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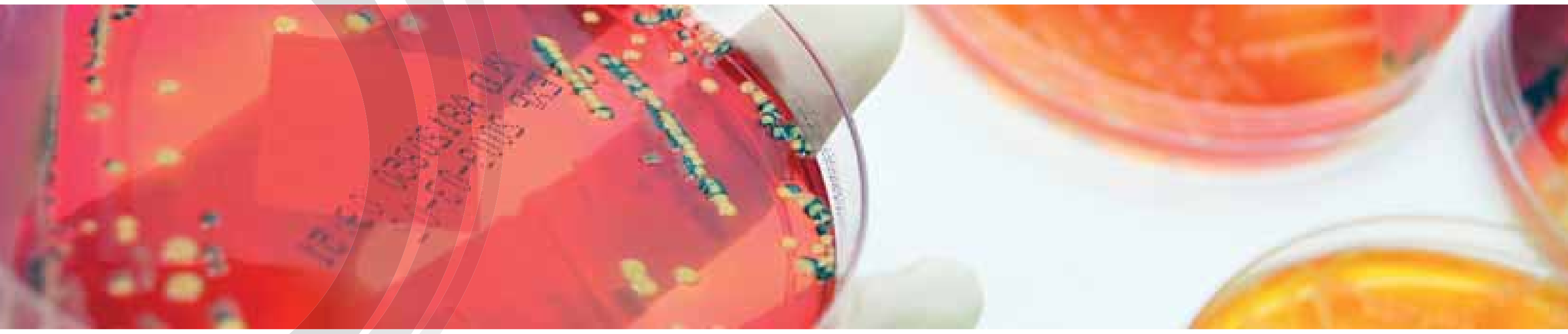
SURVEILLANCE REPORT



Antimicrobial resistance surveillance in Europe

2009

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Annual report of the European Antimicrobial Resistance Surveillance Network (EARS-Net)

2009

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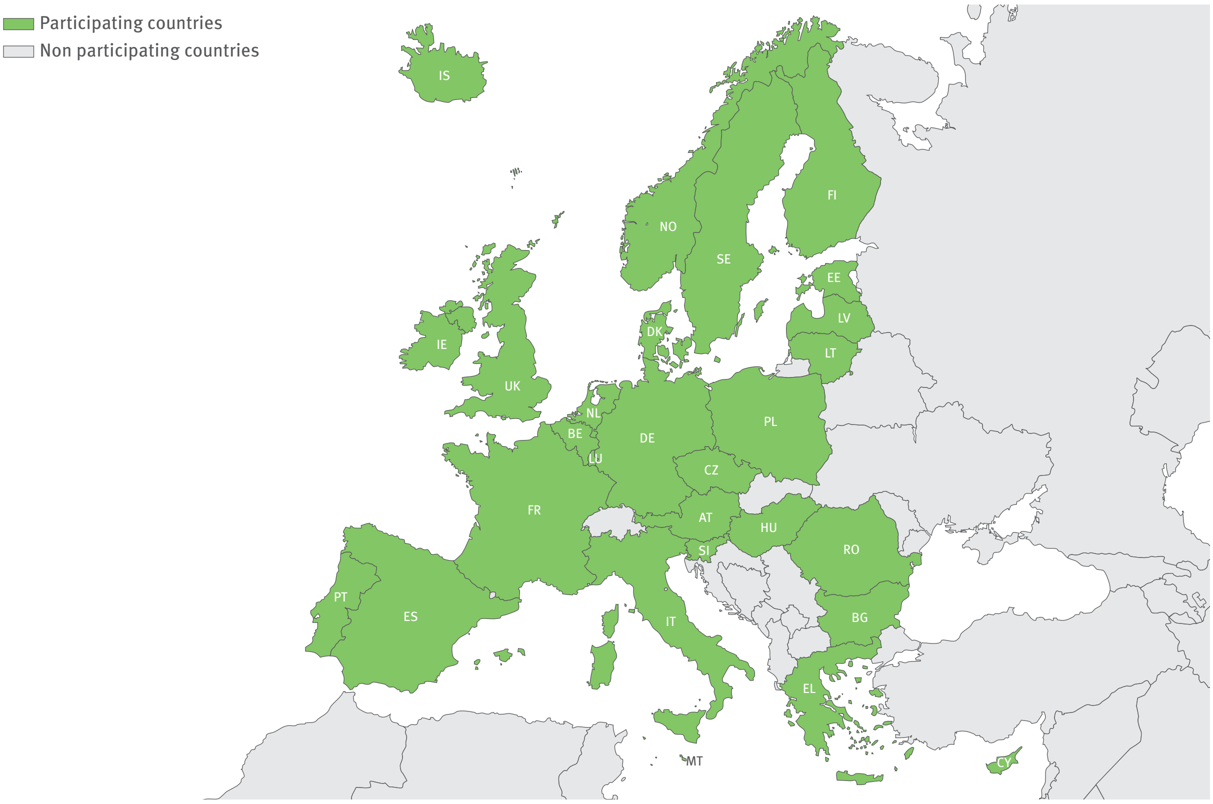
Abbreviations and acronyms

AMR	Antimicrobial resistance
AmpC	Ampicillinase C
ARMed	Antibiotic resistance surveillance and control in the Mediterranean region
AST	Antimicrobial susceptibility testing
BSAC	British Society for Antimicrobial Chemotherapy
BSI	Bloodstream infections
CC	Clonal complex
CMY	Cephamycinase
CLSI	Clinical and Laboratory Standards Institute
CREC	Third-generation cephalosporin-resistant *E. coli*
CRKP	Third-generation cephalosporin-resistant *K. pneumoniae*
CSF	Cerebrospinal fluid
DCFP	Data Check and Feedback Programme
DEFS	Data Entry & Feedback Software
DG SANCO	Directorate-General for Health and Consumer Protection
DIN	Deutsche Industrie Norm (German)
DNA	Deoxyribonucleic acid
EARSS	European Antimicrobial Resistance Surveillance System
EARS-Net	European Antimicrobial Resistance Surveillance Network
ECDC	European Centre for Disease Prevention and Control
ENSP	Erythromycin non-susceptible *Streptococcus pneumoniae*
EU	European Union
EQA	External quality assessment
ESAC	European Surveillance of Antimicrobial Consumption
ESBL	Extended-spectrum beta-lactamase
ESCMID	European Society of Clinical Microbiology and Infectious Diseases
ESGARS	ESCMID Study Group for Antimicrobial Resistance Surveillance
EUCAST	European Committee on Antimicrobial Susceptibility Testing
FREC	Fluoroquinolone-resistant *E. coli*
GISA	Glycopeptide intermediate-resistant *Staphylococcus aureus*
GRC	Commissie Richtlijnen Gevoeligheidsbepalingen (Dutch)
ICU	Intensive care unit
IMP	Imipenemase
KPC	*Klebsiella pneumoniae* carbapenemase
MIC	Minimum inhibitory concentration
MLS	Macrolide, lincosamide and streptogramin
MNSP	Macrolide non-susceptible *S. pneumoniae*
MRSA	Meticillin-resistant *Staphylococcus aureus*
NDM-1	New Delhi metallo-beta-lactamase 1
NRL	National reference laboratories
NWGA	Norwegian Working Group on Antimicrobials
OXA	Oxacillinase gene
PBP	Penicillin-binding protein
PCV	Pneumococcal conjugate vaccine
PNSP	Penicillin-non-susceptible *Streptococcus pneumoniae*
PRSP	Penicillin-resistant *Streptococcus pneumoniae*
RNA	Ribonucleic acid
SeqNet	European Network of Laboratories for Sequence Based Typing of Microbial Pathogens
SFM	Comité de l'Antibiogramme de la Société Française de Microbiologie (French)
SIR	Sensitive, intermediate, resistant
SHV	Sulfhydryl-variable extended-spectrum beta-lactamase gene
Spa-typing	*S. aureus* protein A-gene sequence typing
SRGA	Swedish Reference Group for Antibiotics
TESSy	The European Surveillance System (at ECDC)
TEM	Temoneira extended-spectrum beta-lactamase gene
UK NEQAS	United Kingdom National External Quality Assessment Scheme for Microbiology
VISA	Vancomycin-intermediate *Staphylococcus aureus*
VIM	Verona integron-encoded metallo-beta-lactamase
VRE	Vancomycin-resistant enterococci
VREF	Vancomycin-resistant *Enterococcus faecalis*
VRSA	Vancomycin-resistant *Staphylococcus aureus*
WHO	World Health Organization
WHONET	WHO microbiology laboratory database software

Countries participating in EARS-Net 2010



AT Austria
BE Belgium
BG Bulgaria
CY Cyprus
CZ Czech Republic
DE Germany
DK Denmark
EE Estonia
EL Greece
ES Spain
FI Finland
FR France
HU Hungary
IE Ireland
IS Iceland
IT Italy
LT Lithuania
LU Luxembourg
LV Latvia
MT Malta
NL Netherlands
NO Norway
PL Poland
PT Portugal
RO Romania
SE Sweden
SI Slovenia
UK United Kingdom

As of 1 January 2010, only EU and EEA Member States can report data to EARS-Net. Antimicrobial resistance surveillance data from five countries previously participating in EARSS (Bosnia-Herzegovina, Croatia, Israel, Switzerland and Turkey) are therefore not included in this report.

National institutions/organisations participating in EARS-Net

Austria
Federal Ministry of Health
Medical University Vienna
Elisabethinen Hospital, Linz
www.elisabethinen.or.at

Belgium
Scientific Institute of Public Health
www.iph.fgov.be
University of Antwerp

Bulgaria
Alexander University Hospital, Sofia
National Center of Infectious and Parasitic Diseases

Cyprus
Nicosia General Hospital

Czech Republic
National Institute of Public Health
National Reference Laboratory for Antibiotics

Denmark
Statens Serum Institut, Danish Study Group for Antimicrobial Resistance Surveillance (DANRES)
www.danmap.org

Estonia
Health Board
East-Tallinn Central Hospital
Tartu University Hospital

Finland
National Institute for Health and Welfare, Finnish Hospital Infection Program (SIRO)
www.thl.fi/siro
Finnish Study Group for Antimicrobial Resistance (FiRe)
www.finres.fi

France
Pitié-Salpêtrière Hospital
National Institute for Public Health Surveillance
www.invs.sante.fr
French National Observatory for the Epidemiology of Bacterial Resistance to Antimicrobials (ONERBA): Azay-Résistance, Île-de-France and Réussir networks
www.onerba.org
National Reference Centre for Pneumococci (CNRP)

Germany
Robert Koch Institute

Greece
Hellenic Pasteur Institute
National School of Public Health
National and Kapodistrian University of Athens, Medical School
www.mednet.gr/whonet

Hungary
National Centre for Epidemiology
www.antsz.hu

Ireland
Health Protection Surveillance Centre (HPSC)
www.hpsc.ie

Iceland
National University Hospital of Iceland
Centre for Health Security and Infectious Disease Control

Italy
National Institute of Public Health
www.simi.iss.it/antibiotico_resistenza.htm

Latvia
Paul Stradins Clinical University Hospital
State Agency 'Infectology Centre of Latvia'

Lithuania
National Public Health Surveillance Laboratory
Institute of Hygiene

Luxembourg
National Health Laboratory
Microbiology Lab, Luxembourg's Hospital Centre

Malta
Hospital of Malta

Netherlands
National Institute for Public Health and the Environment

Norway
University Hospital of North Norway
Norwegian Institute of Public Health
St. Olav University Hospital, Trondheim

Poland
National Medicines Institute

Portugal
National Institute of Health Dr. Ricardo Jorge
www.insarj.pt
Ministry of Health
Directorate-General of Health

Romania
National Institute of Research and Development for Microbiology and Immunology 'Cantacuzino'
Institute of Public Health

Slovenia

National Institute of Public Health

University of Ljubljana

Spain

Health Institute Carlos lll

www.isciii.es/htdocs/en/index.jsp

National Centre of Epidemiology

Sweden

Swedish Institute for Infectious Disease Control

www.smittskyddsinstitutet.se

United Kingdom

Health Protection Agency

www.hpa.org.uk

Health Protection Scotland

Public Health Agency Northern Ireland

Summary

This is the first Annual Report of the European Antimicrobial Resistance Surveillance Network (EARS-Net) after the transition of the European Antimicrobial Resistance Surveillance System (EARSS) to the European Centre of Disease Prevention and Control (ECDC) by 1 January 2010. This report represents the continuation of the series of highly valued EARSS Annual Reports published by the network since 2001.

During the last decade, antimicrobial resistance has moved steadily to a more and more prominent position on the public health agenda in Europe. The surveillance of antimicrobial resistance conducted previously by EARSS, and currently by EARS-Net, has played an important role to provide documentation of the occurrence and spread of antimicrobial resistance, and to increase awareness of the problem at the political level, among public health officials and in the scientific community.

Based on the antimicrobial resistance data reported to EARS-Net by 28 countries in 2009, and on the results of trend analyses including EARSS data from previous years, the resistance situation in Europe displays large variation depending on pathogen type, antimicrobial substance and geographic region.

In 2009, the most concerning resistance results come from the rapidly decreasing susceptibility of invasive *Escherichia coli* to basically all antimicrobial agents included in the EARS-Net surveillance except carbapenems, and from the high prevalence of resistance in *Klebsiella pneumoniae* to third-generation cephalosporins, fluoroquinolone and aminoglycosides. In half of the reporting countries, the proportion of multiresistant *K. pneumoniae* isolates (combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides) is above 10%, and a few countries are now also reporting high proportions of resistance to carbapenems. These antibiotics have been widely used in many countries due to the increasing rate of extended-spectrum beta-lactamase (ESBL) producing Enterobacteriaceae with a consequent impact on the emergence of carbapenemase production (VIM, KPC and NDM-1), especially in *K. pneumoniae*.

The highest resistance proportions in *E. coli* were reported for aminopenicillins ranging up to 66%. Irrespective of the high level of resistance, proportions continue to increase even in countries already presenting resistance levels well above 50%. Resistance to third-generation cephalosporins in *E. coli* has also increased significantly during the last four years in more than half of the reporting countries. This resistance is directly linked to the high proportions (85–100%) of ESBL positives among the resistant isolates in countries reporting on ESBL in 2009.

Other trends in the occurrence of resistance reported to EARS-Net bring hope that national efforts on infection control and efforts targeted at containment of resistance may in some cases bring the development of resistance to a halt, or even reverse undesirable resistance trends, as exemplified by the development for meticillin-resistant *Staphylococcus aureus* (MRSA). Even though the proportion of MRSA among *Staphylococcus aureus* is still above 25% in 10 out of 28 countries, the occurrence of MRSA is stabilising or decreasing in some countries and a sustained decrease was observed in Austria, France, Ireland, Latvia and UK.

Furthermore, the United Kingdom has shown a consistent reduction of resistant proportions in *K. pneumoniae* for all the antibiotic classes under surveillance, and in a few countries (Greece, Germany, Italy and France) the efforts to control glycopeptide resistance in *Enterococcus faecium* seem to be successful and resulting in a continuous decrease of proportions of resistant isolates. Meanwhile, high-level aminoglycoside resistance in *Enterococcus faecalis* seems to stabilise at a relatively high level. The majority of countries reported proportions of resistant isolates between 30% and 50%.

For *Streptococcus pneumoniae*, non-susceptibility to penicillin is generally stable in Europe and non-susceptibility to macrolides has declined in six countries while no country reported increasing trends. For *Pseudomonas aeruginosa*, high proportions of resistance to fluoroquinolones, carbapenems and combined resistance have been reported by many countries, especially in southern and eastern Europe.

For several antimicrobial and pathogen combinations, e.g. fluoroquinolone resistance in *E. coli*, *K. pneumoniae*, *P. aeruginosa* and for MRSA, a north to south gradient is evident in Europe. In general, lower resistance proportions are reported in the north and higher proportions in the south of Europe likely reflecting differences in infection control practices, presence or absence of legislation regarding prescription of antimicrobials and other factors known to influence the occurrence of resistance. However, for *K. pneumoniae*, increasing trends of resistance to specific antibiotic classes and of multiresistance have been observed also in northern European countries, like Denmark and Norway, with a traditionally prudent approach to the antibiotic use.

In addition to the regular trend analysis and situation overview, this 2009 EARS-Net report features a new focus chapter providing in-depth analysis for *E. coli* and MRSA. These analyses are based exclusively on data from laboratories reporting consistently over several years. The in-depth analysis confirms a consistent rise in multidrug resistance and reveals a steady and significant decline of antimicrobial susceptibility in *E. coli*

over several years. For MRSA, the observed decline likely reflects the efficacy of infection control measures at hospital level, and may even leave some hope for the success of containment strategies in other areas.

In conclusion, the data reported to EARS-Net for 2009 by the participating countries provide a knowledge baseline on the occurrence of antimicrobial resistance in Europe and document the unfortunate and steadily diminishing antimicrobial treatment options for major bacterial pathogens.

1 Introduction

The European Antimicrobial Resistance Surveillance Network (EARS-Net) is a European-wide network of national surveillance systems, providing European reference data on antimicrobial resistance for public health purposes. The network is coordinated and funded by the European Centre for Disease Prevention and Control (ECDC).

The surveillance of antimicrobial resistance within the EU is carried out in agreement with Decision No 2119/98/EC of the European Parliament and of the Council of 24 September 1998 and Regulation (EC) No 851/2004 of the European Parliament and of the Council of 21 April 2004 establishing a European Centre for Disease Prevention and Control.

The coordination of EARS-Net (former EARSS) was transferred from the Dutch National Institute for Public Health and the Environment (RIVM) to ECDC in January 2010. At the same time, EU Member States were requested to nominate disease-specific contact points for antimicrobial resistance. Five non-EU Member States previously participating in EARSS (Bosnia-Herzegovina, Croatia, Israel, Switzerland and Turkey) had to be detached from the network.

At ECDC, the management and coordination of EARS-Net is carried out by the Section for Antimicrobial Resistance and Healthcare-associated Infections. Scientific guidance and support to the coordination of the network is provided by the EARS-Net Coordination Group (previous EARSS Advisory Board), composed of experts selected among the nominated disease-specific contact points and experts selected from other organisations involved in surveillance of antimicrobial resistance.

EARS-Net consists of national antimicrobial resistance surveillance networks in Europe and conducts surveillance of antimicrobial susceptibility in seven major invasive pathogens of public health importance: *Streptococcus pneumoniae*, *Staphylococcus aureus*, *Escherichia coli*, *Enterococcus faecalis*, *Enterococcus faecium*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*.

The national networks systematically collect data from clinical laboratories in their own countries. At present, EARS-Net includes over 900 public health laboratories serving over 1 400 hospitals in Europe. The national networks upload data to a central database at ECDC (The European Surveillance System – TESSy).

EARS-Net maintains an interactive database at the ECDC website (www.ecdc.europa.eu) and publishes annual reports on the occurrence of antimicrobial resistance in Europe. This constitutes an important source of information on antimicrobial resistance for policymakers, scientists, doctors and the public.

2 *Escherichia coli* and *Staphylococcus aureus*: bad news and good news. Analysis of data from laboratories reporting continuously from 2002 to 2009

The results presented in this focus chapter are based on data from laboratories (n=198) that participated to EARS-Net and previously EARSS from 2002 to 2009, and reported continuously during the period on susceptibility of *Escherichia coli* and *Staphylococcus aureus* to selected antimicrobial agents. The long-standing contribution of these laboratories to the surveillance of antimicrobial resistance allow for accurate comparison of proportions of resistant isolates and number of reported infections over time. Thus, results presented in this focus chapter may be slightly different from results obtained from the full group of laboratories reporting to EARS-Net and previously to EARSS.

Key points

- A significant decline of antimicrobial susceptibility was observed for *E. coli* between 2002 and 2009, with a concomitant increase of reported bloodstream infections of 71%.
- *S. aureus* showed a different tendency, with a significant decrease of the proportion of meticillin resistance (MRSA) and an increase of 34% in the number of reported bloodstream infections.
- The trends observed for *E. coli* could suggest an incremental burden of disease caused by this microorganism, and the simultaneous decline of antimicrobial susceptibility is a serious public health concern.
- The reduction of the MRSA proportion and the relative containment of the number of *S. aureus* infections could result from efficacy of infection control measures at hospital level in some countries. However, efforts to reduce MRSA occurrence should remain a priority, irrespective of decreasing trends.

Escherichia coli and *Staphylococcus aureus* are the most frequent causes of bloodstream infections (BSI). The temporal trends of resistance and the trends in the incidence of BSI caused by these microorganisms, observed through the EARSS/EARS-Net data, are described for the period 2002–2009.

The antimicrobial susceptibility of *E. coli* BSI isolates shows an alarming Europe-wide decline as previously reported by EARSS [1]. Increasing resistance in *E. coli* and combined resistance of invasive and non-invasive isolates is reported in several national European surveillance reports [2–6]. At the same time, the proportion of MRSA has showed a significant decrease in many European countries. The numbers of BSI caused by MRSA, as reported by the mandatory surveillance system in England, decreased by 56% between 2004 and 2008 [7], and in France a significant decrease in the occurrence of MRSA was reported in 2008 [8] A similar reduction of the rate of healthcare-associated invasive MRSA infections has been observed at population level in the United States [9].

A total of 198 laboratories in 22 countries reported continuously from 2002 to 2009. The number of laboratories per country ranged between 1 (Iceland and Malta) and 33 (Czech Republic) (Table 2.1). Considering the whole group of selected laboratories, the reported number of *E. coli* BSI, increased by 71% from 10 688 in 2002 to 18 240 in 2009. In the same period, *S. aureus* BSI showed a 34% increase from 7 855 to 10 503 (Figure 2.1); this increase was observed in most but not all countries (Table 2.1).

During this interval, the proportion of third-generation cephalosporin-resistant *E. coli* increased significantly from 1.7% to 8% ($p < 0.001$) and the proportion of MRSA decreased from 21.5% to 19.7% ($p < 0.001$) (Figure 2.2). The trends of resistance proportions at country level were consistent with those of the whole group of 198 laboratories in 18 countries out of 22 for *E. coli* and in seven countries out of 22 for *S. aureus*.

Combined resistance in *E. coli* (defined as resistance to two, three and four antibiotic classes reported to EARS-Net) showed a significant increase (Figure 2.3) ($p < 0.001$) and became a frequent phenotype in most countries, whereby single resistance diminished from 37.1% in 2002 and 35.8% in 2009 ($p < 0.001$). The proportion of isolates susceptible to all four antibiotic classes decreased from 51.4% in 2002 to 41.7% in 2009 ($p < 0.001$).

The decline of antimicrobial activity in *E. coli* was evident both through the observed increase of combined resistance and through the reduction of full susceptibility to the antimicrobials included in the analysis. In the same time period and considering the same data source, a significant decrease of meticillin resistance was observed for *S. aureus*. For this species, the number of BSI increased less (+34%) than for *E. coli* BSI (+71%).

Importantly, most of the rise (38% of 71%) in *E. coli* BSI appeared to be due to isolates resistant to two or more antibiotics. Furthermore, the increase in the number of BSI was similar for meticillin-susceptible *S. aureus* (MSSA, 37%) and for fully susceptible *E. coli* (39%).

Despite the possible limitations of the presented results (see section 2.2), the trends of third-generation cephalosporins and combined resistance are relevant findings that deserve further consideration. According to the results, it appears that, during the study period, the emergence and spread of combined resistance is the main factor that influences the decline of antimicrobial activity against *E. coli*. In the period 2002–2009, only an increase of combined resistance with a concurrent relative reduction of the proportion of single resistance was observed. The resistant subpopulation with the largest relative growth in the period 2002–2009 was the resistance to all the four antibiotic classes under surveillance: this pattern increased more than fivefold from 0.6% to 3.4%. This trend suggests that inside the subpopulation of resistant isolates there was a continuous relative growth of combined resistance possibly caused by the addition of resistance traits to strains that were already resistant to at least one among the considered antibiotic classes. This trend may be explained by the spread of multidrug-resistant plasmids, which also contain genes for extended-spectrum beta-lactamase (ESBL) production [10].

The growing number of *E. coli* BSI indicates an increasing burden of disease caused by this microorganism. A similar trend in the number of reported cases of *E. coli* BSI has been observed in England, Wales and Northern Ireland by the national voluntary surveillance scheme, in the period 2004–2008. The increase (38%) observed by the British surveillance system is greater than the 16% increase in all BSI reported in the country during the same time period [11].

In conclusion, the reported data show a significant increase of antimicrobial resistance in *E. coli* invasive isolates and an overall increase in BSI caused by this microorganism. This is a serious public health concern since, if the increasing trend of antimicrobial resistance and the spread of ESBL are not contained, the use of carbapenems will increase favouring the emergence of carbapenemase-producing enterobacteria. This has been already observed for *Klebsiella pneumoniae* in Greece, Israel and Cyprus [1].

At the same time, *S. aureus* showed a relatively smaller increase in the number of reported BSI, but a significant decrease in the proportion of MRSA overall in EARSS/EARS-Net. This could be the result of the public health efforts targeted at containment of MRSA in several European countries and in the US. Even though an overall decreasing trend for MRSA is evident in Europe, not all countries contribute to this result. Efforts to reduce MRSA occurrence should remain a priority irrespective of decreasing trends.

In this perspective, coordinated international surveillance is particularly important in order to obtain accurate knowledge of the occurrence and spread of antimicrobial resistance and to enable planning of public health interventions aimed at prevention and control of the problem.

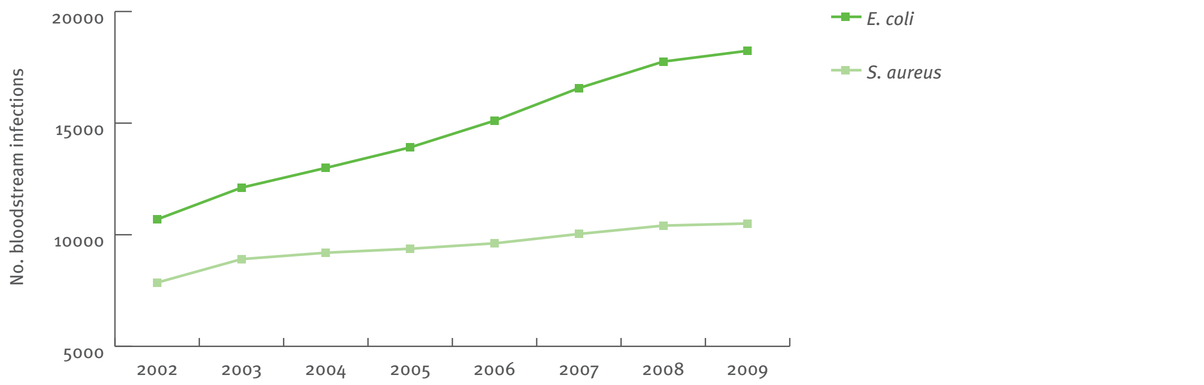
2.1 Methods of analysis

- Data for *E. coli* and *S. aureus* BSIs were extracted from the EARSS/EARS-Net database for laboratories

Table 2.1: Average numbers of *Escherichia coli* and *Staphylococcus aureus* isolates per country reported yearly from 2002 to 2009 by laboratories participating continuously in EARSS/EARS-Net during this time interval

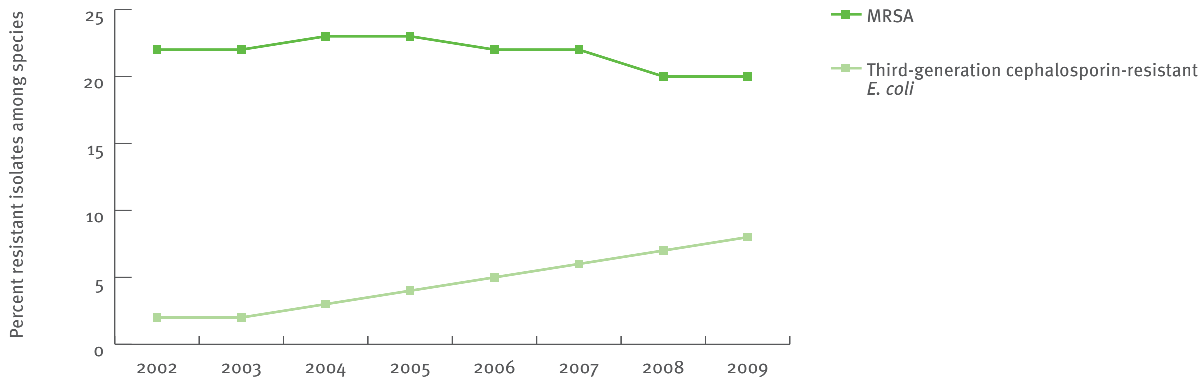
Country	Number of laboratories	Number of *E. coli* isolates average per year (2002–2009)	Number of *S. aureus* isolates average per year (2002–2009)
Austria	10	802	630
Belgium	9	646	343
Bulgaria	7	96	82
Czech Republic	33	1837	1290
Estonia	5	142	125
Finland	5	849	381
France	12	1583	1018
Germany	2	156	121
Greece	22	829	472
Hungary	14	446	526
Iceland	1	97	56
Ireland	15	1086	961
Italy	3	237	166
Luxemburg	4	176	80
Malta	1	104	96
Netherlands	4	291	238
Norway	7	975	467
Portugal	8	559	574
Slovenia	9	572	321
Spain	19	1973	835
Sweden	3	578	331
United Kingdom	5	641	373

Figure 2.1: **Yearly number of bloodstream infections caused by *Escherichia coli* and *Staphylococcus aureus*. EARSS/EARS-Net 2002–2009 (22 countries/198 laboratories)**



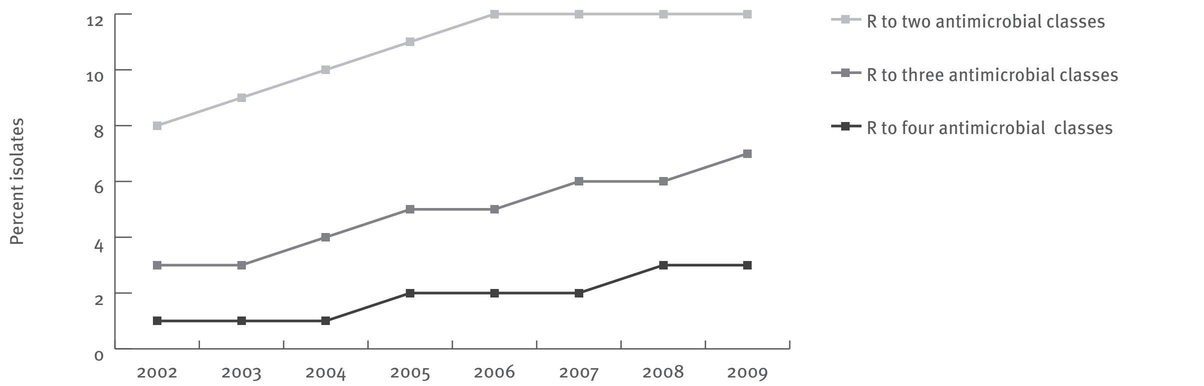
Only laboratories reporting susceptibility results for specific antimicrobials continuously during the period 2002–2009 are included in the analysis.

Figure 2.2: **Proportion of third-generation cephalosporin-resistant *Escherichia coli* (CREC) and meticillin-resistant *Staphylococcus aureus* (MRSA). EARSS/EARS-Net 2002–2009 (22 countries/198 laboratories)**



Only laboratories reporting susceptibility results for specific antimicrobials continuously during the period 2002–2009 are included in the analysis.

Figure 2.3: **Combined resistance (R) of *Escherichia coli* to aminopenicillins, third-generation cephalosporins, fluoroquinolones and aminoglycosides. EARSS/EARS-Net 2002–2009 (22 countries/198 laboratories)**



Only laboratories reporting susceptibility results for specific antimicrobials continuously during the period 2002–2009 are included in the analysis.

reporting susceptibility results continuously during the period 2002–2009 for aminopenicillin, fluoroquinolones, third-generation cephalosporin and aminoglycosides in *E. coli* and for oxacillin in *S. aureus*. Countries with no laboratory participating for the entire period or with small amount of data (less than 20 isolates per microorganism and per year) were not included in the analysis. Only the first isolate per patient, microorganism and year was included.

- The number of BSI caused by *E. coli* and *S. aureus* and the proportions of third-generation cephalosporin resistant *E. coli* and of MRSA were calculated for each year of the period 2002–2009. Three additional antibiotic classes (aminopenicillins, aminoglycosides and fluoroquinolones) were also considered for *E. coli* to assess the patterns of combined resistance of this pathogen.
- The significance of the temporal trends for resistance proportions was evaluated by the Cochran-Armitage test for trend.

2.2 Limitations of the analysis

- Even considering a stable group of laboratories, it is still possible that a change in the population coverage of these laboratories has occurred over time.
- The different trends observed for *E. coli* and *S. aureus* could also be explained by ascertainment bias leading to higher reporting of *E. coli* infections and caused by an increase of empirical treatment failures triggering delayed diagnostic procedures (blood culture).
- The indicator used to monitor the resistance trend was the SIR (sensitive, intermediate, resistant) interpretation, since the actual MIC (minimum inhibitory concentration) values are not systematically made available by participating laboratories. Reporting MIC instead of the SIR interpretation – defined by clinical breakpoints – would improve the monitoring of dynamic and subtle changes of antimicrobial susceptibility.

2.3 References

1. RIVM. EARSS annual report 2008. Bilthoven: Rijksinstituut voor Volksgezondheid en Milieu; 2009.
2. DANMAP 2008. Jensen VJ, Hammerum A (eds). Consumption of antimicrobial agents and occurrence of antimicrobial resistance in bacteria from food animals, food and humans in Denmark. Copenhagen: National Food Institute, Technical University of Denmark; 2009.
3. Health Protection Agency. Antimicrobial Resistance and Prescribing in England, Wales and Northern Ireland, 2008. London: Health Protection Agency; 2008.
4. NORM/NORM-VET 2009. Norström M, Simonsen GS (eds). Usage of Antimicrobial Agents and Occurrence of Antimicrobial Resistance in Norway. Tromsø/Oslo; 2010.
5. RIVM, SWAB. NethMap 2009. Consumption of antimicrobial agents and antimicrobial resistance among medically important bacteria in the Netherlands.
6. SWEDRES 2009. Dohnhammar U, Olsson-Liljequist B (eds). A Report on Swedish Antimicrobial Utilisation and Resistance in Human Medicine. Swedish Strategic Programme against Antibiotic Resistance (STRAMA). Stockholm: Swedish Institute for Infectious Disease Control; 2010.
7. Pearson A, Chronias A, Murray M. Voluntary and mandatory surveillance for methicillin-resistant Staphylococcus aureus (MRSA) and methicillin-susceptible S. aureus (MSSA) bacteraemia in England. J Antimicrob Chemother. 2009;64(Suppl 1):i11-7.
8. Anonymous. Recent trends in antimicrobial resistance among Streptococcus pneumoniae and Staphylococcus aureus isolates: the French experience. Euro Surveill. 13 Nov 2008;13(46).
9. Kallen AJ, Mu Y, Bulens S et al. Health care-associated invasive MRSA infections, 2005–2008. JAMA 2010;304(6):641-648.
10. Coque TM, Baquero F, Canton R. Increasing prevalence of ESBL-producing Enterobacteriaceae in Europe. Euro Surveill 20 Nov 2008;13(47).
11. HPA. Escherichia coli bacteraemia in England, Wales, and Northern Ireland, 2004 to 2008. London: Health Protection Agency, 2009.

3 External Quality Assessment Exercise (EQA) 2009

3.1. Introduction

Since 2000, EARSS has been organising external quality assessment (EQA) exercises of antimicrobial susceptibility testing in collaboration with UK NEQAS (United Kingdom National External Quality Assessment Service). UK NEQAS is based at the Health Protection Agency, in London, and is a non-profit organisation with more than 35 years experience with external quality assessment in different countries (www.ukneqasmicro.org.uk).

The rationale of these EQA exercises is:

- to assess the ability of participating laboratories to identify antimicrobial resistance of clinical and public health importance;
- to determine the accuracy of susceptibility test results reported by individual laboratories; and
- to decide on the overall comparability of routinely collected test results between laboratories and countries and thus provide the means for justifying the pooling and comparison of antimicrobial susceptibility test (AST) data across Europe.

The external quality assessment exercise, held in the second half of 2009, was open to all countries participating in EARSS in 2009, including Bosnia-Herzegovina, Croatia, Israel and Turkey. A panel of six strains was included in the exercise. The strains were characterised and tested in two reference laboratories (Addenbrooke's Hospital, Cambridge, and City Hospital, Birmingham). Both reference laboratories confirmed MICs and interpreted the results according to frequently used breakpoint criteria such as CLSI and EUCAST, as indicated in each of the species' chapters.

3.2. Results

Strain panels were distributed to 886 participating laboratories, who were asked to report the clinical susceptibility categorisation – susceptible, intermediate and resistant (S, I, R) – according to the guideline used. The laboratories returned 775 (87%) reports, which is equivalent to the return rate of previous years. Turkey was not able to perform the tests, due to difficulties related to the shipment of strains. Figure 3.1 shows the proportion of participating laboratories returning reports per country.

All results were collected via the UK NEQAS internet website. Results were analysed and considered 'concordant' if the reported categorisation agreed with the interpretation of the reference laboratories.

For the determination of AST results, laboratories used automated methods (35%), disc diffusion tests (33%), or combined methods (23%). For species identification, 60% used automated and 40% used conventional methods.

The majority of laboratories applied CLSI guidelines (68%), and some countries used national guidelines, e.g. France (SFM), UK (BSAC), and Sweden (SRGA). The use of EUCAST guidelines was mainly reported by laboratories that utilise automated diagnostic test systems already calibrated for EUCAST breakpoints. However, the UK, Sweden, the Netherlands, Germany, France and Norway have been implementing EUCAST breakpoints in their national MIC breakpoint recommendations as harmonised breakpoints have been agreed, and in addition have adjusted the interpretation of their disk diffusion methods accordingly. Harmonisation efforts between the different national guideline committees have accomplished a satisfactory degree of agreement and, therefore, previous discrepancies between different guidelines have become less significant. Figure 3.2 shows the adherence to (inter)national guidelines by number of laboratories per country.

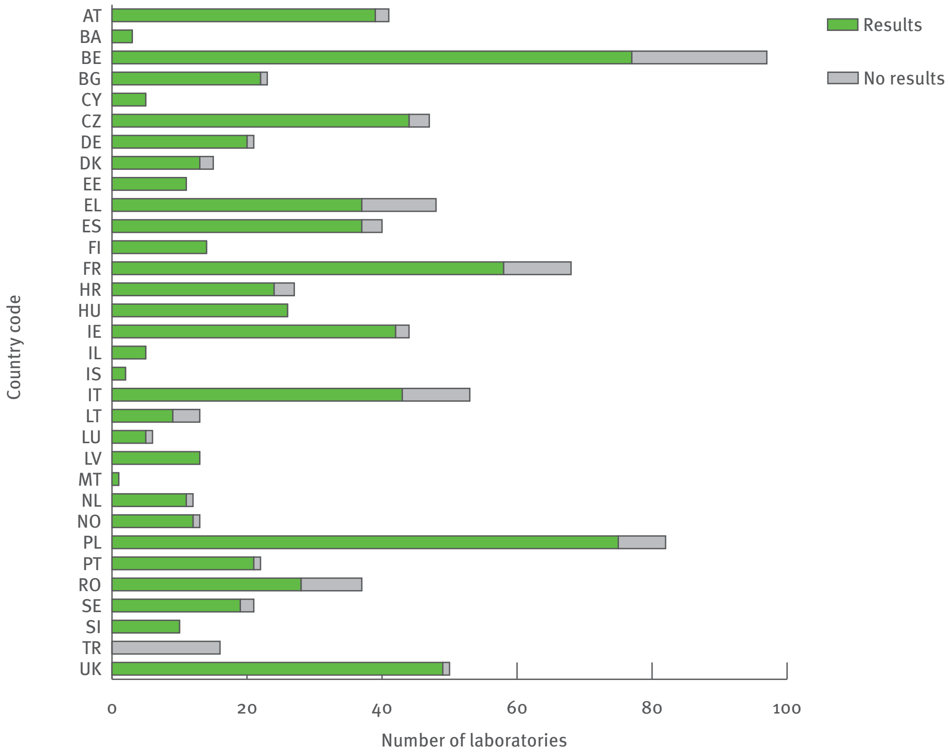
3.2.1. Specimen 9448 *Escherichia coli*

This specimen consisted of an *Escherichia coli* with CTX-M-14 ESBL production. Unlike most TEM- and SHV-derived ESBLs, CTX-M enzymes are more active against cefotaxime than ceftazidime. This organism should clearly be interpreted as resistant to cefotaxime (MIC ≥ 128 mg/L) using EUCAST (S ≤ 1, R > 2 mg/L), and CLSI (S ≤ 8, R ≥ 64 mg/L) guidelines. With ceftazidime (MIC 2 mg/L) the isolate appears intermediate by EUCAST guidelines (S ≤ 1, I 2–8, R > 8 mg/L) and susceptible by standard CLSI guidelines (S ≤ 8, I 16, R ≥ 32 mg/L). However, current EUCAST expert rules recommend that ESBL-producing isolates are reported resistant if they appear intermediate in routine tests and intermediate if they appear susceptible. Resistance should be reported if CLSI ESBL screening methods are used as recommended.

Detection of reduced susceptibility to cefotaxime and ceftriaxone was not a problem and < 1% participants reported the organism susceptible to these agents. With ceftazidime, reports of intermediate (15%) and susceptible (6%) were more common. A large majority (98%) of participants testing for ESBLs correctly reported the organism ESBL-positive.

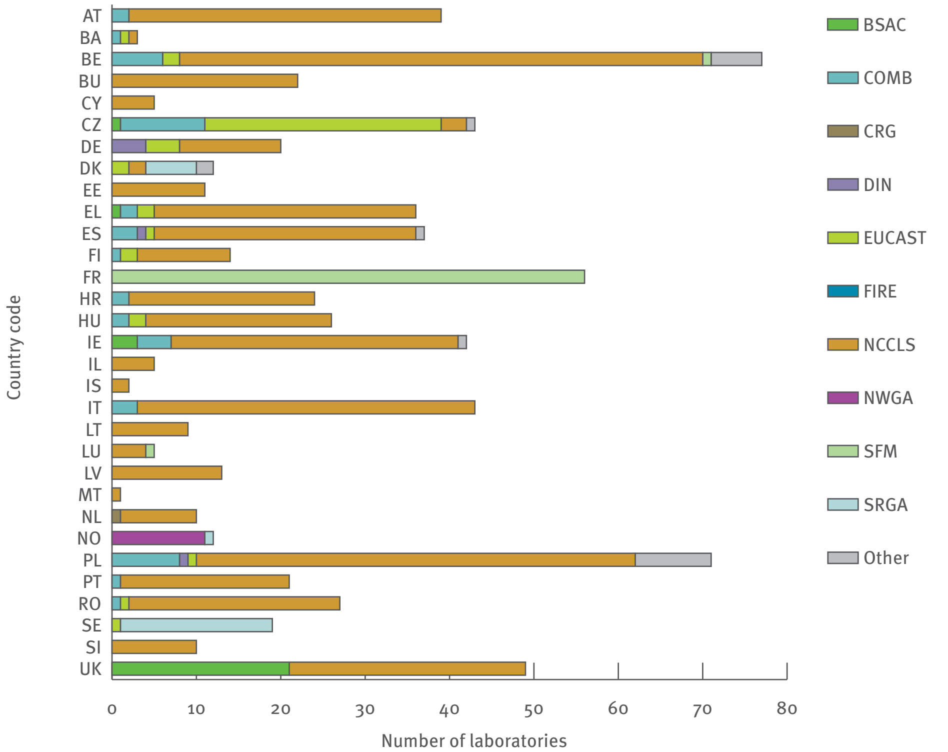
This organism was susceptible to piperacillin+tazobactam in MIC tests (MIC 2–4 mg/L). Despite some reports of clinical efficacy, there has been considerable debate about whether ESBL-producing strains from serious infections should be reported susceptible to beta-lactamase inhibitor combinations when they appear susceptible in routine tests. While the majority

Figure 3.1: Proportion of participating laboratories returning reports per country, 2009



The external quality assessment exercise was open to all countries participating in EARSS in 2009.
BA = Bosnia-Herzegovina; HR = Croatia; IL = Israel; TR = Turkey.

Figure 3.2: Adherence to guidelines*: number of laboratories per country



BSAC, British Society for Antimicrobial Chemotherapy; CRG, (Dutch) Commissie Richtlijnen Gevoeligheidsbepalingen; DIN, Deutsche Industrie Norm; EUCAST, European Committee on Antimicrobial Susceptibility Testing; NCCLS/CLSI, (American) Clinical and Laboratory Standards Institute; NWGA, Norwegian Working Group on Antimicrobials; SFM, Comité de l'Antibiogramme de la Société Française de Microbiologie; SRGA, Swedish Reference Group for Antibiotics.
BSAC, CRG, DIN, NWGA, SFM and SRGA have implemented EUCAST breakpoints for MIC determinations and have adjusted the interpretation of their disk diffusions accordingly.
The external quality assessment exercise was open to all countries participating in EARSS in 2009.
BA = Bosnia-Herzegovina; HR = Croatia; IL = Israel.

of participants (71%) reported the organism susceptible to piperacillin+tazobactam, significant proportions reported intermediate (9%) or resistant (20%).

In reference tests, this organism was resistant to gentamicin, highly variable in susceptibility to tobramycin (reference MICs 4 to > 128 mg/L) and susceptible to amikacin. It is likely that this reflects production of an ANT (2'') enzyme, expression of which can be variable. EUCAST expert rules suggest that such isolates should be reported resistant to tobramycin if they appear intermediate. While 99% participants reported the organism gentamicin resistant and 98% amikacin susceptible, for tobramycin, 30%, 28% and 42% were reporting resistant, intermediate and susceptible, respectively (Table 3.1).

3.2.2. Specimen 9449 *Klebsiella pneumoniae*

This organism is a *Klebsiella pneumoniae* with a high-level beta-lactamase production; not only penicillin resistant, but also reduced susceptibility to beta-lactamase inhibitor combinations. Piperacillin+tazobactam MICs of 64 to ≥ 128 mg/L for this organism indicate resistance by EUCAST breakpoints and intermediate/resistant by CLSI breakpoints. Among participants, 70% reported the organism resistant, 25% intermediate and 5% susceptible. ESBL production was incorrectly reported by 9% participants and this was frequently associated with incorrect reporting of resistance to cefotaxime, ceftriaxone and ceftazidime by these participants (Table 3.2).

3.2.3. Specimen 9450 *Streptococcus pneumoniae*

This organism is a *Streptococcus pneumoniae* with reduced susceptibility to penicillin (MIC 0.25 mg/L). For *S. pneumoniae* with no mechanism of resistance to penicillin, MICs are ≤ 0.06 mg/L. EUCAST guidelines divide reduced susceptibility to penicillin into intermediate (penicillin MIC 0.12–2 mg/L) and resistant (MIC > 2 mg/L) categories. However, the interpretation of susceptibility to penicillin depends on whether the isolate is from a patient with meningitis or other infections (most commonly pneumonia). Strains with intermediate susceptibility are treatable with the high doses of penicillin, ampicillin or amoxicillin routinely used to treat pneumonia. Hence such strains may be reported susceptible in this situation. Patients with meningitis caused by strains with intermediate susceptibility to penicillin are unlikely to respond to therapy, and hence such strains should be reported as resistant in this situation.

Overall, 92% participants reported resistance in the oxacillin screening test for penicillin resistance. A further 3% reported the isolate intermediate to oxacillin, although the oxacillin screening test does not distinguish penicillin intermediate and resistant isolates and published guidelines do not include an intermediate category.

The participants' results for penicillin will include those that only screened for reduced susceptibility with oxacillin discs, those that screened with oxacillin and confirmed with a penicillin MIC, and those that tested with other methods. Overall, 76% reported the isolate as being of intermediate susceptibility to penicillin, with a further 8% reporting the isolate resistant. Susceptibility reported to clinicians for this organism – if isolated from cases of meningitis or pneumonia – indicates that many participants do interpret test results to suit the clinical situation. Eighty-five per cent reported the isolate as resistant when the isolate was from a case of meningitis and 70% as susceptible when the isolate was from a case of pneumonia, but significant numbers of participants interpreted the organism as intermediate in susceptibility to penicillin irrespective of whether the isolate was from meningitis (11% reported intermediate) or from pneumonia (26% reported intermediate). However, it is recognised that some local reporting guidelines may recommend categorisation of pneumonia isolates with intermediate penicillin susceptibility as intermediate, with the note that the isolate is susceptible if the patient is treated with a high dose.

With EUCAST, breakpoints for ciprofloxacin wild type organisms such as this (MIC 1 mg/L) are reported intermediate in susceptibility to ciprofloxacin, reflecting the uncertain outcome of therapy. CLSI do not give ciprofloxacin breakpoints for *S. pneumoniae*. This uncertainty was reflected in the high discrepancy rate in reporting for this agent (69% susceptible, 27% intermediate and 4% resistant) (Table 3.3).

3.2.4. Specimen 9451 *Pseudomonas aeruginosa*

This organism is a *Pseudomonas aeruginosa* with borderline resistance to piperacillin+tazobactam (MIC 32–64 mg/L) but susceptible to ceftazidime, a susceptibility profile seen with some beta-lactamase-producing strains. This organism produces the PSE-4 (CARB-1) beta-lactamase. The borderline resistance to piperacillin+tazobactam was reflected in the variation in susceptibility reported by participants, with 49% reporting susceptible, 12% intermediate and 39% resistant. The different categorisation largely relates to the breakpoint differences between EUCAST (susceptible ≤ 16 mg/L, resistant > 16 mg/L) and CLSI (susceptible ≤ 64 mg/L, resistant ≥ 128 mg/L) (Table 3.4).

3.2.5. Specimen 9452 *Pseudomonas aeruginosa*

This organism is a *Pseudomonas aeruginosa* resistant to gentamicin and susceptible to other reference agents tested. Some laboratories experienced problems with piperacillin+tazobactam testing in that overall 14% participants reported the isolate intermediate and 2% resistant. The reason for the problems is not obvious as the isolate was clearly susceptible in reference tests (Table 3.5).

3.2.6. Specimen 9453 *Staphylococcus aureus*

This organism is a meticillin-resistant *Staphylococcus aureus* (EMRSA-6) and most participants correctly reported resistance. There was no significant difference

Table 3.1: *Escherichia coli* (9448): Minimum inhibitory concentration (MIC) and intended results reported by reference laboratories and the overall concordance of the participating laboratories

Antibiotic agent	MIC range ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Amikacin	1	1	S	98
Amoxicillin	NT*	-	R	93
Ampicillin	› 128	› 128	R	100
Cefotaxime	128	› 128	R	97
Ceftazidime	2	2	R (expert rule)	80
Ceftriaxone	› 128	› 128	R	99
Ciprofloxacin	64	128	R	100
ESBL			positive	98
Gentamicin	32	64	R	99
Imipenem	0.12	0.12	S	100
Meropenem	≤ 0.03	≤ 0.03	S	99
Piperacillin	≥ 128	≥ 128	R	99
Piperacillin+tazobactam	2	4	S	71
Tobramycin	4	› 128	I-R/S-I-R	

* Not tested, result inferred from ampicillin.

Table 3.2: *Klebsiella pneumoniae* (9449): Minimal inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories

Antibiotic agent	MIC range ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Amikacin	64	64	R	97
Ampicillin/amoxicillin	128	≥ 128	R	100
Cefotaxime	0.12	0.5	S	92
Ceftazidime	0.12	0.25	S	93
Ceftriaxone	0.5	0.5	S	93
Ciprofloxacin	0.015	0.03	S	100
ESBL	-	-	negative	91
Gentamicin	64	128	R	99
Imipenem	0.12	0.12	S	99
Meropenem	≤ 0.03	≤ 0.03	S	99
Piperacillin	64	≥ 128	I/R	99
Piperacillin+tazobactam	64	128	I/R	95
Tobramycin	16	128	R	99

Table 3.3: *Streptococcus pneumoniae* (9450): Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories

Antibiotic agent	MIC range ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Cefotaxime	0.06	0.12	S	98
Meningitis	-	-	S	96
Pneumonia	-	-	S	99
Ceftriaxone	0.06	0.12	S	98
Meningitis	-	-	S	95
Pneumonia	-	-	S	98
Ciprofloxacin	1	1	I/-	27
Clindamycin	0.12	0.12	S	99
Erythromycin	0.12	0.25	S	99
Oxacillin	-	-	R	92
Penicillin	0.25	0.25	I	76
Meningitis	-	-	R	85
Pneumonia	-	-	S	70

Table 3.4: ***Pseudomonas aeruginosa*** **(9451): Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories**

Antibiotic agent	MIC range ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Amikacin	1	8	S	100
Ceftazidime	1	2	S	98
Ciprofloxacin	0.12	0.5	S	100
Gentamicin	1	4	S	97
Imipenem	1	2	S	99
Meropenem	0.5	2	S	99
Piperacillin+tazobactam	32	64	R/S	39
Tobramycin	0.5	1	S	99

Table 3.5: ***Pseudomonas aeruginosa*** **(9452): Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories**

Antibiotic agent	MIC range ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Amikacin	1	4	S	99
Ceftazidime	1	2	S	99
Ciprofloxacin	0.12	0.25	S	100
Gentamicin	16	64	R	99
Imipenem	1	2	S	99
Meropenem	0.5	2	S	99
Piperacillin+tazobactam	4	8	S	84
Tobramycin	0.5	1	S	99

Table 3.6: ***Staphylococcus aureus*** **(9453): Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories**

Antibiotic agent	MIC range ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Cefoxitin	8	16	R	95
Ciprofloxacin	0.5	0.5	S	95
Erythromycin	4	≥ 128	I/R	93
Fucidic acid	0.06	0.12	S	100
Gentamicin	0.25	0.50	S	99
Methicillin	NT*		R	97
Oxacillin	8	32	R	94
Penicillin	1	4	R	99
Rifampicin	0.004	0.008	S	99
Teicoplanin	1	1	S	99
Tetracycline	64	64	R	97
Vancomycin	1	2	S	99

* Not tested, result inferred from oxacillin and cefoxitin.

in reliability of detection of meticillin resistance in tests with oxacillin (94% participants reported resistance) and cefoxitin (95% participants reported resistance).

About a third of participants reported a result for meticillin (97% resistant) but it may be that oxacillin or cefoxitin were actually tested. Erythromycin reference MICs were very variable (4 to >128 mg/L), probably because resistant colonies of this organism grew slowly. MICs in this range indicate resistance by EUCAST breakpoints and intermediate/resistant by CLSI breakpoints; 93% participants reported the organism resistant and only 6% intermediate (Table 3.6).

3.3 Conclusions

In this eighth EARSS EQA exercise, participation of laboratories was high. The results show that routinely reported results, as collected by EARSS in most instances, have sufficient accuracy to provide good estimates of overall resistance prevalence and trends. The overall concordance was high, except in case of borderline susceptibility, when various guidelines reveal remaining discrepancies in routine susceptibility testing, and when a breakpoint was recently changed. The latter was found for penicillin susceptibility of *Streptococcus pneumoniae* in relation to the source of the isolate, where the isolate was regularly reported non-susceptible for pneumonia. Furthermore, differences in interpretation of results were found for piperacillin+tazobactam (as frequently noted previously).

EARSS Management Team would like to thank UK NEQAS for Microbiology, the reference laboratories, the members of the Advisory Board, the country coordinators for the swift distribution of the strains, and all the participating laboratories for their excellent response rate.

4 EARS-Net laboratory/hospital denominator data 2009

4.1 Introduction

For correct interpretation of the EARS-Net data on antimicrobial resistance, accurate background information is important. Therefore, laboratory and hospital and denominator data are collected and presented in this chapter.

4.2 Methods

Questionnaires, in Microsoft Excel files, were sent to the EARS-Net contact points at the beginning of June 2010. The contact points distributed the questionnaires to the participating laboratories and hospitals in their country. Information was collected on the total number of blood culture sets processed in the laboratories, and the number of hospital beds for each participating hospital, the type of hospital, the bed occupancy and the number of admissions. The national data managers received the completed questionnaires, compiled them and produced the final format suitable for uploading in the European Surveillance System (TESSy). Laboratories have been defined as reporting denominator data if they have provided the number of blood culture sets performed for one or for more than one hospital; hospitals have been defined as reporting denominator data if they have provided the number of beds.

4.3 Participation

Fifteen out of 28 countries reporting antimicrobial resistance results returned hospital denominator data while 14 countries returned laboratory denominator data. Considering the responding countries, 219 of the 307 laboratories (71.3%) and 606 of the 871 hospitals (69.6%) reporting antimicrobial susceptibility results for the 15 countries in 2009, also provided denominator data (Figures 4.1–4.2, Tables 4.1–4.3). Some denominator data of laboratories and hospitals not participating to antimicrobial resistance surveillance, or reporting zero cases, have been included in Figure 4.1, but were not included in the analysis.

4.4 Population coverage

The population coverage of antimicrobial resistance data at country level is not reported for 2009 because of the low number of countries submitting denominator data and because of possible limitations in the use of the data on population coverage:

- laboratories/hospitals reporting antimicrobial susceptibility data do not always provide denominator data and this could give a biased figure of the country population coverage since it can be calculated only for laboratories/hospitals with denominator data; and
- laboratories and hospitals cluster in big cities and, for this reason, some of the catchment areas overlap. This could lead to double counts, which could artificially increase the estimated coverage.

The coverage at European level possibly increased in 2009 compared to the previous year since the number of reporting laboratories increased from 825 in 2008 to 916 in 2009. A high coverage at country level is very important to properly describe the country profile and it also allows a more accurate calculation of the culture rate and the MRSA incidence rate. Calculation of the MRSA incidence rate (not included in the 2009 report) would be based on the assumption that each hospital is served by one laboratory. Therefore, in cases where the laboratory denominator data is referring to a specific hospital (with patient days available), calculation of the culture rate for that hospital is possible. Similarly, having AMR data referring to a specific hospital (with patient days available) would enable calculation the MRSA rate for that hospital.

However, looking into the available data, this assumption seems not always correct. Some hospitals are served by more than one laboratory; it occurs mainly in UK (where the hospital code often refers to a trust instead of a single hospital), but there are examples also in Ireland and Hungary. The implication of the relation 'one hospital to more than one laboratory' is that, if one hospital is reported in the AMR and denominator data while only one of the laboratories serving this hospital is reported, then the culture rate and the MRSA incidence rate will be underestimated.

4.5 Hospital denominator information

The total number of hospital beds for the hospitals reporting AMR results and providing denominator data in different countries ranged from 1 274 in Malta to 143 433 in France, reflecting the size of the country as well as the rate of participation to EARS-Net and the rate of response to the questionnaires. The proportion of ICU beds over total hospital beds shows wide variation according with the country, ranging from 1% in UK to 9% in Cyprus. The median length of stay was 6.6 days with a minimum in UK (3.4 days) and a maximum in Malta (12.7 days). The annual occupancy rate was 75% or higher in 10 out of 15 countries (Table 4.1).

4.6 Hospital characteristics

Both the size of a hospital and the level of specialisation can influence the proportion of resistance. As can be seen from Table 4.2 and Figure 4.2, the distribution of size and specialisation level of hospitals varied

Figure 4.1: Number of laboratories and hospitals reporting AMR and/or denominator data in 2009

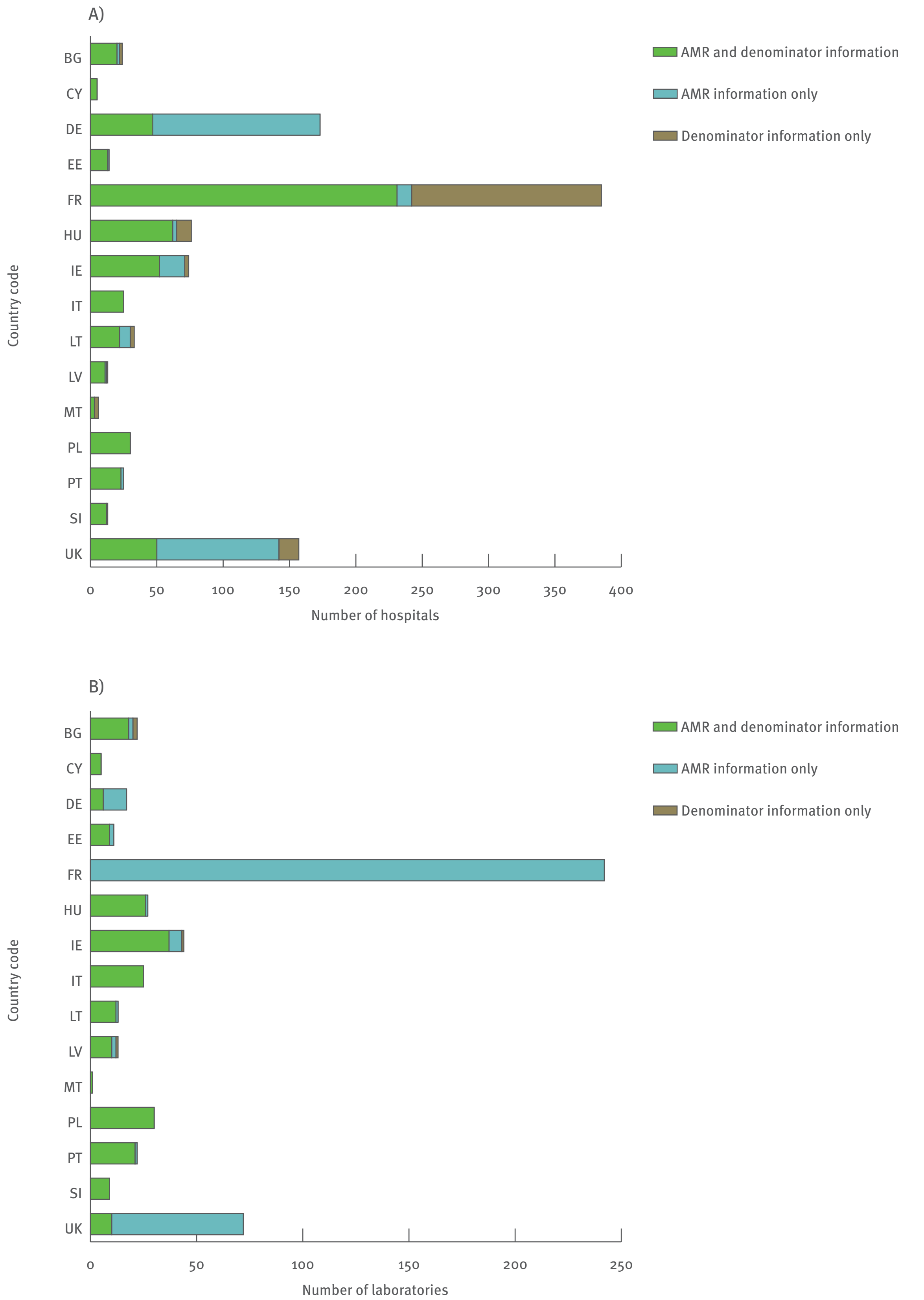


Table 4.1: Hospital denominator data for 2009

Country	Hospitals reporting (denominator/AMR data)	Total number of beds	Proportion of ICU beds (%)	Annual occupancy rate (%)	Median length of stay (days)	IQR length of stay (days)
Bulgaria	(20/22)	9326	8	77	6.3	5.4–6.9
Cyprus	(5/5)	1313	9	72	5.5	5.4–5.7
Estonia	(13/14)	4989	6	75	6.4	5.1–7.0
France	(231*/242)	143433	5	83	7.7	6.4–9.2
Germany	(47/173)	18897	6	73	7.1	6.7–9.1
Hungary	(62/65)	40749	2	76	7.8	6.5–9.6
Ireland	(52/71)	12175	3	87	5.8	4.6–7.1
Italy	(25/25)	15358	5	84	-	-
Latvia	(11/12)	5251	2	68	6.8	5.6–7.4
Lithuania	(22/30)	9792	4	75	7.0	6.3–8.1
Malta	(3/3)	1274	5	85	12.7	5.4–38.6
Poland	(30/30)	15045	2	70	5.5	4.4–6.2
Portugal	(23/25)	10885	5	79	7.3	5.5–8.6
Slovenia	(12/12)	6559	5	79	5.4	4.8–6.2
United Kingdom	(50/142)	60775	1	74	3.4	2.7–6.1

* 178 hospitals in France reported data for a six-month period.

Table 4.2: Hospital characteristics for 2009

Country	Hospitals reporting (denominator/AMR data)	Proportion of hospitals by level of care (%)				
		Tertiary level	Secondary level	Primary level	Other	Unknown
Bulgaria	(20/22)	50	35	5	10	0
Cyprus	(5/5)	20	20	40	20	0
Estonia	(13/14)	31	38	23	0	8
France	(231/242)	22	78	0	0	0
Germany	(47/173)	23	32	30	15	0
Hungary	(62/65)	50	29	15	6	0
Ireland	(52/71)	17	52	12	17	2
Italy	(25/25)	68	28	4	0	0
Latvia	(11/12)	36	55	0	0	9
Lithuania	(22/30)	41	55	5	0	0
Malta	(3/3)	33	33	0	33	0
Poland	(30/30)	13	77	10	0	0
Portugal	(23/25)	57	26	4	13	0
Slovenia	(12/12)	17	50	17	17	0
United Kingdom	(50/142)	6	20	6	18	50

Primary level or district hospital = has few specialties, limited laboratory services; bed capacity ranges from 30 to 200 beds.
Secondary level, or provincial hospital = highly differentiated by function with five to 10 clinical specialties; bed capacity ranging from 200 to 800 beds.
Tertiary level or central/regional hospital = highly specialised staff and technical equipment; clinical services are highly differentiated by function; may have teaching activities; bed capacity ranges from 300 to 1500 beds.
Other = hospitals for a specific patient population, like a military hospital, or hospitals with any single specialty, like a burns unit.
Unknown = not available.

Table 4.3: Laboratory denominator information for 2009

Country	Laboratories reporting (denominator/AMR data)	Number of hospitals*	Total number of blood culture sets	Number of blood culture sets per 1000 patient days
Bulgaria	(18/20)	20	19855	7.5
Cyprus	(5/5)	5	12991	37.6
Estonia	(9/11)	11	11691	10.7
Germany	(6/17)	28	38466	14.7
Hungary	(26/27)	60	83624	7.8
Ireland	(37/43)	51	184985	47.8
Italy	(25/25)	25	125577	26.8
Latvia	(10/12)	10	7859	6.2
Lithuania	(12/13)	20	15618	6.1
Malta	(1/1)	3	4879	12.4
Poland	(30/30)	30	82521	21.6
Portugal	(21/22)	23	158902	50.7
Slovenia	(9/9)	12	46040	24.2
United Kingdom	(10/72)	10	95017	45.2

* Number of hospitals served by laboratories reporting denominator data.

considerably between the reporting countries. This does not necessarily reflect different distributions of the origin of EARS-Net blood cultures per country, because not all hospitals contribute evenly to the EARS-Net database. On the other hand, this diversity can indicate differences in case-mix, which may confound comparison of AMR results between countries.

The type of hospital and the size of hospital are not always linked and it is not rare, especially in small countries, that university hospitals have less than 500 beds.

4.7 Laboratory denominator information

In 2009, the number of blood culture sets processed in the EARS-Net laboratories responding to the questionnaire was 888 025. The median culturing frequency was 18.2 blood culture sets per 1 000 patient days in 2009. The highest rate was reported by Portugal (50.7) and the lowest by Lithuania (6.1). For the majority of the reporting countries, only minor changes in the number of blood culture sets taken per 1 000 patient days (Table 4.3) was observed when comparing 2008 data to 2009. The most significant change was observed for the UK and may originate from the increasing number of reporting hospitals (10 in 2008 and 20 in 2009).

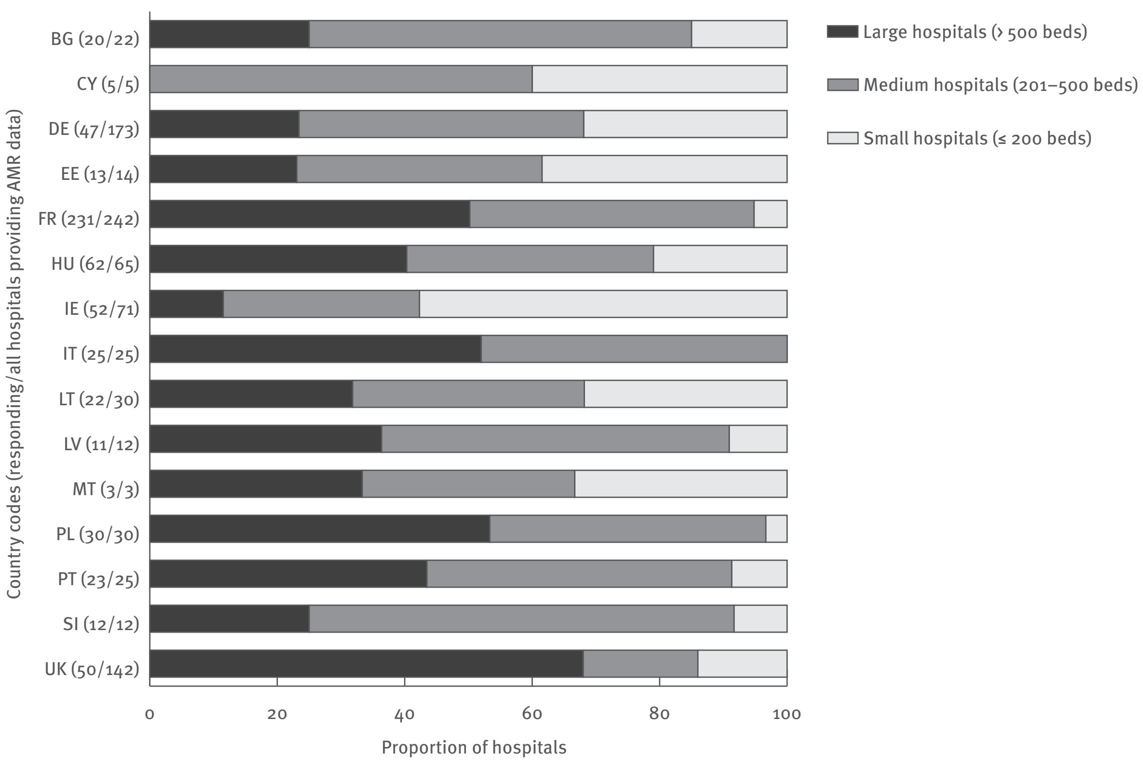
The BSIs ascertainment is strongly linked to the blood culture rate. Therefore, the very wide range of culture rate observed in the countries providing denominator data could have implications on inter-country comparison of both the incidence rate of infections, which could be underestimated in some countries, and of the proportion of resistance. In particular, the proportion of resistance could be overestimated if there is a frequent use of empiric therapy also for invasive infections, and if the cultures are more likely to be performed in patients not responding to the empiric treatment.

4.8 Conclusions

In summary, the situation as assessed from denominator data reported in 2009 is similar to 2008, with only few changes. For future improvement of the denominator data collection and analysis, it is important to address the following issues:

- increase the number of countries reporting denominator data;
- increase the number of hospital and laboratories participating within countries;
- improve the data quality for the variable HospitalId (unique identifier for the hospital within each laboratory); and
- improve the estimation of the coverage of the EARS-Net surveillance, e.g. by using estimations done at the national level based on knowledge of the country-specific situation.

Figure 4.2: Proportion of small, medium and large hospitals per country, based on the number of beds, for all hospital reporting both antimicrobial resistance data and denominator data in 2009



5 Antimicrobial resistance in Europe

5.1 *Streptococcus pneumoniae*

5.1.1 Clinical and epidemiological importance

Streptococcus pneumoniae is a common cause of disease, especially among young children, elderly people and patients with compromised immune functions. The clinical spectrum ranges from upper airway infections, such as sinusitis, and otitis media to pneumonia and invasive bloodstream infections and meningitis. Since *S. pneumoniae* is the most common cause of pneumonia worldwide, morbidity and mortality are high and annually approximately 3 million people are estimated to die of pneumococcal infections.

Pneumococci carry a variety of virulence factors that facilitate adherence and transcytosis of epithelial cells. The cell wall of pneumococci is coated with a viscous polysaccharide slime layer termed the capsule. This is the most important virulence factor because it protects the bacteria from the adhesion of opsonising antibodies and the destruction by leucocytes. Capsular polysaccharides are highly diverse and play an important role in immune evasion. Around 80 different serotypes have been described. The serotype distribution varies with age, disease and geographical region. Interestingly, serotypes most frequently involved in pneumococcal disease or colonisation in infants are also most frequently associated with antimicrobial resistance.

5.1.2 Resistance mechanisms

Beta-lactam antibiotics bind to cell wall synthesising enzymes, so called penicillin-binding proteins (PBPs) and interfere with the biosynthesis and remodelling of the bacterial cell wall during cell growth and division. The mechanism of penicillin resistance in *S. pneumoniae* consists of alterations in PBPs, which results in reduced affinity to this class of antibiotics. Alterations in PBPs occur in a stepwise fashion that causes different degrees of resistance proceeding from reduced susceptibility through low-level clinical resistance – conventionally termed intermediate[1] (I) to full clinical resistance (R). Although intermediately resistant strains are clearly less susceptible than sensitive strains, in absence of meningitis, infections with these strains are often successfully treated with high doses of penicillin or other beta-lactam compounds.

Macrolide, lincosamine and streptogramin (MLS) antibiotics are chemically distinct, but all bind to a ribosomal subunit inhibiting the initiation of mRNA binding and thus act as protein synthesis inhibitors. In *S. pneumoniae* two resistance mechanisms against MLS antibiotics have been reported:

- The acquisition of an erythromycin ribosomal methylation gene (*erm*) results in a post-transcriptional modification of the 23S subunit of ribosomal RNA, which blocks the binding of the macrolide to the ribosome. Once expression of the gene is induced, this often results in high-level resistance (MICs > 128 mg/L) to macrolide, lincosamines and streptogramin B, termed MLS_B resistance.
- The acquisition of a macrolide efflux system gene (*mef*E) results in the excretion of the antimicrobial, and effectively reduces intracellular erythromycin, azithromycin and clarithromycin to subinhibitory concentrations. In contrast to beta-lactam resistance, macrolide resistance via these mechanisms (particularly for MLS_B) provides very high MICs, and cannot be overcome by increasing the dosages of antibiotics.

Since *S. pneumoniae* is the most frequent cause of community-acquired pneumonia and cannot clinically be easily distinguished from lower airway infections caused by other pathogens, empirical treatment of community-acquired lower respiratory infections needs to be active against pneumococci and should take the local prevalence of antimicrobial resistance into account. Habitual prescription of non-beta-lactam compounds is therefore typical in countries where penicillin resistance has been frequently reported. Such reactive prescribing increases the selection pressure for alternative antibiotics such as macrolides and novel fluoroquinolones. It is therefore no surprise to see a dynamic antimicrobial resistance picture emerge in different European countries. At the same time, the existence of frequent dual beta-lactam/macrolides resistance, particularly among children's serotypes, assures that in practice the use of drugs of any of these families will increase resistance for the members of the other one, and so the extended use of macrolides has been considered as a major driver for the increase in beta-lactam resistance.

Even though a certain small decrease in penicillin resistance was detected in some countries before the introduction of the PCV7 vaccine, the widespread use of this vaccine is probably an important factor that may have influenced the decrease in antibiotic resistance levels, eliminating the infections (and more importantly, the children's carriage) of frequent 'classic' resistant serotypes, 14, 6B, 19F and 23F, all of them covered by PCV7. The distribution of serotypes detected in this 2009 report (almost identical to that of 2008) includes serotypes 1 (15%), 19A (12%), 7F (11%), 3 (8%), 12F (7%), 6A (6%), 14 (5%). Even though a limited number of countries have provided serotyping data, ad hoc studies in other EU countries, like France, Spain, Greece, Norway

1 Microorganisms are defined as intermediate by a level of antimicrobial activity with uncertain clinical effect. Occasionally, this can be overcome if antibiotics can be administered at a higher dose and/or are concentrated at the infected body site.

and Portugal, confirm the current generality of this pattern. This shift indicates the effect of the PCV7 vaccine, selecting the non-vaccine serotypes, and more importantly the serotype 19A. In fact the 'classic diversity pattern' of well-adapted types of *S. pneumoniae* clones in children has been maintained, being these clones 'disguised' under the PCV7-non-covered 19A capsule type. At least 10 non-19A serotypes had a 19A capsular switch. Eventually, the introduction of PCV13 vaccine (covering 19A) will produce a new reduction in antibiotic resistance in *S. pneumoniae*.

5.1.3 Results

Penicillin

- Twenty-seven countries reported 11 055 isolates of which 828 were non-susceptible to penicillin; 344 of the 828 non-susceptible isolates were identified as resistant. One country did not report (Greece) and one country reported less than 10 isolates (Malta), therefore, no data displayed on the maps.
- Proportion of non-susceptibility was: below 1% in three countries, 1–5% in nine countries, 5–10% in two countries, 10–25% in seven countries and 25–50% in five countries (Figure 5.1, Table 5.1).
- Trends in the 2006–2009 period have been calculated for 22 countries. Three countries (Bulgaria, Ireland and Luxembourg) reported a significant increasing trend with proportions of non-susceptibility to penicillin, which, in 2009, were 37%, 20% and 19%, respectively. In one of these countries, the trends are significant also when considering only data from laboratories consistently reporting all four years (Figure 5.4).
- Significant decreasing trends have been observed for Belgium[2], France and Spain with proportions of non-susceptibility to penicillin of < 1%, 27% and 22%, respectively, in 2009. In two of these countries the trend is significant also when considering only data from laboratories consistently reporting all four years (Figure 5.4).

Macrolides

- Twenty-seven countries reported 10 934 isolates of which 1 469 were non-susceptible to macrolides. One country (Malta) reported less than 10 isolates (no data displayed in maps).
- Proportion of non-susceptibility was: 1–5% in seven countries, 5–10% in four countries, 10–25% in 10 countries and 25–50% in five countries (Figure 5.2, Table 5.1).
- Trends in the 2006–2009 period have been calculated for 22 countries. No country reported a significant increasing trend (Figure 5.5).
- Significant decreasing trends have been observed for six countries. In four of these countries the trends are significant also when considering only data from laboratories consistently reporting all four years (Figure 5.5). In 2009, these six countries reported the following proportion of resistance to macrolides: 1–5% in one case (United Kingdom), 5–10% in two cases (Netherlands and Norway), 10–25% in two cases (Belgium and Italy) and 25–50% in one case (France).

Dual non-susceptibility (penicillin and macrolides)

- Twenty-seven countries reported 10 577 isolates tested for penicillin and macrolides. In 2009, 5% of isolates had dual non-susceptibility to these two antibiotic classes. One country (Malta) reported less than 10 isolates (therefore not included in Figure 5.3).
- Proportion of dual non-susceptibility was: below 1% in seven countries, 1–5% in seven countries, 5–10% in three countries, 10–25% in seven countries and 25–50% in two countries (Figure 5.3, Table 5.1).
- Trends for 2006–2009 were calculated for 22 countries. A significant increase was observed for Ireland reporting 12% dual non-susceptibility in 2009. A significant decreasing trend has been observed for Belgium (proportion of dual non-susceptibility in 2009 was < 1%) (Figure 5.6).

Serogroups

- Six countries reported 2 959 *S. pneumoniae* isolates with identification of the serotype/serogroup (Table 5.2).
- In 2009 data, the serogroup 1 was the most prevalent (16% of total), followed by serogroups 19 and 7 (both 11% of total), serogroup 3 (8%), serogroup 12 (7%) and serogroups 6, 14, 9 and 22 (all at 5%) (Figure 5.7, Table 5.2).
- Dual non-susceptibility has been mainly retrieved in serogroups 14, 19, 6, 9 and 23. Single non-susceptibility to penicillin in serogroups 14, 9, 19 and 6. Single non-susceptibility to macrolides in serogroups 1, 19, 14, 6, 33, 15, 9, 23, 11, 3 and 12 (Figure 5.7, Table 5.2).

5.1.4 Conclusions

In 2009, the proportion of non-susceptibility to penicillin remained generally stable in Europe with three countries reporting significant increasing trends and other three reporting significant decreasing trends. Fourteen of 26 countries reported proportions of non-susceptibility below 10%. The proportion of non-susceptibility to macrolides declined significantly in six countries while no country reported increasing trends. Nevertheless, 14 countries out of 25 reported proportion of non-susceptibility above 10%.

2 The proportion of *Streptococcus pneumoniae* non-susceptible to penicillin reported by Belgium dropped from 8% in 2008 to < 1% in 2009. This is largely due to the fact that the clinical breakpoints (CLSI) used to determine SIR have changed. The laboratory that performs all the susceptibility tests started using the new CLSI clinical breakpoints in the beginning of 2009. During the entire EARS-Net surveillance, the same method of susceptibility testing has been used, only clinical breakpoints have changed.

The dual non-susceptibility to penicillin and macrolides was above 10% in eight countries out of 25 countries reporting more than 10 isolates.

The highest proportions of non-susceptibility of *S. pneumoniae* to penicillin and/or macrolides were reported by countries of southern and eastern Europe, with Finland as the only northern exception.

So far, the serogroup data reported to EARS-Net should not be regarded as representative for Europe in general; only six countries reported more than 30 isolates with serogroup information and more than 60% of results were provided by Belgium. The serogroup distribution reported in 2009 is similar to the previous year. Most non-susceptible isolates belong to few serogroups, especially serogroups 1, 19, 14, 6 and 9. The serogroup 14, which is particularly important in relation to penicillin resistance, was the most frequent serogroup only in Ireland (12%) (Figure 5.7, Table 5.2).

Figure 5.1: *Streptococcus pneumoniae*: proportion of invasive isolates non-susceptible to penicillin (PNSP) in 2009

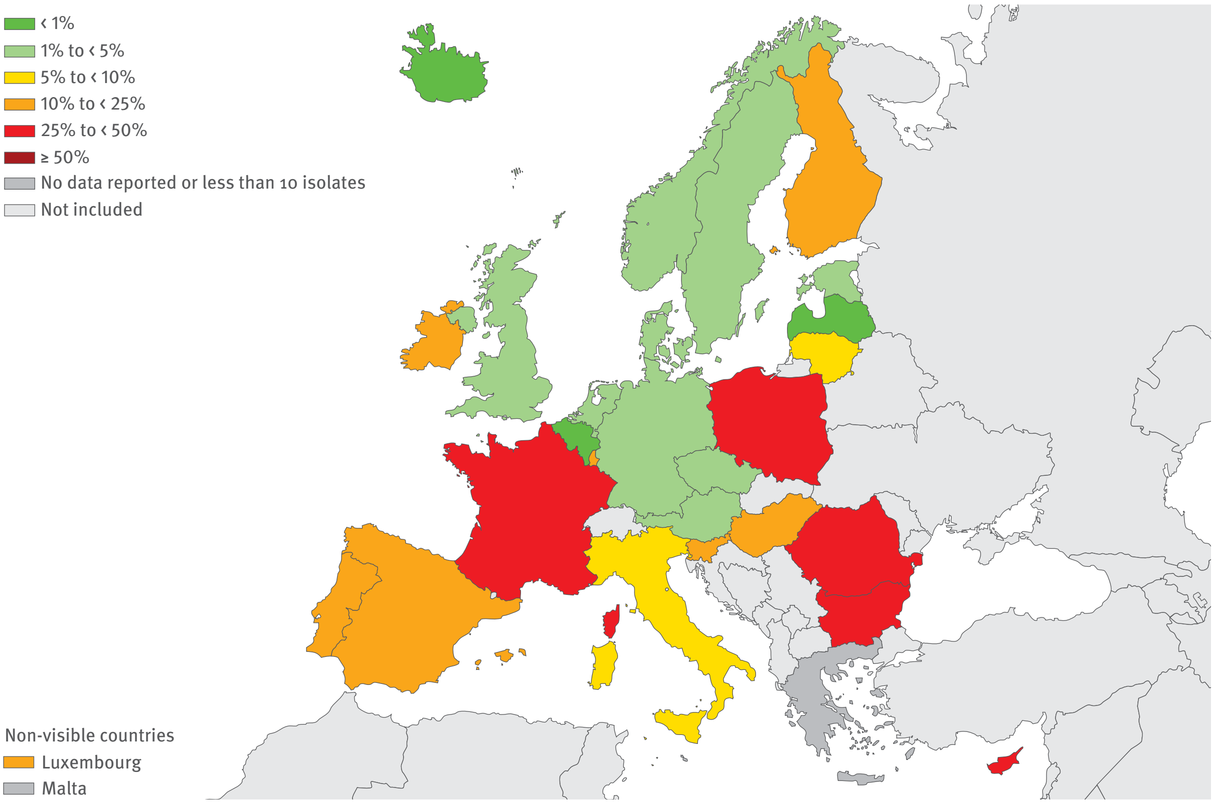


Figure 5.2: ***Streptococcus pneumoniae*: proportion of invasive isolates non-susceptible to macrolides in 2009**

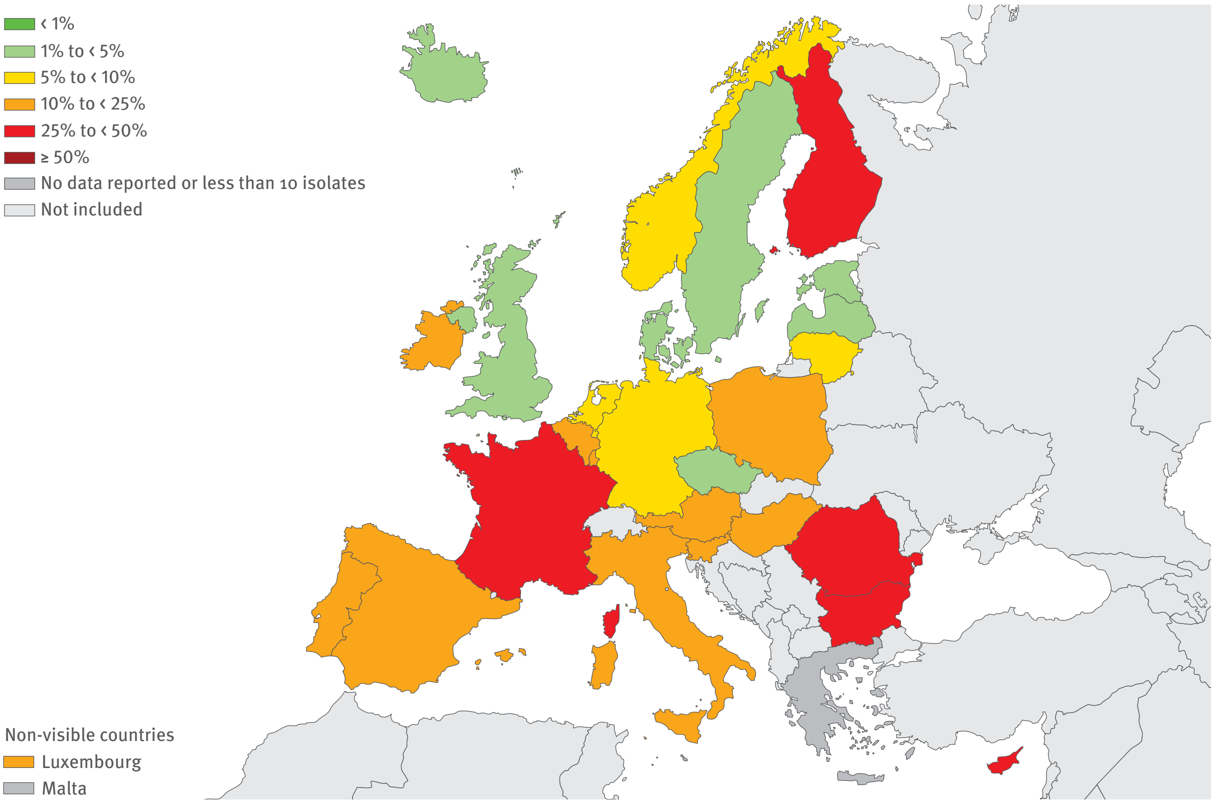


Figure 5.3: ***Streptococcus pneumoniae*: proportion of invasive isolates with dual non-susceptibility to penicillin and macrolides in 2009**

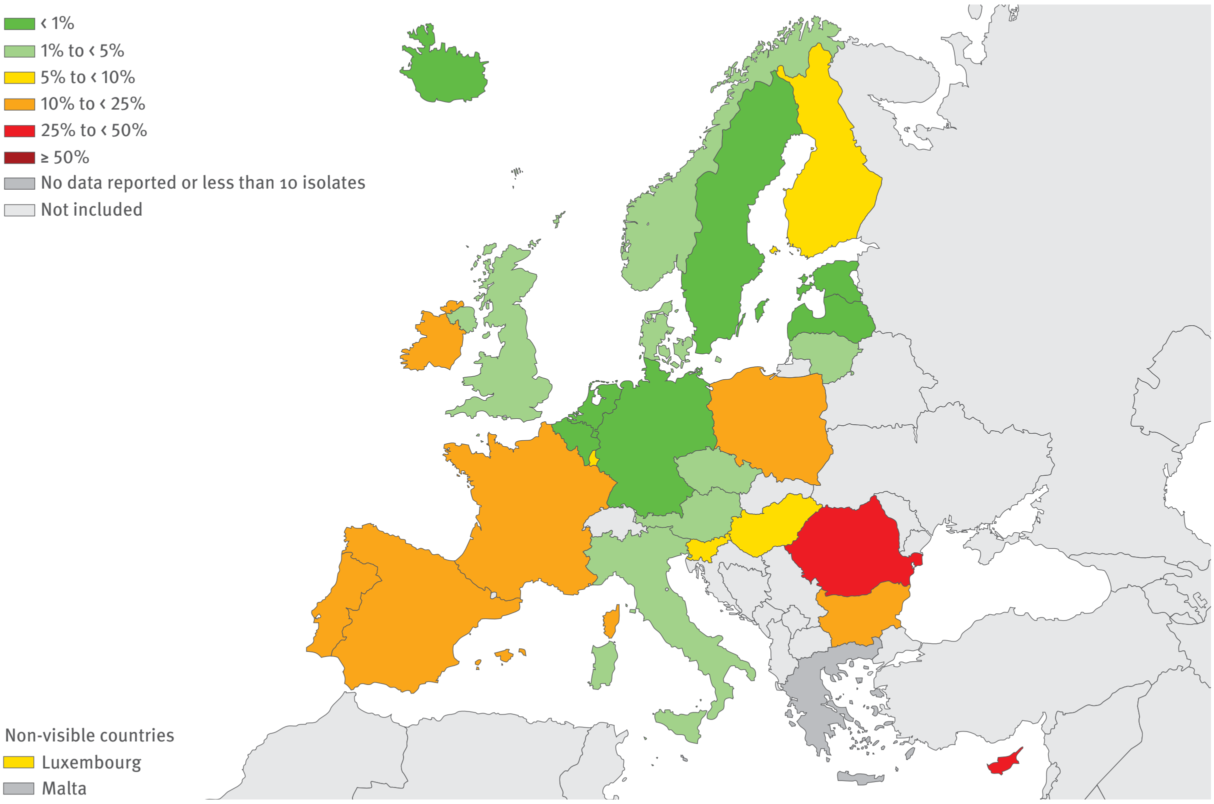
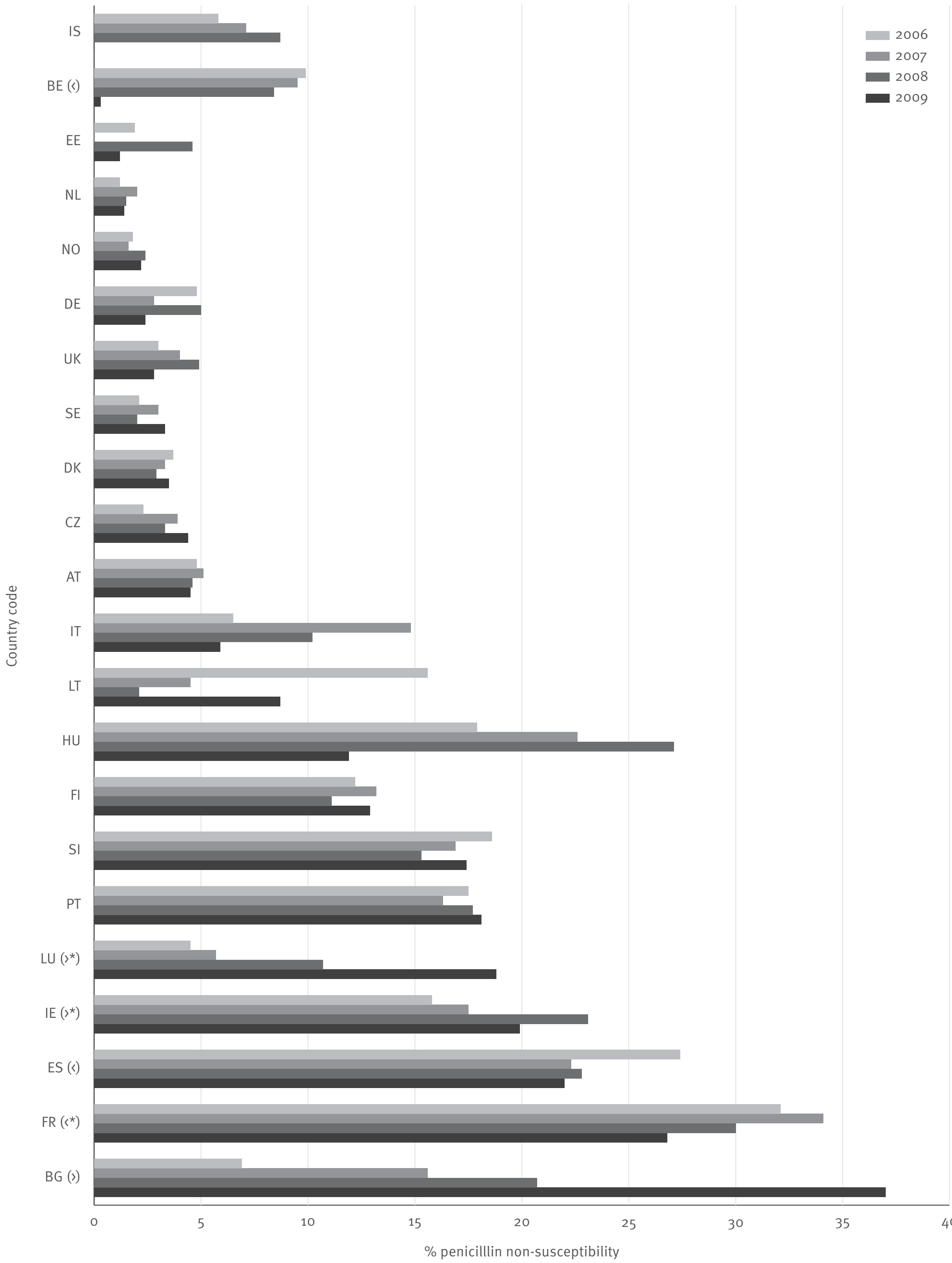
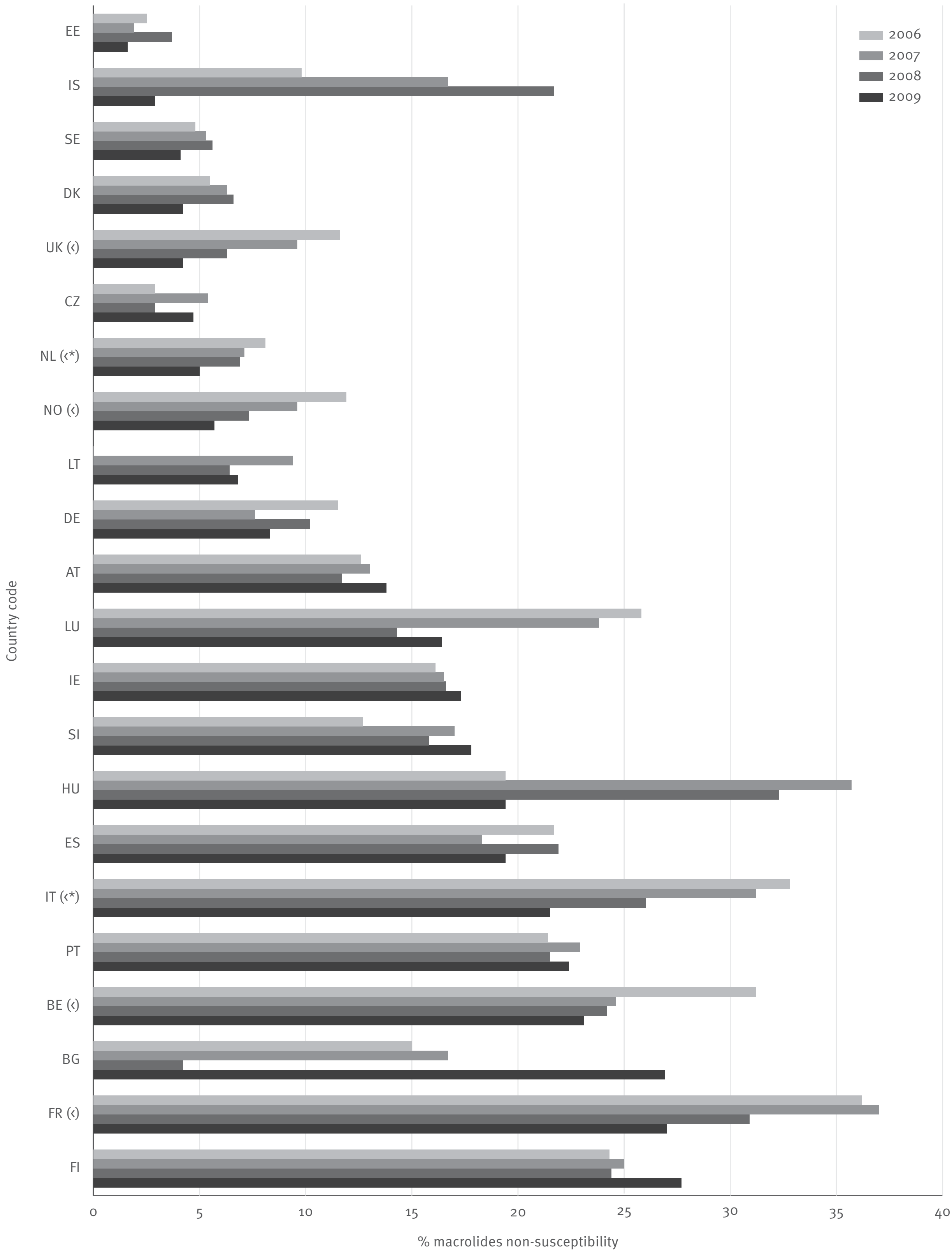


Figure 5.4: *Streptococcus pneumoniae*: trend of penicillin non-susceptibility by country, 2006–2009



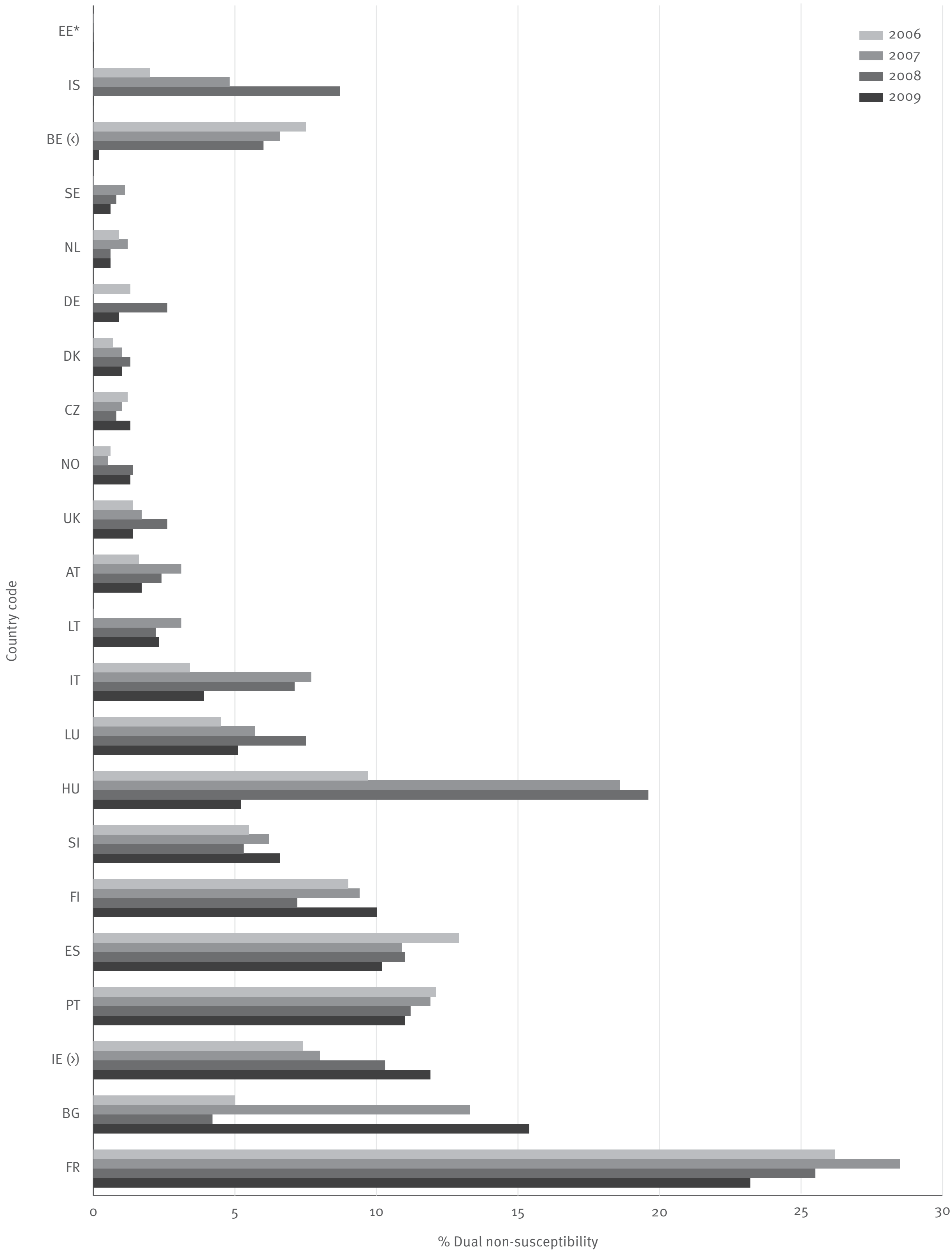
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Figure 5.5: *Streptococcus pneumoniae*: trend of macrolides non-susceptibility by country, 2006–2009



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Figure 5.6: ***Streptococcus pneumoniae*****: trend of dual non-susceptibility (penicillin and macrolides) by country, 2006–2009**



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively.
* 0% resistance for all four years.

Table 5.1: Number of invasive *S. pneumoniae* isolates and proportion of penicillin-non-susceptible (PNSP), penicillin-resistant (PRSP), macrolide non-susceptible (MNSP), single penicillin (PEN), single macrolides (MACR) and dual non-susceptible (DUAL) isolates, including 95% confidence intervals (95% CI), reported per country in 2009

Country	Number of isolates tested for (PEN/ MACR/both)	%PNSP (95%CI)	%PRSP (95%CI)	%MNSP (95%CI)	%single PEN (95%CI)	%single MACR (95%CI)	%DUAL (95%CI)*
Austria	352/319/294	4.5 (3–7)	2.6 (1–5)	13.8 (10–18)	2.7 (1–5)	12.9 (9–17)	1.7 (1–4)
Belgium	1885/1885/1885	0.3 (0–1)	0.2 (0–1)	23.1 (21–25)	0.1 (0–0)	23.0 (21–25)	0.2 (0–0)
Bulgaria	27/26/26	37.0 (19–58)	22.2 (9–42)	26.9 (12–48)	23.1 (9–44)	11.5 (2–30)	15.4 (4–35)
Cyprus	11/11/11	36.4 (11–69)	18.2 (2–52)	36.4 (11–69)	9.1 (0–41)	9.1 (0–41)	27.3 (6–61)
Czech Republic	297/297/297	4.4 (2–7)	0.7 (0–2)	4.7 (3–8)	3.0 (1–6)	3.4 (2–6)	1.3 (0–3)
Denmark	996/996/996	3.5 (2–5)	0.7 (0–1)	4.2 (3–6)	2.9 (2–4)	3.2 (2–5)	1.0 (0–2)
Estonia	82/63/63	1.2 (0–7)	0.0 (0–4)	1.6 (0–9)	1.6 (0–9)	1.6 (0–9)	0.0 (0–6)
Finland	652/679/643	12.9 (10–16)	1.7 (1–3)	27.7 (24–31)	2.8 (2–4)	17.9 (15–21)	10.0 (8–13)
France	826/826/826	26.8 (24–30)	5.9 (4–8)	27.0 (24–30)	3.5 (2–5)	3.8 (3–5)	23.2 (20–26)
Germany	328/339/323	2.4 (1–5)	0.6 (0–2)	8.3 (6–12)	1.5 (1–4)	7.4 (5–11)	0.9 (0–3)
Hungary	143/134/134	11.9 (7–18)	2.8 (1–7)	19.4 (13–27)	5.2 (2–10)	14.2 (9–21)	5.2 (2–10)
Iceland	35/35/35	0.0 (0–10)	0.0 (0–10)	2.9 (0–15)	0.0 (0–10)	2.9 (0–15)	0.0 (0–10)
Ireland	356/336/336	19.9 (16–24)	6.2 (4–9)	17.3 (13–22)	7.7 (5–11)	5.4 (3–8)	11.9 (9–16)
Italy	202/191/178	5.9 (3–10)	3.0 (1–6)	21.5 (16–28)	1.7 (0–5)	16.3 (11–23)	3.9 (2–8)
Latvia	30/30/30	0.0 (0–12)	0.0 (0–12)	3.3 (0–17)	0.0 (0–12)	3.3 (0–17)	0.0 (0–12)
Lithuania	46/44/44	8.7 (2–21)	6.5 (1–18)	6.8 (1–19)	6.8 (1–19)	4.5 (1–15)	2.3 (0–12)
Luxembourg	64/61/59	18.8 (10–30)	10.9 (5–21)	16.4 (8–28)	6.8 (2–16)	11.9 (5–23)	5.1 (1–14)
Malta	7/8/7	14.3 (0–58)	0.0 (0–41)	12.5 (0–53)	0.0 (0–41)	0.0 (0–41)	14.3 (0–58)
Netherlands	572/679/505	1.4 (1–3)	0.2 (0–1)	5.0 (3–7)	0.6 (0–2)	4.8 (3–7)	0.6 (0–2)
Norway	554/545/545	2.2 (1–4)	0.4 (0–1)	5.7 (4–8)	0.9 (0–2)	4.4 (3–6)	1.3 (1–3)
Poland	68/62/62	29.8 (18–43)	29.8 (18–43)	16.1 (8–27)	8.8 (3–18)	1.5 (0–8)	14.7 (7–25)
Portugal	237/237/237	18.1 (13–24)	18.1 (13–24)	22.4 (17–28)	7.2 (4–11)	11.4 (8–16)	11.0 (7–16)
Romania	17/16/16	29.4 (10–56)	11.8 (1–36)	25.0 (7–52)	6.3 (0–30)	0.0 (0–21)	25.0 (7–52)
Slovenia	213/213/213	17.4 (13–23)	1.4 (0–4)	17.8 (13–24)	10.8 (7–16)	11.3 (7–16)	6.6 (4–11)
Spain	708/697/697	22.0 (19–25)	8.3 (6–11)	19.4 (16–23)	11.8 (9–14)	9.2 (7–12)	10.2 (8–13)
Sweden	1058/1008/1005	3.3 (2–5)	2.5 (2–4)	4.1 (3–5)	2.8 (2–4)	3.5 (2–5)	0.6 (0–1)
United Kingdom	1300/1252/1166	2.8 (2–4)	1.0 (1–2)	4.2 (3–5)	1.5 (1–2)	2.7 (2–4)	1.4 (1–2)

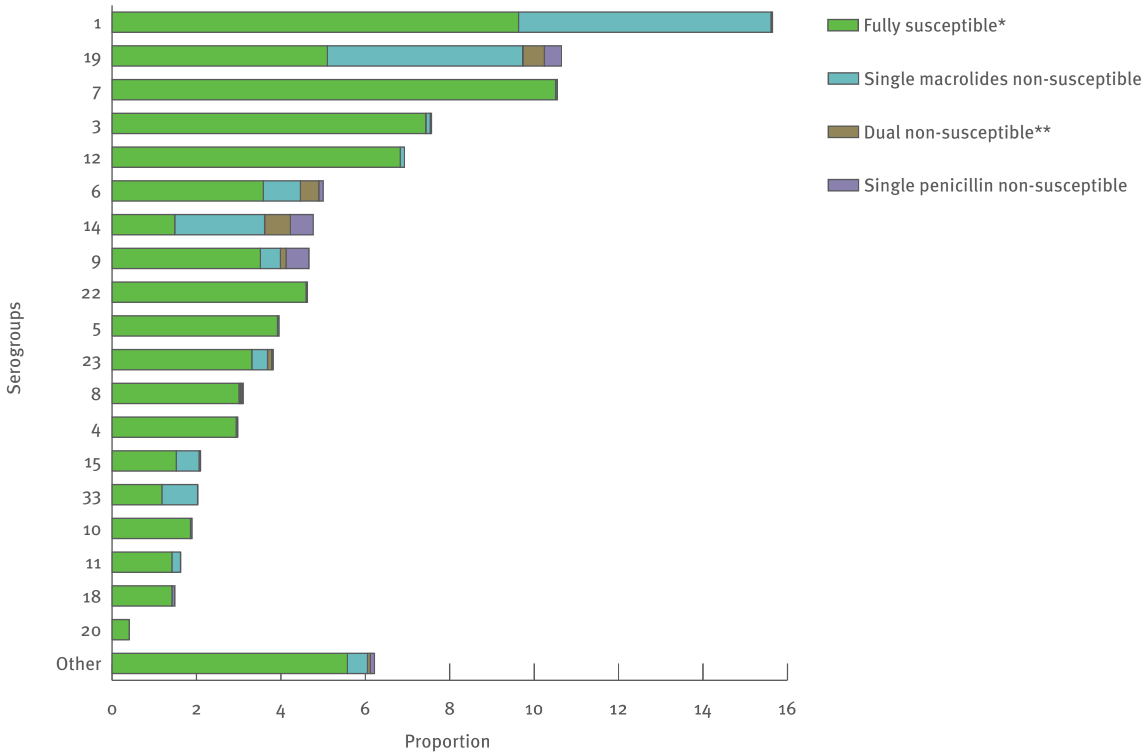
* Dual non-susceptibility defined as being non-susceptible to penicillin and macrolides.

Table 5.2: Distribution of single penicillin, single macrolides and dual penicillin-macrolides non-susceptibility, among the most common serogroups reported per country in 2009

Serogroups	Belgium				Czech Republic				Iceland				Ireland				Slovenia				United Kingdom			
	Number	% single PEN	% single MACR	% DUAL	Number	% single PEN	% single MACR	% DUAL	Number	% single PEN	% single MACR	% DUAL	Number	% single PEN	% single MACR	% DUAL	Number	% single PEN	% single MACR	% DUAL	Number	% single PEN	% single MACR	% DUAL
1	368	0	48	0	28	0	0	0	1	0	0	0	13	0	0	0	25	4	0	0	28	0	0	0
3	125	0	1	0	24	0	4	0	1	0	0	0	18	0	6	0	33	0	0	0	23	4	0	0
4	42	0	0	0	20	0	5	0	0	0	0	0	11	0	0	0	9	0	0	0	6	0	0	0
5	115	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
6	71	0	30	1	18	0	6	0	3	0	0	0	22	5	5	45	16	13	13	13	18	0	6	0
7	202	0	0	0	24	0	0	0	4	0	0	0	32	0	3	0	9	0	0	0	41	0	0	0
8	42	0	2	0	14	0	0	0	0	0	0	0	9	0	0	0	1	0	0	0	26	4	0	4
9	49	0	22	0	28	25	4	0	9	0	0	0	20	15	0	20	21	29	5	0	11	0	9	0
10	40	0	3	0	11	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	2	0	0	0
11	24	0	17	0	2	0	0	0	1	0	0	0	5	0	20	0	3	0	0	0	13	0	8	0
12	193	0	2	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0	0	7	0	0	0
14	37	0	65	3	26	4	8	12	6	0	17	0	33	27	36	24	28	21	61	18	11	0	64	9
15	38	0	39	0	3	0	0	0	0	0	0	0	11	0	9	0	3	0	0	0	7	0	0	14
18	16	0	0	0	6	0	0	0	0	0	0	0	16	13	0	0	5	0	0	0	1	0	0	0
19	201	1	64	0	16	6	25	0	4	0	0	0	32	6	3	28	21	29	5	24	41	2	7	0
20	5	0	0	0	3	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
22	88	0	0	0	7	0	0	0	0	0	0	0	15	0	0	0	2	0	0	0	25	4	0	0
23	49	0	20	0	23	0	0	4	2	0	0	0	20	0	0	5	11	0	9	9	8	13	0	0
33	36	0	64	0	1	0	0	0	1	0	0	0	7	0	0	0	6	0	17	0	9	0	11	0
other	139	0	9	0	12	0	0	0	0	0	0	0	10	20	0	10	9	0	11	11	14	7	0	0
Total/ average	**1880**	**0**	**23**	**0**	**266**	**3**	**4**	**2**	**33**	**0**	**3**	**0**	**283**	**7**	**6**	**12**	**206**	**10**	**12**	**7**	**291**	**2**	**5**	**1**

Only countries reporting more that 30 isolates were presented.

Figure 5.7: Distribution of serogroups and the resistance profile of *S. pneumoniae* isolates per serogroup in 2009



Only countries that reported serogroup information for more than 30 isolates were included in the figure.
* Susceptible to at least penicillin and macrolides.
** Non-susceptible to penicillin and macrolides.

5.2 *Staphylococcus aureus*

5.2.1 Clinical and epidemiological importance

Staphylococcus aureus is a gram-positive bacterium that colonises the skin of about 30% of healthy humans. Although mainly a harmless coloniser, *S. aureus* can cause severe infection. Its oxacillin-resistant form (meticillin-resistant *S. aureus*, MRSA) is the most important cause of antibiotic-resistant healthcare-associated infections worldwide. Since healthcare-associated MRSA infections add to the number of infections caused by meticillin-susceptible *S. aureus*, a high incidence of MRSA adds to the overall burden of infections caused by this species in hospitals. Moreover, infections with MRSA may result in prolonged hospital stay and in higher mortality rates, owing mainly to the increased toxicity and limited effectiveness of alternative treatment regimens. MRSA is currently the most commonly identified antibiotic-resistant pathogen in hospitals in many parts of the world, including Europe, the Americas, North Africa and the Middle- and Far East.

5.2.2 Resistance mechanisms

S. aureus acquires resistance to meticillin and all other beta-lactam antibiotics through expression of the exogenous *mecA* gene, that codes for a variant penicillin binding protein PBP2' (PBP2a) with low affinity to beta-lactams, thus preventing the drug induced inhibition of cell wall synthesis. The level of meticillin resistance, defined by its MIC, depends on the amount of PBP2' production, which is influenced by various genetic factors. Resistance levels of *mecA*-positive strains can thus range from phenotypically susceptible to highly resistant. Upon challenge with meticillin, a population of a heterogeneously resistant MRSA strain may quickly be outgrown by a subpopulation of highly resistant variants.

5.2.3 Results

Beta-lactams

- Twenty-eight countries reported 30 680 isolates of which 5 965 were identified as meticillin-resistant *Staphylococcus aureus* (MRSA).
- Proportion of MRSA was: below 1% in two countries, 1–5% in five countries, 5–10% in two countries, 10–25% in nine countries, 25–50% in nine countries and above 50% in one country (Figure 5.8, Table 5.3).
- Trends in the 2006–2009 period have been calculated for 28 countries. Significant decreasing trends have been observed for eight countries. In six of these countries the trends are significant also when considering only data from laboratories consistently reporting all four years (Figure 5.9). In 2009, these eight countries reported the following proportion of MRSA: 5–10% in two cases (Austria and Latvia), 10–25% in two cases (Bulgaria and France) and 25–50% in four cases (Greece, Ireland, Romania and UK).
- One country (Czech Republic) reported a significant increasing trend of MRSA proportion (Figure 5.9) which, in 2009, was 15%.

Rifampin

- Twenty-five countries reported 21 190 isolates of which 203 were identified as resistant to rifampin. Seventeen countries reported at least one resistant isolate. Most resistant isolates (159) were also MRSA. The proportion of rifampin resistance was 3.7% among the MRSA isolates and 0.3% among the MSSA isolates.
- Proportion of resistance was: below 1% in 17 countries, 1–5% in six countries, 5–10% in one country, 10–25% in one country (Table 5.3).

5.2.4 Conclusions

The proportion of MRSA is stabilising or decreasing in most European countries. Eight countries reported decreasing trends while only one reported an increasing trend. The countries showing a more evident and sustained decrease of MRSA proportion are: Austria, France, Ireland, Latvia and UK. Although these signals provide reasons for optimism, MRSA should remain a public health priority, since the proportion of MRSA is still above 25% in 10 out of 28 countries, mainly in southern Europe and on the British Isles.

The occurrence of resistance to rifampin, which is recommended in combination with other antimicrobials to treat various staphylococcal infections, is still very low in most European countries.

Figure 5.8: ***Staphylococcus aureus*****: proportion of invasive isolates resistant to meticillin (MRSA) in 2009**

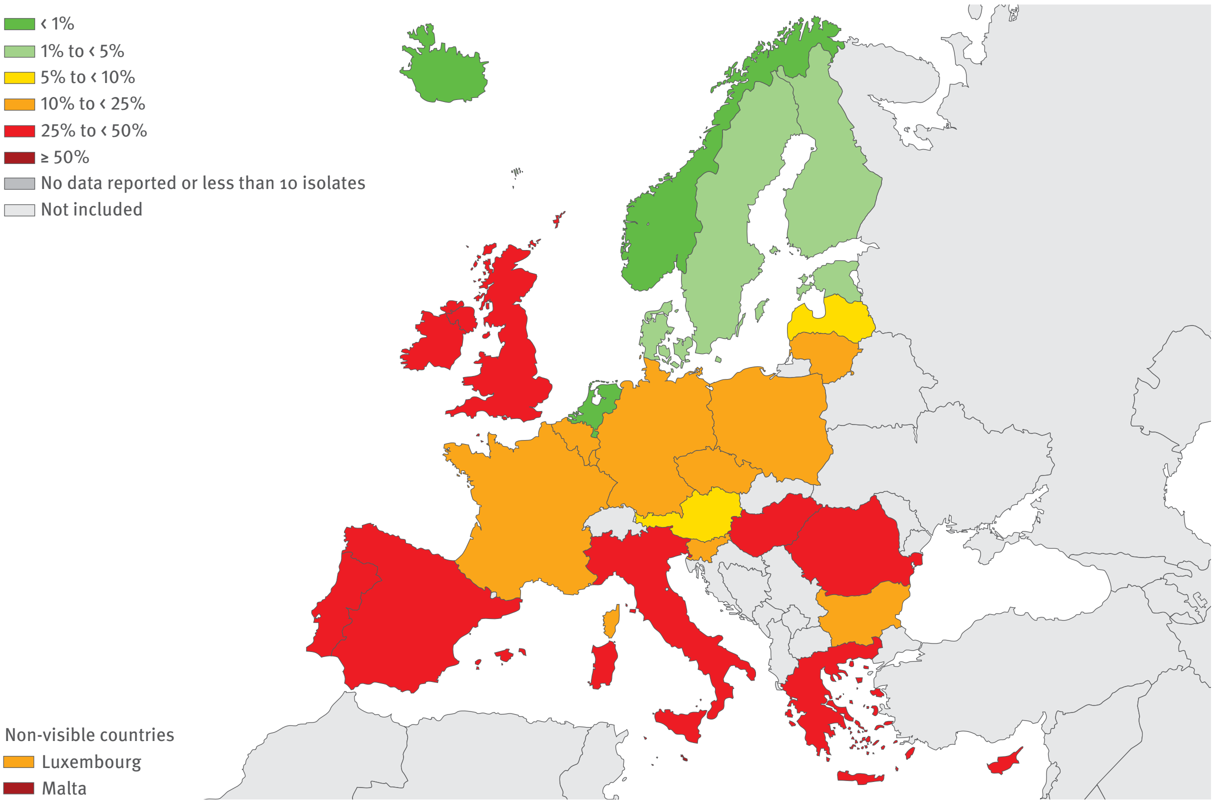
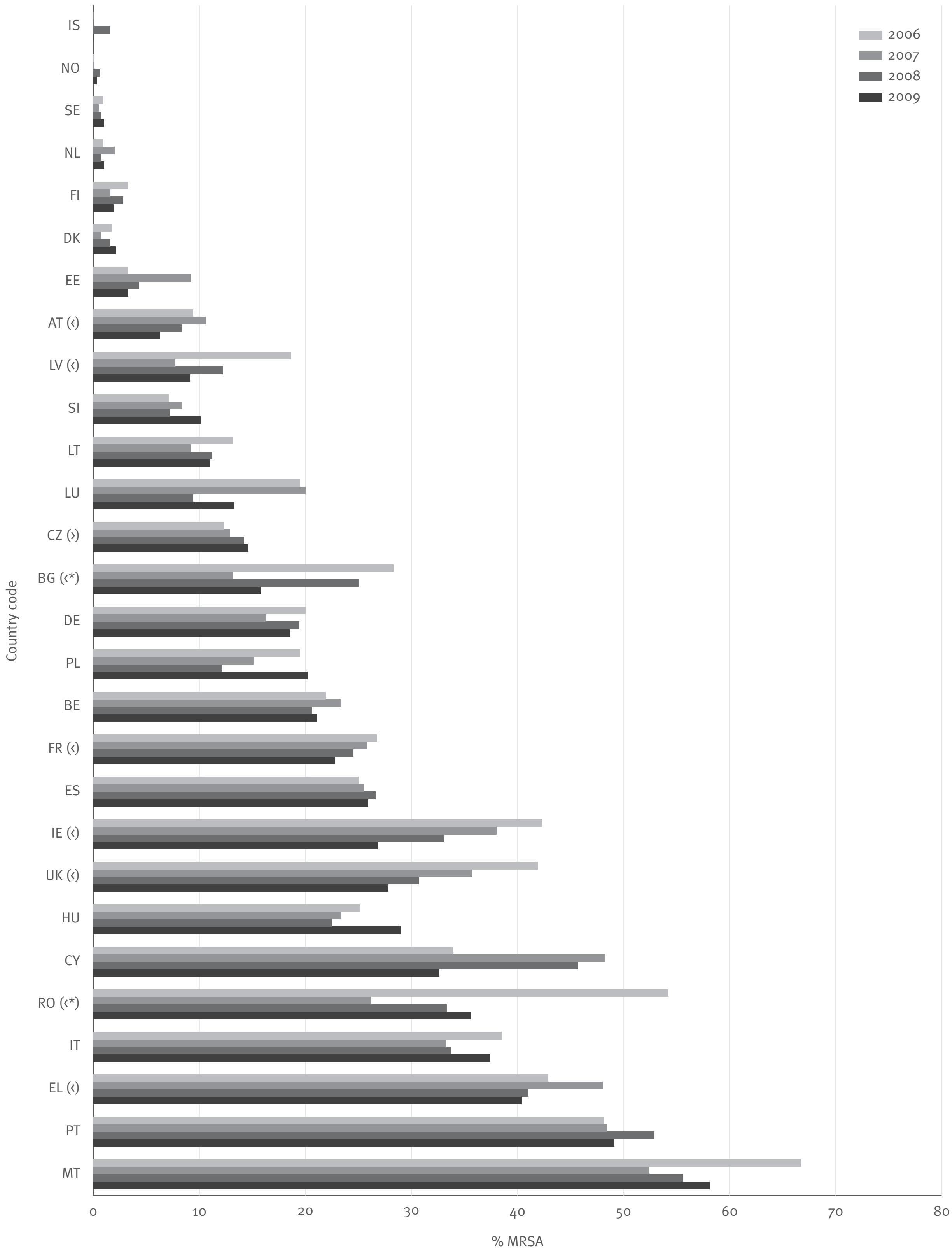


Table 5.3: **Number of invasive *S. aureus* isolates and proportion resistant to meticillin (MRSA) and rifampin (RIF), including 95% confidence intervals (95% CI), reported per country in 2009**

Country	Meticillin		Rifampin	
	N	% MRSA (95%CI)	N	% RIF (95%CI)
Austria	1739	6.3 (5–8)	1677	0.2 (0–1)
Belgium	949	21.1 (19–24)	0	-
Bulgaria	221	15.8 (11–21)	137	2.9 (1–7)
Cyprus	89	32.6 (23–43)	89	0.0 (0–4)
Czech Republic	1695	14.6 (13–16)	716	1.3 (1–2)
Denmark	1395	2.1 (1–3)	1395	0.1 (0–1)
Estonia	213	3.3 (1–7)	63	0.0 (0–6)
Finland	978	1.9 (1–3)	934	0.0 (0–0)
France	4720	22.8 (22–24)	4519	1.2 (1–2)
Germany	1885	18.5 (17–20)	1152	0.5 (0–1)
Greece	996	40.4 (37–43)	0	-
Hungary	1068	29.0 (26–32)	287	2.4 (1–5)
Iceland	59	0.0 (0–6)	0	-
Ireland	1261	26.8 (24–29)	1051	0.4 (0–1)
Italy	978	37.4 (34–41)	908	5.5 (4–7)
Latvia	186	9.1 (5–14)	159	0.6 (0–3)
Lithuania	254	11.0 (7–16)	164	0.0 (0–2)
Luxembourg	113	13.3 (8–21)	72	0.0 (0–5)
Malta	86	58.1 (47–69)	86	0.0 (0–4)
Netherlands	1035	1.0 (0–2)	861	0.0 (0–0)
Norway	907	0.3 (0–1)	262	0.0 (0–1)
Poland	506	20.2 (17–24)	259	1.2 (0–3)
Portugal	1824	49.1 (47–51)	828	3.5 (2–5)
Romania	45	35.6 (22–51)	45	15.6 (6–29)
Slovenia	424	10.1 (7–13)	395	0.5 (0–2)
Spain	1715	25.9 (24–28)	1614	0.5 (0–1)
Sweden	2456	1.0 (1–1)	1608	0.1 (0–0)
United Kingdom	2883	27.8 (26–29)	1909	0.6 (0–1)

Figure 5.9: ***Staphylococcus aureus*****: trend of meticillin-resistance (MRSA) by country, 2006–2009**



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

5.3 Enterococci

5.3.1 Clinical and epidemiological importance

Enterococci belong to the normal bacterial flora of the gastrointestinal tract of humans, other mammals, birds and reptiles. Enterococci are regarded harmless commensals, and are even believed to have positive effects on a number of gastrointestinal and systemic conditions. However, when the commensal relationship with the host is disrupted, enterococci can cause invasive diseases. Recently, the recognition of high risk clones as those of the polyclonal subcluster CC17 in *Enterococcus faecium*, suggests that some particular strains can act as true pathogens, and not only as opportunistic commensals. Enterococci can cause a variety of clinical syndromes, including endocarditis, bacteraemia, meningitis, wound and urinary tract infections and are associated with peritonitis and intra-abdominal abscesses. In the United States, three to four nosocomial bloodstream infections per 10 000 hospital discharges are caused by enterococci, and contribute to patient mortality as well as additional hospital stay.

The vast majority (around 80%) of clinical enterococcal infections in humans are caused by *Enterococcus faecalis*, whereas *E. faecium* accounts for the majority of the remaining 20%. Epidemiological data collected over the last two decades have documented the emergence of enterococci, and in particular *E. faecium*, as important nosocomial pathogens, which is seen as the expansion of a major hospital adapted polyclonal subcluster CC17, but also in *E. faecalis* CC2 and CC9, which are also isolated from farm animals. The emergence of particular clones and clonal complexes of *E. faecalis* and *E. faecium* was paralleled by increases in glycopeptide and high-level aminoglycoside resistance. These two antimicrobial groups represent the few remaining therapeutic options for treatment of human infections caused by *E. faecium* when resistance has emerged against penicillins. Besides the fact that infections caused by resistant enterococci are difficult to treat, they are highly tenacious and thus easily disseminate in the hospital setting.

5.3.2 Resistance mechanisms

Enterococci are intrinsically resistant to a broad range of antibiotics including cephalosporins, sulphonamides and low concentrations of aminoglycosides. Patient safety in hospitals is challenged by the ability of enterococci to acquire additional resistance through the transfer of plasmids and transposons and recombination or mutation.

Beta-lactam antibiotics – By nature, enterococci have low susceptibility to many beta-lactam antibiotics – a consequence of their low-affinity PBPs. Two possible mechanisms of resistance of enterococci to beta-lactams have been reported: the production of beta-lactamase, which is an extremely rare finding; and the overproduction and modification of penicillin-binding proteins (PBPs, particularly PBP5) that causes high-level penicillin resistance in *E. faecium*. Complete penicillin resistance in *E. faecalis* is currently absent; therefore, the first choice for treatment of infections caused by this microorganism is still an aminopenicillin such as ampicillin. In *E. faecium*, ampicillin-resistance has increased significantly during the last years due to the wide dissemination of ampicillin-resistant strains belonging to the polyclonal subcluster CC17.

Aminoglycosides – In addition to the intrinsic mechanism of low-level resistance, which causes a low uptake of the drug, enterococci have acquired genes conferring high-level resistance to aminoglycosides. High-level resistance to streptomycin can be mediated by single mutations within a protein of the 30S ribosomal subunit, the target of aminoglycoside activity. In addition, different aminoglycoside-modifying enzymes have been identified, targeting eight different aminoglycosides.

Glycopeptides – Vancomycin resistance in enterococci was first encountered in France and England but showed the most dramatic increase in the United States and was attributed to the widespread use of vancomycin in US hospitals. Whereas vancomycin consumption was less pronounced in Europe, a closely related glycopeptide, avoparcin, was widely used as growth promoter in animal husbandry from the late-1970s until it was banned in the EU by 1998. Glycopeptide resistance is due to the synthesis of modified cell wall precursors that show a decreased affinity for glycopeptides. Five phenotypes have been identified of which two have clinical relevance: VanA, with high-level resistance to both vancomycin and teicoplanin; and VanB, with a variable level of resistance to only vancomycin. The VanA and VanB phenotypes, mostly found among *E. faecalis* and *E. faecium*, may be transferred by plasmids and conjugative transposition.

5.3.3 Results *E. faecalis*

High-level aminoglycosides

- Twenty-six countries reported 6 950 isolates of which 2 484 were high-level resistant to aminoglycosides.
- Three countries reported resistance proportions above 50% (Cyprus, Greece and Hungary), and the majority of countries (18 of 26) reported resistant proportions between 50% and 30%. Among five countries reporting proportions below 30%, the lowest proportions were reported by Sweden (18.6%), France (18.0%) and Iceland (15.4%) (Figure 5.10 and Table 5.4).
- Nineteen of 26 countries reported more than 20 isolates per year since 2006 and were included in the trend analysis for the period 2006–2009. During the past four years, a significant increase was observed for three of 19 countries. Only for Cyprus, the increasing trend was significant, when considering data from laboratories reporting consistently for all four years (Figure 5.11).
- Two countries (Germany and Ireland) reported significant decreasing trends of high-level aminoglycosides resistance. The decreasing trend was significant only for Ireland when considering data from laboratories reporting consistently for all four years (Figure 5.11).

5.3.4 Results *E. faecium*

Vancomycin

- Twenty-eight countries reported 4945 isolates of which 451 were resistant to vancomycin. Only two countries (Malta and Romania) reported less than 10 isolates (thus not shown in Figure 5.12).
- Three countries reported resistance proportions above 25% (Ireland, Luxembourg and Greece) and five countries reported resistant proportions between 10% and 25%, while the majority of countries (18 of 26) reported resistant proportions below 10%. Several countries reported even below 1% (Bulgaria, Estonia, Finland, France, Norway, Romania and Sweden) (Figure 5.12 and Table 5.4).
- Nineteen of 28 countries reported more than 20 isolates per year since 2006 and were included in the trend analysis for the period 2006–2009. During the past four years, a significant increase was observed only for Austria; however, the increasing trend was not significant when considering data from laboratories reporting consistently for all four years (Figure 5.13).
- Four countries (Greece, Germany, Italy and France) reported significant decreasing trends of vancomycin resistance. Considering data from laboratories reporting consistently for all four years, the decreasing trend was significant for Greece and Italy (Figure 5.13).

5.3.5 Conclusions

High-level aminoglycoside resistance in *E. faecalis* seems stable in Europe but at a relatively high level. The majority of countries reported proportions of resistant isolates between 30% and 50%, however, a consistent decrease was reported by Germany and Ireland.

The occurrence of vancomycin resistance in *E. faecium* seems also to stabilise in Europe, although fluctuations may arise from hospitals outbreaks, e.g. related to the continuing dissemination of strains belonging to the polyclonal subcluster CC17. This may, however, not reflect the overall trend or the situation in hospitals, which have remained unaffected.

In some countries (Greece, Germany, Italy and France) the efforts to control glycopeptide-resistant enterococci seem to be successful and resulting in a continuous decrease of proportions of resistant isolates, and several countries reported resistant proportions below 1%.

Figure 5.10: ***Enterococcus faecalis*****: proportion of invasive isolates with high-level resistance to aminoglycosides in 2009**

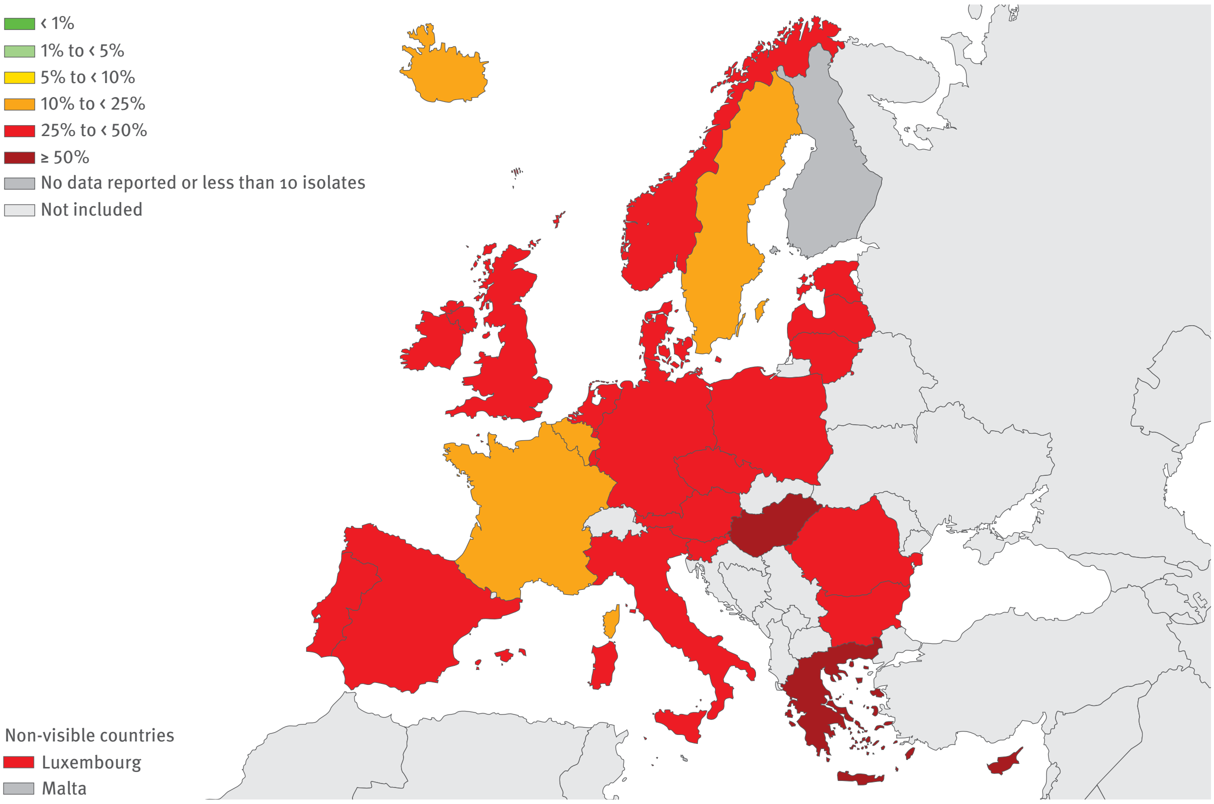
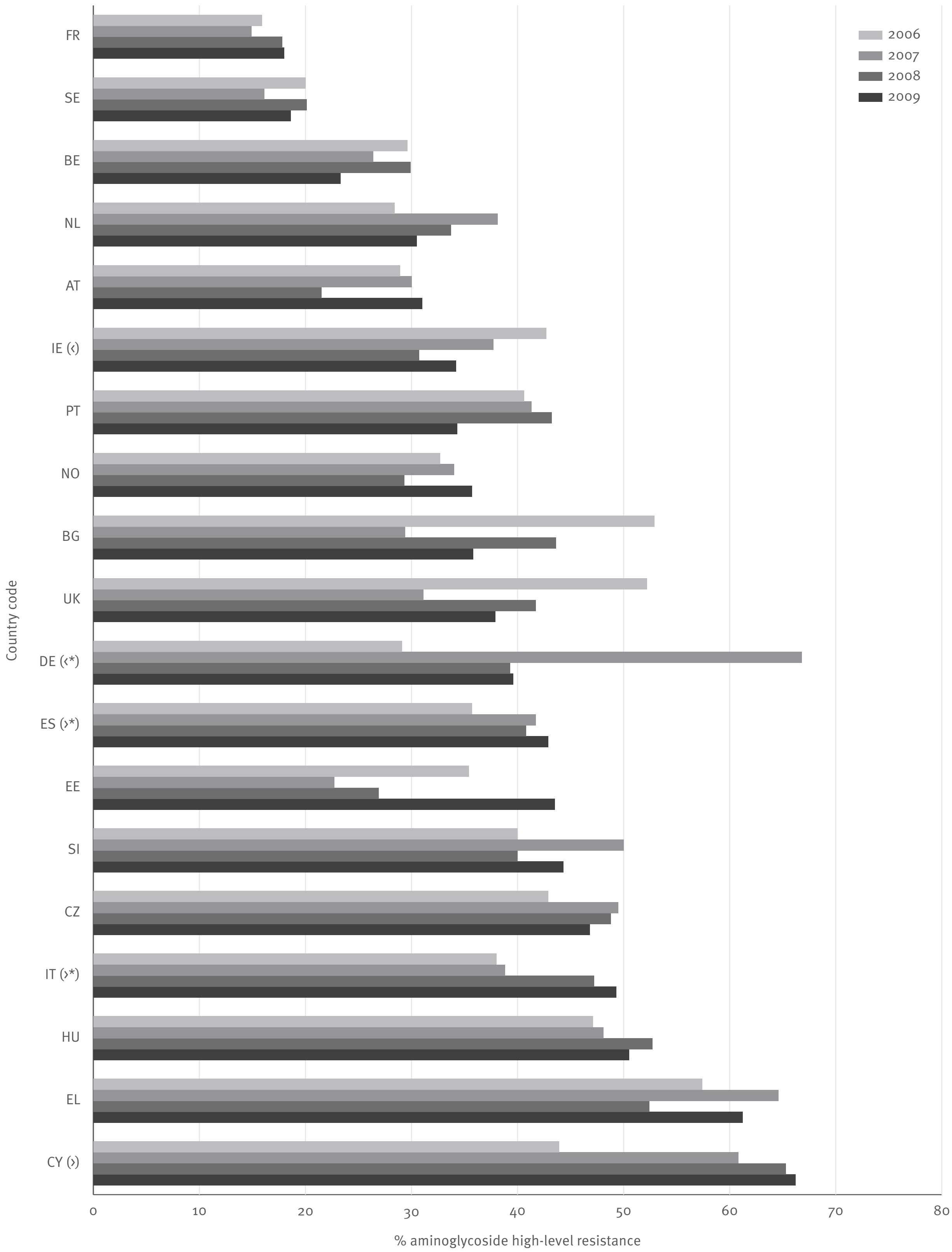


Figure 5.11: ***Enterococcus faecalis*****: trends of high-level aminoglycoside resistance by country, 2006–2009**



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Figure 5.12: *Enterococcus faecium*: proportion of invasive isolates resistant to vancomycin in 2009

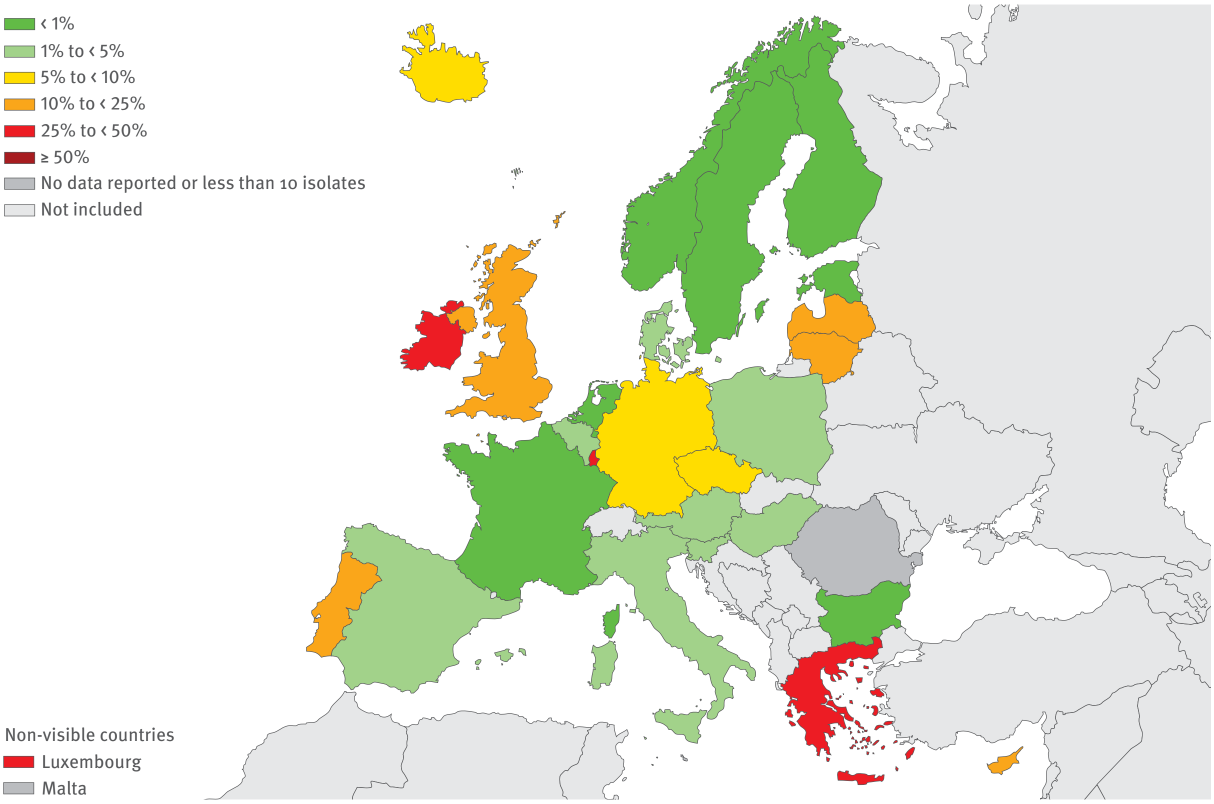
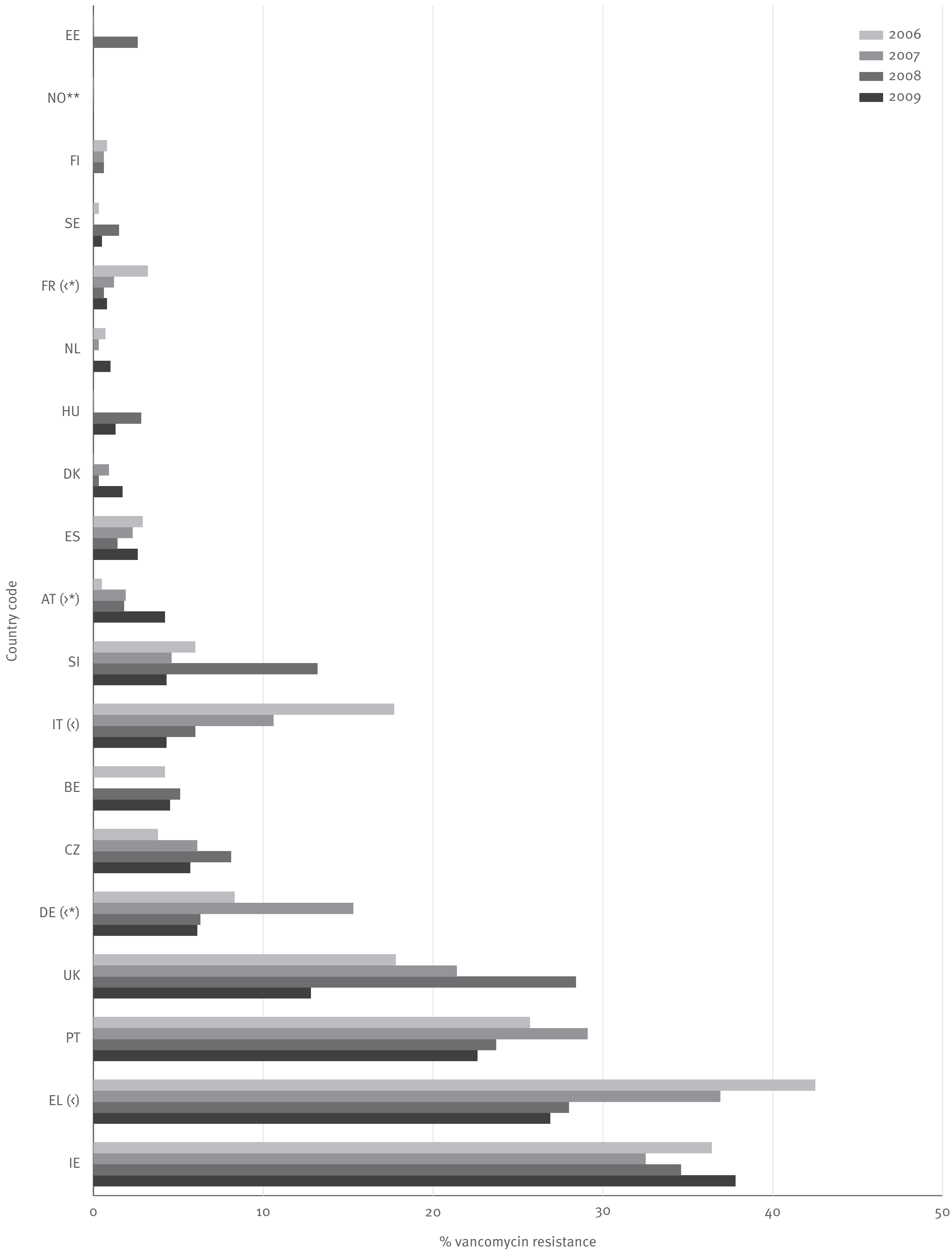


Table 5.4: Number of invasive *E. faecalis* and *E. faecium* isolates and proportion of high–level aminoglycoside–resistant *E. faecalis* and vancomycin–resistant *E. faecium* (%R), including 95% confidence intervals (95% CI), reported per country in 2009

Country	High-level aminoglycoside resistant *E. faecalis*		Vancomycin-resistant *E. faecium*	
	N	% R (95% CI)	N	% R (95% CI)
Austria	252	31.0 (25–37)	310	4.2 (2–7)
Belgium	150	23.3 (17–31)	67	4.5 (1–13)
Bulgaria	53	35.8 (23–50)	26	0.0 (0–13)
Cyprus	65	66.2 (53–77)	15	13.3 (2–40)
Czech Republic	626	46.8 (43–51)	209	5.7 (3–10)
Denmark	52	32.7 (20–47)	348	1.7 (1–4)
Estonia	23	43.5 (23–66)	40	0.0 (0–9)
Finland	0	-	243	0.0 (0–2)
France	1298	18.0 (16–20)	591	0.8 (0–2)
Germany	450	39.6 (35–44)	408	6.1 (4–9)
Greece	547	61.2 (57–65)	435	26.9 (23–31)
Hungary	368	50.5 (45–56)	76	1.3 (0–7)
Iceland	26	15.4 (4–35)	25	8.0 (1–26)
Ireland	260	34.2 (28–40)	386	37.8 (33–43)
Italy	136	49.3 (41–58)	188	4.3 (2–8)
Latvia	26	38.5 (20–59)	22	18.2 (5–40)
Lithuania	31	48.4 (30–67)	19	10.5 (1–33)
Luxembourg	32	28.1 (14–47)	14	35.7 (13–65)
Malta	0	-	6	0.0 (0–46)
Netherlands	190	30.5 (24–38)	207	1.0 (0–3)
Norway	252	35.7 (30–42)	101	0.0 (0–4)
Poland	163	38.7 (31–47)	85	1.2 (0–6)
Portugal	420	34.3 (30–39)	217	22.6 (17–29)
Romania	17	35.3 (14–62)	9	0.0 (0–34)
Slovenia	115	44.3 (35–54)	69	4.3 (1–12)
Spain	735	42.9 (39–47)	342	2.6 (1–5)
Sweden	597	18.6 (16–22)	221	0.5 (0–2)
United Kingdom	66	37.9 (26–51)	266	12.8 (9–17)

Figure 5.13: *Enterococcus faecium*: trends of vancomycin resistance by country 2006–2009



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.
** 0% resistance for all four years.

5.4 *Escherichia coli*

5.4.1 Clinical and epidemiological importance

Escherichia coli is the most frequent gram-negative rod isolated from blood cultures in clinical settings. It is the most frequent cause of bacteremia, community and hospital-acquired urinary tract infections, is associated with spontaneous and surgical peritonitis and with skin and soft tissue infections due to multiple microorganisms, causes neonatal meningitis and is one of the most important foodborne pathogens worldwide.

5.4.2 Resistance mechanisms

Beta-lactamases hydrolyse the beta-lactam ring of beta-lactam antibiotics, which is crucial for inhibition of PBPs in bacteria. In *E. coli*, resistance to broad-spectrum penicillins such as ampicillin or amoxicillin is usually conferred by plasmid coded beta-lactamases mainly of the TEM type and to a lesser extend of the SHV type, whereby TEM-1 accounts for up to 60% of aminopenicillin resistance. In 1982 the first ESBL was identified during a hospital outbreak of *Klebsiella pneumoniae* in Germany. It was soon understood that single or multiple amino acid substitutions in the basic structure of SHV or TEM enzymes can alter their spectrum of activity and enhance their hydrolysing ability to include third-generation cephalosporins (in this report referring to: cefotaxime, ceftriaxone, ceftazidime) and monobactams. Most ESBLs can be inhibited by beta-lactamase inhibitors such as clavulanic acid, sulbactam or tazobactam. More than 200 ESBL variants are known to date. Most of them belong to four enzyme families TEM, SHV, CTX-M and OXA (an overview of identified ESBL types is given on http://www.lahey.org/studies/). Until 2000, over 90% of ESBL resistance was mediated through TEM or VHS variants. In the late 1980s, new ESBLs of the CTX-M family emerged first in South America and, during early 2000s, attained global importance. In contrast to conventional TEM, and SHV ESBLs, most CTX-Ms display a higher hydrolysing ability against cefotaxime than ceftazidime (hence their name). An important part of this global success is due to the wide dissemination of particular plasmids or bacterial clones producing ESBL (e.g. CTX-M15). Other enzymes affecting the susceptibility to third-generation cephalosporins include plasmid encoded variants from the chromosomal AmpC beta-lactamases. CMY-2 is the most widespread enzyme belonging to this group, which is still less common in *E. coli* in Europe but frequent in the United States. An important threat that will require close surveillance in the future is the development of carbapenem-resistance in E coli, mediated by metallo-beta-lactamases (as VIM or IMP enzymes, or the emerging NDM enzyme) and serin-beta-lactamases (as KPC enzymes), providing resistance to virtually all available beta-lactam agents.

Fluoroquinolones interact with DNA gyrase and topoisomerase IV, which are enzymes that regulate conformational changes in the bacterial chromosome during replication and transcription. This interaction leads to irreversible inhibition of the enzyme activity followed by DNA fragmentation and eventually to cell death. Resistance to fluoroquinolones arises through stepwise mutations in the coding regions of the gyrase subunits (gyrA and gyrB) and DNA topoisomerase IV (parC). Accumulation of mutations in several of these genes increases the MIC in a stepwise manner. Low-level resistance to fluoroquinolones may also arise through changes in outer membrane porins or from upregulation of efflux pumps, resulting in lower outer membrane permeability and higher efflux, respectively. In recent years, several plasmid-mediated quinolone resistance mechanisms have also been identified, including the Qnr proteins, which protect DNA topoisomerases from quinolone binding, the AAC6'-Ib-cr enzyme, which inactivates some fluoroquinolones by acetylation, and the QepA efflux pump, which effluxes hydrophilic quinolones. These mechansims are of concern because of transferability and their frequent association with CTX-M and CMY-type enzymes inactivating third-generation cephalosporins.

Aminoglycosides block protein synthesis by binding to the ribosomes, which are involved in the translation of RNA into proteins, and are also able to damage the outer membrane of gram-negative rods. Resistance to aminoglycosides can be due to targeted modification (methylation) of the large ribosomal subunit, which excludes aminoglycoside molecules, or by aminoglycoside modifying enzymes that acetylate, adenylate or phosphorylate their target molecules and thereby neutralise the biologic effect of aminoglycosides.

5.4.3 Results

Aminopenicillins

- Twenty-eight countries reported 47 318 isolates of which 25 254 were resistant to aminopenicillins.
- The majority of countries (19 of 28) reported resistance proportions from 50% to 66.5%. Among nine countries reporting proportions below 50%, the lowest proportions were reported by Sweden (33.2 %), Finland (36.4 %) and Norway (37.2 %) (Table 5.5). Trends for the period 2006–2009 were calculated for 28 countries. During the past four years, a significant increase was observed in 10 of 28 countries. In seven of these countries, the trends were significant also when considering only data from laboratories reporting consistently for all four years (Figure 5.17). Among the 10 countries with increasing trends, four countries reported proportion of resistance to aminopenicillin higher than 60% even though these countries were already at relatively high levels, five countries reported between 60% and 50%, and one country reported below 50%.
- Two countries (Austria and Estonia) reported significant decreasing trends of resistance to aminopenicillin, although both countries were already at relatively low levels (Figure 5.17).

Third-generation cephalosporins

- Twenty-eight countries reported 49720 isolates of which 3657 were resistant to third-generation cephalosporins.
- Nine of 28 countries reported third-generation cephalosporins resistance higher than 10% and the proportions ranged up to 19.2%. Among the 19 countries reporting less than 10% resistance, the lowest proportions were reported by Iceland (1.8%), Estonia (2.2%) and Norway (2.3%) (Table 5.5 and Figure 5.14).
- Trends for the period the 2006–2009 were calculated for 28 countries. During the past four years, a significant increase was observed in more than half (16 of 28) of the countries. In 15 of these, the trends were significant also when considering only data from laboratories reporting consistently for all four years (Figure 5.18). Among the 16 countries with increasing trends for 2006–2009, five countries reported proportions of resistance to third-generation cephalosporins above 10%, nine countries reported between 10% and 5%, and two countries reported below 5%.
- Only one country reported a decreasing trend in resistance to third-generation cephalosporins, however the trend was not significant when considering only data from laboratories reporting consistently for all four years.

Extended-spectrum beta-lactamase (ESBL)

- Among *E. coli* isolates resistant to third-generation cephalosporins, a large proportion has been ascertained as ESBL positive by the participating laboratories in 2009. Twelve of 13 countries reported proportions of ESBL production between 85% and 100% among isolates resistant to third-generation cephalosporins (Table 5.6).

Fluoroquinolones

- Twenty-eight countries reported 48054 isolates of which 9488 were resistant to fluoroquinolones.
- The majority of countries (16 of 28) reported resistant proportions higher than 20%, ranging up to 43.4%. Seven countries reported between 20% and 10%. Among five countries reporting below 10%, the lowest proportions of resistant isolated were reported by Iceland (7.1%), Sweden (8.2 %) and Estonia (8.3%) (Table 5.5 and Figure 5.15).
- Trends in the period 2006–2009 were calculated for 28 countries. A significant increase was observed for seven countries. In six of these countries the trends were significant also when considering only data from laboratories reporting consistently all four years (Figure 5.19).
- Among the seven countries with increasing trends for 2006–2009, two reported proportions of resistance to fluoroquinolones above 30%, two reported between 30% and 20%, and three countries reported below 20%.
- Only two countries (Austria and Germany) reported significant decreasing trends in resistance to fluoroquinolones (Figure 5.19).

Aminoglycosides

- Twenty-eight countries reported 50699 isolates of which 3983 were resistant to aminoglycosides.
- Eleven of 28 countries reported proportions of resistance higher than 10%, ranging up to 21.4%. Eleven countries reported between 10% and 5%. Among six countries reporting below 5%, the lowest proportions of resistant isolated were reported by Norway (3.3%), Finland (2.8%) and Sweden (2.5%) (Table 5.5 and Figure 5.16).
- Trends in the period 2006–2009 were calculated for 28 countries. A significant increase in the proportion of isolates resistant to aminoglycosides was observed for 10 countries. Among these, five countries reported proportions higher than 10%, one country reported between 10% and 5%, and four countries reported below 5%.
- For two countries (Austria and Romania) the proportions of resistance to aminoglycosides significantly decreased over the last four years. For Austria, the trend was significant also when considering only data from laboratories consistently reporting for all four years (Figure 5.20).

Combined resistance (aminopenicillins, third-generation cephalosporins, fluoroquinolones and aminoglycosides)

- In 2009, 28 countries reported 42898 isolates tested for aminopenicillins, third-generation cephalosporins, fluoroquinolones and aminoglycosides. Fifty-seven per cent of these isolates were resistant to one or more of the four considered antibiotic classes.
- In nine countries, the proportion of multiresistant isolates (resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides) was higher than 5%, between 5% and 1% in 14 countries, and below 1% in four countries (Table 5.7 and Figure 5.21).
- Trends in the period 2006–2009 were calculated for 28 countries. A significant increase in proportions of multiresistant isolates was observed for 12 countries. In 10 of these countries the trends were significant also when considering only data from laboratories reporting consistently for all four years (Figure 5.21). Among the 12 countries with significantly increasing proportions of multiresistant isolates, four countries reported above 5%, eight countries reported between 5% and 1%, whereas no country reported below 1%. No country had a significantly decreasing trend of proportions of multiresistance in *E. coli* in 2006–2009.
- The most frequent resistance phenotypes in *E. coli* were single aminopenicillin resistance (33.3%), followed by dual resistance to aminopenicillins and fluoroquinolones (8.7%). Combined resistance to all four antimicrobials was reported for 3.3% of the isolates and combined resistance to aminopenicillins,

fluoroquinolones and aminoglycosides was 3.2% (Table 5.7).

5.4.4 Conclusions

The remarkable and constant Europe-wide decline of antimicrobial susceptibility in *E. coli* observed during recent years continued in 2009. Resistance in *E. coli* shows increasing trends in several countries and for both multiresistance and for single antimicrobials under surveillance.

The highest proportions of resistance in *E. coli* were reported for aminopenicillins ranging up to 66.5%. Irrespective of the high level of resistance, proportions continue to increase in several countries, including those already presenting resistance well above 50%.

The proportion of third-generation cephalosporins resistance reported for *E. coli* has increased significantly during the last four years in more than half of the reporting countries. Among isolates resistant to third-generation cephalosporins, a high proportion (85–100%) was identified as ESBL positive. These data indicate that ESBL production is highly prevalent in third-generation cephalosporin-resistant *E. coli* in European hospitals.

Fluoroquinolone resistance in *E. coli* continues the increase as in previous years. Although the number of countries showing an increasing trend over the last four years was reduced compared to 2008, the situation becomes progressively dire and more than half of the countries are reporting resistance proportions higher than 20%.

Ten countries had significant increases in the proportion of isolates resistant to aminoglycosides and five of these countries reported proportions higher than 10%. This indicates that aminoglycosides resistance is increasing even among the countries already reporting higher levels of resistance.

The most frequent resistance phenotypes in *E. coli* were single aminopenicillin resistance (33.3%), followed by dual resistance to aminopenicillins and fluoroquinolones (8.7%). Combined resistance to all four antimicrobials was reported for 3.3% of the isolates and combined resistance to aminopenicillins, fluoroquinolones and aminoglycosides was 3.2%. Resistance to third-generation cephalosporins was associated with resistance to aminoglycosides in almost half of the cases and to fluoroquinolones in approximate 75% of the cases. These results indicate that the loss of antimicrobial susceptibility in *E. coli* requires close surveillance.

Table 5.5: Number of invasive *E. coli* isolates and proportion aminopenicillins, third-generation cephalosporins, fluoroquinolones, aminoglycosides and multiresistance (%R), including 95% confidence intervals (95% CI), reported per country in 2009

Country	Aminopenicillins		Fluoroquinolones		Third-gen. cephalosporins		Aminoglycosides		Multiresistance*	
	N	%R (95%CI)	N	%R (95%CI)	N	%R (95%CI)	N	%R (95%CI)	N	%R (95%CI)
Austria	2605	48.6 (47–51)	2616	20.5 (19–22)	2597	7.5 (7–9)	2619	6.1 (5–7)	2588	2.2 (2–3)
Belgium	1607	55.9 (53–58)	1504	19.9 (18–22)	1596	6.5 (5–8)	1195	7.3 (6–9)	1175	1.6 (1–3)
Bulgaria	181	66.3 (59–73)	193	28.0 (22–35)	193	19.2 (14–25)	194	18.0 (13–24)	192	7.3 (4–12)
Cyprus	136	66.2 (58–74)	136	43.4 (35–52)	136	14.0 (9–21)	136	9.6 (5–16)	136	5.1 (2–10)
Czech Republic	2759	60.6 (59–62)	2758	23.2 (22–25)	2759	9.8 (9–11)	2742	9.0 (8–10)	2741	3.0 (2–4)
Denmark	3531	42.9 (41–45)	3406	13.2 (12–14)	2705	6.2 (5–7)	3530	4.4 (4–5)	2634	1.4 (1–2)
Estonia	319	38.2 (33–44)	302	8.3 (5–12)	319	2.2 (1–4)	320	3.8 (2–6)	301	0.7 (0–2)
Finland	1906	36.4 (34–39)	2223	9.2 (8–10)	2176	2.8 (2–4)	2033	2.8 (2–4)	1984	1.5 (1–2)
France	8436	55.5 (54–57)	8353	18.6 (18–19)	8449	6.7 (6–7)	8448	8.2 (8–9)	8350	3.0 (3–3)
Germany	2158	56.1 (54–58)	2786	23.4 (22–25)	2759	8.2 (7–9)	2796	8.4 (7–9)	2745	3.2 (3–4)
Greece	1694	50.9 (48–53)	1806	23.4 (21–25)	1815	10.1 (9–12)	1828	14.5 (13–16)	1806	6.4 (5–8)
Hungary	1047	59.8 (57–63)	1046	30.5 (28–33)	1052	12.9 (11–15)	1056	15.9 (14–18)	1042	9.8 (8–12)
Iceland	109	49.5 (40–59)	99	7.1 (3–14)	110	1.8 (0–6)	110	7.3 (3–14)	99	0.0 (0–4)
Ireland	1987	66.5 (64–69)	2005	21.7 (20–24)	1986	6.5 (5–8)	2009	8.8 (8–10)	1976	2.4 (2–3)
Italy	764	63.4 (60–67)	863	36.2 (33–39)	687	17.0 (14–20)	863	12.5 (10–15)	687	5.5 (4–8)
Latvia	86	43.0 (32–54)	85	23.5 (15–34)	86	11.6 (6–20)	86	12.8 (7–22)	85	5.9 (2–13)
Lithuania	291	58.4 (53–64)	295	14.6 (11–19)	293	7.8 (5–12)	297	15.2 (11–20)	291	3.8 (2–7)
Luxembourg	298	57.0 (51–63)	300	25.7 (21–31)	300	8.3 (5–12)	300	9.3 (6–13)	300	4.3 (2–7)
Malta	159	54.7 (47–63)	159	30.8 (24–39)	159	15.1 (10–22)	159	21.4 (15–29)	159	12.6 (8–19)
Netherlands	2359	45.1 (43–47)	2377	11.0 (10–12)	2368	4.3 (3–5)	2389	4.4 (4–5)	2339	1.4 (1–2)
Norway	1845	37.2 (35–39)	1830	8.7 (7–10)	1846	2.3 (2–3)	1841	3.3 (3–4)	1827	0.7 (0–1)
Poland	487	64.7 (60–69)	567	23.1 (20–27)	584	9.1 (7–12)	595	7.1 (5–9)	546	1.8 (1–3)
Portugal	1919	58.3 (56–61)	1973	27.7 (26–30)	1912	9.2 (8–11)	2038	10.8 (9–12)	1885	5.5 (4–7)
Romania	12	83.3 (52–98)	53	22.6 (12–36)	53	17.0 (8–30)	80	12.5 (6–22)	53	15.1 (7–28)
Slovenia	783	53.8 (50–57)	783	18.9 (16–22)	783	6.6 (5–9)	783	10.5 (8–13)	783	4.6 (3–6)
Spain	3821	64.7 (63–66)	3810	31.5 (30–33)	3821	11.3 (10–12)	3820	13.0 (12–14)	3809	4.5 (4–5)
Sweden	2195	33.2 (31–35)	1596	8.2 (7–10)	4233	2.8 (2–3)	4121	2.5 (2–3)	1529	0.7 (0–1)
United Kingdom	3824	61.6 (60–63)	4130	18.0 (17–19)	3943	9.4 (8–10)	4311	7.4 (7–8)	3616	4.0 (3–5)

* Multiresistance defined as being resistant to third-generation cephalosporins, fluoroquinolones and aminoglycosides.

Table 5.6: Number of invasive *E. coli* isolates resistant to third-generation cephalosporins (CREC) and proportion of ESBL positive among these isolates, as ascertained by the participating laboratories in 2009

Country	Number of laboratories	Number of CREC	%ESBL
Austria	24	86	94.2
Belgium	4	14	92.9
Bulgaria	12	37	94.6
Cyprus	5	19	100
Czech Republic	42	270	85.6
France	38	316	64.9
Ireland	25	117	85.5
Lithuania	8	23	100
Netherlands	6	40	90
Poland	16	53	89
Portugal	15	122	91.8
Sloveni	7	52	92.3
Spain	33	432	90.7

Only data from laboratories consistently reporting the ESBL test results for all isolates identified as resistant to third-generation cephalosporins and from countries with at least 10 of such isolates were selected for the analysis.

Table 5.7: Overall resistance and resistance combinations among invasive *Escherichia coli* isolates tested against aminopenicillins, fluoroquinolones, third-generation cephalosporins and aminoglycosides (n= 42 898) in Europe, 2009

Resistance pattern	Number	% of total
Fully susceptible	18 622	43.4
Single resistance (to indicated drug classes)		
Aminopenicillins	14 292	33.3
Fluoroquinolones	908	2.1
Aminoglycosides	86	0.2
Resistance to two classes of antimicrobial drugs		
Aminopenicillins + fluoroquinolones	3718	8.7
Aminopenicillins + third-generation cephalosporins	640	1.5
Aminopenicillins + aminoglycosides	555	1.3
Fluoroquinolones + aminoglycosides	40	0.1
Resistance to three classes of antimicrobial drugs		
Aminopenicillins + fluoroquinolones + aminoglycosides	1387	3.2
Aminopenicillins + third-generation cephalosporins + fluoroquinolones	1123	2.6
Aminopenicillins + third-generation cephalosporins + aminoglycosides	132	0.3
Resistance to four classes of antimicrobial drugs		
Aminopenicillins + third-generation cephalosporins + fluoroquinolones + aminoglycosides	1395	3.3

Figure 5.14: *Escherichia coli*: proportion of third-generation cephalosporin resistance in 2009

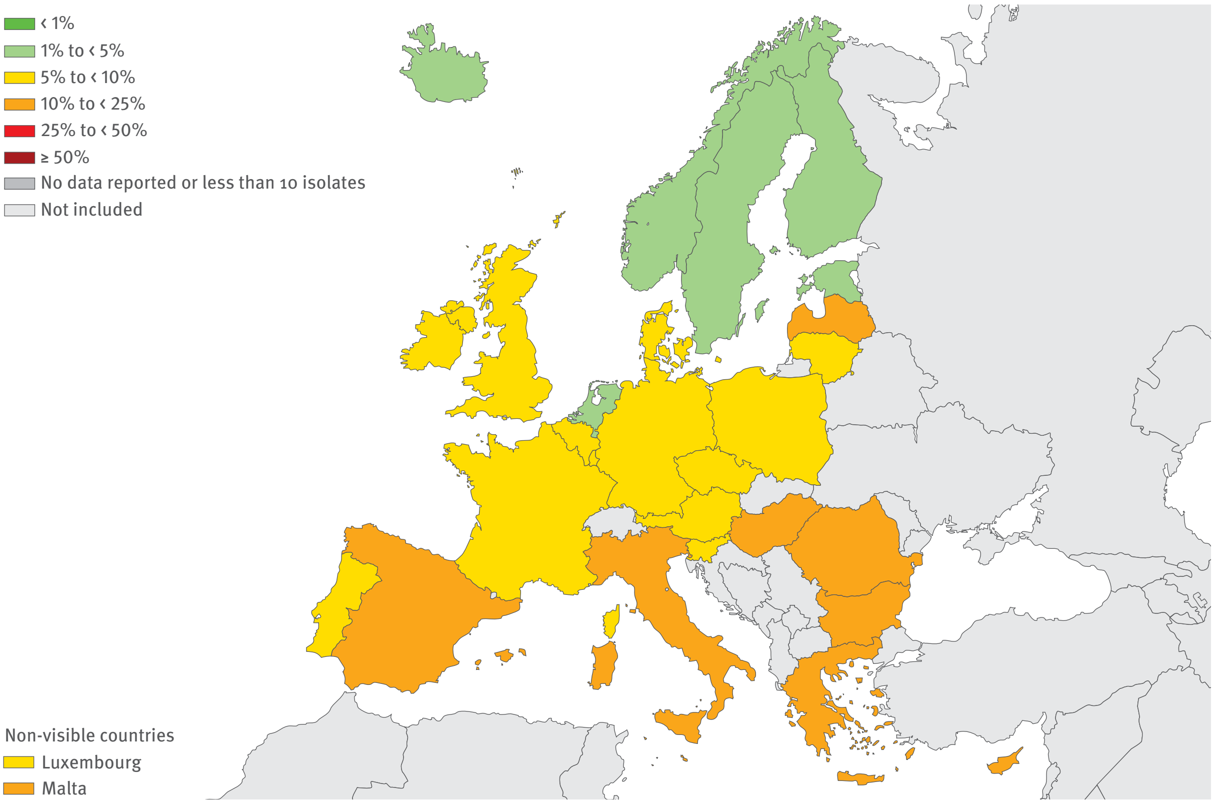


Figure 5.15: ***Escherichia coli*: proportion of invasive isolates with resistance to fluoroquinolones in 2009**

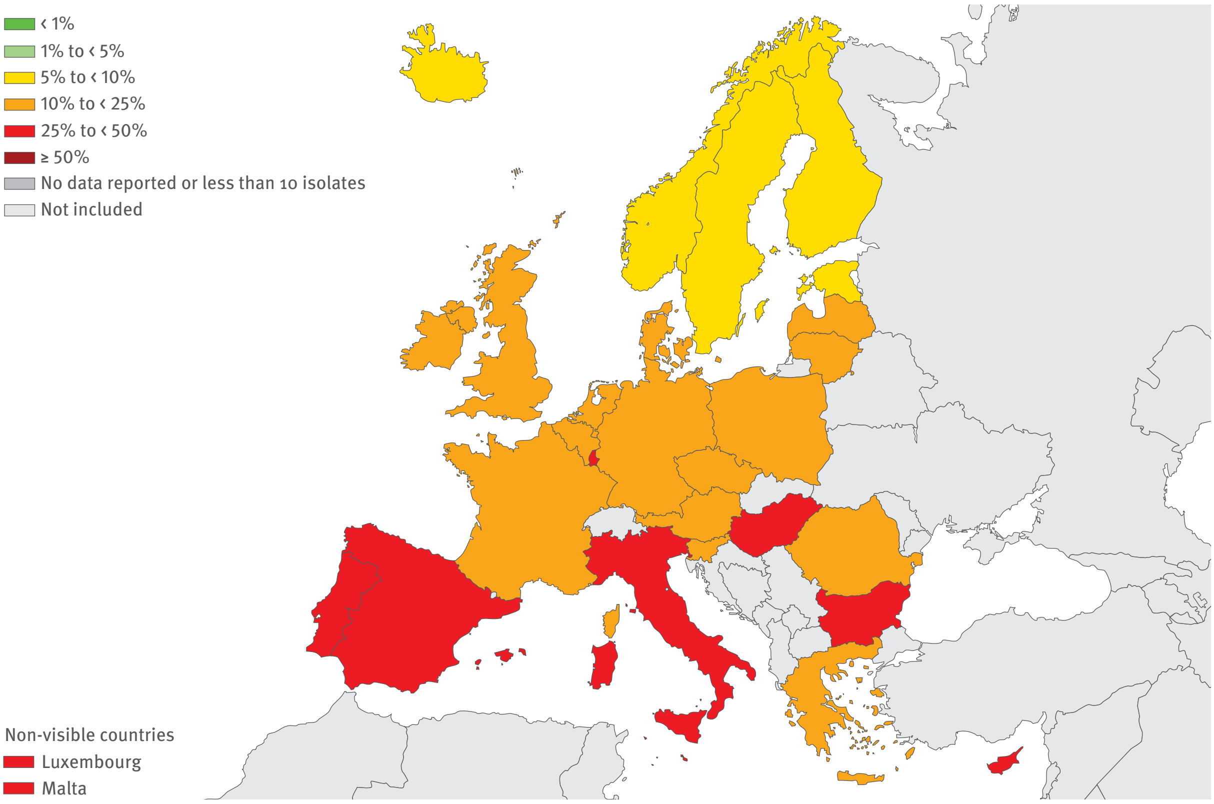


Figure 5.16: ***Escherichia coli*: proportion of invasive isolates with resistance to aminoglycosides in 2009**

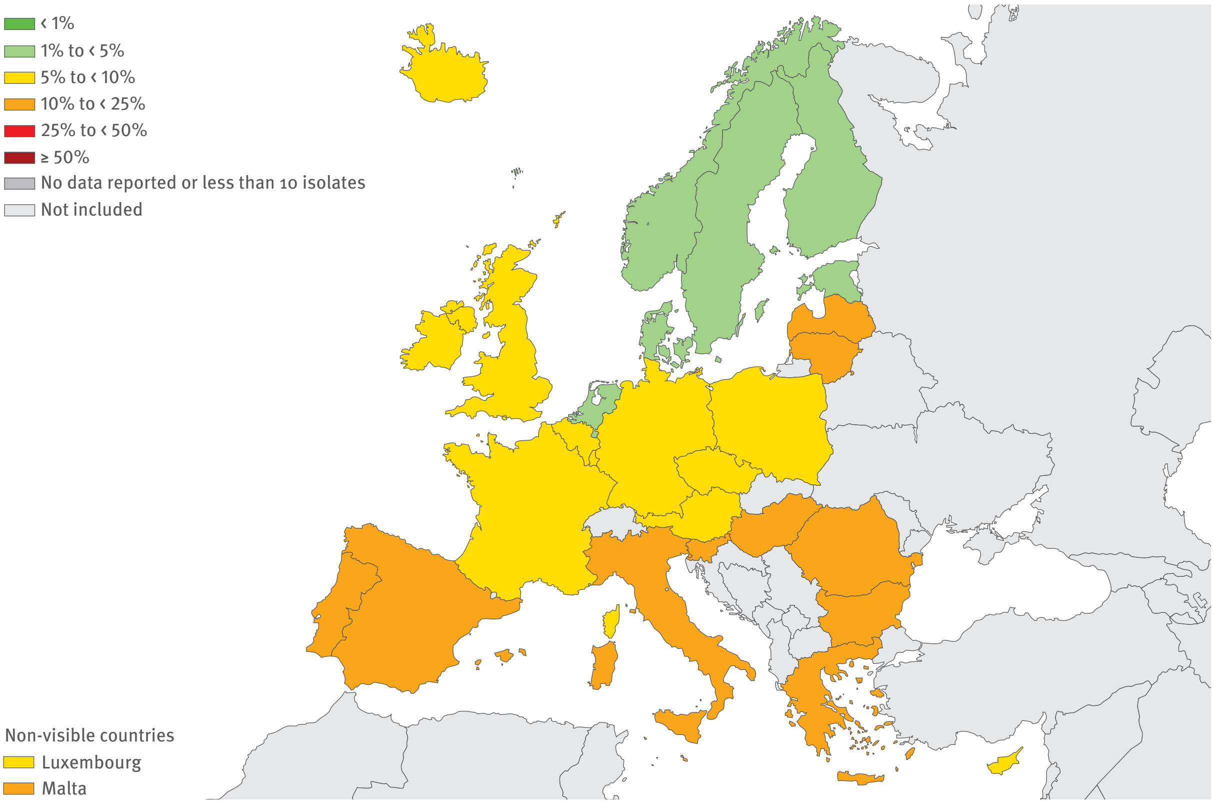
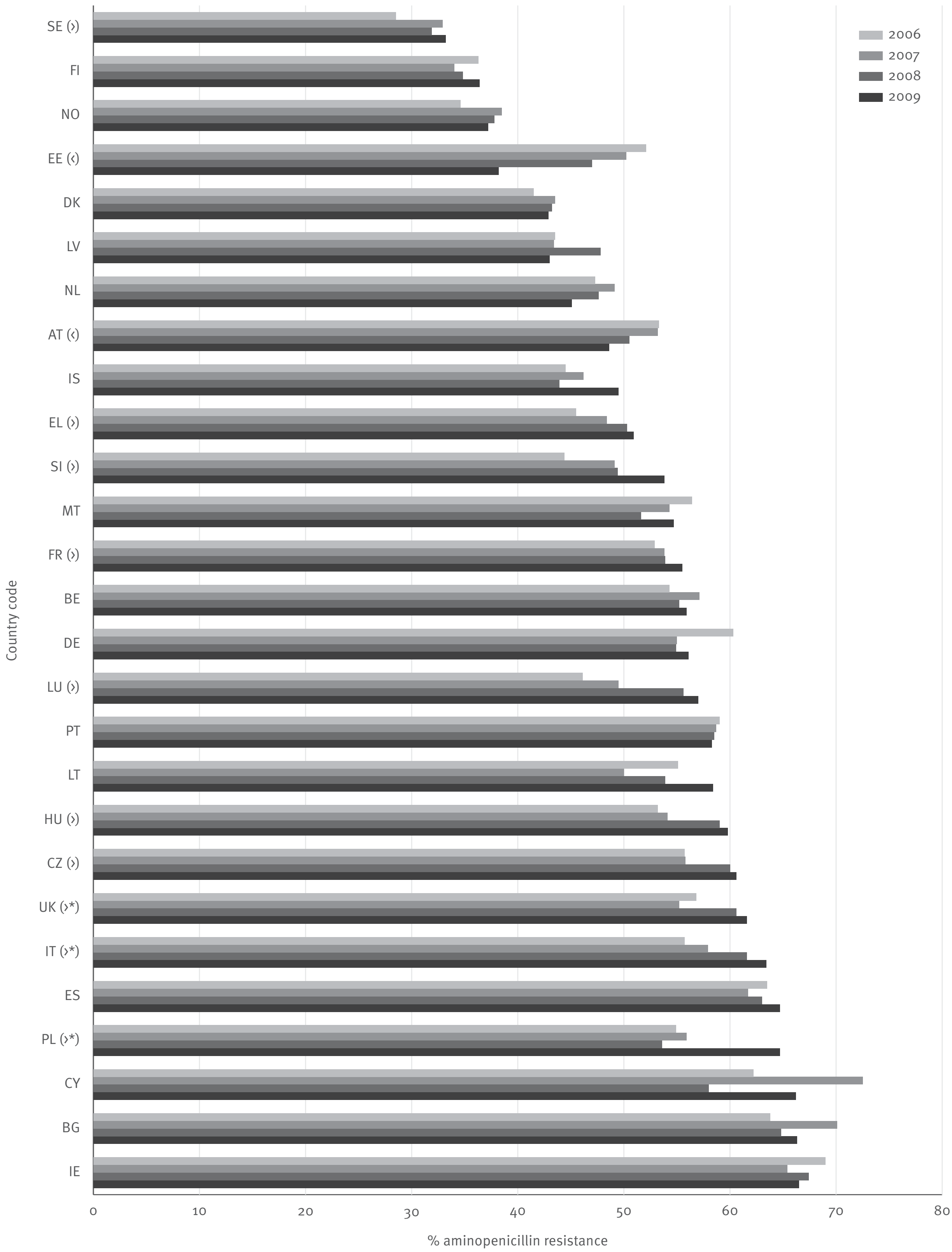
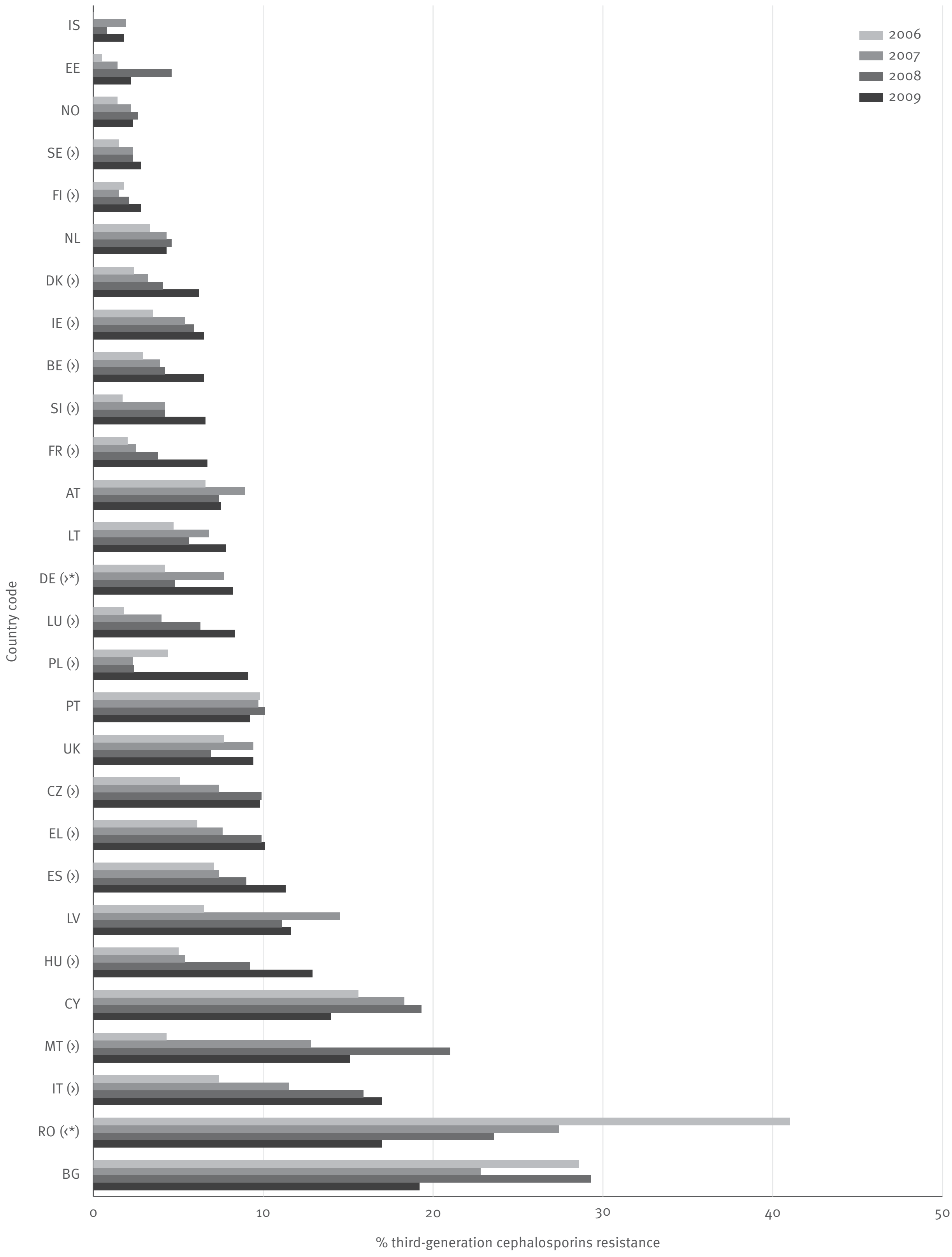


Figure 5.17: *Escherichia coli*: trends of aminopenicillin resistance by country, 2006–2009



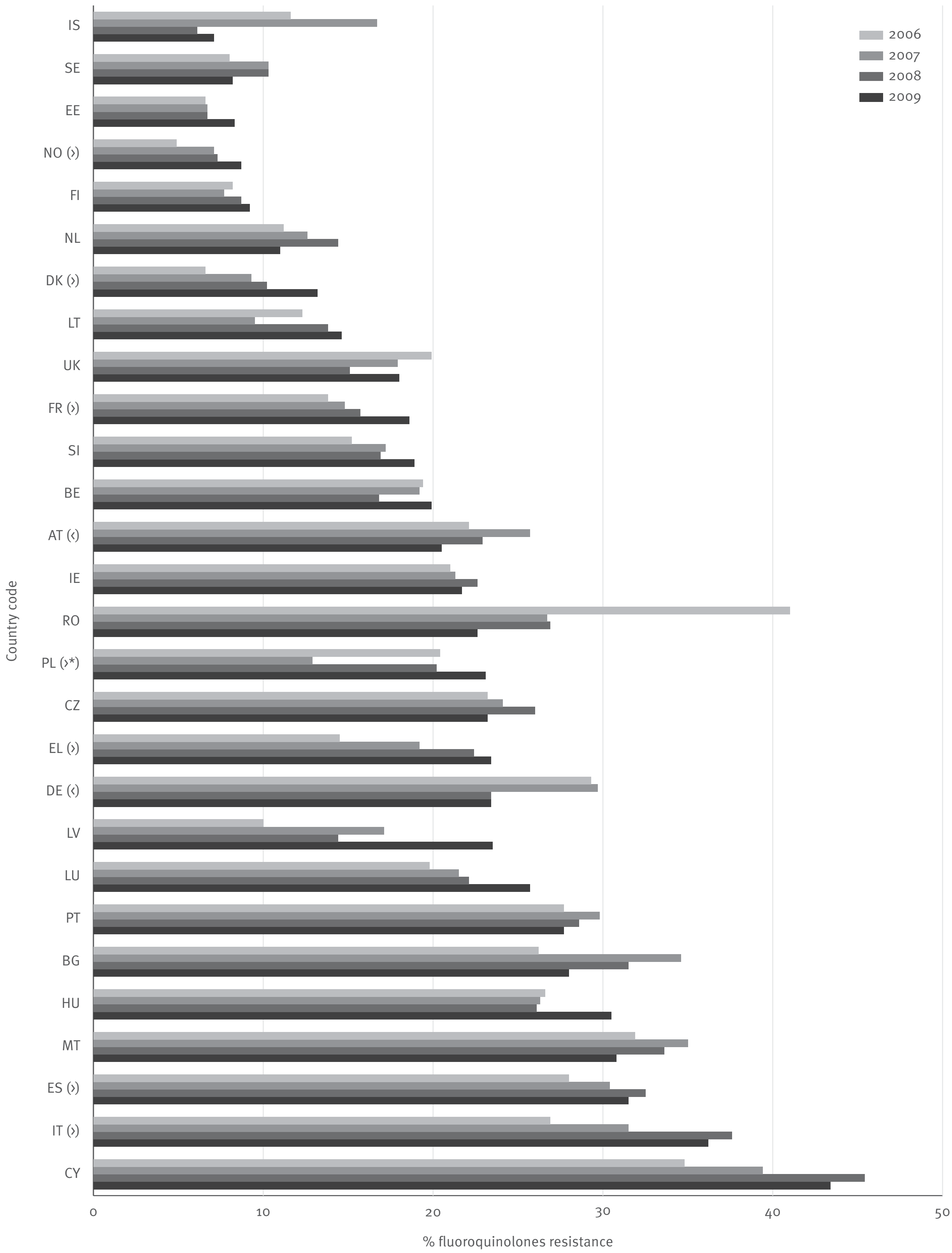
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Figure 5.18: ***Escherichia coli*****: trends of third-generation cephalosporin resistance by country, 2006–2009**



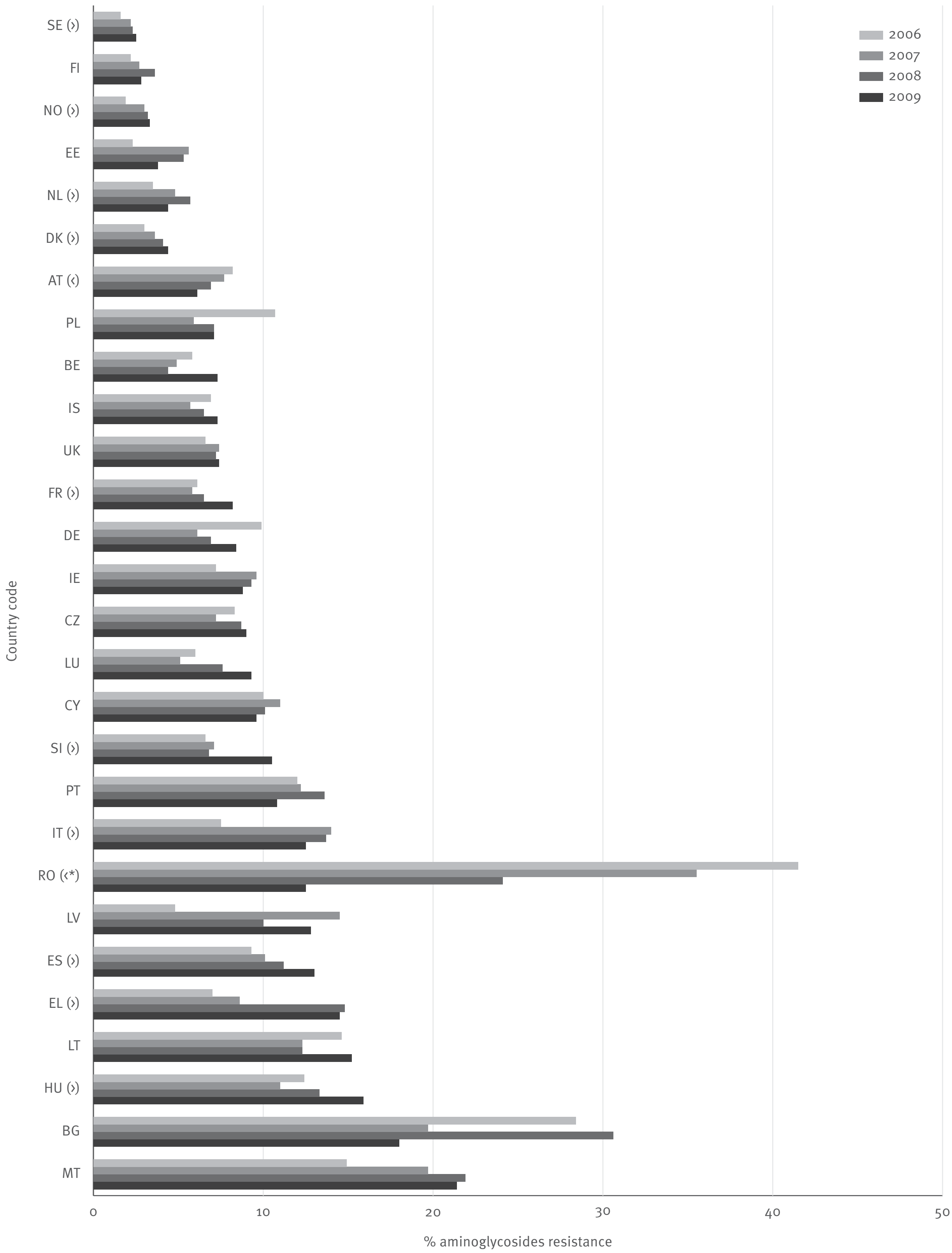
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Figure 5.19: *Escherichia coli*: trends of fluoroquinolone resistance by country, 2006–2009



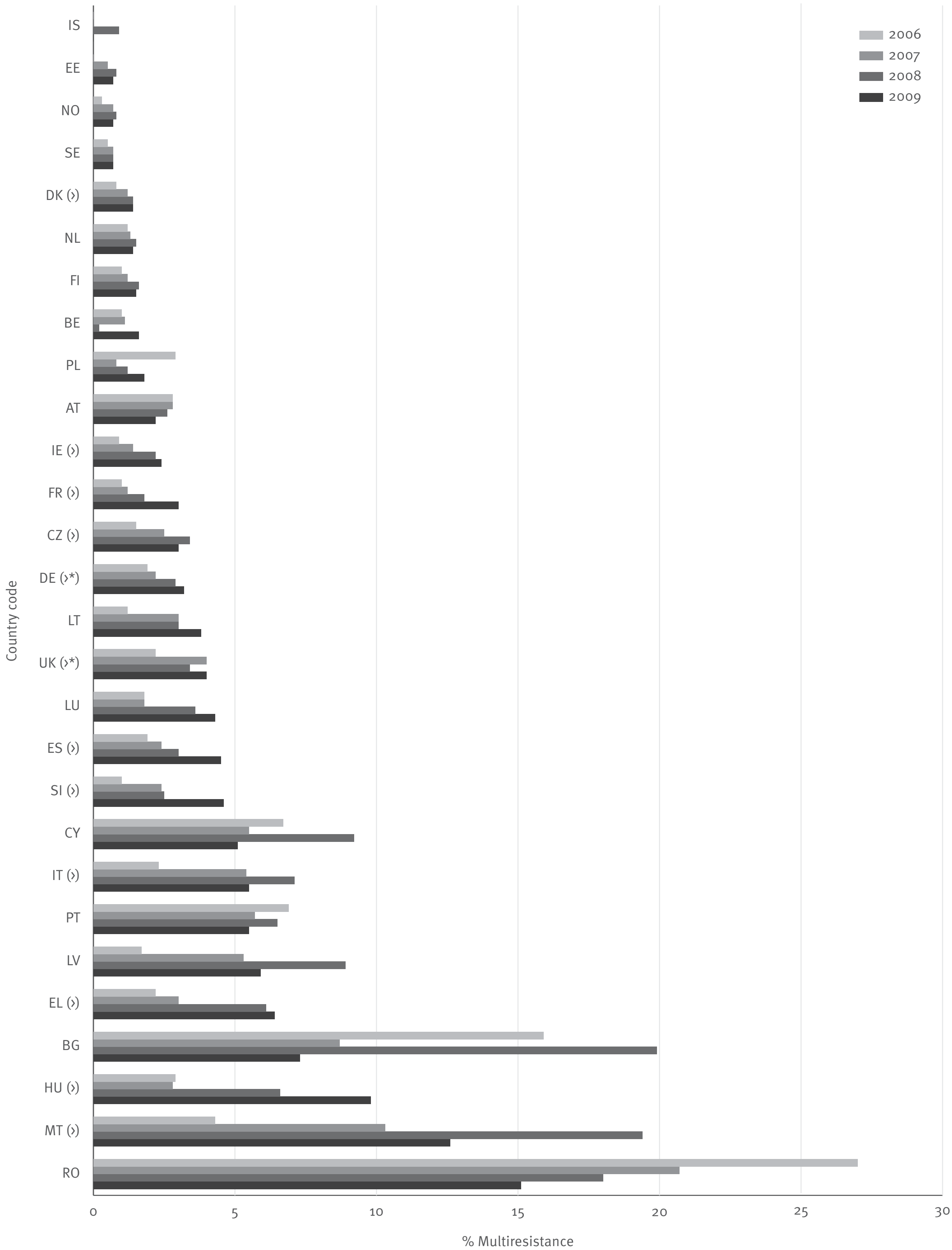
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Figure 5.20: ***Escherichia coli*****: trends of aminoglycoside resistance by country, 2006–2009**



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Figure 5.21: ***Escherichia coli*: trends of combined resistance (resistant to fluoroquinolones, third-generation cephalosporins and aminoglycosides) by country, 2006–2009**



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

5.5 *Klebsiella pneumoniae*

5.5.1 Clinical and epidemiological importance

Bacteria of the genus *Klebsiella* are frequent colonisers of the gastrointestinal tract in humans but may also be found on skin, in the oropharynx and upper airways in hospitalised individuals. *Klebsiella pneumoniae* is associated with opportunistic infections in individuals with impaired immune defences, such as diabetics, alcoholics and hospitalised patients with indwelling devices. The most common sites of infection are the urinary and the respiratory tract. Organisms can spread rapidly, from the gastrointestinal tract of patients and via the hands of hospital personnel to other patients, leading to nosocomial outbreaks. *K. pneumoniae* is the second most frequent cause of gram-negative bloodstream infections after *Escherichia coli*. The mortality rates of pneumonia caused by *K. pneumoniae* can be high even when appropriate antibiotic treatment is given, however, also depends on the severity of the underlying condition.

5.5.2 Resistance mechanisms

Similar to *E. coli*, *K. pneumoniae* can be resistant to multiple antibiotics, and resistance traits are frequently acquired through plasmids. However, in contrast to *E. coli*, *K. pneumoniae* has a chromosomally encoded SHV beta-lactamase and is thus intrinsically resistant against aminopenicillins. Moreover, this organism readily acquires plasmid-mediated resistance determinants. Many novel ESBL variants were initially identified in *K. pneumoniae* and were only subsequently found in *E. coli*. Since the resistance mechanisms do not significantly differ from those described for *E. coli*, readers should refer to the *E. coli* chapter for further details. Carbapenems have been widely used in many countries due to the increasing rate of ESBL-producing Enterobacteriaceae with a consequent impact on the emergence of resistance to these antibiotics, especially in *K. pneumoniae*. KPC carbapenemase-producing clones of *K. pneumoniae* have been observed in the United States, Greece and Israel, while plasmids encoding the VIM metallo-carbapenemase are frequent in *K. pneumoniae* in Greece. Recently, a new type of plasmidic carbapenemase, the New Delhi metallo-beta-lactamase 1 (NDM-1), has been observed in patients returning from the Indian subcontinent.

5.5.3 Results

Third-generation cephalosporins

- Twenty-eight countries reported 11 665 isolates of which 3 214 were resistant to third-generation cephalosporins.
- Proportion of resistance was: below 1% in two countries, 1–5% in three countries, 5–10% in three countries, 10–25% in seven countries, 25–50% in seven countries and above 50% in six countries (Figure 5.22, Table 5.8).
- Trends in the 2006–2009 period have been calculated for 24 countries. A significant increase has been observed for nine countries. In eight of these, the trends are significant also when considering only data from laboratories consistently reporting all four years (Figure 5.26). In 2009, the nine countries with increasing trends reported the following proportion of resistance to third-generation cephalosporins: 10–25% in three cases (Denmark, Estonia and France), 25–50% in three cases (Hungary, Luxembourg and Portugal) and above 50% in three cases (Czech Republic, Greece and Latvia).
- Two countries (Malta and the United Kingdom) reported significant decreasing trends of proportions of resistance to third-generation cephalosporins (Figure 5.26) which, in 2009, were 0% and 7%, respectively.

Extended-spectrum beta-lactamase (ESBL)

- Sixteen countries have been included in the analysis of ESBL proportion for *K. pneumoniae*. Only data from laboratories consistently reporting ESBL test results for all isolates identified as resistant to third-generation cephalosporins and from countries with at least 10 of such isolates were selected for the analysis.
- The proportion of *K. pneumoniae* isolates resistant to third-generation cephalosporins and ESBL producers, as ascertained by the participating laboratories, ranged between 73% and 100%. Proportion of ESBL producers was: 70–80% in three countries, 80–90% in four countries and above 90% in nine countries (Table 5.9).

Fluoroquinolones

- Twenty-eight countries reported 11 344 isolates of which 3 203 were resistant to fluoroquinolones.
- Proportion of resistance was: below 1% in one country, 1–5% in four countries, 5–10% in three countries, 10–25% in 10 countries, 25–50% in eight countries and above 50% in two countries (Figure 5.23, Table 5.8).
- Trends in the 2006–2009 period have been calculated for 23 countries. A significant increase has been observed for 11 countries. In 10 of these countries the trends are significant also when considering only data from laboratories consistently reporting all four years (Figure 5.27). In 2009, the 11 countries with increasing trends reported the following proportion of resistance to fluoroquinolones: 10–25% in four cases (Denmark, Estonia, France and Spain), 25–50% in five cases (Bulgaria, Cyprus, Hungary, Lithuania and Portugal) and above 50% in two cases (Czech Republic and Greece).
- Two countries (Ireland and the United Kingdom) reported significant decreasing trends of proportions of resistance to fluoroquinolones (Figure 5.27) which, in 2009, were 11% and 6%, respectively.

Aminoglycosides

- Twenty-eight countries reported 11 922 isolates of which 2 787 were resistant to aminoglycosides.

- Proportion of resistance was: below 1% in three countries, 1–5% in four countries, 5–10% in five countries, 10–25% in seven countries, 25–50% in six countries and above 50% in three countries (Figure 5.24, Table 5.8).
- Trends in the 2006–2009 period have been calculated for 24 countries. A significant increase has been observed for 11 countries. In 10 of these countries the trends are significant also when considering only data from laboratories consistently reporting all four years (Figure 5.28). In 2009, the 11 countries with increasing trends reported the following proportion of resistance to aminoglycosides: 1–5% in one case (Norway), 5–10% in one case (Denmark), 10–25% in four cases (Estonia, France, Luxembourg and Portugal), 25–50% in three cases (Czech Republic, Hungary and Latvia) and above 50% in two cases (Greece and Lithuania).
- Two countries (Malta and the United Kingdom) reported significant decreasing trends of proportions of resistance to aminoglycosides (Figure 5.28) which, in 2009, were 0% and 5%, respectively.

Combined resistance (third-generation cephalosporins, fluoroquinolones and aminoglycosides)

- Twenty-eight countries reported 10 952 isolates tested for third-generation cephalosporins, fluoroquinolones and aminoglycosides. In 2009, 35% of isolates were resistant to one or more of the three considered antibiotic classes. The most frequent pattern of resistance was the multiresistance (R to all three antibiotic classes) (19%). More than 90% of the isolates resistant to third-generation cephalosporins were also resistant to either fluoroquinolones or aminoglycosides and two thirds were resistant to both these classes (Table 5.10).
- Proportion of multiresistance was: below 1% in four countries, 1–5% in six countries, 5–10% in four countries, 10–25% in nine countries, 25–50% in four countries and above 50% in one country (Table 5.8).
- Trends in the 2006–2009 period have been calculated for 23 countries. A significant increase of multiresistance has been observed for 13 countries. In 10 of these countries the trends are significant also when considering only data from laboratories consistently reporting all four years (Figure 5.29). In 2009, the 13 countries with increasing trends reported the following proportion of multiresistance: below 1% in one case (Sweden), 1–5% in two cases (Norway and Spain), 5–10% in two cases (Denmark and Estonia), 10–25% in three cases (Latvia, France and Portugal), 25–50% in four cases (Bulgaria, Czech Republic, Hungary and Lithuania) and above 50% in one case (Greece).
- One country (the United Kingdom) reported a significant decreasing trend of proportions of multiresistance (Figure 5.29), which, in 2009, was 3%.

Carbapenems

- Twenty-seven countries reported 10 573 isolates of which 738 were resistant to carbapenems. Most of the resistant isolates (708) were identified in Greece; other 12 countries reported at least one resistant isolate.
- Proportion of resistance was: 43.5% in Greece, 17.0% in Cyprus, 1.3% in Italy, 1.2% in Belgium and below 1% in the other 23 reporting countries (Figure 5.25).

5.5.4 Conclusions

The antimicrobial resistance of *K. pneumoniae* is a worrisome problem in Europe. In 2009, many countries reported high proportions and increasing trends of resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides. Greece and Cyprus have also reported high proportions of resistance to carbapenems; proportions of resistance to these agents above 1% have been observed so far in Belgium and Italy.

Two thirds of the countries reported proportions of resistance to third-generation cephalosporins and fluoroquinolones higher than 10%. Proportions of multiresistance (R to third-generation cephalosporins, fluoroquinolones and aminoglycosides) above 10% have been reported by half of the countries.

The majority of isolates resistant to third-generation cephalosporins were resistant also to fluoroquinolones and aminoglycosides. Increasing trends of resistance to specific antibiotic classes and of multiresistance have been observed also in northern European countries, like Denmark and Norway, with a traditionally prudent approach to the antibiotic use.

Only the United Kingdom has shown a consistent reduction of resistance proportion of *K. pneumoniae* for all the antibiotic classes under surveillance. Decreasing trends for specific antibiotic classes were also observed for Ireland and Malta.

Figure 5.22: ***Klebsiella pneumoniae*: proportion of invasive isolates resistant to third-generation cephalosporins in 2009**

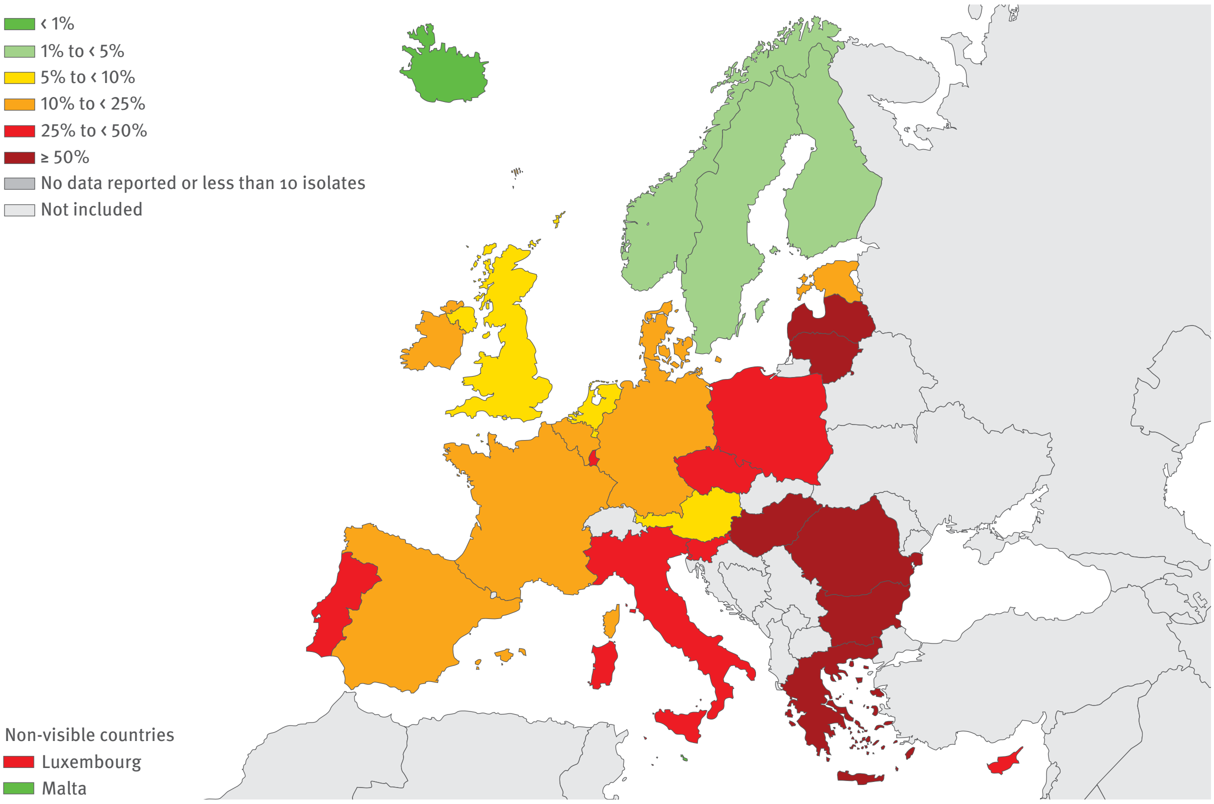


Figure 5.23: ***Klebsiella pneumoniae*: proportion of invasive isolates resistant to fluoroquinolones in 2009**

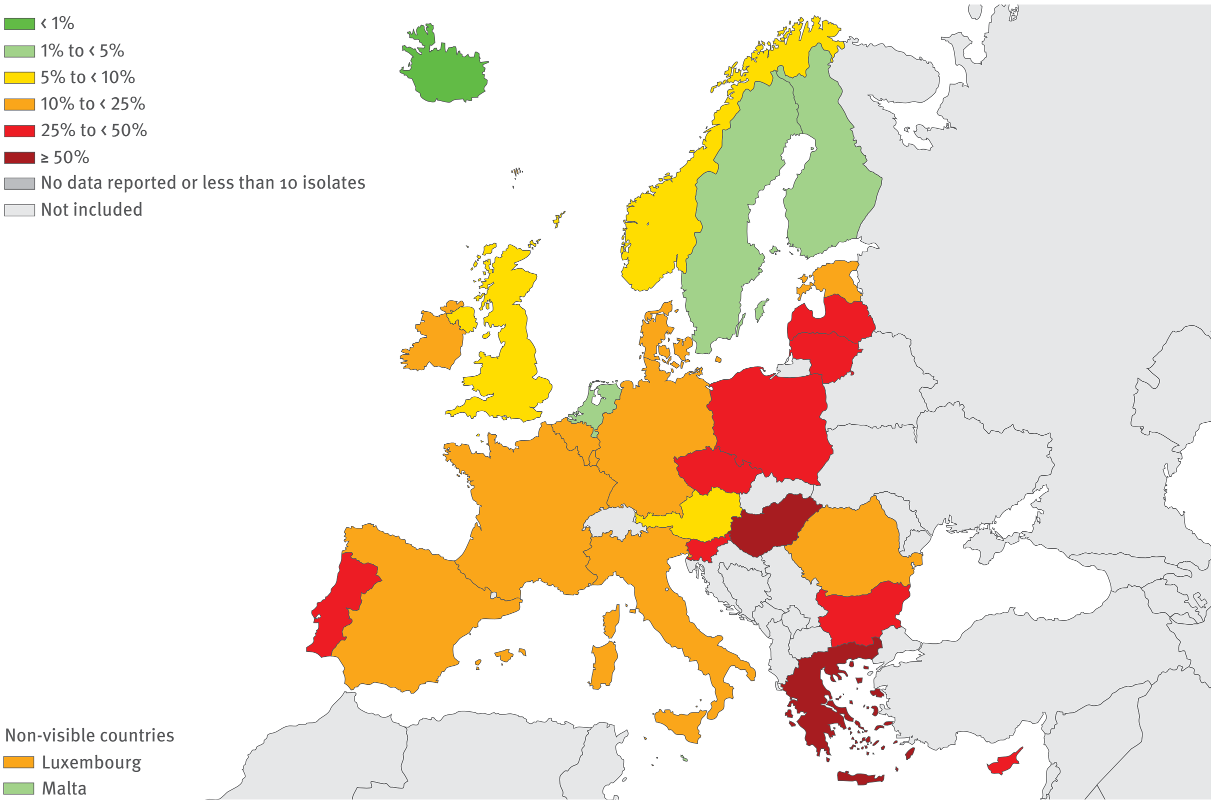


Figure 5.24: *Klebsiella pneumoniae*: proportion of invasive isolates resistant to aminoglycosides in 2009

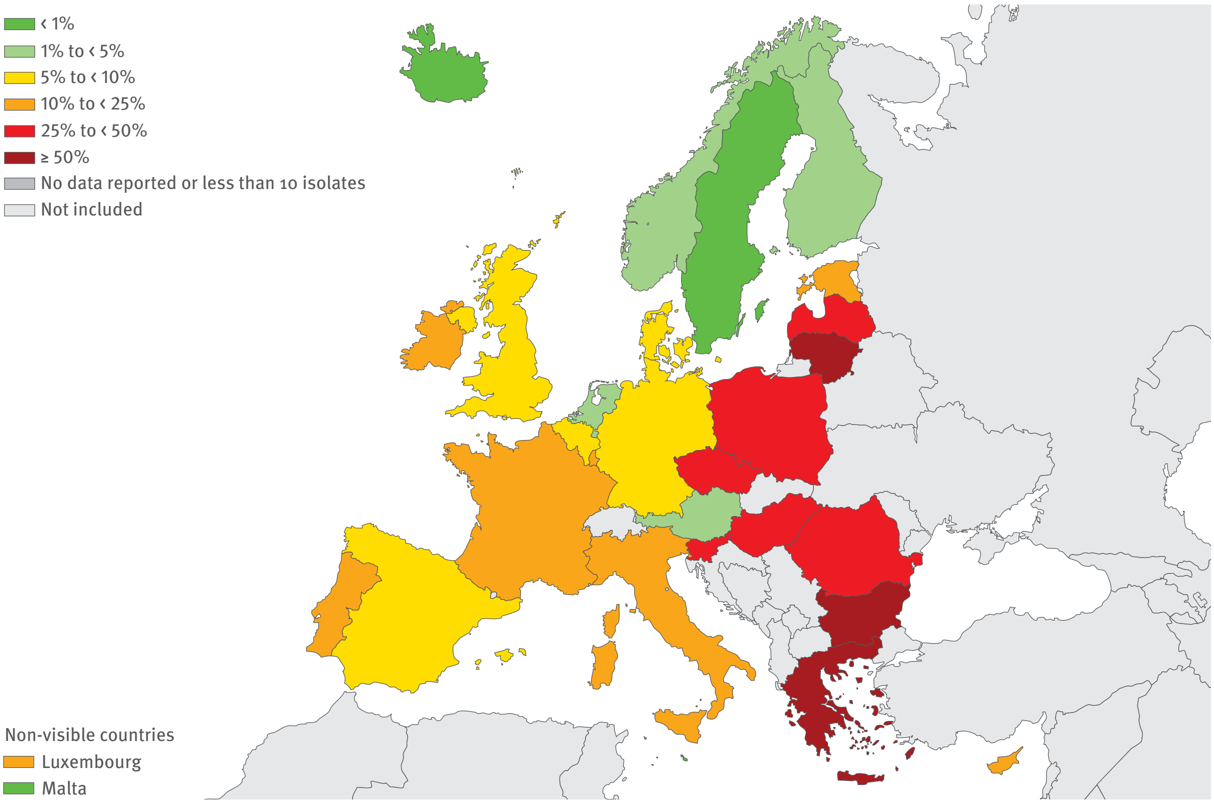
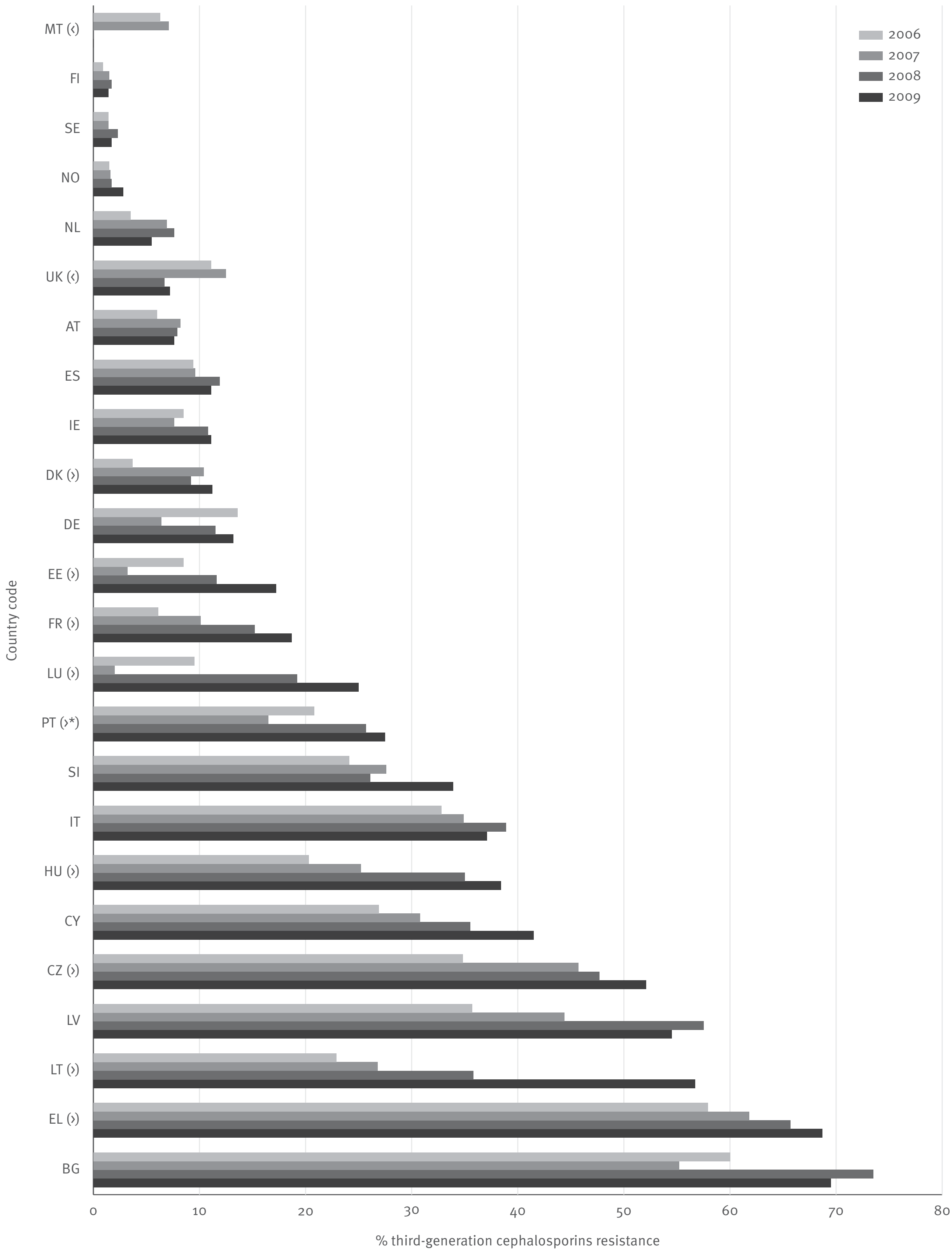


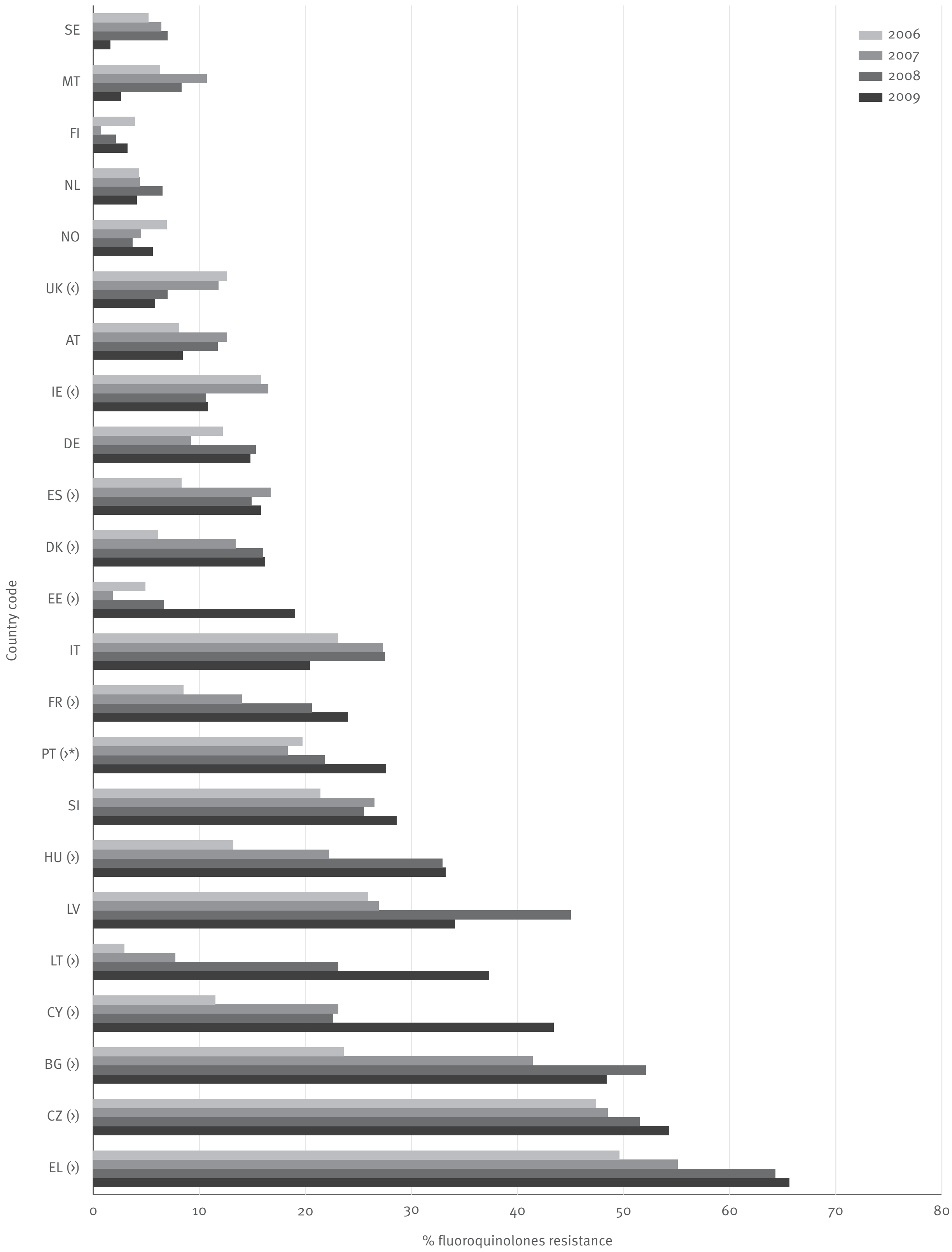
Figure 5.25: *Klebsiella pneumoniae*: proportion of invasive isolates resistant to carbapenems in 2009

Figure 5.26: *Klebsiella pneumoniae*: trend of third-generation cephalosporins resistance by country, 2006–2009



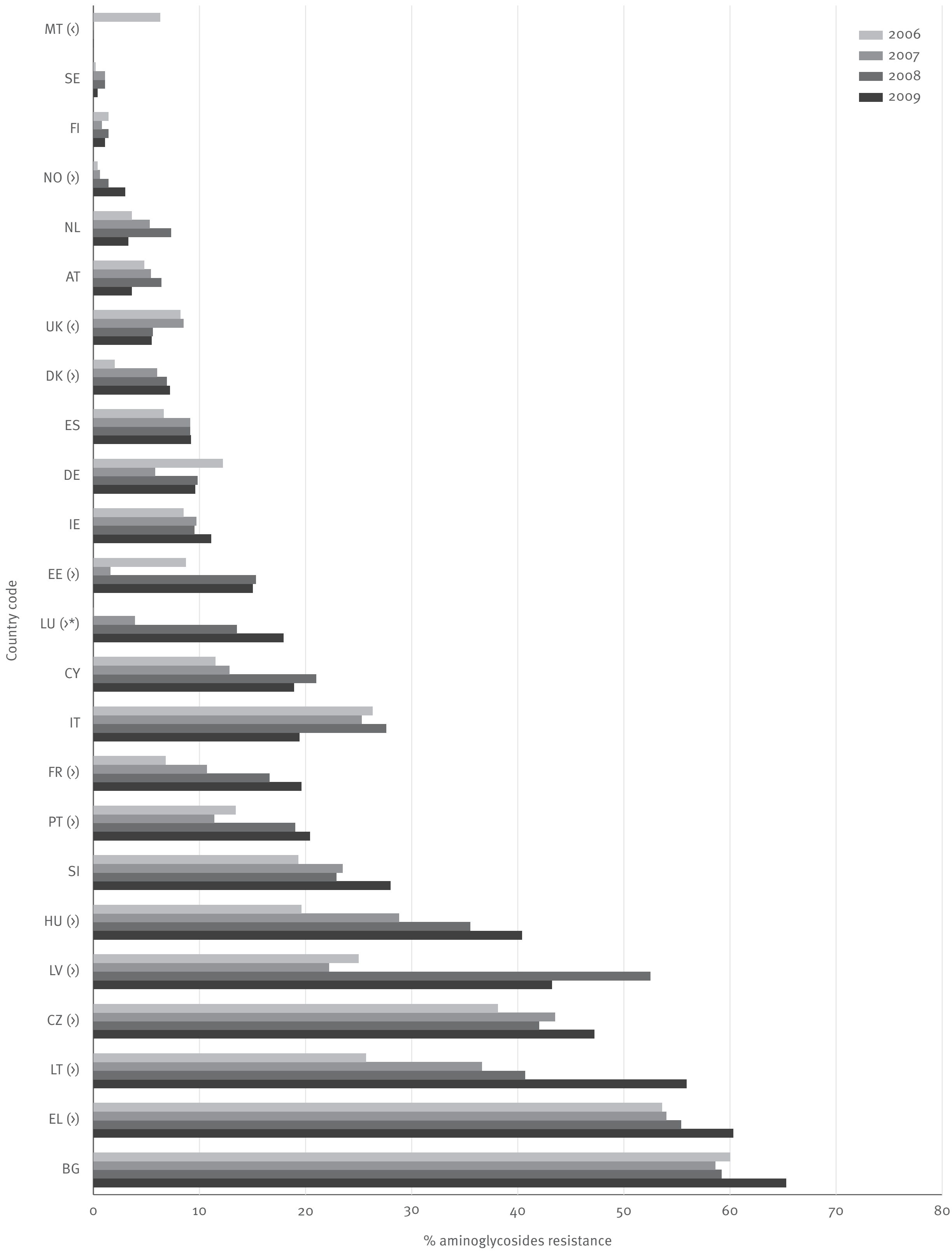
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Figure 5.27: ***Klebsiella pneumoniae*****: trend of fluoroquinolones resistance by country, 2006–2009**



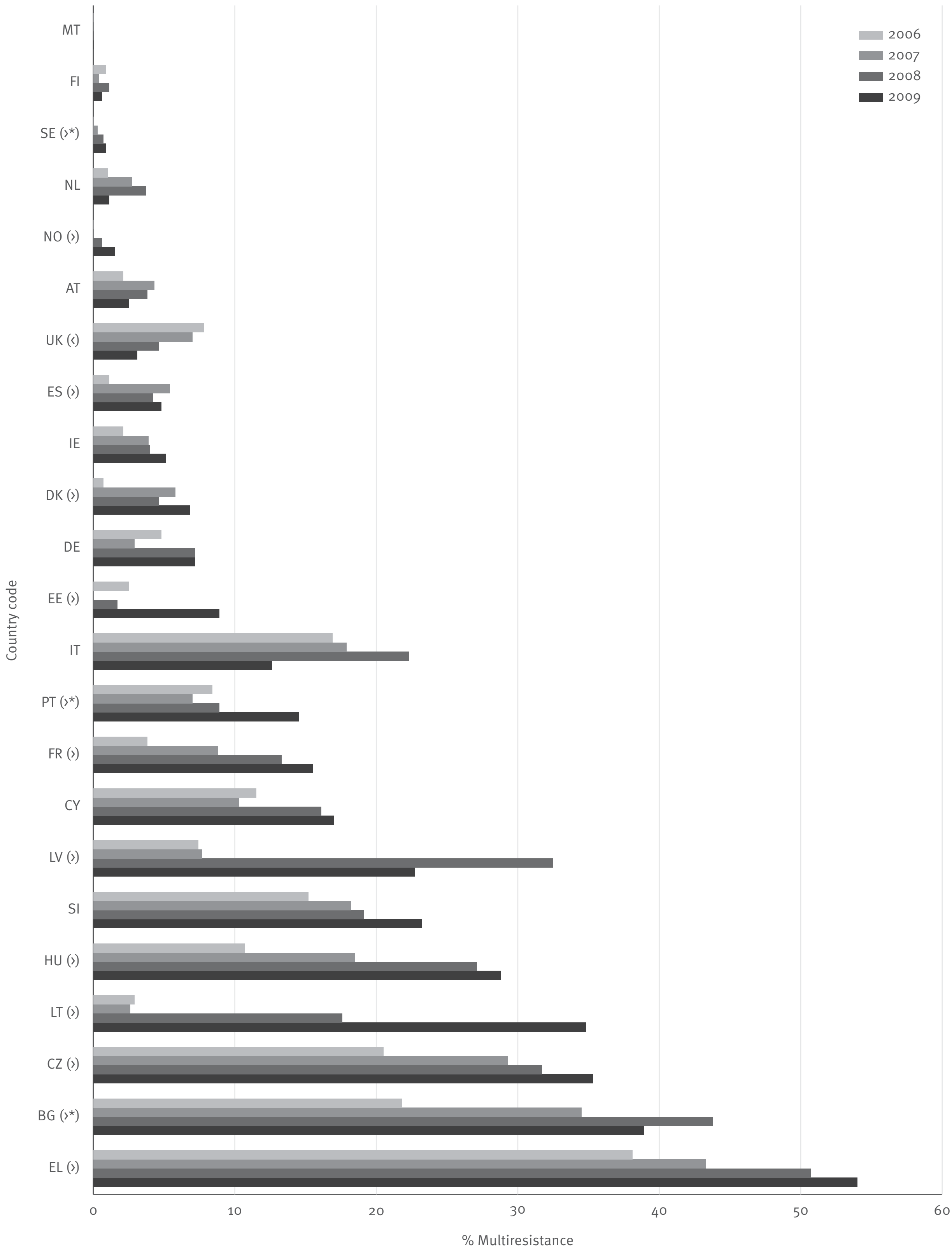
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Figure 5.28: ***Klebsiella pneumoniae*****: trend of aminoglycosides resistance by country, 2006–2009**



Only countries that reported 20 isolates or more per year were included. The symbols > and < indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Figure 5.29: ***Klebsiella pneumoniae*: trend of multiresistance (third-generation cephalosporins, fluoroquinolones and aminoglycosides) by country, 2006–2009**



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Table 5.8: Number of invasive *K. pneumoniae* isolates and proportion of fluoroquinolones, third-generation cephalosporins, aminoglycosides and multiresistance (%R), including 95% confidence intervals (95% CI), reported per country in 2009

Country	Fluoroquinolones		Third-gen. cephalosporins		Aminoglycosides		Multiresistance*	
	N	%R (95%CI)	N	%R (95%CI)	N	%R (95%CI)	N	%R (95%CI)
Austria	604	8.4 (6–11)	615	7.6 (6–10)	618	3.6 (2–5)	599	2.5 (1–4)
Belgium	142	13.4 (8–20)	142	14.8 (9–22)	142	9.9 (5–16)	142	2.8 (1–7)
Bulgaria	95	48.4 (38–59)	95	69.5 (59–79)	95	65.3 (55–75)	95	38.9 (29–49)
Cyprus	53	43.4 (30–58)	53	41.5 (28–56)	53	18.9 (9–32)	53	17.0 (8–30)
Czech Republic	1415	54.3 (52–57)	1415	52.1 (49–55)	1394	47.2 (45–50)	1394	35.3 (33–38)
Denmark	791	16.2 (14–19)	623	11.2 (9–14)	822	7.2 (6–9)	600	6.8 (5–9)
Estonia	58	19.0 (10–31)	58	17.2 (9–29)	60	15.0 (7–27)	56	8.9 (3–20)
Finland	375	3.2 (2–6)	367	1.4 (0–3)	349	1.1 (0–3)	341	0.6 (0–2)
France	1352	24.0 (22–26)	1378	18.7 (17–21)	1378	19.6 (18–22)	1352	15.5 (14–17)
Germany	479	14.8 (12–18)	471	13.2 (10–17)	478	9.6 (7–13)	470	7.2 (5–10)
Greece	1626	65.6 (63–68)	1634	68.7 (66–71)	1644	60.3 (58–63)	1625	54.0 (52–56)
Hungary	355	33.2 (28–38)	359	38.4 (33–44)	361	40.4 (35–46)	354	28.8 (24–34)
Iceland	26	0.0 (0–13)	27	0.0 (0–13)	27	0.0 (0–13)	26	0.0 (0–13)
Ireland	315	10.8 (8–15)	314	11.1 (8–15)	316	11.1 (8–15)	313	5.1 (3–8)
Italy	299	20.4 (16–25)	272	37.1 (31–43)	309	19.4 (15–24)	254	12.6 (9–17)
Latvia	44	34.1 (20–50)	44	54.5 (39–70)	44	43.2 (28–59)	44	22.7 (11–38)
Lithuania	67	37.3 (26–50)	67	56.7 (44–69)	68	55.9 (43–68)	66	34.8 (24–48)
Luxembourg	28	21.4 (8–41)	28	25.0 (11–45)	28	17.9 (6–37)	28	14.3 (4–33)
Malta	38	2.6 (0–14)	38	0.0 (0–9)	38	0.0 (0–9)	38	0.0 (0–9)
Netherlands	393	4.1 (2–7)	400	5.5 (3–8)	397	3.3 (2–6)	380	1.1 (0–3)
Norway	392	5.6 (4–8)	396	2.8 (1–5)	394	3.0 (2–5)	391	1.5 (1–3)
Poland	139	32.4 (25–41)	143	49.0 (41–57)	150	29.3 (22–37)	133	15.0 (9–22)
Portugal	537	27.6 (24–32)	556	27.5 (24–31)	564	20.4 (17–24)	532	14.5 (12–18)
Romania	18	11.1 (1–35)	18	55.6 (31–78)	26	30.8 (14–52)	18	11.1 (1–35)
Slovenia	168	28.6 (22–36)	168	33.9 (27–42)	168	28.0 (21–35)	168	23.2 (17–30)
Spain	627	15.8 (13–19)	628	11.1 (9–14)	628	9.2 (7–12)	627	4.8 (3–7)
Sweden	248	1.6 (0–4)	701	1.7 (1–3)	676	0.4 (0–1)	235	0.9 (0–3)
United Kingdom	660	5.8 (4–8)	655	7.2 (5–9)	695	5.5 (4–7)	618	3.1 (2–5)

* Multiresistance defined as being resistant to third-generation cephalosporins, fluoroquinolone and aminoglycosides.

Table 5.9: Number of invasive *K. pneumoniae* isolates resistant to third-generation cephalosporins (CRKP) and proportion of ESBL positive among these isolates, as ascertained by the participating laboratories in 2009

Country	Number of laboratories	Number of CRKP	%ESBL
Austria	16	40	87.5
Bulgaria	10	66	98.5
Cyprus	4	22	86.4
Czech Republic	44	737	79.9
Estonia	4	10	100
Spain	20	70	85.7
France	27	89	80.9
Ireland	12	32	78.1
Italy	7	47	91.5
Lithuania	9	38	97.4
Latvia	5	17	94.1
Netherlands	4	11	72.7
Poland	12	70	92.9
Portugal	11	92	90.2
Romania	3	10	100
Slovenia	7	57	96.5

Only data from laboratories consistently reporting ESBL test results for all isolates identified as resistant to third-generation cephalosporins and from countries with at least 10 of such isolates were selected for the analysis.

Table 5.10: Overall resistance and resistance combinations among invasive *Klebsiella pneumoniae* isolates tested against fluoroquinolones, third-generation cephalosporins and aminoglycosides (n= 10 952) in Europe, 2009

Resistance pattern	Number	% of total
Fully susceptible	7108	64.9
Single resistance (to indicated drug classes)		
Fluoroquinolones	409	3.7
Third-generation cephalosporins	241	2.2
Aminoglycosides	135	1.2
Resistance to two classes of antimicrobial drugs		
Third-generation cephalosporins + fluoroquinolones	477	4.4
Third-generation cephalosporins + aminoglycosides	320	2.9
Fluoroquinolones + aminoglycosides	150	1.4
Resistance to three classes of antimicrobial drugs		
third-generation cephalosporins + fluoroquinolones + aminoglycosides	2112	19.3

5.6 *Pseudomonas aeruginosa*

5.6.1 Clinical and epidemiological importance

Pseudomonas aeruginosa is a non-fermenting gram-negative bacterium that is ubiquitously present in aquatic environments in nature. It is an opportunistic pathogen for plants, animals and humans, and is a major and dreaded cause of infection among hospitalised patients with localised or systemic impairment of immune defences, being a common cause of hospital-acquired pneumonia (including ventilator-associated pneumonia), bloodstream and urinary tract infections. Because of its ubiquitous presence, its enormous versatility and intrinsic tolerance to many detergents, disinfectants and antimicrobial compounds, it is difficult to control *P. aeruginosa* in hospitals and institutional environments. Moreover, *P. aeruginosa* is a frequent cause of skin infections such as folliculitis and otitis externa in recreational and competitive swimmers. In patients with cystic fibrosis, *P. aeruginosa* causes the most important bacterial complication leading to chronic colonisation and intermittent exacerbations ranging from bronchiolitis to acute respiratory distress syndrome. Finally, *P. aeruginosa* is a common pathogen found in burns units, and in these locations it is almost impossible to eradicate colonising strains by classical infection control procedures.

5.6.2 Resistance mechanism

P. aeruginosa is intrinsically resistant to the majority of antimicrobial compounds due to its selective ability to exclude various molecules from penetrating its outer membrane. The antibiotic classes that remain active include the fluoroquinolones, the aminoglycosides, some beta-lactams (piperacillin, ceftazidime, carbapenems) and colistin. Acquired resistance in *P. aeruginosa* is caused by one or more of several mechanisms:

- mutational modification of antibiotic targets, such as gyrase, topoisomerase or ribosomal proteins, which confer resistance to fluoroquinolones or aminoglycosides, respectively;
- mutational derepression of the chromosomally coded AmpC beta-lactamase;
- mutational loss of outer membrane proteins preventing the uptake of antimicrobial substances such as carbapenems;
- mutational upregulation of efflux systems, that can confer resistance to beta-lactams, fluoroquinolones and aminoglycosides; and
- acquisition of plasmid-mediated resistance genes coding for various beta-lactamases and aminoglycoside modifying enzymes that can confer resistance to various beta-lactams including carbapenems (e. g. metallo-beta-lactamases) and aminoglycosides.

5.6.3 Results

Piperacillin±tazobactam

- Twenty-eight countries reported 8 028 isolates of which 1 306 were resistant to piperacillin±tazobactam.
- Proportion of resistance was: 1–5% in six countries, 5–10% in four countries, 10–25% in 12 countries and 25–50% in six countries (Figure 5.30, Table 5.11).
- Trends in the 2006–2009 period have been calculated for 21 countries. A significant increase has been observed for France and Hungary that, in 2009, reported a proportion of resistance to piperacillin±tazobactam of 21% and 19%, respectively. A significant decreasing trend has been observed for Greece (proportion of resistance in 2009 was 33%) (Figure 5.35).

Ceftazidime

- Twenty-eight countries reported 7 937 isolates of which 1 171 were resistant to ceftazidime; one country (Romania) reported less than 10 isolates and, therefore, it was not included in the map.
- Proportion of resistance was: 1–5% in four countries, 5–10% in eight countries, 10–25% in 12 countries and 25–50% in three countries (Figure 5.31, Table 5.11).
- Trends in the 2006–2009 period have been calculated for 21 countries. A significant increase has been observed for France and Hungary, which, in 2009, reported a proportion of resistance to ceftazidime of 17% and 12%, respectively. A significant decreasing trend has been observed for Portugal (proportion of resistance in 2009 was 13%) but the trend significance disappears when considering only data from laboratories consistently reporting all four years (Figure 5.36).

Fluoroquinolones

- Twenty-eight countries reported 8 253 isolates of which 1 884 were resistant to fluoroquinolones.
- Proportion of resistance was: 1–5% in one country, 5–10% in five countries, 10–25% in 13 countries and 25–50% in nine countries (Figure 5.32, Table 5.11).
- Trends in the 2006–2009 period have been calculated for 20 countries. A significant increase has been observed for Hungary (proportion of resistance in 2009 was 27%). A significant decreasing trend has been observed for Germany, Ireland and Norway, which, in 2009, reported a proportion of resistance to fluoroquinolones of 17%, 9% and 3%, respectively. In two of these countries (Ireland and Norway) the trends are significant also when considering only data from laboratories consistently reporting all four years (Figure 5.37).

Aminoglycosides

- Twenty-eight countries reported 8 223 isolates of which 1 437 were resistant to aminoglycosides.
- Proportion of resistance was: below 1% in four countries, 1–5% in four countries, 5–10% in six countries, 10–25% in seven countries and 25–50% in seven countries (Figure 5.33, Table 5.11).
- Trends in the 2006–2009 period have been calculated for 21 countries. Three countries (Hungary, Malta and Spain) reported a significant increasing trend (Fig

5.38) with proportions of resistance to aminoglycosides of 29%, 21% and 19%, respectively, in 2009.

- Significant decreasing trends have been observed for five countries. In three of these the trends are significant also when considering only data from laboratories consistently reporting all four years (Figure 5.38). In 2009, these five countries reported the following proportion of resistance to aminoglycosides: 1–5% in one case (the United Kingdom), 5–10% in one case (Germany), 10–25% in one case (Portugal) and 25–50% in two cases (Greece and Poland).

Carbapenems

- Twenty-eight countries reported 8 129 isolates of which 1 541 were resistant to carbapenems.
- Proportion of resistance was: below 1% in one country, 1–5% in two countries, 5–10% in nine countries, 10–25% in 10 countries, 25–50% in five countries and above 50% in one country (Figure 5.34, Table 5.11).
- Trends in the 2006–2009 period have been calculated for 20 countries. Three countries (France, Hungary and Italy) reported a significant increasing trend with proportions of resistance to carbapenems, which, in 2009, were 17%, 27% and 31%, respectively. In two of these countries (Hungary and Italy) the trends are significant also when considering only data from laboratories consistently reporting all four years (Figure 5.39).
- Significant decreasing trends have been observed for Austria, Czech Republic and Germany, with proportions of resistance to carbapenems of 9%, 29% and 11%, respectively, in 2009. In one of these countries (Austria) the trend is significant also when considering only data from laboratories consistently reporting all four years (Figure 5.39).

Combined resistance (piperacillin±tazobactam, ceftazidime, fluoroquinolones, aminoglycosides and carbapenems)

- Twenty-eight countries reported 8 376 isolates tested for at least three antibiotic classes among piperacillin±tazobactam, ceftazidime, fluoroquinolones, aminoglycosides and carbapenems. In 2009, 33% of isolates were resistant to one or more of the five considered antibiotic classes while 16% were resistant to three or more. The most frequent pattern was the resistance to all five antibiotic classes (5%) (Table 5.12).
- Proportion of multiresistance (R to at least three of the five considered antibiotic classes) was: below 1% in one country, 1–5% in seven countries, 5–10% in four countries, 10–25% in 11 countries and 25–50% in five countries (Table 5.11).
- Trends in the 2006–2009 period have been calculated for 21 countries. Significant increasing trends of multiresistance have been observed for four countries. In three of these countries the trends are significant also when considering only data from laboratories consistently reporting all four years (Figure 5.40). In 2009, these four countries (France, Hungary, Malta and Spain) reported proportion of multiresistance between 10% and 25%.
- Significant decreasing trends of multiresistance have been observed for four countries. In two of these the trends are significant also when considering only data from laboratories consistently reporting all four years (Figure 5.40). In 2009, these four countries reported the following proportion of multiresistance: 1–5% in one case (Ireland), 5–10% in one case (Germany), 10–25% in one case (Portugal) and 25–50% in one case (Greece).

5.6.4 Conclusions

High proportions of resistance of *P. aeruginosa* to antimicrobials have been reported by many countries especially in southern and eastern Europe. The combined resistance is also frequent with 16% of isolates resistant to at least three antibiotic classes (multiresistance) and with 5% of isolates resistant to all five antibiotic classes under surveillance. Despite the high proportions of resistance, the situation appears to be generally stable in Europe with few countries reporting significant increasing or decreasing trends of resistance. The countries with increasing trends of resistance to specific antibiotic classes or of multiresistance are: France, Hungary, Italy, Malta and Spain. In 2009, Greece reported the highest proportion of multiresistance (40%) although a significant decreasing trend was observed from 2006 to 2009.

Figure 5.30: *Pseudomonas aeruginosa*: proportion of invasive isolates resistant to piperacillin±tazobactam in 2009

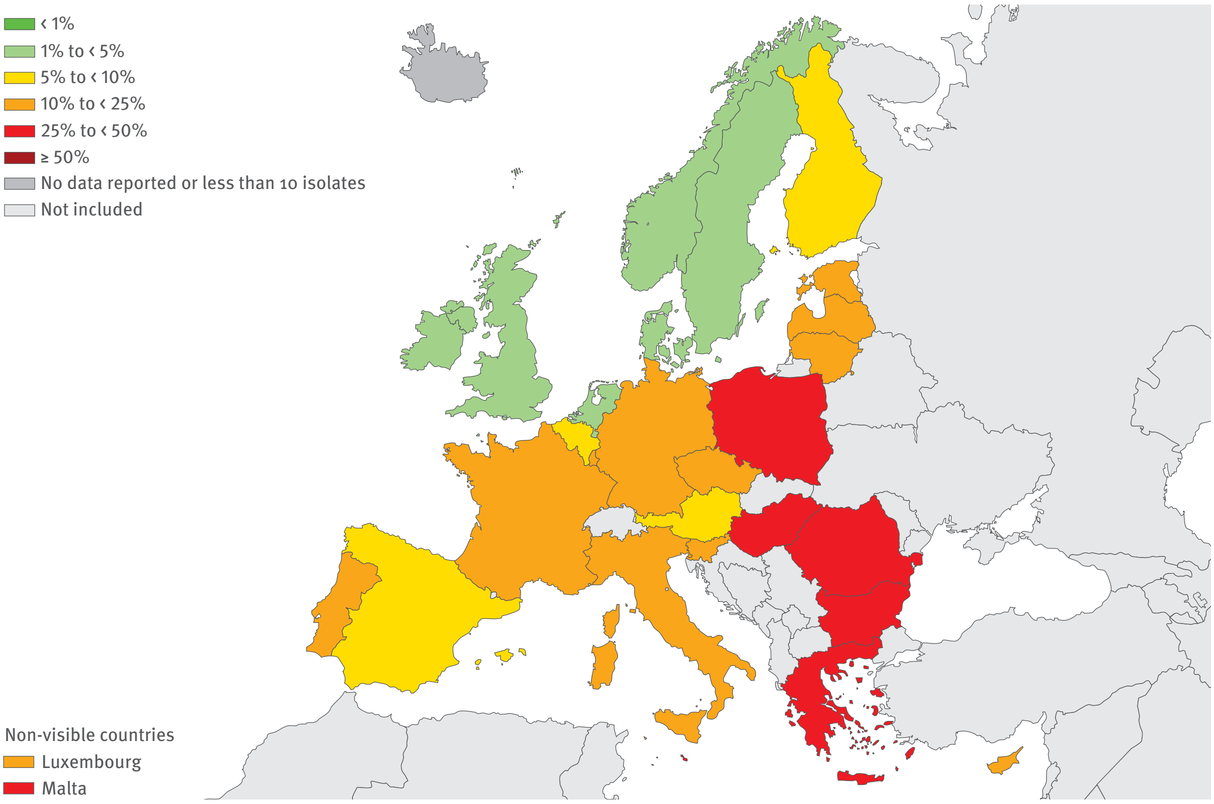


Figure 5.31: *Pseudomonas aeruginosa*: proportion of invasive isolates resistant to ceftazidime in 2009

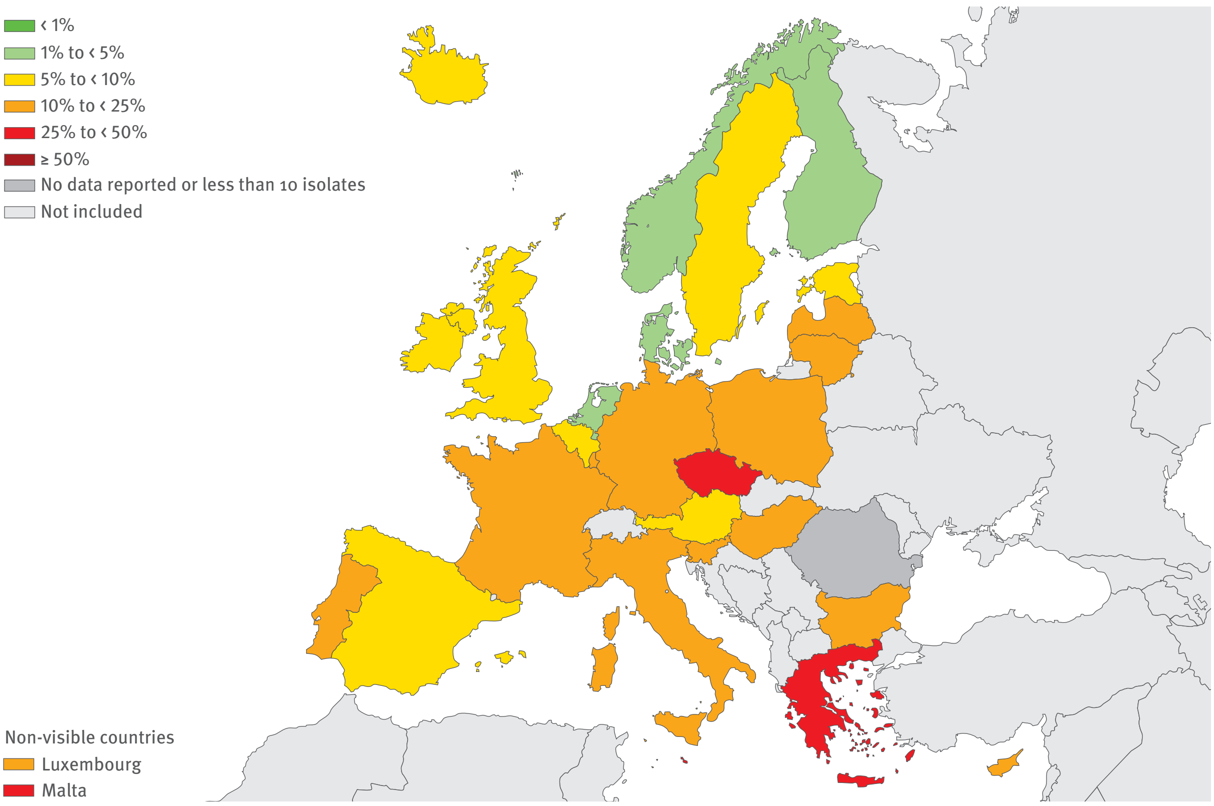


Figure 5.32: ***Pseudomonas aeruginosa*: proportion of invasive isolates resistant to fluoroquinolones in 2009**

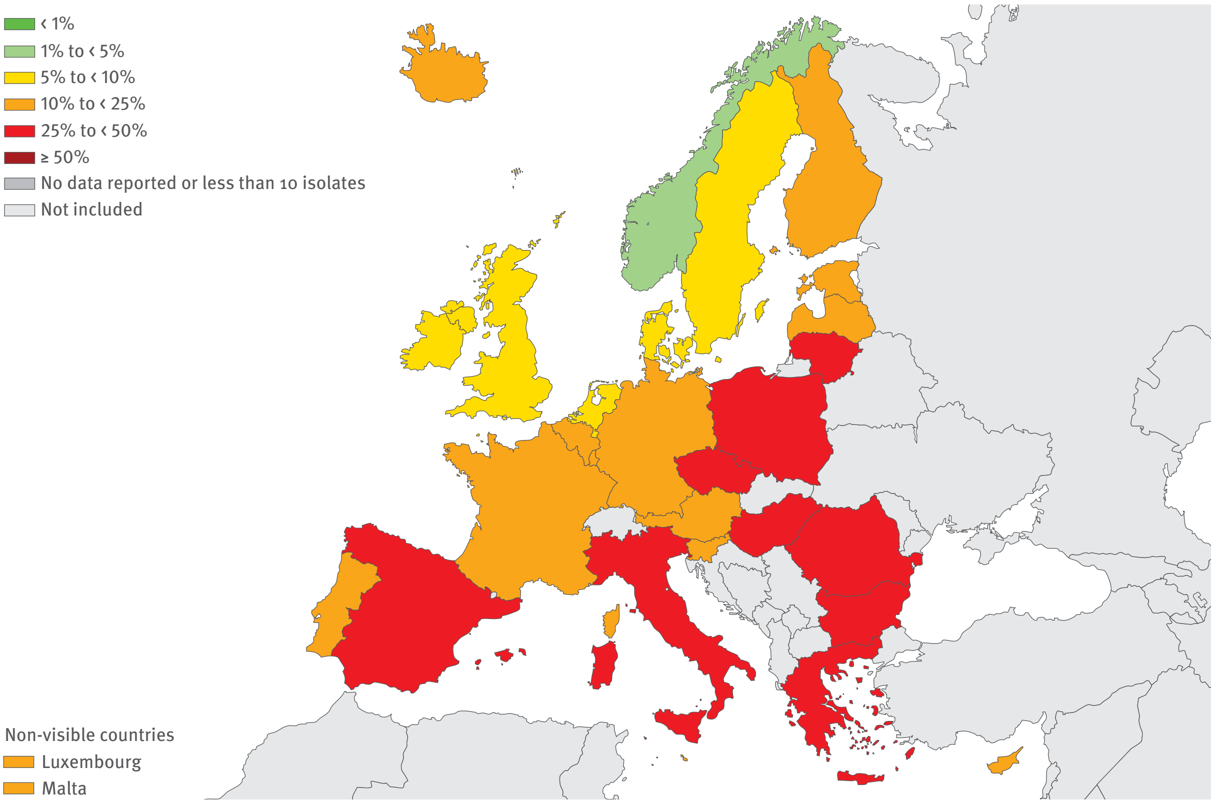


Figure 5.33: ***Pseudomonas aeruginosa*: proportion of invasive isolates resistant to aminoglycosides in 2009**

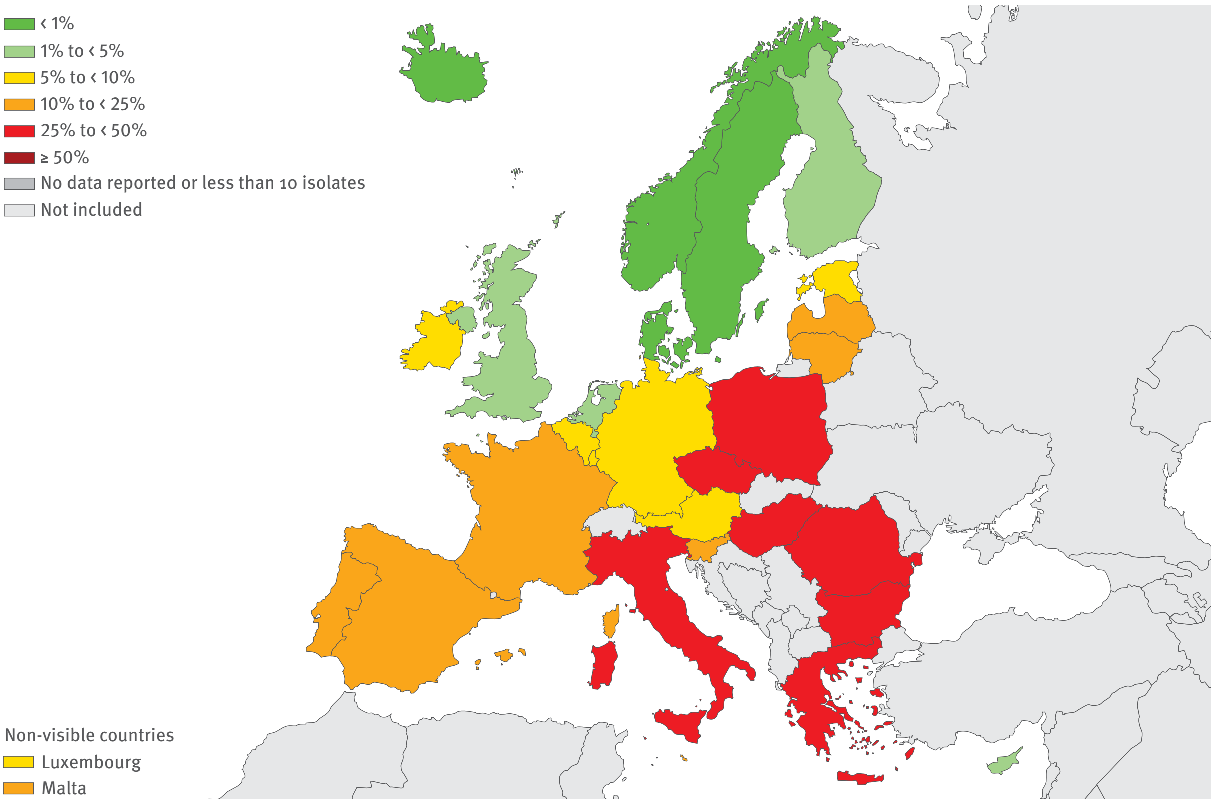


Figure 5.34: *Pseudomonas aeruginosa*: proportion of invasive isolates resistant to carbapenems in 2009

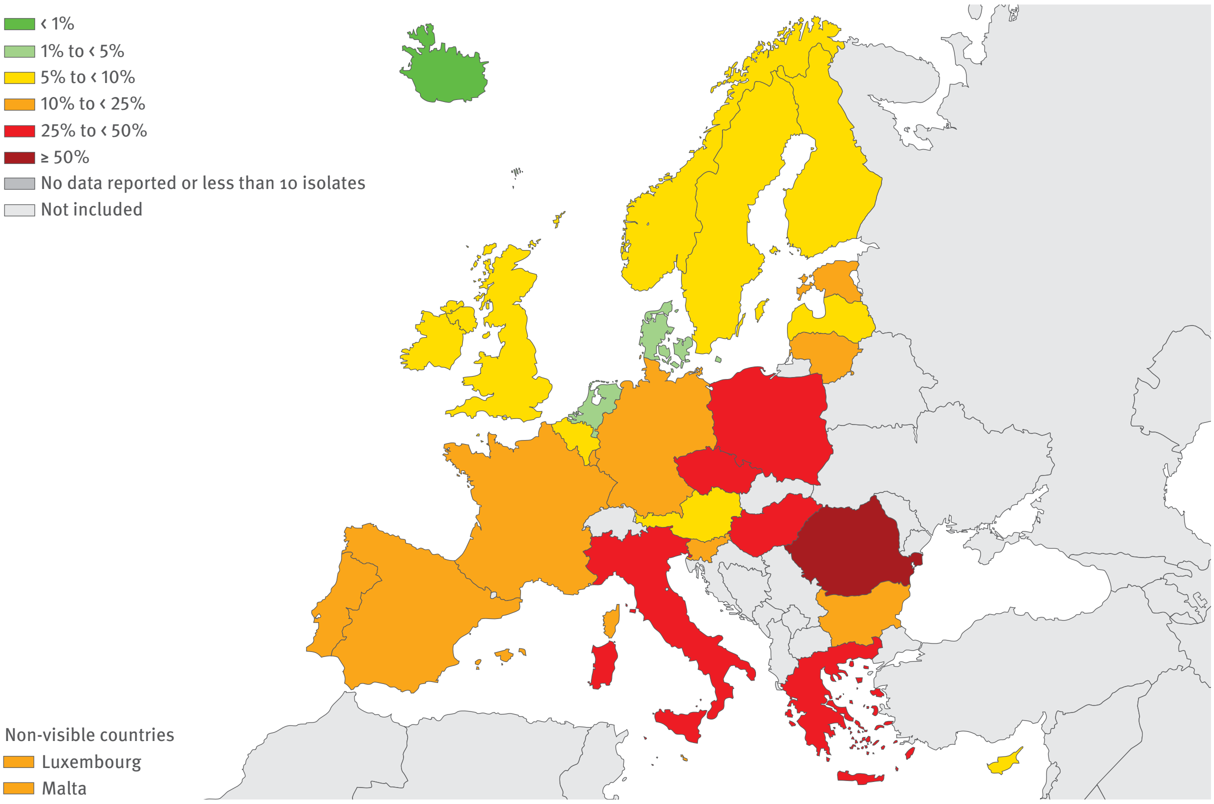
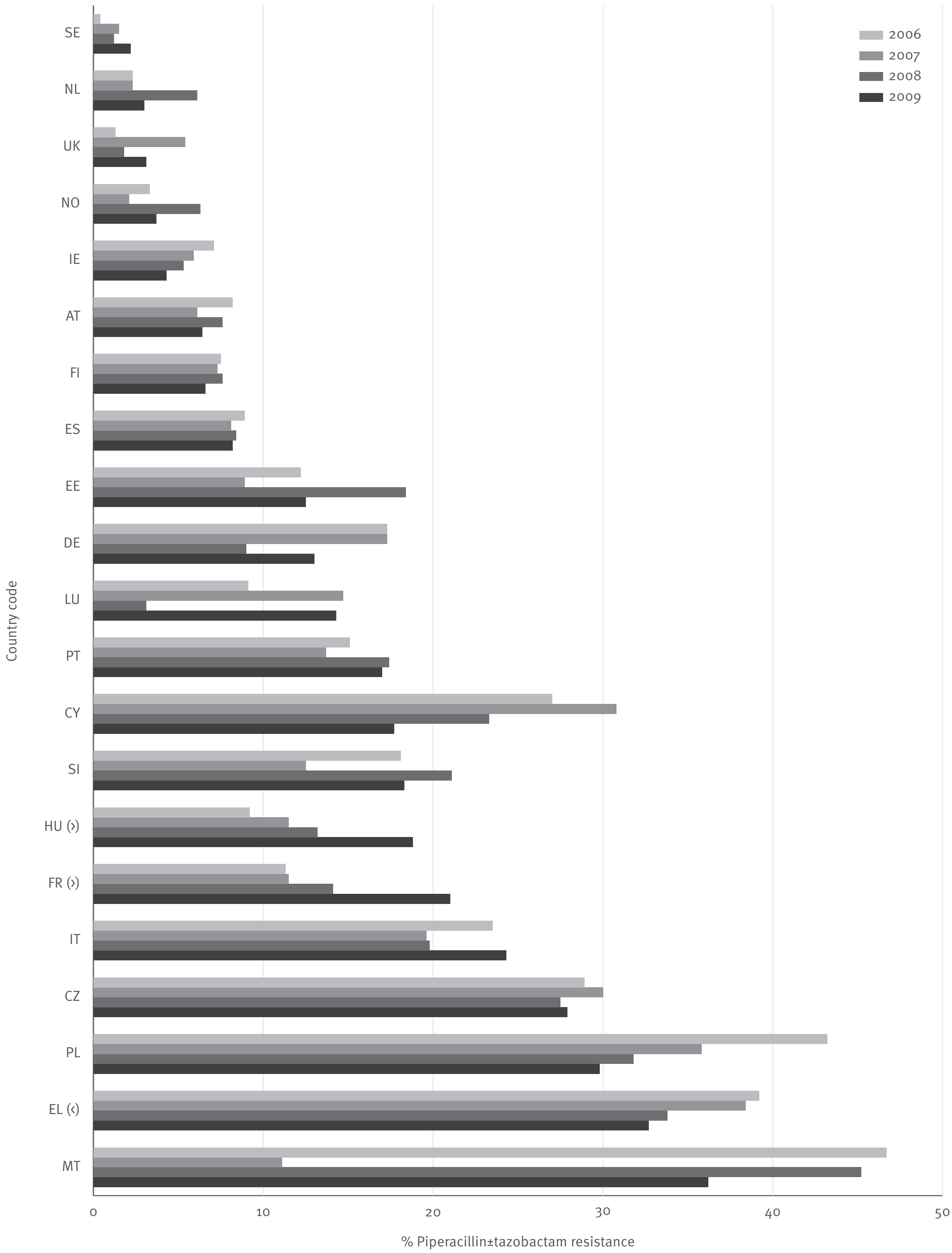
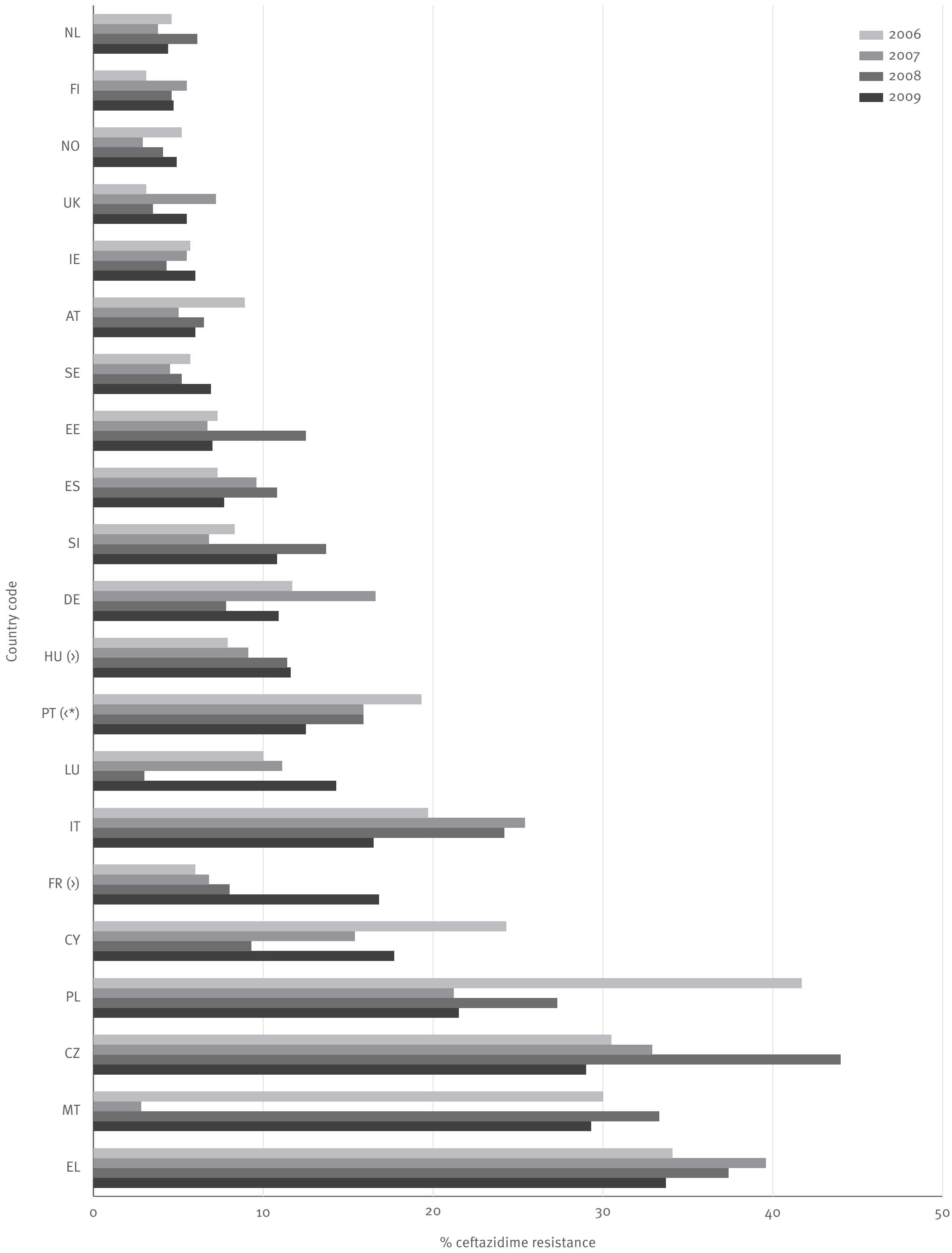


Figure 5.35: ***Pseudomonas aeruginosa*****: trend of piperacillin±tazobactam resistance by country, 2006–2009**



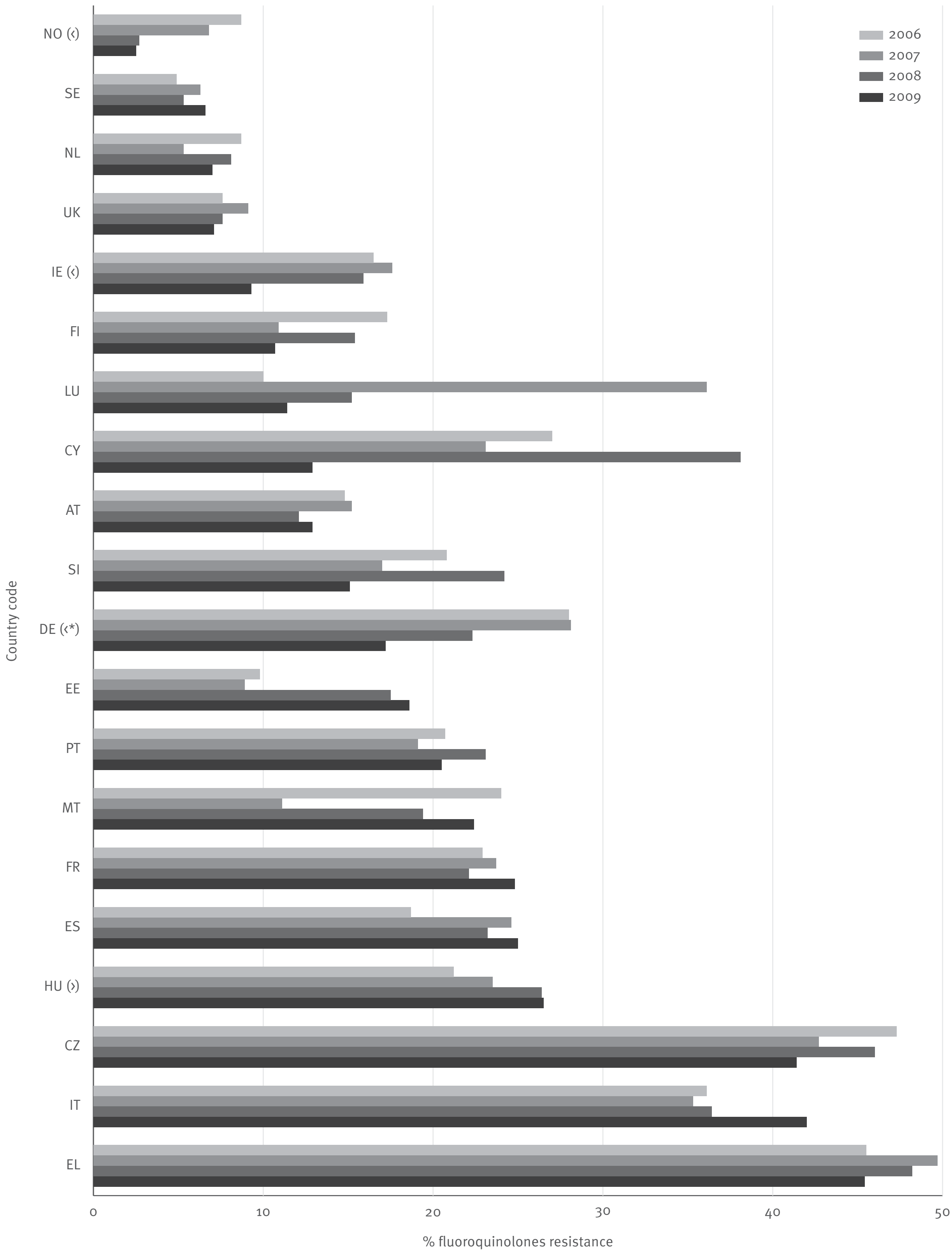
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Figure 5.36: ***Pseudomonas aeruginosa*****: trend of ceftazidime resistance by country, 2006–2009**



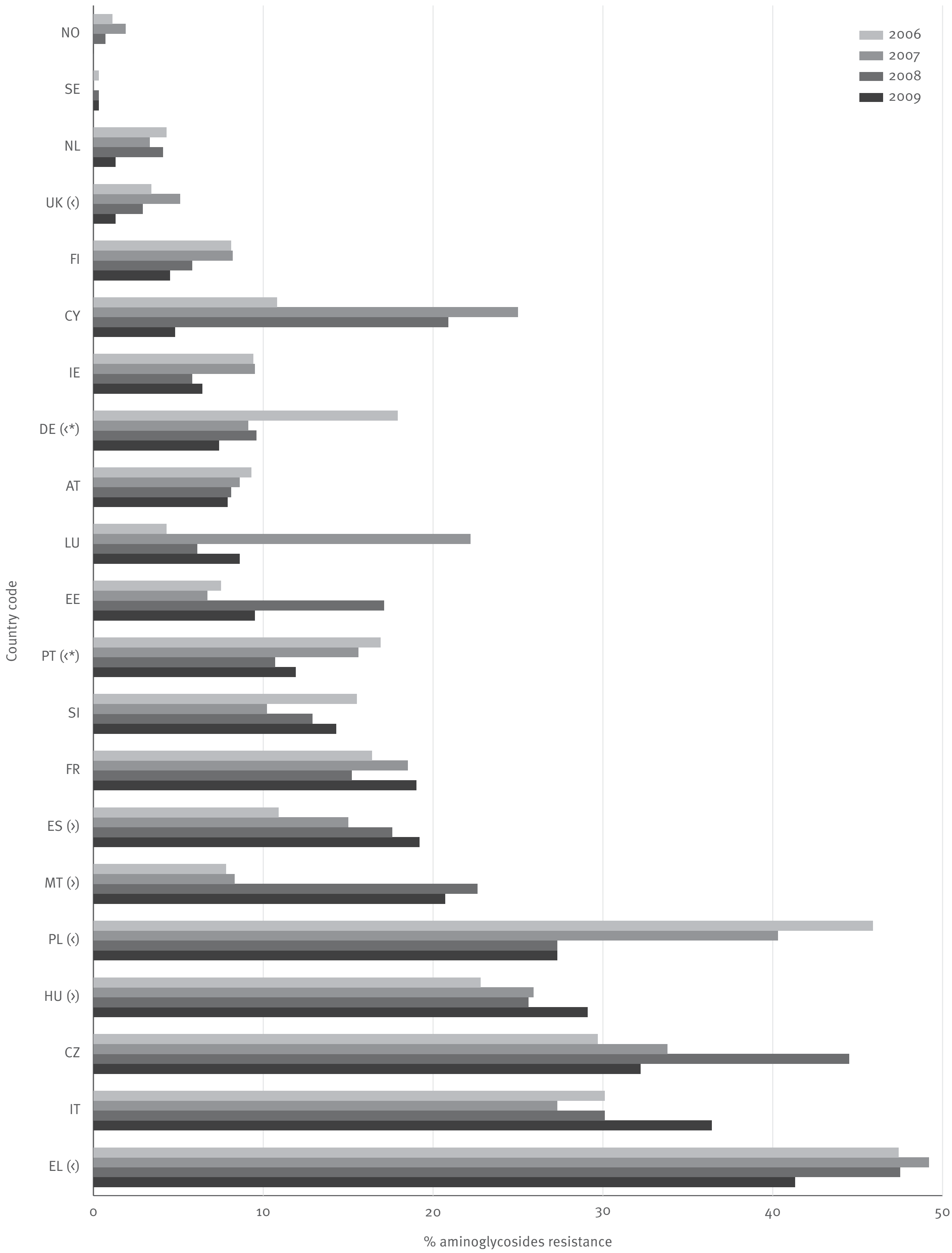
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Figure 5.37: *Pseudomonas aeruginosa*: trend of fluoroquinolones resistance by country, 2006–2009



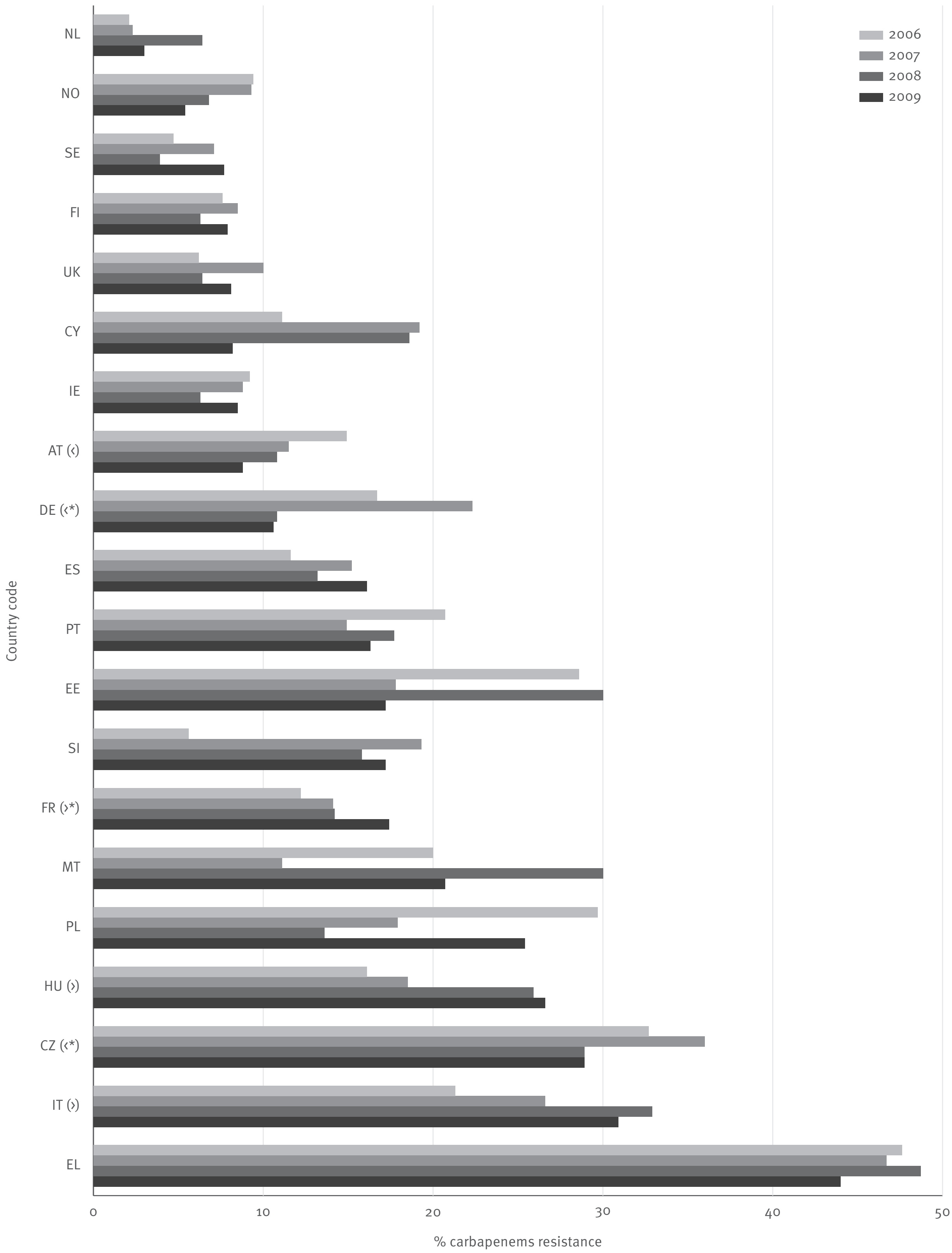
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Figure 5.38: ***Pseudomonas aeruginosa*****: trend of aminoglycosides resistance by country, 2006–2009**



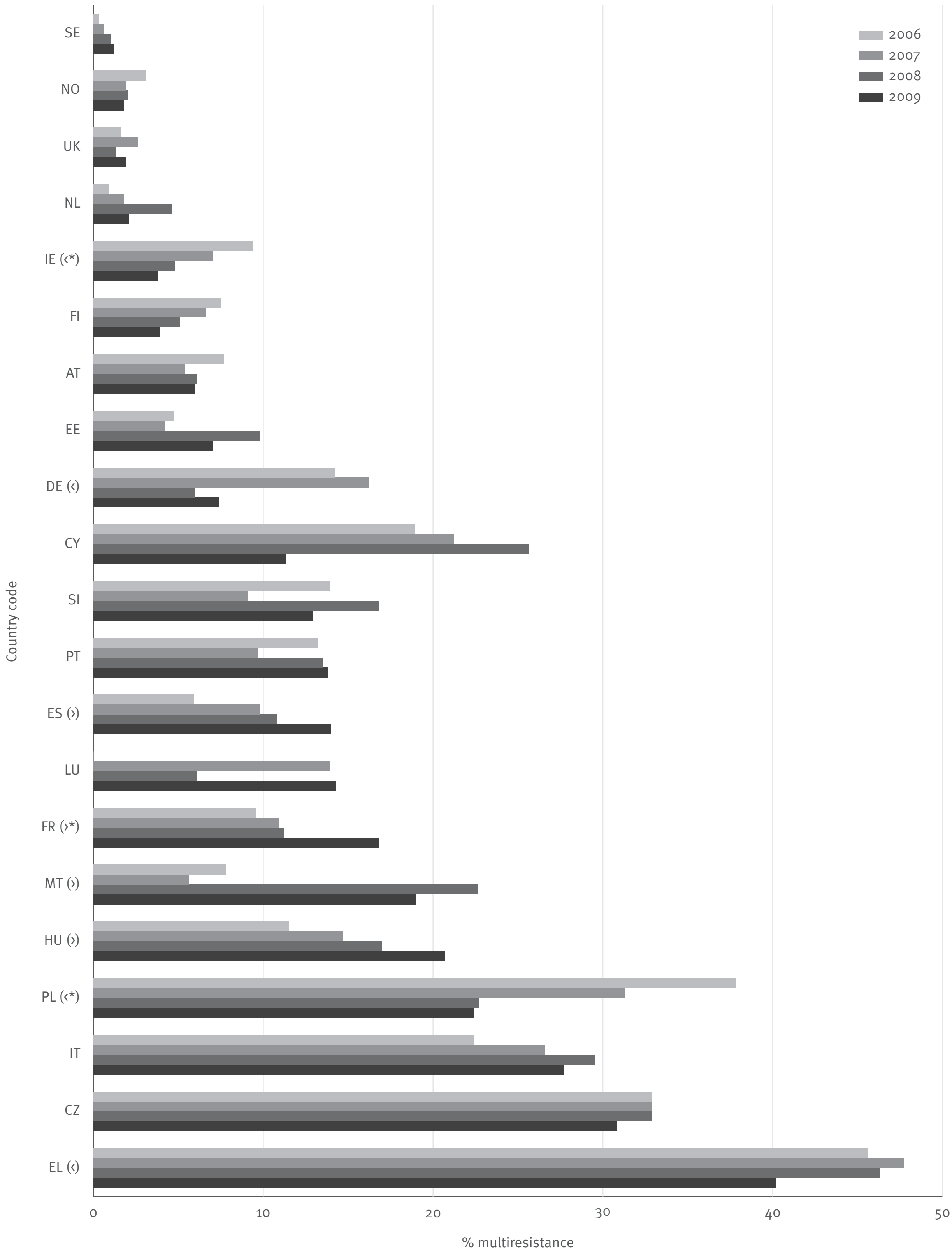
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Figure 5.39: ***Pseudomonas aeruginosa*: trend of carbapenems resistance by country, 2006–2009**



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Figure 5.40: ***Pseudomonas aeruginosa*****: trend of multiresistance (R to three or more antibiotic classes among piperacillin±tazobactam, ceftazidime, fluoroquinolones, aminoglycosides and carbapenems) by country, 2006–2009**



Only countries that reported 20 isolates or more per year were included. The symbols > and < indicate significant increasing and decreasing trend, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.

Table 5.11: Number of invasive *P. aeruginosa* isolates and proportion of piperacillin±tazobactam, fluoroquinolones, ceftazidime, aminoglycosides, carbapenems and multiresistance (%R), including 95% confidence intervals (95% CI), reported per country in 2009

Country	Piperacillin± tazobactam		Fluoroquinolones		Ceftazidime		Aminoglycosides		Carbapenems		Multiresistance*	
	N	%R (95%CI)	N	%R (95%CI)	N	%R (95%CI)	N	%R (95%CI)	N	%R (95%CI)	N	%R (95%CI)
Austria	512	6.4 (4–9)	512	12.9 (10–16)	483	6.0 (4–9)	509	7.9 (6–11)	513	8.8 (6–12)	516	6.0 (4–8)
Belgium	104	6.7 (3–13)	134	15.7 (10–23)	134	6.0 (3–11)	105	9.5 (5–17)	134	9.0 (5–15)	134	5.2 (2–10)
Bulgaria	36	33.3 (19–51)	36	33.3 (19–51)	35	22.9 (10–40)	33	33.3 (18–52)	34	23.5 (11–41)	36	27.8 (14–45)
Cyprus	62	17.7 (9–30)	62	12.9 (6–24)	62	17.7 (9–30)	62	4.8 (1–13)	61	8.2 (3–18)	62	11.3 (5–22)
Czech Republic	574	27.9 (24–32)	575	41.4 (37–46)	575	29.0 (25–33)	575	32.2 (28–36)	575	28.9 (25–33)	575	30.8 (27–35)
Denmark	373	1.9 (1–4)	411	5.4 (3–8)	311	3.5 (2–6)	428	0.7 (0–2)	347	2.9 (1–5)	415	1.7 (1–3)
Estonia	40	12.5 (4–27)	43	18.6 (8–33)	43	7.0 (1–19)	42	9.5 (3–23)	29	17.2 (6–36)	43	7.0 (1–19)
Finland	229	6.6 (4–11)	233	10.7 (7–15)	233	4.7 (2–8)	224	4.5 (2–8)	229	7.9 (5–12)	233	3.9 (2–7)
France	1156	21.0 (19–23)	1204	24.8 (22–27)	1085	16.8 (15–19)	1159	19.0 (17–21)	1219	17.4 (15–20)	1220	16.8 (15–19)
Germany	284	13.0 (9–18)	285	17.2 (13–22)	284	10.9 (8–15)	284	7.4 (5–11)	283	10.6 (7–15)	285	7.4 (5–11)
Greece	1084	32.7 (30–36)	1080	45.4 (42–48)	1074	33.7 (31–37)	1090	41.3 (38–44)	1095	44.0 (41–47)	1077	40.2 (37–43)
Hungary	505	18.8 (15–22)	513	26.5 (23–31)	516	11.6 (9–15)	516	29.1 (25–33)	516	26.6 (23–31)	516	20.7 (17–24)
Iceland	16	12.5 (2–38)	16	12.5 (2–38)	16	6.3 (0–30)	16	0.0 (0–21)	16	0.0 (0–21)	16	0.0 (0–21)
Ireland	235	4.3 (2–8)	236	9.3 (6–14)	232	6.0 (3–10)	235	6.4 (4–10)	224	8.5 (5–13)	236	3.8 (2–7)
Italy	185	24.3 (18–31)	193	42.0 (35–49)	164	16.5 (11–23)	151	36.4 (29–45)	188	30.9 (24–38)	195	27.7 (22–35)
Latvia	18	16.7 (4–41)	17	11.8 (1–36)	18	16.7 (4–41)	18	22.2 (6–48)	14	7.1 (0–34)	18	11.1 (1–35)
Lithuania	20	20.0 (6–44)	21	33.3 (15–57)	21	14.3 (3–36)	21	19.0 (5–42)	21	19.0 (5–42)	21	19.0 (5–42)
Luxembourg	35	14.3 (5–30)	35	11.4 (3–27)	35	14.3 (5–30)	35	8.6 (2–23)	33	15.2 (5–32)	35	14.3 (5–30)
Malta	58	36.2 (24–50)	58	22.4 (13–35)	58	29.3 (18–43)	58	20.7 (11–33)	58	20.7 (11–33)	58	19.0 (10–31)
Netherlands	233	3.0 (1–6)	230	7.0 (4–11)	228	4.4 (2–8)	230	1.3 (0–4)	234	3.0 (1–6)	234	2.1 (1–5)
Norway	161	3.7 (1–8)	162	2.5 (1–6)	164	4.9 (2–9)	165	0.0 (0–2)	166	5.4 (3–10)	165	1.8 (0–5)
Poland	151	29.8 (23–38)	149	25.5 (19–33)	121	21.5 (15–30)	143	27.3 (20–35)	142	25.4 (18–33)	152	22.4 (16–30)
Portugal	535	17.0 (14–20)	517	20.5 (17–24)	536	12.5 (10–16)	536	11.9 (9–15)	520	16.3 (13–20)	536	13.8 (11–17)
Romania	11	36.4 (11–69)	11	36.4 (11–69)	8	37.5 (9–76)	11	45.5 (17–77)	11	54.5 (23–83)	11	36.4 (11–69)
Slovenia	93	18.3 (11–28)	93	15.1 (8–24)	93	10.8 (5–19)	91	14.3 (8–23)	93	17.2 (10–26)	93	12.9 (7–21)
Spain	539	8.2 (6–11)	544	25.0 (21–29)	544	7.7 (6–10)	543	19.2 (16–23)	540	16.1 (13–19)	544	14.0 (11–17)
Sweden	224	2.2 (1–5)	259	6.6 (4–10)	317	6.9 (4–10)	321	0.3 (0–2)	326	7.7 (5–11)	330	1.2 (0–3)
United Kingdom	555	3.1 (2–5)	624	7.1 (5–9)	547	5.5 (4–8)	622	1.3 (1–3)	508	8.1 (6–11)	620	1.9 (1–3)

* Multiresistance defined as being resistant to three or more antibiotic classes among piperacillin±tazobactam, ceftazidime, fluoroquinolones, aminoglycosides and carbapenems.

Table 5.12: Overall resistance and resistance combinations among invasive *Pseudomonas aeruginosa* isolates tested against at least three antibiotic classes among piperacillin±tazobactam, ceftazidime, fluoroquinolones, aminoglycosides and carbapenems (n= 8 376) in Europe, 2009

Resistance pattern	Number	% of total
Fully susceptible (to the tested drugs)	5588	66.7
Resistance to one class of antimicrobial drugs		
Fluoroquinolones	350	4.2
Carbapenems	309	3.7
Aminoglycosides	101	1.2
Ceftazidime	83	1
Piperacillin(±tazobactam)	72	0.9
Resistance to two classes of antimicrobial drugs		
Fluoroquinolones + aminoglycosides	185	2.2
Piperacillin(±tazobactam) + ceftazidime	147	1.8
Fluoroquinolones + carbapenems	93	1.1
Piperacillin(±tazobactam) + fluoroquinolones	27	0.3
Piperacillin(±tazobactam) + carbapenems	26	0.3
Piperacillin(±tazobactam) + aminoglycosides	21	0.3
Aminoglycosides + carbapenems	16	0.2
Ceftazidime + carbapenems	16	0.2
Fluoroquinolones + ceftazidime	11	0.1
Ceftazidime + aminoglycosides	5	0.1
Resistance to three classes of antimicrobial drugs		
Fluoroquinolones + aminoglycosides + carbapenems	165	2
Piperacillin(±tazobactam) + fluoroquinolones + aminoglycosides	83	1
Piperacillin(±tazobactam) + ceftazidime + carbapenems	62	0.7
Piperacillin(±tazobactam) + fluoroquinolones + ceftazidime	39	0.5
Fluoroquinolones + ceftazidime + aminoglycosides	36	0.4
Piperacillin(±tazobactam) + fluoroquinolones + carbapenems	19	0.2
Fluoroquinolones + ceftazidime + carbapenems	16	0.2
Piperacillin(±tazobactam) + aminoglycosides + carbapenems	12	0.1
Piperacillin(±tazobactam) + ceftazidime + aminoglycosides	9	0.1
Ceftazidime + aminoglycosides + carbapenems	9	0.1
Resistance to four classes of antimicrobial drugs		
Piperacillin(±tazobactam) + fluoroquinolones + aminoglycosides + carbapenems	139	1.7
Fluoroquinolones + ceftazidime + aminoglycosides + carbapenems	100	1.2
Piperacillin(±tazobactam) + fluoroquinolones + ceftazidime + aminoglycosides	96	1.1
Piperacillin(±tazobactam) + fluoroquinolones + ceftazidime + carbapenems	94	1.1
Piperacillin(±tazobactam) + ceftazidime + aminoglycosides + carbapenems	18	0.2
Resistance to five classes of antimicrobial drugs		
Piperacillin(±tazobactam) + fluoroquinolones + ceftazidime + aminoglycosides + carbapenems	429	5.1

5.7 References

- Prevention of pneumococcal disease: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep 1997;46:1-24.
- Arthur M, Molinas C, Depardieu F, Courvalin P. Characterization of Tn1546, a Tn3-related transposon conferring glycopeptide resistance by synthesis of depsipeptide peptidoglycan precursors in Enterococcus faecium BM4147. J Bacteriol 1993;175:117-27.
- Banerjee SN, Emori TG, Culver DH, Gaynes RP, Jarvis WR, Horan T et al. Secular trends in nosocomial primary bloodstream infections in the United States, 1980–1989. National Nosocomial Infections Surveillance System. Am J Med 1991;91:86S-9S.
- Benyacoub J, Czarnecki-Maulden GL, Cavadini C, Sauthier T, Anderson RE, Schiffrin EJ et al. Supplementation of food with Enterococcus faecium (SF68) stimulates immune functions in young dogs. J Nutr 2003;133:1158-62.
- Berger-Bachi B, Rohrer S. Factors influencing methicillin resistance in staphylococci. Arch Microbiol 2002;178:165-71.
- Chow JW. Aminoglycoside resistance in enterococci. Clin Infect Dis 2000;31:586-9.
- Cosgrove SE, Sakoulas G, Perencevich EN, Schwaber MJ, Karchmer AW, Carmeli Y. Comparison of mortality associated with methicillin-resistant and methicillin-susceptible Staphylococcus aureus bacteremia: a meta-analysis. Clin Infect Dis 2003;36:53-9.
- DiazGranados CA, Jernigan JA. Impact of vancomycin resistance on mortality among patients with neutropenia and enterococcal bloodstream infection. J Infect Dis 2005;191:588-95.
- Diekema DJ, Pfaller MA, Schmitz FJ, Smayevsky J, Bell J, Jones RN et al. Survey of infections due to Staphylococcus species: frequency of occurrence and antimicrobial susceptibility of isolates collected in the United States, Canada, Latin America, Europe, and the Western Pacific region for the SENTRY Antimicrobial Surveillance Program, 1997–1999. Clin Infect Dis 2001;32 Suppl 2:S114-32.
- Evans AS BP. Bacterial infections of humans, epidemiology and control. New York: Plenum Medical Book Company; 1991. p. 525-46.
- Fluit AC, Jones ME, Schmitz FJ, Acar J, Gupta R, Verhoef J. Antimicrobial susceptibility and frequency of occurrence of clinical blood isolates in Europe from the SENTRY antimicrobial surveillance program, 1997 and 1998. Clin Infect Dis 2000;30:454-60.
- Fontana R, Ligozzi M, Pittaluga F, Satta G. Intrinsic penicillin resistance in enterococci. Microb Drug Resist 1996;2:209-13.
- Franz CM, Holzapfel WH, Stiles ME. Enterococci at the crossroads of food safety? Int J Food Microbiol 1999;47:1-24.
- Garau J. Role of beta-lactam agents in the treatment of community-acquired pneumonia. Eur J Clin Microbiol Infect Dis 2005;24:83-99.
- Gold HS, Moellering RC Jr. Antimicrobial-drug resistance. N Engl J Med 1996;335:1445-53.
- Hausdorff WP, Bryant J, Kloek C, Paradiso PR, Siber GR. The contribution of specific pneumococcal serogroups to different disease manifestations: implications for conjugate vaccine formulation and use, part II. Clin Infect Dis 2000;30:122-40.
- Hausdorff WP, Bryant J, Paradiso PR, Siber GR. Which pneumococcal serogroups cause the most invasive disease: implications for conjugate vaccine formulation and use, part I. Clin Infect Dis 2000;30:100-21.
- Hausdorff WP, Siber G, Paradiso PR. Geographical differences in invasive pneumococcal disease rates and serotype frequency in young children. Lancet 2001;357:950-2.
- Hawkey PM. Mechanisms of quinolone action and microbial response. J Antimicrob Chemother 2003;51 Suppl 1:29-35.
- Herwaldt LA. Control of methicillin-resistant Staphylococcus aureus in the hospital setting. Am J Med 1999;106:11S-8S; discussion 48S-52S.
- Hiramatsu K, Cui L, Kuroda M, Ito T. The emergence and evolution of methicillin-resistant Staphylococcus aureus. Trends Microbiol 2001;9:486-93.
- Huycke MM, Sahm DF, Gilmore MS. Multiple-drug resistant enterococci: the nature of the problem and an agenda for the future. Emerg Infect Dis 1998;4:239-49.
- Jacobs MR. In vivo veritas: in vitro macrolide resistance in systemic Streptococcus pneumoniae infections does result in clinical failure. Clin Infect Dis 2002;35:565-9.
- Jacobs MR. Worldwide trends in antimicrobial resistance among common respiratory tract pathogens in children. Pediatr Infect Dis J 2003;22(8 Suppl):S109-19.
- Jett BD, Huycke MM, Gilmore MS. Virulence of enterococci. Clin Microbiol Rev 1994;7:462-78.
- Karchmer AW. Nosocomial bloodstream infections: organisms, risk factors, and implications. Clin Infect Dis 2000;31 Suppl 4:S139-43.
- Kumarasamy KK, et al. Emergence of a new antibiotic resistance mechanism in India, Pakistan, and the UK: a molecular, biological, and epidemiological study. Lancet Infect Dis 2010;10:597-602.
- Landry SL, Kaiser DL, Wenzel RP. Hospital stay and mortality attributed to nosocomial enterococcal bacteremia: a controlled study. Am J Infect Control 1989;17:323-9.
- Leclercq R, Courvalin P. Resistance to glycopeptides in enterococci. Clin Infect Dis 1997;24:545-54; quiz 555-6.
- Marchaim D, Navon-Venezia S, Schwaber MJ, and Carmeli Y. Isolation of imipenem-resistant Enterobacter species: Emergence of KPC-2 carbapenemase, molecular characterization, epidemiology, and outcomes. Antimicrob Agents Chemother 2008;52(4): 1413–18. Published online 2008 January 28. doi: 10.1128/AAC.01103-07.
- McCormick AW, Whitney CG, Farley MM, Lynfield R, Harrison LH, Bennett NM et al. Geographic diversity and temporal trends of antimicrobial resistance in Streptococcus pneumoniae in the United States. Nat Med 2003;9:424-30.
- McGowan JE. Resistance in nonfermenting gram-negative bacteria: multidrug resistance to the maximum. Am J Infect Control 2006;34(5 Suppl 1).
- Mitra AK, Rabbani GH. A double-blind, controlled trial of bioflorin (Streptococcus faecium SF68) in adults with acute diarrhea due to Vibrio cholerae and enterotoxigenic Escherichia coli. Gastroenterology 1990;99:1149-52.
- Mundy LM, Sahm DF, Gilmore M. Relationships between enterococcal virulence and antimicrobial resistance. Clin Microbiol Rev 2000;13:513-22.
- Murray BE. Beta-lactamase-producing enterococci. Antimicrob Agents Chemother 1992;36:2355-9.
- Paterson DL. Resistance in gram-negative bacteria: Enterobacteriaceae. Am J Infect Control 2006;34(5 Suppl 1).
- Paterson DL, Ko WC, Von Gottberg A, Mohapatra S, Casellas JM, Goossens H et al. International prospective study of Klebsiella pneumoniae bacteremia: implications of extended-spectrum beta-lactamase production in nosocomial Infections. Ann Intern Med 2004;140:26-32.
- Perichon B, Reynolds P, Courvalin P. VanD-type glycopeptide-resistant Enterococcus faecium BM4339. Antimicrob Agents Chemother 1997;41:2016-8.
- Peterson LR. Squeezing the antibiotic balloon: the impact of antimicrobial classes on emerging resistance. Clin Microbiol Infect 2005;11 Suppl 5.
- Reacher MH, Shah A, Livermore DM, Wale MC, Graham C, Johnson AP, et al. Bacteraemia and antibiotic resistance of its pathogens reported in England and Wales between 1990 and 1998: trend analysis. BMJ 2000;320:213-6.
- Rodriguez-Martinez JM, Poirel L, Pascual A, Nordmann P. Plasmid-mediated quinolone resistance in Australia. Microb Drug Resist 2006;12:99-102.
- Strahilevitz J, Jacoby GA, Hooper DC, Robicsek A. Plasmid-mediated quinolone resistance: a multifaceted threat. Clin Microbiol Rev. 2009;22:664-89.
- Schmitt HJ. Pneumococcal conjugate vaccines in Europe, Berlin, Germany, 23-25 August 2000. Report of a European advisory board meeting. Vaccine 2001;19:3347-54.
- Shepard BD, Gilmore MS. Antibiotic-resistant enterococci: the mechanisms and dynamics of drug introduction and resistance. Microbes Infect 2002;4:215-24.
- Sturenburg E, Mack D. Extended-spectrum beta-lactamases: implications for the clinical microbiology laboratory, therapy, and infection control. J Infect 2003;47:273-95.
- Vatopoulos A. High rates of metallo-beta-lactamase-producing Klebsiella pneumoniae in Greece – a review of the current evidence. Euro Surveill 2008; 13(4) pii 8023.
- Watson DA, Musher DM. A brief history of the pneumococcus in biomedical research. Semin Respir Infect 1999;14:198-208.
- Weisblum B. Insights into erythromycin action from studies of its activity as inducer of resistance. Antimicrob Agents Chemother 1995;39:797-805.
- Willems RJ, Top J, van Santen M, Robinson DA, Coque TM, Baquero F et al. Global spread of vancomycin-resistant Enterococcus faecium from distinct nosocomial genetic complex. Emerg Infect Dis 2005;11:821-8.
- Wuorimaa T, Kayhty H. Current state of pneumococcal vaccines. Scand J Immunol 2002;56:111-29.
- Zhong P, Cao Z, Hammond R, Chen Y, Beyer J, Shortridge VD et al. Induction of ribosome methylation in MLS-resistant Streptococcus pneumoniae by macrolides and ketolides. Microb Drug Resist 1999;5:183-8.

Annex 1: Technical notes

Technical notes for chapter 4

Number of blood culture sets

The total number of blood culture sets was defined as the number of blood samples, not the number of patients sampled.

Patient days

If patient days were not available at hospital level, these were calculated by:

Number of beds * (annual occupancy / 100) * 365

Type of hospitals

Since hospital categorisation was always intricate, more specific definitions from WHO have been implemented to make the categorisation of hospitals easier.

Primary level, often referred to as a district hospital or first-level referral: A hospital with few specialities, mainly internal medicine, obstetrics-gynecology, paediatrics, and general surgery, or only general practice; limited laboratory services are available for general, but not for specialised pathological analysis; the bed capacity ranges from 30 to 200 beds.

Secondary level, often referred to as provincial hospital: A hospital highly differentiated by function with five to 10 clinical specialities; bed capacity ranging from 200 to 800 beds.

Tertiary level, often referred to as central, regional or tertiary-level hospital: A hospital with highly specialised staff and technical equipment, e.g., cardiology, ICU and specialised imaging units; clinical services are highly differentiated by function; the hospital may have teaching activities; bed capacity ranges from 300 to 1500 beds. A fourth category was for hospitals with a single specialty.

Averaged variables

Annual occupancy rate and length of stay were averaged per country. In these totals only laboratory/hospital questionnaires that provided information on all variables needed for the specific formula were included.

Technical notes for chapter 5

Resistance trend analysis

Resistance trends were calculated for the last four years. To determine significant trends over time, the Cochrane-Armitage test was used, excluding countries reporting less than 20 isolates per year. To exclude possible biases in the trend analyses, a sensitivity analysis was done, per country, to determine the sensitivity of the trend analysis for using the complete dataset, versus a subset from laboratories reporting all four years. In the graphs, trends were indicated in the following way:

- using '‹*' if decreasing or '›*' if increasing when significant trends were only identified in the complete dataset; and
- using '‹' if decreasing or '›' if increasing when a significant trend was detected in both the subset and the complete dataset.

European maps showing resistance levels

To be included in the maps of Europe displaying the resistance proportions per country, for all drug-bug combinations under surveillance by EARS-Net, a country had to report results for at least 10 isolates.

Annex 2: Country summary sheets

Explanation to the country summary sheets

General information about EARS-Net participating laboratories and hospitals

Table 1 gives the number of laboratories and isolates reported by year and by pathogen under EARS-Net surveillance for the period 2002–2009.

Antibiotic resistance 2002–2009

Table 2 provides information on the proportion of invasive bacterial isolates non-susceptible (I+R) or resistant (R) to the antibiotics or antibiotic classes mentioned in the EARSS protocols. When interpreting the results in Table 2, always check the number of isolates provided in Table 1.

Demographic characteristics

Table 3 gives the proportional distribution of the isolates reported by source, gender, age, and hospital department, and the proportion of resistance within the different groups, for the period 2008–2009.

The abbreviations used in this table stand for:

PNSP = penicillin-non-susceptible *S. pneumoniae*;

MRSA = meticillin-resistant *S. aureus*;

FREC = fluoroquinolone-resistant *E. coli*;

VRE = vancomycin-resistant *E. faecalis* or *E. faecium*;

CRKP = third-generation cephalosporin resistant *K. pneumoniae*; and

CRPA = carbapenem-resistant *P. aeruginosa*.

If the number of isolates in a certain category accounts for less than 0.5% of the total number of isolates, the % total is set at 0 and the % resistance is not shown.

PNSP at laboratory level/MRSA, FREC and CRKP at hospital level

Figures 1, 2, 3 and 4 show the local variation in the proportions of PNSP by laboratory and of MRSA, FREC and CRKP by hospital. These figures are based on data from 2008 and 2009, only including the laboratories and hospitals that reported at least five isolates in these two years. The total number of laboratories or hospitals, the minimum, maximum, median, first and third quartile of the proportion of resistance is displayed in a box in the figures.

Austria

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	10	80	11	456	10	479	10	181	-	-	-	-
2003	20	163	20	871	21	985	19	327	-	-	-	-
2004	28	257	30	1453	31	1862	28	604	-	-	-	-
2005	31	298	32	1481	33	2058	30	568	7	89	8	77
2006	32	293	33	1640	33	2483	33	699	30	434	31	405
2007	35	322	34	1577	34	2545	33	688	33	445	33	411
2008	38	380	38	1899	38	2985	38	864	38	583	38	510
2009	38	379	38	1794	38	2625	36	825	37	622	36	525

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	<1	1	1	<1	<1	2	<1	3
Penicillin RI	1	9	5	5	5	5	5	5
Macrolides RI	10	13	13	15	13	13	12	14
Staphylococcus aureus								
Oxacillin/Meticillin R	12	15	14	14	9	11	8	6
Escherichia coli								
Aminopenicilins R	33	41	46	49	53	53	50	49
Aminoglycosides R	4	5	6	6	8	8	7	6
Fluoroquinolones R	10	14	17	19	22	26	23	20
Third-gen. cephalosporins R	1	2	3	4	7	9	7	8
Enterococcus faecalis								
Aminopenicilins RI	3	1	<1	1	2	2	2	1
HL Gentamicin R	29	33	23	29	29	30	21	31
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	84	85	85	85	89	82	91	88
HL Gentamicin R	21	22	22	30	21	28	19	31
Vancomycin R	7	<1	<1	1	<1	2	2	4
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	3	5	5	6	4
Fluoroquinolones R	-	-	-	11	8	13	12	8
Third-gen. cephalosporins R	-	-	-	6	6	8	8	8
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	13	8	6	8	6
Ceftazidime R	-	-	-	7	9	5	6	6
Carbapenems R	-	-	-	10	15	12	11	9
Aminoglycosides R	-	-	-	6	9	9	8	8
Fluoroquinolones R	-	-	-	14	15	15	12	13

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=719		*S. aureus* n=3633		*E. coli* n=5591		*E. faecalis* n=1020		*E. faecium* n=644		*K. pneumoniae* n=1194		*P. aeruginosa* n=1020	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	97	4	100	7	100	22	100	0	100	3	100	8	100	10
CSF	3	15	-	-	<1	25	-	-	-	-	0	0	<1	0
Gender														
Male	57	6	58	8	41	25	62	1	58	4	56	10	58	11
Female	42	3	41	6	58	19	37	0	41	2	44	5	40	9
Unknown	1	0	1	16	1	13	1	0	1	0	1	17	1	7
Age (years)														
0–4	8	7	2	5	2	6	4	0	1	0	2	8	1	7
5–19	4	4	2	3	1	19	1	0	1	0	<1	0	1	5
20–64	41	5	37	10	28	21	36	0	42	2	34	10	35	16
65 and over	47	4	58	12	70	21	59	0	56	2	63	6	63	9
Unknown	<1	0	<1	25	<1	29	0	0	<1	0	-	-	-	-
Hospital department														
ICU	15	7	12	18	7	24	18	1	27	2	12	12	17	18
Internal med.	50	4	48	9	54	19	39	0	33	2	41	6	33	9
Surgery	2	7	11	17	8	18	13	0	13	1	12	7	10	6
Other	30	5	28	8	28	24	28	0	24	2	31	8	37	12
Unknown	2	2	2	7	2	21	3	0	3	5	3	0	3	3

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Austria

Figure 1: **Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)**

N laboratories	36
Minimum	0
First quartile	0
Median	0
Third quartile	5.8
Maximum	25

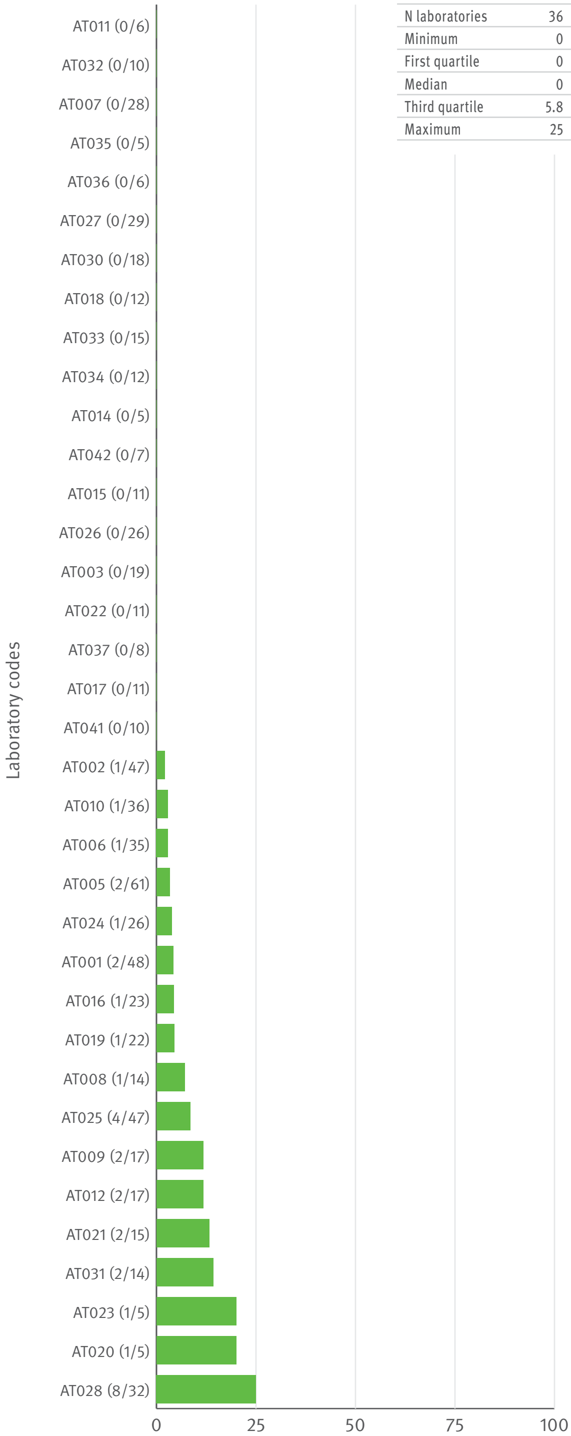


Figure 2: **Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)**

N hospitals	96
Minimum	0
First quartile	0
Median	3.9
Third quartile	9.2
Maximum	31.6

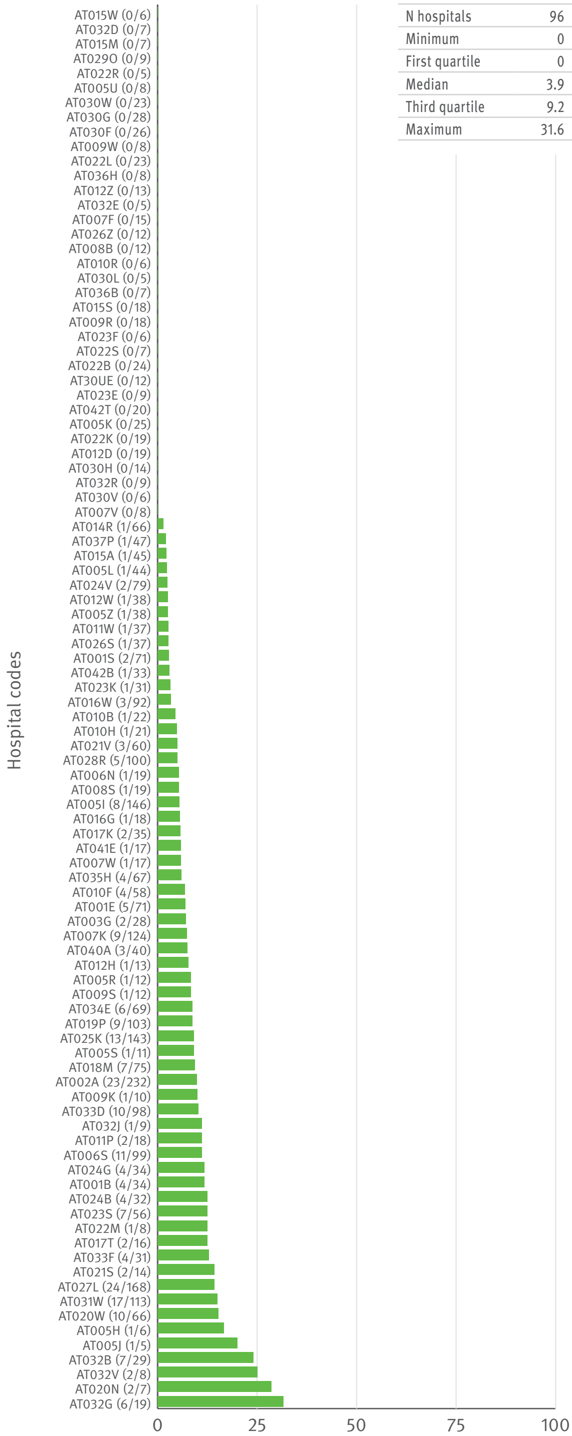
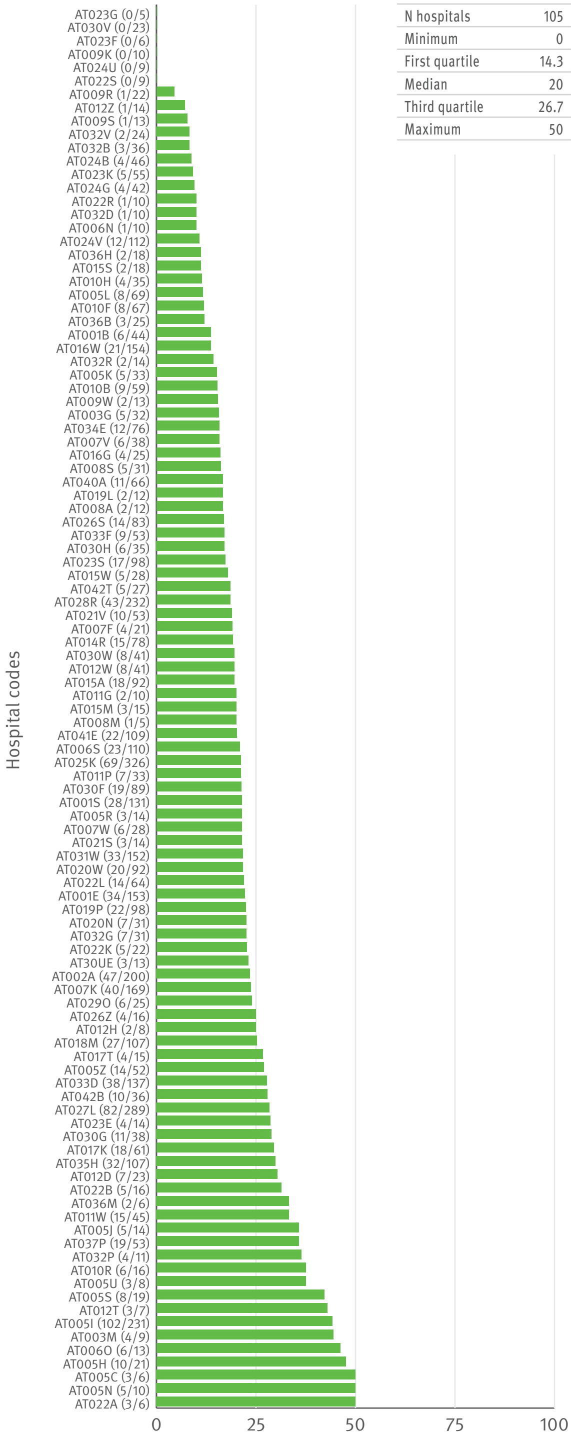
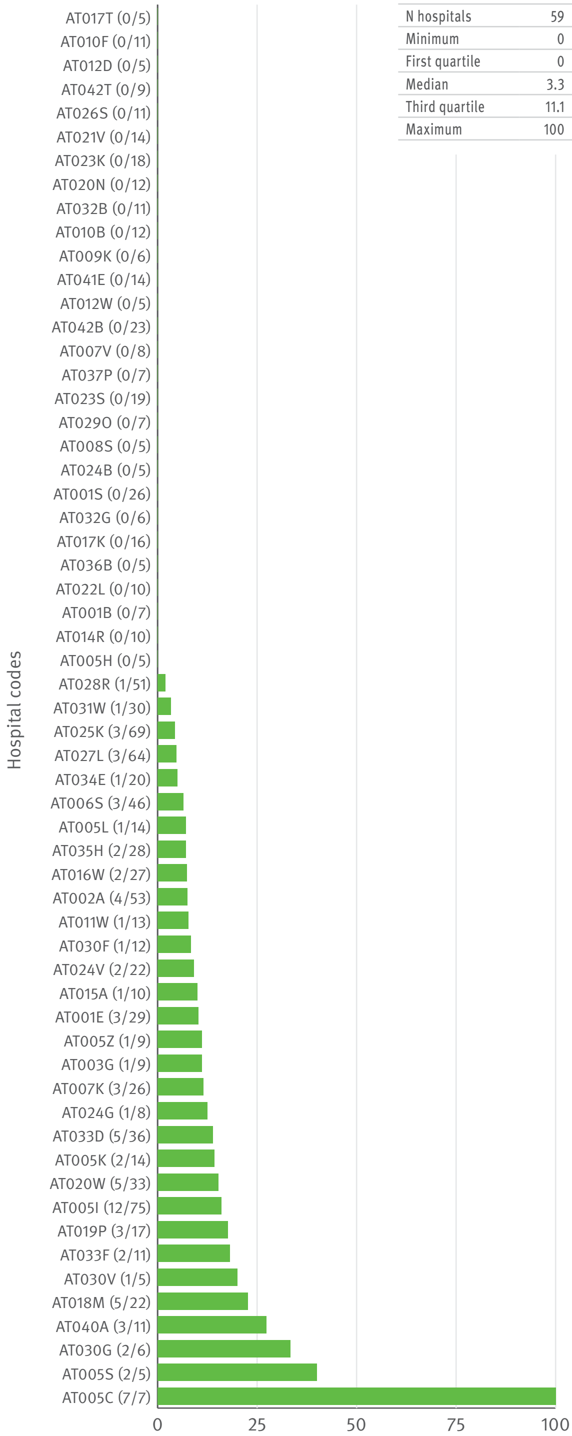


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)



N hospitals	105
Minimum	0
First quartile	14.3
Median	20
Third quartile	26.7
Maximum	50

Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



N hospitals	59
Minimum	0
First quartile	0
Median	3.3
Third quartile	11.1
Maximum	100

Belgium

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	98	1210	48	1092	27	1184	23	205	-	-	-	-
2003	107	1488	47	1133	24	1326	16	146	-	-	-	-
2004	95	1443	49	1227	25	1601	18	228	-	-	-	-
2005	97	1539	41	1048	25	1592	19	223	-	-	-	-
2006	98	1427	33	858	21	1632	22	267	-	-	-	-
2007	105	1511	34	855	17	1460	20	245	-	-	-	-
2008	101	1647	38	906	16	1430	19	236	-	-	-	-
2009	101	1885	34	949	18	1610	14	227	8	142	8	136

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	3	4	3	<1	<1
Penicillin RI	14	12	9	12	10	9	8	<1
Macrolides RI	34	34	33	31	31	25	24	23
Staphylococcus aureus								
Oxacillin/Meticillin R	28	30	33	31	22	23	21	21
Escherichia coli								
Aminopenicilins R	47	50	50	53	54	57	55	56
Aminoglycosides R	6	5	5	4	6	5	4	7
Fluoroquinolones R	13	12	15	17	19	19	17	20
Third-gen. cephalosporins R	3	3	3	4	3	4	4	6
Enterococcus faecalis								
Aminopenicilins RI	<1	1	2	<1	<1	<1	3	1
HL Gentamicin R	20	17	22	26	30	26	30	23
Vancomycin R	<1	1	<1	<1	<1	1	<1	1
Enterococcus faecium								
Aminopenicilins RI	56	78	63	61	67	68	76	90
HL Gentamicin R	5	<1	11	22	19	23	17	32
Vancomycin R	<1	<1	5	14	4	<1	5	4
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	-	-	-	-	10
Fluoroquinolones R	-	-	-	-	-	-	-	13
Third-gen. cephalosporins R	-	-	-	-	-	-	-	15
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	-	-	-	-	7
Ceftazidime R	-	-	-	-	-	-	-	6
Carbapenems R	-	-	-	-	-	-	-	9
Aminoglycosides R	-	-	-	-	-	-	-	10
Fluoroquinolones R	-	-	-	-	-	-	-	16

Demographic characteristics

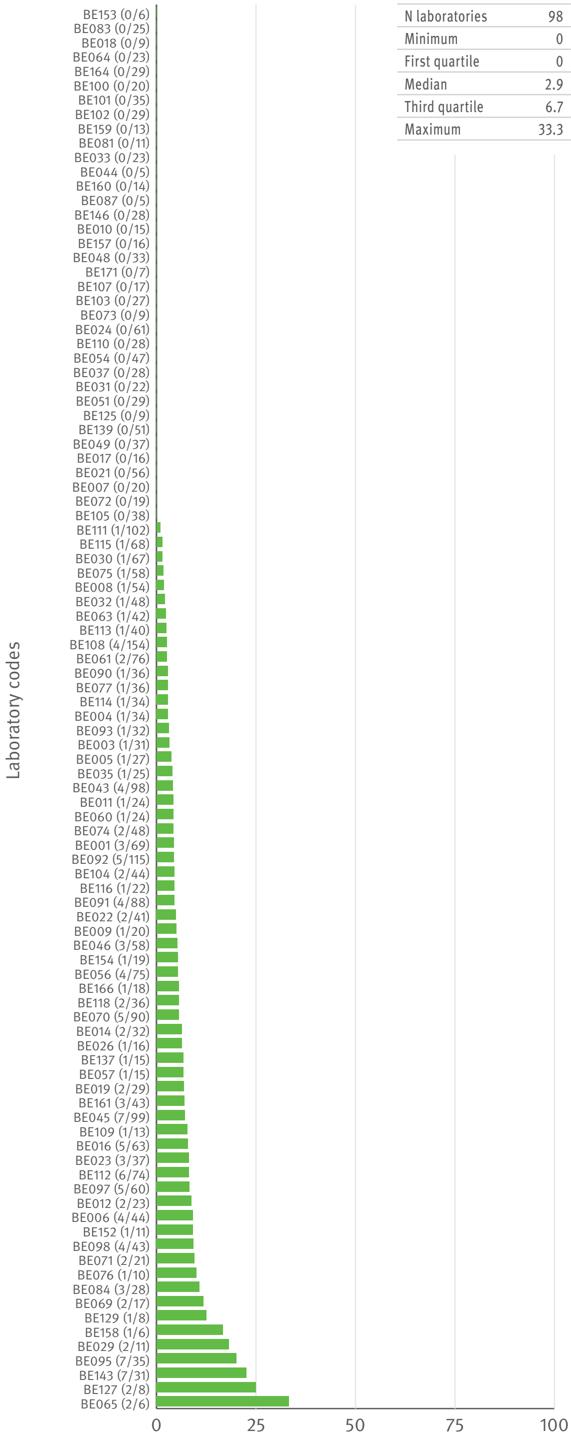
Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=3532		*S. aureus* n=1855		*E. coli* n=2828		*E. faecalis* n=335		*E. faecium* n=126		*K. pneumoniae* n=142		*P. aeruginosa* n=134	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	96	4	100	21	100	19	100	1	100	5	99	15	100	9
CSF	4	7	-	-	‹1	0	-	-	-	-	1	0	-	-
Gender														
Male	53	4	61	22	46	20	63	1	55	7	58	16	66	6
Female	46	5	38	19	53	17	34	0	41	2	41	14	34	15
Unknown	1	0	1	13	1	6	2	0	4	0	1	0	-	-
Age (years)														
0–4	19	11	4	8	2	5	4	0	3	0	6	22	3	0
5–19	5	3	2	9	1	13	1	0	-	-	-	-	1	0
20–64	34	6	34	21	29	16	29	0	37	2	31	18	25	12
65 and over	41	11	58	32	68	18	66	1	59	6	63	12	72	8
Unknown	-	-	1	20	‹1	50	0	0	1	0	-	-	-	-
Hospital department														
ICU	14	9	15	34	3	17	23	0	22	4	-	-	-	-
Internal med.	34	9	34	24	10	16	34	1	31	3	-	-	-	-
Surgery	2	10	10	30	2	18	9	0	6	0	-	-	-	-
Other	30	9	26	26	14	15	24	0	26	5	-	-	-	-
Unknown	21	8	16	23	71	17	11	1	15	10	100	15	100	9

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

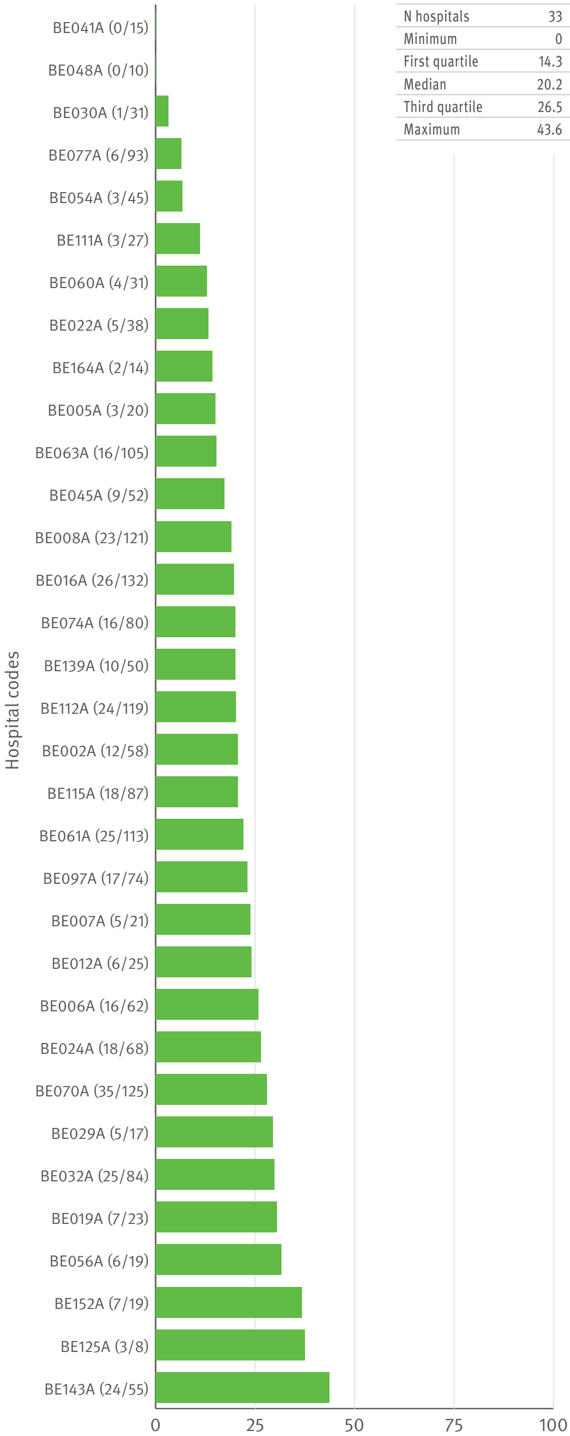
Belgium

Figure 1: **Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)**



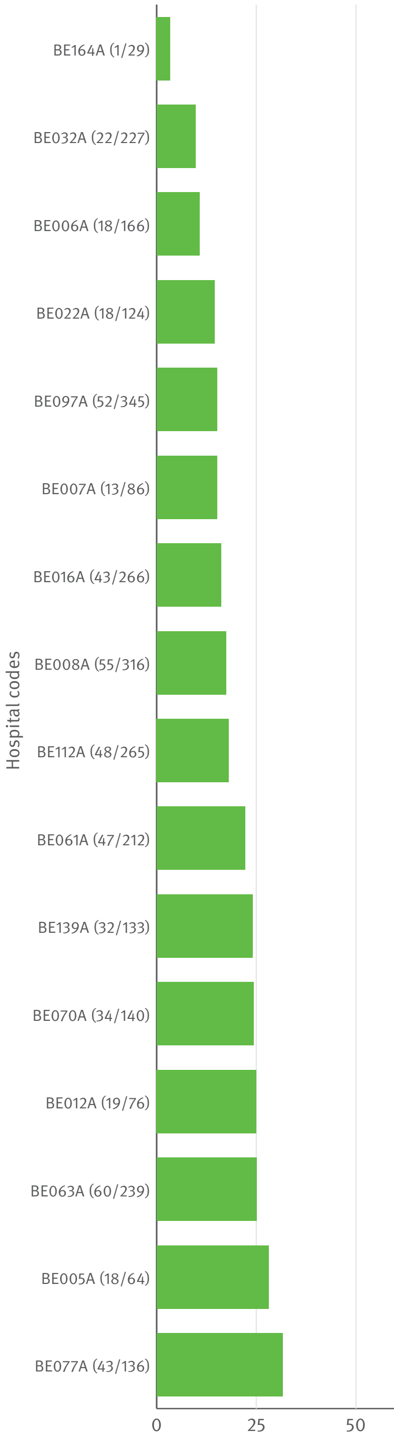
N laboratories	98
Minimum	0
First quartile	0
Median	2.9
Third quartile	6.7
Maximum	33.3

Figure 2: **Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)**



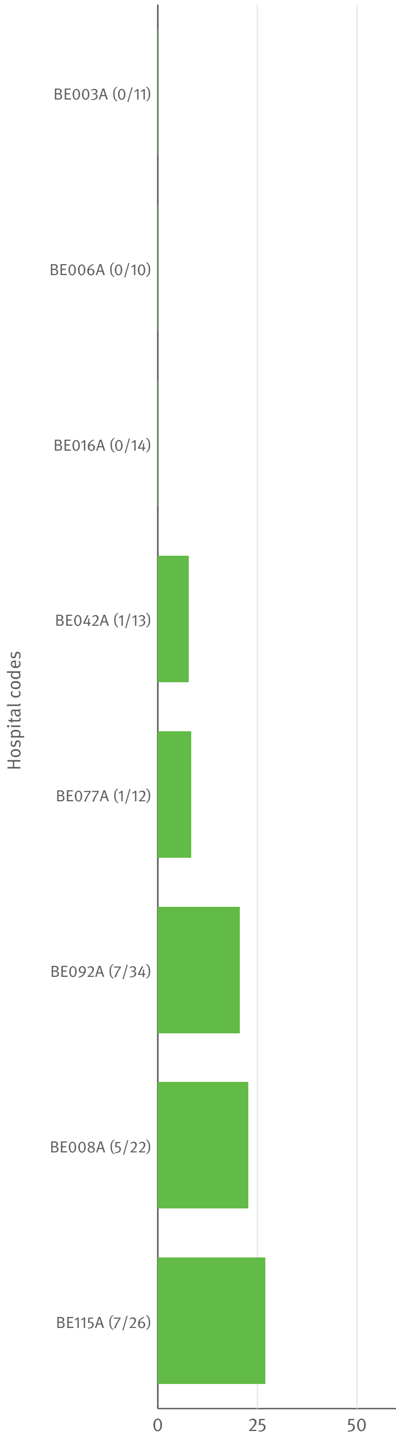
N hospitals	33
Minimum	0
First quartile	14.3
Median	20.2
Third quartile	26.5
Maximum	43.6

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)



N hospitals	16
Minimum	3.4
First quartile	14.8
Median	17.8
Third quartile	24.6
Maximum	31.6

Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



N hospitals	8
Minimum	0
First quartile	0
Median	8
Third quartile	21.7
Maximum	26.9

Bulgaria

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	11	25	21	116	20	135	16	42	-	-	-	-
2003	13	22	20	157	20	158	16	49	-	-	-	-
2004	13	32	22	170	20	167	16	75	-	-	-	-
2005	16	43	26	160	23	203	21	95	15	34	9	34
2006	11	29	23	159	20	196	19	98	15	55	13	31
2007	10	32	14	121	15	127	13	65	9	29	6	14
2008	13	29	21	160	22	147	18	70	11	49	10	23
2009	10	27	20	221	17	194	16	92	12	95	11	36

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	8	9	22	30	7	9	21	22
Penicillin RI	8	14	22	33	7	16	21	37
Macrolides RI	9	11	17	8	15	17	4	27
Staphylococcus aureus								
Oxacillin/Meticillin R	33	31	23	29	28	13	25	16
Escherichia coli								
Aminopenicilins R	52	54	64	69	64	70	65	66
Aminoglycosides R	17	22	20	24	28	20	31	18
Fluoroquinolones R	14	19	24	29	26	35	32	28
Third-gen. cephalosporins R	13	18	22	28	29	23	29	19
Enterococcus faecalis								
Aminopenicilins RI	26	7	15	8	31	13	8	16
HL Gentamicin R	63	36	33	24	53	29	44	36
Vancomycin R	<1	<1	2	<1	2	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	71	60	59	96	97	100	93	96
HL Gentamicin R	83	60	62	56	79	75	84	65
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	53	60	59	59	65
Fluoroquinolones R	-	-	-	26	24	41	52	48
Third-gen. cephalosporins R	-	-	-	50	60	55	73	69
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	50	33	14	48	33
Ceftazidime R	-	-	-	45	13	21	55	23
Carbapenems R	-	-	-	38	14	7	17	24
Aminoglycosides R	-	-	-	53	42	29	48	33
Fluoroquinolones R	-	-	-	47	17	14	36	33

Demographic characteristics

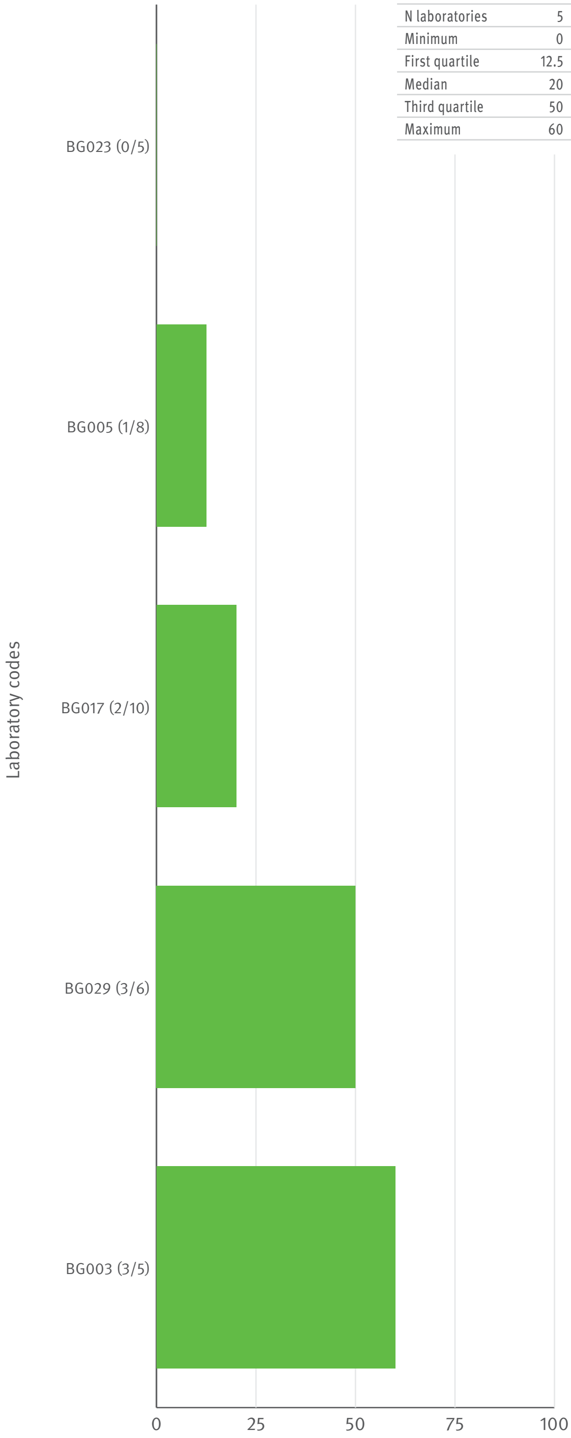
Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=56		*S. aureus* n=381		*E. coli* n=339		*E. faecalis* n=101		*E. faecium* n=54		*K. pneumoniae* n=144		*P. aeruginosa* n=57	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	63	34	100	20	99	30	100	0	100	0	100	71	100	21
CSF	38	19	-	-	1	0	-	-	-	-	-	-	-	-
Gender														
Male	63	26	61	21	48	36	67	0	48	0	65	71	74	17
Female	38	33	39	18	52	23	33	0	52	0	35	71	26	33
Unknown	-	-	0	100	-	-	-	-	-	-	-	-	-	-
Age (years)														
0–4	13	41	10	34	7	12	11	0	16	0	13	67	8	18
5–19	9	10	5	14	4	20	1	0	1	0	4	82	2	0
20–64	58	14	57	24	48	27	50	1	49	0	47	68	60	18
65 and over	18	30	28	23	41	26	37	0	31	0	36	56	30	33
Unknown	1	33	<1	20	1	50	<1	0	4	0	-	-	-	-
Hospital department														
ICU	15	16	15	40	11	31	20	0	35	0	20	73	32	31
Internal med.	31	20	35	15	47	20	34	1	18	0	24	47	16	5
Surgery	2	0	12	38	12	35	11	0	13	0	19	70	16	19
Other	51	23	38	23	29	29	35	0	35	0	37	67	36	23
Unknown	-	-	-	-	<1	50	-	-	-	-	-	-	-	-

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

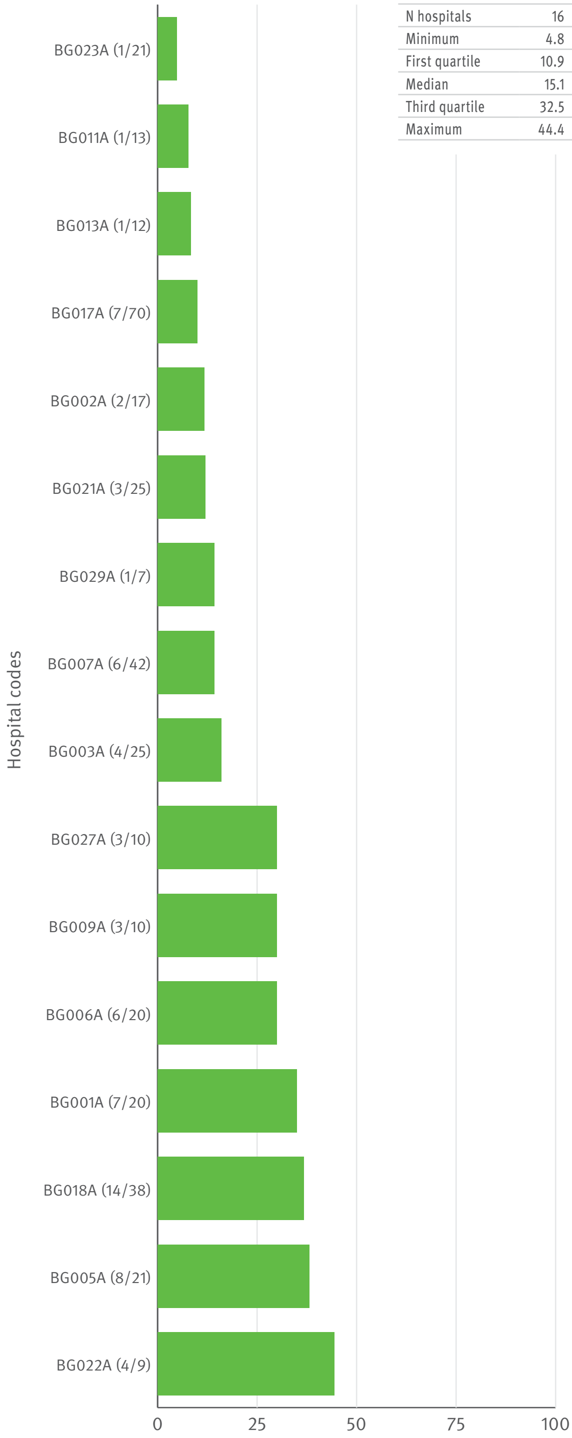
Bulgaria

Figure 1: **Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)**



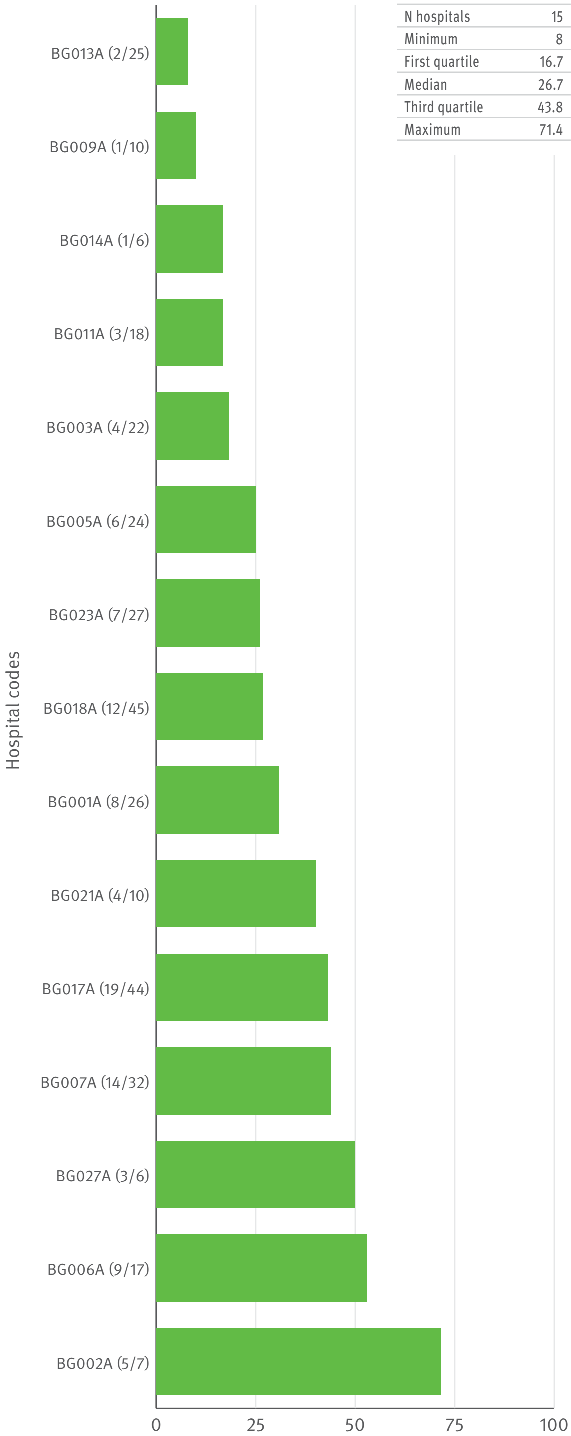
N laboratories	5
Minimum	0
First quartile	12.5
Median	20
Third quartile	50
Maximum	60

Figure 2: **Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)**



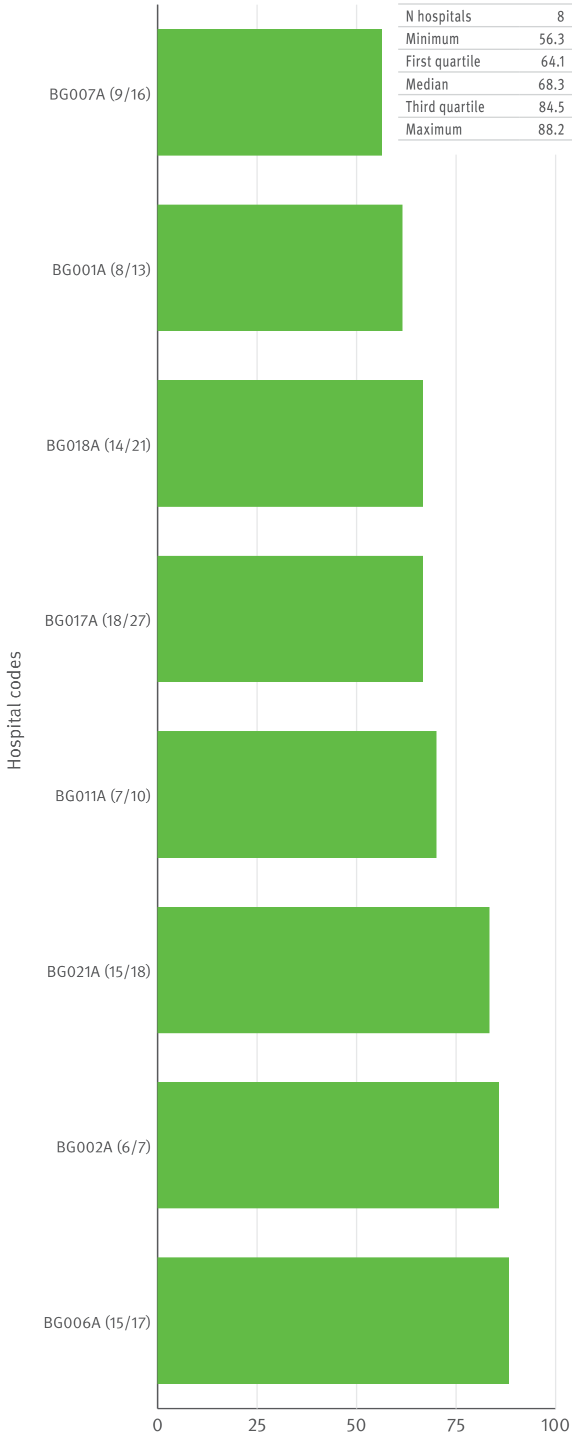
N hospitals	16
Minimum	4.8
First quartile	10.9
Median	15.1
Third quartile	32.5
Maximum	44.4

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)



N hospitals	15
Minimum	8
First quartile	16.7
Median	26.7
Third quartile	43.8
Maximum	71.4

Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



N hospitals	8
Minimum	56.3
First quartile	64.1
Median	68.3
Third quartile	84.5
Maximum	88.2

Cyprus

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2003	1	3	1	28	1	19	1	28	-	-	-	-
2004	1	7	3	39	4	46	3	38	-	-	-	-
2005	4	16	5	54	5	75	3	40	4	9	4	8
2006	5	13	5	62	5	90	4	48	4	26	4	37
2007	4	15	4	85	5	109	3	63	4	39	3	52
2008	4	14	5	92	4	119	5	85	5	62	5	43
2009	4	11	5	89	5	136	5	80	5	53	5	62

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	-	<1	<1	<1	31	7	21	18
Penicillin RI	-	<1	14	19	38	33	43	36
Macrolides RI	-	33	<1	13	31	27	29	36
Staphylococcus aureus								
Oxacillin/Meticillin R	-	64	49	56	34	48	46	33
Escherichia coli								
Aminopenicilins R	-	63	61	72	62	72	58	66
Aminoglycosides R	-	11	11	13	10	11	10	10
Fluoroquinolones R	-	32	22	29	35	39	45	43
Third-gen. cephalosporins R	-	11	9	16	16	18	19	14
Enterococcus faecalis								
Aminopenicilins RI	-	<1	3	3	5	2	16	32
HL Gentamicin R	-	43	77	71	44	61	65	66
Vancomycin R	-	<1	3	<1	<1	<1	1	<1
Enterococcus faecium								
Aminopenicilins RI	-	100	100	80	43	92	60	80
HL Gentamicin R	-	-	33	<1	14	33	10	13
Vancomycin R	-	<1	33	40	14	25	20	13
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	11	12	13	21	19
Fluoroquinolones R	-	-	-	22	12	23	23	43
Third-gen. cephalosporins R	-	-	-	33	27	31	35	42
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	13	27	31	23	18
Ceftazidime R	-	-	-	38	24	15	9	18
Carbapenems R	-	-	-	13	11	19	19	8
Aminoglycosides R	-	-	-	13	11	25	21	5
Fluoroquinolones R	-	-	-	13	27	23	38	13

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=25		*S. aureus* n=181		*E. coli* n=255		*E. faecalis* n=140		*E. faecium* n=25		*K. pneumoniae* n=115		*P. aeruginosa* n=104	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	96	42	100	39	100	44	100	1	100	16	100	38	100	13
CSF	4	0	-	-	-	-	-	-	-	-	-	-	-	-
Gender														
Male	64	38	67	40	55	45	68	0	64	19	57	34	59	16
Female	36	44	32	36	45	43	31	2	36	11	37	40	34	9
Unknown	-	-	1	50	<1	100	1	0	-	-	6	71	8	0
Age (years)														
0–4	10	13	2	10	3	0	1	0	4	0	4	57	5	0
5–19	6	20	2	27	2	44	0	0	2	0	2	0	1	0
20–64	15	33	18	36	13	39	17	0	11	33	23	45	24	10
65 and over	9	57	21	53	27	50	28	1	39	9	28	33	25	12
Unknown	59	30	56	46	57	34	54	1	45	28	43	30	46	19
Hospital department														
ICU	6	40	19	42	9	35	30	0	38	19	31	49	41	18
Internal med.	65	31	35	46	54	38	29	0	25	14	27	20	20	10
Surgery	-	-	13	58	6	42	19	0	21	25	11	35	14	26
Other	29	26	33	38	30	37	22	3	16	22	31	34	26	4
Unknown	-	-	<1	100	1	50	-	-	-	-	-	-	1	0

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Cyprus

Figure 1: **Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)**

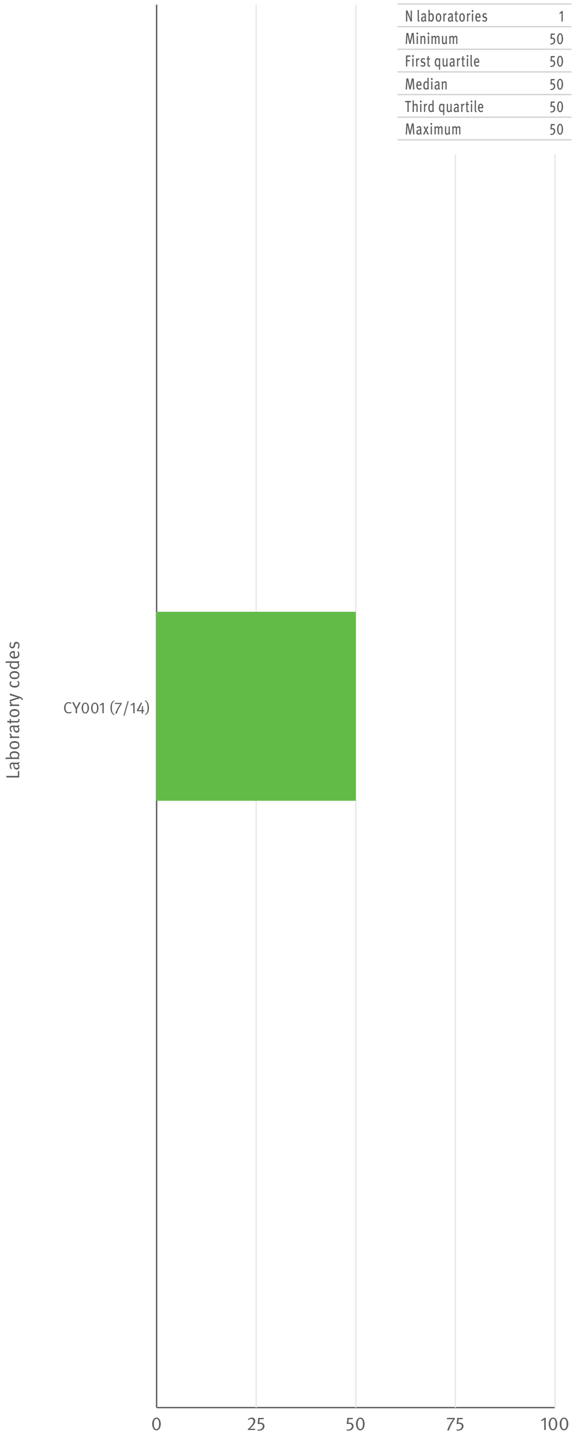


Figure 2: **Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)**

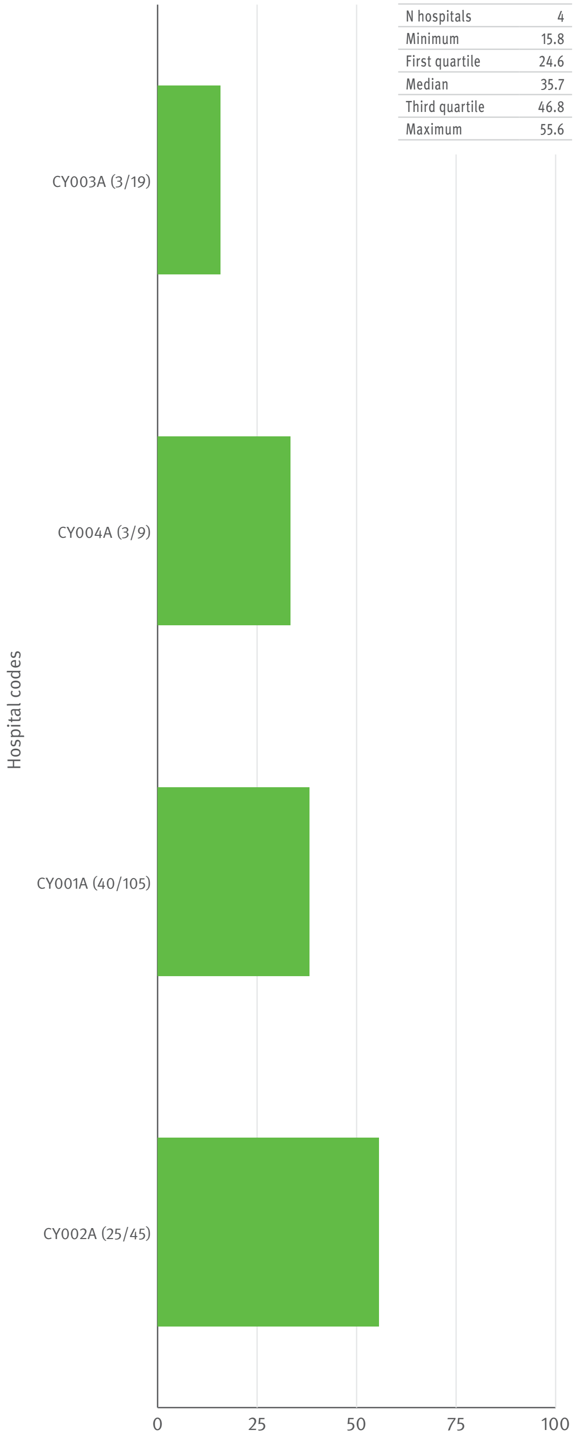
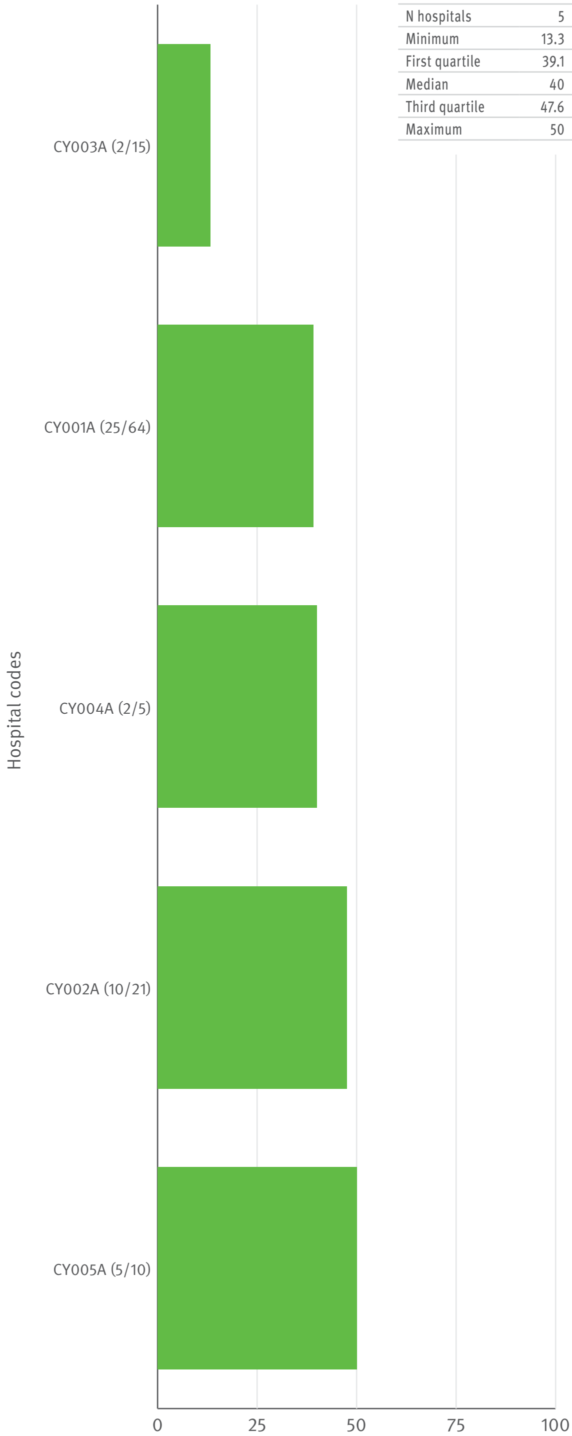


Figure 3: **Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)**

N hospitals	5
Minimum	33.3
First quartile	38.9
Median	40.5
Third quartile	48.6
Maximum	51.5

Figure 4: **Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)**



N hospitals	5
Minimum	13.3
First quartile	39.1
Median	40
Third quartile	47.6
Maximum	50

Czech Republic

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	34	144	41	1168	40	1587	39	587	-	-	-	-
2003	32	204	45	1387	43	1766	44	630	-	-	-	-
2004	37	162	45	1444	44	1966	41	660	-	-	-	-
2005	39	195	47	1553	47	2234	45	758	37	478	36	257
2006	39	172	47	1527	47	2176	45	697	45	1130	43	490
2007	41	205	47	1653	48	2407	47	816	48	1230	41	517
2008	40	244	47	1715	46	2738	44	883	45	1493	42	568
2009	41	297	46	1695	45	2759	44	835	45	1415	45	575

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	<1	<1	2	<1	<1	<1	<1	<1
Penicillin RI	8	2	6	4	2	4	3	4
Macrolides RI	4	2	4	2	3	5	3	5
Staphylococcus aureus								
Oxacillin/Meticillin R	6	6	9	13	12	13	14	15
Escherichia coli								
Aminopenicilins R	45	45	47	50	56	56	60	61
Aminoglycosides R	6	5	5	6	8	7	9	9
Fluoroquinolones R	10	13	16	20	23	24	26	23
Third-gen. cephalosporins R	1	1	2	2	5	7	10	10
Enterococcus faecalis								
Aminopenicilins RI	2	4	<1	<1	2	3	2	<1
HL Gentamicin R	39	44	43	45	43	49	49	47
Vancomycin R	<1	<1	<1	<1	<1	1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	73	80	81	92	90	91	94	98
HL Gentamicin R	35	48	43	69	74	79	75	65
Vancomycin R	9	3	3	14	4	6	8	6
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	36	38	43	42	47
Fluoroquinolones R	-	-	-	38	47	48	52	54
Third-gen. cephalosporins R	-	-	-	32	35	46	48	52
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	21	29	30	27	28
Ceftazidime R	-	-	-	40	30	33	44	29
Carbapenems R	-	-	-	31	33	36	29	29
Aminoglycosides R	-	-	-	28	30	34	45	32
Fluoroquinolones R	-	-	-	45	47	43	46	41

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=540		*S. aureus* n=3410		*E. coli* n=5494		*E. faecalis* n=1275		*E. faecium* n=443		*K. pneumoniae* n=2908		*P. aeruginosa* n=1139	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	85	3	100	14	100	25	100	0	100	7	100	50	99	29
CSF	15	6	-	-	<1	6	-	-	-	-	<1	27	1	50
Gender														
Male	56	3	61	14	43	28	64	0	59	8	60	53	63	30
Female	44	6	39	15	57	22	36	0	41	5	40	45	37	27
Unknown	-	-	-	-	0	100	-	-	-	-	-	-	-	-
Age (years)														
0–4	11	7	4	3	3	6	4	1	1	0	3	26	3	13
5–19	6	3	3	3	1	12	1	0	1	0	1	32	2	26
20–64	51	4	44	11	33	19	45	1	50	10	42	49	44	37
65 and over	32	4	49	13	63	22	50	0	47	4	54	43	51	28
Unknown	<1	0	<1	0	<1	0	-	-	-	-	<1	20	<1	0
Hospital department														
ICU	23	4	22	16	17	23	41	0	43	3	38	52	41	38
Internal med.	38	4	47	10	51	20	30	0	23	5	34	37	28	26
Surgery	2	7	11	13	8	20	10	1	6	1	10	46	7	27
Other	35	5	20	8	24	21	20	0	28	16	17	43	23	28
Unknown	2	6	1	16	<1	22	<1	0	<1	100	<1	48	1	31

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Czech Republic

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)

N laboratories	31
Minimum	0
First quartile	0
Median	0
Third quartile	11.1
Maximum	40

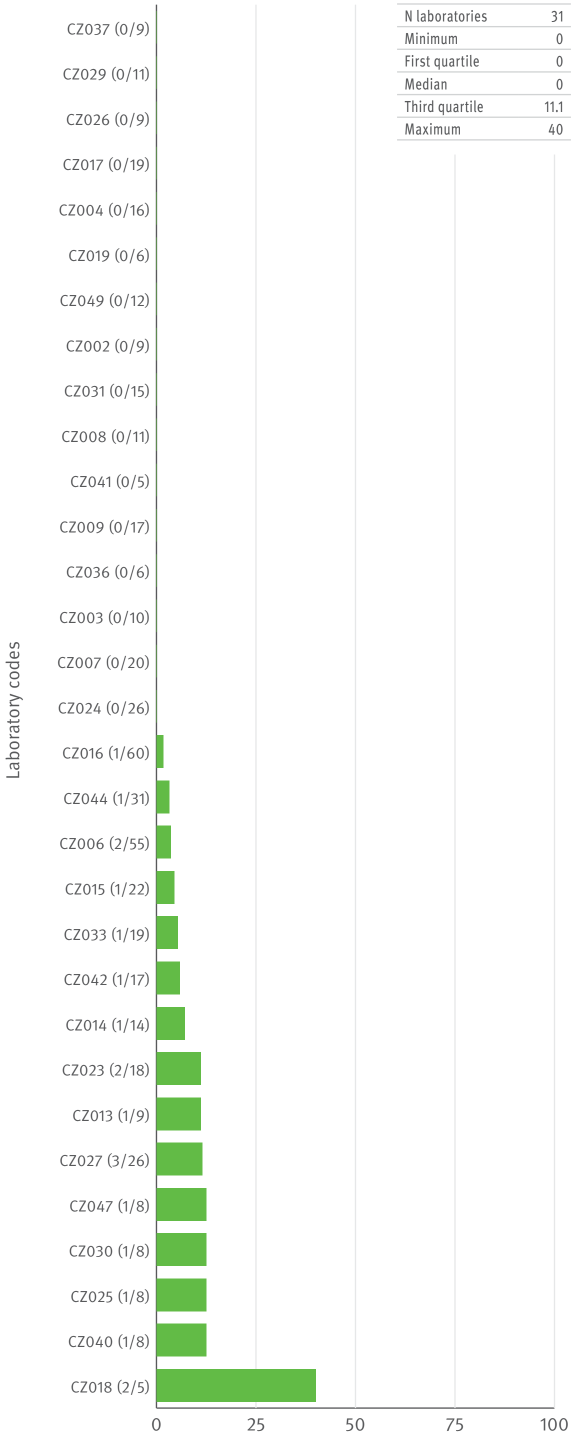


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)

N hospitals	69
Minimum	0
First quartile	6.7
Median	12.5
Third quartile	20
Maximum	100

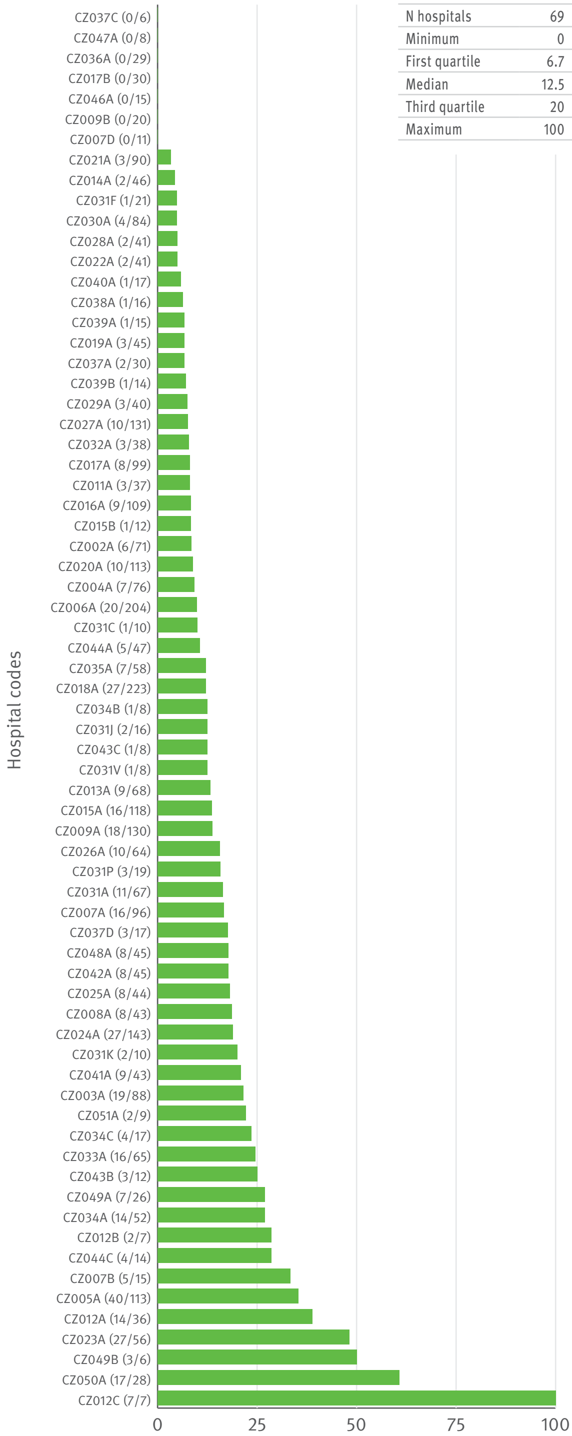
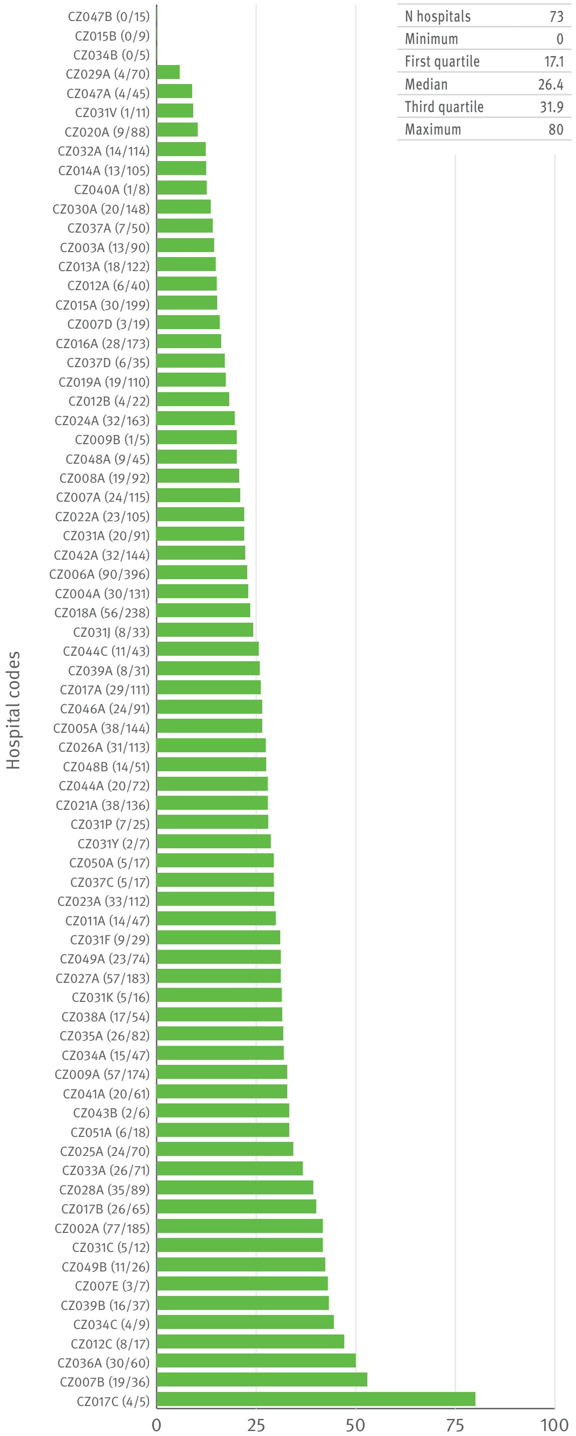
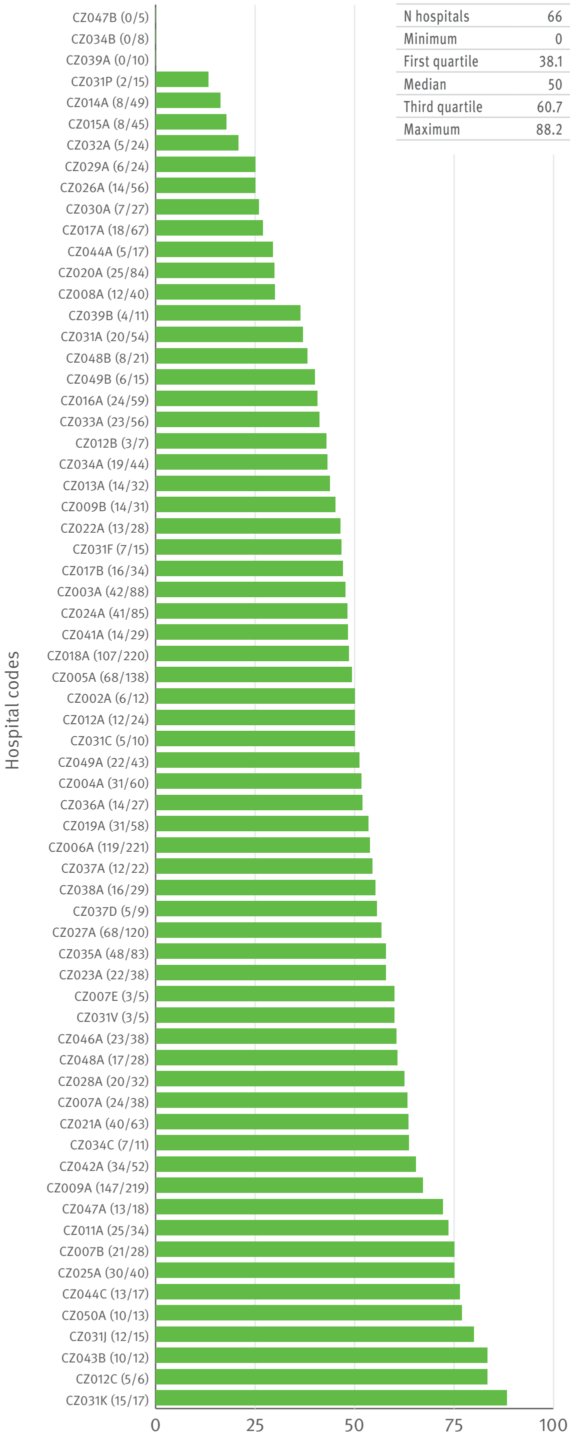


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)



N hospitals	73
Minimum	0
First quartile	17.1
Median	26.4
Third quartile	31.9
Maximum	80

Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



N hospitals	66
Minimum	0
First quartile	38.1
Median	50
Third quartile	60.7
Maximum	88.2

Denmark

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	5	366	5	752	-	-	-	-	-	-	-	-
2003	5	606	5	671	-	-	-	-	-	-	-	-
2004	15	1188	15	1436	-	-	-	-	-	-	-	-
2005	14	1081	15	1350	5	1283	-	-	-	-	-	-
2006	15	872	15	1279	11	2723	11	711	11	607	-	-
2007	15	1030	14	1315	12	3021	13	927	13	784	13	417
2008	15	934	15	1295	14	3283	14	1005	14	793	14	420
2009	15	996	15	1395	14	3532	14	1100	14	822	14	429

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	<1	<1	<1	<1	<1
Penicillin RI	4	3	3	4	4	3	3	4
Macrolides RI	5	5	5	6	6	6	7	4
Staphylococcus aureus								
Oxacillin/Meticillin R	<1	<1	1	2	2	<1	2	2
Escherichia coli								
Aminopenicilins R	-	-	-	40	42	43	43	43
Aminoglycosides R	-	-	-	2	3	4	4	4
Fluoroquinolones R	-	-	-	5	7	9	10	13
Third-gen. cephalosporins R	-	-	-	1	2	3	4	6
Enterococcus faecalis								
Aminopenicilins RI	-	-	-	-	<1	2	2	1
HL Gentamicin R	-	-	-	-	-	-	37	33
Vancomycin R	-	-	-	-	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	-	-	-	-	87	88	88	88
HL Gentamicin R	-	-	-	-	-	-	61	52
Vancomycin R	-	-	-	-	<1	<1	<1	2
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	-	2	6	7	7
Fluoroquinolones R	-	-	-	-	6	13	16	16
Third-gen. cephalosporins R	-	-	-	-	4	10	9	11
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	-	-	3	2	2
Ceftazidime R	-	-	-	-	-	2	3	4
Carbapenems R	-	-	-	-	-	2	1	3
Aminoglycosides R	-	-	-	-	-	1	1	<1
Fluoroquinolones R	-	-	-	-	-	6	3	5

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=1930		*S. aureus* n=2690		*E. coli* n=6424		*E. faecalis* n=926		*E. faecium* n=692		*K. pneumoniae* n=1243		*P. aeruginosa* n=687	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	93	3	100	2	100	12	100	0	100	1	100	10	99	2
CSF	7	3	-	-	<1	0	-	-	-	-	<1	0	1	0
Gender														
Male	24	3	62	2	49	14	71	0	58	0	59	12	61	2
Female	24	3	38	1	51	9	29	0	41	2	41	7	39	2
Unknown	52	4	-	-	<1	100	<1	0	<1	0	-	-	-	-
Age (years)														
0–4	8	4	3	1	1	6	2	0	1	0	1	3	2	0
5–19	2	1	3	1	1	3	1	0	2	5	1	5	2	9
20–64	38	3	40	1	29	11	33	0	45	0	35	10	31	4
65 and over	52	4	54	1	69	9	64	0	52	1	63	8	65	1
Unknown	-	-	<1	0	<1	0	-	-	-	-	-	-	-	-
Hospital department														
ICU	-	-	2	2	3	15	12	0	32	1	5	8	8	12
Internal med.	-	-	19	1	44	9	42	0	24	0	44	9	29	0
Surgery	-	-	7	2	17	8	19	0	18	1	22	8	13	3
Other	-	-	6	1	21	11	22	1	18	1	24	9	30	1
Unknown	100	4	65	1	15	12	5	0	7	2	5	11	20	2

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Denmark

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)

Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)

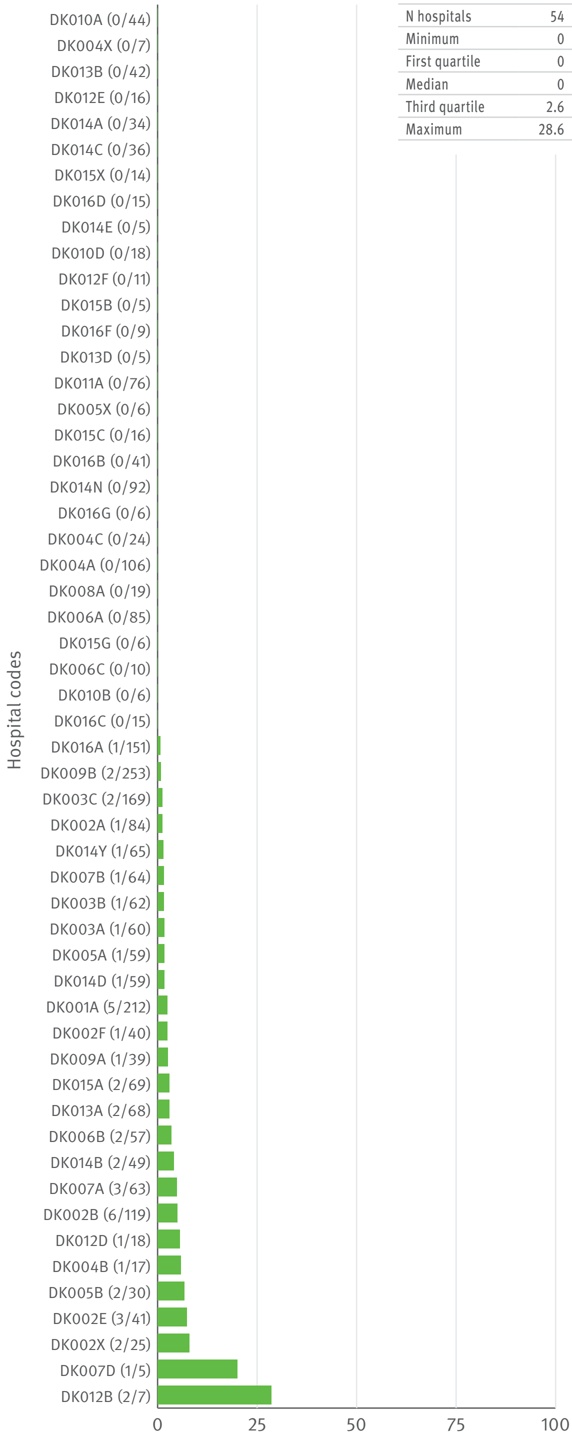


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)

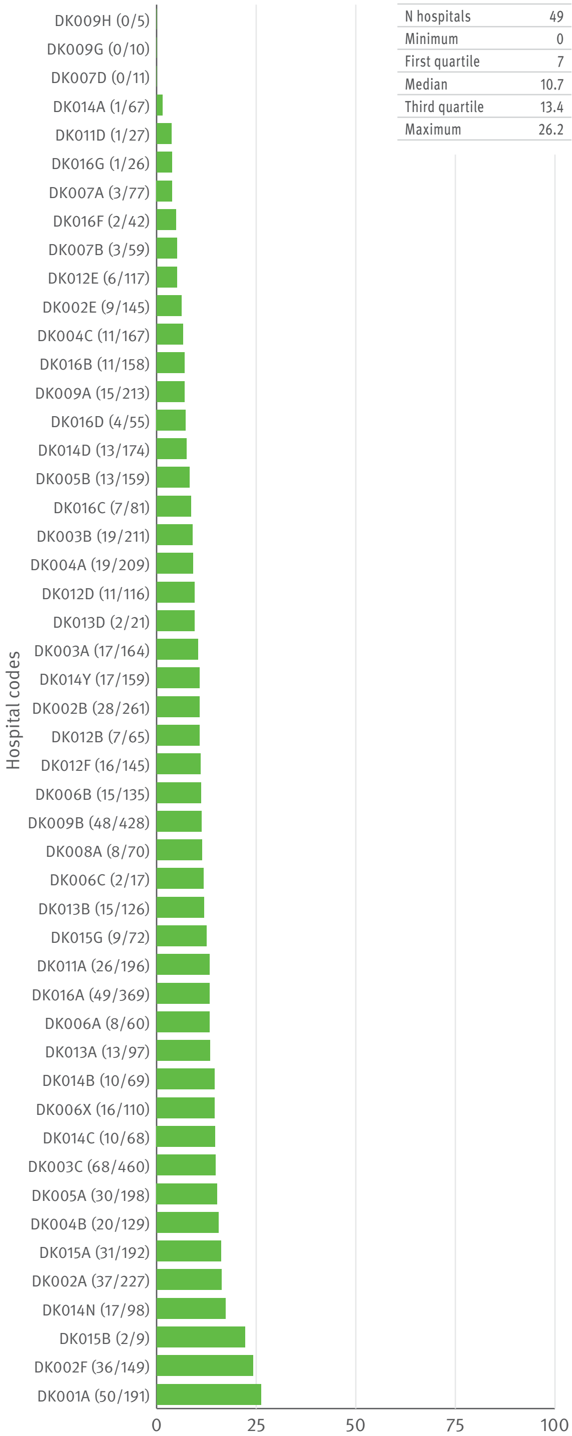
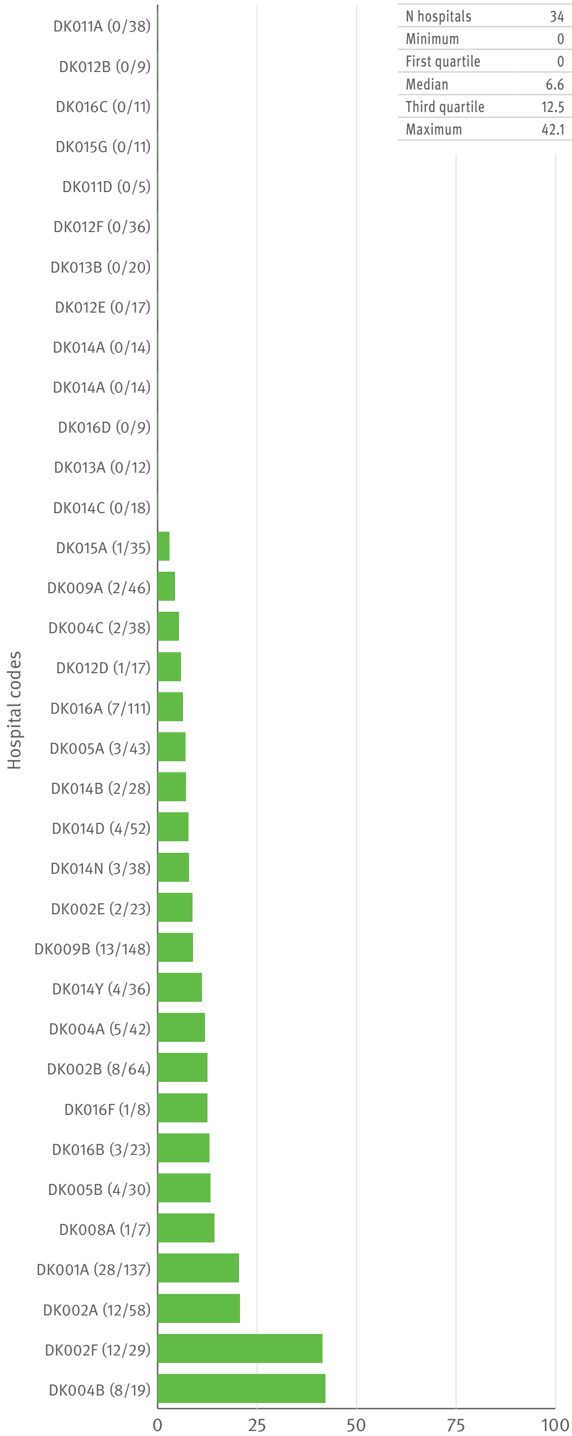


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



Estonia

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	5	21	8	82	6	67	3	13	-	-	-	-
2003	8	26	9	98	9	98	6	27	-	-	-	-
2004	6	40	9	104	10	167	5	63	-	-	-	-
2005	7	53	8	141	10	156	7	66	7	38	5	38
2006	8	52	9	154	9	215	8	85	6	47	6	43
2007	8	64	10	206	11	219	8	66	9	63	8	48
2008	10	66	11	185	11	267	11	86	10	72	8	41
2009	8	82	11	213	11	320	8	72	7	60	6	43

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	<1	<1	<1	<1	<1
Penicillin RI	<1	<1	<1	2	2	<1	5	1
Macrolides RI	<1	10	6	<1	3	2	4	2
Staphylococcus aureus								
Oxacillin/Meticillin R	<1	4	5	2	3	9	4	3
Escherichia coli								
Aminopenicilins R	42	42	55	45	52	50	47	38
Aminoglycosides R	10	3	2	4	2	6	5	4
Fluoroquinolones R	5	5	6	5	7	7	7	8
Third-gen. cephalosporins R	2	1	4	1	<1	1	5	2
Enterococcus faecalis								
Aminopenicilins RI	10	4	14	14	9	<1	9	9
HL Gentamicin R	50	22	32	50	35	23	27	43
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	33	75	79	83	84	94	85	90
HL Gentamicin R	67	50	79	74	78	89	75	79
Vancomycin R	<1	<1	<1	<1	<1	<1	3	<1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	8	9	2	15	15
Fluoroquinolones R	-	-	-	<1	5	2	7	19
Third-gen. cephalosporins R	-	-	-	8	9	3	12	17
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	27	12	9	18	13
Ceftazidime R	-	-	-	18	7	7	13	7
Carbapenems R	-	-	-	38	29	18	30	17
Aminoglycosides R	-	-	-	28	8	7	17	10
Fluoroquinolones R	-	-	-	14	10	9	18	19

Demographic characteristics

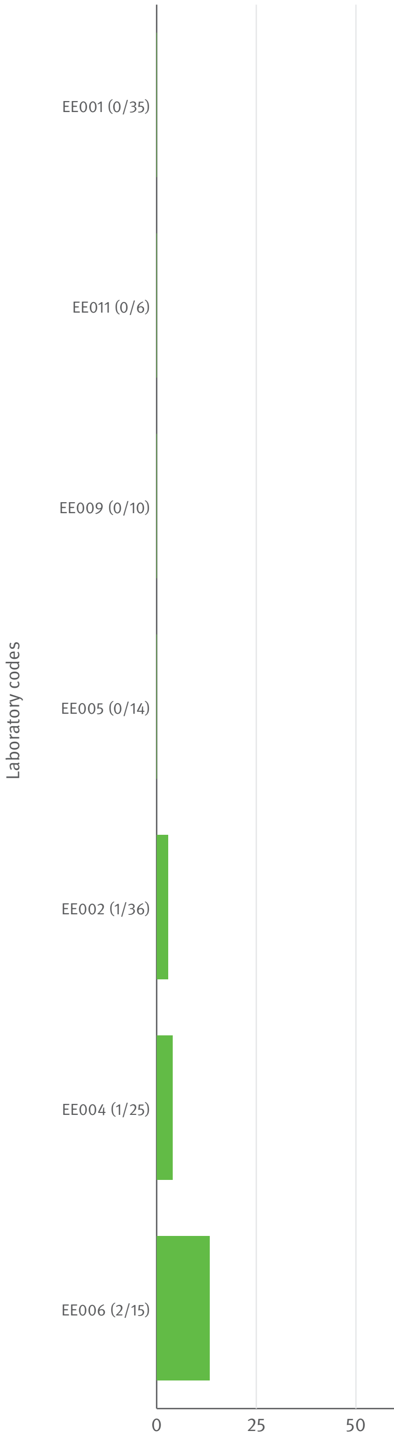
Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=147		*S. aureus* n=398		*E. coli* n=554		*E. faecalis* n=79		*E. faecium* n=79		*K. pneumoniae* n=127		*P. aeruginosa* n=69	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	85	3	100	4	99	8	100	0	100	1	100	14	100	25
CSF	15	0	-	-	1	0	-	-	-	-	-	-	-	-
Gender														
Male	60	2	59	3	39	9	59	0	46	0	57	16	57	26
Female	40	3	39	4	60	7	41	0	53	2	43	11	43	23
Unknown	-	-	2	17	1	0	-	-	1	0	-	-	-	-
Age (years)														
0–4	6	4	10	5	3	2	17	0	10	0	16	5	4	25
5–19	3	0	4	6	3	5	<1	0	2	0	1	0	5	33
20–64	55	1	48	4	40	7	31	0	41	1	38	9	46	33
65 and over	27	1	29	5	48	7	45	0	45	0	43	14	45	20
Unknown	8	3	8	1	6	5	6	0	2	0	2	0	1	0
Hospital department														
ICU	37	1	23	6	17	7	29	0	39	0	30	11	55	31
Internal med.	25	2	33	2	41	5	25	0	16	0	28	14	12	17
Surgery	2	0	11	2	6	14	8	0	8	0	6	6	6	9
Other	36	1	33	6	35	7	37	0	38	1	36	6	27	25
Unknown	<1	0	<1	0	<1	0	<1	0	-	-	-	-	-	-

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

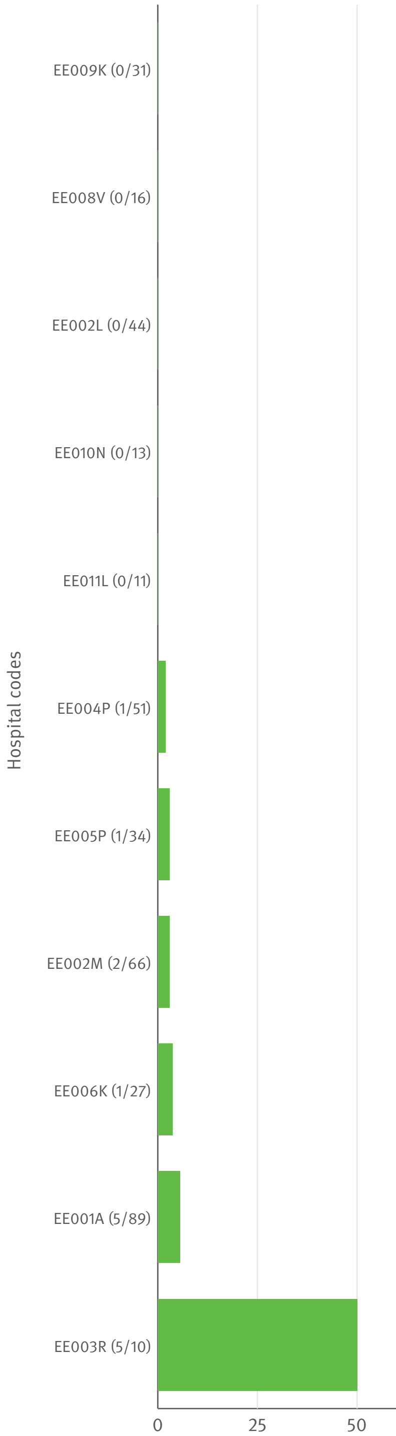
Estonia

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)



N laboratories	7
Minimum	0
First quartile	0
Median	0
Third quartile	4
Maximum	13.3

Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)

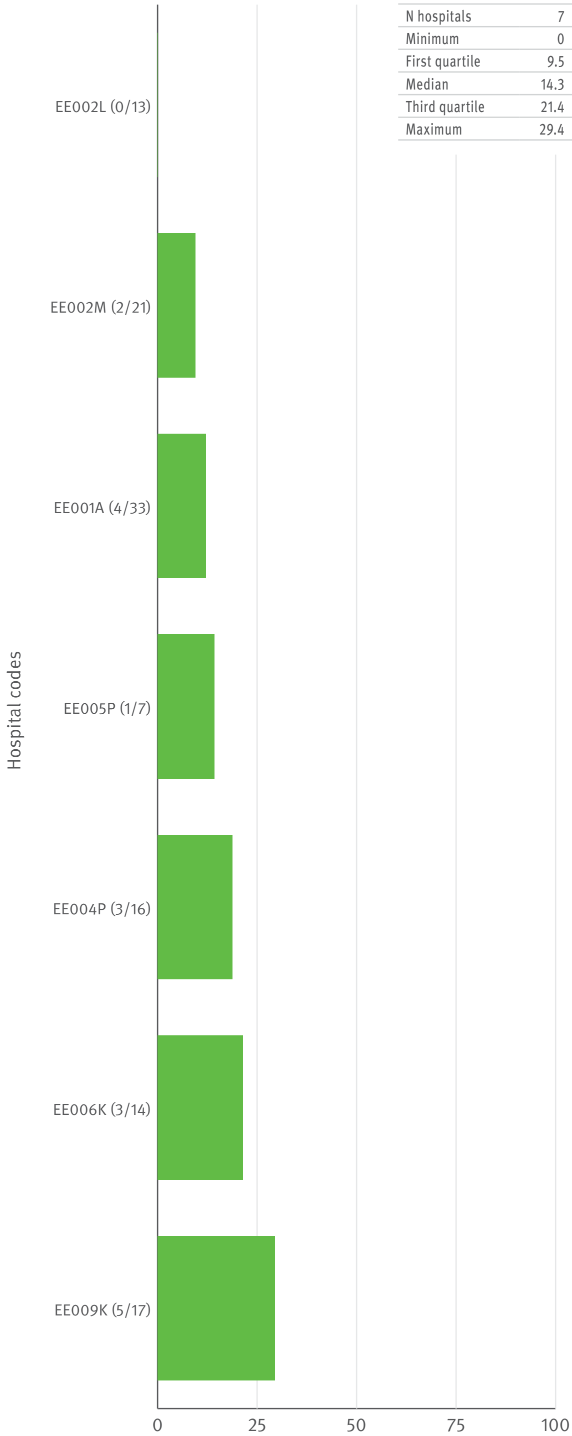


N hospitals	11
Minimum	0
First quartile	0
Median	2
Third quartile	3.7
Maximum	50

Figure 3: **Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)**

N hospitals	12
Minimum	0
First quartile	2.5
Median	7
Third quartile	11.3
Maximum	23.5

Figure 4: **Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)**



N hospitals	7
Minimum	0
First quartile	9.5
Median	14.3
Third quartile	21.4
Maximum	29.4

Finland

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	15	454	15	721	15	1330	14	278	-	-	-	-
2003	16	517	16	727	15	1450	15	266	-	-	-	-
2004	17	548	17	883	17	1749	17	336	-	-	-	-
2005	17	543	17	790	17	1924	17	340	14	175	13	108
2006	15	501	15	894	15	1875	15	348	14	228	14	162
2007	16	547	16	814	16	1949	16	400	15	273	14	183
2008	15	643	15	923	15	2111	15	381	12	288	12	175
2009	20	688	20	978	20	2224	20	506	20	375	18	233

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	2	2	<1	<1	2	1	<1	2
Penicillin RI	6	10	8	7	12	13	11	13
Macrolides RI	14	20	20	20	24	25	24	28
Staphylococcus aureus								
Oxacillin/Meticillin R	<1	1	3	3	3	2	3	2
Escherichia coli								
Aminopenicilins R	30	33	33	35	36	34	35	36
Aminoglycosides R	<1	1	2	2	2	3	4	3
Fluoroquinolones R	6	5	7	7	8	8	9	9
Third-gen. cephalosporins R	<1	1	2	2	2	2	2	3
Enterococcus faecalis								
Aminopenicilins RI	2	<1	<1	<1	<1	2	<1	<1
HL Gentamicin R	13	39	39	27	25	22	13	-
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	80	79	69	78	80	87	87	87
HL Gentamicin R	<1	4	12	1	16	19	15	-
Vancomycin R	1	<1	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	3	1	<1	1	1
Fluoroquinolones R	-	-	-	3	4	<1	2	3
Third-gen. cephalosporins R	-	-	-	2	<1	1	2	1
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	8	8	7	8	7
Ceftazidime R	-	-	-	5	3	5	5	5
Carbapenems R	-	-	-	15	8	9	6	8
Aminoglycosides R	-	-	-	11	8	8	6	4
Fluoroquinolones R	-	-	-	16	17	11	15	11

Demographic characteristics

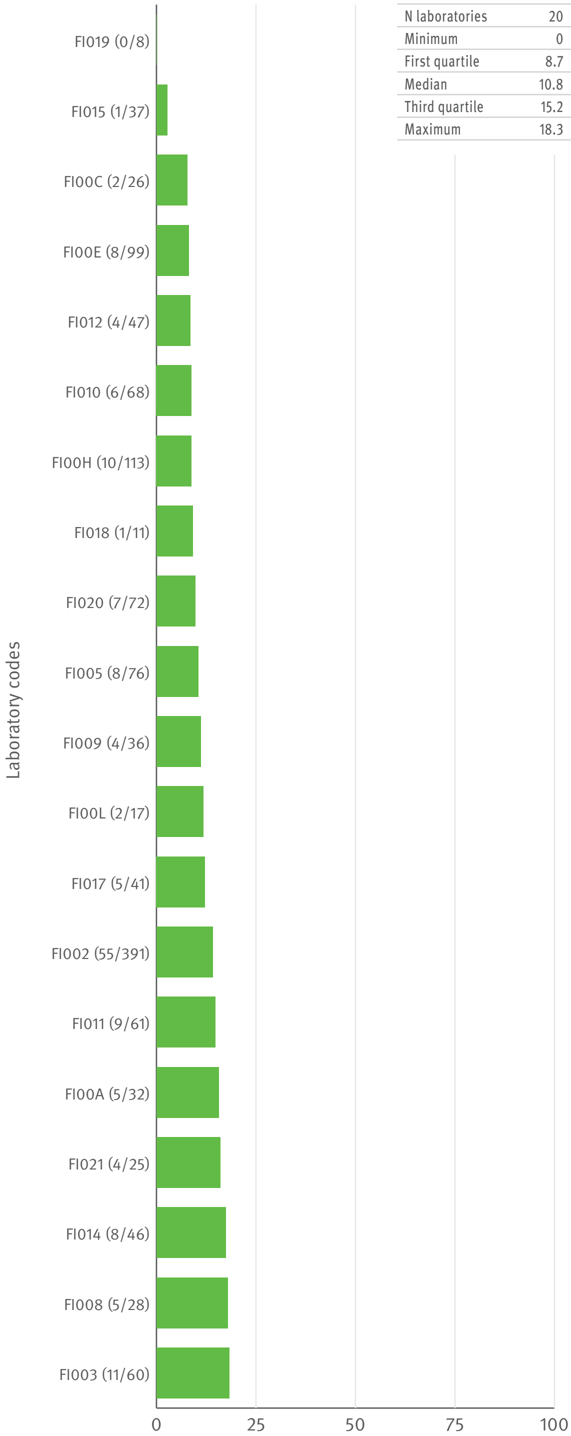
Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=1294		*S. aureus* n=1901		*E. coli* n=4332		*E. faecalis* n=475		*E. faecium* n=398		*K. pneumoniae* n=655		*P. aeruginosa* n=404	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	96	12	100	2	100	9	100	0	100	0	100	2	97	7
CSF	4	9	-	-	<1	13	-	-	-	-	<1	0	3	8
Gender														
Male	56	11	62	3	36	11	71	0	60	0	56	1	64	7
Female	44	13	38	2	64	8	29	0	40	0	44	2	36	8
Unknown	1	0	1	16	1	13	1	0	1	0	1	17	1	7
Age (years)														
0–4	15	15	4	2	2	2	5	0	2	0	2	14	<1	25
5–19	4	9	5	2	1	7	1	0	1	0	1	0	1	8
20–64	49	9	44	2	31	7	30	0	38	0	31	2	29	12
65 and over	33	10	48	2	66	8	63	0	58	0	67	1	69	7
Unknown	<1	0	<1	100	<1	0	<1	0	-	-	-	-	-	-
Hospital department														
ICU	1	8	2	5	1	8	3	0	4	0	2	0	4	19
Internal med.	8	9	12	2	8	6	10	0	11	0	9	2	8	6
Surgery	2	4	5	3	4	8	8	0	10	0	5	1	6	7
Other	29	10	20	2	22	7	18	0	16	0	21	2	18	10
Unknown	61	11	61	2	65	8	60	0	60	1	63	1	65	8

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

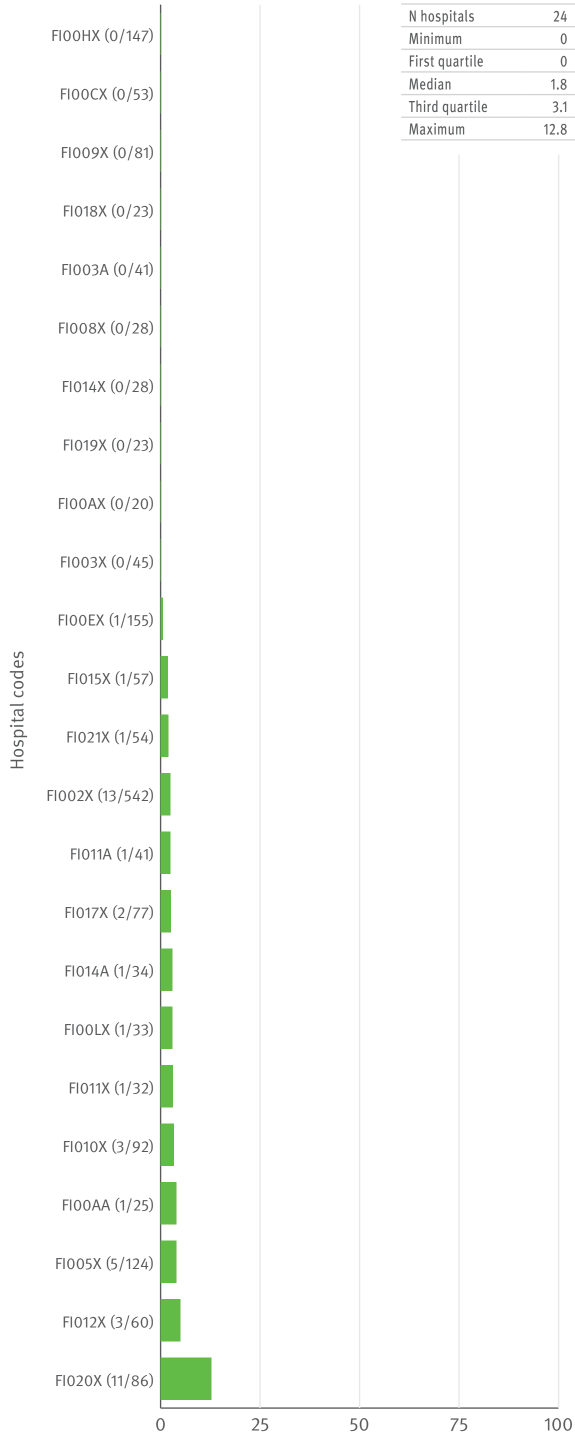
Finland

Figure 1: **Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)**



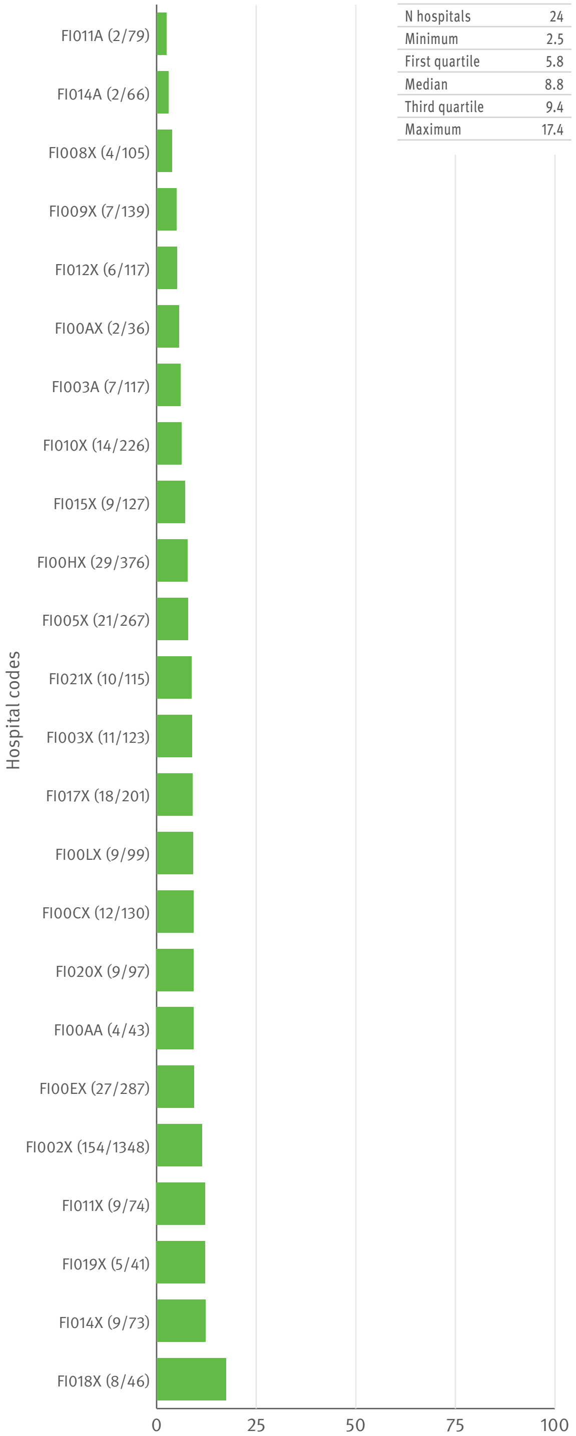
N laboratories	20
Minimum	0
First quartile	8.7
Median	10.8
Third quartile	15.2
Maximum	18.3

Figure 2: **Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)**



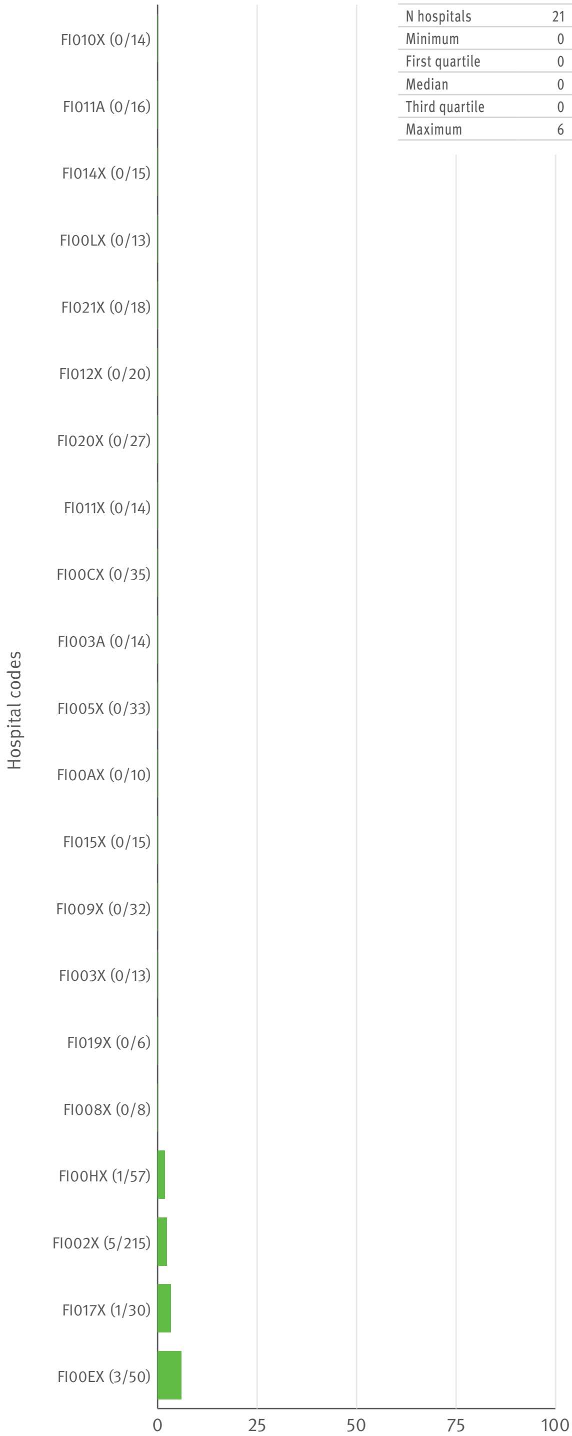
N hospitals	24
Minimum	0
First quartile	0
Median	1.8
Third quartile	3.1
Maximum	12.8

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)



N hospitals	24
Minimum	2.5
First quartile	5.8
Median	8.8
Third quartile	9.4
Maximum	17.4

Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



N hospitals	21
Minimum	0
First quartile	0
Median	0
Third quartile	0
Maximum	6

France

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	-	-	21	1664	21	2495	21	467	-	-	-	-
2003	-	-	21	1710	21	2266	20	468	-	-	-	-
2004	-	-	50	3355	50	5678	46	871	-	-	-	-
2005	195	632	50	3484	50	6056	47	1023	49	838	48	993
2006	97	371	50	3824	50	6718	50	1152	50	963	47	1006
2007	168	663	57	4265	57	8093	56	1545	56	1187	56	1305
2008	127	557	56	4380	56	7993	54	1555	54	1138	54	1225
2009	225	826	54	4727	54	8451	54	1969	52	1378	32	1221

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	-	-	-	5	4	4	7	6
Penicillin RI	-	-	-	36	32	34	30	27
Macrolides RI	-	-	-	41	36	37	31	27
Staphylococcus aureus								
Oxacillin/Meticillin R	33	29	29	27	27	26	24	23
Escherichia coli								
Aminopenicilins R	52	50	47	50	53	54	54	55
Aminoglycosides R	4	5	4	5	6	6	7	8
Fluoroquinolones R	8	9	8	11	14	15	16	19
Third-gen. cephalosporins R	<1	<1	<1	1	2	2	4	7
Enterococcus faecalis								
Aminopenicilins RI	5	3	1	<1	1	1	<1	1
HL Gentamicin R	15	16	17	15	16	15	18	18
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	34	30	56	64	69	67	68	63
HL Gentamicin R	10	23	21	24	30	30	30	38
Vancomycin R	2	<1	5	3	3	1	<1	<1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	5	7	11	17	20
Fluoroquinolones R	-	-	-	7	9	14	21	24
Third-gen. cephalosporins R	-	-	-	4	6	10	15	19
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	15	11	11	14	21
Ceftazidime R	-	-	-	9	6	7	8	17
Carbapenems R	-	-	-	14	12	14	14	17
Aminoglycosides R	-	-	-	22	16	18	15	19
Fluoroquinolones R	-	-	-	27	23	24	22	25

Demographic characteristics

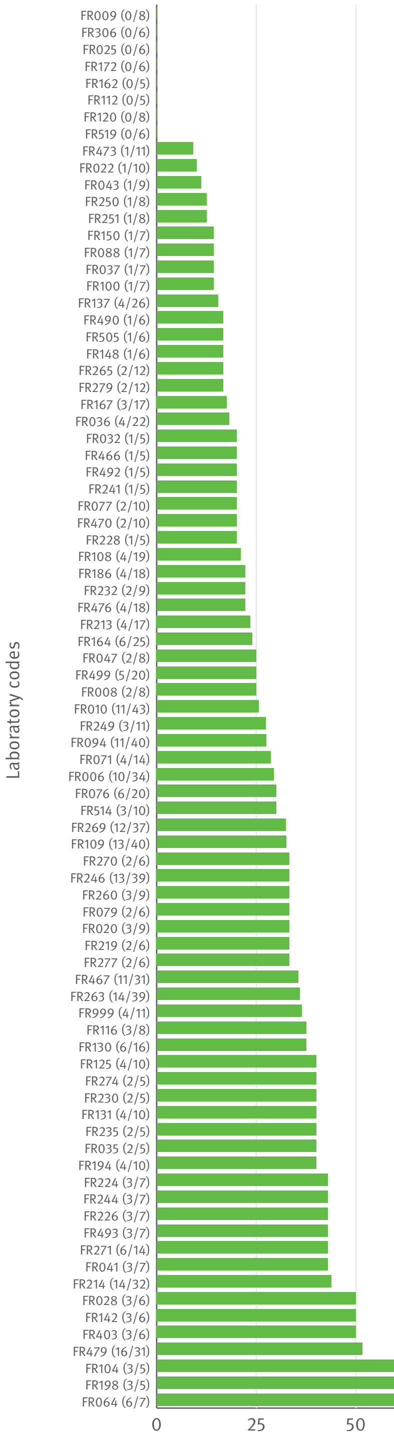
Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=1383		*S. aureus* n=9096		*E. coli* n=15838		*E. faecalis* n=2431		*E. faecium* n=944		*K. pneumoniae* n=2516		*P. aeruginosa* n=2442	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	69	29	100	24	100	17	100	0	100	1	100	17	100	16
CSF	31	26	-	-	-	-	-	-	-	-	-	-	-	-
Gender														
Male	55	26	61	23	47	20	64	0	60	1	58	20	60	16
Female	44	31	38	24	51	15	35	0	38	0	40	14	39	15
Unknown	<1	20	2	22	2	17	2	0	2	0	2	5	1	26
Age (years)														
0–4	25	35	4	12	2	4	3	0	3	0	2	14	2	5
5–19	11	16	3	9	1	8	1	0	1	0	1	18	2	14
20–64	32	26	41	19	35	13	39	0	44	2	45	14	48	19
65 and over	32	39	52	34	61	14	56	0	51	1	51	9	48	11
Unknown	<1	25	<1	40	<1	9	<1	0	<1	11	<1	56	<1	17
Hospital department														
ICU	-	-	17	28	9	15	24	0	24	2	15	24	29	23
Internal med.	73	33	34	28	29	14	28	0	26	1	30	9	24	11
Surgery	-	-	15	26	12	15	17	0	17	2	16	15	12	14
Other	-	-	32	24	49	13	29	0	32	2	36	6	32	10
Unknown	27	27	2	23	2	16	2	0	1	0	3	14	2	10

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

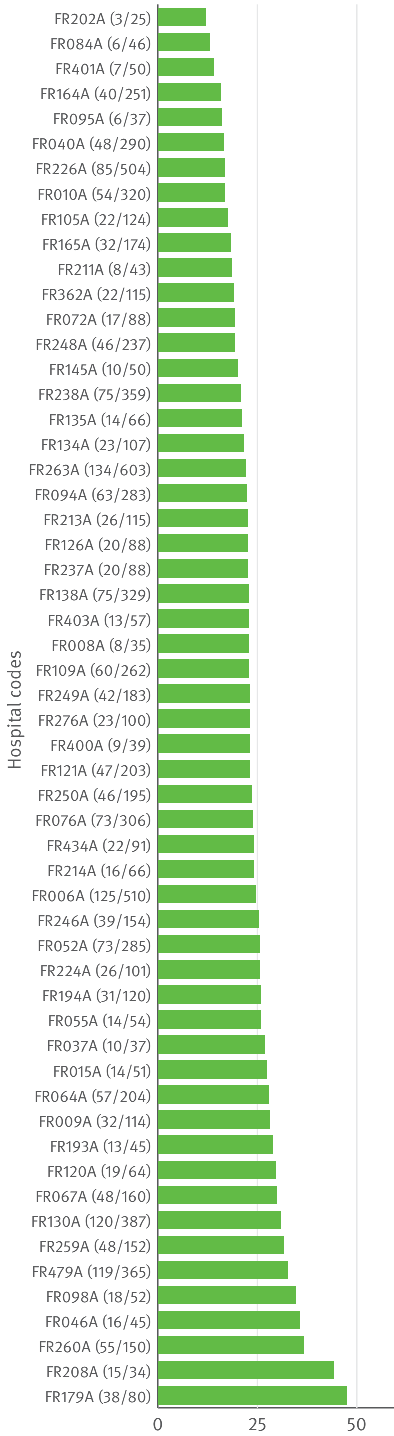
France

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)



N laboratories	83
Minimum	0
First quartile	16.7
Median	25.6
Third quartile	40
Maximum	85.7

Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)



N hospitals	56
Minimum	12
First quartile	19.7
Median	23
Third quartile	27.2
Maximum	47.5

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)

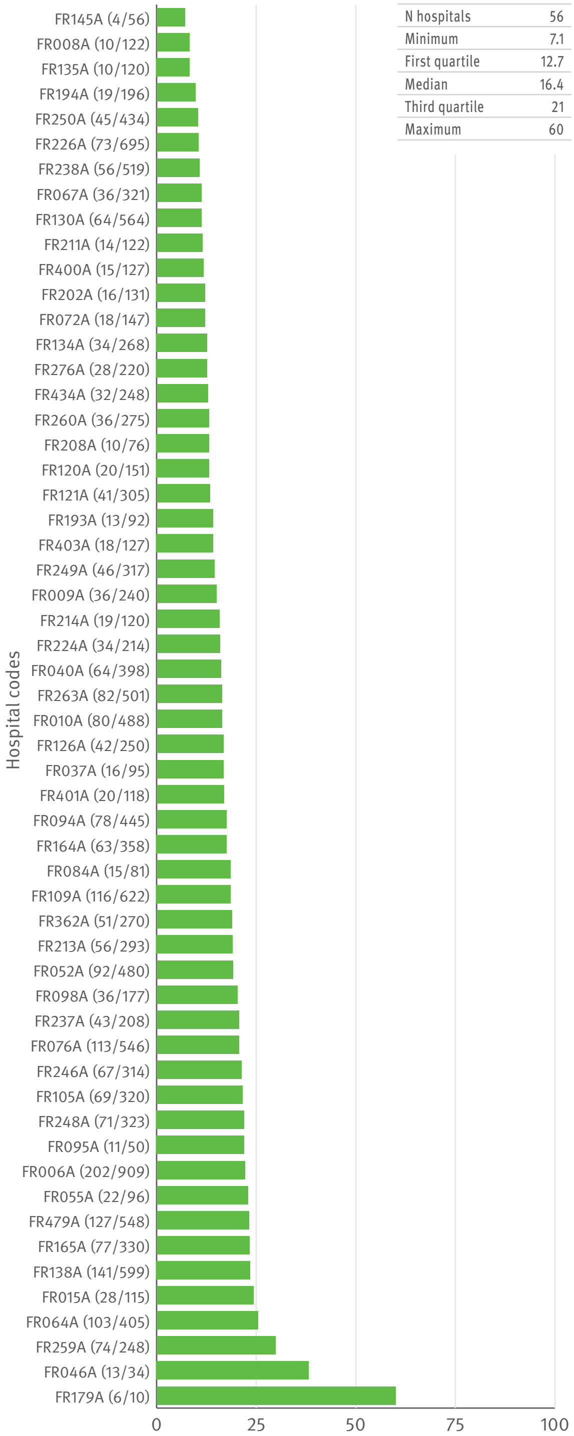
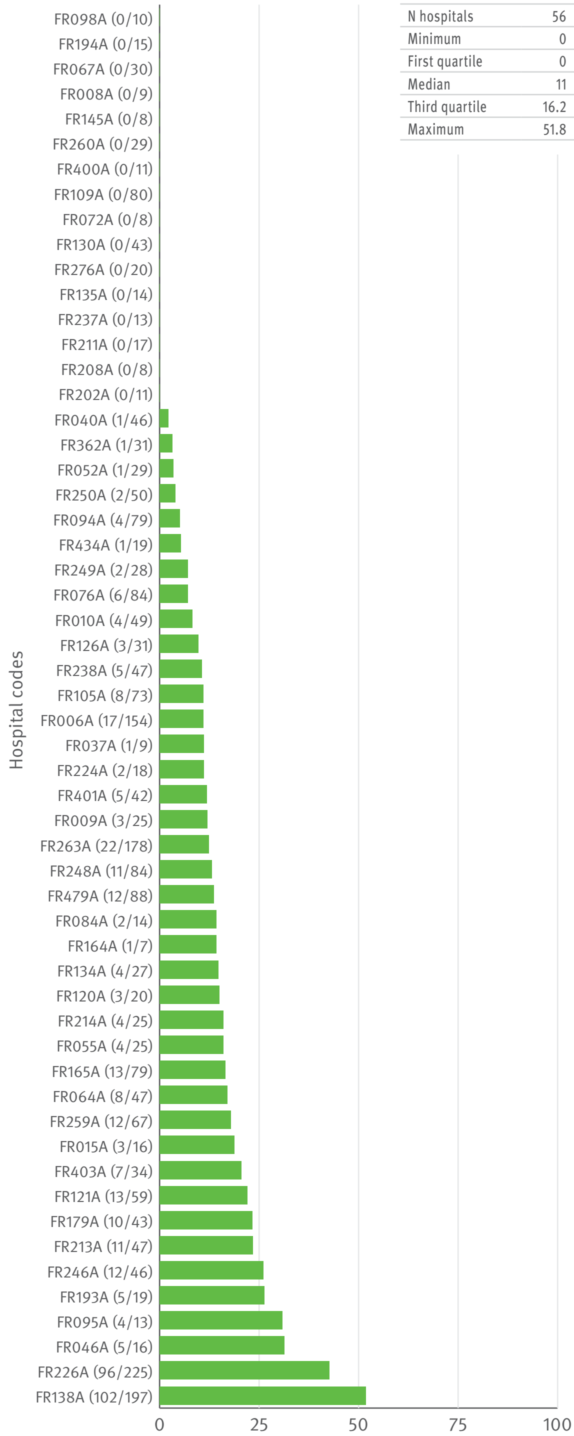


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



Germany

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	17	248	18	1067	16	1068	14	290	.	.	.	.
2003	17	175	20	920	19	997	17	347	.	.	.	.
2004	16	145	22	1107	22	1217	22	606	.	.		
2005	15	119	17	827	17	961	17	569	12	105	12	117
2006	15	85	18	799	18	850	16	529	14	148	12	162
2007	11	75	12	853	12	977	12	648	10	173	11	197
2008	11	209	14	1090	14	1615	13	451	11	235	11	167
2009	16	346	17	1894	17	2803	17	952	15	479	16	287

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	<1	1	<1	<1	<1
Penicillin RI	1	1	1	4	5	3	5	2
Macrolides RI	14	11	13	17	12	8	10	8
Staphylococcus aureus								
Oxacillin/Meticillin R	18	18	20	21	20	16	19	18
Escherichia coli								
Aminopenicilins R	50	47	55	54	60	55	55	56
Aminoglycosides R	5	5	4	6	10	6	7	8
Fluoroquinolones R	15	14	24	23	29	30	23	23
Third-gen. cephalosporins R	<1	<1	2	2	4	8	5	8
Enterococcus faecalis								
Aminopenicilins RI	10	7	7	3	3	7	<1	3
HL Gentamicin R	42	47	42	34	29	67	39	40
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	80	78	93	96	94	95	95	94
HL Gentamicin R	68	47	61	52	38	73	35	45
Vancomycin R	4	3	11	10	8	15	6	6
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	10	12	6	10	10
Fluoroquinolones R	-	-	-	6	12	9	15	15
Third-gen. cephalosporins R	-	-	-	7	14	6	11	13
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	18	17	17	9	13
Ceftazidime R	-	-	-	11	12	17	8	11
Carbapenems R	-	-	-	25	17	22	11	11
Aminoglycosides R	-	-	-	12	18	9	10	7
Fluoroquinolones R	-	-	-	23	28	28	22	17

Demographic characteristics

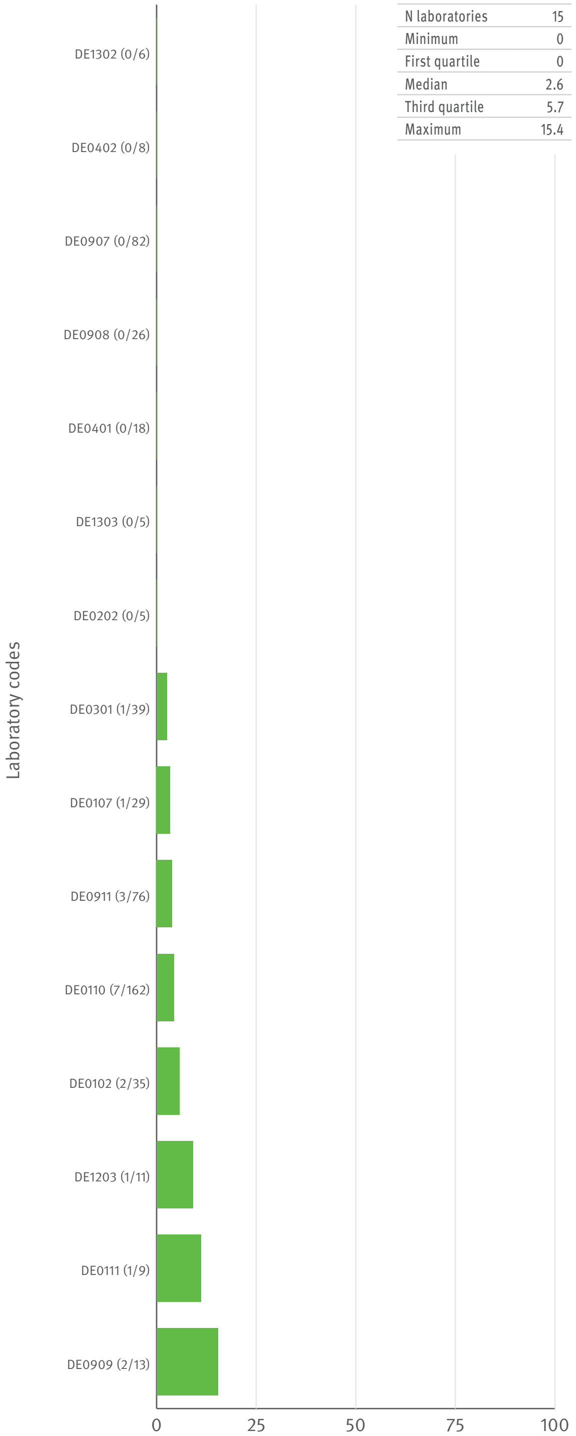
Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=527		*S. aureus* n=2974		*E. coli* n=4396		*E. faecalis* n=816		*E. faecium* n=583		*K. pneumoniae* n=706		*P. aeruginosa* n=450	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	93	3	100	19	100	24	100	0	100	6	100	13	99	10
CSF	7	5	-	-	<1	0	-	-	-	-	<1	0	1	33
Gender														
Male	36	3	43	19	30	28	49	1	48	6	43	13	46	10
Female	29	5	24	18	37	21	21	0	28	5	28	9	24	13
Unknown	35	3	33	20	32	22	31	0	24	8	28	15	30	10
Age (years)														
0–4	11	6	2	5	2	3	3	0	3	2	3	9	3	10
5–19	3	4	2	9	1	22	1	0	1	24	1	25	2	19
20–64	38	2	35	17	29	26	38	0	46	10	33	16	37	22
65 and over	48	2	60	21	69	22	57	0	50	8	63	9	58	12
Unknown	<1	0	<1	7	<1	16	<1	0	<1	0	0	0	<1	100
Hospital department														
ICU	21	3	20	25	14	23	26	1	37	7	20	10	21	23
Internal med.	46	2	42	17	49	20	35	0	24	9	38	8	31	11
Surgery	2	0	12	21	8	26	12	0	13	5	12	7	12	13
Other	27	3	22	17	25	29	25	0	25	15	28	18	33	18
Unknown	4	0	4	21	4	18	3	0	1	4	2	8	2	9

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

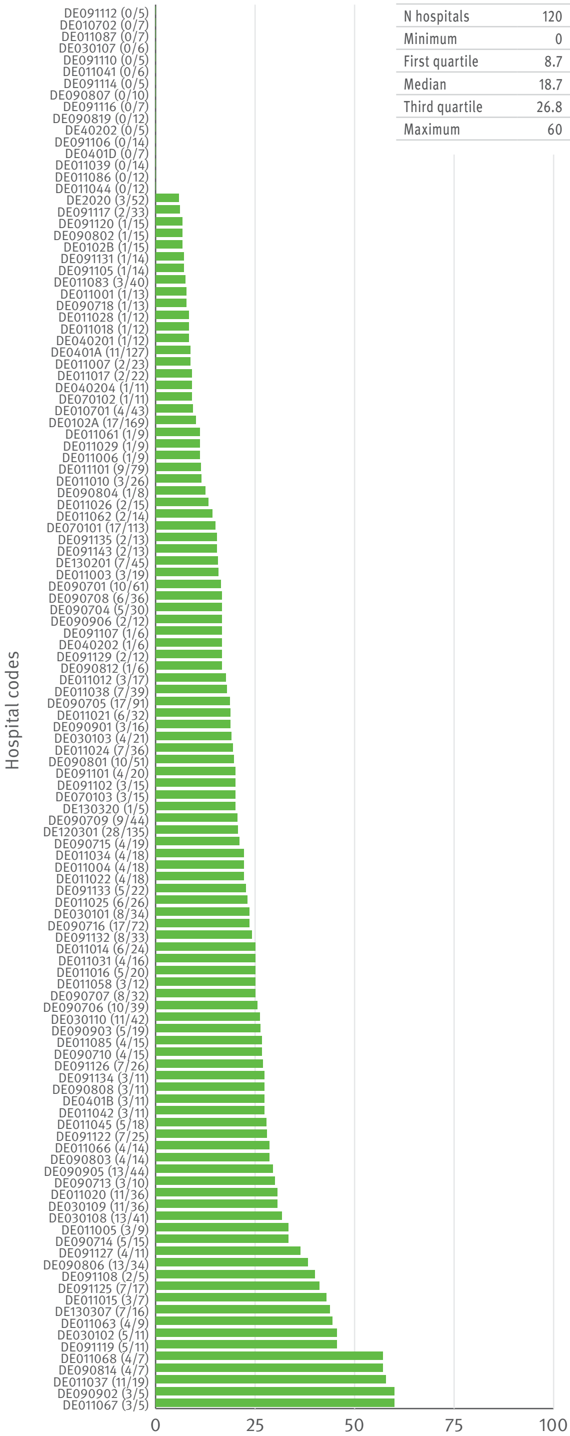
Germany

Figure 1: **Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)**



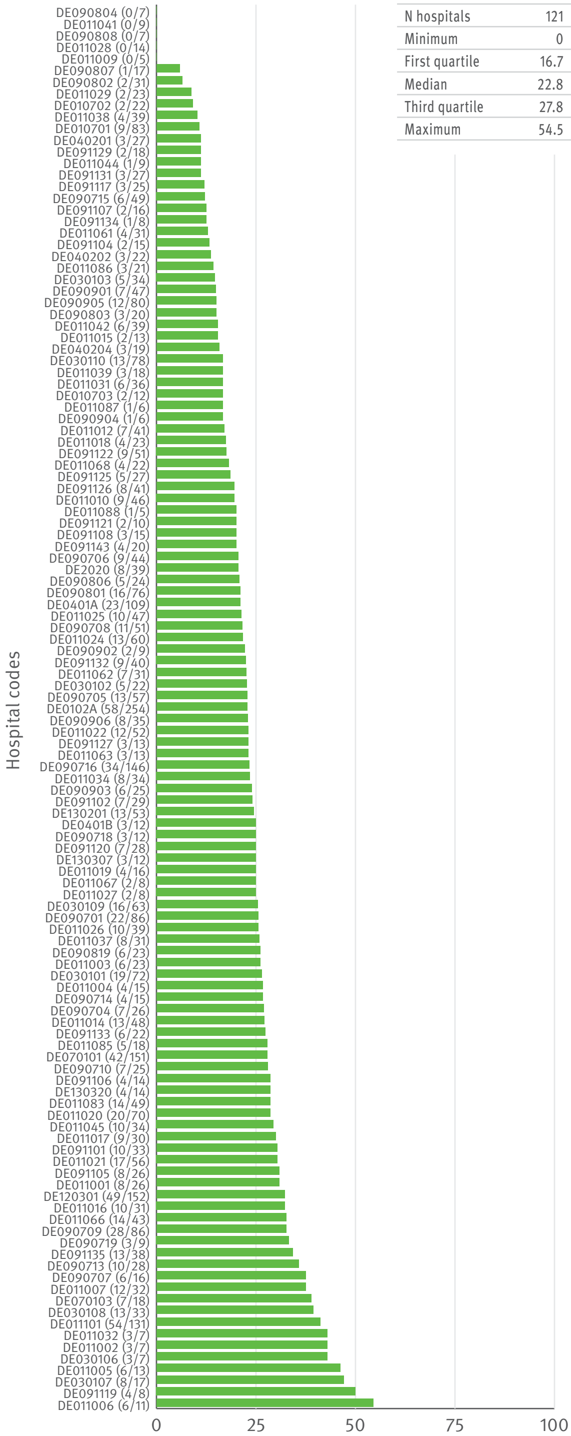
N laboratories	15
Minimum	0
First quartile	0
Median	2.6
Third quartile	5.7
Maximum	15.4

Figure 2: **Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)**



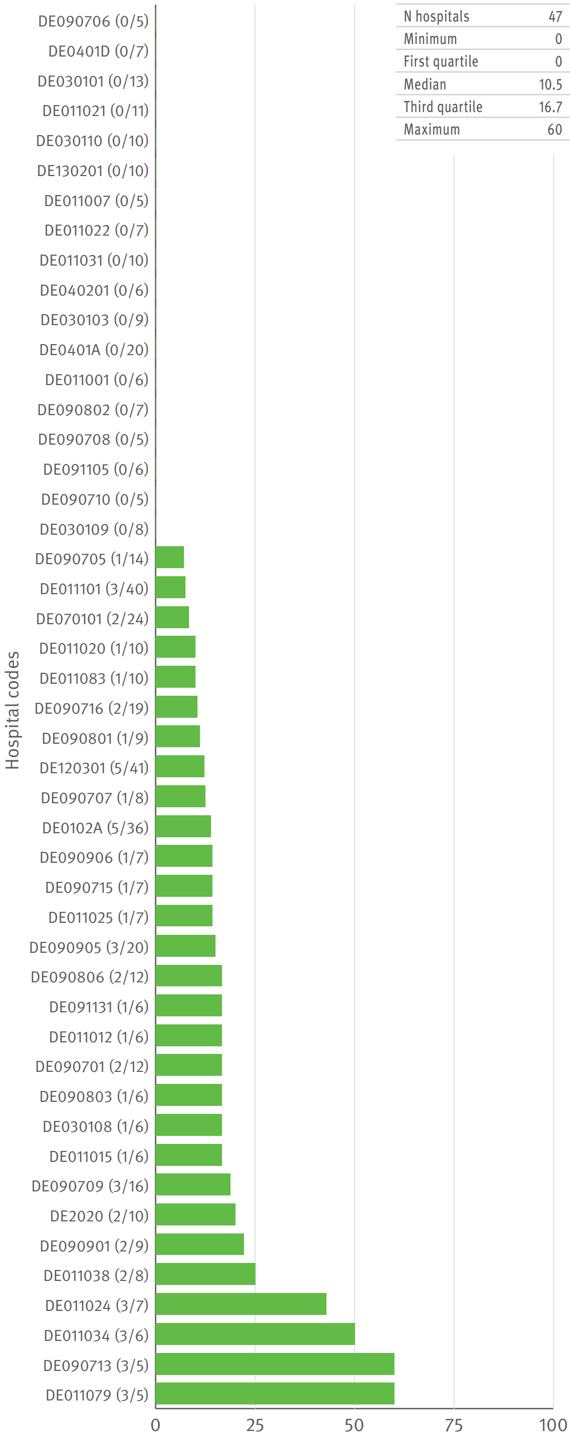
N hospitals	120
Minimum	0
First quartile	8.7
Median	18.7
Third quartile	26.8
Maximum	60

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)



N hospitals	121
Minimum	0
First quartile	16.7
Median	22.8
Third quartile	27.8
Maximum	54.5

Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



N hospitals	47
Minimum	0
First quartile	0
Median	10.5
Third quartile	16.7
Maximum	60

Greece

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	-	-	33	368	35	588	28	292	-	-	-	-
2003	-	-	34	682	35	1076	32	621	-	-	-	-
2004	-	-	35	610	39	1131	34	565	-	-	-	-
2005	-	-	35	682	35	1140	34	737	33	774	33	699
2006	-	-	42	828	41	1253	39	949	38	841	38	818
2007	-	-	41	819	43	1234	39	999	38	972	37	802
2008	-	-	46	907	44	1462	42	992	41	1093	42	920
2009	-	-	48	1025	49	1831	47	1190	47	1649	47	1123

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	-	-	-	-	-	-	-	-
Penicillin RI	-	-	-	-	-	-	-	-
Macrolides RI	-	-	-	-	-	-	-	-
Staphylococcus aureus								
Oxacillin/Meticillin R	44	45	44	42	43	48	41	40
Escherichia coli								
Aminopenicilins R	45	44	46	46	46	48	50	51
Aminoglycosides R	7	6	6	7	7	9	15	14
Fluoroquinolones R	13	12	12	12	14	19	22	23
Third-gen. cephalosporins R	6	6	6	7	6	8	10	10
Enterococcus faecalis								
Aminopenicilins RI	4	4	4	3	5	4	3	4
HL Gentamicin R	60	52	59	54	57	65	52	61
Vancomycin R	13	7	4	4	5	7	7	6
Enterococcus faecium								
Aminopenicilins RI	75	89	84	85	88	91	85	86
HL Gentamicin R	52	40	52	34	35	44	52	63
Vancomycin R	19	18	20	37	42	37	28	27
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	60	54	54	55	60
Fluoroquinolones R	-	-	-	54	50	55	64	66
Third-gen. cephalosporins R	-	-	-	61	58	62	66	69
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	30	39	38	34	33
Ceftazidime R	-	-	-	27	34	40	37	34
Carbapenems R	-	-	-	39	48	47	49	44
Aminoglycosides R	-	-	-	40	47	49	48	41
Fluoroquinolones R	-	-	-	39	45	50	48	45

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=.		*S. aureus* n=1855		*E. coli* n=3252		*E. faecalis* n=1341		*E. faecium* n=803		*K. pneumoniae* n=2714		*P. aeruginosa* n=2011	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	-	-	100	41	99	23	100	6	100	27	98	67	95	45
CSF	-	-	-	-	1	0	-	-	-	-	2	77	5	72
Gender														
Male	-	-	8	38	6	23	6	4	9	28	6	59	6	38
Female	-	-	4	36	8	19	4	2	7	25	4	63	3	48
Unknown	-	-	88	41	86	23	90	7	84	28	90	68	91	47
Age (years)														
0–4	-	-	3	41	3	17	4	9	5	38	6	74	4	50
5–19	-	-	<1	0	<1	0	<1	0	-	-	<1	0	<1	0
20–64	-	-	2	33	2	14	1	6	3	46	2	52	2	40
65 and over	-	-	2	54	2	23	3	5	3	33	2	56	2	24
Unknown	-	-	93	43	92	17	92	6	90	30	91	64	92	46
Hospital department														
ICU	-	-	14	65	4	24	35	10	32	34	46	87	44	58
Internal med.	-	-	67	37	77	16	46	4	48	31	36	39	38	33
Surgery	-	-	12	58	11	24	14	4	14	24	13	62	14	44
Other	-	-	3	33	3	5	1	2	2	32	3	32	1	20
Unknown	-	-	5	43	5	15	3	10	4	26	2	40	2	27

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Greece

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)

No data reported

Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)

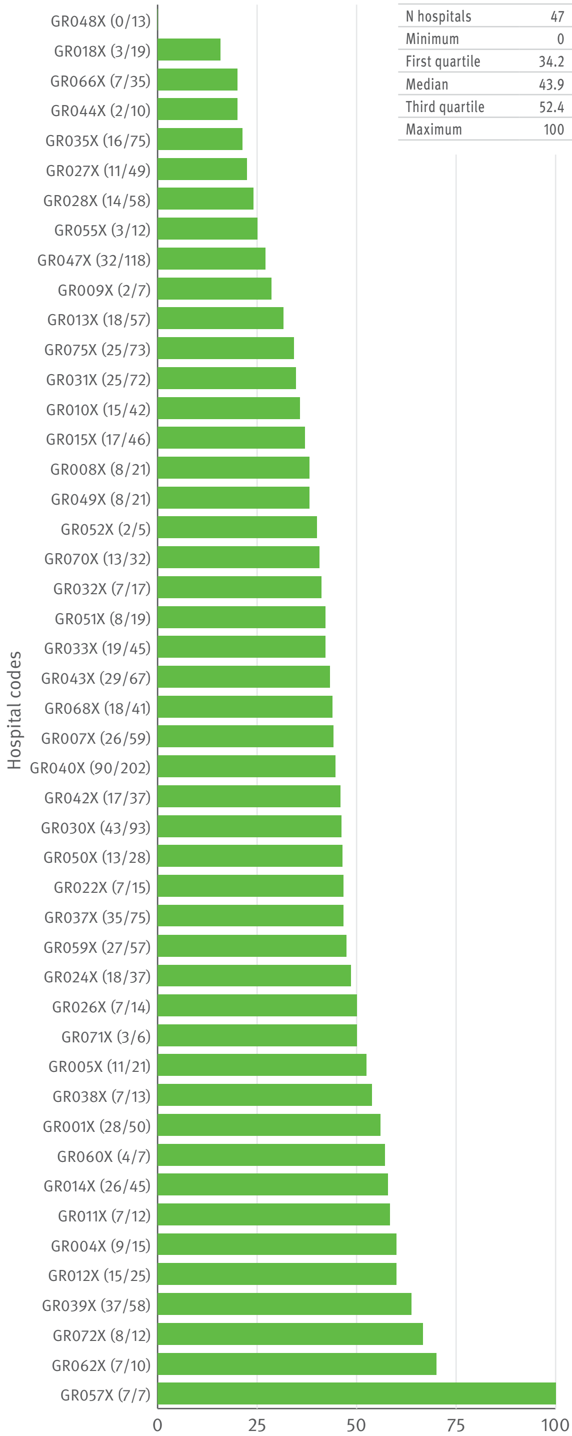


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)

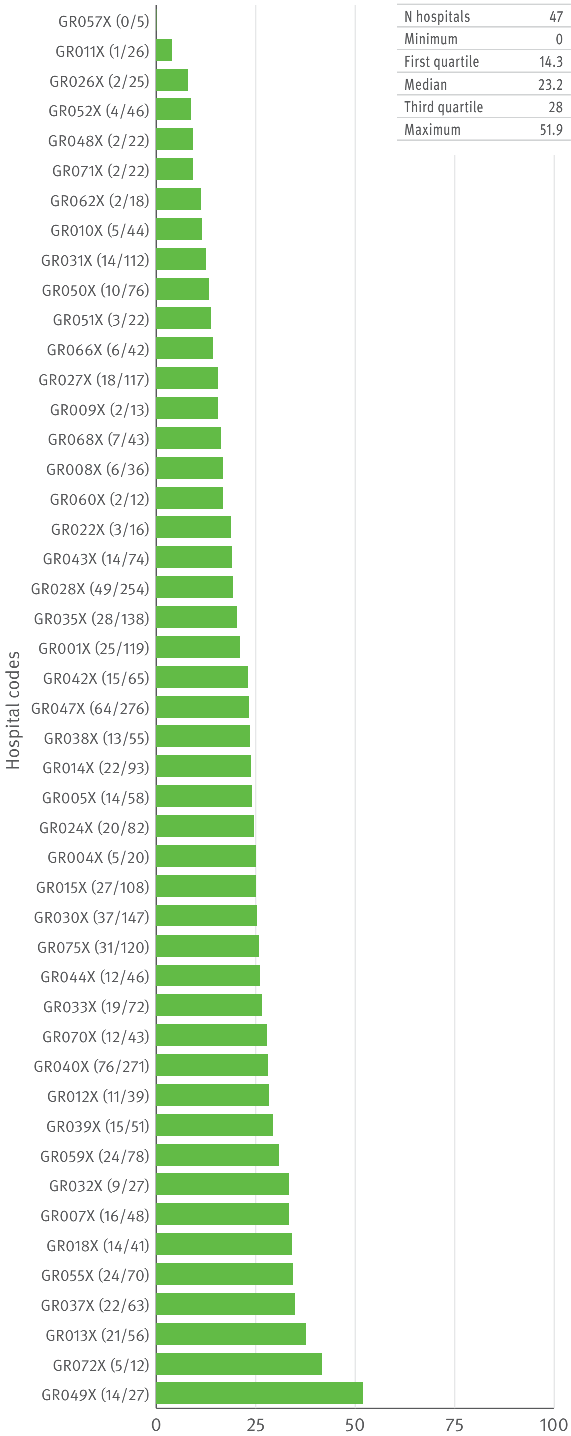
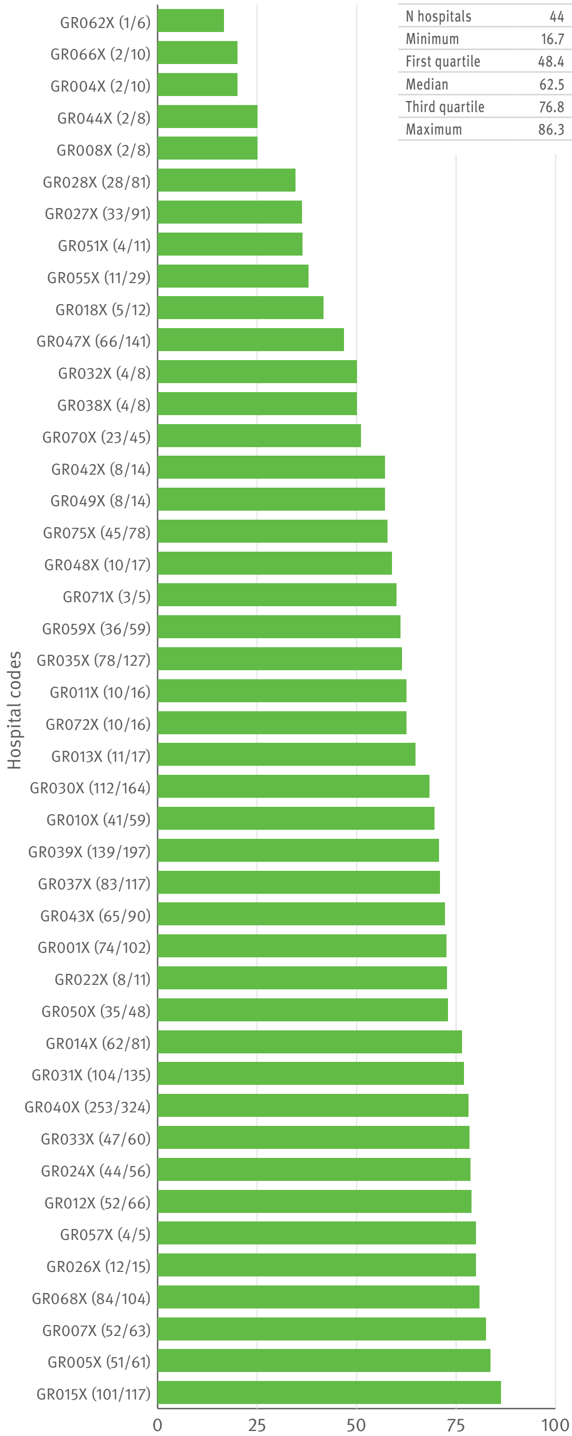


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



Hungary

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	17	61	24	416	24	354	23	169	-	-	-	-
2003	20	134	27	858	27	842	25	279	-	-	-	-
2004	26	143	30	1020	28	967	26	366	-	-	-	-
2005	23	133	28	1083	27	1046	27	476	21	314	24	507
2006	23	151	27	1127	26	1135	25	453	24	302	25	546
2007	22	146	26	1199	25	1179	26	400	23	322	24	518
2008	22	166	26	1181	25	1057	21	428	23	369	25	513
2009	22	143	26	1068	25	1057	27	444	24	361	25	518

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	3	3	<1	4	1	5	8	3
Penicillin RI	23	24	16	21	18	23	27	12
Macrolides RI	21	25	25	32	19	36	32	19
Staphylococcus aureus								
Oxacillin/Meticillin R	9	15	17	20	25	23	23	29
Escherichia coli								
Aminopenicilins R	45	49	55	51	53	54	59	60
Aminoglycosides R	6	8	10	9	12	11	13	16
Fluoroquinolones R	10	15	19	22	27	26	26	30
Third-gen. cephalosporins R	2	<1	3	4	5	5	9	13
Enterococcus faecalis								
Aminopenicilins RI	2	<1	2	1	3	2	3	2
HL Gentamicin R	100	87	57	43	47	48	53	51
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	89	91	95	91	88	88	96	97
HL Gentamicin R	100	96	80	64	67	53	62	70
Vancomycin R	<1	<1	<1	<1	<1	<1	3	1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	26	20	29	36	40
Fluoroquinolones R	-	-	-	21	13	22	33	33
Third-gen. cephalosporins R	-	-	-	28	20	25	35	38
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	10	9	11	13	19
Ceftazidime R	-	-	-	10	8	9	11	12
Carbapenems R	-	-	-	18	16	19	26	27
Aminoglycosides R	-	-	-	32	23	26	26	29
Fluoroquinolones R	-	-	-	28	21	24	26	27

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=309		*S. aureus* n=2249		*E. coli* n=2091		*E. faecalis* n=716		*E. faecium* n=147		*K. pneumoniae* n=728		*P. aeruginosa* n=1010	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	71	22	100	26	100	28	100	0	100	2	99	37	98	26
CSF	29	14	-	-	-	-	-	-	-	-	1	40	2	25
Gender														
Male	82	21	89	26	84	30	93	0	93	1	91	38	90	26
Female	18	16	11	23	16	22	7	0	7	10	9	26	10	31
Unknown	1	0	1	16	1	13	1	0	1	0	1	17	1	7
Age (years)														
0–4	12	36	2	8	2	7	4	0	5	0	9	35	4	13
5–19	5	22	2	8	1	23	2	0	1	0	2	32	2	28
20–64	55	18	48	21	41	23	46	0	49	1	44	33	50	24
65 and over	29	18	49	23	56	25	48	0	44	0	45	26	44	18
Unknown	-	-	<1	0	<1	0	-	-	-	-	-	-	-	-
Hospital department														
ICU	26	20	18	30	12	23	31	0	36	0	27	38	39	24
Internal med.	19	16	28	18	29	20	20	0	14	0	19	22	12	13
Surgery	2	24	12	28	7	26	11	0	12	0	11	28	12	19
Other	44	22	30	17	41	25	28	0	28	2	33	27	27	22
Unknown	9	21	12	18	11	25	11	0	9	0	10	34	10	19

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Hungary

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)

N laboratories	17
Minimum	0
First quartile	9.1
Median	21.7
Third quartile	33.3
Maximum	50

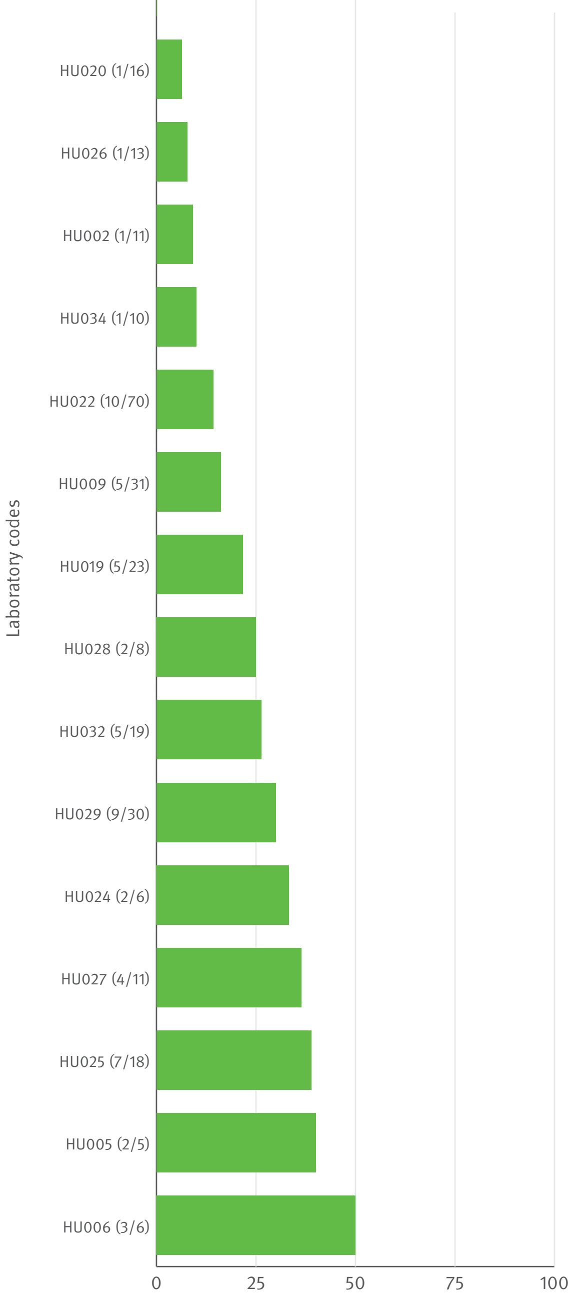


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)

N hospitals	42
Minimum	0
First quartile	15.4
Median	20
Third quartile	30.5
Maximum	61.8

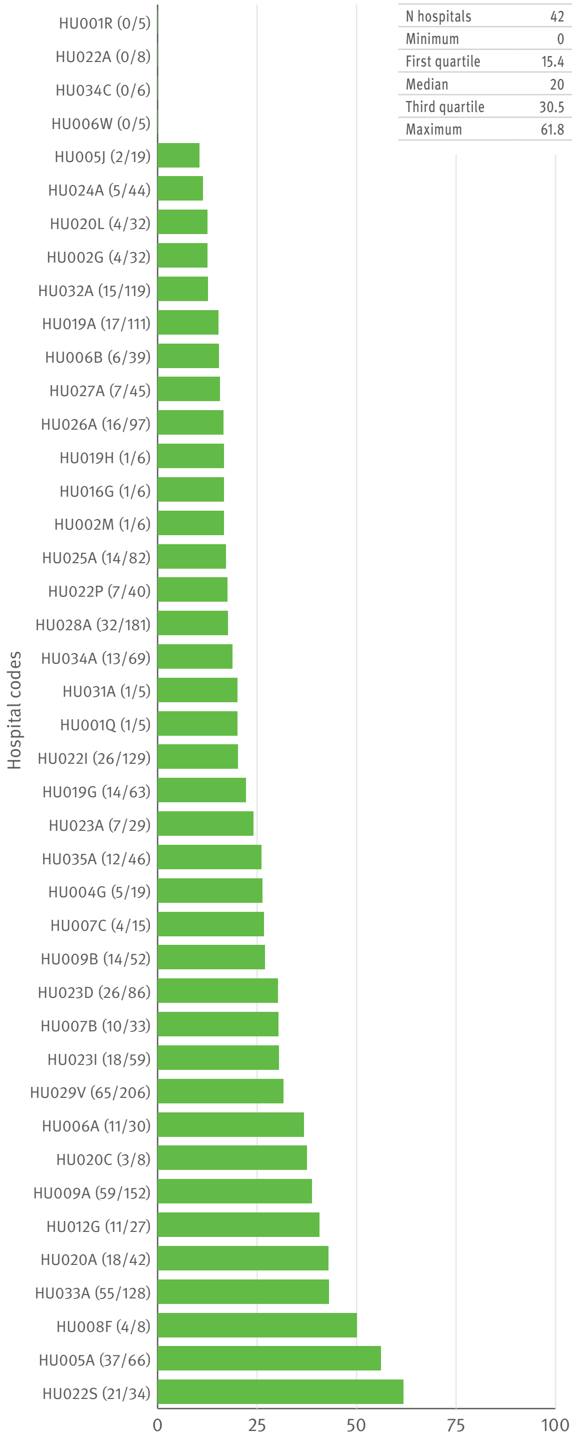
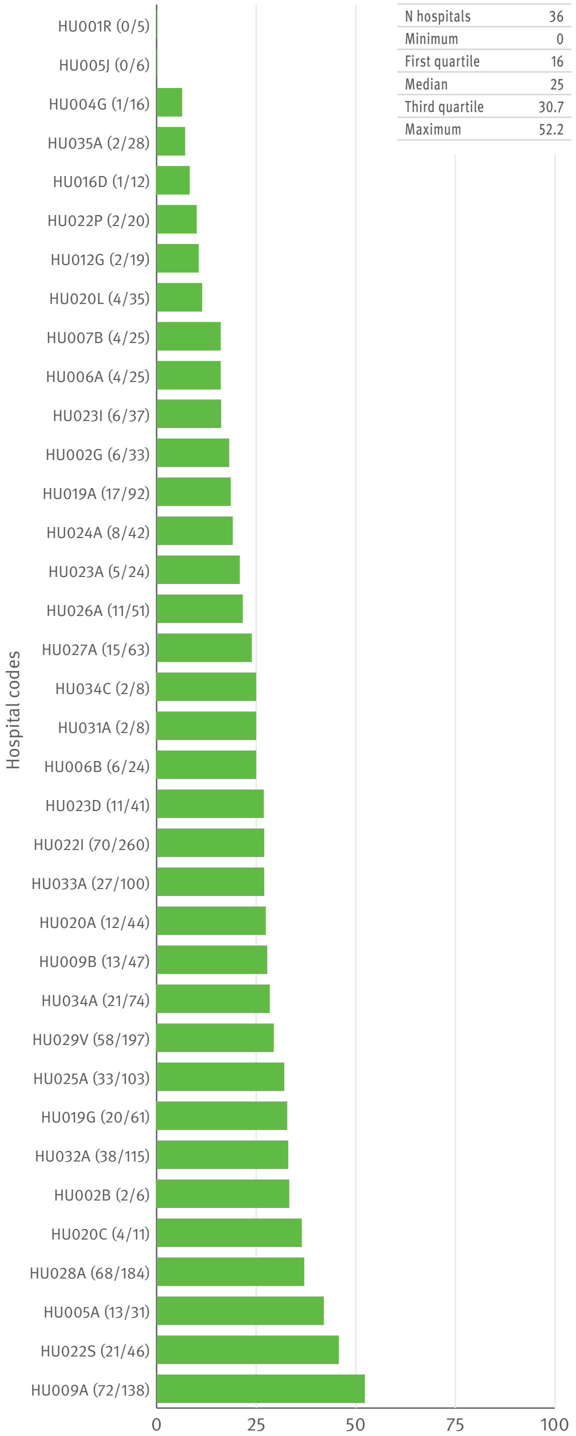
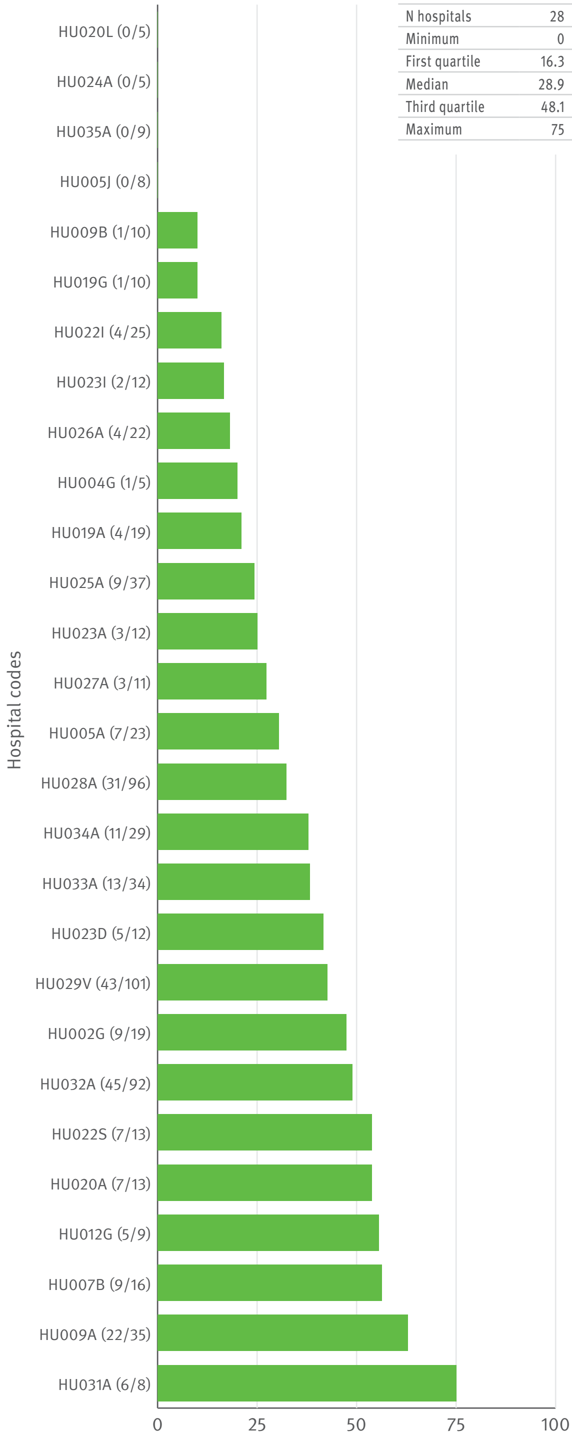


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)



N hospitals	36
Minimum	0
First quartile	16
Median	25
Third quartile	30.7
Maximum	52.2

Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



N hospitals	28
Minimum	0
First quartile	16.3
Median	28.9
Third quartile	48.1
Maximum	75

Iceland

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	2	43	2	60	2	83	2	25	-	-	-	-
2003	2	35	2	64	2	100	2	22	-	-	-	-
2004	2	54	2	55	2	119	1	27	-	-	-	-
2005	2	37	2	78	2	130	2	31	2	22	1	13
2006	2	52	2	57	2	130	2	40	2	13	1	9
2007	2	42	2	65	2	105	1	29	2	27	1	11
2008	2	46	2	63	2	123	2	17	1	24	2	7
2009	2	35	2	59	2	111	2	51	2	27	2	16

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	2	<1	2	<1	<1	2	<1	<1
Penicillin RI	5	9	17	8	6	7	9	<1
Macrolides RI	5	20	8	17	10	17	22	3
Staphylococcus aureus								
Oxacillin/Meticillin R	<1	<1	<1	<1	<1	<1	2	<1
Escherichia coli								
Aminopenicilins R	19	42	43	38	45	46	44	50
Aminoglycosides R	1	2	<1	<1	7	6	7	7
Fluoroquinolones R	3	6	2	3	12	17	6	7
Third-gen. cephalosporins R	<1	1	<1	<1	<1	2	<1	2
Enterococcus faecalis								
Aminopenicilins RI	<1	<1	<1	<1	7	<1	<1	<1
HL Gentamicin R	6	<1	5	<1	3	13	30	15
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	29	57	63	80	56	57	43	68
HL Gentamicin R	<1	<1	13	<1	14	14	43	36
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	8
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	<1	<1	<1	4	<1
Fluoroquinolones R	-	-	-	<1	<1	<1	8	<1
Third-gen. cephalosporins R	-	-	-	<1	<1	<1	4	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	8	<1	<1	<1	-
Ceftazidime R	-	-	-	8	<1	<1	<1	6
Carbapenems R	-	-	-	8	<1	<1	<1	<1
Aminoglycosides R	-	-	-	<1	<1	<1	<1	<1
Fluoroquinolones R	-	-	-	<1	<1	<1	<1	13

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=81		*S. aureus* n=122		*E. coli* n=214		*E. faecalis* n=36		*E. faecium* n=32		*K. pneumoniae* n=51		*P. aeruginosa* n=23	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	96	5	100	1	100	7	100	0	100	6	100	2	100	0
CSF	4	0	-	-	<1	0	-	-	-	-	-	-	-	-
Gender														
Male	51	2	61	1	44	9	78	0	50	13	53	0	74	0
Female	49	8	39	0	56	4	22	0	50	0	47	4	26	0
Unknown	1	0	1	16	1	13	1	0	1	0	1	17	1	7
Age (years)														
0–4	22	9	5	0	4	3	4	0	1	0	-	-	2	0
5–19	3	0	9	0	1	0	-	-	1	0	-	-	-	-
20–64	38	9	40	1	31	9	29	0	26	5	37	2	27	0
65 and over	38	7	46	0	64	6	67	0	71	2	63	0	71	3
Unknown	-	-	<1	0	-	-	-	-	-	-	-	-	-	-
Hospital department														
ICU	3	0	4	0	2	0	12	0	12	0	3	0	7	0
Internal med.	8	4	16	0	9	6	16	0	10	0	16	0	16	0
Surgery	<1	0	6	0	4	12	8	0	10	0	8	0	2	0
Other	64	9	49	0	61	8	41	0	48	5	71	1	71	3
Unknown	25	7	25	0	25	3	23	0	21	0	3	0	4	0

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Iceland

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)

N laboratories	2
Minimum	0
First quartile	0
Median	2.8
Third quartile	5.6
Maximum	5.6

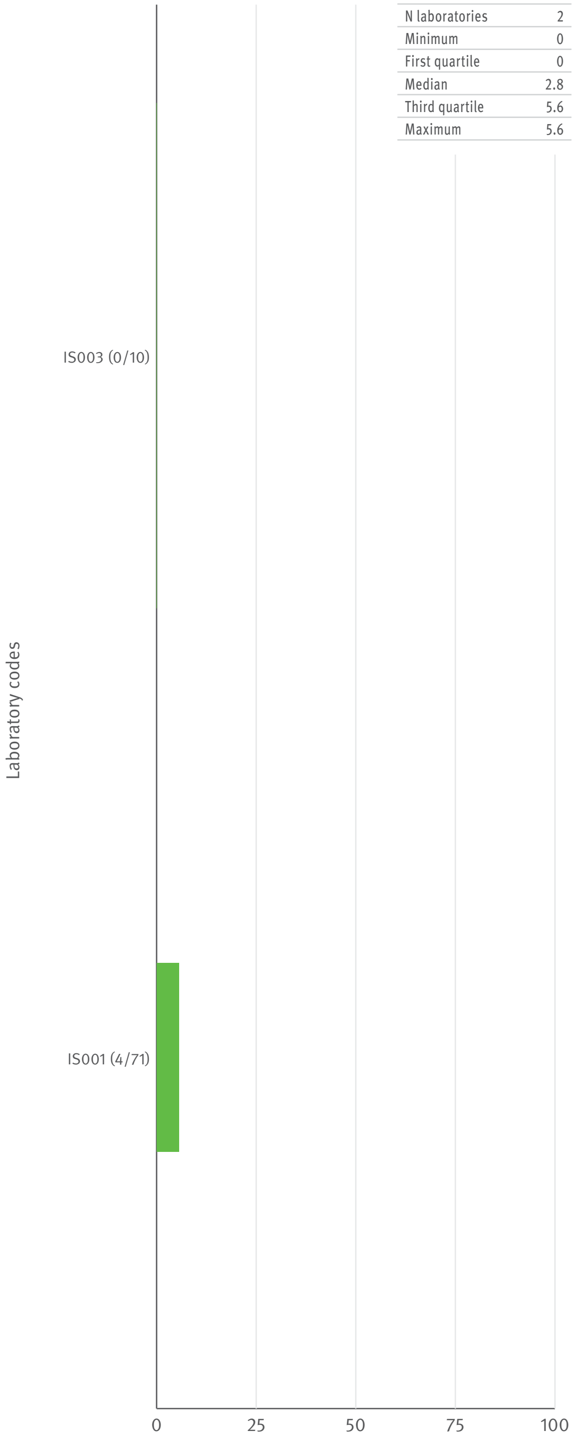


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)

N hospitals	2
Minimum	0
First quartile	0
Median	0.5
Third quartile	1
Maximum	1

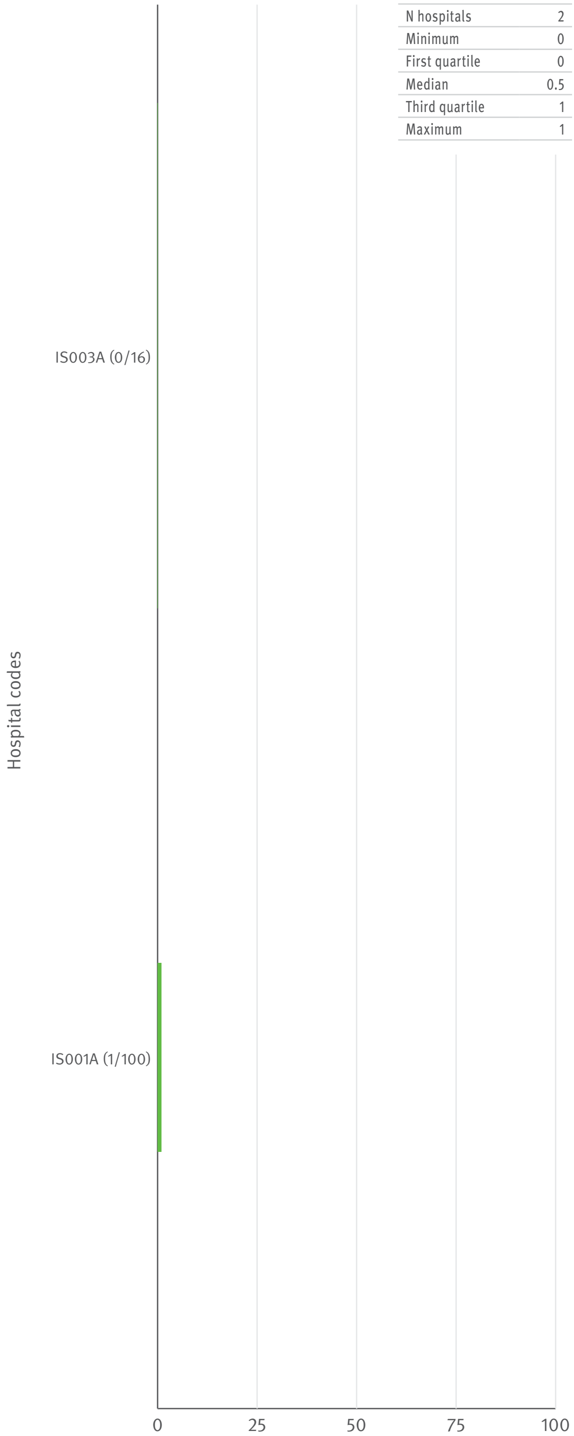


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)

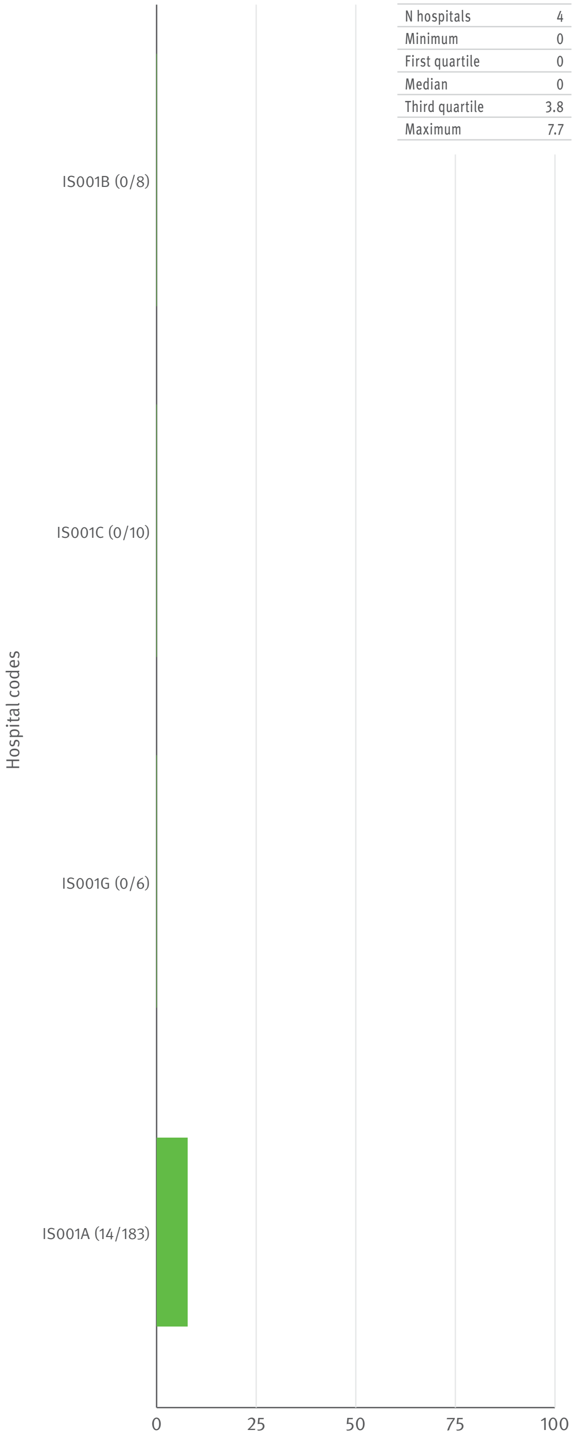
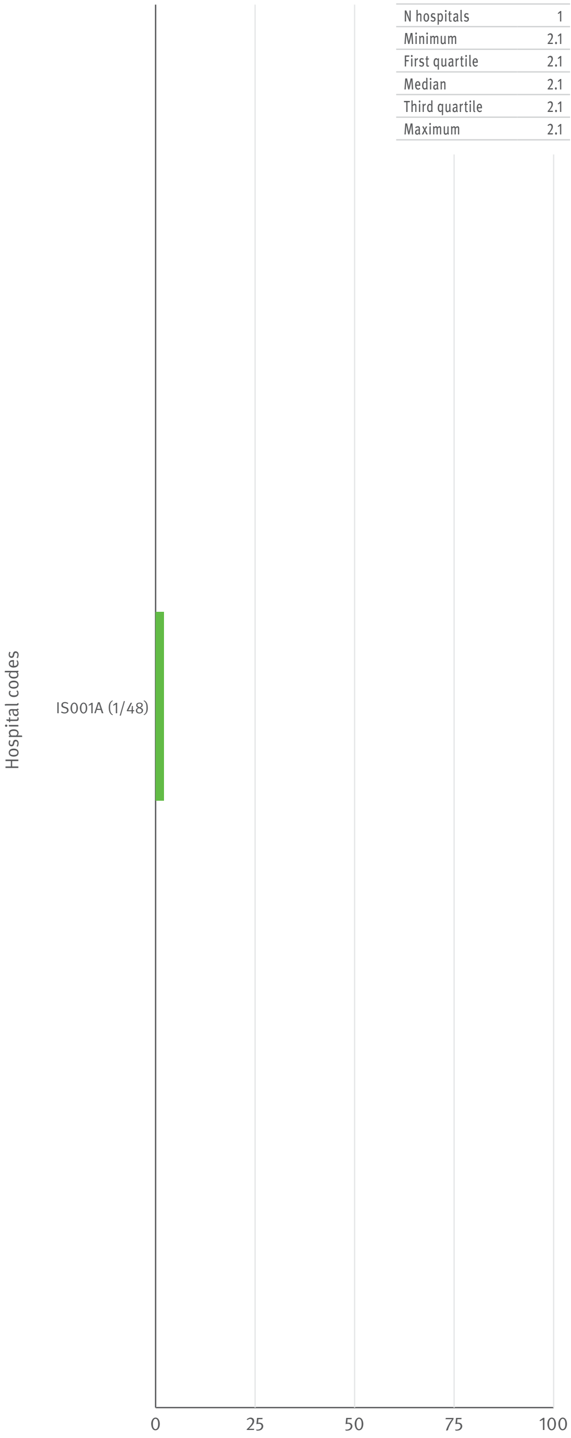


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



Ireland

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	20	277	22	998	20	736	15	250	-	-	-	-
2003	24	363	26	1108	26	978	21	348	-	-	-	-
2004	28	399	38	1286	37	1235	29	418	-	-	-	-
2005	31	397	38	1360	39	1424	33	502	15	42	11	29
2006	32	406	38	1347	39	1638	32	550	28	211	23	128
2007	33	435	41	1332	42	1750	37	598	31	237	29	172
2008	35	442	38	1242	41	1875	37	685	33	307	29	191
2009	34	356	41	1261	41	2012	38	671	37	316	30	236

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	2	3	3	3	3	6	6	6
Penicillin RI	12	12	10	11	16	17	23	20
Macrolides RI	13	12	14	12	16	17	17	17
Staphylococcus aureus								
Oxacillin/Meticillin R	42	42	41	42	42	38	33	27
Escherichia coli								
Aminopenicilins R	62	61	65	67	69	65	67	66
Aminoglycosides R	3	4	5	7	7	10	9	9
Fluoroquinolones R	5	10	12	17	21	21	23	22
Third-gen. cephalosporins R	2	2	2	4	4	5	6	6
Enterococcus faecalis								
Aminopenicilins RI	8	5	<1	4	5	2	<1	3
HL Gentamicin R	39	32	42	42	43	38	31	34
Vancomycin R	2	<1	1	3	3	3	3	<1
Enterococcus faecium								
Aminopenicilins RI	89	91	96	93	94	93	95	93
HL Gentamicin R	17	54	56	52	44	36	27	38
Vancomycin R	11	19	22	31	36	33	35	38
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	5	9	10	9	11
Fluoroquinolones R	-	-	-	3	16	17	11	11
Third-gen. cephalosporins R	-	-	-	7	9	8	11	11
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	7	7	6	5	4
Ceftazidime R	-	-	-	10	6	5	4	6
Carbapenems R	-	-	-	11	9	9	6	8
Aminoglycosides R	-	-	-	7	9	10	6	6
Fluoroquinolones R	-	-	-	14	17	18	16	9

Demographic characteristics

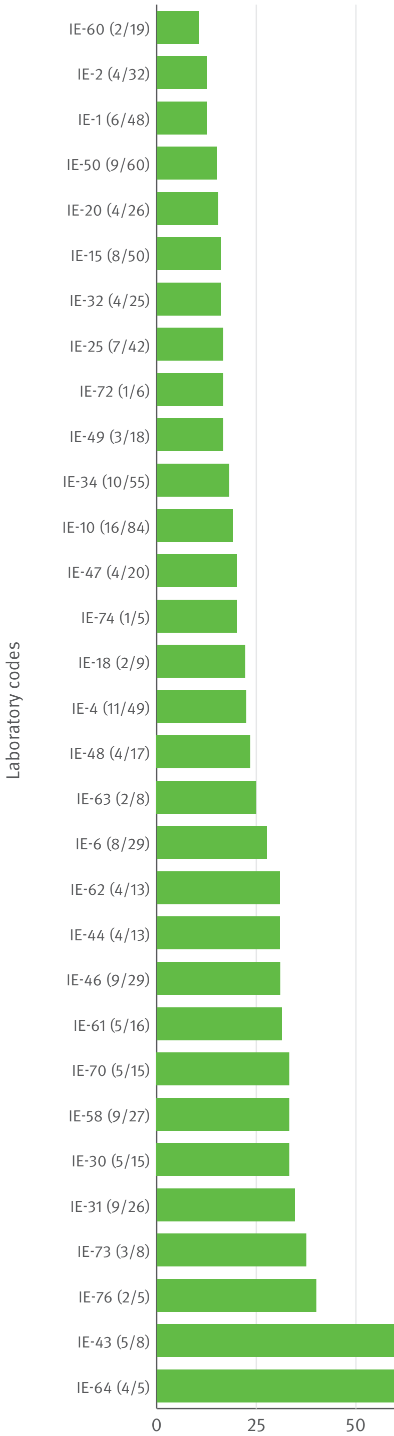
Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=797		*S. aureus* n=2503		*E. coli* n=3861		*E. faecalis* n=578		*E. faecium* n=776		*K. pneumoniae* n=619		*P. aeruginosa* n=399	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	96	22	100	30	100	22	100	2	100	36	100	11	99	8
CSF	4	19	-	-	<1	0	-	-	-	-	-	-	1	0
Gender														
Male	57	21	63	30	45	27	61	1	57	38	58	11	59	9
Female	43	22	37	30	55	18	39	3	43	34	42	11	41	6
Unknown	<1	0	<1	50	<1	25	<1	0	-	-	-	-	-	-
Age (years)														
0–4	16	19	6	13	3	3	8	0	4	7	6	11	4	0
5–19	4	9	4	11	1	5	1	4	2	28	1	25	3	28
20–64	37	12	40	31	32	17	37	3	43	38	41	11	37	11
65 and over	42	18	50	49	62	20	53	2	51	28	52	8	56	6
Unknown	<1	14	<1	43	<1	16	<1	0	<1	33	<1	33	<1	0
Hospital department														
ICU	3	13	4	53	3	20	6	0	10	31	3	9	7	13
Internal med.	17	16	15	43	15	17	14	1	7	30	9	6	11	12
Surgery	2	22	7	49	7	19	7	3	6	18	8	2	6	10
Other	28	15	17	28	22	12	15	1	9	22	19	6	17	9
Unknown	50	15	57	38	54	21	58	3	67	34	61	12	60	7

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

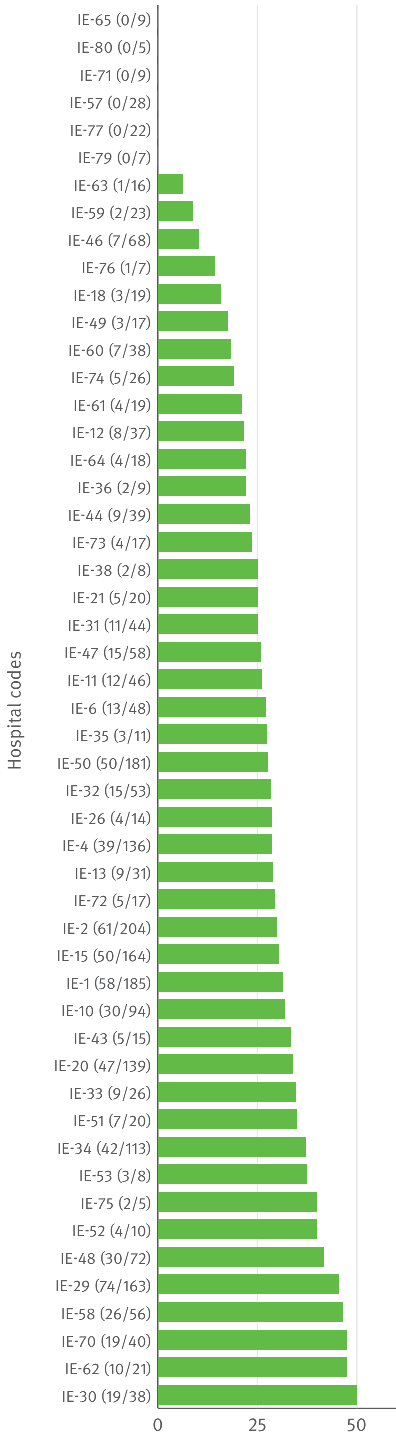
Ireland

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)



N laboratories	31
Minimum	10.5
First quartile	16.7
Median	22.4
Third quartile	33.3
Maximum	80

Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)



N hospitals	51
Minimum	0
First quartile	18.4
Median	27.1
Third quartile	33.8
Maximum	50

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)

N hospitals	53
Minimum	0
First quartile	15.3
Median	20
Third quartile	27.3
Maximum	60

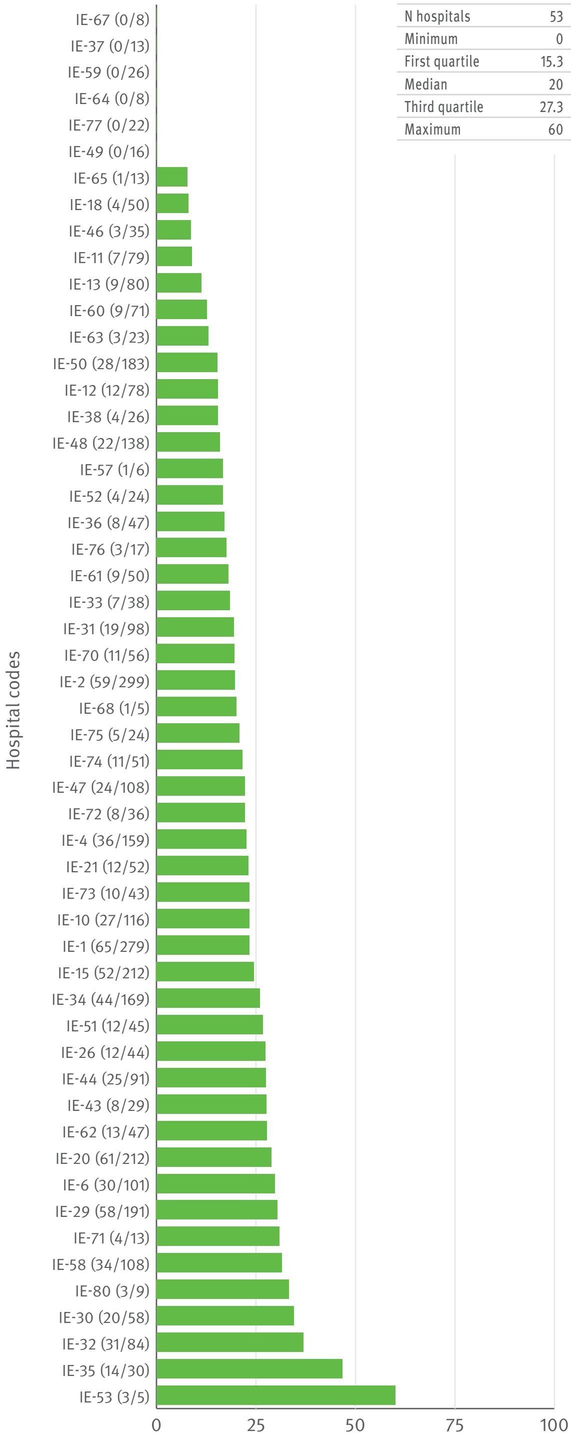
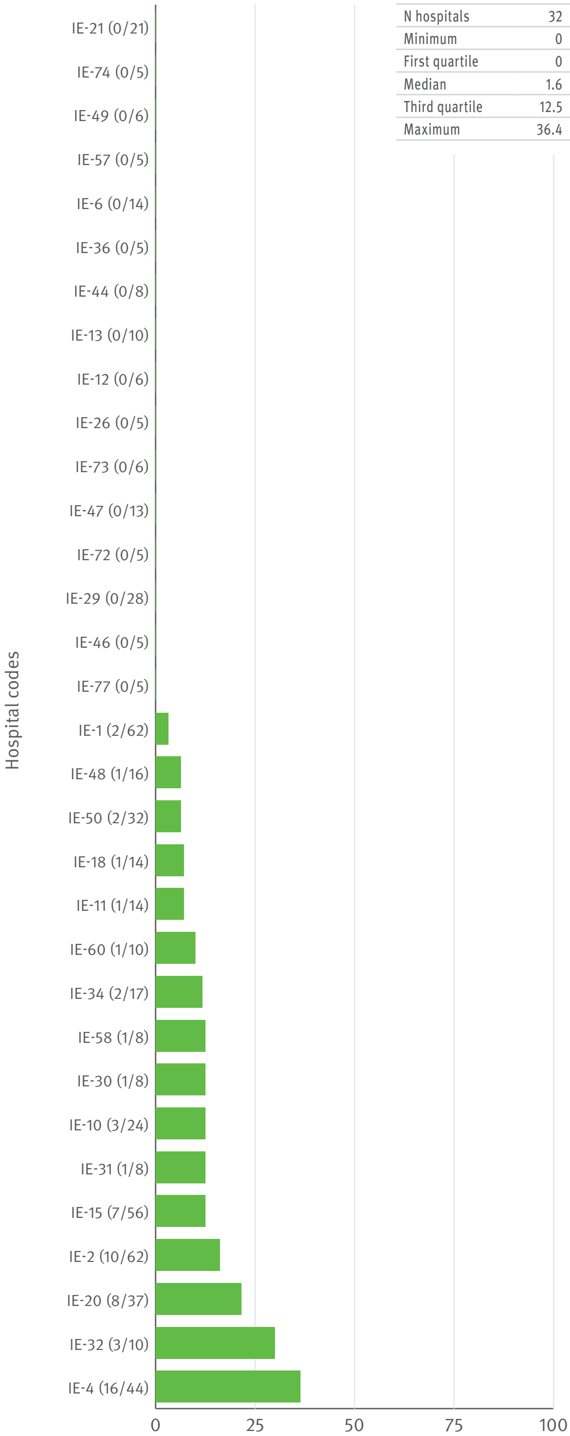


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)

N hospitals	32
Minimum	0
First quartile	0
Median	1.6
Third quartile	12.5
Maximum	36.4



Italy

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	51	300	53	1343	17	618	49	602	-	-	-	-
2003	44	293	46	1480	17	923	44	634	-	-	-	-
2004	37	271	42	1225	14	645	40	576	-	-	-	-
2005	38	331	41	1479	16	1195	40	714	38	344	-	-
2006	34	269	38	1164	13	910	35	650	32	321	12	183
2007	34	298	38	1167	14	1052	36	656	37	391	10	185
2008	27	194	30	939	14	957	31	580	27	331	11	168
2009	21	216	23	987	9	863	22	509	22	313	10	195

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	2	5	5	5	<1	4	3	3
Penicillin RI	11	13	14	9	7	15	10	6
Macrolides RI	32	37	29	31	33	31	26	21
Staphylococcus aureus								
Oxacillin/Meticillin R	38	39	40	37	38	33	34	37
Escherichia coli								
Aminopenicilins R	48	52	53	55	56	58	62	63
Aminoglycosides R	6	10	9	11	8	14	14	13
Fluoroquinolones R	21	25	28	28	27	32	38	36
Third-gen. cephalosporins R	3	6	5	8	7	11	16	17
Enterococcus faecalis								
Aminopenicilins RI	6	4	4	4	4	4	13	20
HL Gentamicin R	38	39	36	38	38	39	47	49
Vancomycin R	<1	2	2	3	3	2	2	3
Enterococcus faecium								
Aminopenicilins RI	79	80	78	77	86	73	64	60
HL Gentamicin R	37	44	39	36	48	53	49	52
Vancomycin R	19	24	21	19	18	11	6	4
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	8	26	25	28	19
Fluoroquinolones R	-	-	-	11	23	27	28	20
Third-gen. cephalosporins R	-	-	-	20	33	35	39	37
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	-	23	20	20	24
Ceftazidime R	-	-	-	-	20	25	24	16
Carbapenems R	-	-	-	-	21	27	33	31
Aminoglycosides R	-	-	-	-	30	27	30	36
Fluoroquinolones R	-	-	-	-	36	35	36	42

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=378		*S. aureus* n=1908		*E. coli* n=1770		*E. faecalis* n=618		*E. faecium* n=403		*K. pneumoniae* n=552		*P. aeruginosa* n=349	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	90	7	100	36	100	37	100	2	100	5	100	38	99	32
CSF	10	16	-	-	<1	0	-	-	-	-	<1	50	1	40
Gender														
Male	39	11	43	37	31	43	47	3	37	7	41	47	33	34
Female	23	8	28	40	34	32	29	1	35	5	25	36	26	31
Unknown	38	5	30	30	35	37	24	2	28	3	34	28	42	30
Age (years)														
0–4	11	12	2	16	2	8	3	0	2	3	5	65	1	30
5–19	3	10	1	22	<1	31	1	6	<1	0	1	50	1	13
20–64	30	12	26	28	17	31	23	3	23	16	25	36	24	41
65 and over	35	9	46	43	35	27	46	2	43	13	43	27	39	24
Unknown	21	13	25	40	46	32	27	2	31	16	26	31	34	23
Hospital department														
ICU	6	9	11	56	4	28	18	3	13	18	12	52	15	39
Internal med.	31	11	34	35	35	25	29	2	29	14	28	29	14	17
Surgery	2	13	10	42	7	27	10	2	11	15	10	34	6	34
Other	39	11	17	27	14	34	15	2	15	17	16	34	7	24
Unknown	23	11	28	38	40	33	28	2	32	13	35	27	58	27

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Italy

Figure 1: **Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)**

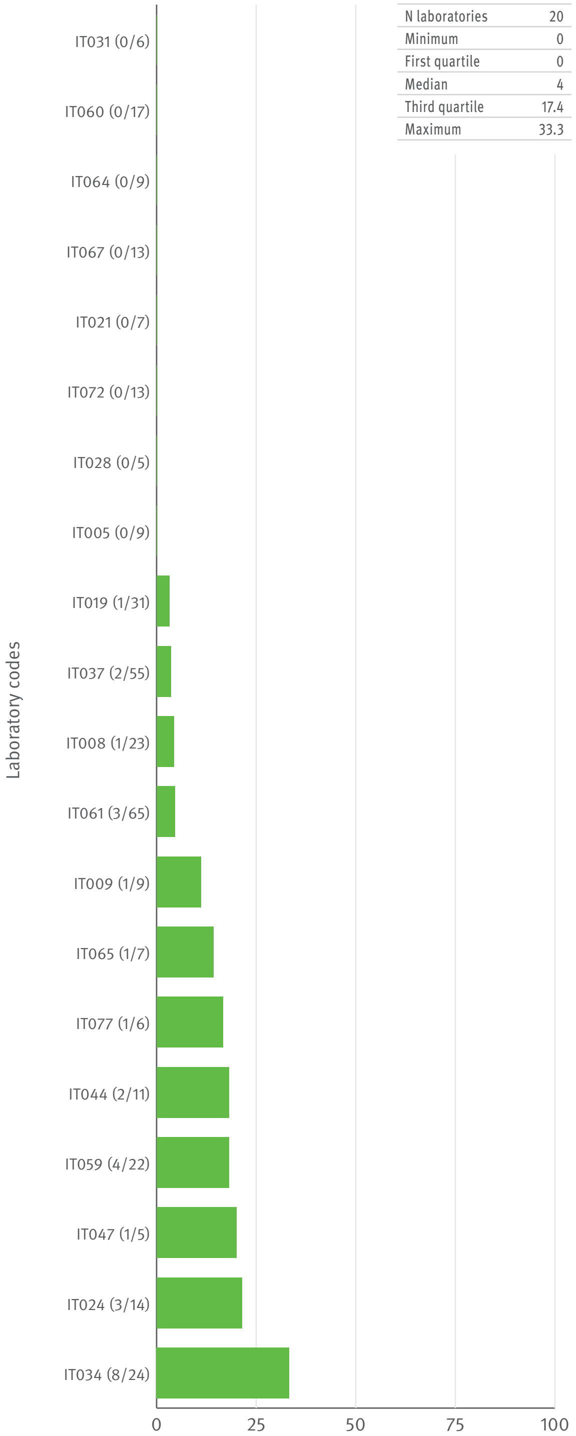


Figure 2: **Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)**

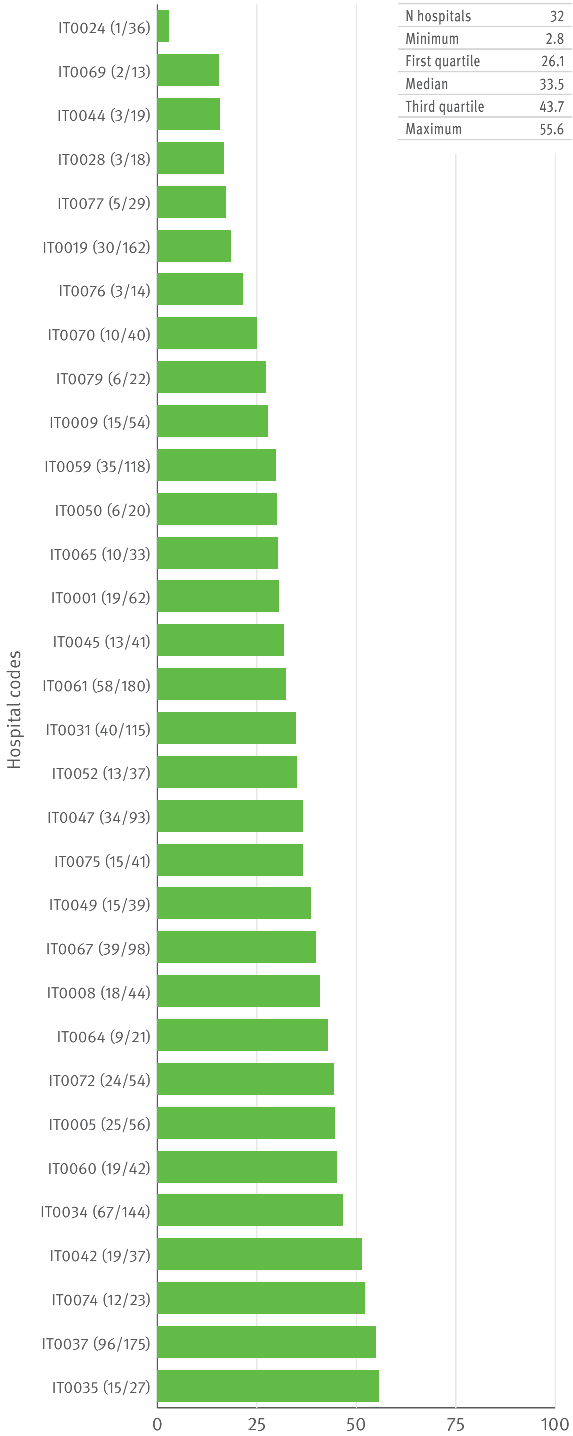
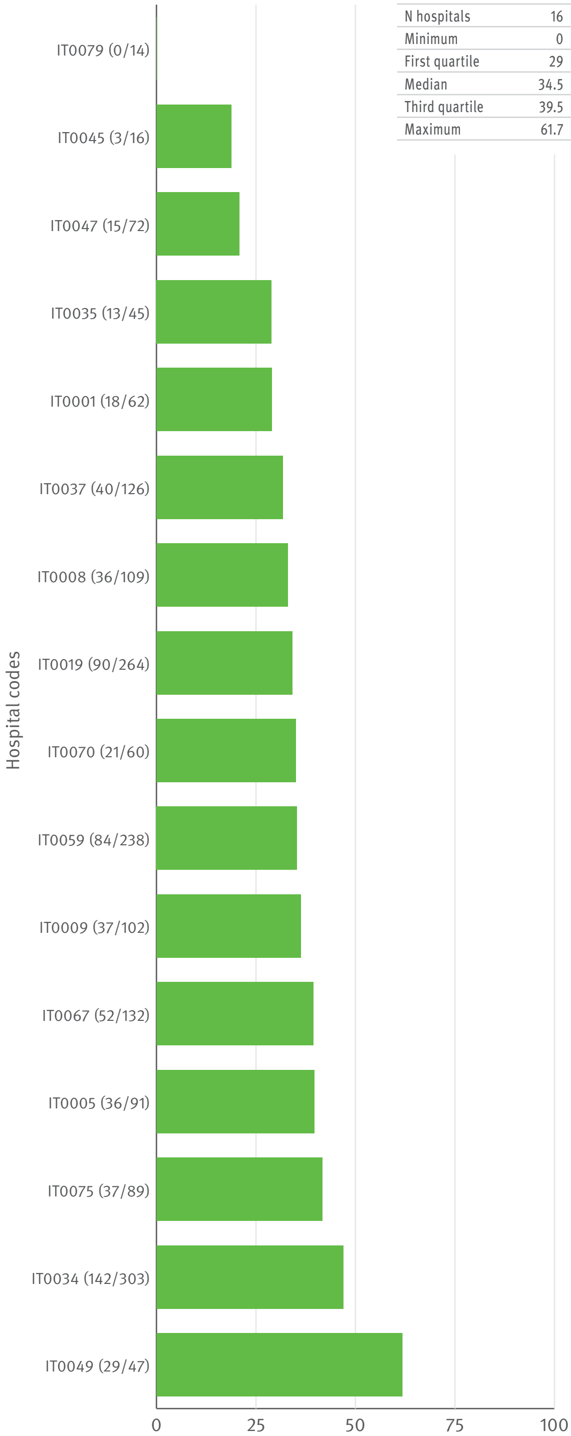
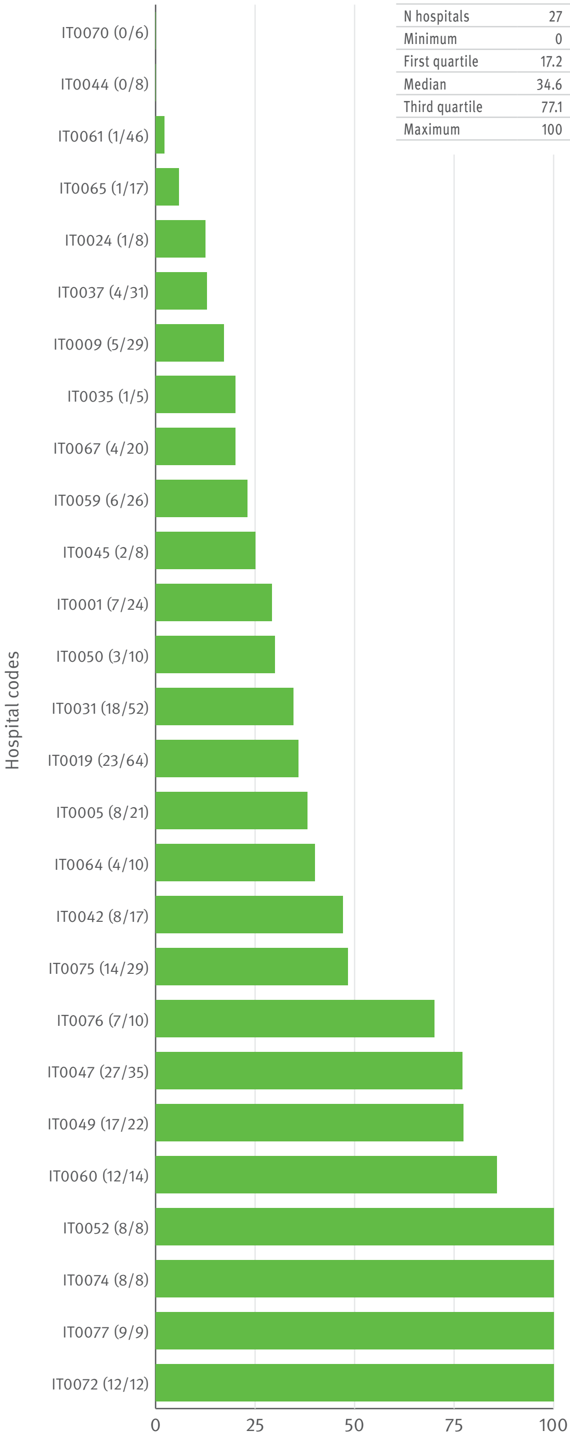


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)



N hospitals	16
Minimum	0
First quartile	29
Median	34.5
Third quartile	39.5
Maximum	61.7

Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



N hospitals	27
Minimum	0
First quartile	17.2
Median	34.6
Third quartile	77.1
Maximum	100

Latvia

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	-	-	-	-	-	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-	-	-	-	-	-
2004	4	17	7	87	-	-	-	-	-	-	-	-
2005	5	36	7	127	-	-	-	-	-	-	-	-
2006	7	37	11	172	10	62	10	56	6	28	9	16
2007	6	31	12	169	9	76	8	57	7	27	6	16
2008	3	18	12	164	10	90	9	51	11	40	6	11
2009	7	30	12	188	9	86	8	48	10	44	7	18

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	-	-	<1	<1	<1	<1	6	<1
Penicillin RI	-	-	<1	<1	<1	<1	6	<1
Macrolides RI	-	-	7	3	3	<1	<1	3
Staphylococcus aureus								
Oxacillin/Meticillin R	-	-	26	20	19	8	12	9
Escherichia coli								
Aminopenicilins R	-	-	-	-	44	43	48	43
Aminoglycosides R	-	-	-	-	5	14	10	13
Fluoroquinolones R	-	-	-	-	10	17	14	24
Third-gen. cephalosporins R	-	-	-	-	6	14	11	12
Enterococcus faecalis								
Aminopenicilins RI	-	-	-	-	9	30	5	12
HL Gentamicin R	-	-	-	-	50	-	27	38
Vancomycin R	-	-	-	-	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	-	-	-	-	94	77	90	82
HL Gentamicin R	-	-	-	-	73	<1	78	79
Vancomycin R	-	-	-	-	<1	<1	7	18
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	-	25	22	52	43
Fluoroquinolones R	-	-	-	-	26	27	45	34
Third-gen. cephalosporins R	-	-	-	-	36	44	58	55
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	-	17	31	30	17
Ceftazidime R	-	-	-	-	29	13	36	17
Carbapenems R	-	-	-	-	13	6	40	7
Aminoglycosides R	-	-	-	-	47	31	44	22
Fluoroquinolones R	-	-	-	-	33	13	45	12

Demographic characteristics

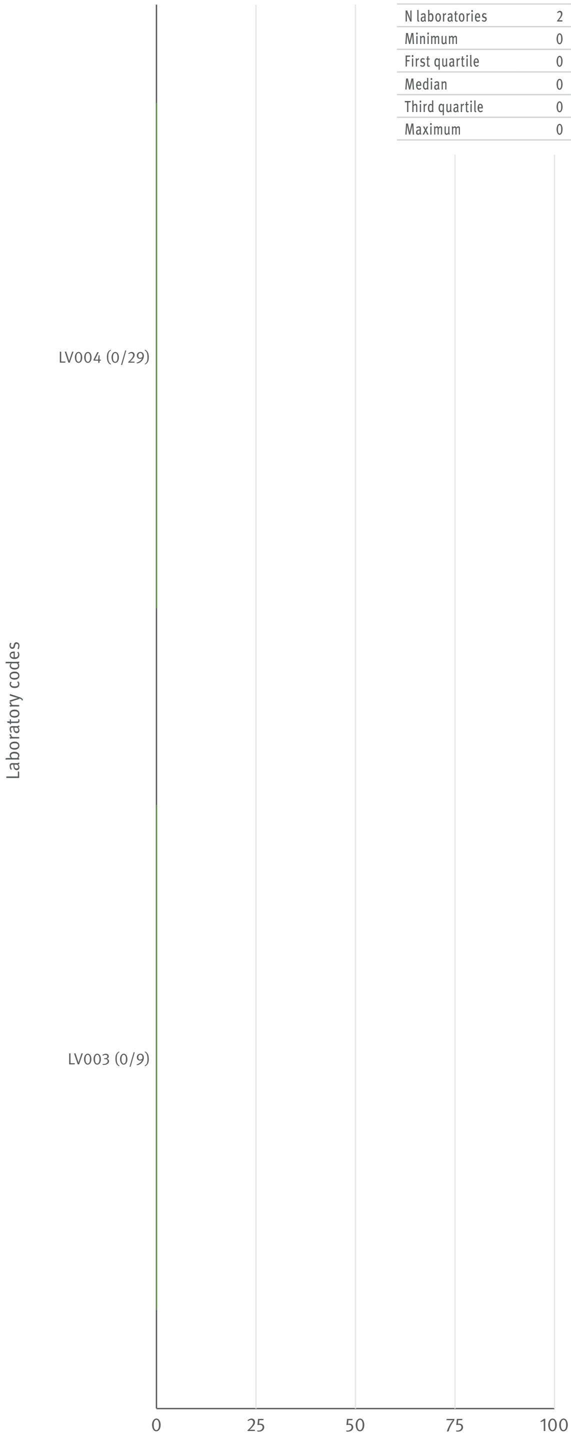
Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=48		*S. aureus* n=350		*E. coli* n=175		*E. faecalis* n=46		*E. faecium* n=52		*K. pneumoniae* n=84		*P. aeruginosa* n=24	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	94	2	100	11	100	19	100	0	100	12	100	56	100	21
CSF	6	0	-	-	-	-	-	-	-	-	-	-	-	-
Gender														
Male	56	4	48	12	35	16	61	0	46	8	61	55	79	26
Female	44	0	51	9	65	20	39	0	54	14	39	58	21	0
Unknown	-	-	<1	0	-	-	-	-	-	-	-	-	-	-
Age (years)														
0–4	3	20	9	4	6	0	12	0	12	0	19	63	18	0
5–19	4	0	4	5	3	10	3	0	-	-	1	0	5	33
20–64	74	0	54	15	50	17	49	0	43	2	46	45	43	17
65 and over	18	0	29	17	38	18	33	0	41	10	31	49	32	17
Unknown	1	0	3	12	3	40	4	0	5	20	2	67	2	0
Hospital department														
ICU	62	0	23	19	23	31	33	0	54	11	35	59	45	12
Internal med.	7	0	28	11	22	12	20	0	13	0	11	20	11	0
Surgery	2	0	8	22	6	17	4	0	8	0	7	70	2	0
Other	30	2	39	13	49	12	42	0	24	0	46	47	43	21
Unknown	-	-	1	0	<1	0	2	0	1	0	1	0	-	-

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

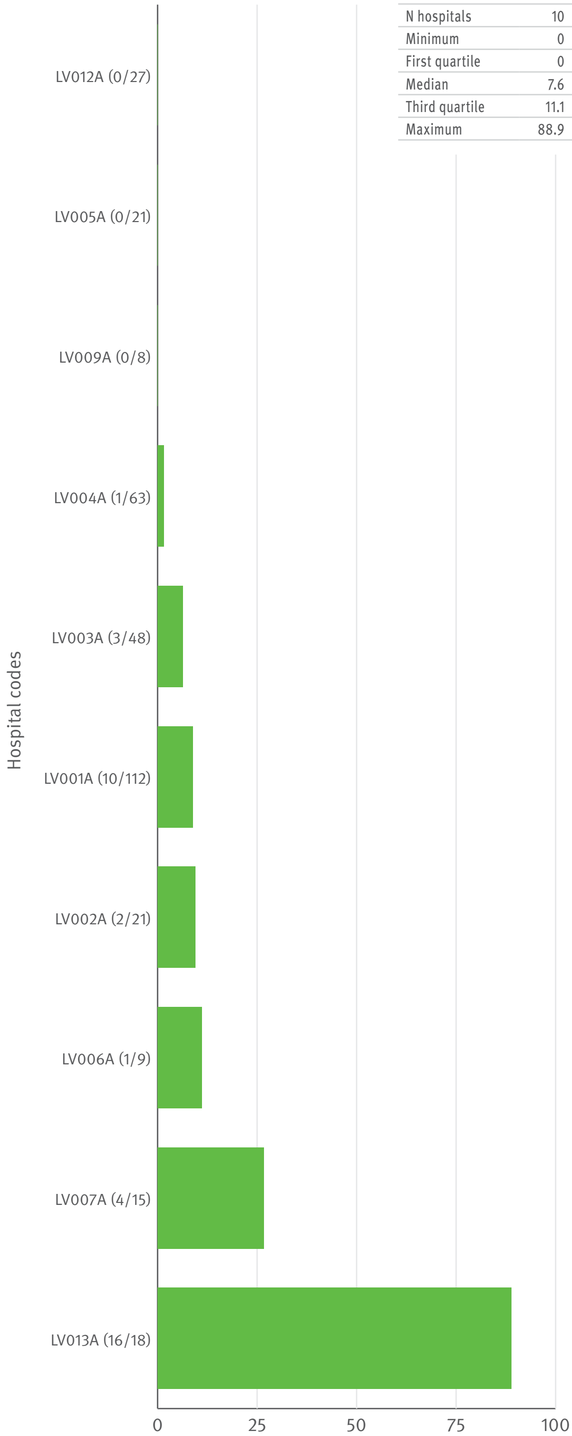
Latvia

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)



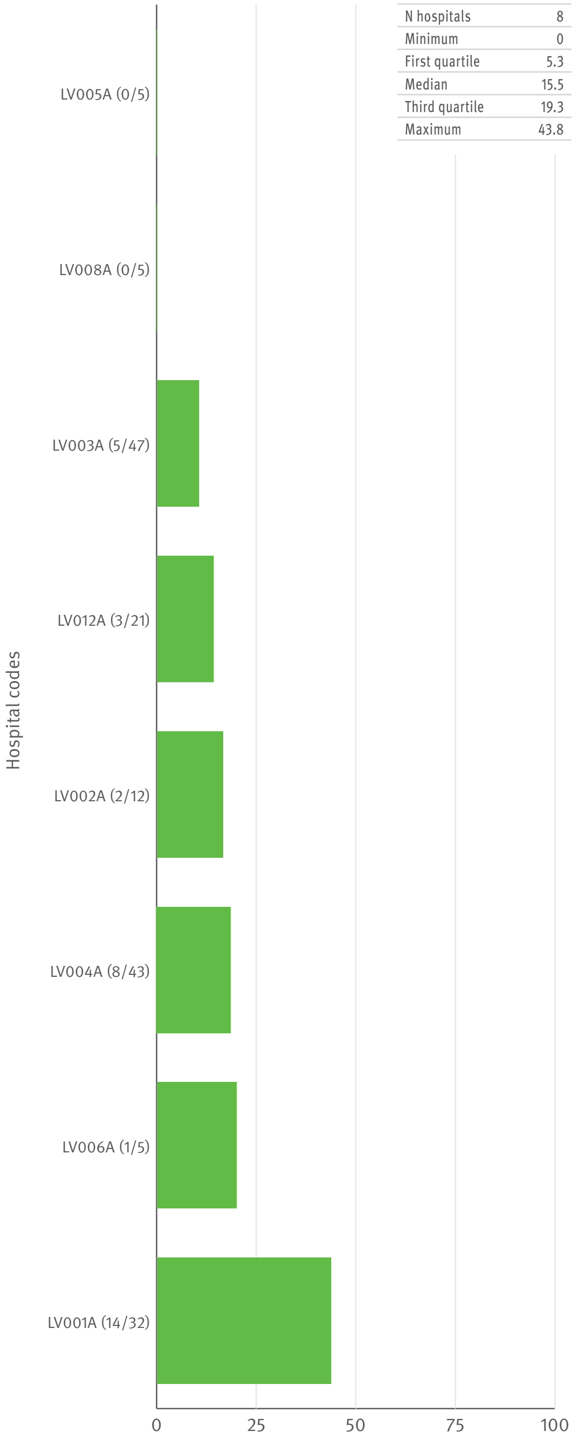
N laboratories	2
Minimum	0
First quartile	0
Median	0
Third quartile	0
Maximum	0

Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)



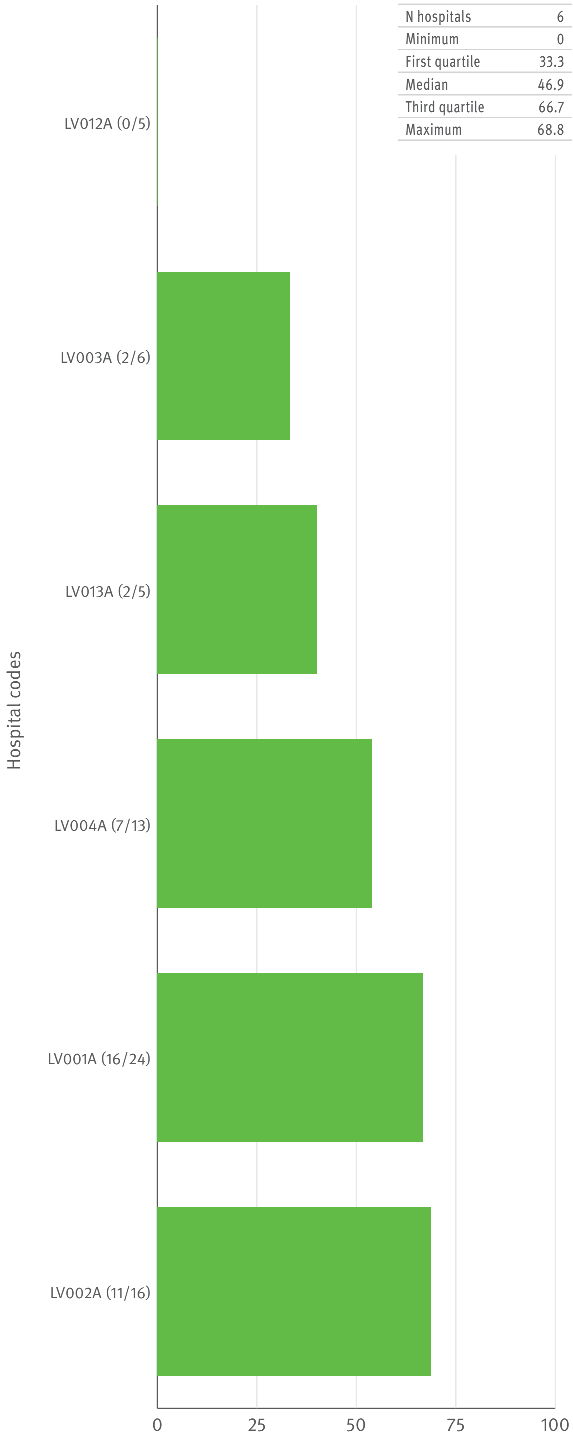
N hospitals	10
Minimum	0
First quartile	0
Median	7.6
Third quartile	11.1
Maximum	88.9

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)



N hospitals	8
Minimum	0
First quartile	5.3
Median	15.5
Third quartile	19.3
Maximum	43.8

Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



N hospitals	6
Minimum	0
First quartile	33.3
Median	46.9
Third quartile	66.7
Maximum	68.8

Lithuania

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	-	-	-	-	-	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-	-	-	-	-	-
2004	-	-	-	-	-	-	-	-	-	-	-	-
2005	-	-	-	-	-	-	-	-	-	-	-	-
2006	9	35	13	167	11	171	8	30	8	35	7	14
2007	10	67	12	240	13	235	10	56	10	41	7	21
2008	11	48	12	278	12	304	10	67	11	54	7	21
2009	10	46	13	258	13	297	11	57	12	68	8	21

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	-	-	-	-	<1	1	<1	7
Penicillin RI	-	-	-	-	16	4	2	9
Macrolides RI	-	-	-	-	<1	9	6	7
Staphylococcus aureus								
Oxacillin/Meticillin R	-	-	-	-	13	9	11	11
Escherichia coli								
Aminopenicilins R	-	-	-	-	55	50	54	58
Aminoglycosides R	-	-	-	-	15	12	12	15
Fluoroquinolones R	-	-	-	-	12	9	14	15
Third-gen. cephalosporins R	-	-	-	-	5	7	6	8
Enterococcus faecalis								
Aminopenicilins RI	-	-	-	-	5	3	5	3
HL Gentamicin R	-	-	-	-	50	41	33	48
Vancomycin R	-	-	-	-	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	-	-	-	-	75	100	88	95
HL Gentamicin R	-	-	-	-	75	81	78	64
Vancomycin R	-	-	-	-	<1	<1	<1	11
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	-	26	37	41	56
Fluoroquinolones R	-	-	-	-	3	8	23	37
Third-gen. cephalosporins R	-	-	-	-	23	27	36	57
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	-	21	5	14	20
Ceftazidime R	-	-	-	-	31	<1	10	14
Carbapenems R	-	-	-	-	21	30	24	19
Aminoglycosides R	-	-	-	-	29	33	38	19
Fluoroquinolones R	-	-	-	-	46	38	35	33

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=48		*S. aureus* n=350		*E. coli* n=175		*E. faecalis* n=46		*E. faecium* n=52		*K. pneumoniae* n=84		*P. aeruginosa* n=24	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	94	2	100	11	100	19	100	0	100	12	100	56	100	21
CSF	6	0	-	-	-	-	-	-	-	-	-	-	-	-
Gender														
Male	56	4	48	12	35	16	61	0	46	8	61	55	79	26
Female	44	0	51	9	65	20	39	0	54	14	39	58	21	0
Unknown	-	-	<1	0	-	-	-	-	-	-	-	-	-	-
Age (years)														
0–4	3	20	9	4	6	0	12	0	12	0	19	63	18	0
5–19	4	0	4	5	3	10	3	0	-	-	1	0	5	33
20–64	74	0	54	15	50	17	49	0	43	2	46	45	43	17
65 and over	18	0	29	17	38	18	33	0	41	10	31	49	32	17
Unknown	1	0	3	12	3	40	4	0	5	20	2	67	2	0
Hospital department														
ICU	62	0	23	19	23	31	33	0	54	11	35	59	45	12
Internal med.	7	0	28	11	22	12	20	0	13	0	11	20	11	0
Surgery	2	0	8	22	6	17	4	0	8	0	7	70	2	0
Other	30	2	39	13	49	12	42	0	24	0	46	47	43	21
Unknown	-	-	1	0	<1	0	2	0	1	0	1	0	-	-

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Lithuania

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)

N laboratories	5
Minimum	0
First quartile	0
Median	0
Third quartile	6.3
Maximum	11.5

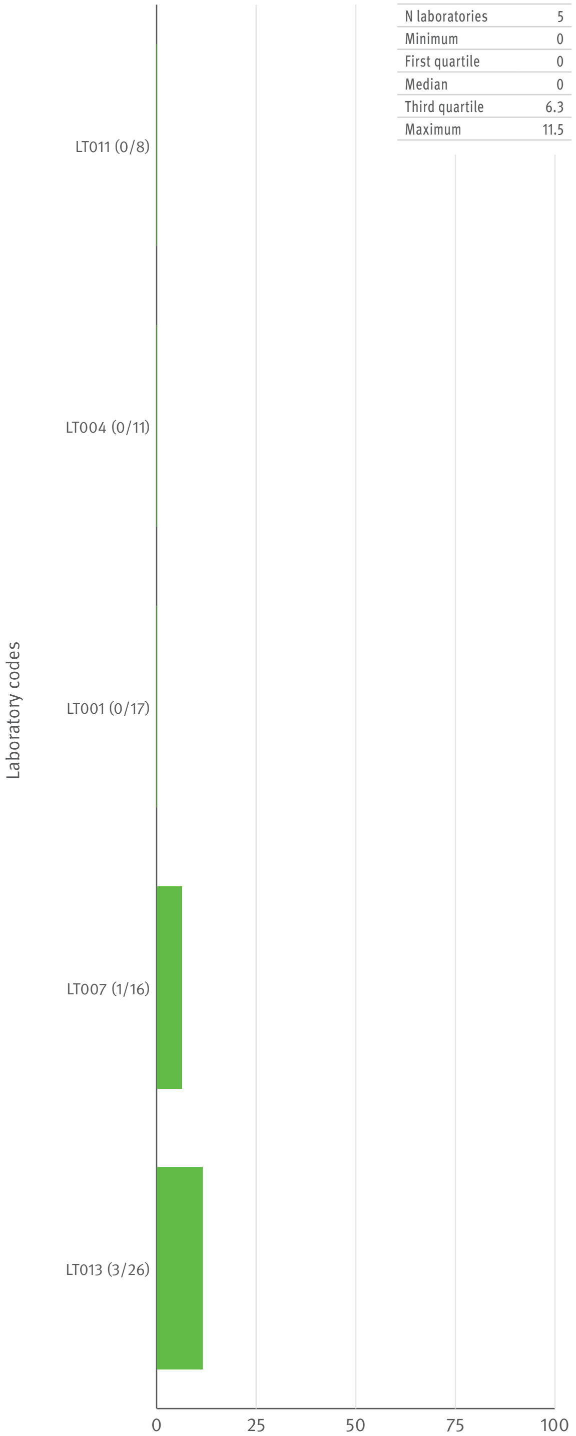


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)

N hospitals	14
Minimum	0
First quartile	0
Median	7
Third quartile	12.5
Maximum	25

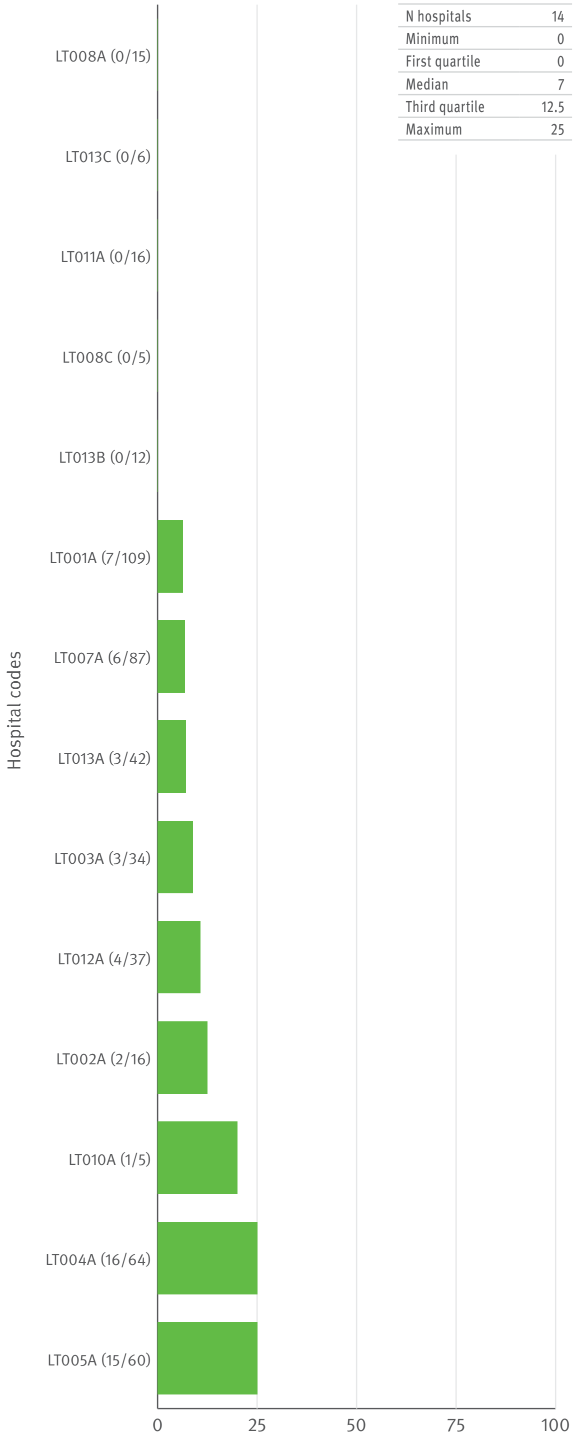


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)

N hospitals	15
Minimum	0
First quartile	5.9
Median	9.5
Third quartile	16.7
Maximum	28.8

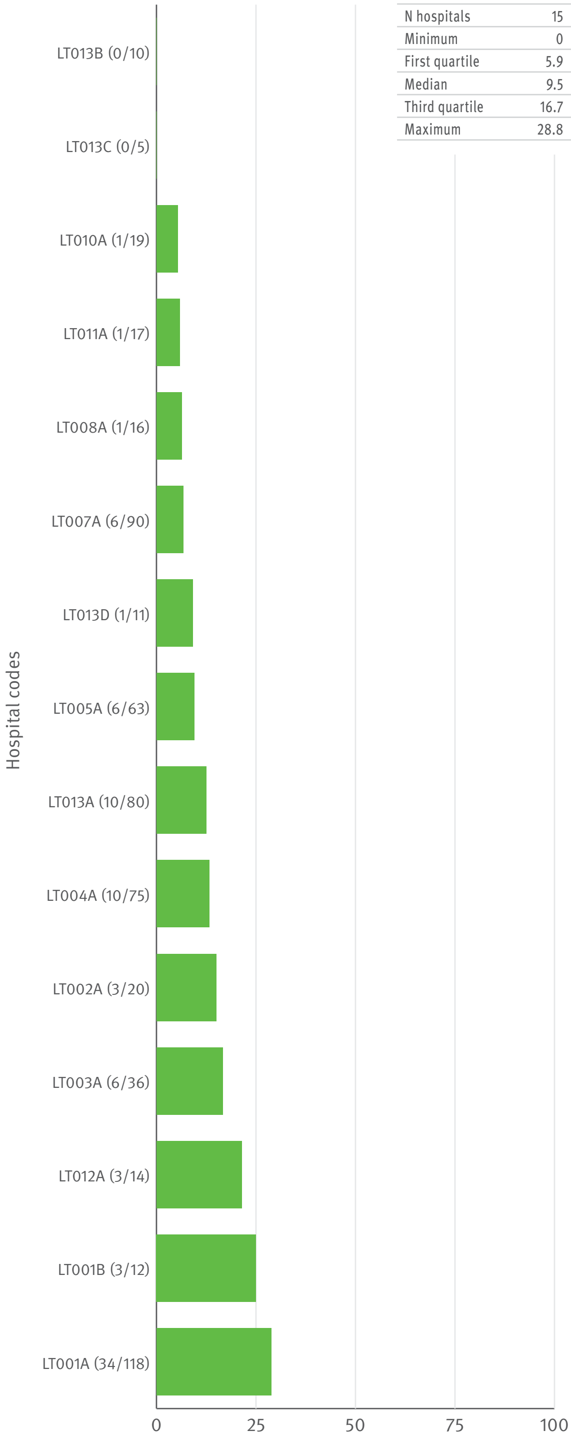
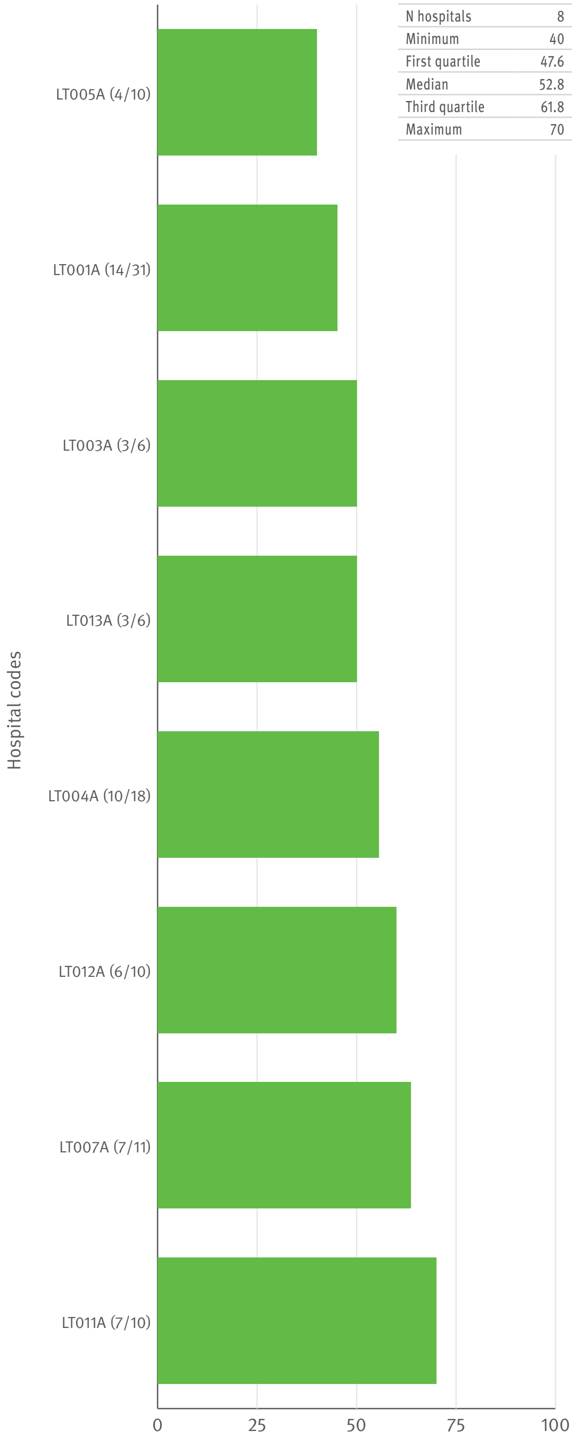


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)

N hospitals	8
Minimum	40
First quartile	47.6
Median	52.8
Third quartile	61.8
Maximum	70



Luxembourg

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	9	33	9	97	9	193	8	30	-	-	-	-
2003	7	54	8	95	8	227	7	41	-	-	-	-
2004	6	36	7	96	7	216	5	28	-	-	-	-
2005	5	47	5	83	5	188	5	31	-	-	1	1
2006	5	31	5	77	5	167	4	42	4	21	4	23
2007	6	48	6	117	6	275	5	37	6	52	5	36
2008	6	59	5	117	6	303	5	61	6	52	4	33
2009	6	67	6	113	6	301	5	54	3	28	6	35

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	7	<1	6	7	5	3	5	11
Penicillin RI	22	15	11	12	5	6	11	19
Macrolides RI	25	28	33	24	26	24	14	16
Staphylococcus aureus								
Oxacillin/Meticillin R	15	21	16	13	19	20	9	13
Escherichia coli								
Aminopenicilins R	43	49	49	49	46	49	56	57
Aminoglycosides R	4	4	4	7	6	5	8	9
Fluoroquinolones R	9	12	18	19	20	21	22	26
Third-gen. cephalosporins R	<1	<1	<1	3	2	4	6	8
Enterococcus faecalis								
Aminopenicilins RI	<1	5	<1	<1	<1	<1	3	10
HL Gentamicin R	17	32	18	24	32	44	17	28
Vancomycin R	<1	<1	<1	<1	<1	<1	3	10
Enterococcus faecium								
Aminopenicilins RI	60	100	50	36	75	67	76	93
HL Gentamicin R	14	<1	<1	23	30	10	21	29
Vancomycin R	<1	<1	<1	<1	<1	<1	5	36
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	-	<1	4	13	18
Fluoroquinolones R	-	-	-	-	6	12	12	21
Third-gen. cephalosporins R	-	-	-	-	10	2	19	25
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	<1	9	15	3	14
Ceftazidime R	-	-	-	<1	10	11	3	14
Carbapenems R	-	-	-	<1	7	20	25	15
Aminoglycosides R	-	-	-	<1	4	22	6	9
Fluoroquinolones R	-	-	-	<1	10	36	15	11

Demographic characteristics

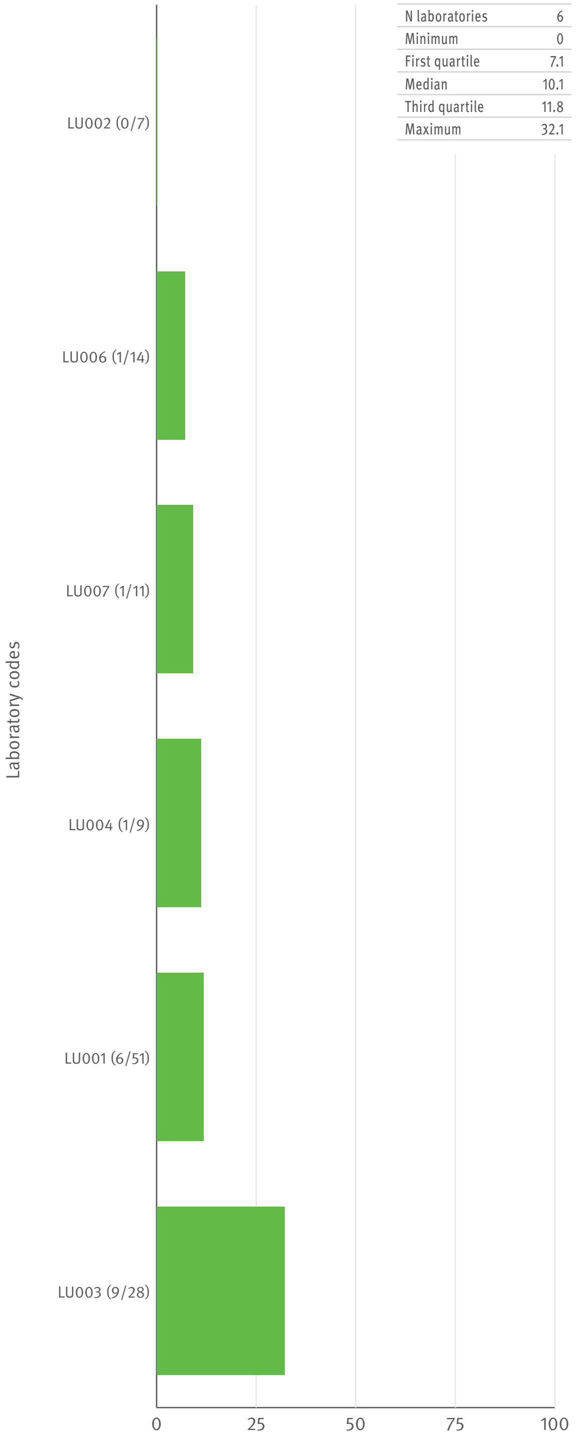
Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=120		*S. aureus* n=230		*E. coli* n=603		*E. faecalis* n=78		*E. faecium* n=36		*K. pneumoniae* n=80		*P. aeruginosa* n=41	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	98	15	100	11	100	24	100	6	100	17	98	22	100	17
CSF	3	33	-	-	<1	50	-	-	-	-	3	0	-	-
Gender														
Male	51	11	49	8	35	25	53	10	36	23	39	19	61	16
Female	38	20	30	16	47	23	32	4	33	25	41	27	34	21
Unknown	11	15	22	12	19	25	15	0	31	0	20	13	5	0
Age (years)														
0–4	12	10	3	11	2	5	3	0	2	0	1	0	2	0
5–19	5	11	4	29	<1	20	-	-	-	-	-	-	-	-
20–64	40	8	40	10	28	16	35	1	31	7	39	19	35	22
65 and over	40	20	47	19	64	21	59	3	64	7	51	12	62	12
Unknown	2	13	6	24	6	24	3	0	2	0	9	0	2	0
Hospital department														
ICU	12	8	11	14	7	14	27	0	22	5	13	15	9	33
Internal med.	15	20	13	22	20	16	14	0	7	0	5	13	9	17
Surgery	3	0	6	17	4	16	4	0	2	0	3	0	-	-
Other	26	9	22	15	20	22	18	0	29	0	19	24	18	8
Unknown	43	15	48	15	48	20	37	6	39	14	59	10	64	14

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

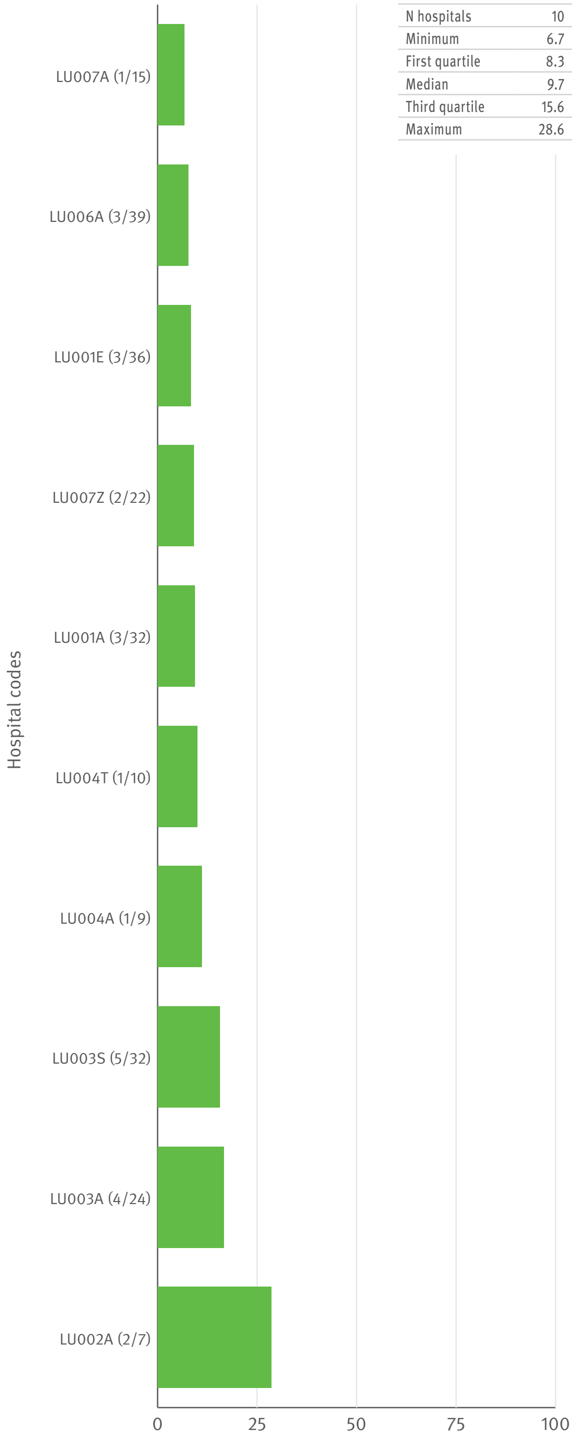
Luxembourg

Figure 1: **Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)**



N laboratories	6
Minimum	0
First quartile	7.1
Median	10.1
Third quartile	11.8
Maximum	32.1

Figure 2: **Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)**



N hospitals	10
Minimum	6.7
First quartile	8.3
Median	9.7
Third quartile	15.6
Maximum	28.6

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)

N hospitals	11
Minimum	15.1
First quartile	20.2
Median	26.5
Third quartile	30.8
Maximum	35.7

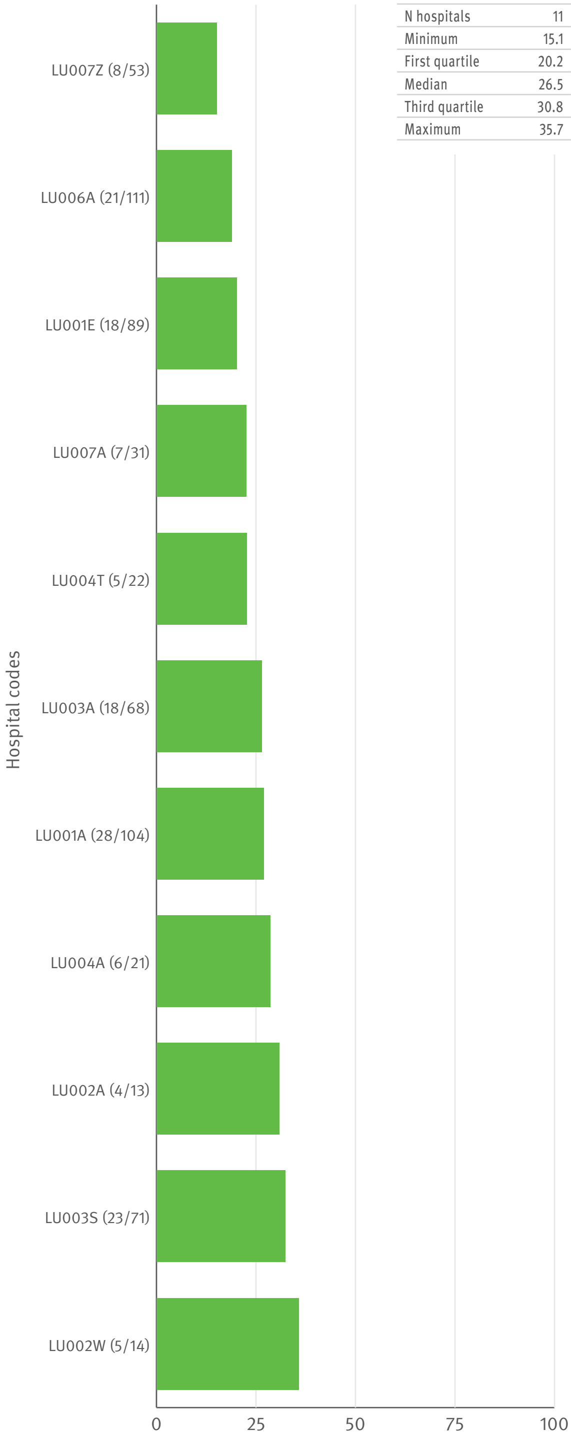
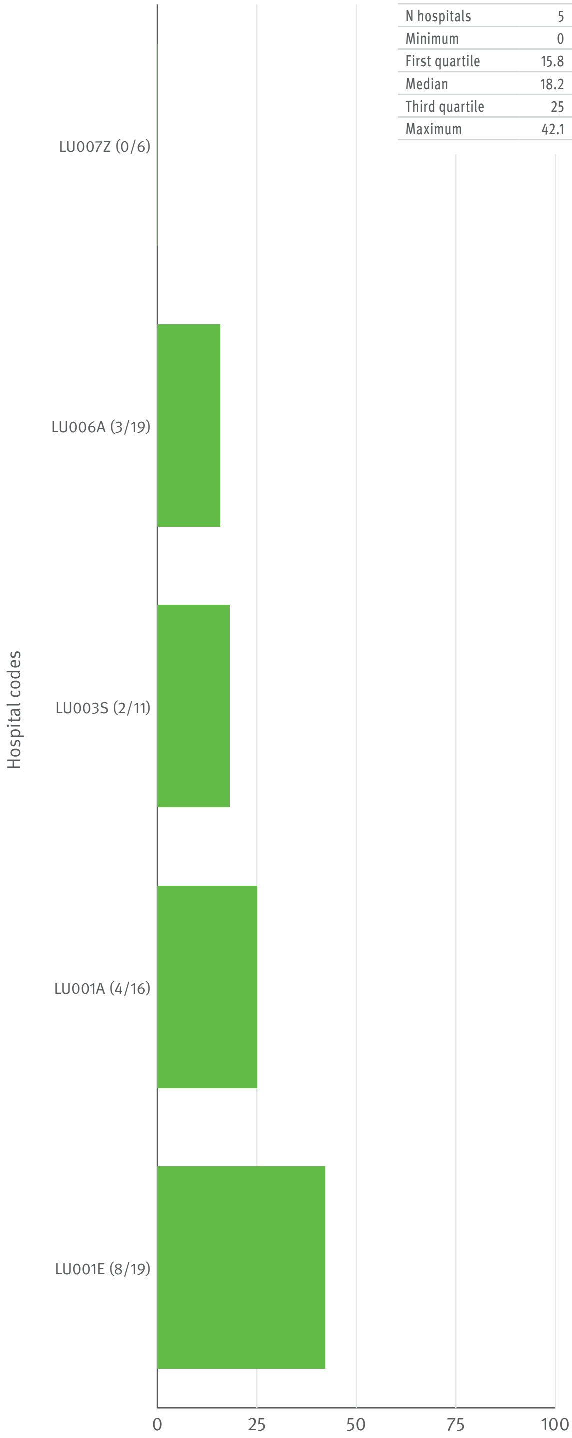


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)

N hospitals	5
Minimum	0
First quartile	15.8
Median	18.2
Third quartile	25
Maximum	42.1



Malta

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	1	12	1	87	1	74	1	33	-	-	-	-
2003	1	9	1	121	1	91	1	26	-	-	-	-
2004	1	18	1	94	1	91	1	41	-	-	-	-
2005	1	13	1	77	1	85	1	38	1	18	1	45
2006	1	31	1	90	1	94	1	53	1	32	1	51
2007	1	13	1	105	1	117	1	37	1	28	1	36
2008	1	17	1	108	1	128	1	32	1	36	1	31
2009	1	8	1	86	1	159	1	36	1	38	1	58

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	8	3	<1	24	<1
Penicillin RI	<1	<1	<1	15	7	<1	47	14
Macrolides RI	25	38	25	46	45	8	35	13
Staphylococcus aureus								
Oxacillin/Meticillin R	43	43	56	56	67	52	56	58
Escherichia coli								
Aminopenicilins R	43	39	48	51	56	54	52	55
Aminoglycosides R	8	18	20	7	15	20	22	21
Fluoroquinolones R	12	24	36	31	32	35	34	31
Third-gen. cephalosporins R	3	2	4	1	4	13	21	15
Enterococcus faecalis								
Aminopenicilins RI	<1	5	<1	3	2	3	<1	5
HL Gentamicin R	17	29	44	32	-	-	-	-
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	33	33	43	25	14	40	60	75
HL Gentamicin R	<1	50	<1	<1	-	-	-	-
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	17	6	<1	<1	<1
Fluoroquinolones R	-	-	-	11	6	11	8	3
Third-gen. cephalosporins R	-	-	-	6	6	7	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	22	47	11	45	36
Ceftazidime R	-	-	-	11	30	3	33	29
Carbapenems R	-	-	-	18	20	11	30	21
Aminoglycosides R	-	-	-	16	8	8	23	21
Fluoroquinolones R	-	-	-	44	24	11	19	22

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=24		*S. aureus* n=194		*E. coli* n=287		*E. faecalis* n=57		*E. faecium* n=11		*K. pneumoniae* n=74		*P. aeruginosa* n=88	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	92	41	100	57	100	32	100	0	100	0	100	0	97	25
CSF	8	0	-	-	-	-	-	-	-	-	-	-	3	0
Gender														
Male	42	30	70	60	47	36	67	0	64	0	62	0	65	26
Female	58	43	30	50	53	28	33	0	36	0	36	0	35	19
Unknown	-	-	-	-	-	-	-	-	-	-	1	0	-	-
Age (years)														
0–4	18	9	9	39	3	0	11	0	4	0	9	15	3	0
5–19	4	20	5	38	2	14	3	0	4	0	2	0	5	17
20–64	33	8	40	49	27	28	39	0	43	0	43	5	41	25
65 and over	42	14	46	62	68	33	46	0	48	0	46	0	51	17
Unknown	3	0	1	25	<1	0	0	0	-	-	1	0	-	-
Hospital department														
ICU	23	7	17	60	8	25	60	0	52	0	20	10	52	26
Internal med.	39	6	44	49	42	31	17	0	28	0	43	2	23	14
Surgery	3	50	19	60	22	34	13	0	11	0	18	0	11	20
Other	23	15	11	49	14	21	5	0	4	0	14	0	9	5
Unknown	12	14	9	56	14	32	6	0	4	0	5	13	5	9

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Malta

Figure 1: **Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)**

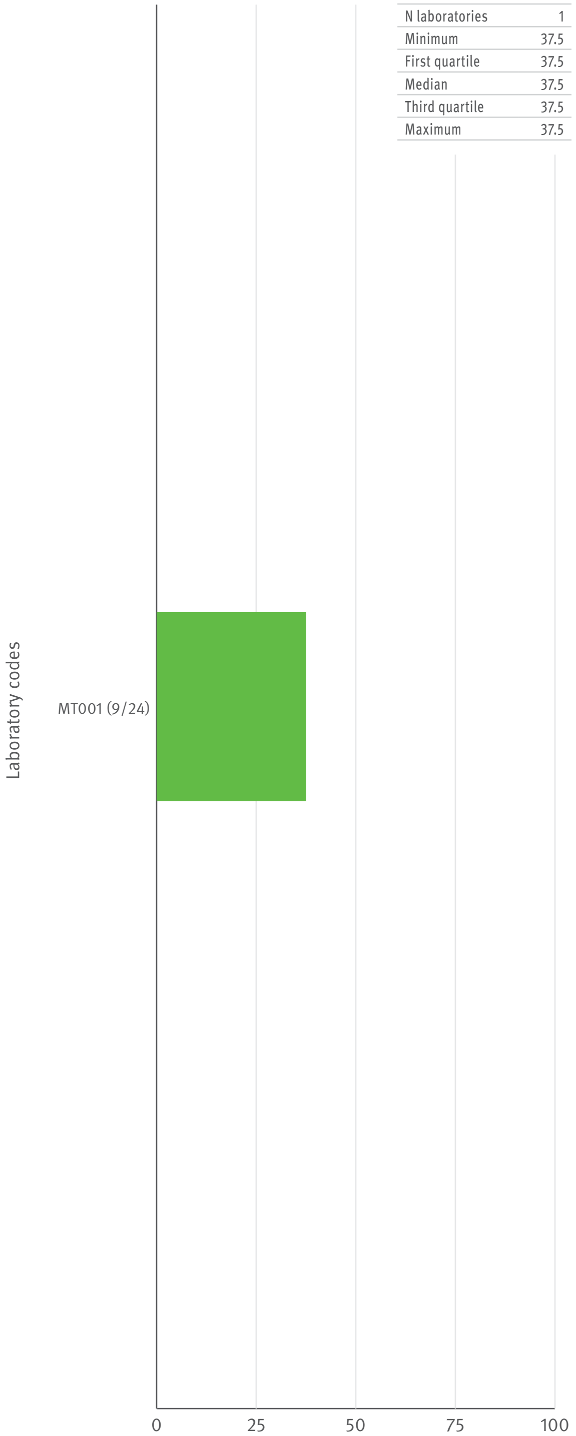


Figure 2: **Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)**

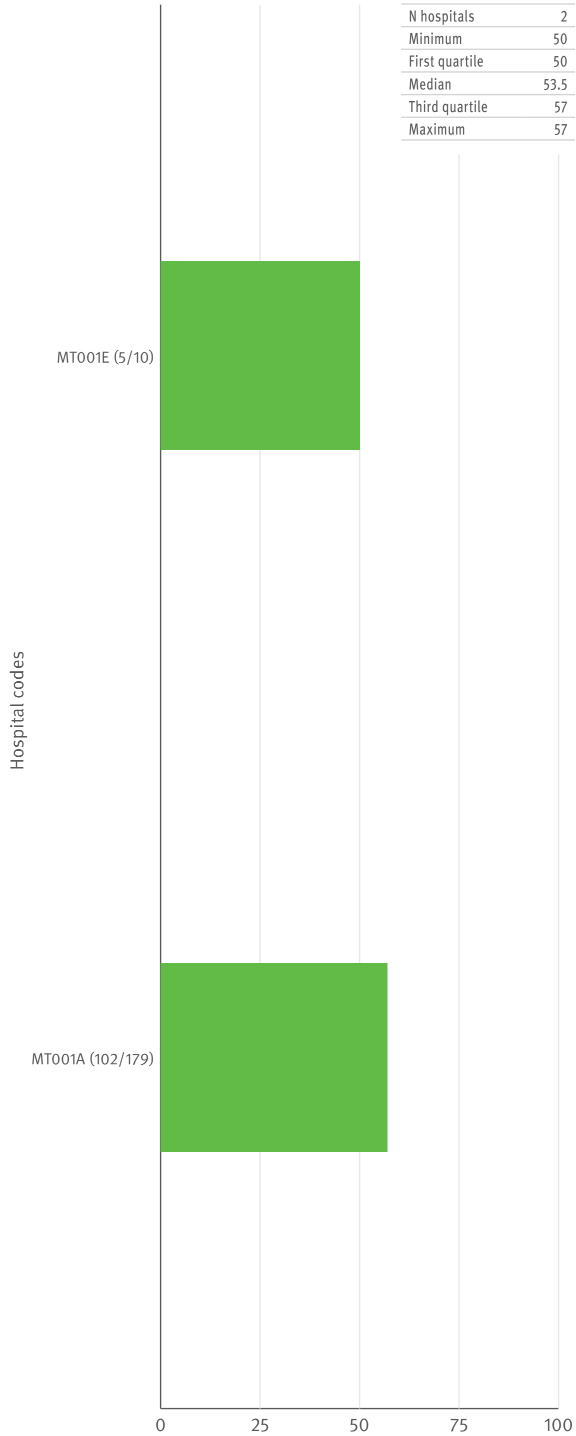


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)

N hospitals	3
Minimum	29.8
First quartile	29.8
Median	43.8
Third quartile	44.4
Maximum	44.4

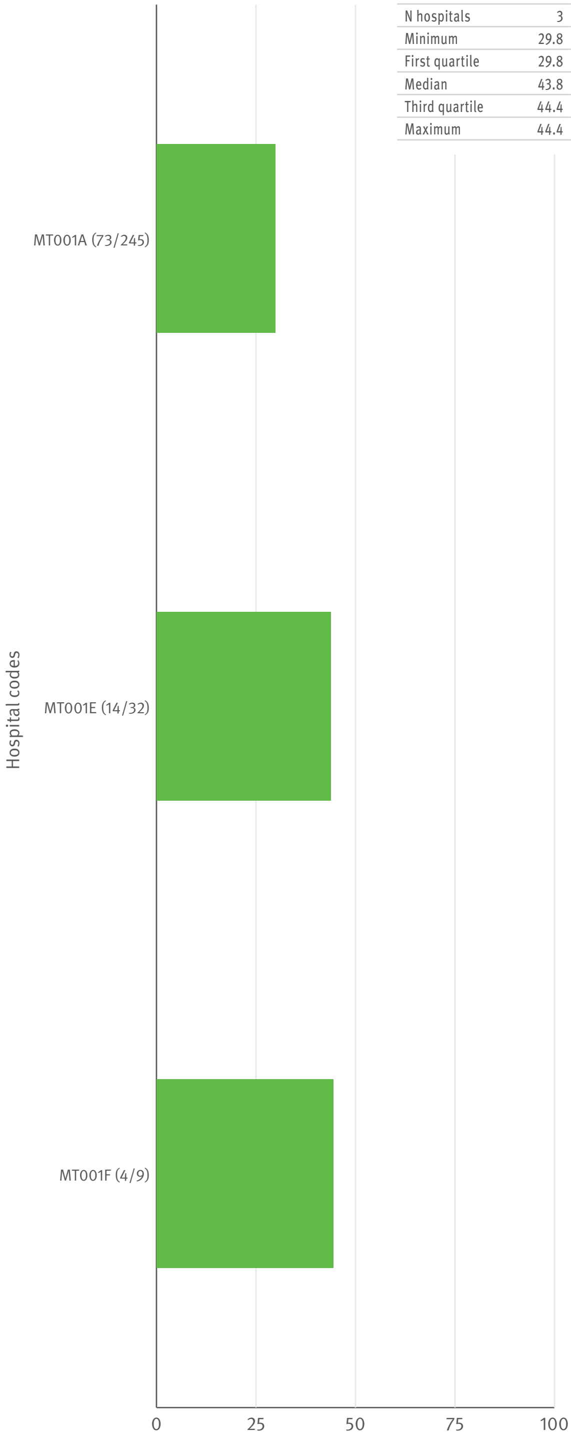
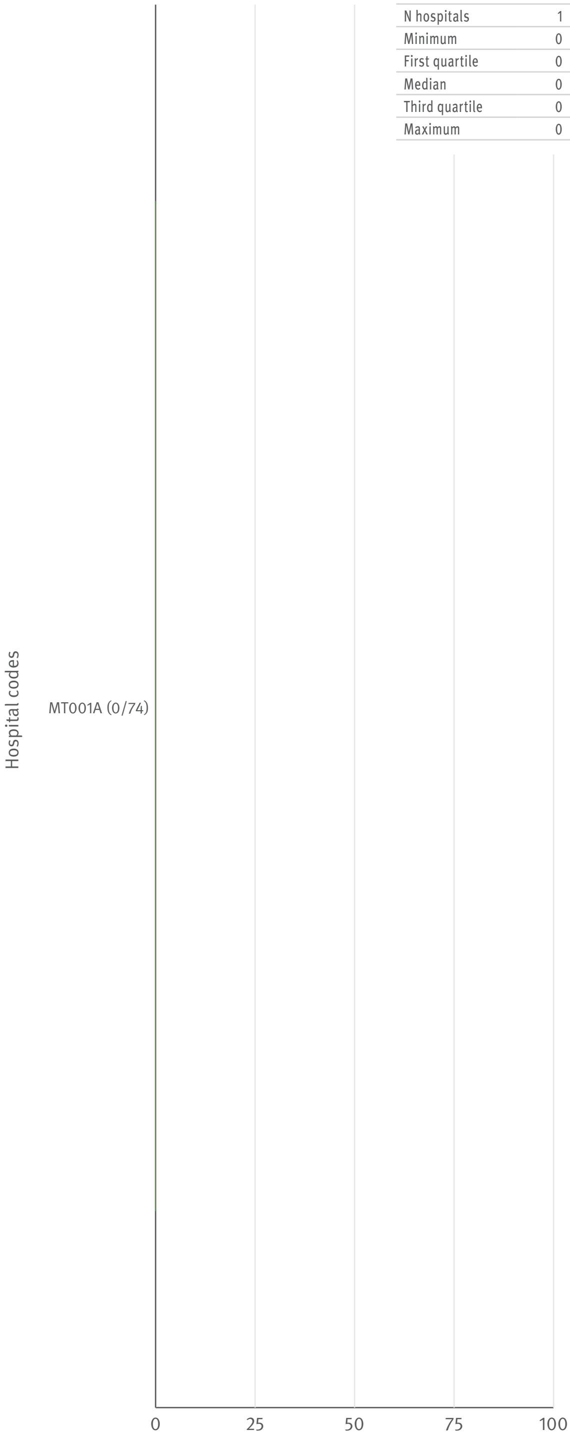


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)

N hospitals	1
Minimum	0
First quartile	0
Median	0
Third quartile	0
Maximum	0



Netherlands

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	23	892	23	1550	22	2427	22	530	-	-	-	-
2003	24	891	23	1422	23	2133	23	480	-	-	-	-
2004	22	758	22	1339	21	2111	22	444	-	-	-	-
2005	23	815	23	1407	23	2201	23	563	16	301	16	210
2006	22	1006	23	1636	22	2905	23	776	18	458	19	330
2007	21	940	21	1471	21	2801	21	827	19	497	19	338
2008	17	723	16	1191	16	2283	17	632	15	463	15	345
2009	17	746	16	1035	16	2398	16	522	15	408	15	235

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	<1	<1	<1	<1	<1
Penicillin RI	1	1	2	1	1	2	2	1
Macrolides RI	7	5	8	11	8	7	7	5
Staphylococcus aureus								
Oxacillin/Meticillin R	<1	1	1	<1	<1	2	<1	<1
Escherichia coli								
Aminopenicilins R	40	45	43	48	47	49	48	45
Aminoglycosides R	2	3	3	4	3	5	6	4
Fluoroquinolones R	5	7	7	10	11	13	14	11
Third-gen. cephalosporins R	1	1	1	2	3	4	5	4
Enterococcus faecalis								
Aminopenicilins RI	3	4	3	3	5	5	<1	2
HL Gentamicin R	39	29	37	38	28	38	34	31
Vancomycin R	<1	1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	21	30	42	61	73	83	86	89
HL Gentamicin R	4	20	20	40	50	62	53	76
Vancomycin R	2	<1	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	5	4	5	7	3
Fluoroquinolones R	-	-	-	6	4	4	7	4
Third-gen. cephalosporins R	-	-	-	4	4	7	8	6
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	4	2	2	6	3
Ceftazidime R	-	-	-	5	5	4	6	4
Carbapenems R	-	-	-	5	2	2	6	3
Aminoglycosides R	-	-	-	7	4	3	4	1
Fluoroquinolones R	-	-	-	9	9	5	8	7

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=1282		*S. aureus* n=2111		*E. coli* n=4614		*E. faecalis* n=530		*E. faecium* n=372		*K. pneumoniae* n=862		*P. aeruginosa* n=579	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	94	2	100	1	100	13	100	0	100	1	99	7	98	5
CSF	6	0	-	-	<1	15	-	-	-	-	1	13	2	11
Gender														
Male	50	2	57	1	47	16	63	0	62	1	57	7	69	5
Female	47	1	39	1	49	9	32	1	38	0	43	6	31	5
Unknown	3	0	3	0	4	15	5	0	-	-	-	-	-	-
Age (years)														
0–4	7	2	9	1	4	3	9	0	7	0	4	7	3	3
5–19	3	1	3	1	1	18	1	0	3	0	1	21	2	10
20–64	38	1	35	1	30	11	37	0	42	1	37	6	36	4
65 and over	49	1	50	1	61	10	49	0	46	1	58	5	60	3
Unknown	3	2	3	0	4	11	4	0	2	0	<1	0	<1	100
Hospital department														
ICU	6	1	8	2	6	11	21	0	26	0	10	9	16	8
Internal med.	18	2	17	1	20	11	13	1	9	0	18	3	17	4
Surgery	3	1	9	2	7	9	9	0	5	2	9	8	10	4
Other	22	2	22	1	20	13	22	0	21	1	21	7	18	3
Unknown	51	1	44	1	47	8	35	1	40	1	42	4	39	2

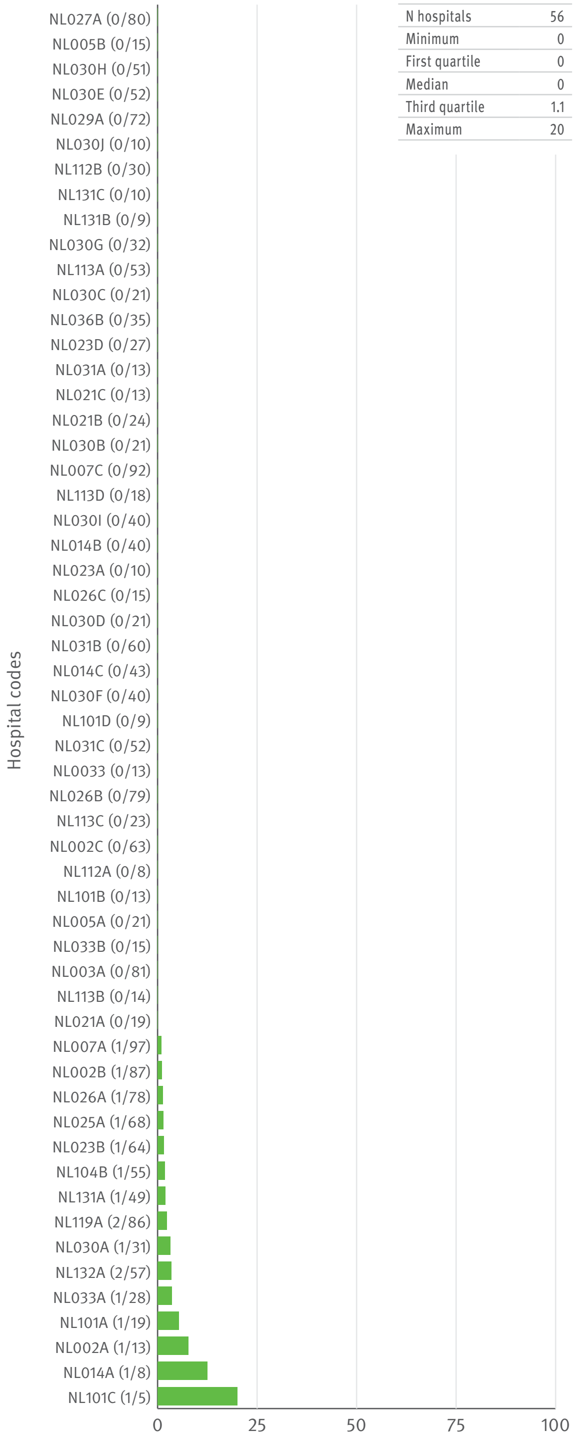
PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Netherlands

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)

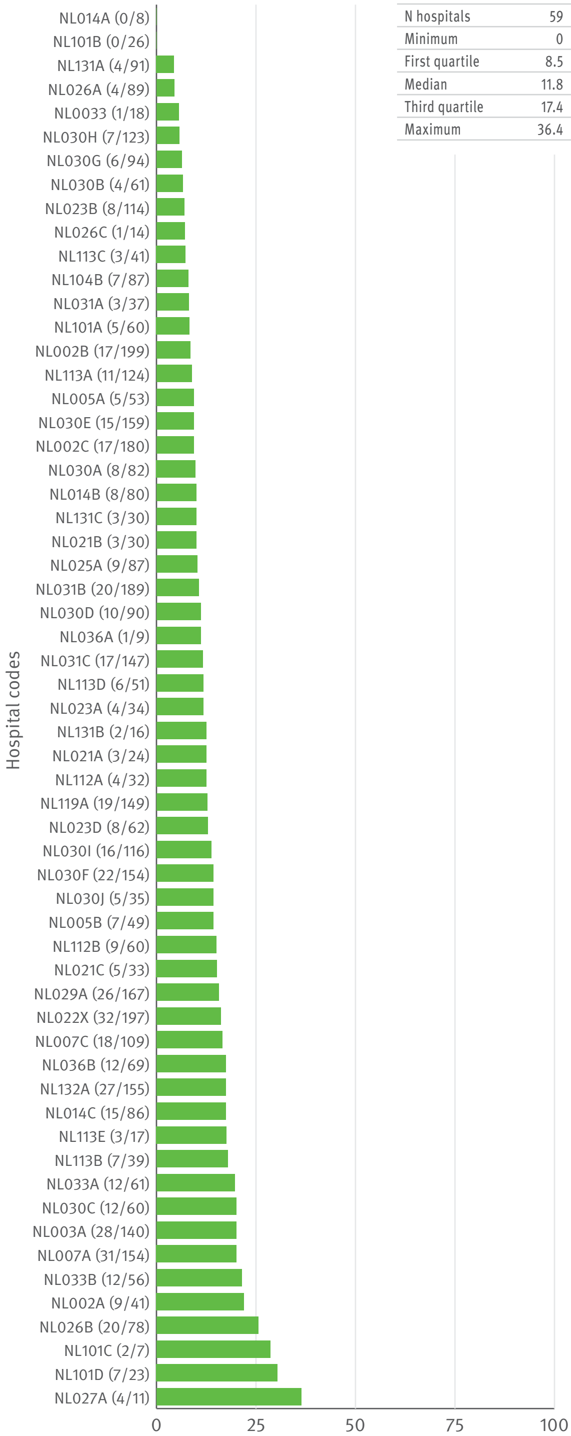
N laboratories	23
Minimum	0
First quartile	0
Median	0
Third quartile	3.6
Maximum	8.6

Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)



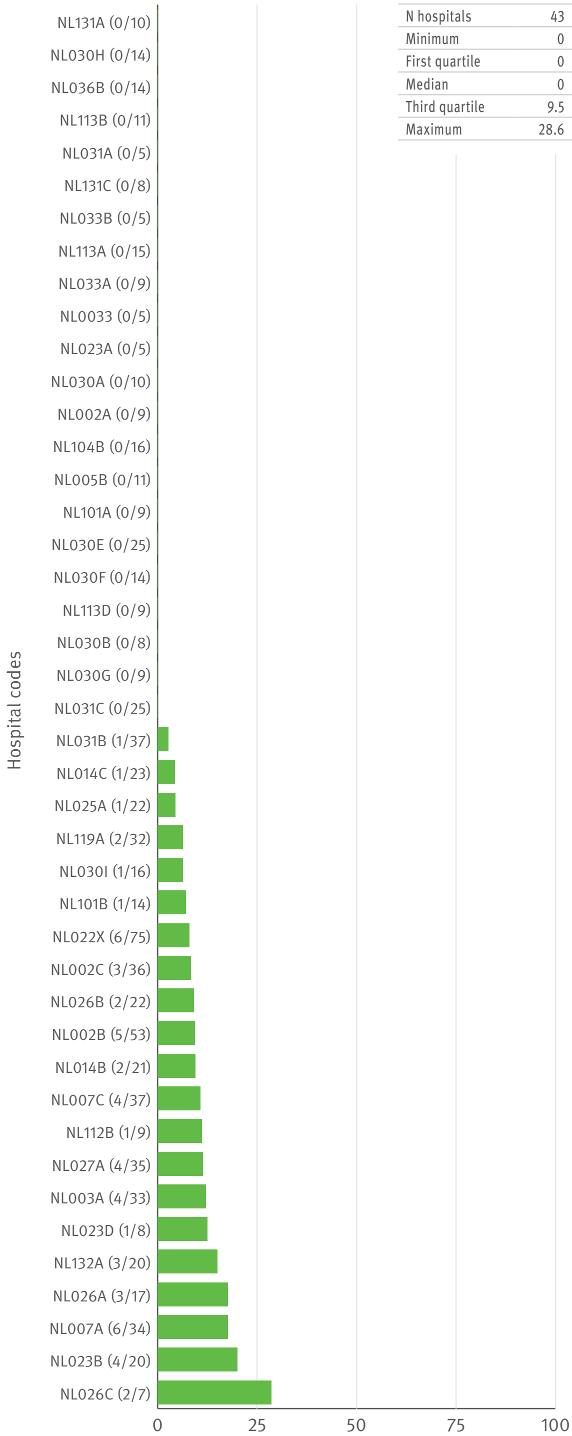
N hospitals	56
Minimum	0
First quartile	0
Median	0
Third quartile	1.1
Maximum	20

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)



N hospitals	59
Minimum	0
First quartile	8.5
Median	11.8
Third quartile	17.4
Maximum	36.4

Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



N hospitals	43
Minimum	0
First quartile	0
Median	0
Third quartile	9.5
Maximum	28.6

Norway

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	11	453	11	502	11	1119	11	177	4	29	4	27
2003	11	512	11	506	11	1179	11	192	4	46	4	25
2004	11	600	11	516	11	1212	11	235	4	51	4	27
2005	11	606	11	553	11	1331	11	304	11	193	11	97
2006	12	601	12	734	12	1574	12	349	12	263	12	96
2007	13	616	13	794	13	1713	13	416	13	320	13	105
2008	13	576	13	837	13	1799	13	403	13	349	13	148
2009	12	554	12	909	12	1846	12	478	12	396	12	166

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	<1	<1	<1	<1	<1
Penicillin RI	<1	<1	2	2	2	2	2	2
Macrolides RI	6	8	8	14	12	10	7	6
Staphylococcus aureus								
Oxacillin/Meticillin R	<1	<1	<1	<1	<1	<1	<1	<1
Escherichia coli								
Aminopenicilins R	29	34	32	34	35	38	38	37
Aminoglycosides R	<1	<1	<1	2	2	3	3	3
Fluoroquinolones R	2	2	4	5	5	7	7	9
Third-gen. cephalosporins R	<1	<1	<1	<1	1	2	3	2
Enterococcus faecalis								
Aminopenicilins RI	4	4	<1	3	3	2	2	<1
HL Gentamicin R	30	38	27	32	33	34	29	36
Vancomycin R	3	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	49	43	80	72	75	81	78	76
HL Gentamicin R	14	14	25	44	45	52	54	38
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae								
Aminoglycosides R	<1	<1	2	3	<1	<1	1	3
Fluoroquinolones R	<1	<1	<1	1	7	5	4	6
Third-gen. cephalosporins R	<1	<1	<1	2	2	2	2	3
Pseudomonas aeruginosa								
Piperacillin R	<1	<1	13	3	3	2	6	4
Ceftazidime R	<1	<1	<1	3	5	3	4	5
Carbapenems R	<1	<1	4	3	9	9	7	5
Aminoglycosides R	<1	<1	4	<1	1	2	<1	<1
Fluoroquinolones R	<1	4	5	4	9	7	3	2

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=1128		*S. aureus* n=1743		*E. coli* n=3616		*E. faecalis* n=616		*E. faecium* n=211		*K. pneumoniae* n=745		*P. aeruginosa* n=312	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	97	2	100	0	100	8	100	0	100	0	100	2	100	6
CSF	3	9	-	-	-	-	-	-	-	-	-	-	<1	0
Gender														
Male	48	2	63	0	45	10	74	0	59	0	60	3	69	6
Female	52	2	37	0	55	6	26	0	41	0	40	1	30	6
Unknown	<1	0	<1	0	<1	9	<1	0	-	-	0	0	1	0
Age (years)														
0–4	7	2	4	1	2	4	2	3	1	0	1	7	2	27
5–19	3	0	3	0	1	4	1	0	<1	0	1	6	2	8
20–64	41	1	35	0	26	7	23	0	31	0	27	3	27	8
65 and over	49	2	57	0	71	5	74	0	68	0	71	1	69	5
Unknown	<1	0	<1	0	<1	33	<1	0	-	-	-	-	-	-
Hospital department														
ICU	10	2	7	0	5	7	9	0	15	0	7	4	10	15
Internal med.	53	1	42	0	46	5	40	0	34	0	41	1	41	5
Surgery	4	3	17	0	17	7	21	0	22	0	20	2	12	6
Other	30	2	31	0	30	6	28	0	28	0	30	2	34	4
Unknown	3	1	3	1	2	4	2	0	2	0	2	3	2	15

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Norway

Figure 1: **Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)**

N laboratories	14
Minimum	0
First quartile	0
Median	1.4
Third quartile	2.8
Maximum	8.2

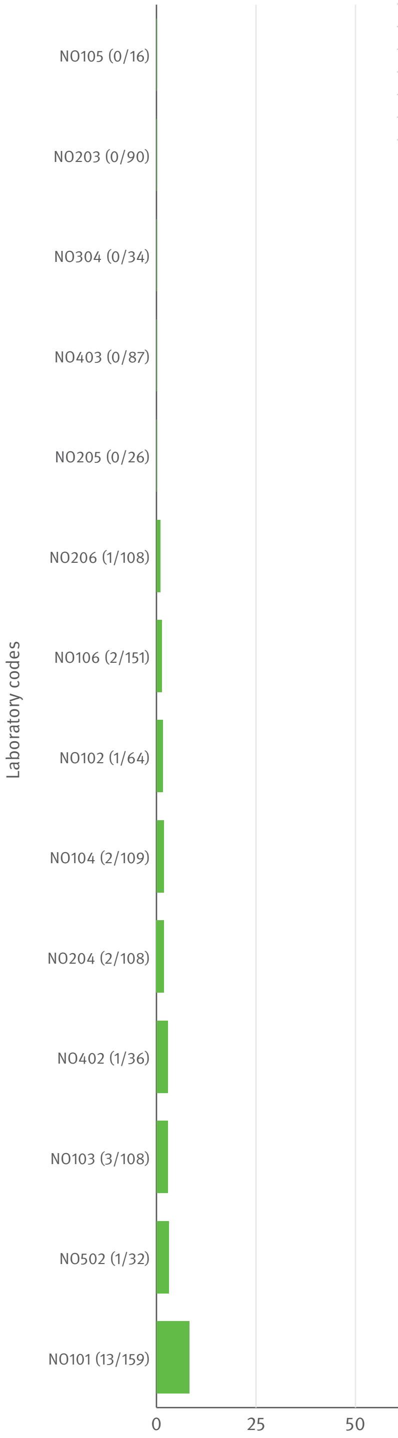


Figure 2: **Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)**

N hospitals	34
Minimum	0
First quartile	0
Median	0
Third quartile	0
Maximum	2.3

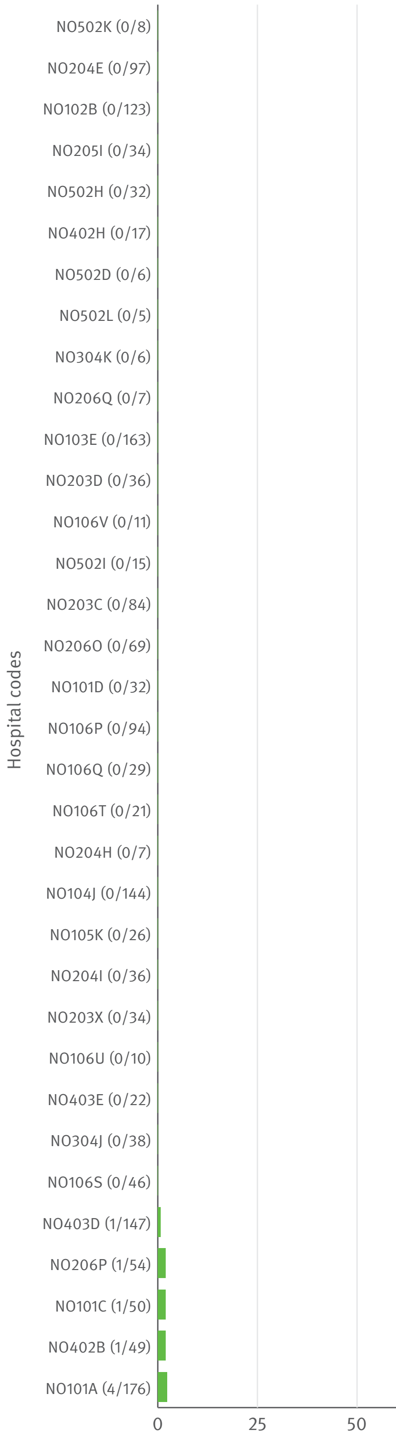
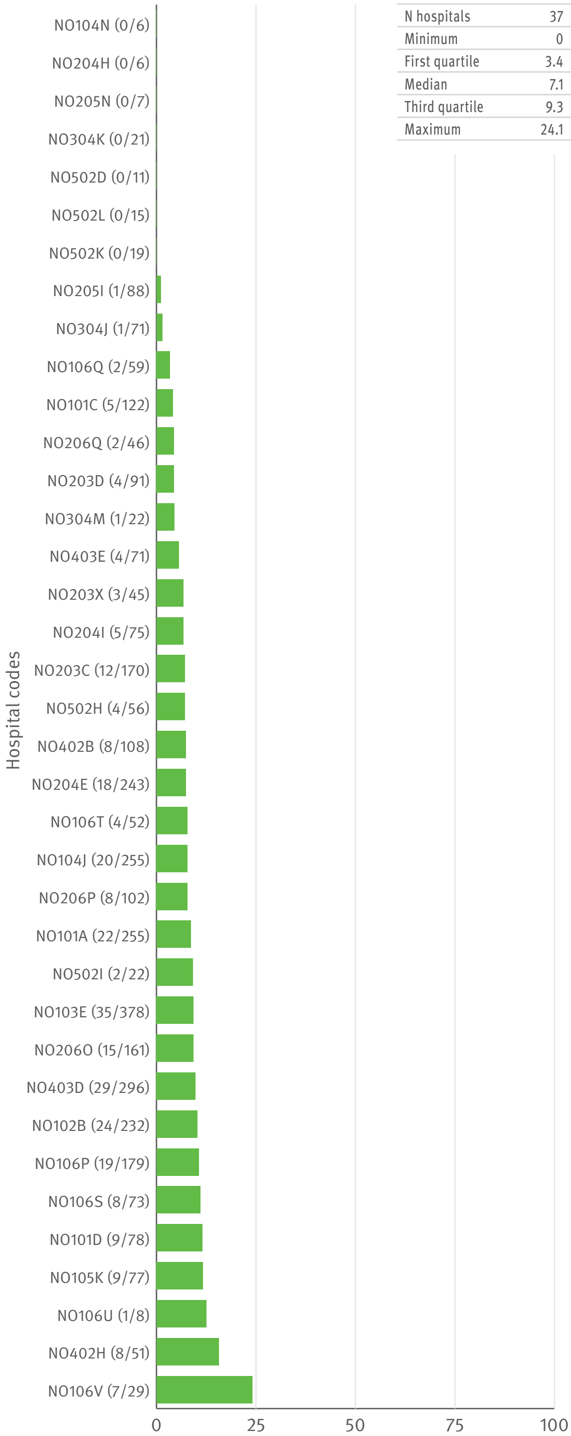


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)



N hospitals	37
Minimum	0
First quartile	3.4
Median	7.1
Third quartile	9.3
Maximum	24.1

Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)

N hospitals	29
Minimum	0
First quartile	0
Median	0
Third quartile	3.6
Maximum	28.6

Poland

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	7	10	21	186	22	135	19	56	-	-	-	-
2003	11	16	24	166	25	124	16	64	-	-	-	-
2004	11	16	30	262	29	192	23	52	-	-	-	-
2005	6	6	30	198	30	176	21	54	17	53	14	26
2006	4	9	24	174	26	206	21	68	15	42	16	37
2007	10	22	24	185	27	256	20	71	18	32	23	67
2008	34	84	15	99	14	84	11	26	11	19	8	22
2009	20	68	30	551	29	625	28	267	25	151	27	153

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	30	19	<1	17	<1	10	12	30
Penicillin RI	30	19	<1	33	<1	29	13	30
Macrolides RI	67	14	19	33	11	-	50	16
Staphylococcus aureus								
Oxacillin/Meticillin R	23	19	19	24	20	15	12	20
Escherichia coli								
Aminopenicilins R	52	50	45	56	55	56	54	65
Aminoglycosides R	11	10	5	7	11	6	7	7
Fluoroquinolones R	11	7	9	20	20	13	20	23
Third-gen. cephalosporins R	6	4	5	5	4	2	2	9
Enterococcus faecalis								
Aminopenicilins RI	12	<1	2	9	2	4	6	<1
HL Gentamicin R	41	48	33	48	50	46	29	39
Vancomycin R	<1	<1	<1	<1	<1	2	<1	<1
Enterococcus faecium								
Aminopenicilins RI	80	91	86	95	95	88	78	98
HL Gentamicin R	73	55	100	62	85	84	67	75
Vancomycin R	<1	<1	<1	5	<1	<1	<1	1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	57	36	31	26	29
Fluoroquinolones R	-	-	-	34	29	3	32	32
Third-gen. cephalosporins R	-	-	-	66	38	34	37	49
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	50	43	36	32	30
Ceftazidime R	-	-	-	31	42	21	27	21
Carbapenems R	-	-	-	27	30	18	14	25
Aminoglycosides R	-	-	-	56	46	40	27	27
Fluoroquinolones R	-	-	-	31	41	37	13	26

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=141		*S. aureus* n=605		*E. coli* n=651		*E. faecalis* n=157		*E. faecium* n=94		*K. pneumoniae* n=162		*P. aeruginosa* n=164	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	74	16	100	19	99	23	100	0	100	1	99	48	98	24
CSF	26	31	-	-	1	25	-	-	-	-	1	0	2	0
Gender														
Male	56	22	57	19	38	29	54	0	57	0	60	48	57	27
Female	42	17	40	19	59	19	42	0	36	3	35	46	37	18
Unknown	2	33	3	11	3	10	4	0	6	0	5	50	7	27
Age (years)														
0–4	16	32	9	14	6	6	5	0	8	0	13	50	5	13
5–19	9	21	3	16	1	5	1	0	1	50	1	33	3	11
20–64	49	17	49	21	43	18	43	1	46	1	47	49	50	28
65 and over	26	14	38	20	48	18	50	0	42	0	37	46	38	20
Unknown	1	33	1	6	2	23	2	0	3	0	2	57	4	23
Hospital department														
ICU	20	12	17	36	17	22	21	0	32	2	34	62	41	30
Internal med.	39	15	38	12	41	16	31	1	19	0	20	33	15	20
Surgery	1	50	13	31	10	18	19	0	16	3	14	60	11	22
Other	39	25	26	13	25	13	17	0	20	0	25	38	19	7
Unknown	1	67	7	24	7	24	11	0	13	0	8	36	14	32

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Poland

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)

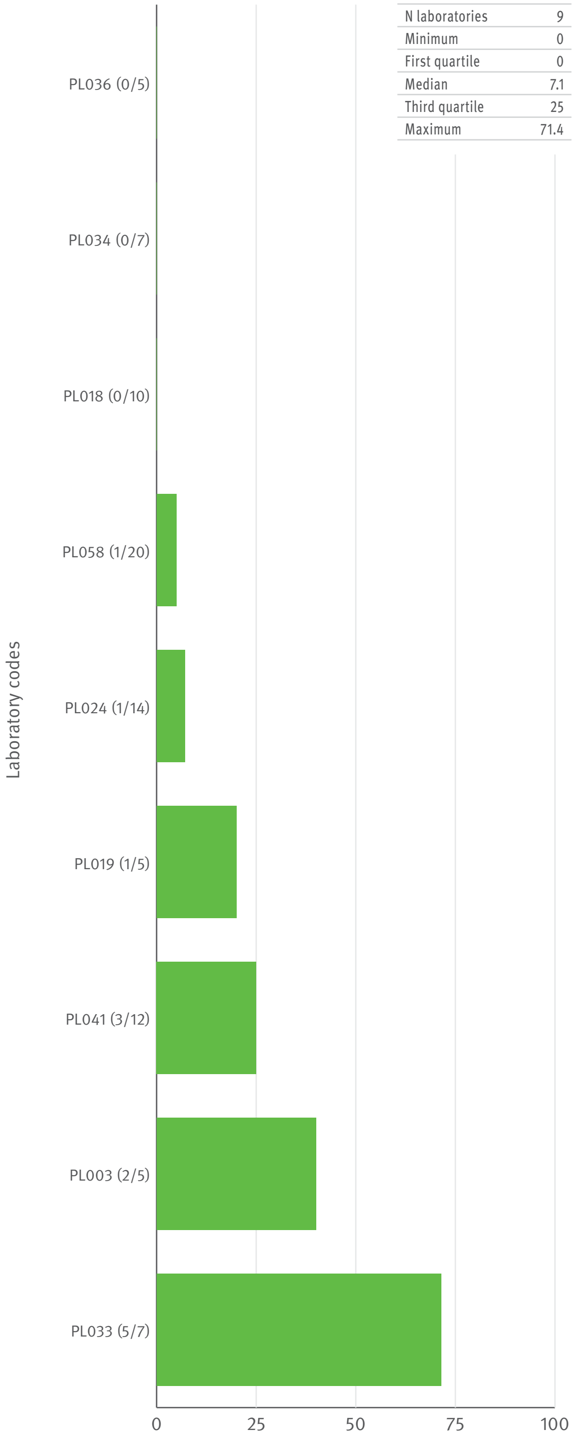


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)

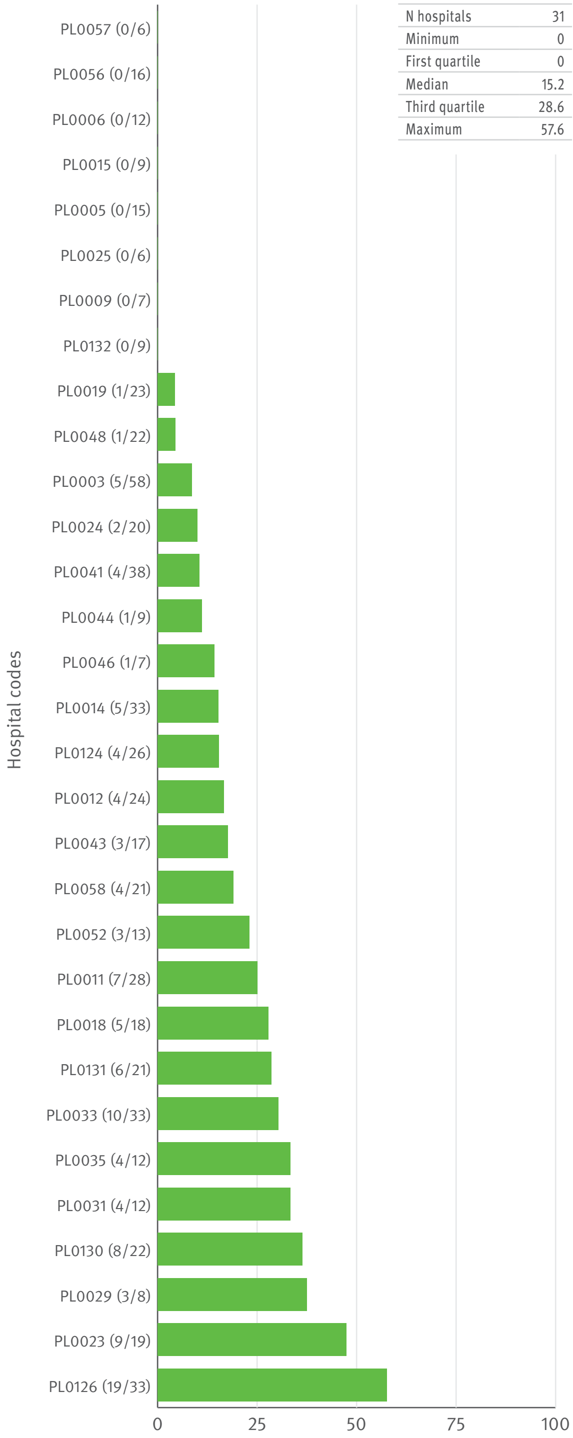


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)

N hospitals	26
Minimum	8.3
First quartile	14.3
Median	23.1
Third quartile	30
Maximum	52.9

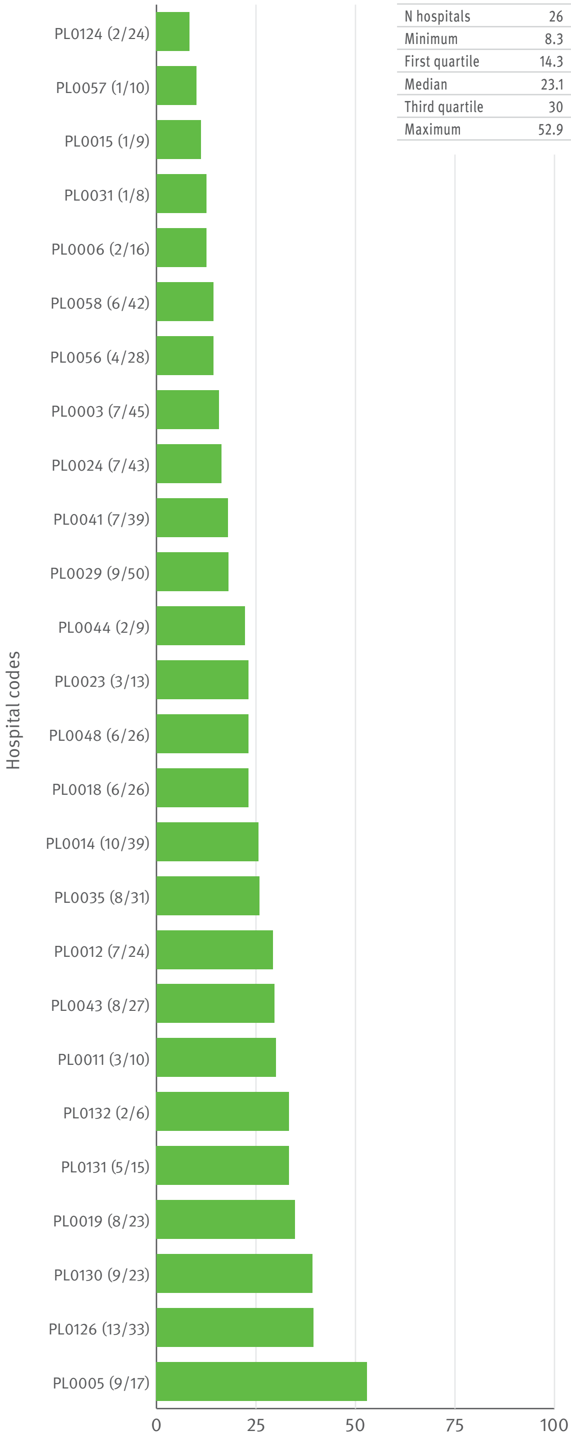
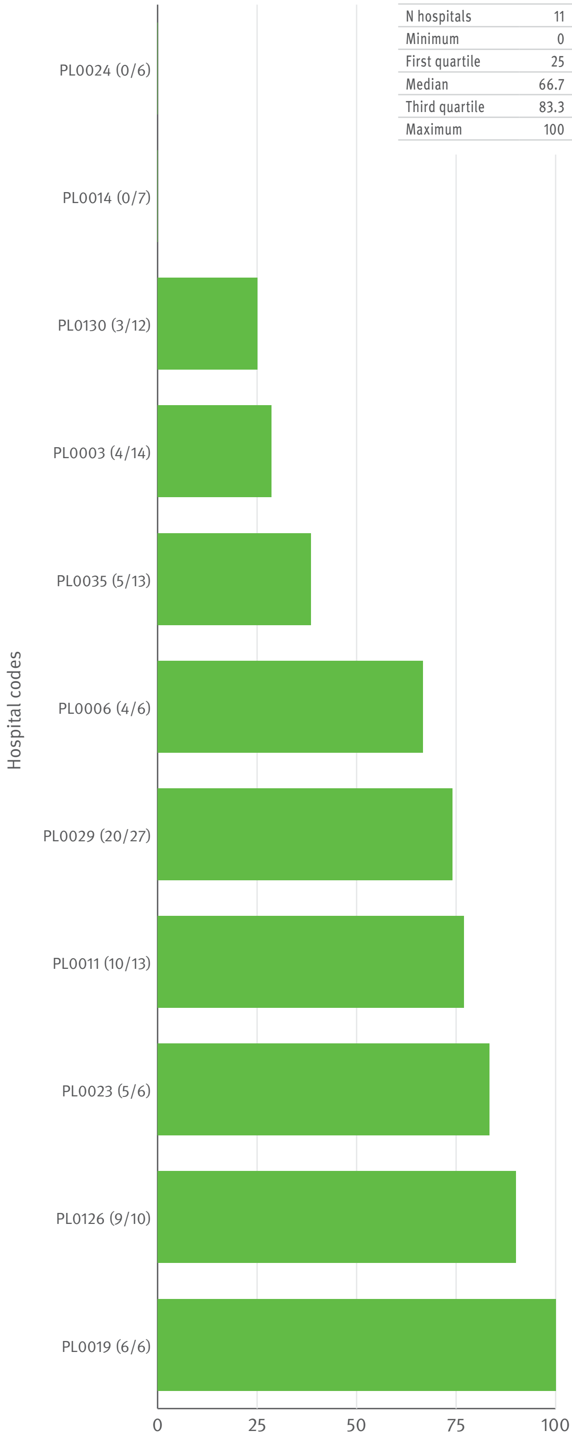


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)

N hospitals	11
Minimum	0
First quartile	25
Median	66.7
Third quartile	83.3
Maximum	100



Portugal

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	14	185	16	544	17	444	13	101	-	-	-	-
2003	12	95	22	1033	21	792	18	398	-	-	-	-
2004	14	166	23	1063	19	761	19	410	-	-	-	-
2005	13	202	19	1153	19	1171	17	405	1	1	-	-
2006	15	183	17	1306	18	1331	17	464	13	315	11	266
2007	12	202	20	1383	20	1432	19	518	18	370	16	340
2008	14	260	20	1557	21	1625	20	588	21	543	19	467
2009	17	237	20	1824	20	2040	19	675	20	564	18	536

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	<1	<1	<1	<1	18
Penicillin RI	20	20	27	17	17	16	18	18
Macrolides RI	<1	-	20	19	21	23	22	22
Staphylococcus aureus								
Oxacillin/Meticillin R	38	45	46	47	48	48	53	49
Escherichia coli								
Aminopenicilins R	58	53	58	58	59	59	58	58
Aminoglycosides R	9	9	13	12	12	12	14	11
Fluoroquinolones R	23	26	27	29	28	30	29	28
Third-gen. cephalosporins R	6	7	8	12	10	10	10	9
Enterococcus faecalis								
Aminopenicilins RI	2	4	5	<1	2	4	4	7
HL Gentamicin R	25	34	29	38	41	41	43	34
Vancomycin R	6	3	6	5	5	4	4	4
Enterococcus faecium								
Aminopenicilins RI	79	88	83	92	76	93	86	91
HL Gentamicin R	33	55	66	68	53	49	28	49
Vancomycin R	<1	47	42	34	26	29	24	23
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	<1	13	11	19	20
Fluoroquinolones R	-	-	-	<1	20	18	22	28
Third-gen. cephalosporins R	-	-	-	-	21	17	26	28
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	-	15	14	17	17
Ceftazidime R	-	-	-	-	19	16	16	13
Carbapenems R	-	-	-	-	21	15	18	16
Aminoglycosides R	-	-	-	-	17	16	11	12
Fluoroquinolones R	-	-	-	-	21	19	23	21

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=497		*S. aureus* n=3380		*E. coli* n=3550		*E. faecalis* n=844		*E. faecium* n=394		*K. pneumoniae* n=1089		*P. aeruginosa* n=950	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	92	18	100	51	100	28	100	4	100	23	100	27	100	17
CSF	8	13	-	-	<1	0	-	-	-	-	-	-	<1	100
Gender														
Male	56	18	62	49	46	33	57	4	53	19	57	28	58	20
Female	44	18	38	53	54	24	43	5	47	28	43	25	42	13
Unknown	<1	0	<1	100	-	-	-	-	-	-	<1	50	-	-
Age (years)														
0–4	9	31	3	15	1	7	2	2	1	20	2	43	2	7
5–19	5	17	2	18	1	15	1	4	1	8	2	18	2	12
20–64	43	14	34	38	34	25	30	5	39	32	36	24	41	18
65 and over	37	19	50	58	56	31	57	4	50	28	48	23	48	17
Unknown	5	30	11	46	7	21	10	5	8	28	12	22	8	15
Hospital department														
ICU	6	21	9	58	5	32	15	4	15	22	11	27	17	25
Internal med.	15	16	24	56	22	29	22	6	19	32	18	30	15	15
Surgery	<1	14	8	63	5	30	10	2	13	20	11	18	9	19
Other	78	19	54	40	64	27	50	5	51	33	57	22	56	15
Unknown	1	22	4	55	3	30	2	2	2	38	3	15	3	21

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Portugal

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)

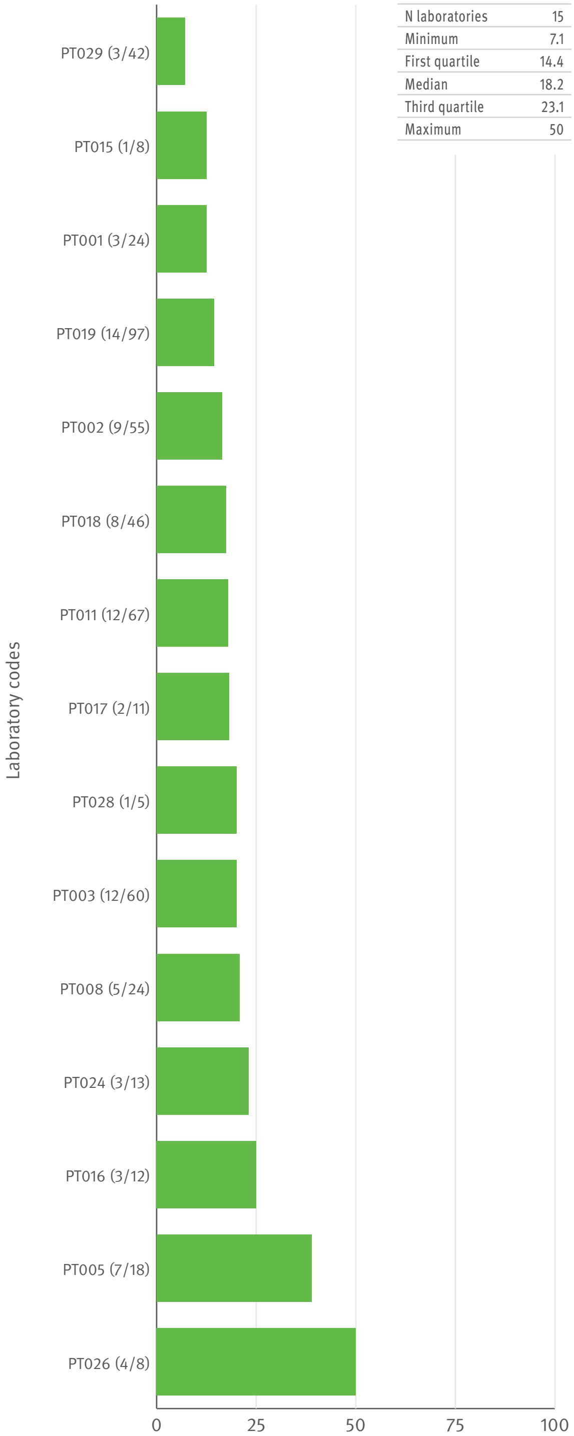


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)

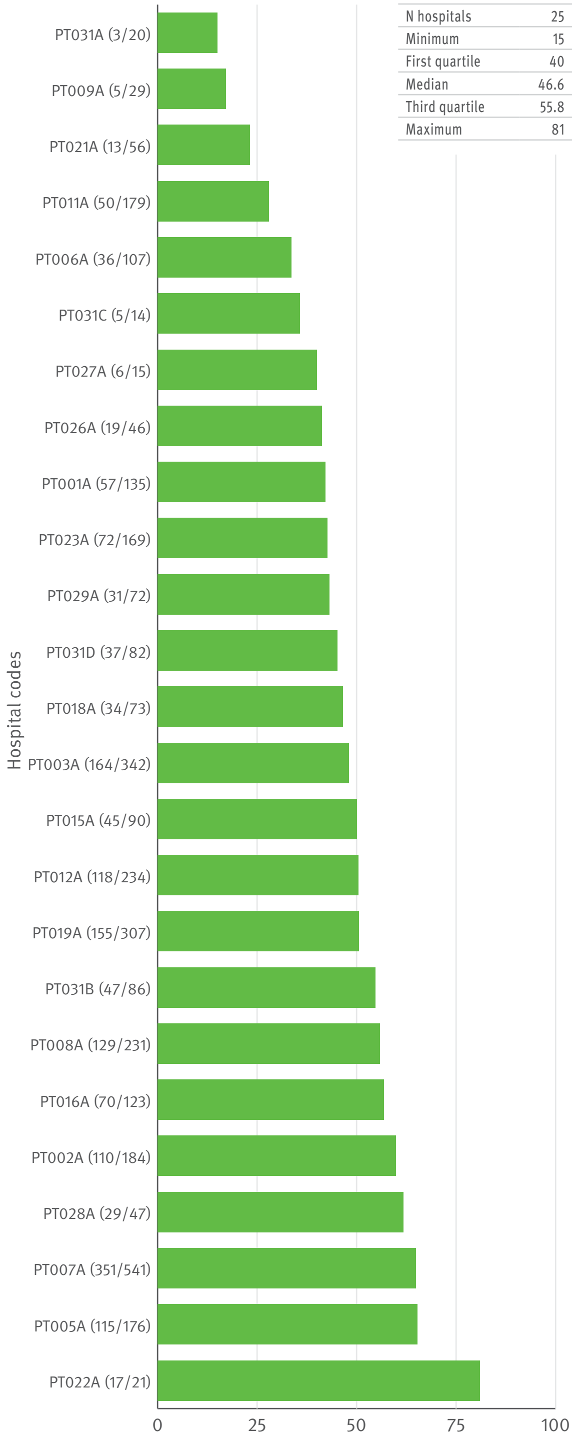
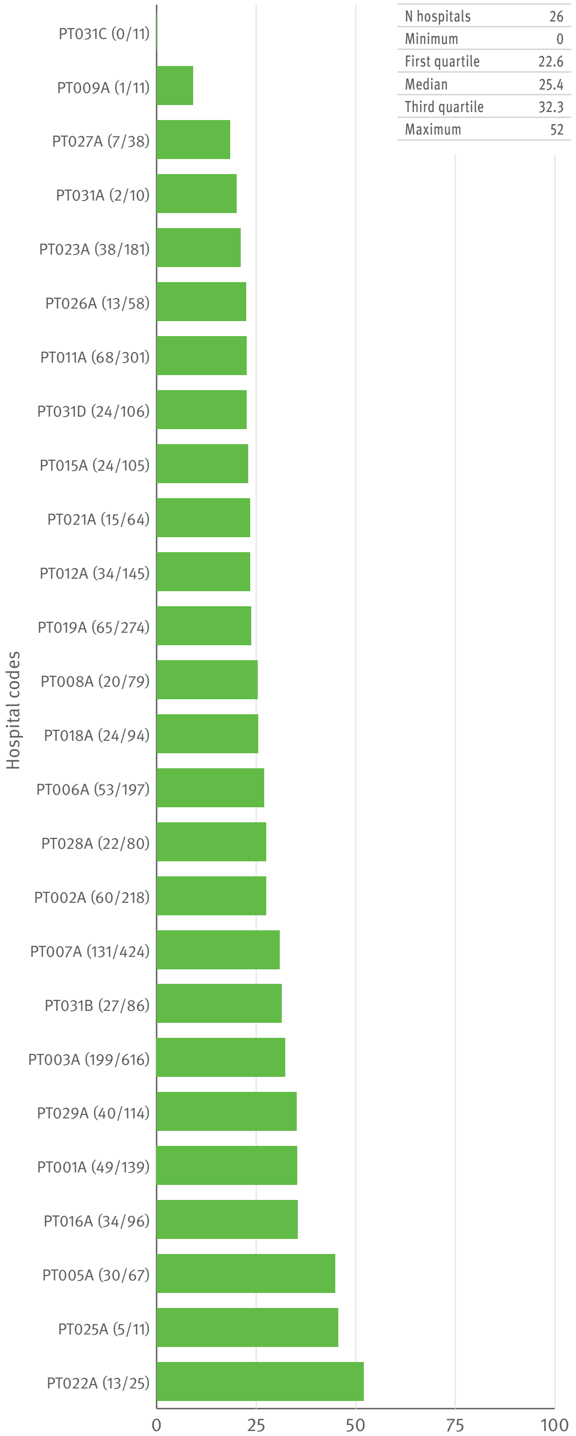
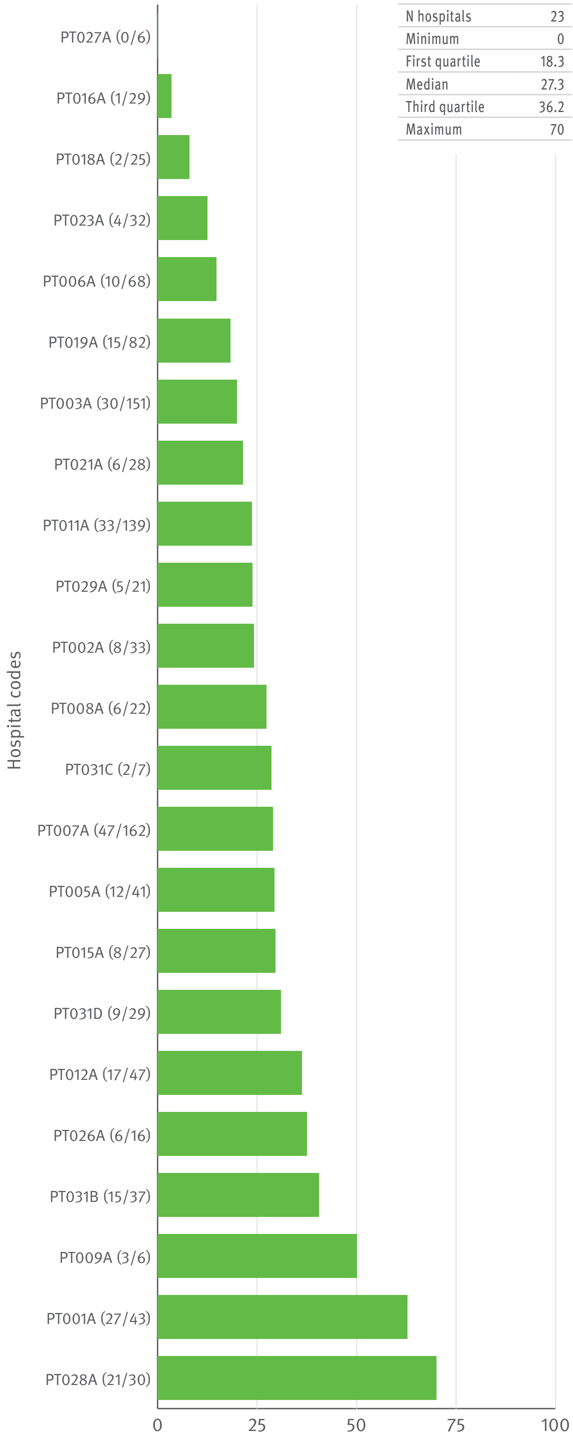


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)



N hospitals	26
Minimum	0
First quartile	22.6
Median	25.4
Third quartile	32.3
Maximum	52

Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



N hospitals	23
Minimum	0
First quartile	18.3
Median	27.3
Third quartile	36.2
Maximum	70

Romania

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	6	10	10	80	8	28	4	11	-	-	-	-
2003	5	26	9	85	9	50	5	12	-	-	-	-
2004	4	9	15	95	12	48	4	9	-	-	-	-
2005	5	18	13	93	13	84	7	14	1	3	2	23
2006	8	29	11	83	9	41	9	28	5	32	2	3
2007	5	27	9	42	9	63	5	14	6	30	2	4
2008	4	14	5	39	4	58	4	16	3	6	3	8
2009	3	17	5	45	6	80	5	26	3	26	3	22

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	10	21	11	22	10	22	54	12
Penicillin RI	50	33	11	39	28	33	69	29
Macrolides RI	10	29	<1	31	25	19	27	25
Staphylococcus aureus								
Oxacillin/Meticillin R	36	46	71	60	54	26	33	36
Escherichia coli								
Aminopenicilins R	50	70	79	78	85	76	55	83
Aminoglycosides R	15	21	33	14	41	35	24	13
Fluoroquinolones R	20	14	21	9	41	27	27	23
Third-gen. cephalosporins R	18	19	23	17	41	27	24	17
Enterococcus faecalis								
Aminopenicilins RI	<1	<1	29	<1	<1	25	10	12
HL Gentamicin R	40	25	<1	50	15	50	22	35
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	100	86	100	100	100	100	100	100
HL Gentamicin R	80	63	100	70	80	67	50	56
Vancomycin R	17	<1	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	100	91	80	60	31
Fluoroquinolones R	-	-	-	33	34	23	20	11
Third-gen. cephalosporins R	-	-	-	100	94	80	50	56
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	61	33	25	25	36
Ceftazidime R	-	-	-	52	<1	<1	13	38
Carbapenems R	-	-	-	61	<1	<1	13	55
Aminoglycosides R	-	-	-	64	33	25	38	45
Fluoroquinolones R	-	-	-	64	33	25	25	36

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=30		*S. aureus* n=84		*E. coli* n=105		*E. faecalis* n=27		*E. faecium* n=15		*K. pneumoniae* n=22		*P. aeruginosa* n=19	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	63	63	100	35	100	25	100	0	100	0	100	55	95	39
CSF	37	18	-	-	-	-	-	-	-	-	-	-	5	0
Gender														
Male	53	63	35	38	46	23	56	0	53	13	59	62	53	40
Female	47	29	18	33	54	26	44	0	47	0	41	44	37	43
Unknown	-	-	48	33	-	-	-	-	-	-	-	-	11	0
Age (years)														
0–4	22	66	24	57	20	19	27	0	35	0	60	96	16	0
5–19	12	11	11	23	7	43	2	0	8	0	7	50	4	100
20–64	44	34	41	51	37	20	33	0	28	11	22	58	10	80
65 and over	20	21	12	53	33	20	34	0	18	0	10	44	6	33
Unknown	2	33	13	47	3	18	5	0	11	0	-	-	63	45
Hospital department														
ICU	1	50	9	66	5	20	6	0	8	0	8	71	22	82
Internal med.	5	13	8	50	20	20	20	0	25	0	17	60	-	-
Surgery	-	-	7	61	3	17	2	0	3	0	2	100	6	100
Other	82	38	42	48	68	23	59	0	46	3	71	85	51	20
Unknown	12	29	34	42	3	14	13	0	18	8	1	0	20	40

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Romania

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)

N laboratories	2
Minimum	29.4
First quartile	29.4
Median	56.4
Third quartile	83.3
Maximum	83.3

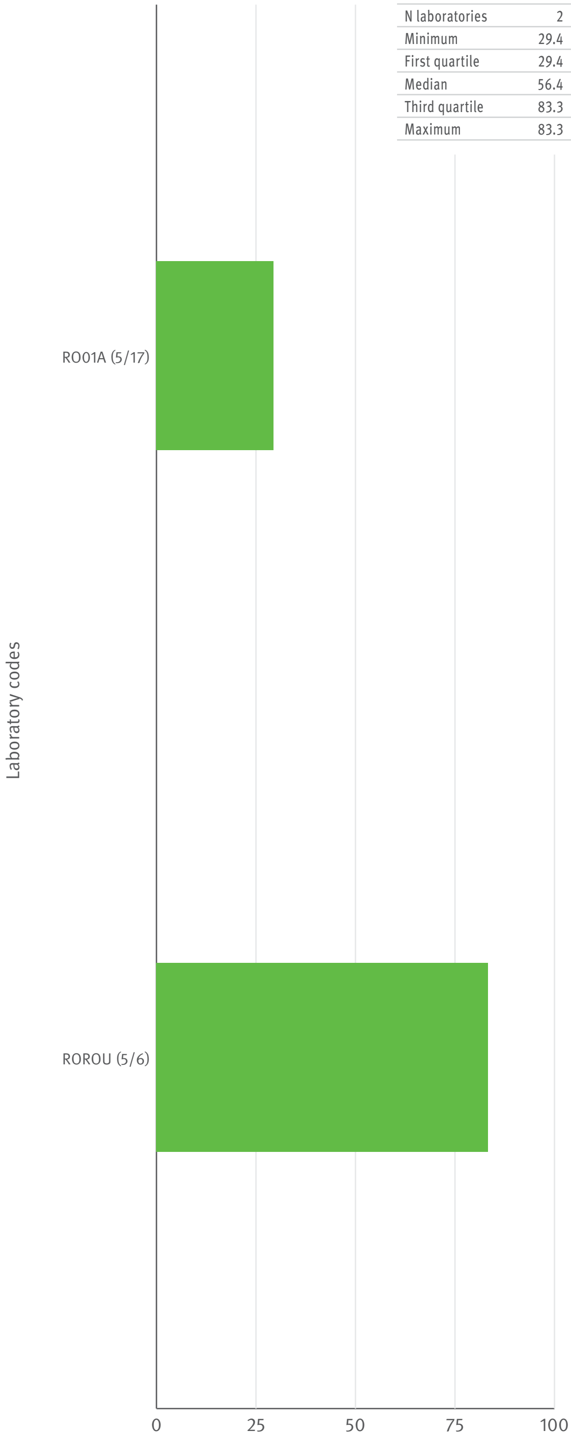


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)

N hospitals	8
Minimum	0
First quartile	18.7
Median	38.1
Third quartile	44.9
Maximum	57.1

Figure 3: **Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)**

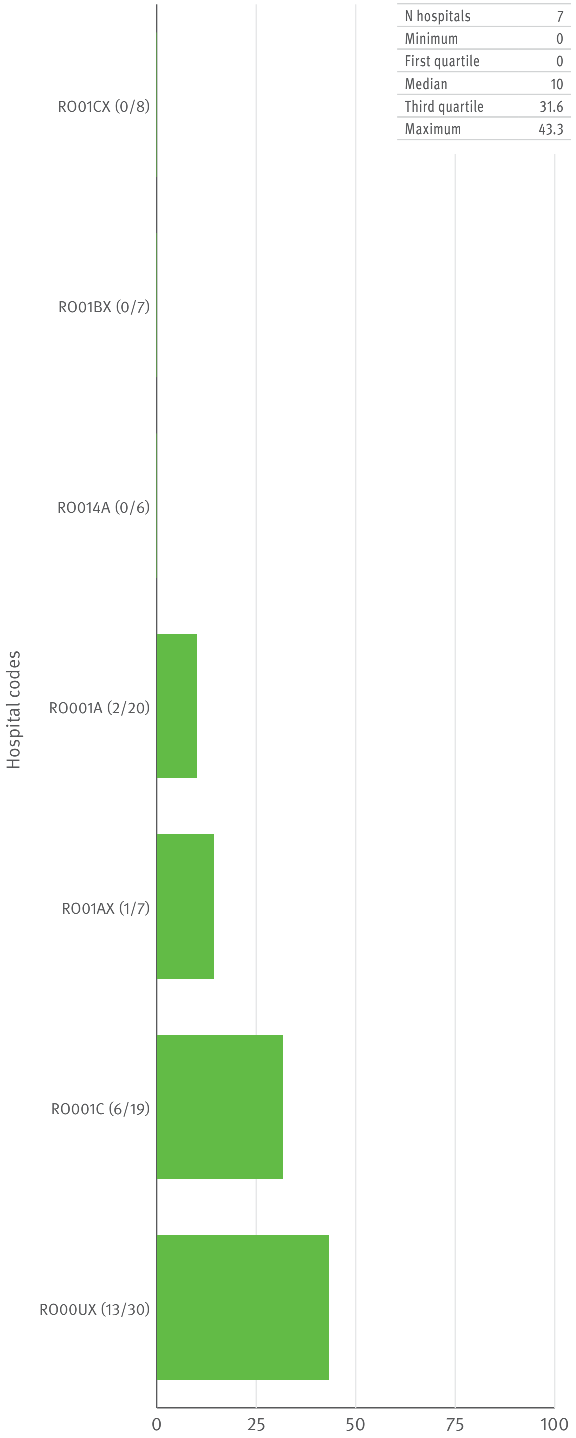
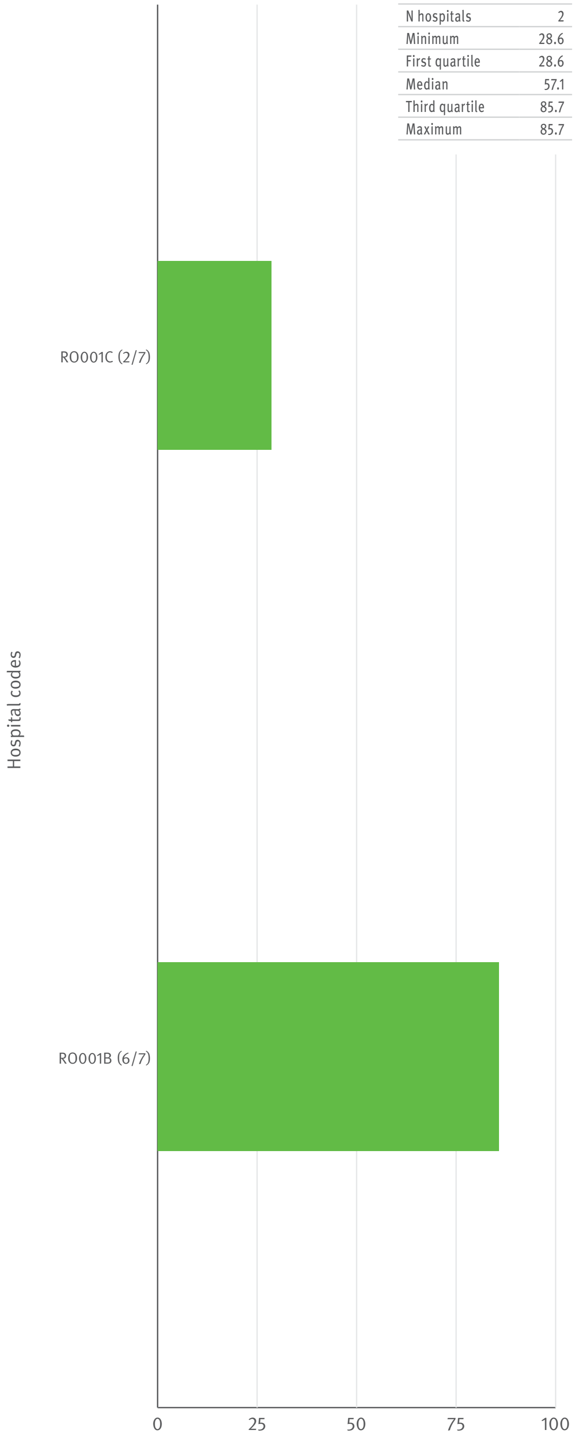


Figure 4: **Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)**



Slovenia

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	11	101	11	276	11	409	9	45	-	-	-	-
2003	11	172	11	299	11	401	10	76	-	-	-	-
2004	10	166	11	347	11	573	9	91	-	-	-	-
2005	11	208	11	349	11	657	11	119	10	78	8	38
2006	11	167	11	365	11	717	10	145	10	145	10	72
2007	10	195	10	422	10	851	9	183	10	170	9	88
2008	10	209	10	418	10	874	10	196	9	157	10	95
2009	9	213	9	424	9	783	9	184	9	168	9	93

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	<1	2	2	2	5	4	3	1
Penicillin RI	19	15	25	11	19	17	15	17
Macrolides RI	10	9	11	11	13	17	16	18
Staphylococcus aureus								
Oxacillin/Meticillin R	14	13	12	10	7	8	7	10
Escherichia coli								
Aminopenicilins R	43	41	40	42	44	49	49	54
Aminoglycosides R	3	2	5	4	7	7	7	10
Fluoroquinolones R	12	11	12	12	15	17	17	19
Third-gen. cephalosporins R	1	<1	1	2	2	4	4	7
Enterococcus faecalis								
Aminopenicilins RI	<1	<1	<1	1	1	<1	<1	<1
HL Gentamicin R	50	49	37	46	40	50	40	44
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	69	83	76	93	86	92	96	94
HL Gentamicin R	62	82	56	47	54	63	57	58
Vancomycin R	<1	<1	<1	<1	6	5	13	4
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	17	19	24	23	28
Fluoroquinolones R	-	-	-	14	21	26	25	29
Third-gen. cephalosporins R	-	-	-	19	24	28	26	34
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	21	18	13	21	18
Ceftazidime R	-	-	-	11	8	7	14	11
Carbapenems R	-	-	-	13	6	19	16	17
Aminoglycosides R	-	-	-	18	15	10	13	14
Fluoroquinolones R	-	-	-	29	21	17	24	15

Demographic characteristics

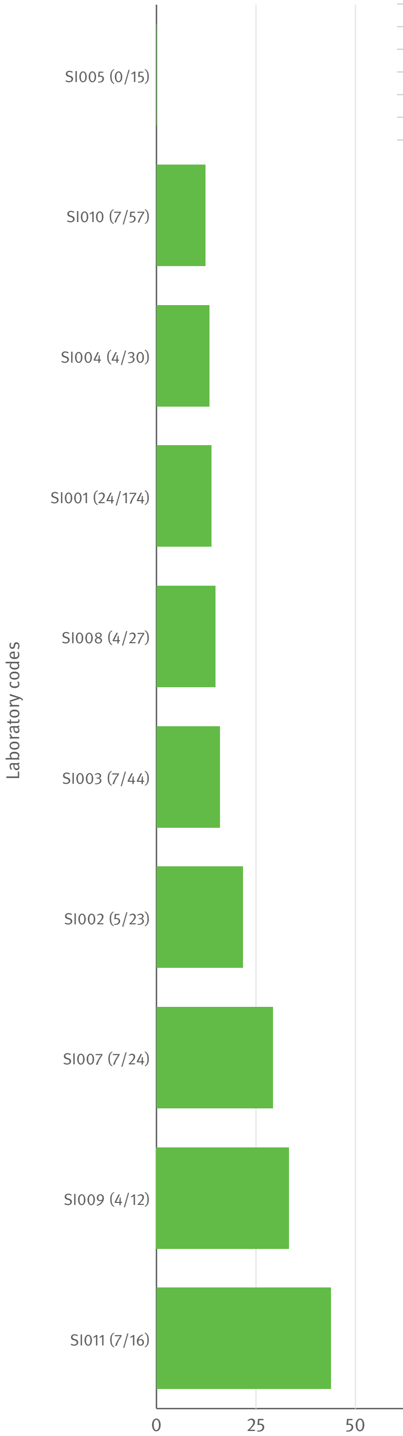
Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=422		*S. aureus* n=842		*E. coli* n=1657		*E. faecalis* n=235		*E. faecium* n=145		*K. pneumoniae* n=325		*P. aeruginosa* n=188	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	93	16	100	9	100	18	100	0	100	9	100	30	99	16
CSF	7	21	-	-	<1	0	-	-	-	-	-	-	1	50
Gender														
Male	59	16	62	9	41	21	59	0	59	11	55	34	70	18
Female	41	16	38	8	59	16	41	0	41	7	45	26	30	12
Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Age (years)														
0–4	21	30	4	1	3	2	7	0	1	0	3	15	2	0
5–19	5	7	3	4	1	4	<1	0	-	-	1	40	2	14
20–64	35	12	38	9	30	15	30	0	39	9	31	30	38	23
65 and over	39	15	55	12	67	16	63	0	59	3	65	26	58	10
Unknown	<1	0	<1	25	<1	29	<1	0	<1	0	-	-	-	-
Hospital department														
ICU	9	15	10	15	7	17	11	0	21	0	13	45	15	24
Internal med.	38	13	46	8	52	14	38	0	31	1	42	18	35	9
Surgery	1	11	11	21	6	16	15	0	14	2	15	32	16	25
Other	52	20	33	7	35	16	35	0	33	14	30	30	34	12
Unknown	-	-	0	0	-	-	-	-	-	-	-	-	-	-

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Slovenia

Figure 1: **Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)**



N laboratories	10
Minimum	0
First quartile	13.3
Median	15.4
Third quartile	29.2
Maximum	43.8

Figure 2: **Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)**

N hospitals	14
Minimum	0
First quartile	0
Median	3
Third quartile	8.8
Maximum	17.7

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)

N hospitals	14
Minimum	3.3
First quartile	10.5
Median	17.7
Third quartile	19.2
Maximum	35.1

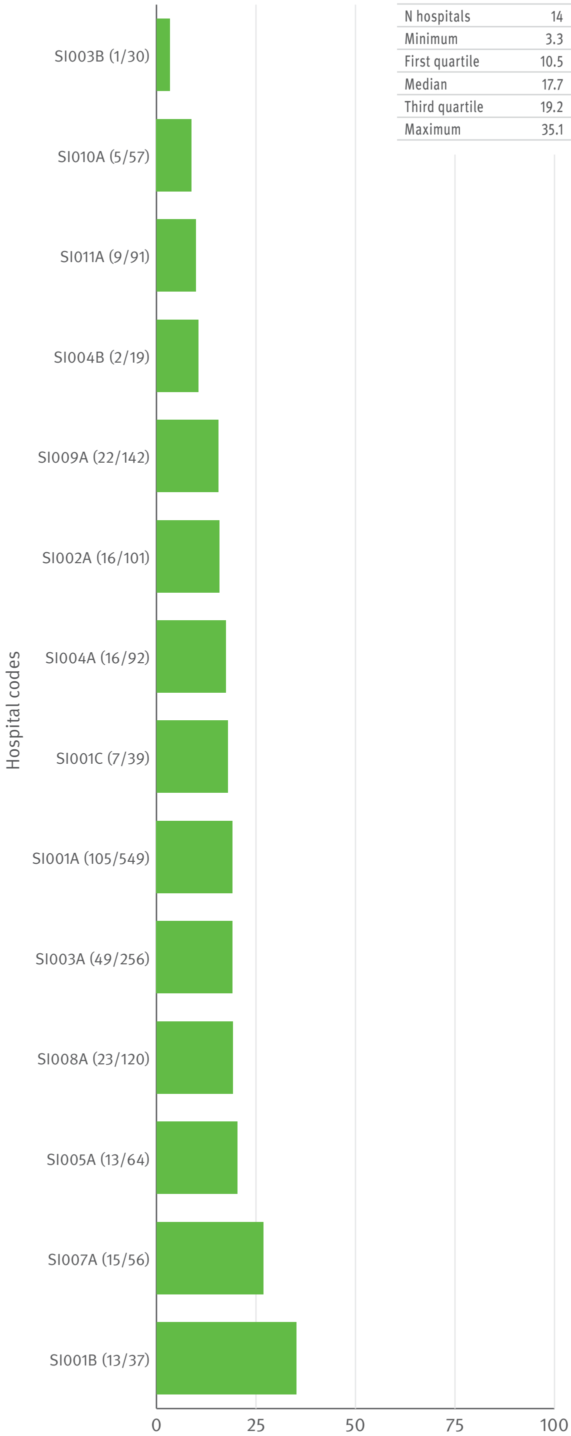
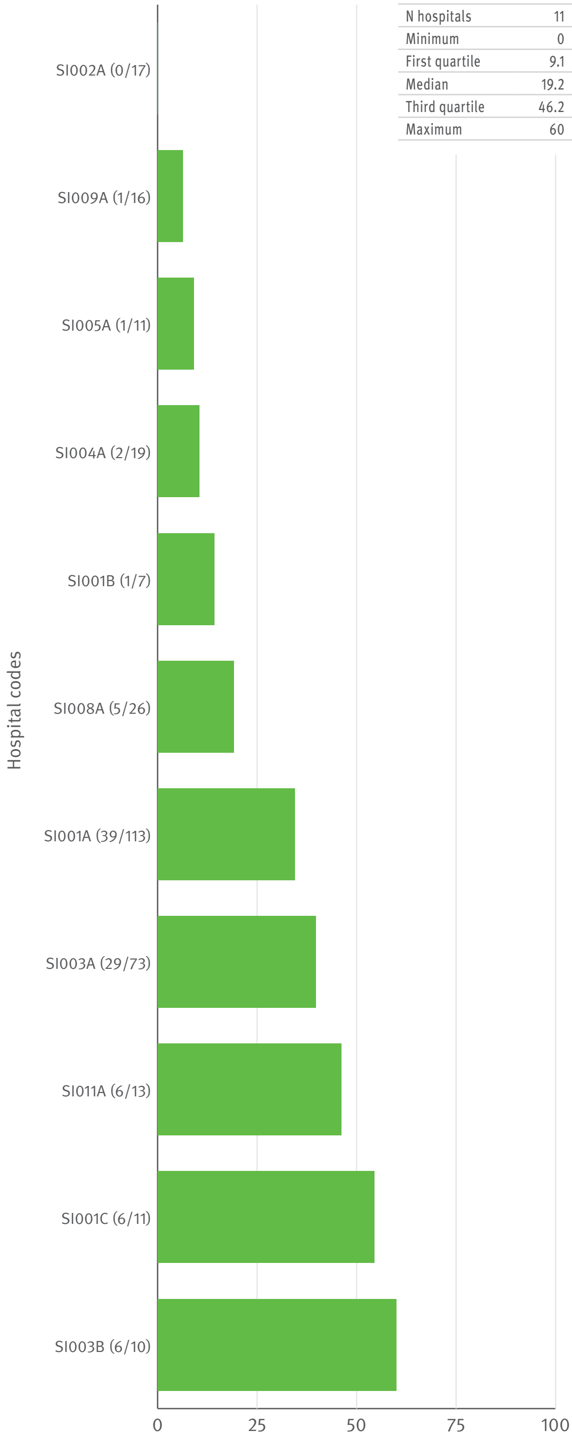


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)

N hospitals	11
Minimum	0
First quartile	9.1
Median	19.2
Third quartile	46.2
Maximum	60



Spain

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	35	658	36	1196	29	2484	35	566	-	-	-	-
2003	35	656	36	1391	29	2650	36	608	-	-	-	-
2004	36	684	36	1527	36	3471	36	710	-	-	-	-
2005	34	740	34	1337	34	2997	35	623	14	56	13	70
2006	35	625	35	1483	35	3364	34	755	33	564	32	405
2007	35	862	35	1645	35	3678	35	885	33	618	35	448
2008	31	695	32	1505	32	3626	32	1002	30	639	32	548
2009	32	708	33	1715	33	3821	33	1093	32	628	33	544

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	10	7	9	9	8	8	7	8
Penicillin RI	33	32	29	25	27	22	23	22
Macrolides RI	26	27	27	23	22	18	22	19
Staphylococcus aureus								
Oxacillin/Meticillin R	23	24	26	27	25	25	27	26
Escherichia coli								
Aminopenicilins R	60	58	60	62	64	62	63	65
Aminoglycosides R	8	7	7	10	9	10	11	13
Fluoroquinolones R	19	21	25	28	28	30	33	31
Third-gen. cephalosporins R	2	4	7	8	7	7	9	11
Enterococcus faecalis								
Aminopenicilins RI	2	1	2	<1	2	1	3	3
HL Gentamicin R	37	36	36	36	36	42	41	43
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	59	64	66	67	73	79	79	83
HL Gentamicin R	16	11	17	16	21	40	35	38
Vancomycin R	1	3	2	3	3	2	1	3
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	4	7	9	9	9
Fluoroquinolones R	-	-	-	11	8	17	15	16
Third-gen. cephalosporins R	-	-	-	7	9	10	12	11
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	4	9	8	8	8
Ceftazidime R	-	-	-	6	7	10	11	8
Carbapenems R	-	-	-	17	12	15	13	16
Aminoglycosides R	-	-	-	4	11	15	18	19
Fluoroquinolones R	-	-	-	14	19	25	23	25

Demographic characteristics

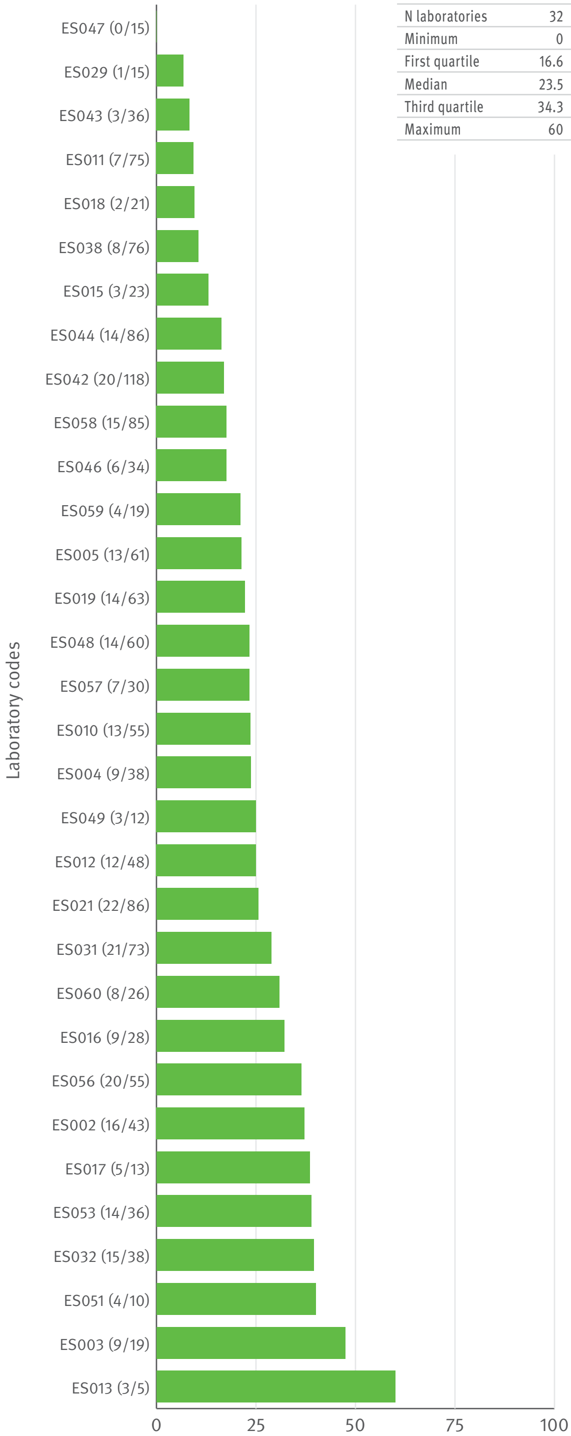
Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=1402		*S. aureus* n=3220		*E. coli* n=7420		*E. faecalis* n=1463		*E. faecium* n=631		*K. pneumoniae* n=1267		*P. aeruginosa* n=1087	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	97	22	100	26	100	32	100	0	100	2	100	12	100	15
CSF	3	21	-	-	<1	0	-	-	-	-	-	-	-	-
Gender														
Male	59	22	65	26	51	36	61	0	60	3	58	12	68	16
Female	38	23	33	28	47	28	36	0	38	1	39	11	30	12
Unknown	3	10	2	19	2	31	3	0	2	0	3	16	2	4
Age (years)														
0–4	14	36	4	7	3	9	8	0	6	0	5	19	3	2
5–19	4	13	3	9	1	13	1	0	1	10	1	16	1	8
20–64	40	22	37	20	29	24	31	0	35	4	34	10	37	19
65 and over	40	29	55	32	66	30	57	0	57	2	58	10	58	12
Unknown	2	22	1	19	1	18	3	0	1	0	3	10	2	6
Hospital department														
ICU	8	24	12	32	5	30	21	0	16	3	12	15	23	26
Internal med.	25	27	35	28	29	30	26	0	29	3	29	8	28	12
Surgery	1	24	9	32	7	26	10	0	14	0	9	12	7	21
Other	64	26	42	20	58	26	41	0	39	2	49	11	40	8
Unknown	2	26	2	25	1	29	1	0	2	0	1	11	1	7

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

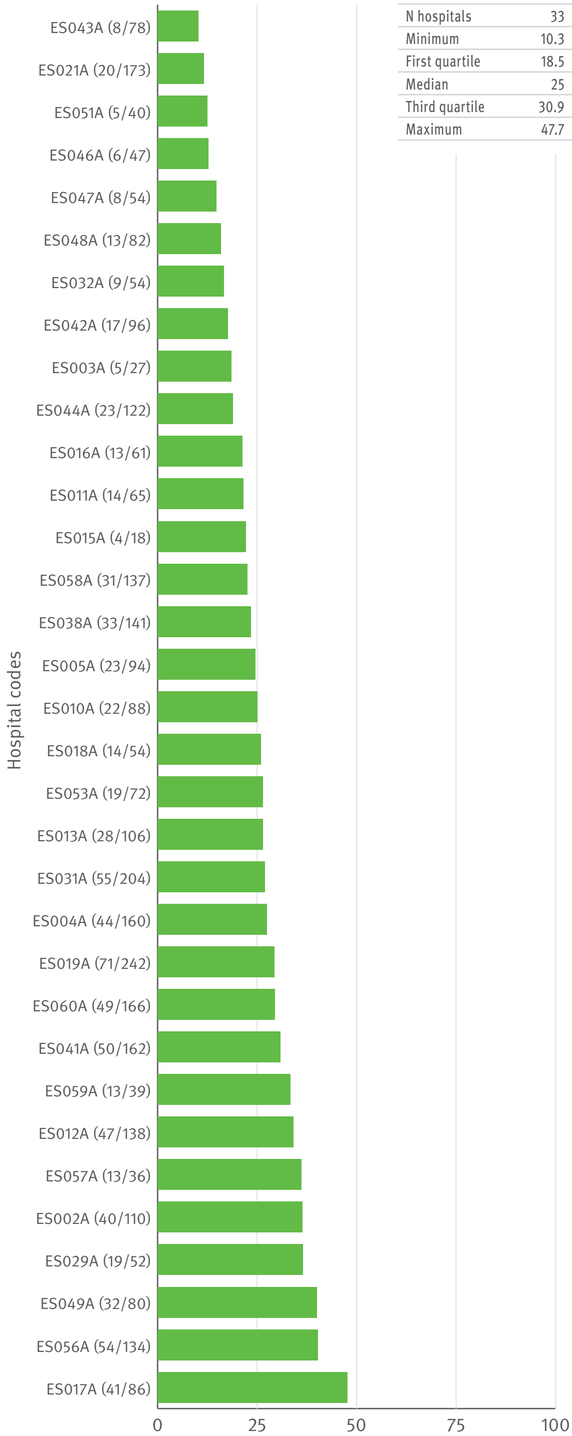
Spain

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)



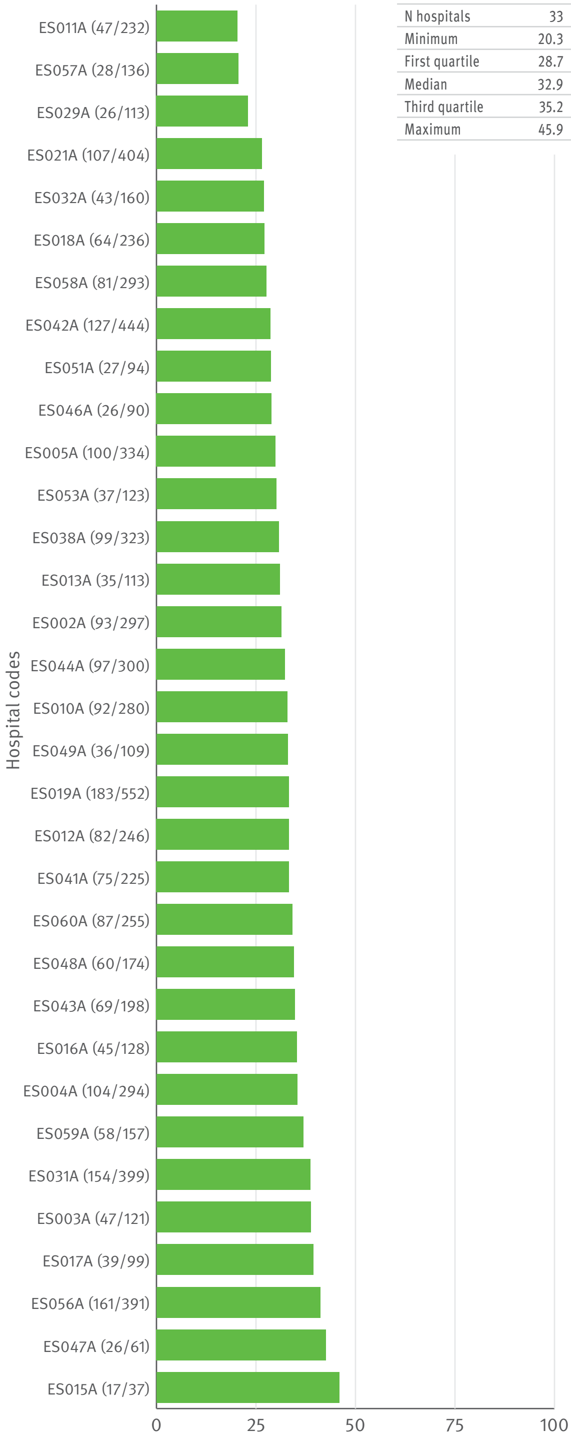
N laboratories	32
Minimum	0
First quartile	16.6
Median	23.5
Third quartile	34.3
Maximum	60

Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)



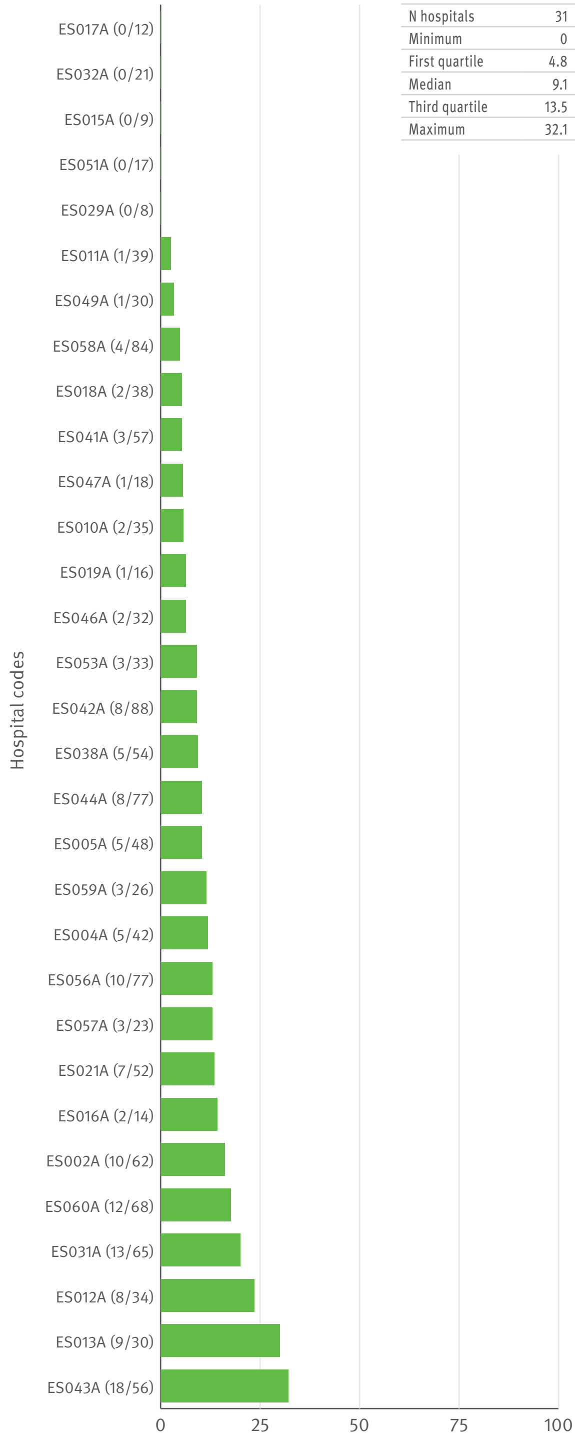
N hospitals	33
Minimum	10.3
First quartile	18.5
Median	25
Third quartile	30.9
Maximum	47.7

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)



N hospitals	33
Minimum	20.3
First quartile	28.7
Median	32.9
Third quartile	35.2
Maximum	45.9

Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



N hospitals	31
Minimum	0
First quartile	4.8
Median	9.1
Third quartile	13.5
Maximum	32.1

Sweden

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	21	830	21	1837	21	3066	21	695	-	-	-	-
2003	21	919	21	1855	21	3350	21	850	-	-	-	-
2004	21	955	21	1906	21	3372	21	856	-	-	-	-
2005	21	1025	21	1774	21	3241	21	821	18	282	17	149
2006	21	996	21	1968	20	3539	21	884	20	621	18	300
2007	21	1032	21	2163	20	3749	21	932	20	649	20	343
2008	21	1219	21	2410	20	4032	21	1059	20	826	20	315
2009	19	1061	19	2459	18	4245	19	967	18	705	18	338

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	<1	<1	<1	<1	2
Penicillin RI	2	5	3	4	2	3	2	3
Macrolides RI	6	5	5	6	5	5	6	4
Staphylococcus aureus								
Oxacillin/Meticillin R	<1	<1	<1	1	<1	<1	<1	1
Escherichia coli								
Aminopenicilins R	25	29	23	26	28	33	32	33
Aminoglycosides R	<1	1	1	1	2	2	2	2
Fluoroquinolones R	5	7	8	6	8	10	10	8
Third-gen. cephalosporins R	<1	<1	<1	1	2	2	2	3
Enterococcus faecalis								
Aminopenicilins RI	1	<1	<1	<1	<1	<1	<1	<1
HL Gentamicin R	-	17	16	19	20	16	20	19
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	75	77	78	74	76	79	82	76
HL Gentamicin R	-	11	7	4	12	14	25	24
Vancomycin R	<1	2	1	<1	<1	<1	2	<1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	1	<1	1	1	<1
Fluoroquinolones R	-	-	-	5	5	6	7	2
Third-gen. cephalosporins R	-	-	-	1	1	1	2	2
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	9	<1	2	1	2
Ceftazidime R	-	-	-	5	6	4	5	7
Carbapenems R	-	-	-	18	5	7	4	8
Aminoglycosides R	-	-	-	<1	<1	<1	<1	<1
Fluoroquinolones R	-	-	-	6	5	6	5	7

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=2 271		*S. aureus* n=4 865		*E. coli* n=5 176		*E. faecalis* n=1 283		*E. faecium* n=554		*K. pneumoniae* n=1 526		*P. aeruginosa* n=605	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	98	3	100	1	100	10	100	0	100	1	100	2	100	6
CSF	2	3	-	-	-	-	-	-	-	-	‹1	0	-	-
Gender														
Male	50	2	62	1	45	12	70	0	57	1	60	2	68	6
Female	50	3	38	1	55	7	30	0	43	1	40	2	32	6
Unknown	-	-	‹1	0	-	-	-	-	-	-	-	-	-	-
Age (years)														
0–4	5	5	4	1	1	3	5	0	3	0	2	4	2	11
5–19	2	4	4	0	1	6	1	0	1	0	1	0	2	12
20–64	41	2	33	1	25	10	24	0	31	2	24	3	26	8
65 and over	51	3	60	1	73	7	69	0	65	1	73	1	70	6
Unknown	‹1	0	‹1	13	‹1	0	-	-	-	-	‹1	0	-	-
Hospital department														
ICU	7	2	6	1	4	8	6	0	10	2	4	2	7	13
Internal med.	44	3	41	1	40	7	34	0	35	0	38	2	42	7
Surgery	4	2	16	1	20	8	24	0	27	1	25	1	14	5
Other	44	3	37	1	36	9	36	0	28	1	33	2	37	5
Unknown	‹1	0	‹1	0	‹1	33	‹1	0	‹1	0	‹1	20	‹1	33

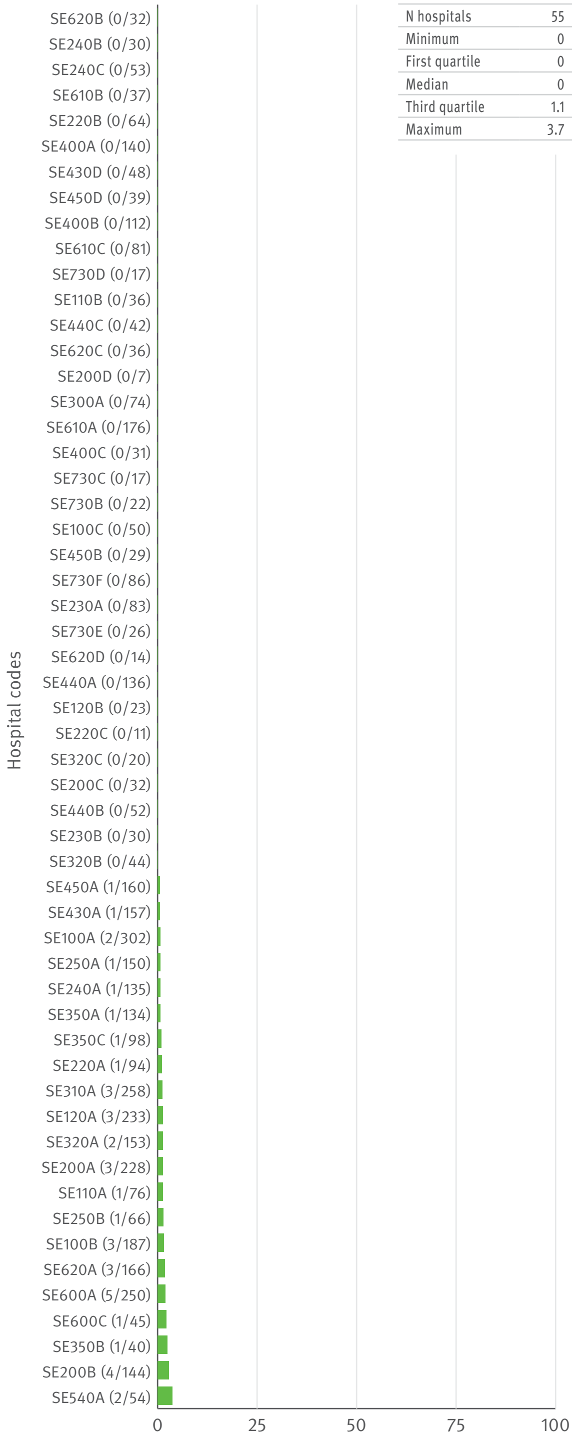
PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

Sweden

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)

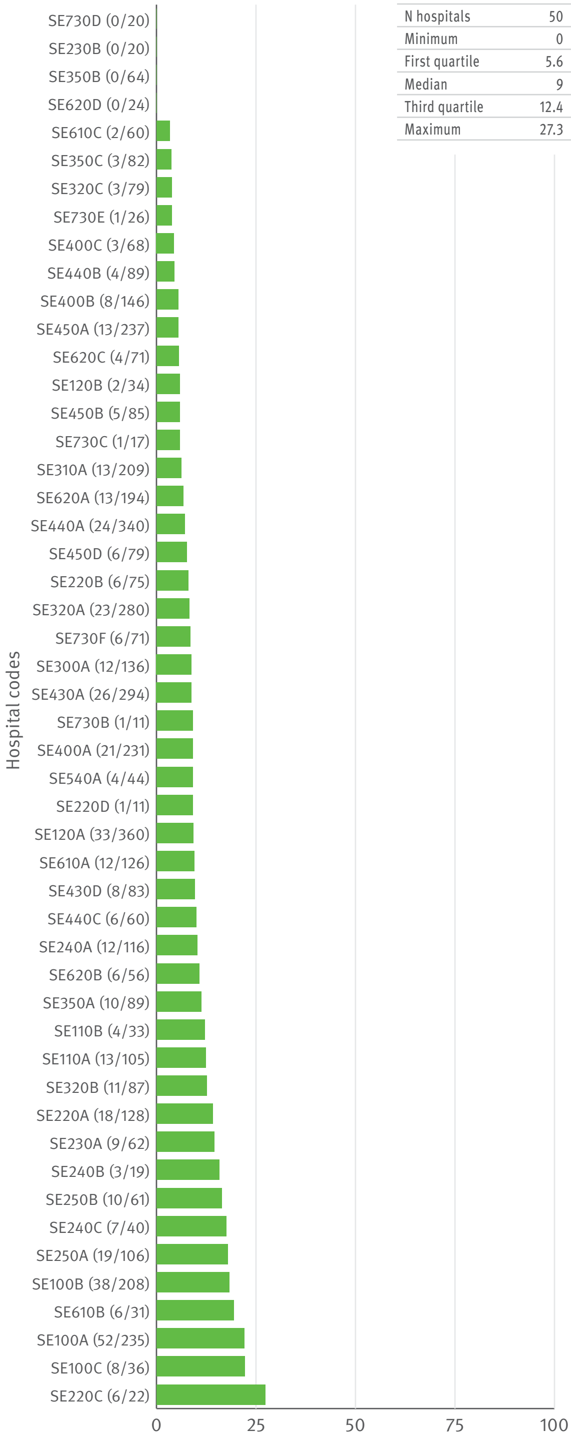
N laboratories	21
Minimum	0
First quartile	1.2
Median	2.2
Third quartile	3
Maximum	9.3

Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)



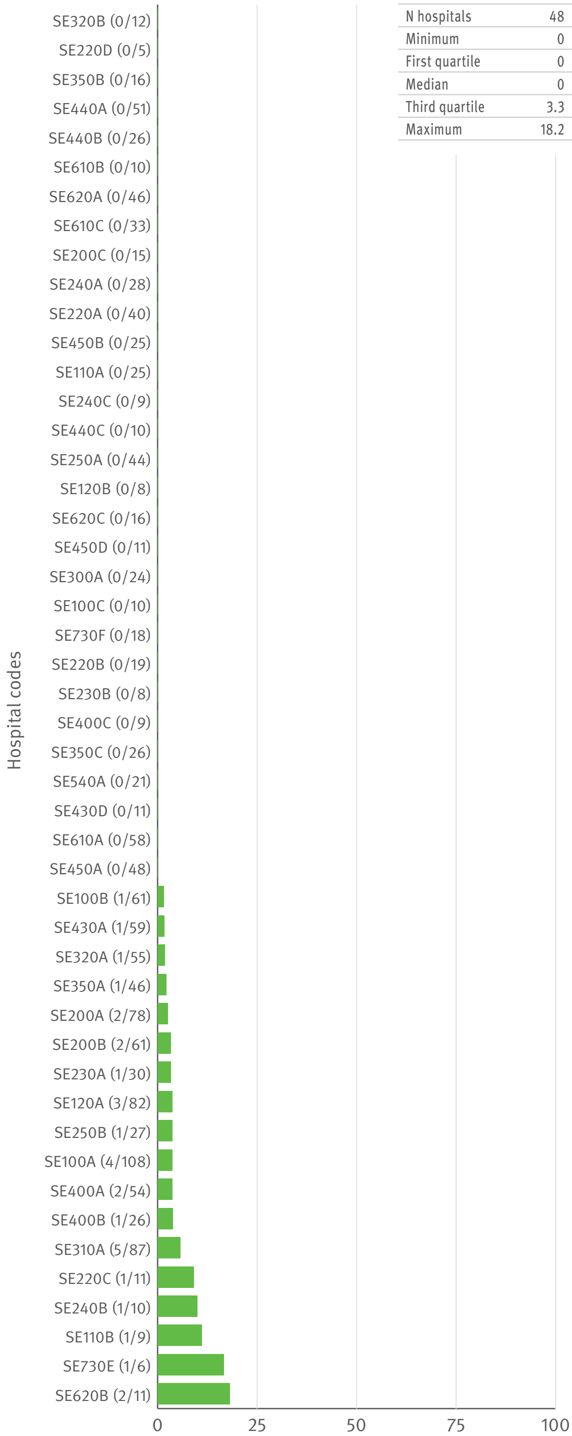
N hospitals	55
Minimum	0
First quartile	0
Median	0
Third quartile	1.1
Maximum	3.7

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)



N hospitals	50
Minimum	0
First quartile	5.6
Median	9
Third quartile	12.4
Maximum	27.3

Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



N hospitals	48
Minimum	0
First quartile	0
Median	0
Third quartile	3.3
Maximum	18.2

United Kingdom

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2002–2009

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2002	23	617	21	1588	20	1958	-	-	-	-	-	-
2003	50	1334	51	3548	19	2253	-	-	-	-	-	-
2004	54	1059	54	3562	20	2091	-	-	-	-	-	-
2005	53	1375	58	3971	23	2359	27	591	23	420	25	438
2006	51	1514	55	4132	26	2438	22	547	22	404	24	353
2007	50	1785	55	4865	20	2374	18	435	18	382	19	370
2008	51	1223	55	3355	15	2456	14	274	15	350	14	345
2009	59	1396	69	2977	28	4712	26	712	27	725	26	639

Antibiotic resistance from 2002 to 2009

Table 2: Proportion (%) of antibiotic non-susceptible isolates

Pathogens by antimicrobial classes	2002	2003	2004	2005	2006	2007	2008	2009
Streptococcus pneumoniae								
Penicillin R	3	1	<1	2	<1	2	1	1
Penicillin RI	6	5	3	4	3	4	5	3
Macrolides RI	13	13	13	11	12	10	6	4
Staphylococcus aureus								
Oxacillin/Meticillin R	47	44	44	44	42	36	31	28
Escherichia coli								
Aminopenicilins R	52	55	53	56	57	55	61	62
Aminoglycosides R	3	4	6	8	7	7	7	7
Fluoroquinolones R	7	11	14	17	20	18	15	18
Third-gen. cephalosporins R	2	3	3	6	8	9	7	9
Enterococcus faecalis								
Aminopenicilins RI	-	-	-	2	3	4	2	2
HL Gentamicin R	-	-	-	47	52	31	42	38
Vancomycin R	-	-	-	2	1	2	4	2
Enterococcus faecium								
Aminopenicilins RI	-	-	-	84	78	82	83	91
HL Gentamicin R	-	-	-	53	18	35	7	38
Vancomycin R	-	-	-	33	18	21	28	13
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	6	8	9	6	5
Fluoroquinolones R	-	-	-	12	13	12	7	6
Third-gen. cephalosporins R	-	-	-	12	11	13	7	7
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	2	1	5	2	3
Ceftazidime R	-	-	-	3	3	7	4	5
Carbapenems R	-	-	-	9	6	10	6	8
Aminoglycosides R	-	-	-	3	3	5	3	1
Fluoroquinolones R	-	-	-	8	8	9	8	7

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2008 and 2009

Characteristic	*S. pneumoniae* n=2 477		*S. aureus* n=6 233		*E. coli* n=6 500		*E. faecalis* n=572		*E. faecium* n=354		*K. pneumoniae* n=953		*P. aeruginosa* n=759	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	99	4	100	29	100	17	100	2	100	17	100	7	100	8
CSF	1	3	-	-	-	-	-	-	-	-	-	-	-	-
Gender														
Male	52	4	61	31	46	19	62	3	54	13	61	8	64	6
Female	47	4	38	27	53	15	38	1	44	21	38	6	35	11
Unknown	1	0	1	14	<1	35	-	-	3	22	<1	0	<1	0
Age (years)														
0–4	9	4	4	14	3	7	8	2	6	21	4	6	4	7
5–19	4	4	2	13	1	9	1	0	3	30	1	12	3	18
20–64	36	3	35	32	26	16	31	3	39	29	31	10	31	12
65 and over	39	5	49	47	70	16	60	2	51	16	63	10	63	6
Unknown	12	3	10	42	<1	20	<1	100	-	-	<1	0	-	-
Hospital department														
ICU	5	3	7	56	-	-	-	-	-	-	-	-	-	-
Internal med.	24	4	26	41	-	-	-	-	-	-	-	-	-	-
Surgery	1	3	8	50	-	-	-	-	-	-	-	-	-	-
Other	36	4	34	34	-	-	-	-	-	-	-	-	-	-
Unknown	34	4	25	35	100	16	100	2	100	22	100	9	100	8

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; CRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenems-resistant *P. aeruginosa*.

United Kingdom

Figure 1: **Proportion (%) of penicillin-non-susceptible *S. pneumonia* by laboratory (2008–2009)**

N laboratories	60
Minimum	0
First quartile	0
Median	2.7
Third quartile	5.3
Maximum	36.4

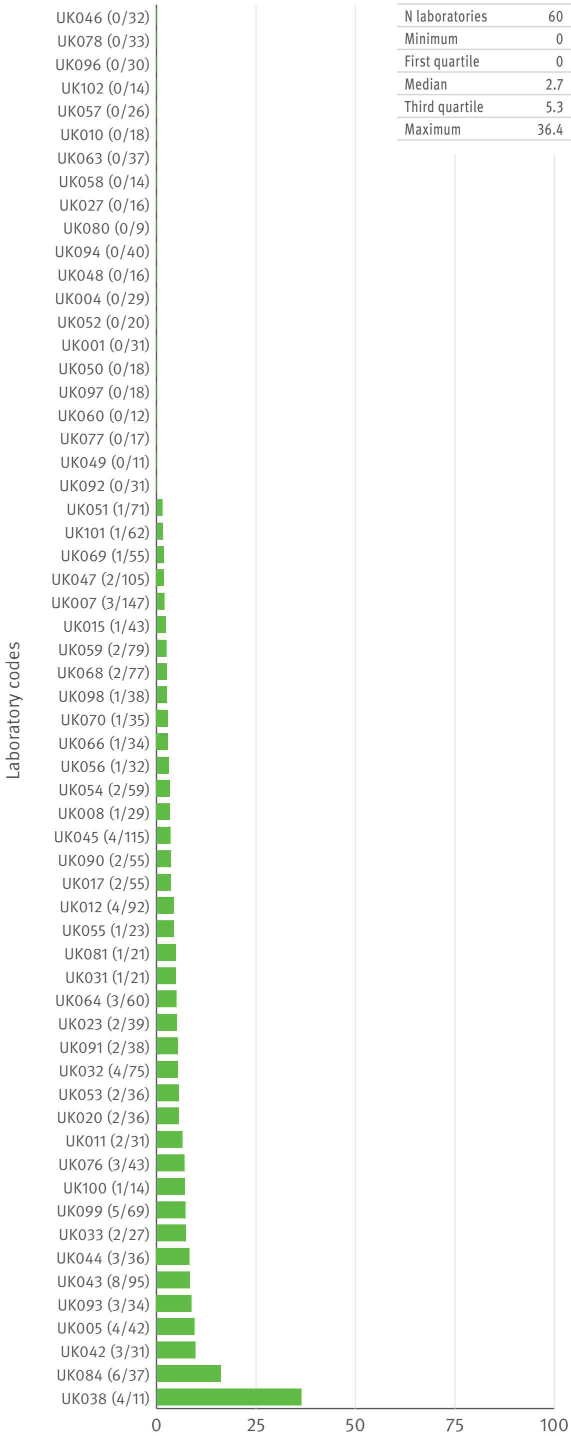


Figure 2: **Proportion (%) of meticillin-resistant *S. aureus* by hospital (2008–2009)**

N hospitals	108
Minimum	4
First quartile	21.1
Median	30.3
Third quartile	36.5
Maximum	100

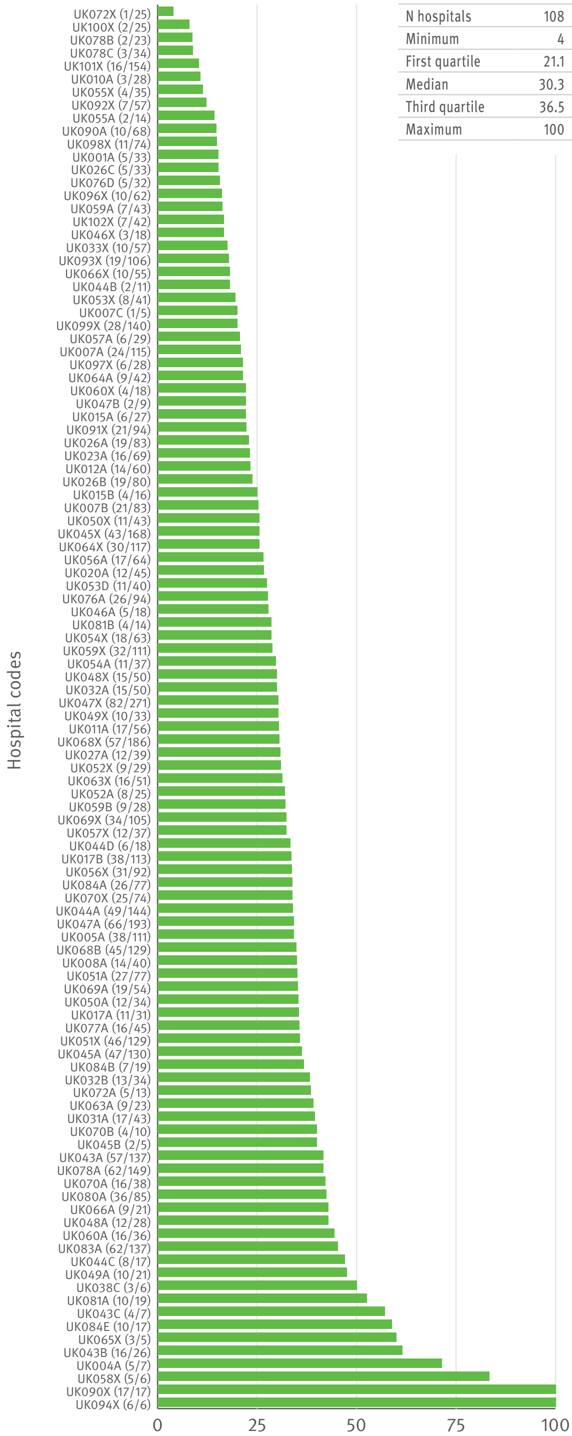
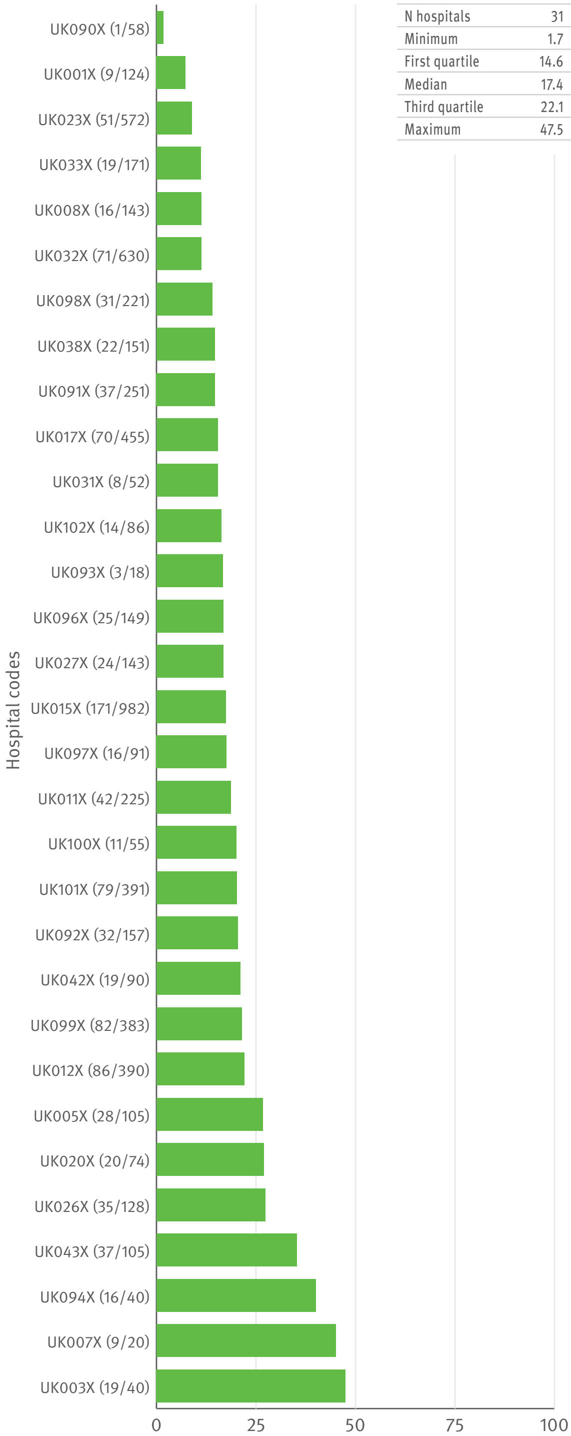
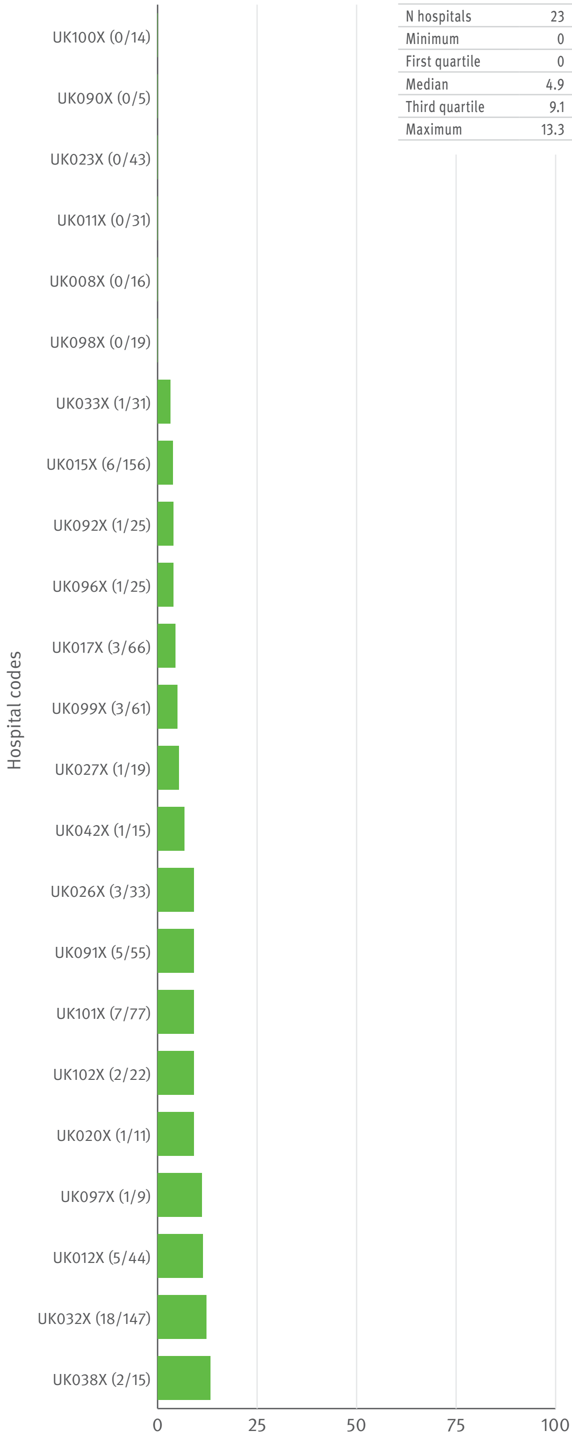


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2008–2009)



N hospitals	31
Minimum	1.7
First quartile	14.6
Median	17.4
Third quartile	22.1
Maximum	47.5

Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2008–2009)



N hospitals	23
Minimum	0
First quartile	0
Median	4.9
Third quartile	9.1
Maximum	13.3

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