjugate (PCV7; target population: children <2 years) vaccines, respectively. From adults ≥65 years, 119 of 137 (87%) isolates were covered by PPV23, while from children <2 years, 15 of 27 (56%) isolates were covered by PCV7. Of the 57 PNSP isolates for which serotyping data were available, 28 of 30 (93%) from adults ≥65 years were covered by PPV23 while 7 of 8 (87.5%) from children <2 years were covered by PCV7. On-going surveillance of the predominant serotypes is required as strains with serotypes other than those in the vaccine have been reported to increase in prevalence following introduction of PCV7 in other countries, hence the need for a fully resourced reference facility.

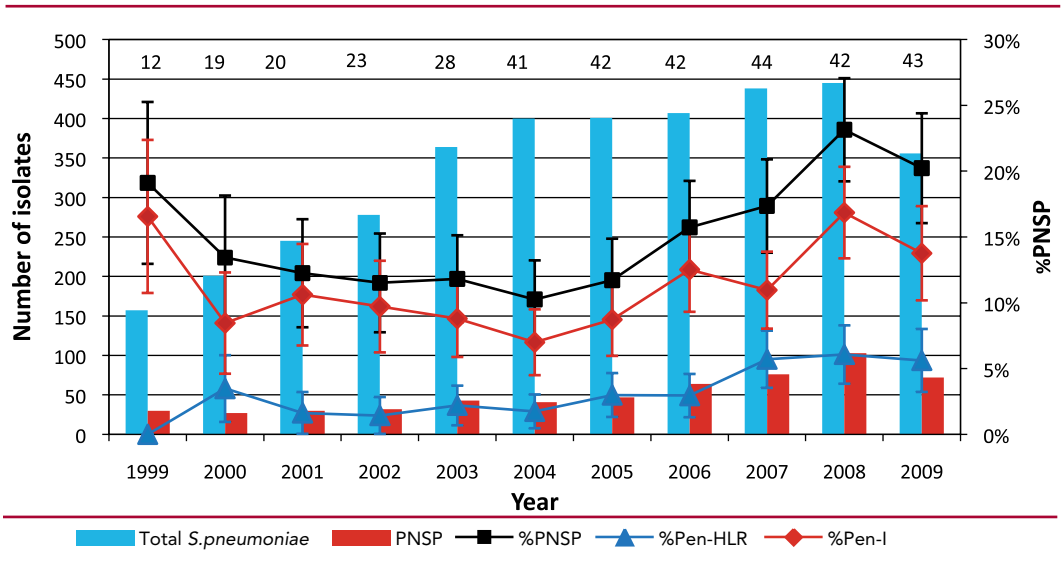

Figure 2a. Trends for S. pneumoniae – total numbers of S. pneumoniae/PNSP and percentage PNSP with 95% confidence intervals
HLR, High-level resistant; I, Intermediately resistant
The numbers of participating laboratories by year-end are indicated above the bars

The rate of invasive pneumococcal disease (IPD) in Ireland in 2009 was estimated to be 8.6 per 100,000 population compared with 10.8 in 2008 (note: both calculated using the 2006 census data and adjusted for the estimated population coverage by EARS-Net for that year). The highest rates of IPD were observed in children <1 year (27.8 per 100,000) and adults aged 75-79 years (24.4), 80-84 years (44.3) and ≥85 years (53.1) (figure 2b). The rates in all age groups decreased compared with the data for 2008 with the exception of the 5-9 year group, which increased marginally from 1.0 to 2.8. The biggest drop was seen in the <1 and 1 year age groups, which decreased from 57.3 to 27.8 and 28.1 to 18.2, respectively.

Males were approximately 1.2-times more likely to have an invasive *S. pneumoniae* infection [1.25-times for PNSP, z=0.95, P=0.35; 1.2-times for penicillin-susceptible *S. pneumoniae* (PSP), z=1.55, P=0.12] than females (z=1.8, P=0.07). None of these findings were significant. The median age was 63 years (95%CI, 59-65).

Enterococcus faecalis

There were 289 reports of *E. faecalis* bacteraemia from 285 patients, a decrease of 4.0% from 301 reports in 2008. See table 1 for the annual proportions of *E. faecalis* isolates resistant to the three "indicator" antibiotics (ampicillin, vancomycin and high-level gentamicin) by year since 2002 when surveillance began. Vancomycin-resistant *E. faecalis* (VREfa) accounted for 0.7% of isolates, a significant decrease from 3.7% in 2008 (Chi^2=5.9; P=0.015). Although this proportion was low, Ireland still had one of the higher proportions of VREfa in Europe in 2008.

Six isolates were ampicillin-resistant, which suggests that these isolates were either misidentified as *E. faecalis* or misclassified as ampicillin-resistant, as resistance to ampicillin is rare in *E. faecalis*.

Males were approximately 1.6-times more likely to have an invasive *E. faecalis* infection than females (z=3.9, P<0.0001). The frequency of invasive *E. faecalis* infection increased with age with the majority of infections (n=218; 75%) occurring in adults over 50 years. The median age was 66 years (95%CI, 64-71).

Enterococcus faecium

There were 397 reports of *E. faecium* bacteraemia from 386 patients, a decrease of 2.2% from 406 reports in 2008 (but still up on 332 in 2007). See table 1 for the annual proportions of *E. faecium* isolates resistant to the three "indicator" antibiotics (as for *E. faecalis* above) by year since 2002. Vancomycin-resistant *E. faecium* (VREfm) accounted for 38.3% of isolates. This represents an increase from 35.7% in 2008. While the rate of increase in the proportion of VREfm appeared to slow down after 2006, the number of VREfm isolates increased by almost 50% between 2006 (n=98) and 2009 (n=145). Between 2002 and 2009, the proportion of isolates that was VREfm increased significantly (Chi^2_{trend}=36.9; P<0.0001) (figure 3). In 2009, Ireland had the highest proportion of VREfm in Europe, followed by Luxembourg (35.7%) and Greece (29.2%).

Resistance to high-level gentamicin increased significantly from 28.1% in 2008 to 29.1% in 2009 (Chi^2=10.2; P=0.0014). This marks a reversal of the highly significant downward trend seen between 2004 and 2008 (Chi^2_{trend}=62.1; P<0.0001) (figure 3).

Of 375 isolates tested against all three "indicator" antibiotics, 100 (26.7%) were resistant to all three and therefore classed as multi-drug resistant (MDR). This represents a significant increase from 16.2% in 2008 (Chi^2=12.3; P=0.0005).

Males were approximately 1.3-times more likely to have an invasive *E. faecium* infection than females (z=2.8, P=0.005). The frequency of invasive *E. faecium* infection increased with age with the majority of infections (n=324; 81%) occurring in adults over 45 years. The median age was 66 years (95%CI, 63-67).

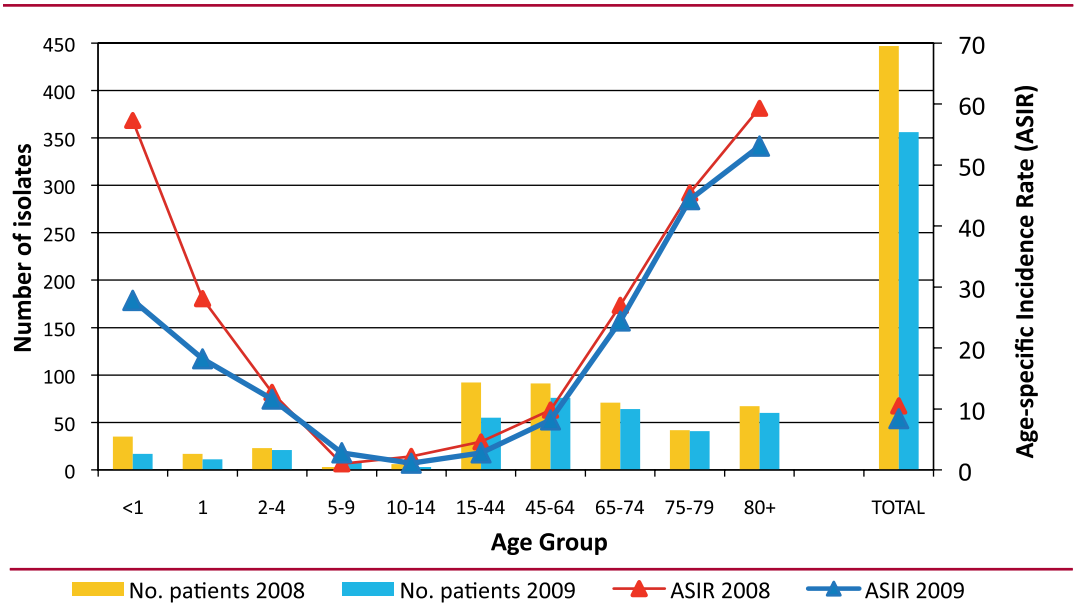

Figure 2b. Numbers and age-specific incidence rates of patients with invasive S. pneumoniae infection in 2009 compared with 2008

Escherichia coli

There were 2,064 reports of invasive *E. coli* infection (2,061 from blood and three from CSF) from 2,012 patients, an increase of 7.3% from 1,924 reports in 2008. See table 1 for the proportion of *E. coli* isolates resistant to the four "indicator" antibiotics/antibiotic classes [ampicillin, third-generation cephalosporins (3GCs; cefotaxime, ceftriaxone, ceftazidime or cefpodoxime), fluoroquinolones (ciprofloxacin or ofloxacin) and aminoglycosides (gentamicin, amikacin or tobramycin)] by year since 2002. Ciprofloxacin resistance decreased from 23.3% in 2008 to 22.3% in 2009 (non-significant; Chi^2=0.54, P=0.46). Looking at the overall trend, the proportion of ciprofloxacin resistant isolates increased significantly between 2002 and 2008 (Chi^2_{trend}=209.5, P<0.0001) (figure 4), although the rate of increase slowed down since 2006 and showed the first signs of a downward trend in 2009, but this finding is not statistically significant. The proportion of isolates with resistance to 3GCs remained the same in 2009 as in 2008 (7.5%) while resistance to gentamicin decreased from 10.2% in 2008 to 7.6% in 2009 (borderline not significant; Chi^2=7.4, P=0.064). Resistance to 3GCs, ciprofloxacin and gentamicin in *E. coli* isolates increased in many European countries in 2009, which is not the case in Ireland. 3GC and gentamicin resistance are at moderately low levels in this country, similar to those in other northern European countries, while ciprofloxacin resistance is at moderately high levels along with the majority of other European countries.

Extended spectrum beta-lactamases (ESBLs) were detected in 114 (5.8%) of 1,978 isolates tested. Although the increase in ESBLs from 5.0% in 2008 was not found to be significant (Chi^2=1.2, P=0.28), the increasing trend since 2004 (1.1%) is highly significant (Chi^2_{trend}=60.1, P<0.0001). ESBLs are enzymes that confer resistance to most penicillins and cephalosporins (including 3GCs). ESBL-producing bacteria (including *E. coli* and *K. pneumoniae*) are often resistant to other classes of antibiotics and have emerged as important causes of infections in hospitals.

Of 2,032 isolates tested against all four "indicator" antibiotics, 211 (10.4%) were identified as MDR (defined as resistance to three or more of these), including 56 with resistance to all four. The proportion of isolates that are MDR increased significantly (Chi^2_{trend}=125.3, P<0.0001) from 2.4% in 2002 when surveillance began. However, the decrease from 12.1% in 2008 was not significant (Chi^2=2.9, P=0.09).

Females were approximately 1.25-times more likely to have an invasive *E. coli* infection than males (z=4.9, P<0.0001), however males were 1.2-times more likely to get an infection with ciprofloxacin-resistant *E. coli* (z=2.3, P=0.024) and 1.2-times more likely to get an infection with MDR *E. coli* (z=1.45, P=0.15), however, the latter was not significant. The frequency of invasive *E. coli* infection increased with age with the majority of infections (n=1,597; 77%) occurring in adults over 55 years. The median age was 72 years (95%CI, 71-73).

Klebsiella pneumoniae

There were 323 reports of invasive *K. pneumoniae* infection (all from blood) from 316 patients (with 42 of 43 laboratories participating in the surveillance of this pathogen), an increase of 3.8% from 311 reports in 2008. See table 1 for the proportion of *K. pneumoniae* isolates resistant to the four "indicator" antibiotics (as for *E. coli* above), plus imipenem/meropenems, since 2006.

Ciprofloxacin resistance increased marginally from 12.7% in 2008 to 13.0% in 2009, while gentamicin resistance increased slightly from 10.6% to 11.1%. Neither of these increases was found to be significant. Resistance to 3GCs remained approximately stable (11.2% in 2008 vs. 11.3% in 2009). No isolates with resistance to imipenem/meropenem were reported.

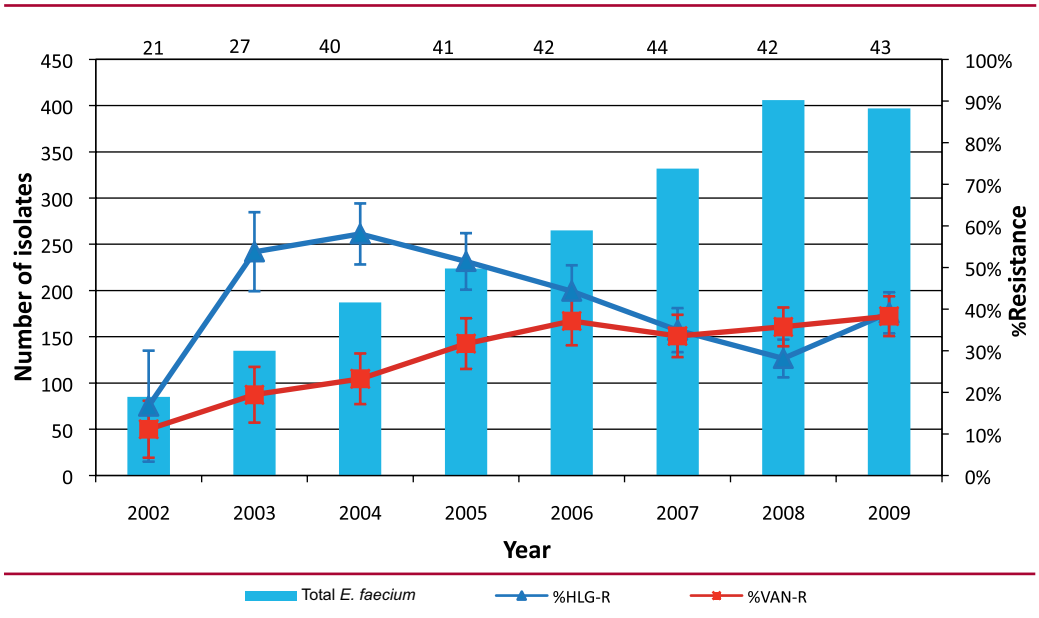

Figure 3. Trends for E. faecium – total numbers of E. faecium and percentage resistance to high-level gentamicin (HLG) and vancomycin (VAN) with 95% confidence intervals
The numbers of participating laboratories by year-end are indicated above the bars

One isolate was ampicillin-susceptible, which either represents an isolate that was misidentified as *K. pneumoniae* or misclassified as ampicillin-susceptible, as all klebsiellae are inherently resistant to this antibiotic.

ESBLs were detected in 25 (8.2%) of 305 isolates tested, representing a slight increase from 7.7% in 2008. Thirty-eight, or 11.9%, of 319 isolates tested against all four "indicator" antibiotics were identified as MDR, including 16 with resistance to all four, an increase from 9.9% in 2008.

Males were approximately 1.3-times more likely to have an invasive *K. pneumoniae* infection than females (z=2.3, P=0.021). The frequency of invasive *K. pneumoniae* infection increased with age with the majority of infections (n=250; 77%) occurring in adults over 50 years. The median age was 65 years (95%CI, 62-68).

Pseudomonas aeruginosa

There were 248 reports of invasive *P. aeruginosa* infection (247 from blood and one from CSF) from 236 patients (with 42 of 43 laboratories participating in the surveillance of this pathogen), an increase of 24.6% from 199 reports in 2008. See table 1 for the proportion of *P. aeruginosa* isolates resistant to the five "indicator" antibiotics/antibiotic classes [piperacillin-tazobactam, ceftazidime, carbapenems (meropenem or imipenem), fluoroquinolones (ciprofloxacin or ofloxacin) and gentamicin] since 2006. The most significant change in the resistance proportions in 2009 compared to 2008 was for ciprofloxacin, which decreased from 21.8% to 12.1% (Chi^2=7.6, P=0.006). This may be related to a reduction in fluoroquinolone prescribing in hospitals with antibiotic stewardship interventions that targeted this class of antibiotics. Ceftazidime resistance increased from 8.7% to 11.8% but this was not significant (Chi^2=1.1, P=0.29).

Fifteen (6.4%) of 235 isolates tested against all five "indicator" antibiotics were MDR, including one with resistance to all five. This represents a decrease from 11.1% in 2008, which was not significant (Chi^2=2.95, P=0.09).

Males were approximately 1.3-times more likely to have an invasive *P. aeruginosa* infection than females (z=2.05, P=0.04). The frequency of invasive *P. aeruginosa* infection increased with age with the majority of infections (n=180; 73%) occurring in adults over 55 years. The median age was 67 years (95%CI, 65-70).

Enhanced Surveillance

EARS-Net in Ireland has been enhanced to collect demographic, risk factor and clinical data since 2004. The enhanced programme involves voluntary participation by hospitals that provide data on invasive pathogens causing bloodstream infections (BSI).

There were 2,003 individual records (cases or isolates under the EARS-Net definition) submitted from 14 laboratories. This figure is up from the 2008 finalised figure of 1,917. The total number of records thus far for 2009 represents 40% of the total core EARS-Net

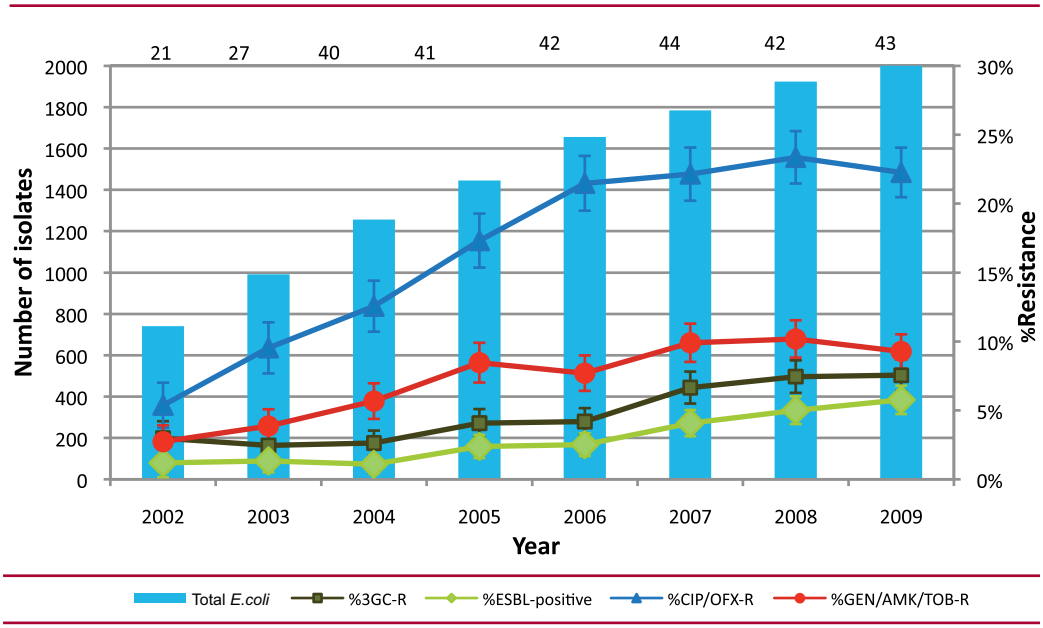

Figure 4. Trends for E. coli – total numbers of E. coli and percentage resistance to 3GCs, ciprofloxacin/ofloxacin (CIP/OFX) and gentamicin/amikacin/tobramycin (GEN/AMK/TOB), and percentage ESBL-positive with 95% confidence intervals.
The numbers of participating laboratories by year-end are indicated above the bars

dataset. Demographic and other basic data for the major resistance profiles of EARS-Net pathogens are shown in table 2.

Analysis of consistent data from hospitals showed that the rate of clinically significant BSI that was acquired in the reporting hospital has changed for *S. aureus* infection. For MRSA, the rate decreased from 0.065 cases per 1,000 patient bed days used in 2008 to 0.058 in 2009, while the rate for MSSA increased from 0.080 in 2008 to 0.122 in 2009.

For further details, go to the HPSC website (http://www.hpsc.ie) and click on "Topics A-Z", then "Enhanced Bacteraemia Surveillance".

Conclusion

Recent improvements in infection prevention and control resources and interventions, along with hospital antibiotic stewardship programmes, may have contributed to reducing the burden of MRSA bacteraemia in Ireland since 2006. The introduction of the 7-valent pneumococcal conjugate vaccine, PCV7, into the childhood immunisation program in September 2008 has already resulted in a reduction in the burden of invasive pneumococcal disease in children. Despite these successes, AMR remains a major problem in other EARS-Net pathogens in this country, in particular the high numbers and proportions of VREfm and *E. coli* isolates that are fluoroquinolone-resistant, plus increases in ESBL-production in *E. coli* and *K. pneumoniae* and high levels of MDR in all three pathogens. AMR is also an issue in other bacterial species as well as in sites other than blood and/or CSF for which no surveillance is currently undertaken in Ireland. The observed increase in reports of MSSA bloodstream infection remains unexplained.

In addition, there are continued threats posed by emerging resistance mechanisms in these and other bacterial pathogens in other countries (e.g. carbapenemases in klebsiellae and other enterobacteriaceae, and vancomycin resistance in *S. aureus*). These current problems and future threats highlight the on-going commitment and resources that are necessary to reduce the burden of AMR and healthcare-associated infection (HCAI) in this country, as outlined in the Strategy for the control of Antimicrobial Resistance in Ireland (SARI) in 2001, and in particular measures to promote more prudent antibiotic use in both hospital and community settings.

HPSC thanks all the microbiology laboratories for their continued participation and enthusiasm for the EARS-Net project.

The data presented in this report were taken from the EARS-Net database on 1st August 2010.

For further details of EARS-Net and antimicrobial resistance in Ireland see http://www.hpsc.ie

European data are available at http://ecdc.europa.eu/en/activities/surveillance/EARS-Net/Pages/Database.aspx

Table 2. Age and gender breakdown of patients by organism with major resistance profiles (data from 14 laboratories participating in enhanced surveillance). Proportion of isolates detected <48 hours and >5 days post-admission is also shown.

	Total for 2009	Percent female	Mean age in years	Percent <5 years	Percent 65 years or older	Detected <48 hours after admission	Detected >5 days after admission
MRSA	**168**	38%	69.7	1%	68%	42%	48%
MSSA	**431**	35%	60.9	4%	53%	56%	28%
PNSP	**24**	46%	60.7	13%	63%	67%	8%
PSSP	**112**	42%	56.8	5%	46%	64%	12%
FQREC	**194**	46%	70.0	0%	70%	54%	19%
FQSEC	**591**	59%	66.9	3%	63%	53%	20%
VRE	**66**	32%	61.9	0%	41%	11%	76%
VSE	**199**	45%	65.4	3%	60%	30%	44%
KPN	**134**	44%	64.2	1%	52%	49%	32%
PAE	**84**	45%	65.7	0%	60%	33%	37%

Abbreviations used (not in text): PSSP, Penicillin-susceptible S. pneumoniae; FQREC, Fluoroquinolone-resistant E. coli; FQSEC, Fluoroquinolone-susceptible E. coli; VRE, Vancomycin-resistant enterococci; VRE, Vancomycin-susceptible enterococci; KPN, Klebsiella pneumoniae; PAE, Pseudomonas aeruginosa