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Antimicrobial resistance surveillance in Europe

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Antimicrobial resistance surveillance in Europe

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

2010

Coordination
This report of the European Centre for Disease Prevention and Control (ECDC) was coordinated by Ole Heuer.

Contributing authors
Ole Heuer, Anna-Pelagia Magiorakos, Marianne Gunell, Assimoula Economopoulou, Paula Bianca Blomquist, Derek Brown, Christine Walton, Nita Patel and Dominique Monnet.

Data analysis
Carlo Gagliotti, Carl Suetens, Jolanta Griskeviciene

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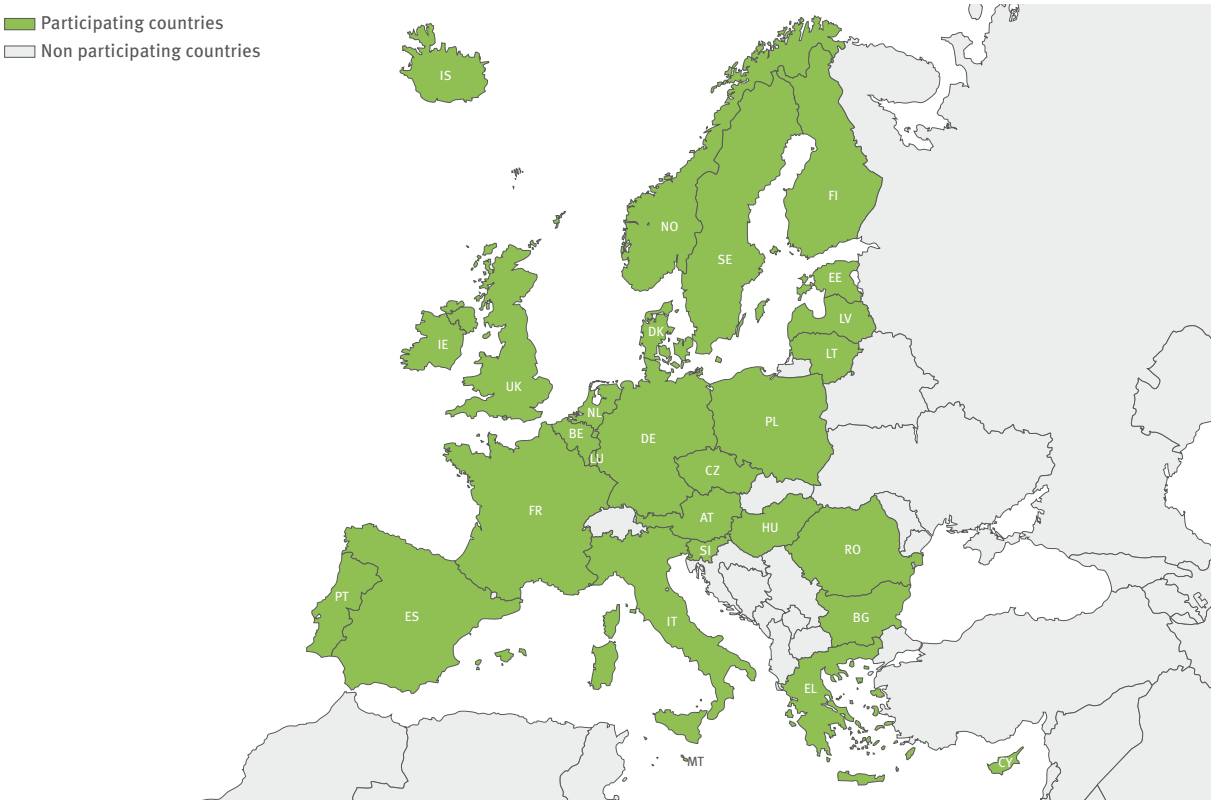
Abbreviations and acronyms

AMR	Antimicrobial resistance
AmpC	Ampicillinase C
AST	Antimicrobial susceptibility testing
BSAC	British Society for Antimicrobial Chemotherapy
BSI	Bloodstream infections
CC	Clonal complex
CLSI	Clinical and Laboratory Standards Institute
CMY	Cephamycinase
CNSE	Carbapenem-non-susceptible Enterobacteriaceae
CPE	Carbapenemase-producing Enterobacteriaceae
CREC	Third-generation cephalosporin-resistant *Escherichia coli*
CRG	Commissie Richtlijnen Gevoeligheidsbepalingen (Dutch)
CRKP	Third-generation cephalosporin-resistant *Klebsiella pneumoniae*
CSF	Cerebrospinal fluid
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
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 *Escherichia coli*
ICU	Intensive care unit
IMP	Imipenemase
KPC	*Klebsiella pneumoniae* carbapenemase
MIC	Minimum inhibitory concentration
MLS	Macrolide, lincosamide and streptogramin
MNSP	Macrolide non-susceptible *Streptococcus pneumoniae*
MRSA	Meticillin-resistant *Staphylococcus aureus*
NDM	New Delhi metallo-beta-lactamase
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
SFM	Comité de l'Antibiogramme de la Société Française de Microbiologie (French)
SIR	Sensitive, intermediate, resistant
SHV	Sulfhydryl-variable extended-spectrum beta-lactamase gene
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
WHO	World Health Organization
WHONET	WHO microbiology laboratory database software

Countries participating in EARS-Net 2010



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

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
www.szu.cz
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
www.rki.de

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 Laboratory, Luxembourg's Hospital Centre

Malta
Mater Dei Hospital, B'Kara

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
National Reference Centre for Antimicrobial Resistance and Surveillance

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
National Centre of Microbiology

Sweden

Swedish Institute for Communicable Disease Control
www.smi.se

United Kingdom

Health Protection Agency
www.hpa.org.uk
Health Protection Scotland
Public Health Agency Northern Ireland

Summary

Antimicrobial resistance data reported to EARS-Net by 28 countries in 2010 and trend analyses including EARSS data from previous years, show that the Europe-wide increase of antimicrobial resistance observed in *Escherichia coli* during recent years is continuing unimpeded. The highest resistance proportions in *E. coli* were reported for aminopenicillins ranging up to 83%. Despite the already high level of resistance the increase continues even in countries presenting resistance well above 50%. The percentage of third-generation cephalosporin resistance reported among *E. coli* isolates has increased significantly over the last four years in half of the reporting countries, while a decreasing trend was observed in only one country. This resistance is directly linked to the high proportions (65–100%) of ESBL-positives among cephalosporin-resistant *E. coli* isolates reported in 2010.

A high frequency of multi-drug resistant *Klebsiella pneumoniae* was observed in southern, central and eastern Europe. In half of the reporting countries, the proportion of multiresistant *K. pneumoniae* isolates (combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides) was above 10% and five countries show an increasing trend of carbapenem-resistant *K. pneumoniae*. Carbapenems 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).

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 *S. aureus* is still above 25% in eight out of 28 countries, the occurrence of MRSA is stabilising or decreasing in some countries and a sustained decrease has been observed in Austria, France, Ireland, Latvia, the UK and Cyprus.

Furthermore, the United Kingdom has shown a consistent reduction of resistant proportions in *K. pneumoniae* for all antimicrobial classes under surveillance, and in a few countries (Germany, Greece, Italy and the UK) 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* is stabilising in Europe at a level of 25–50%.

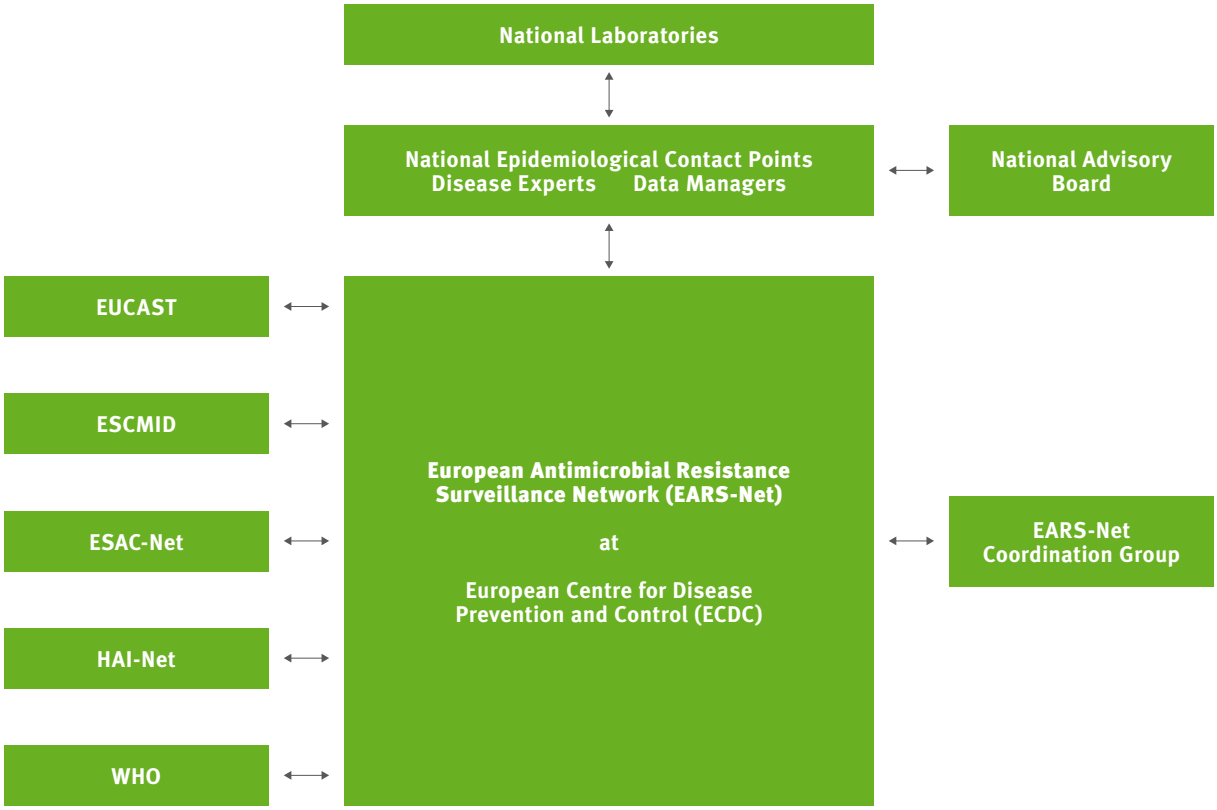
For *Streptococcus pneumoniae*, non-susceptibility to penicillin remains generally stable in Europe and non-susceptibility to macrolides has declined in five countries while an increasing trend was observed in only one country. For *Pseudomonas aeruginosa*, high proportions of resistance to fluoroquinolones, 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. This is likely to be a reflection of differences in infection control practices, presence or absence of legislation regarding prescription of antimicrobial drugs. However, for *K. pneumoniae*, increasing trends of resistance to specific antimicrobial classes and of multiresistance have also been observed in northern European countries, like Denmark and Norway, which traditionally have a prudent approach to antimicrobial use.

In addition to the regular trend analysis and situation overview, this 2010 EARS-Net report contains a focus chapter providing in-depth analysis for carbapenem-resistant *K. pneumoniae* and *P. aeruginosa*. Results from susceptibility testing to carbapenems for these two pathogens reported since 2005, reveal a significant decrease of susceptibility to carbapenems in invasive *K. pneumoniae* over the period 2005–2010. Carbapenems are some of the few effective antimicrobials for the treatment of infections caused by bacteria that produce extended-spectrum beta-lactamases and thus resistance to carbapenems leaves very few therapeutic options available.

Based on EARS-Net data, the antimicrobial resistance situation in Europe displays large variation depending on pathogen type, antimicrobial substance and geographical region. Besides evidence of stabilisation of the situation for some pathogens (e.g. MRSA) in a number of countries, the data show the unimpeded decline of antimicrobial susceptibility in other major pathogens (e.g. *E. coli*) and the alarming emergence of carbapenem resistance in *K. pneumonia*, leading to an unfortunate loss of antimicrobial treatment options.

Figure 1.1: Organisation of EARS-Net



1 Introduction

This is the second Annual Report of the European Antimicrobial Resistance Surveillance Network (EARS-Net) published by European Centre of Disease Prevention and Control (ECDC). The report represents the continuation of a series of highly valued EARSS Annual Reports published by the network since 2001. The results presented in this report are based on data submitted from over 900 laboratories serving more than 1400 hospitals in 26 EU Member States, Norway and Iceland.

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 antimicrobial resistance surveillance data collected previously by EARSS and currently by EARS-Net, play an important role in documenting the occurrence and spread of antimicrobial resistance in Europe, and contribute to raising awareness of the problem at the political level, among public health officials, in the scientific community and in the general public.

In the present report, results referring to 2010 and trend analyses including data from previous years are presented and discussed in Chapter 5. This year's focus chapter (Chapter 2) is on carbapenem-resistant *K. pneumoniae* and *P. aeruginosa*. Country-specific information is provided in Annex 2.

About EARS-Net

The European Antimicrobial Resistance Surveillance Network (EARS-Net) is a European-wide network of national surveillance systems, providing European reference data on the occurrence of antimicrobial resistance. EARS-Net is the largest publicly funded surveillance system for antimicrobial resistance in Europe.

The management and coordination of EARS-Net was transferred from the Dutch National Institute for Public Health and the Environment (RIVM) to the European Centre for Disease Prevention and Control in January 2010. At ECDC, the management and coordination of EARS-Net is carried out by the Surveillance Section in collaboration with the Disease Programme 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 (see Figure 1.1), composed of experts selected from among the nominated disease-specific contact points and experts from other organisations involved in surveillance of antimicrobial resistance. EARS-Net activities are coordinated in close collaboration with two other major surveillance networks: the European Surveillance of Antimicrobial Consumption Network (ESAC-Net) and the Healthcare-associated Infections Surveillance Network (HAI-Net). EARS-Net collaborates with the European Society of Clinical Microbiology and Infectious Diseases (ESCMID), in particular with the society's subcommittee, the European Committee on Antimicrobial Susceptibility Testing (EUCAST).

Data for EARS-Net are provided by a network of national surveillance systems in the participating countries. The national surveillance systems collect data from clinical laboratories on antimicrobial susceptibility of seven bacterial pathogens of public health importance in humans: *Streptococcus pneumoniae*, *Staphylococcus aureus*, *Escherichia coli*, *Enterococcus faecalis*, *Enterococcus faecium*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. The majority of countries participating in EARS-Net even collect and report denominator data on laboratory/hospital activity and patient characteristics.

The data from national surveillance systems are uploaded by national data managers to a central database at ECDC (The European Surveillance System, 'TESSy'). After uploading, each country approves its own data and the results are made available from the ECDC website. EARS-Net maintains an interactive database at the ECDC website[i] and publishes annual reports on the occurrence of antimicrobial resistance in Europe.

i http://ecdc.europa.eu/en/activities/surveillance/EARS-Net/Pages/index.aspx

2 Carbapenem-resistant *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*

Analysis of data from laboratories reporting continuously from 2005 to 2010

2.1 Introduction

The increase of carbapenem resistance in Gram-negative bacteria has become an exceedingly important clinical and public health issue in recent years. Carbapenems are some of the few effective antimicrobials for the treatment of infections caused by bacteria that produce extended-spectrum beta-lactamases and so resistance to carbapenems leaves very few therapeutic options[1]. Although carbapenem resistance in both *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* can result through various mechanisms of resistance[2], the emergence and spread of carbapenemases, a group of clinically important beta-lactamases, especially in members of Enterobacteriaceae family[1–4], has made the surveillance of carbapenem resistance and carbapenemases in Gram-negative bacteria imperative.

Key points

- A significant decrease in susceptibility to carbapenems in invasive *K. pneumoniae* isolates was observed in Europe from 2005 to 2010. During the same period, no significant change in susceptibility to carbapenems in invasive *P. aeruginosa* isolates was observed.
- A marked heterogeneity was observed with regard to the interpretive criteria being used by clinical microbiology laboratories for reporting susceptibility testing results. Harmonised use of breakpoints would substantially increase the comparability of data.
- Carbapenem resistance can result through various mechanisms, including the production of carbapenemases. Confirming the presence of carbapenemases in Enterobacteriaceae, would allow a closer surveillance of the spread of carbapenemase-producing Enterobacteriaceae (CPE) in Europe.

Carbapenemase enzymes that can efficiently hydrolyse most beta-lactams, including carbapenems[1,3] have emerged and spread among all members of the Enterobacteriaceae family worldwide[4–6]. Though the exact prevalence of carbapenemase-producing Enterobacteriaceae (CPE) in healthcare facilities and in the community in Europe is not known, publications from Member States indicate that CPE are endemic in certain countries in Europe[7,8]. Although some of the most widespread types of carbapenemases found in Enterobacteriaceae are *K. pneumoniae* carbapenemase (KPC) and Verona integron-encoded metallo-beta-lactamase (VIM)[8–13], other carbapenemases like OXA-48[9,14] and New Delhi metallo-beta-lactamase (NDM)[15,16] have also emerged. Variants of NDM carbapenemase, such as NDM-2, have recently been reported from countries in the north of Africa[17].

The emergence and spread of CPE has been identified as a public health threat, especially since recent studies on CPE[18,19] and carbapenem-non-susceptible Enterobacteriaceae (CNSE)[20,21] have shown that infection or colonisation is associated with higher in-hospital mortality.

Results from testing the susceptibility of *K. pneumoniae* and *P. aeruginosa* to carbapenems have been reported to EARSS/EARS-Net by participating clinical microbiological laboratories since 2005. Susceptibility to carbapenems reported to EARS-Net is based on the results of testing against either imipenem or meropenem. The choice of which breakpoint committee's interpretive criteria is used for the interpretation of minimum inhibitory concentrations (MIC) as either susceptible (S), intermediate (I) or resistant (R), is at the discretion of each clinical microbiology laboratory. In general, however, EARS-Net encourages the use of EUCAST breakpoints.

Because of the public health impact of infections caused by CPE, it is important to follow the trends of carbapenem resistance in Europe. Confirming the presence of carbapenemases in bacteria and understanding the extent of the reservoir in Europe is a prerequisite for targeted intervention to control the spread.

Although carbapenem susceptibility results are available from EARS-Net reports, it is important to note that these only provide resistance profiles with no further characterisation of resistance mechanisms. The results may therefore be useful for the surveillance of carbapenem resistance in Gram-negative bacteria, but may not be useful for following the occurrence of carbapenemases. Performance of phenotypic and molecular testing for screening and confirmation of the presence of carbapenemases would add a significant and important layer of information to the existing data.

2.2 Methods

Results of testing susceptibility to carbapenems of invasive *K. pneumoniae* and *P. aeruginosa* isolates causing blood stream infections (BSI) and infections of cerebrospinal fluid (CSF) were extracted from the EARSS/EARS-Net database for 2005–2010. A trend analysis was performed using the Cochran-Armitage test for trend for both *K. pneumoniae* and *P. aeruginosa*.

The following data were also extracted from the EARSS/EARS-Net database with regard to reporting of carbapenem resistance of *K. pneumoniae* and *P. aeruginosa* isolates from 2005 to 2010:

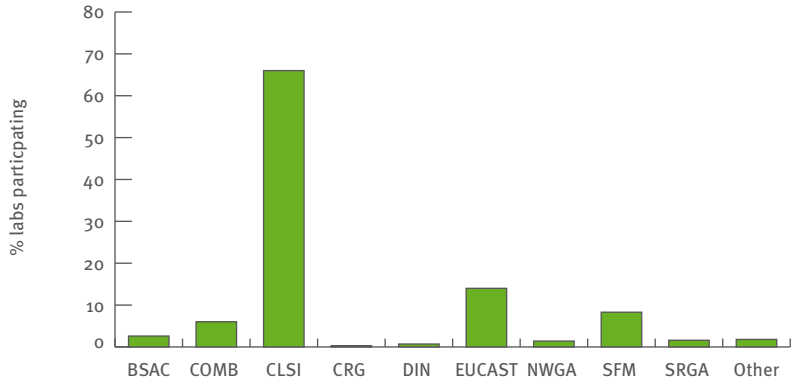
- the number of countries reporting to EARSS/EARS-Net annually for these organisms,
- the number of clinical microbiology laboratories reporting to EARSS/EARS-Net per country per year,
- the number of clinical microbiology laboratories in each country that have reported their results continuously during the period (some countries may report through one central laboratory),
- the total number of laboratories using the interpretive criteria of various breakpoint committees as reported by EARS-Net laboratories participating in the 2010 EARS-Net External Quality Assessment (EQA) exercise (see Figure 3.2).

2.3 Results

Number of participating countries

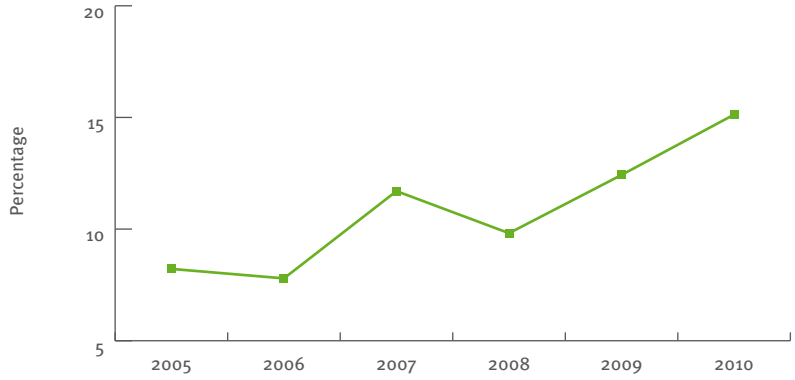
Twenty-one countries reported results to EARSS for *K. pneumoniae* and 22 reported for *P. aeruginosa*, in 2005; this number had increased to 28 for both organisms by 2010. Eighteen countries reported continuously for the two pathogens throughout the period 2005–2010. Trend

Figure 2.1: Percentage of EARS-Net participating laboratories employing interpretive criteria from various breakpoint committees for antimicrobial susceptibility testing in 2010. Only data for laboratories returning EQA data for *K. pneumoniae* and *P. aeruginosa* are included



Data: UKNEQAS 2010
BSAC: British Society of Antimicrobial Chemotherapy; COMB: Combination; CLSI: Clinical Laboratory Standards Institute; CRG: Commissie Richtlijnen Gevoeligheidsbepalingen; DIN: Deutsches Institut für Normung; EUCAST: European Committee for Antimicrobial Susceptibility Testing; NWGA: Norwegian Working Group on Antibiotics; SFM: Société Française de Microbiologie; SRGA: Swedish Reference Group for Antibiotics.

Figure 2.2: *Klebsiella pneumoniae*: Percentage of carbapenem-resistant invasive isolates reported to EARSS/EARS-Net by year, 2005–2010 (18 countries; 140 laboratories)



Only laboratories that continuously reported susceptibility results for carbapenems during the period 2005–2010 are included in the analysis.

analyses for 2005–2010 presented in this chapter for both *K. pneumoniae* and *P. aeruginosa* are based only on data from the laboratories reporting continuously during the period (Table 2.1).

Participation of clinical microbiology laboratories

There has been an overall increase of 56 % (366 to 570) and 69 % (312 to 526) in the total numbers of clinical microbiology laboratories reporting *K. pneumoniae* and *P. aeruginosa* isolates, respectively, from 2005 to 2010.

Number of continuously reporting laboratories

The numbers of laboratories continuously reporting susceptibility results for *K. pneumoniae* and *P. aeruginosa* isolates throughout the period 2005–2010, were 140 and 168, respectively. The number of continuously reporting laboratories per country and the average number of isolates per year and country can be seen in Table 2.1.

Use of various interpretive criteria by participating laboratories

The distribution of the interpretive criteria used by all laboratories that participated in the EARS-Net EQA in June 2010 is shown in Figure 2.1. Data from this EQA showed that 66 % of participating laboratories used guidelines from the Clinical Laboratory Standards Institute (CLSI) and 14 % used those from the European Committee on Antimicrobial Susceptibility Testing (EUCAST); making the interpretive criteria provided by these the two breakpoint committees the most widely used.

Trends in resistance

Klebsiella pneumoniae

Between 2005 and 2010, a total of 140 laboratories from 18 countries continuously reported results on the susceptibility to carbapenems of invasive *K. pneumoniae* isolates. During this period, the number of laboratories reporting continuously per country ranged from one laboratory in the Czech Republic, Iceland, Malta and Sweden, to 33 laboratories in France. Trend analysis was performed only on the results from these 140 laboratories.

Results from this analysis show that in Europe the proportion of *K. pneumoniae* isolates resistant to carbapenems increased from 8 % to 15 % between 2005 and 2010. This increase was found to be highly significant ($p<0.001$) (Figure 2.2) but this is mainly due to a substantial increase in a few countries.

For more detailed trends of carbapenem resistance in *K. pneumoniae* per country for 2007–2010, please refer to chapter 5, figure 5.29.

Pseudomonas aeruginosa

A total of 168 laboratories from 18 countries continuously reported results on susceptibility of invasive *P. aeruginosa* isolates to carbapenems between 2005 and 2010. The number of laboratories continuously reporting per country, ranged from one each in Bulgaria, Iceland and Malta to 24 in Greece. Trend analysis was performed only on the results from these 168 laboratories.

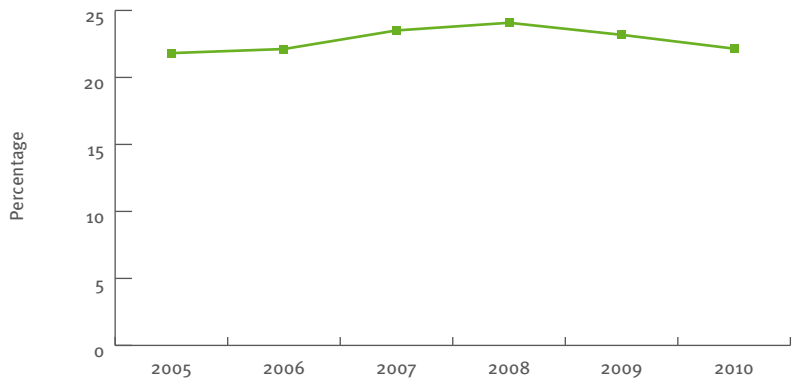
Results from this analysis show that in Europe the proportion of *P. aeruginosa* isolates resistant to carbapenems was 22 % in 2005, increased to 24 % in 2008, and decreased to 22 % in 2010. Trend analysis on these data showed no significant change over the study period ($p<0.49$) (Figure 2.3).

For more detailed trends of carbapenem resistance in *P. aeruginosa* per country for 2007 – 2010, please refer to chapter 5, figure 5.40.

2.4 Discussion

Results from the analyses in this report show that carbapenem resistance is significantly increasing among *K. pneumoniae* invasive isolates in Europe. Reports from

Figure 2.3: *Pseudomonas aeruginosa*: Percentage of carbapenem-resistant invasive isolates reported to EARSS/EARS-Net by year, 2005–2010 (18 countries; 168 laboratories).



Only laboratories that continuously reported susceptibility results for carbapenems during the period 2005–2010 are included in the analysis.

Member States showing similar susceptibility results and an increasing number of reports documenting the spread of CPE have given rise to the suspicion that susceptibility of Enterobacteriaceae to carbapenems is decreasing across Europe. The proportion of carbapenem-resistant *P. aeruginosa*, which is already high at 22%, showed no significant increase. The increase in resistance to carbapenems in *K. pneumoniae*, as well as the high level of resistance in *P. aeruginosa*, constitutes a serious public health concern, since few therapeutic options are available for the treatment of carbapenem-resistant infections.

When making inferences based on the available data on carbapenem-resistant *P. aeruginosa* and *K. pneumoniae*, a number of limitations regarding detection and testing should be taken into consideration. One of the difficulties of accurately detecting carbapenem resistance is that it may be the result of a variety of mechanisms of resistance, including the presence of outer membrane porin protein loss, increased activity of efflux pumps, the production of extended-spectrum beta-lactamases or AmpC beta-lactamases in combination with porin loss and last, but not least, the production of carbapenemases[2,8]. Furthermore, even with routine antimicrobial susceptibility testing, CPE can demonstrate significant variation in their carbapenem MICs, even falling within the susceptibility range as defined by either the CLSI[22] or EUCAST[23], despite a recent reduction of the susceptibility breakpoints for carbapenems and Enterobacteriaceae by CLSI[24]. Moreover, certain testing methods, such as automatic testing, have been shown to not always distinguish between Enterobacteriaceae that produce carbapenemases and those that carry other mechanisms of resistance (e.g. ESBLs and/or porin loss)[8,25]. Another issue affecting the comparability of susceptibility testing results is the marked heterogeneity of the breakpoints used by laboratories in Europe. As shown in Figure 2.1, the most commonly used breakpoints are those from CLSI, followed by EUCAST, but interpretive criteria from a number of other committees are also followed. While the effect of this heterogeneity on the susceptibility results and trends presented here are not explored, it can be argued that in order to obtain fully comparable results, harmonisation of the use of breakpoints and interpretive criteria for all reporting laboratories is needed.

The increased morbidity, mortality and overall public health impact of infections with carbapenemase-producing bacteria calls for action to prevent the spread of these bacteria and resistance mechanisms in Europe. Data on carbapenem resistant bacteria is available through existing surveillance systems; however, in the absence of data on the mechanisms of resistance in these bacteria, the real prevalence of carbapenemase-producing bacteria remains unknown. Having this information would provide better understanding of the extent of the reservoir in Europe, which is a prerequisite for designing and implementing targeted interventions to control the spread.

In support of this, a recent ECDC risk assessment on the spread of CPE through patient transfer between healthcare facilities, with special emphasis on cross-border transfer[6] suggests that the elements necessary to curb the spread of CPE include surveillance data, prompt detection of carbapenem resistance in Enterobacteriaceae, and confirmation of the production of carbapenemases in these bacteria[6,8].

Table 2.1: Numbers of laboratories reporting continuously and average numbers of *K. pneumoniae* and *P. aeruginosa* isolates reported per country per year to EARSS/EARS-Net during 2005–2010

Country	*K. pneumoniae*		*P. aeruginosa*	
	Number of laboratories*	Average number of isolates per year	Number of laboratories*	Average number of isolates per year
Austria	7	336	8	396
Bulgaria	2	61	1	29
Cyprus	2	43	2	41
Czech Republic	1	654	30	485
Estonia	4	46	5	39
Finland	7	270	6	185
France	33	1060	20	1153
Greece	25	1161	24	887
Hungary	15	351	16	530
Iceland	1	20	1	11
Ireland	8	189	9	154
Malta	1	35	1	44
Netherlands	5	392	4	288
Norway	7	292	9	125
Slovenia	7	75	8	82
Spain	10	569	9	456
Sweden	1	403	7	260
United Kingdom	4	396	9	355
Total	**140**		**168**	

* In some countries, data from several laboratories may be reported to EARS-Net from one central laboratory.

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3 External quality assessment exercise (EQA) 2010

3.1 Introduction

Since 2000, EARSS/EARS-Net have organised 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 of experience in external quality assessment in different countries (www.ukneqasmicro.org.uk).

The purpose of the EARS-Net EQA exercises is:

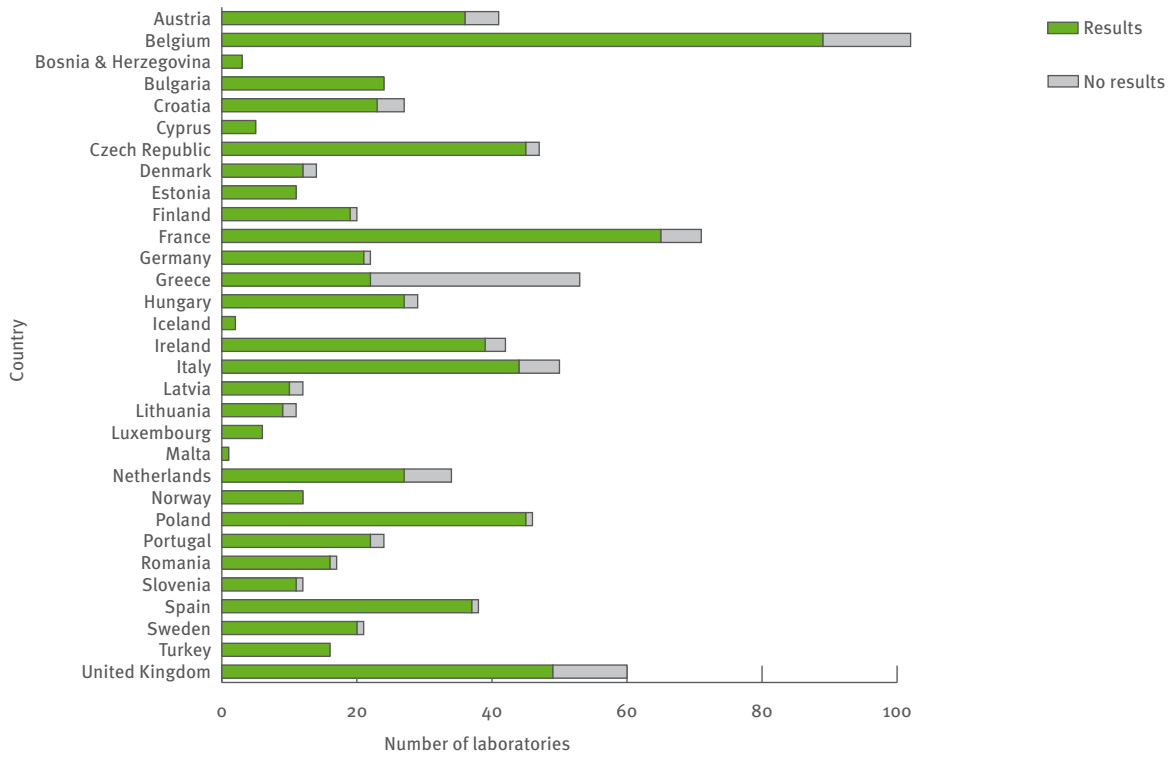
- to assess the ability of participating laboratories to identify antimicrobial resistance of clinical and public health importance;
- to determine the accuracy of susceptibility test results reported by individual laboratories;
- to estimate the overall comparability of routinely collected test results between laboratories and countries across Europe.

The EQA exercise conducted in 2010 was open to all 28 countries participating in EARS-Net. In addition, the EQA was offered to previous EARSS participants including Bosnia-Herzegovina, Croatia, Turkey and Israel. A panel of six strains (*S. pneumoniae, S. aureus, E. coli, K. pneumoniae, P. aeruginosa* and *E. faecium*) resembling resistance phenotypes of bacterial species under surveillance by EARS-Net was included in the exercise. The strains were characterised and tested in two reference laboratories (Addenbrooke's Hospital, Cambridge, UK and City Hospital, Birmingham, UK). 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

The six strains were distributed to 873 laboratories connected to EARS-Net. The laboratories were asked to report the identification of each organism and clinical susceptibility characterisation – susceptible, intermediate and resistant (S, I, R) – according to the guidelines used. The return rate was similar to previous years; 766 laboratories (88%) returned reports. Figure 3.1 shows the number of participating laboratories returning results per country. Participants' results were analysed

Figure 3.1: Number of participating laboratories returning reports per country, 2010



The external quality assessment exercise was open to all countries participating in EARSS in 2010.

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 (42 %), disc diffusion tests (34 %) or combined methods (14 %). For species identification laboratories used automated (52 %) or conventional methods (46 %). Increased use of conventional methods was associated with identification of the *S. pneumoniae* and *E. faecium*.

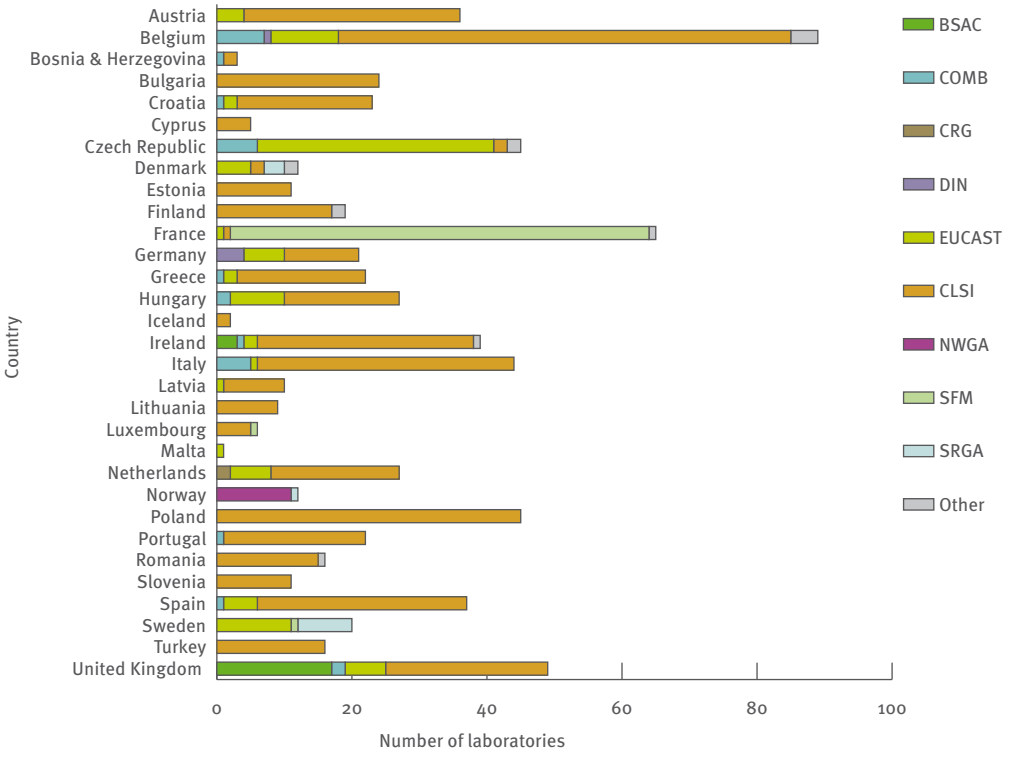
The majority of laboratories applied CLSI guidelines (66 %), and some countries used national guidelines, e.g. France (SFM), United Kingdom (BSAC), and Sweden (SRGA). EUCAST guidelines were reported by 107 (14 %) laboratories. However, the United Kingdom, Sweden, the Netherlands, Germany, France and Norway have been implementing EUCAST breakpoints in their national MIC breakpoint recommendations, as harmonised breakpoints have been agreed, and their disc diffusion method has been adjusted accordingly. Therefore, a combined total of some 29 % of laboratories used EUCAST breakpoints. Figure 3.2 shows the adherence to (inter)national guidelines by number of laboratories per country.

3.2.1 Specimen 0243 *Klebsiella pneumoniae*

This specimen consisted of a *Klebsiella pneumoniae* with plasmid-mediated CIT-type (CMY-like enzymes derived from *C. freundii*) AmpC beta-lactamase production.

Reporting of susceptibility to cephalosporins by participants was very variable (cefotaxime S 20.1 %, I 18.5 %, R 61.4 %; ceftriaxone S 16.1 %, I 24.6 %, R 59.3 %; ceftazidime S 2.8 %, I 22.9 %, R 74.3 %). MICs of cephalosporins included in reference tests (cefotaxime 4–16 mg/L, ceftriaxone >32 mg/L, ceftazidime 32 mg/L) were all in the resistant range with current EUCAST and CLSI breakpoints, although cefotaxime MICs were borderline. CLSI breakpoints for Enterobacteriaceae tested against cefotaxime, ceftriaxone and ceftazidime were significantly reduced in January 2010. It is likely that many laboratories have not yet implemented the new breakpoints in their systems and according to old CLSI

Figure 3.2: Adherence to guidelines: number of laboratories per country, 2010



BSAC: British Society for Antimicrobial Chemotherapy; CRG: (Dutch) Commissie Richtlijnen Gevoeligheidsbepalingen; DIN: Deutsche Industrie Norm; EUCAST: European Committee on Antimicrobial Susceptibility Testing; CLSI: Clinical and Laboratory Standards institute; NWGA: Norwegian Working Group on Antimicrobials; SFM: Société Française de Microbiologie; SRGA: Swedish Reference Group for Antibiotics. Laboratories specifying 'other' indicates did they did not use any of the specified guidelines above. Where more than one guideline was used to cover certain antimicrobial/organism combinations laboratories could select combined (COMB) as the guideline.

recommendations it would have been correct to report bacteria with MICs of 4 or 8 mg/L as sensitive to cefotaxime if the isolate did not have a class A ESBL. Reports of susceptible to cefotaxime, ceftriaxone and ceftazidime were returned by significantly fewer participants following EUCAST-related guidelines (4.0% of 199, 3.4% of 58 and 0.5% of 210, respectively) than participants following CLSI guidelines (27.1% of 431, 18.1% of 221 and 3.7% of 488, respectively).

As seen with the *E. coli* with plasmid-mediated AmpC beta-lactamase distributed in the EARSS EQA distribution in 2009 (specimen 9011), reports that the organism was an ESBL-producer were not uncommon: 22.4% of the participants incorrectly reported the presence of an ESBL. Synergy between third-generation cephalosporins and clavulanate was not seen in reference tests and some participants may have reported the presence of an ESBL simply because ESBLs are the most common mechanism of resistance to third-generation cephalosporins in *K. pneumoniae*. However, AmpC-mediated resistance in *K. pneumoniae* is not rare and reflects acquisition of a plasmid-mediated form of the enzyme. AmpC enzymes do have an extended spectrum of activity and it has been argued that the established definition of an ESBL, based mainly on activity against third-generation cephalosporins and inhibited by clavulanate, is unreasonably narrow. Some participants may have used an extended definition of an ESBL when giving results for the ESBL test, although this extended definition is controversial and not widely accepted.

Isolates with plasmid-mediated AmpC beta-lactamase are typically resistant to third-generation cephalosporins, cefuroxime, penicillin+clavulanate combinations, and cefoxitin, but susceptible to cefepime, cefpirome and carbapenems. They are negative in ESBL confirmation tests, but synergy is seen with cephalosporin–boronic acid or cephalosporin–cloxacillin tests.

High discrepancy rates were also seen with piperacillin–tazobactam, 70.9% of participants reporting the organism susceptible, 17.4% intermediate and 11.7% resistant. However, it is important to notice that piperacillin–tazobactam is an extremely difficult substance to test, and therefore it is difficult to correctly classify isolates that are borderline. In reference MIC tests, the organism appeared borderline susceptible/intermediate to piperacillin–tazobactam (MIC 8–16 mg/L). There is little clinical evidence on whether infections caused by *K. pneumoniae* with plasmid-mediated AmpC are treatable with piperacillin–tazobactam when the producers appear susceptible in vitro, and response will probably depend on the type and amount of AmpC produced. Results should, however, be viewed with considerable caution and it may be that some participants edited results from susceptible to intermediate or resistant on this basis. There were no significant problems with susceptibility testing of this organism against other reference agents (Table 3.1).

Table 3.1: *Klebsiella pneumoniae* (0243): Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories

Antibiotic agent	MIC range (mg/L) ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Amikacin	1	2	S	99
Amoxicillin	NT*		R	100
Ampicillin	128	>128	R	99
Cefotaxime	4	16	R	61
Ceftazidime	32	32	R	74
Ceftriaxone	>32	>32	R	59
Ciprofloxacin	16	32	R	99
Gentamicin	0.25	0.5	S	99
Imipenem	0.12	0.12	S	99
Meropenem	0.016	0.03	S	99
Piperacillin**			R	79
Piperacillin–tazobactam	8	16	S	71
Tobramycin	0.5	1	S	98
ESBL			Negative	78

* Not tested, result inferred from ampicillin result.
** Not tested, reference MICs were participants' results.
S: susceptible; R: resistant; I: intermediate.

3.2.2 Specimen 0244 *Escherichia coli*

This specimen consisted of an *Escherichia coli* with low-level penicillinase production and borderline susceptibility to amikacin.

Reference MICs of ampicillin and amoxicillin both varied from 16 to 128 mg/L (resistant by EUCAST guidelines, intermediate–resistant by CLSI guidelines) and most participants reported resistance to both agents (amoxicillin 89% resistant, ampicillin 96% resistant). No reference MIC results are available for piperacillin alone but the majority of participants reporting an MIC gave results in the range 4–16 mg/L (susceptible by EUCAST and CLSI breakpoints). Among participants, 65.7% reported susceptible, 19.3% intermediate and 15.0% resistant.

The organism is borderline in susceptibility to amikacin (MIC 8–16 mg/L) and would be reported susceptible/intermediate by EUCAST guidelines and susceptible by CLSI guidelines. This was reflected in the variable susceptibility reported by participants (51.4% susceptible, 31.7% intermediate, 16.9% resistant) (Table 3.2).

3.2.3 Specimen 0245 *Streptococcus pneumoniae*

This specimen consisted of a *Streptococcus pneumoniae* resistant to ciprofloxacin and erythromycin but susceptible to other reference agents tested. There were no significant problems in susceptibility testing with any of the reference agents.

Participants were asked if they would use a norfloxacin screening test with this isolate: 185 participants reported that they used a 10µg disc and all correctly reported the isolate resistant to this agent. Some 768 participants, following a variety of guidelines, reported a disc content value for ciprofloxacin with this specimen; 454 indicated that they used a content of 1µg and 313 used 5µg. However, only 429 participants reported a test result. The results for participants using a disc content of 1µg were: 11 susceptible, 4 intermediate and 137 resistant; and for those using a disc content of 5µg were: 4 susceptible, 3 intermediate and 269 resistant (Table 3.3).

Table 3.2: *Escherichia coli* (0244): Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories

Antibiotic agent	MIC range (mg/L) ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Amikacin	8	16	S	51
Amoxicillin	NT*		R	89
Ampicillin	16	128	R	96
Cefotaxime	0.03	0.12	S	99
Ceftazidime	0.12	0.25	S	99
Ceftriaxone	0.125	0.25	S	99
Ciprofloxacin	0.004	0.016	S	99
Gentamicin	16	32	R	93
Imipenem	0.06	0.12	S	99
Meropenem	0.016	0.016	S	99
Piperacillin**			S	66
Piperacillin–tazobactam	2	2	S	99
Tobramycin	32	64	R	98
ESBL			Negative	99

* Not tested, result inferred from ampicillin result.
** Not tested, reference MICs were participants' results.
S: susceptible; R: resistant; I: intermediate.

Table 3.3: *Streptococcus pneumoniae* (0245): Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories

Antibiotic agent	MIC range (mg/L) ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Cefotaxime				99
Meningitis	‹0.004	‹0.004	S	99
Non-meningitis			S	99
Ceftriaxone				99
Meningitis	‹0.04	‹0.04	S	99
Non-meningitis			S	99
Ciprofloxacin	›32	›32	R	95
Clindamycin	0.032	0.064	S	97
Erythromycin	16	16	R	96
Penicillin				98
Meningitis	0.015	0.015	S	99
Non-meningitis			S	95

S: susceptible; R: resistant; I: intermediate.

3.2.4 Specimen 0246 *Enterococcus faecium*

This specimen consisted of an *Enterococcus faecium* with vanA-mediated resistance to vancomycin and teicoplanin.

Resistance to vancomycin was obvious and was detected by 99.6% of participants. It is common for teicoplanin MICs to be lower than vancomycin MICs with VanA isolates. The teicoplanin MIC of 8 mg/L is recognised as resistant with EUCAST breakpoints (S≤2, R>2 mg/L) but as borderline susceptible with CLSI breakpoints (S≤8, R≥32 mg/L). The borderline susceptibility was reflected in the results returned by participants (7.7% susceptible, 14.2% intermediate, 78.1% resistant). The proportion of participants reporting teicoplanin susceptible was much lower with EUCAST-related methods (1% of 196 participants) than with the CLSI method (10.7% of 457 participants). Disc diffusion tests with glycopeptides can be problematic as isolates with borderline resistance may give zone diameters very close to breakpoints. In order to improve test reliability, some guidelines recommend incubation for a full 24 hours before reporting isolates as susceptible, and resistance may be seen only as small colonies inside zone edges, or 'fuzzy' zone edges in contrast with the sharp zone edges seen with susceptible isolates.

Gentamicin mono-therapy is ineffective against enterococci. There is, however, synergism between gentamicin and beta-lactam agents against enterococci without mechanisms conferring high-level gentamicin resistance (usually production of the bi-functional enzyme APH(2'')/AAC(6')). Overall, 20.9% of participants incorrectly reported this isolate high-level gentamicin resistant. This error has been related to the erroneous use of lower content gentamicin discs than specified in disc diffusion method guidelines (Table 3.4).

3.2.5 Specimen 0247 *Pseudomonas aeruginosa*

This specimen consisted of a *Pseudomonas aeruginosa* with borderline susceptibility to piperacillin–tazobactam and tobramycin.

The piperacillin–tazobactam MIC was 32 mg/L, which is interpreted as resistant by EUCAST guidelines and susceptible by CLSI guidelines. As is often the case with borderline susceptibility, this was reflected in varied results from participants: 56.6% reported the organism resistant, 3.9% intermediate and 39.5% susceptible. The percentage of participants reporting piperacillin–tazobactam susceptible was much lower with the EUCAST-related methods (23.2% of 211 participants) than with the CLSI method (47.4% of 492 participants).

In reference tests on aminoglycoside agents MICs were variable. This did not affect categorisation of susceptibility to amikacin and gentamicin and discrepancy rates were low. Reference MICs of tobramycin (4–32 mg/L) covered the range of susceptible to resistant by both EUCAST and CLSI guidelines, and it is likely that the organism produces an aminoglycoside-modifying enzyme with low activity against tobramycin. However, only 4.7% of participants reported the organism susceptible, with 32.5% reporting intermediate and 62.8% resistant (Table 3.5).

Table 3.4: *Enterococcus faecium* (0246): Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories

Antibiotic agent	MIC range (mg/L) ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Amoxicillin	NT*		R	99
Ampicillin	64	64	R	99
High-level gentamicin	4	4	S (not high-level resistance)	79
Teicoplanin	8	8	R/S	78
Vancomycin	64	>128	R	99

* Not tested, result inferred from ampicillin result.
S: susceptible; R: resistant; I: intermediate.

Table 3.5: *Pseudomonas aeruginosa* (0247): Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories

Antibiotic agent	MIC range (mg/L) ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Amikacin	1	8	S	99
Ceftazidime	2	2	S	99
Ciprofloxacin	0.12	0.5	S	99
Gentamicin	32	>128	R	99
Imipenem	1	2	S	97
Meropenem	1	2	S	95
Piperacillin–tazobactam	32	32	R/S	57
Tobramycin	4	32	S/I/R	*

* Reference MICs covered the range of susceptible to resistant by both EUCAST and CLSI.
S: susceptible; R: resistant; I: intermediate.

3.2.6 Specimen 0248 *Staphylococcus aureus*

This specimen consisted of a *Staphylococcus aureus*, sequence type 239, resistant to multiple agents. There were no significant problems with susceptibility testing of this organism against the reference agents (Table 3.6).

3.3 Conclusions

The response to this ninth EARSS/EARS-Net EQA exercise by the participating laboratories was good, with a high return rate and very few late responders. Performance was generally very good and consistent with that seen in previous EQA exercises. Problems, where experienced, were related to borderline susceptibility and when guidelines revealed remaining discrepancies in routine susceptibility testing.

ECDC would like to thank UK NEQAS, the reference laboratories, the members of the EARS-Net Coordination Group and the country coordinators for the swift distribution of the strains, and all the participating laboratories for their efforts and timely response to the exercise.

Table 3.6: *Staphylococcus aureus* (0248): Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories

Antibiotic agent	MIC range (mg/L) ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Cefoxitin	128	>128	R	99
Ciprofloxacin	32	32	R	98
Clindamycin	>128	>128	R	99
Erythromycin	>128	>128	R	100
Fusidic acid	0.06	0.12	S	99
Gentamicin	>128	>128	R	99
Meticillin	NT*		R	98
Oxacillin	>128	>128	R	99
Penicillin	32	64	R	99
Rifampicin	0.004	0.008	S	99
Teicoplanin	1	2	S	99
Tetracycline	>128	>128	R	98
Vancomycin	1	2	S	98

* Not tested, result inferred from oxacillin and cefoxitin results.
S: susceptible; R: resistant; I: intermediate.

4 EARS-Net laboratory/hospital denominator data 2010

4.1 Introduction

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

4.2 Methods

Questionnaires (Microsoft Excel files) were sent to the EARS-Net contact points by June 2011. 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 to the European Surveillance System (TESSy). Laboratories were defined as reporting denominator data if they provided the number of blood culture sets performed for one or more hospitals. Hospitals were defined as reporting denominator data if they provided the number of beds.

4.3 Participation

Eighteen of the 28 countries reporting antimicrobial resistance results also returned hospital and laboratory denominator data referring to 2010, while for two countries, hospital and laboratory denominator data referring to 2009 was available and included in the analysis. In total, 391 of the 658 laboratories (59.4 %) and 833 of the 1173 hospitals (71.0 %) reporting antimicrobial susceptibility results for the 20 countries, also provided denominator data (Figures 4.1–4.2, and Tables 4.1–4.3). Some denominator data for laboratories and hospitals not reporting antimicrobial resistance data, or reporting zero cases, have been included in Figure 4.1, but were not included in other parts of the analysis.

4.4 Population coverage

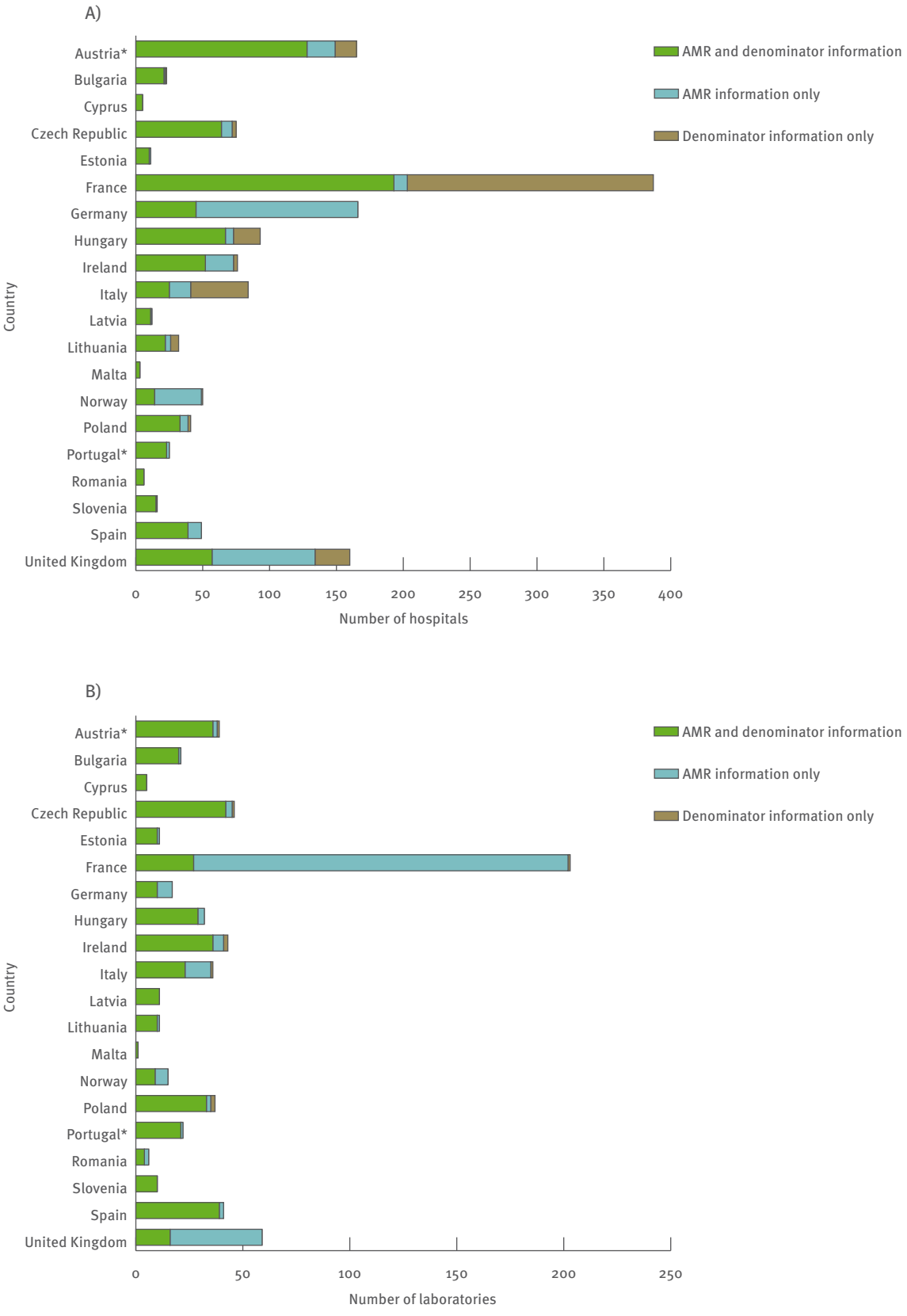
Data on population coverage for antimicrobial resistance data at country level is not reported because of the inherent limitations of these data. Not all laboratories/hospitals reporting antimicrobial susceptibility data provide denominator data, and this will bias the calculation of country population coverage since only laboratories/hospitals reporting denominator data can be included. Secondly, laboratories and hospitals cluster in big cities and, for this reason, some of the catchment areas overlap. This could lead to double counts, which would artificially increase the estimated coverage.

Table 4.1: Hospital denominator data for 2010

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)
Austria*	(128/149)	49 761	6	70	4.7	4.2-5.6
Bulgaria	(21/22)	10 028	8	74	6.1	5.4-6.6
Cyprus	(5/5)	1 333	10	73	5.3	5.3-5.4
Czech Republic	(64/72)	37 682	10	71	7.1	6.1-7.9
Estonia	(10/11)	4 630	4	77	6.5	5.9-9.0
France	(193/202)	124 914	5	83	7.6	6.4-9.2
Germany	(45/166)	16 161	5	76	6.8	6.3-7.8
Hungary	(67/73)	44 998	2	75	8.3	7.1-10.0
Ireland	(55/60)	12 016	3	87	5.6	4.6-7.1
Italy	(25/41)	6 946	7	84	-	-
Latvia	(11/12)	5 135	3	71	6.1	4.1-6.8
Lithuania	(22/26)	10 094	4	73	6.9	6.2-8.2
Malta	(3/3)	1 273	5	83	11.9	5.4-38.8
Norway	(14/49)	4 347	5	84	4.4	4.0-4.7
Poland	(33/39)	16 390	2	76	5.5	4.7-6.4
Portugal*	(23/25)	10 885	5	79	7.3	5.5-8.6
Romania	(6/6)	2 322	8	92	6.6	5.6-6.9
Slovenia	(15/15)	7 265	6	71	5.8	4.8-6.5
Spain	(39/49)	24 571	4	79	-	-
United Kingdom	(57/134)	28 182	2	83	5.2	2.9-7.2

* Data from 2009.

Figure 4.1: Number of hospitals (A) and laboratories (B) reporting AMR and/or denominator data in 2010



* Denominator data from 2009

4.5 Hospital denominator information

The total number of hospital beds for hospitals reporting both AMR and denominator data in different countries ranged from 1273 in Malta to 124914 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 by country, ranging from 2% in Hungary, Poland and the United Kingdom, to 10% in Cyprus and the Czech Republic. The overall median length of stay in hospital was 6.3 days with the lowest median in Norway (4.4 days) and the highest in Malta (11.9 days). The annual occupancy rate was 75% or higher in 13 out of 20 countries (Table 4.1).

4.6 Hospital characteristics

Both the size of a hospital and the level of specialisation may influence the occurrence of antimicrobial resistance in the hospital. As can be seen from Table 4.2 and Figure 4.2, the distribution of size and specialisation level of hospitals varied considerably between the reporting countries. This does not necessarily reflect different distributions of the origin of EARS-Net blood cultures per country, as 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 smaller countries, that university hospitals have fewer than 500 beds.

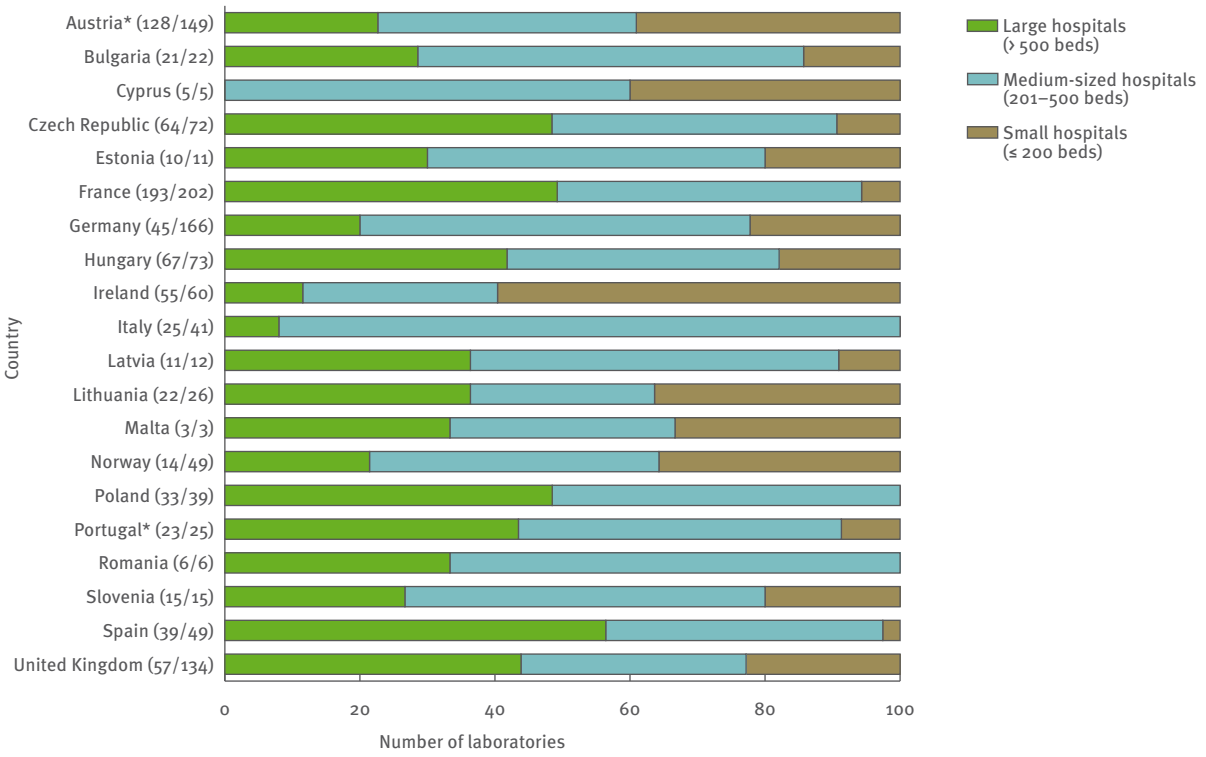
4.7 Laboratory denominator information

In 2010, the number of blood culture sets processed in the EARS-Net laboratories responding to the questionnaire was 2027480. The median culturing frequency was 23.8 blood culture sets per 1000 patient days. The highest rate was reported by Italy (70.7) and the lowest by Lithuania (6.4). For the majority of the reporting countries, there are only minor changes in the number of blood culture sets taken per 1000 patient days (Table 4.3) when comparing 2009 data with 2010. However, in Estonia and Latvia, the total number of blood culture sets almost doubled from 2009 to 2010, while the United Kingdom reported an even more substantial increase accompanied by an increase in the number of reporting hospitals. The highest total number of blood culture sets was reported by Spain (308872) followed by the United Kingdom (215502).

4.8 Conclusions

In summary, the situation for most countries as assessed from denominator data reported to EARS-Net in 2010 appears stable and similar to 2009. This indicates that

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 2010



* Denominator data from 2009

the comparison of occurrence of resistance over time based on EARS-Net data remains feasible, and the increasing number of countries reporting denominator data is encouraging.

The BSIs ascertainment is strongly linked to the blood culture rate. Therefore, the wide range in culture rate observed in the countries providing denominator data will have implications for 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.

For future improvement of the denominator data collection and analysis, a further increase of the number of countries reporting denominator data, as well as an increased number of hospital and laboratories participating within countries, would be desirable. Furthermore, an improved 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, would also be desirable.

Table 4.2: Hospital characteristics for 2010

Country	Hospitals reporting (denominator/AMR data)	Proportion of hospitals by level of care (%)				
		Tertiary level	Secondary level	Primary level	Other	Unknown
Austria*	(128/149)	8	23	44	26	0
Bulgaria	(21/22)	52	33	5	10	0
Cyprus	(5/5)	20	20	40	20	0
Czech Republic	(64/72)	38	36	25	0	2
Estonia	(10/11)	0	50	20	30	0
France	(193/202)	28	72	0	0	0
Germany	(45/166)	24	47	24	4	0
Hungary	(67/73)	45	30	16	9	0
Ireland	(55/60)	17	50	13	17	2
Italy	(25/41)	0	8	0	0	92
Latvia	(11/12)	45	18	9	27	0
Lithuania	(22/26)	45	41	14	0	0
Malta	(3/3)	33	33	0	33	0
Norway	(14/49)	36	36	29	0	0
Poland	(33/39)	39	61	0	0	0
Portugal*	(23/25)	57	26	4	13	0
Romania	(6/6)	50	17	0	0	33
Slovenia	(15/15)	13	47	20	13	7
Spain	(39/49)	56	38	5	0	0
United Kingdom	(57/134)	37	23	16	18	7

* Data from 2009.
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 2010

Country	Laboratories reporting (denominator/AMR data)	Number of hospitals*	Total number of blood culture sets	Number of blood culture sets per 1000 patient days
Austria*	(36/38)	120	158 529	13.1
Bulgaria	(20/21)	21	19 090	7
Cyprus	(5/5)	5	14 207	40
Czech Republic	(42/45)	62	145 548	15.2
Estonia	(10/11)	11	20 593	15.7
France	(27/202)	27	289 724	46.5
Germany	(10/17)	37	44 101	12.1
Hungary	(29/32)	64	84 846	7.3
Ireland	(36/41)	51	176 917	46.1
Italy	(22/35)	22	119 221	70.7
Latvia	(11/11)	11	12 726	9.6
Lithuania	(10/11)	22	17 356	6.4
Malta	(1/1)	3	6 328	16.4
Norway	(9/15)	14	62 532	46.7
Poland	(33/35)	33	93 059	20.5
Portugal*	(21/22)	23	158 902	50.7
Romania	(4/6)	4	28 947	37.3
Slovenia	(10/10)	14	50 480	27
Spain	(39/41)	39	308 872	43.4
United Kingdom	(16/59)	26	215 502	46.1

* Data from 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 result in reduced affinity with this class of antibiotics. Alterations in PBPs are due to a continuous mutation process that causes different degrees of resistance proceeding from reduced susceptibility through low-level clinical resistance – conventionally termed intermediate[i] (I) – to full clinical resistance (R). Although intermediately resistant strains are clearly less susceptible than sensitive strains, in the absence of meningitis, infections with these strains are often successfully treated with high doses of penicillin or other beta-lactam compounds.

Macrolide, lincosamide 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, lincosamide 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 serotypes commonly found in children, assures that in practice the use of drugs from either of these classes 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 had been detected in some countries before the introduction of the PCV7 vaccine, the widespread use of this vaccine is 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 in 2010 had slight changes to that for 2009, and includes serotypes 19A (13.2%), 1 (12.7%), 7F (11.3%), 3 (8.4%), 12F (5.8%), 22 (5.5%) and 6 (5.3%). Even though only a limited number of countries have provided serotyping data, ad hoc studies in other EU countries, like France, Spain, Greece, Norway

i 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 probably produce a new reduction in antibiotic resistance in *S. pneumoniae*.

5.1.3 Results

Penicillin

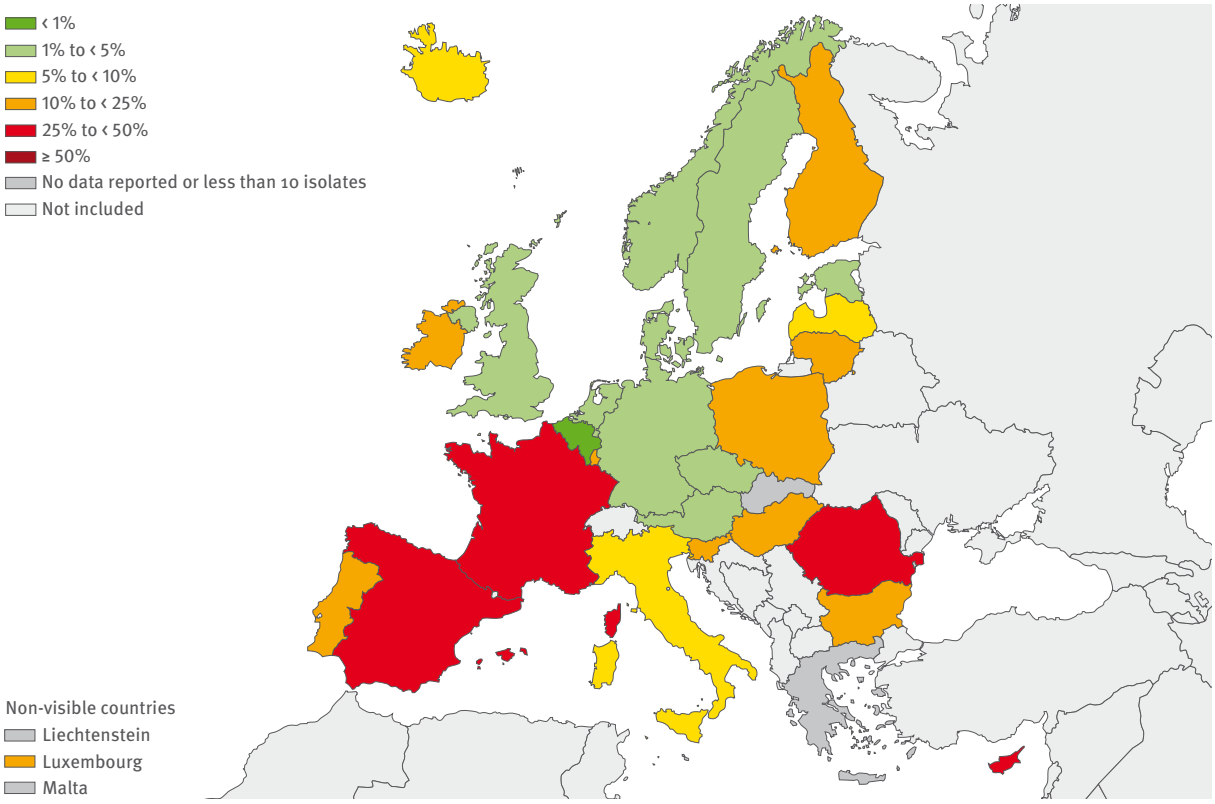
- Twenty-seven countries reported 11389 isolates of which 1056 (9.27%) were non-susceptible to penicillin; 418 of the 1056 non-susceptible isolates were identified as resistant. Greece did not report and Malta reported fewer than 10 isolates (accordingly no data are displayed on the maps for these countries) (Figure 5.1).
- The proportion of isolates reported as non-susceptible was: below 1% in one country, 1–5% in nine countries, 5–10% in three countries, 10–25% in 10 countries and 25–50% in four countries (Figure 5.1, Table 5.1).
- Trends for the period 2007–2010 were calculated for 22 countries. Two countries (Spain and Norway) had a significant increasing trend with proportions of non-susceptibility to penicillin in 2010 of 29.8%, and 3.7% respectively. These trends were, however, not significant when considering only data from laboratories reporting consistently for all four years (Figure 5.4).
- Significant decreasing trends were observed for five countries: Belgium[i], the United Kingdom, Italy, Hungary, and France, with proportions of non-susceptibility to penicillin of 0.4%, 3.1%, 9.2%, 15%, and 27.6% respectively in 2010. In three of these countries, (Belgium, Hungary and France) the trends remained significant even when considering only the data from laboratories reporting consistently for all four years (Figure 5.4).

Macrolides

- Twenty-seven countries reported 11439 isolates of which 1778 (15.5%) were non-susceptible to macrolides (Figure 5.2).
- The proportion of isolates reported as non-susceptible ranged from 0.0% (Lithuania) to 54.5% (Cyprus), and was reported as under 5% in six countries, 5–10% in four countries, 10–25% in ten countries (including

i 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.

Figure 5.1: *Streptococcus pneumoniae*: proportion of invasive isolates non-susceptible to penicillin (PNSP) in 2010



Bulgaria with exactly 25%), 25–50% in six countries and over 50% in one country (Figure 5.2, Table 5.1).

- Trends for the period 2007–2010 were calculated for 22 countries. Spain, which reported a proportion of non-susceptibility of 26.7% in 2010, had a significant increasing trend, which remained significant even when considering only data from laboratories reporting consistently throughout the period 2007–2010 (Figure 5.5).
- Significant decreasing trends were observed for five countries: Denmark, France, Hungary, Norway and the United Kingdom, with proportions of non-susceptibility to macrolides of 4.2%, 30.0%, 24.1%, 3.8%, and 4.7% respectively in 2010. In all these countries, the trends were significant even when including only data from laboratories reporting consistently for all four years (Figure 5.5).

Non-susceptibility to penicillin and macrolides

- Twenty-seven countries reported 10959 isolates tested for penicillin and macrolides. In 2010, 676 (6.2%) of these isolates were non-susceptible to both these antibiotic classes. One country (Malta) reported fewer than 10 isolates (therefore it is not included in Figure 5.3).
- Proportions of non-susceptibility to penicillin and macrolides ranged from 0.0% (Estonia, Lithuania) to 36.4% (Cyprus), and were reported below 1% in six countries, 1–5% in eight countries (including Bulgaria with exactly 5%), 5–10% in five countries 10–25% in six countries, and 25–50% in two countries (Figure 5.3, Table 5.1).
- Trends for 2007–2010 were calculated for 22 countries. A significant increase was observed for Ireland and Spain, which in 2010 reported 12.4% and 17.2%, respectively. For Spain the trend was significant even when including only laboratories reporting for all four years. A significant decreasing trend was observed for three countries (Belgium, France and Hungary) which reported non-susceptibility to penicillin and macrolides proportions of 22.7%, 9.8%, and 0.3%, respectively, in 2010. The trends for these three countries remained significant even when considering only the data from laboratories reporting consistently throughout the period 2007–2010 (Figure 5.6).

Serogroups

- Six countries reported 2852 *S. pneumoniae* isolates with identification of the serotype / serogroup (Table 5.2).
- In 2010, serogroups 19 and 1 were the most prevalent (each accounting for 13% of the isolates), followed by serogroup 7 (11%), serogroup 3 (8%), serogroup 12 (6%) as well as serogroups 22 and 6 (both at 5%) (Figure 5.7, Table 5.2).
- Non-susceptibility to penicillin and macrolides has been mainly observed in serogroups 19, 6, 14, 15, 9, and 7; (order of decreasing proportion). Single

Table 5.1: Number and proportion of invasive *S. pneumoniae* isolates penicillin-non-susceptible (PNSP), penicillin-resistant (PRSP), macrolide non-susceptible (MNSP), single penicillin (PEN), single macrolides (MACR) and non-susceptible to penicillin and microlides isolates, including 95% confidence intervals (95% CI), reported per country in 2010

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	351/323/310	4.0 (2-7)	2.3 (1-4)	10.5 (7-14)	2.6 (1-5)	8.4 (6-12)	1.9 (1-4)
Belgium	1797/1797/1797	0.4 (0-1)	0.4 (0-1)	24.8 (23-27)	0.1 (0-0)	24.5 (23-27)	0.3 (0-1)
Bulgaria	22/20/20	18.2 (5-40)	18.2 (5-40)	25.0 (9-49)	10.0 (1-32)	20.0 (6-44)	5.0 (0-25)
Cyprus	12/11/11	41.7 (15-72)	33.3 (10-65)	54.5 (23-83)	0.0 (0-28)	18.2 (2-52)	36.4 (11-69)
Czech Republic	288/288/288	4.9 (3-8)	0.0 (0-1)	6.3 (4-10)	3.1 (1-6)	4.5 (2-8)	1.7 (1-4)
Denmark	954/954/954	3.6 (2-5)	0.1 (0-1)	4.2 (3-6)	2.0 (1-3)	2.6 (2-4)	1.6 (1-3)
Estonia	64/45/45	1.6 (0-8)	1.6 (0-8)	4.4 (1-15)	2.2 (0-12)	4.4 (1-15)	0.0 (0-8)
Finland	611/607/596	14.2 (12-17)	1.3 (1-3)	27.5 (24-31)	3.5 (2-5)	16.4 (14-20)	11.1 (9-14)
France	1127/1127/1127	27.6 (25-30)	0.2 (0-1)	30.0 (27-33)	4.9 (4-6)	7.3 (6-9)	22.7 (20-25)
Germany	354/358/349	3.7 (2-6)	0.3 (0-2)	9.2 (6-13)	1.7 (1-4)	7.2 (5-10)	2.0 (1-4)
Hungary	140/133/133	15.0 (10-22)	5.7 (2-11)	24.1 (17-32)	5.3 (2-11)	14.3 (9-21)	9.8 (5-16)
Iceland	37/37/37	5.4 (1-18)	2.7 (0-14)	10.8 (3-25)	0.0 (0-9)	5.4 (1-18)	5.4 (1-18)
Ireland	310/290/290	18.1 (14-23)	4.8 (3-8)	15.5 (12-20)	6.6 (4-10)	3.1 (1-6)	12.4 (9-17)
Italy	229/297/222	9.2 (6-14)	5.2 (3-9)	29.0 (24-34)	3.2 (1-6)	21.6 (16-28)	6.3 (3-10)
Latvia	37/38/37	5.4 (1-18)	5.4 (1-18)	5.3 (1-18)	2.7 (0-14)	2.7 (0-14)	2.7 (0-14)
Lithuania	39/35/34	12.8 (4-27)	7.7 (2-21)	0.0 (0-10)	14.7 (5-31)	0.0 (0-10)	0.0 (0-10)
Luxembourg	46/47/46	13.0 (5-26)	4.3 (1-15)	19.1 (9-33)	6.5 (1-18)	13.0 (5-26)	6.5 (1-18)
Malta	09/11/09	22.2 (3-60)	11.1 (0-48)	18.2 (2-52)	22.2 (3-60)	11.1 (0-48)	0.0 (0-34)
Netherlands	753/898/681	2.0 (1-3)	0.3 (0-1)	6.0 (5-8)	1.3 (1-2)	5.6 (4-8)	0.9 (0-2)
Norway	575/547/546	3.7 (2-6)	0.3 (0-1)	3.8 (2-6)	2.9 (2-5)	3.1 (2-5)	0.7 (0-2)
Poland	75/71/70	24.0 (15-35)	24.0 (15-35)	39.4 (28-52)	1.4 (0-8)	17.1 (9-28)	21.4 (13-33)
Portugal	156/156/156	14.7 (10-21)	14.7 (10-21)	21.8 (16-29)	4.5 (2-9)	11.5 (7-18)	10.3 (6-16)
Romania	13/11/11	30.8 (9-61)	30.8 (9-61)	36.4 (11-69)	0.0 (0-28)	9.1 (0-41)	27.3 (6-61)
Slovenia	232/232/232	15.5 (11-21)	0.4 (0-2)	17.2 (13-23)	9.1 (6-14)	10.8 (7-15)	6.5 (4-10)
Spain	862/862/862	29.8 (27-33)	29.8 (27-33)	26.7 (24-30)	12.6 (10-15)	9.5 (8-12)	17.2 (15-20)
Sweden	960/955/907	3.8 (3-5)	2.3 (1-3)	4.0 (3-5)	2.2 (1-3)	2.5 (2-4)	1.7 (1-3)
United Kingdom	1336/1289/1189	3.1 (2-4)	0.7 (0-1)	4.7 (4-6)	1.3 (1-2)	2.9 (2-4)	1.7 (1-3)

non-susceptibility to penicillin in serogroups 19, 9, 14, 23; and single non-susceptibility to macrolides in serogroups 19, 1, 14, 33, 6, 15, 9, 23, 7, 11, 10, and 3 (Figure 5.7, Table 5.2).

5.1.4 Conclusions

In 2010, the proportion of *S. pneumoniae* isolates that were non-susceptible to penicillin remained generally stable in Europe with two countries reporting increasing trends and five reporting decreasing trends. Thirteen of 27 countries reported proportions of non-susceptibility below 10 %. The proportion of *S. pneumoniae* non-susceptible to macrolides declined significantly in five countries while one country had an increasing trend. Nevertheless, 10 of 27 countries reported proportions of non-susceptibility below 10 %. The non-susceptibility to both penicillin and macrolides was above 10 % in 19 countries out of 27. The lowest proportions of *S. pneumoniae* non-susceptible to penicillin and/or macrolides were reported by countries of central and northern 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 2852 *S. pneumoniae* isolates with serogroup identification. The serogroup distribution reported in 2010 is similar to the previous year. Most non-susceptible isolates belong to few serogroups, especially serogroups 1, 19, 7 and 3.

Figure 5.2: *Streptococcus pneumoniae*: proportion of invasive isolates non-susceptible to macrolides in 2010

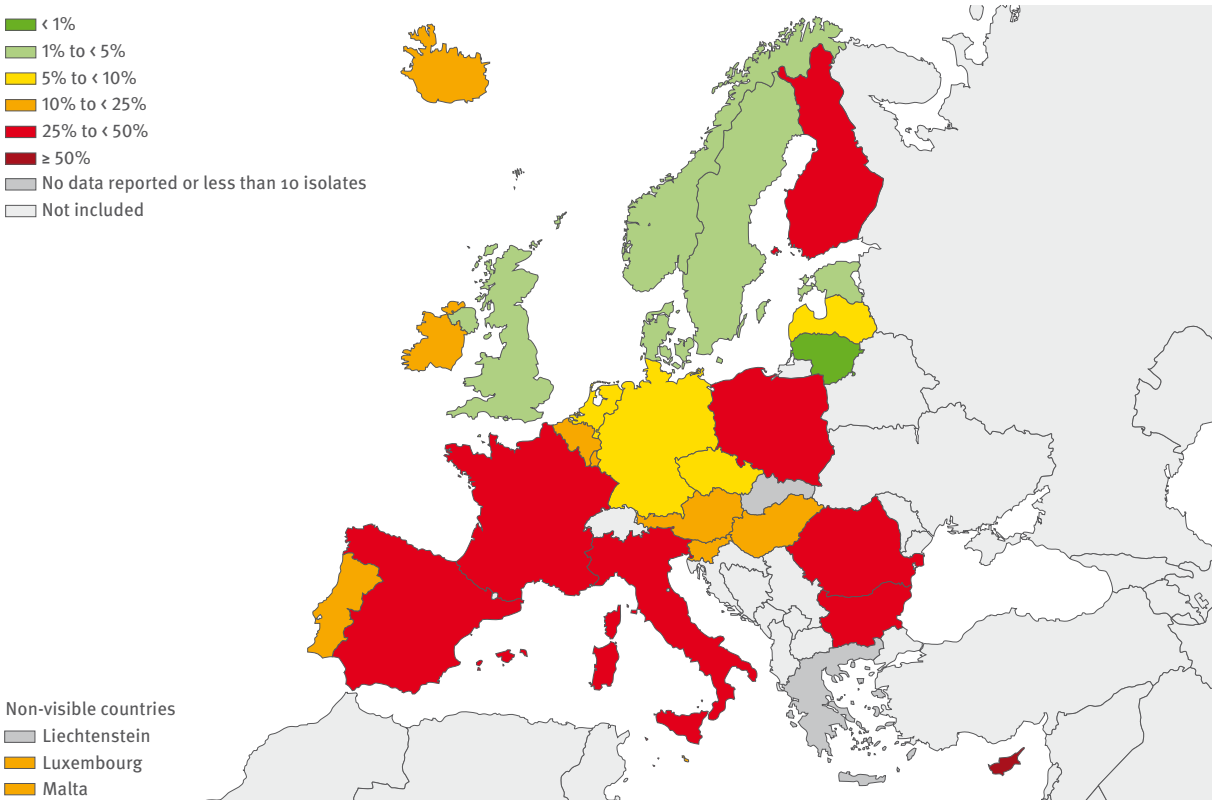


Figure 5.3: ***Streptococcus pneumoniae*****: proportion of invasive isolates with non-susceptibility to penicillin and macrolides in 2010**

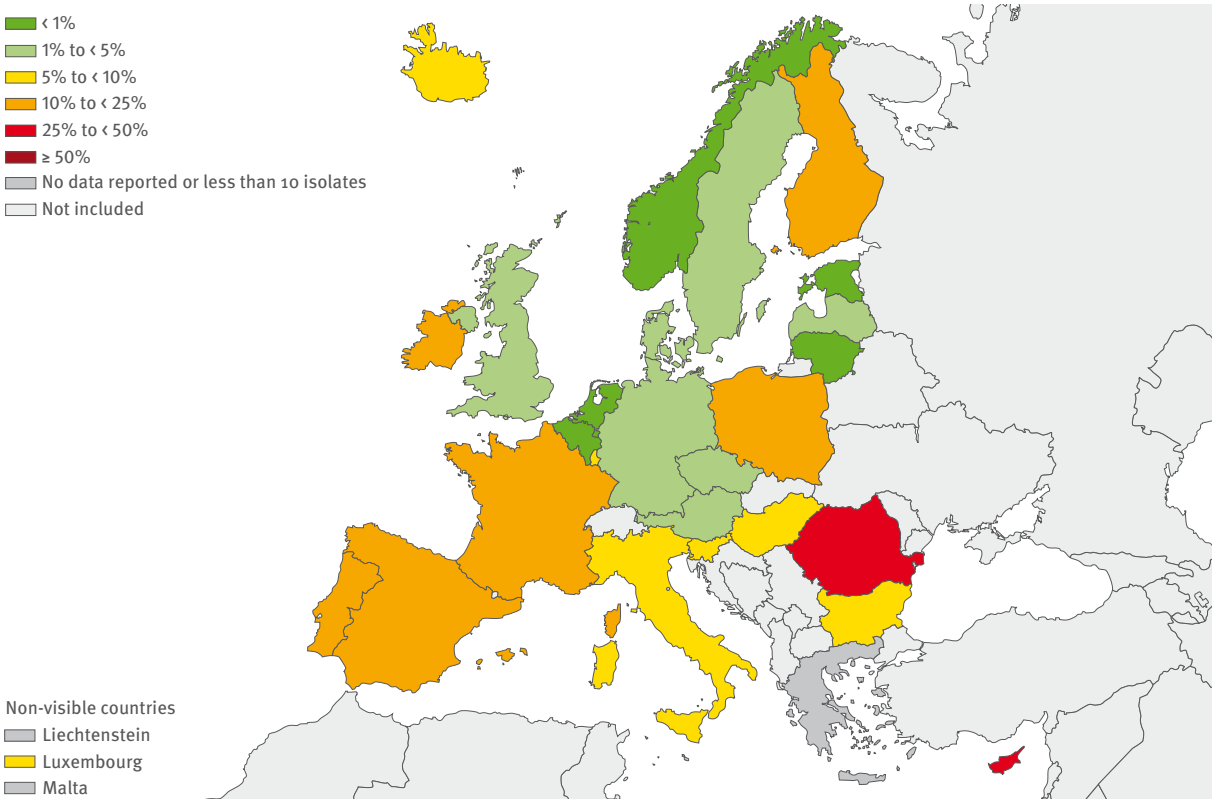
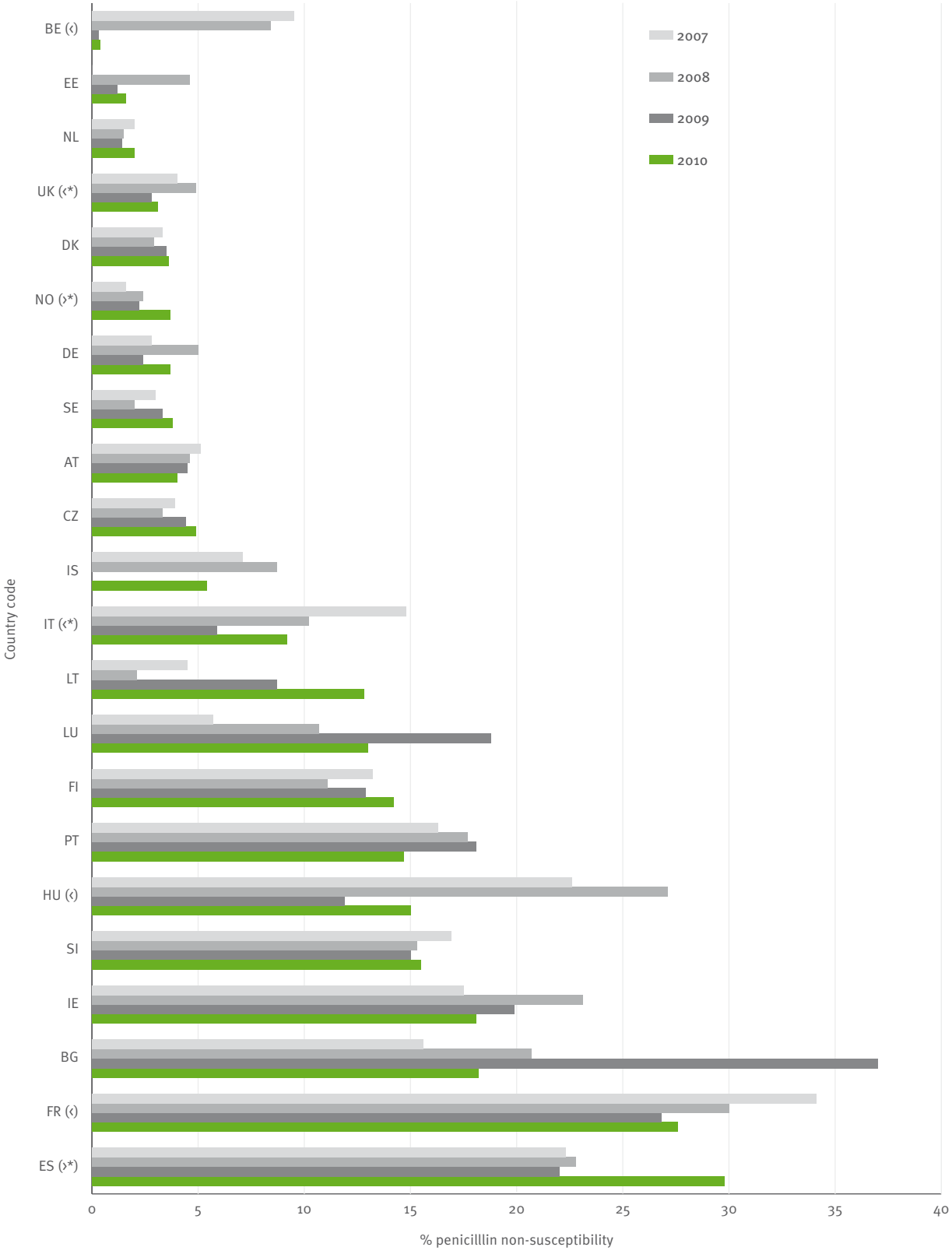


Table 5.2: Distribution of single penicillin (PEN), single macrolides (MACR) and non-susceptibility to penicillin-macrolides (DUAL), among the most common serogroups reported per country in 2010

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	271	0	54	0	36	0	0	0	1	0	0	0	5	20	0	0	17	0	0	0	42	0	0	2
3	122	0	0	0	47	0	2	0	4	0	0	0	13	0	0	0	36	0	0	0	17	0	6	0
4	28	0	0	0	14	0	0	0	2	0	0	0	8	0	0	0	13	0	0	0				
5	88	1	0	0																				
6	68	0	34	0	23	0	9	9	3	0	0	0	23	4	0	39	16	6	0	25	19	0	5	0
7	223	0	1	0	14	0	7	0	4	0	0	0	19	0	0	5	15	0	0	0	48	0	0	0
8	55	0	0	0	5	0	0	0					28	4	0	7	3	0	0	0	21	0	0	0
9	40	0	18	0	27	11	4	0	3	0	0	0	21	38	5	10	21	0	0	0	8	0	0	0
10	38	0	8	0	7	0	0	0					3	0	0	0	5	0	0	0	6	0	0	0
11	24	0	17	0	7	0	0	0	1	0	0	0	7	0	0	0	3	0	0	0	2	0	0	0
12	150	0	2	0	4	0	0	0					8	0	0	0					5	0	0	0
14	34	0	56	0	15	0	13	13	5	0	40	0	14	7	29	50	33	15	67	15	1	0	0	0
15	49	0	51	4	5	0	0	0					9	11	11	22	7	0	0	14	6	0	0	33
18	11	0	0	0	3	0	0	0	2	0	0	0	8	0	0	0	6	0	17	0	3	0	0	0
19	260	0	59	1	17	24	12	6	7	0	0	29	28	0	7	29	23	39	4	22	37	3	3	0
20	4	0	0	0	3	0	0	0					6	17	0	0	1	0	0	0	3	0	0	0
22	104	0	1	0	5	0	0	0	1	0	0	0	20	0	0	0	4	0	0	0	20	0	0	0
23	31	0	23	0	21	5	5	0	2	0	0	0	10	0	0	0	16	25	0	0	8	0	0	0
33	51	0	65	0	3	0	33	0	1	0	0	0	8	0	0	0	5	0	20	0	8	0	13	0
other	142	0	11	1	11	9	0	0	1	0	0	0	17	18	0	0	0	33	0	0	22	9	5	0
Total	**1793**	**0**	**25**	**0**	**267**	**3**	**4**	**2**	**37**	**0**	**5**	**5**	**255**	**7**	**3**	**12**	**224**	**9**	**11**	**7**	**276**	**1**	**2**	**1**

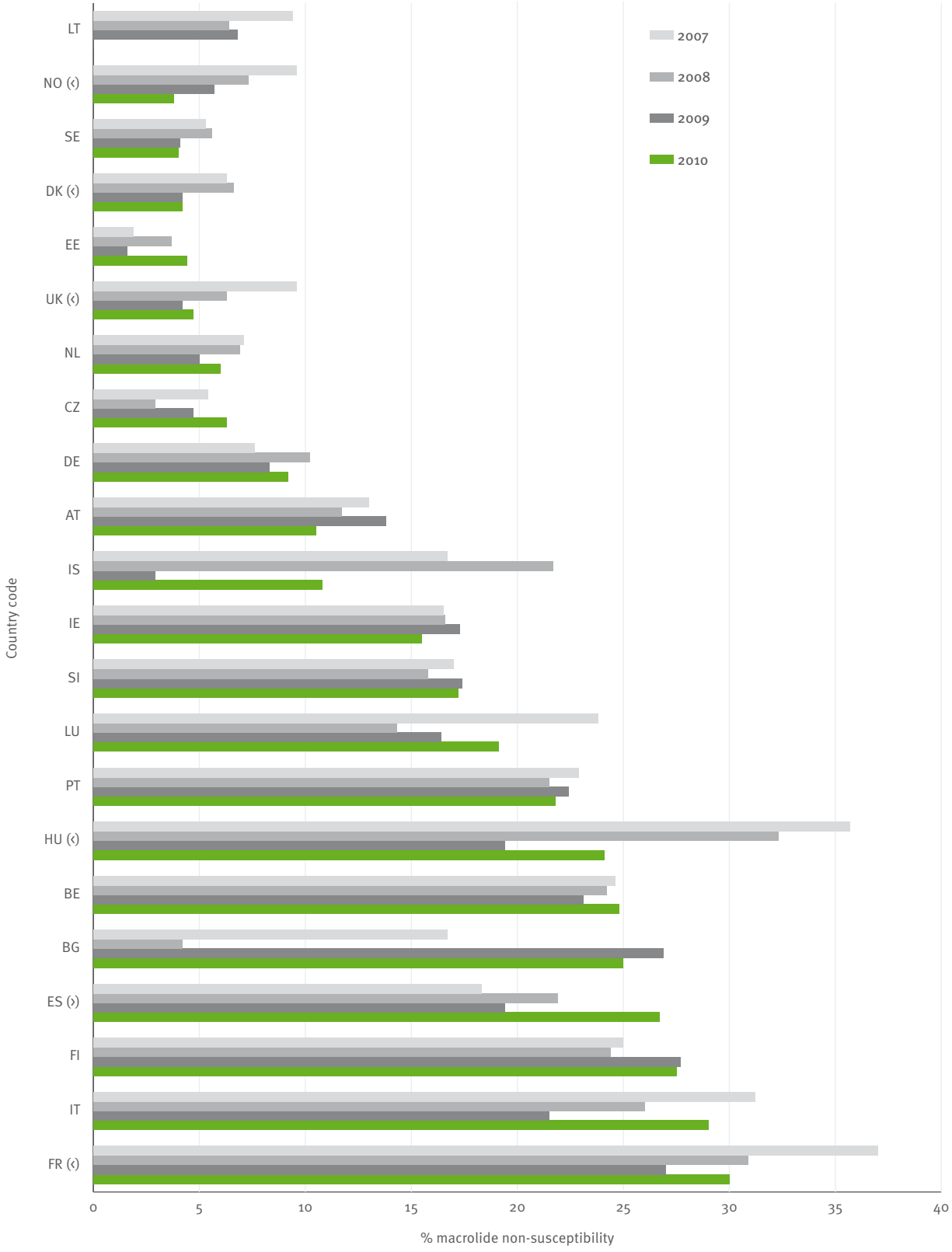
Only countries reporting more that 30 isolates were presented.

Figure 5.4: ***Streptococcus pneumoniae*****: trends of non-susceptibility to penicillin by country, 2007–2010**



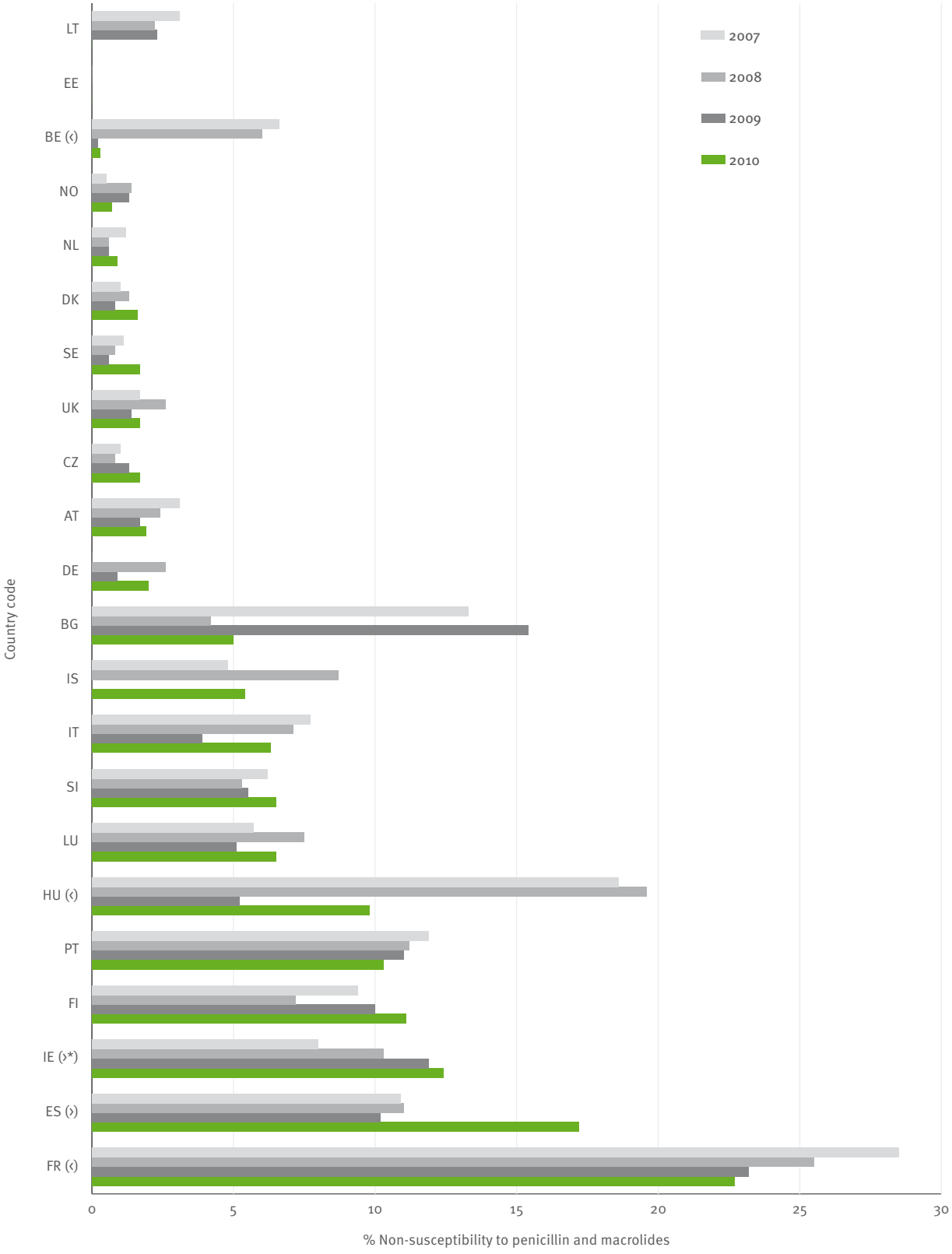
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for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

Figure 5.5: ***Streptococcus pneumoniae*****: trends of non-susceptibility to macrolides by country, 2007–2010**



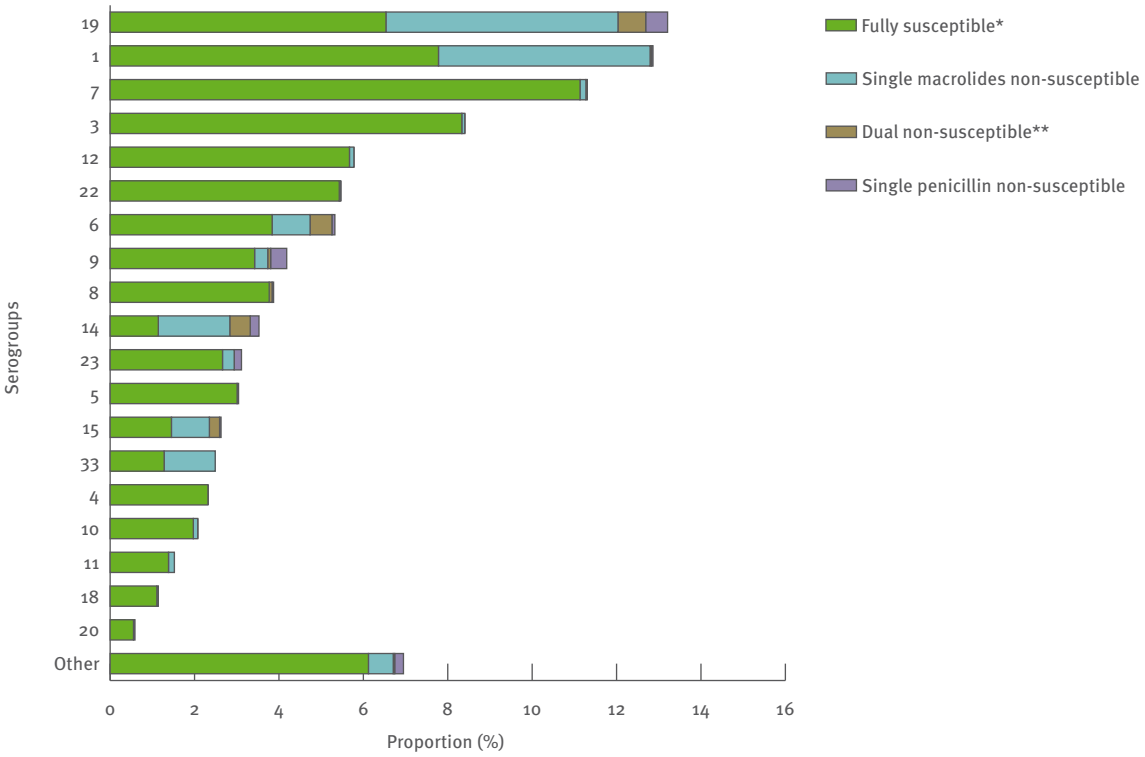
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, respectively.

Figure 5.6: ***Streptococcus pneumoniae*****: trends of non-susceptibility to penicillin and macrolides by country, 2007–2010**



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, 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 5.7: Distribution of serogroups and the resistance profile of *S. pneumoniae* isolates per serogroup in 2010



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, as defined by 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 beta-lactam antibiotics, 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 31854 isolates of which 5555 (17.4%) were identified as meticillin-resistant *S. aureus* (MRSA), with proportions ranging from 0.5% to 52.2% in the reporting countries.
- The proportion of isolates that were found to be MRSA was below 1% in three countries, 1–5% in four countries, 5–10% in one country, 10–25% in 12 countries, 25–50% in seven countries and above 50% in one country (Figure 5.8, Table 5.3).
- Trends for the period 2007–2010 were calculated for 28 countries (Figure 5.9). Significant decreasing trends were observed for seven countries, even when considering only data from laboratories consistently reporting throughout all four years (Figure 5.9). In 2010, these seven countries reported the following proportions of MRSA: 0–5% in one country (Estonia), 5–10% in one country case (Austria), 10–25% in three countries cases (the UK, France, and Ireland) and 25–50% in two countries cases (Cyprus and Greece).
- Four countries (Italy, Hungary, Germany, and Slovenia) reported a significant increasing trend of MRSA proportions (Figure 5.9). The increasing trend remained significant for three of these countries (Hungary, Germany, and Slovenia) when looking only at data from laboratories that reported consistently throughout the 2007–2010 period.

Rifampin

- Twenty-seven countries reported 22949 isolates of which 196 (0.9%) were identified as resistant to rifampin, and 22 of these countries reported at least one resistant isolate. Sixty-five percent of the rifampin-resistant isolates were also MRSA. The proportion of rifampin resistance was 3.0% among the MRSA isolates and 0.4% among the MSSA isolates.
- The proportion of isolates that were resistant was below 1% in 21 countries, 1–5% in four countries, 5–10% in one country, 10–25% in one country (Table 5.3).

Fluoroquinolones

- Twenty-six countries reported susceptibility data for at least one fluoroquinolone in 20683 isolates. Among them, 4825 (23.3%) were non-susceptible to fluoroquinolones. Eighteen percent (3747/20558) of all *S. aureus* isolates reported were non-susceptible to both meticillin and fluoroquinolones. Eighty-nine percent of the MRSA (3747/4203) were resistant to fluoroquinolones.
- Various fluoroquinolones were tested: ciprofloxacin (n=13829), levofloxacin (n=6484), norfloxacin (n=364). The number of isolates tested against at least one of these agents was 20683.

Linezolid

- Twenty-six countries reported susceptibility data for 18527 isolates of *S. aureus*, of which 23 (0.1%) were non-susceptible.

5.2.4 Conclusions

The proportion of *S. aureus* isolates found to be MRSA is stabilising or decreasing in most European countries. Seven countries reported decreasing trends while four reported an increasing trend. The countries showing a more evident and sustained decrease of MRSA proportion are Austria, France, Ireland, Latvia, UK and Cyprus. Although these observations provide reasons for optimism, MRSA remains a public health priority, as the proportion of MRSA is still above 25% in eight out of 28 countries, mainly in southern and eastern Europe. The occurrence of resistance to rifampin, which is recommended in combination with other antimicrobials to treat various staphylococcal infections, remains low in most European countries.

Figure 5.8: ***Staphylococcus aureus*****: proportion of invasive isolates resistant to meticillin (MRSA) in 2010**

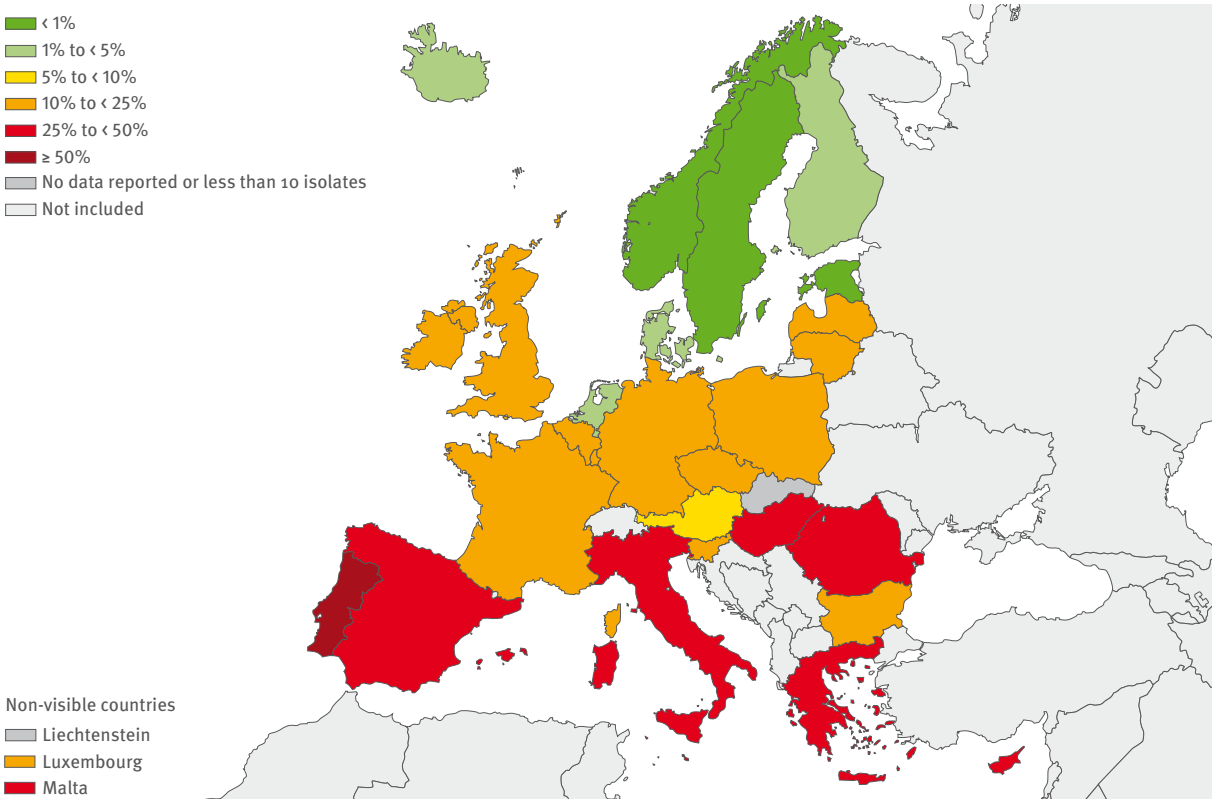
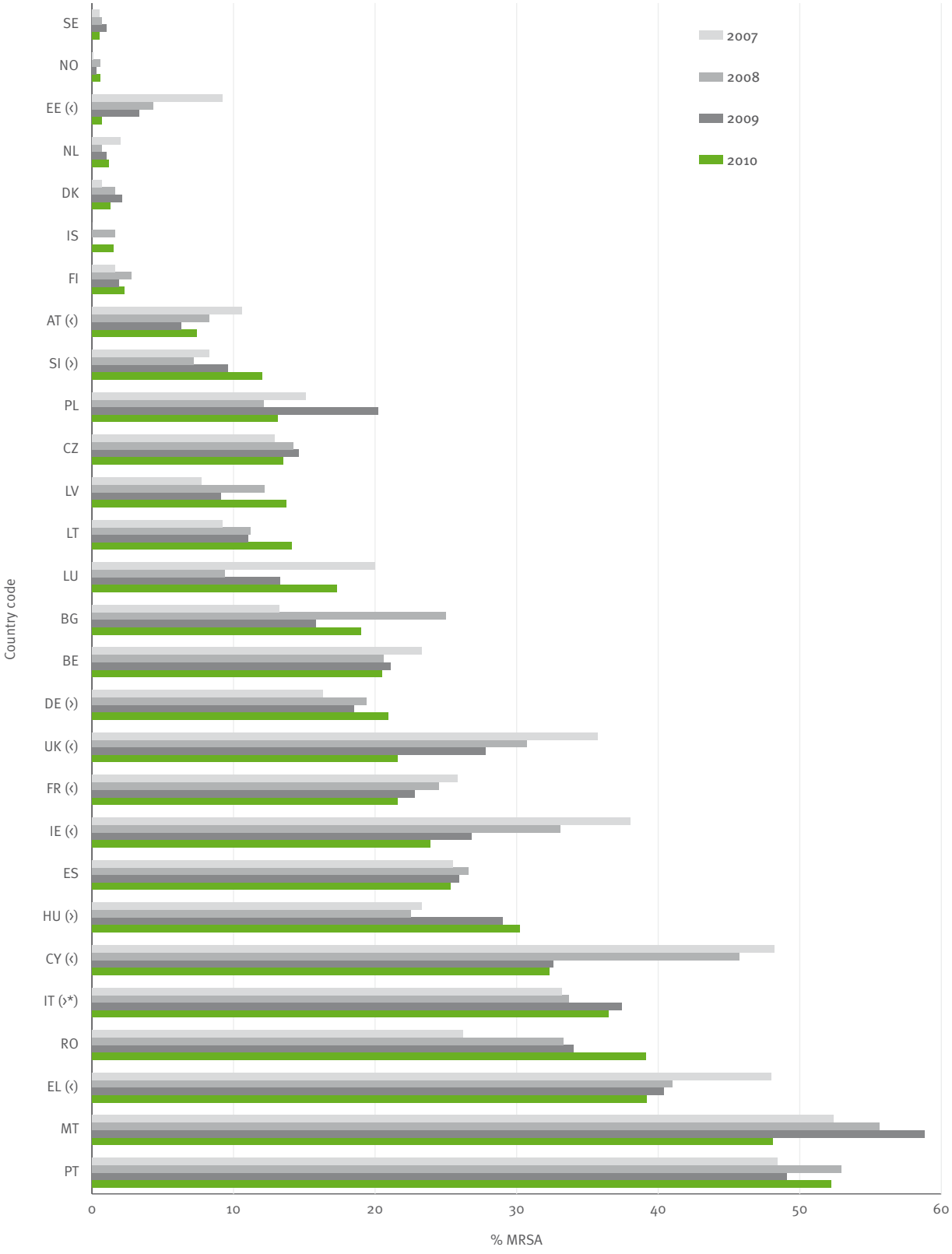


Table 5.3: Number and proportion of invasive *S. aureus* isolates resistant to meticillin (MRSA) and rifampin (RIF), including 95% confidence intervals (95% CI), reported per country in 2010

Country	Meticillin		Rifampin	
	Number of isolates tested	% MRSA (95%CI)	Number of isolates tested	% RIF (95%CI)
Austria	1 813	7.4 (6-9)	1 736	0.2 (0-1)
Belgium	1 057	20.5 (18-23)	246	0.8 (0-3)
Bulgaria	200	19.0 (14-25)	123	7.3 (3-13)
Cyprus	99	32.3 (23-42)	99	0.0 (0-4)
Czech Republic	1 593	13.5 (12-15)	591	1.5 (1-3)
Denmark	1 362	1.3 (1-2)	1 362	0.7 (0-1)
Estonia	145	0.7 (0-4)	33	0.0 (0-11)
Finland	1 094	2.3 (1-3)	1 006	0.3 (0-1)
France	4 859	21.6 (20-23)	4 594	1.1 (1-1)
Germany	1 980	20.9 (19-23)	1 303	0.7 (0-1)
Greece	867	39.2 (36-43)	0	-
Hungary	1 224	30.2 (28-33)	427	0.9 (0-2)
Iceland	65	1.5 (0-8)	1	0.0 (0-98)
Ireland	1 207	23.9 (21-26)	973	0.5 (0-1)
Italy	1 766	36.5 (34-39)	1 798	3.2 (2-4)
Latvia	153	13.7 (9-20)	150	0.7 (0-4)
Lithuania	255	14.1 (10-19)	204	0.0 (0-2)
Luxembourg	104	17.3 (11-26)	62	1.6 (0-9)
Malta	108	48.1 (38-58)	108	0.0 (0-3)
Netherlands	1 564	1.2 (1-2)	1 305	0.2 (0-1)
Norway	1 047	0.6 (0-1)	383	0.3 (0-1)
Poland	526	13.1 (10-16)	213	0.9 (0-3)
Portugal	718	52.2 (49-56)	334	0.6 (0-2)
Romania	46	39.1 (25-55)	45	13.3 (5-27)
Slovenia	476	12.0 (9-15)	457	0.2 (0-1)
Spain	1 986	25.3 (23-27)	1 827	0.5 (0-1)
Sweden	2 856	0.5 (0-1)	1 854	0.1 (0-0.3)
United Kingdom	2 684	21.6 (20-23)	1 715	0.3 (0-1)

Figure 5.9: ***Staphylococcus aureus*****: trends of resistance to meticillin (MRSA) by country, 2007–2010**



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

5.3.4 Results *E. faecium*

Vancomycin

- Twenty-eight countries reported 5577 isolates of which 410 (7.4 %) were resistant to vancomycin. Only one country (Luxembourg) reported fewer than 10 isolates (thus it is not shown in Figure 5.12).
- One country reported resistance proportions above 25 % (Ireland, with 38.7 %) and five countries reported resistant proportions between 10 % and 25 %, while the majority of countries (22 of 28) reported resistant proportions below 10 %. Eight of these countries even reported below 1 % (Sweden, Cyprus, Estonia, Bulgaria, Finland, Malta, Romania and the Netherlands) (Figure 5.12 and Table 5.4).
- Twenty of 28 countries have reported more than 20 isolates per year since 2007 and were included in the trend analysis for the period 2007–2010. During the past four years, a significant increase was observed only for Latvia. However, the increasing trend was not significant when considering data from laboratories reporting consistently for all four years (Figure 5.13).
- Four countries (Greece, the UK, Germany, and Italy) reported significant decreasing trends of vancomycin resistance. Considering data from laboratories reporting consistently for all four years, the decreasing trend was only significant for Italy (Figure 5.13).

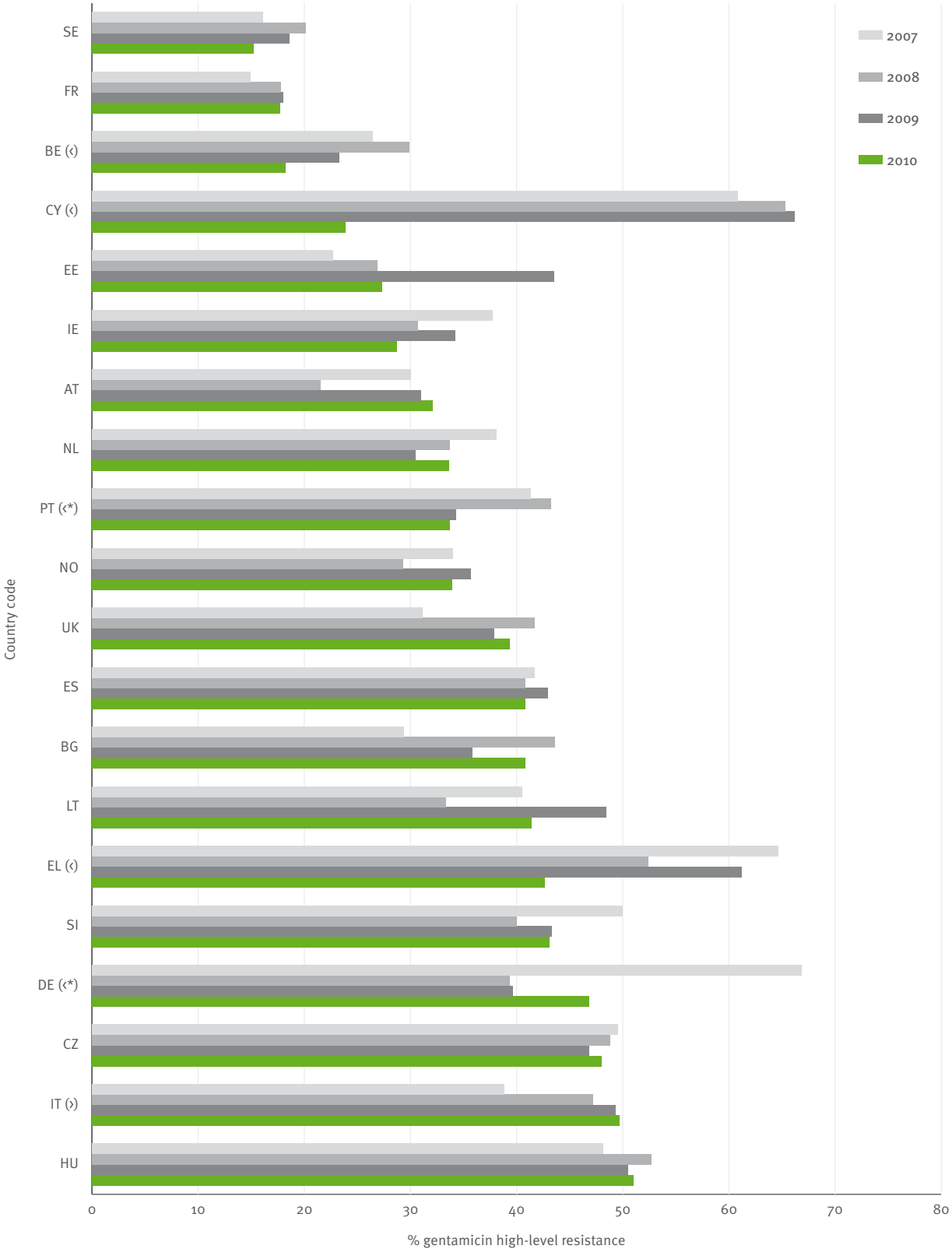
5.3.5 Conclusions

High-level aminoglycoside resistance in *E. faecalis* seems stable in Europe but at a relatively high level of resistance. The majority of countries reported proportions of resistant isolates between 25 % and 50 %. However, a consistent decrease was reported by Germany, Greece, Portugal, Cyprus and Belgium. Only for Italy was a significantly increasing trend observed.

The occurrence of vancomycin resistance in *E. faecium* seems to continue to decrease in Europe. In some countries (Greece, Germany, Italy and UK) the efforts to control glycopeptide-resistant enterococci are obviously successful and resulting in a continuous decrease of proportions of resistant isolates, only one country reported resistance above 25 %, while most of the countries reported resistant proportions below 5 %.

Figure 5.10: ***Enterococcus faecalis***

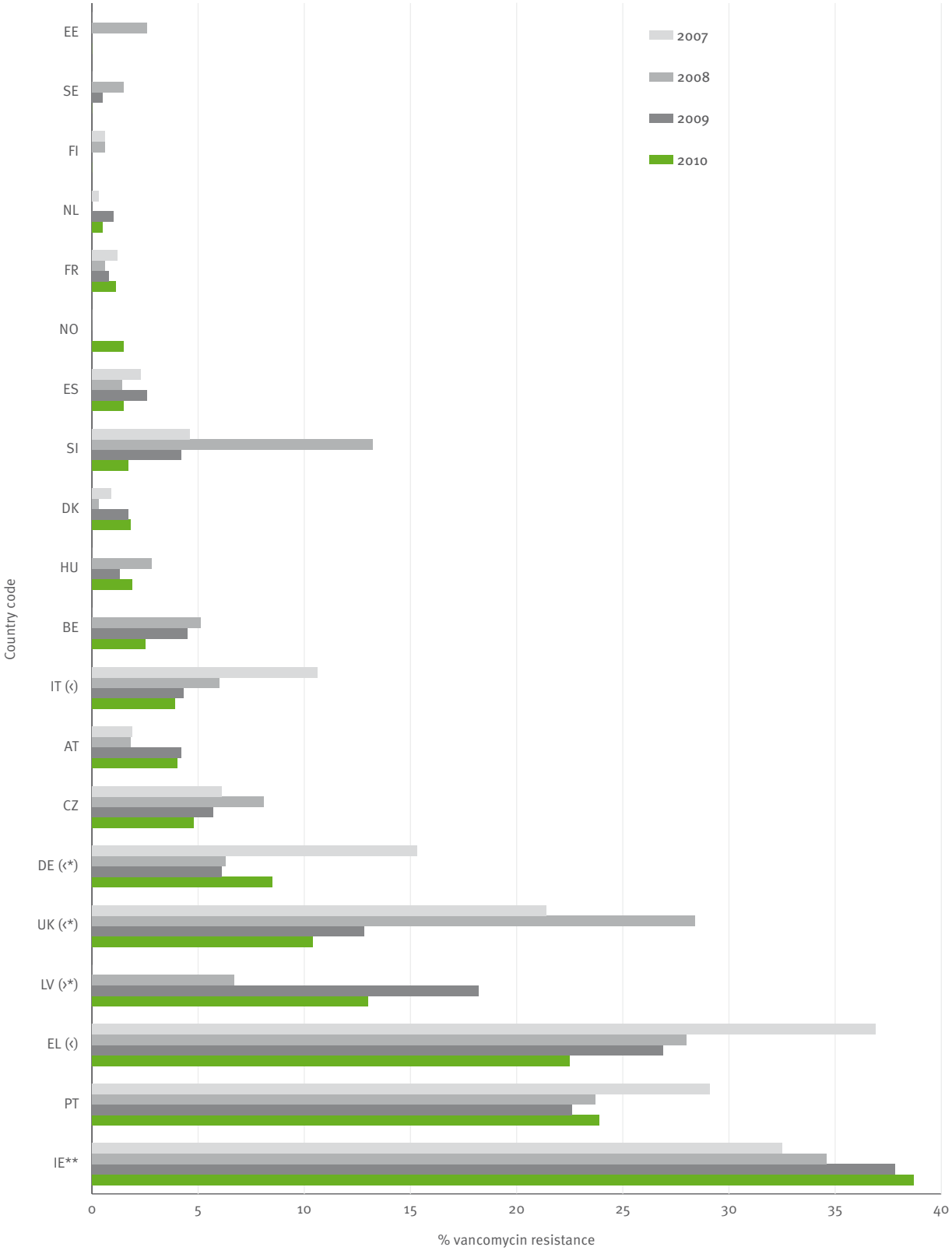
Figure 5.11: ***Enterococcus faecalis*: trends of high-level resistance to aminoglycosides by country, 2007–2010**



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, 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 2010**

Figure 5.13: ***Enterococcus faecium*: trends of resistance to vancomycin by country 2007–2010**



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, respectively.
The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.
** Data for Ireland showed a significant increasing trend only for data from laboratories which reported continuously for the last 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 bacteraemia, community and hospital-acquired urinary tract infections, is associated with spontaneous and surgical peritonitis and with skin and soft tissue infections due to multiple micro-organisms, causes neonatal meningitis and is one of the leading causative agents in food-borne infections 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 extent of the SHV type, (whereby TEM-1 accounts for up to 60% of aminopenicillin resistance), while resistance to third generation cephalosporins is mostly conferred by extended spectrum beta-lactamases (ESBLs). 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 and 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 SHV variants. In the late 1980s, new ESBLs of the CTX-M family emerged first in South America and, during early 2000s, received global attention. In contrast to conventional TEM and SHV ESBLs, most CTX-Ms (CefoTaximase Munich) 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 than ESBL 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 (such as VIM or IMP enzymes, or the emerging NDM enzyme) and serine-beta-lactamases (such as KPC enzymes), providing resistance to virtually all available beta-lactam agents. Another

Table 5.5: Number and proportion of invasive *E. coli* isolates resistant to aminopenicillins, third-generation cephalosporins, fluoroquinolones, aminoglycosides and multiresistant (%R), including 95% confidence intervals (95% CI), reported per country in 2010

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	2928	50.6 (49-52)	2925	20.9 (19-22)	2922	7.3 (6-8)	2915	6.5 (6-7)	2889	2.0 (2-3)
Belgium	1957	56.9 (55-59)	1782	21.5 (20-24)	1952	5.2 (4-6)	1584	5.6 (5-7)	1562	1.0 (1-2)
Bulgaria	142	71.8 (64-79)	151	33.1 (26-41)	153	24.8 (18-32)	152	15.8 (10-23)	150	8.0 (4-14)
Cyprus	137	62.0 (53-70)	138	42.8 (34-51)	139	20.1 (14-28)	138	15.9 (10-23)	138	8.7 (5-15)
Czech Republic	2481	59.3 (57-61)	2481	22.7 (21-24)	2482	10.4 (9-12)	2449	8.5 (7-10)	2447	3.4 (3-4)
Denmark	3412	45.8 (44-47)	3166	13.7 (13-15)	2408	7.6 (7-9)	3412	5.8 (5-7)	2403	2.4 (2-3)
Estonia	259	37.5 (32-44)	263	8.4 (5-12)	309	5.5 (3-9)	269	5.6 (3-9)	255	2.0 (1-5)
Finland	2165	33.8 (32-36)	2550	9.2 (8-10)	2509	3.7 (3-5)	2356	3.8 (3-5)	2315	1.9 (1-3)
France	9017	54.6 (54-56)	9007	17.5 (17-18)	9022	7.2 (7-8)	9025	7.2 (7-8)	9000	2.9 (3-3)
Germany	3022	54.4 (53-56)	3017	24.8 (23-26)	3015	8.4 (7-9)	3021	8.7 (8-10)	3009	3.6 (3-4)
Greece	1474	52.3 (50-55)	1516	24.4 (22-27)	1507	14.2 (12-16)	1530	16.5 (15-18)	1490	9.5 (8-11)
Hungary	1328	65.3 (63-68)	1367	36.6 (34-39)	1383	19.5 (17-22)	1384	21.2 (19-23)	1366	15.4 (14-17)
Iceland	100	46.0 (36-56)	95	10.5 (5-19)	104	3.8 (1-10)	104	2.9 (1-8)	95	1.1 (0-6)
Ireland	2121	66.8 (65-69)	2117	22.9 (21-25)	2119	7.7 (7-9)	2118	9.9 (9-11)	2112	3.0 (2-4)
Italy	2288	64.2 (62-66)	2436	39.2 (37-41)	2419	21.0 (19-23)	2609	15.5 (14-17)	2395	10.5 (9-12)
Latvia	98	50.0 (40-60)	97	14.4 (8-23)	98	12.2 (6-20)	98	11.2 (6-19)	97	6.2 (2-13)
Lithuania	329	55.9 (50-61)	333	13.5 (10-18)	333	8.7 (6-12)	331	14.5 (11-19)	331	5.4 (3-8)
Luxembourg	47	57.4 (42-72)	49	26.5 (15-41)	48	4.2 (1-14)	52	19.2 (10-33)	47	2.1 (0-11)
Malta	192	44.3 (37-52)	192	34.4 (28-42)	192	15.6 (11-22)	192	22.4 (17-29)	192	13.5 (9-19)
Netherlands	3404	47.6 (46-49)	3409	13.6 (12-15)	3387	5.1 (4-6)	3408	7.2 (6-8)	3371	1.8 (1-2)
Norway	2268	38.2 (36-40)	2267	8.7 (8-10)	2275	3.7 (3-5)	2246	4.3 (4-5)	2236	1.4 (1-2)
Poland	616	60.2 (56-64)	691	25.8 (23-29)	744	7.5 (6-10)	704	9.1 (7-11)	661	3.2 (2-5)
Portugal	862	54.3 (51-58)	808	23.8 (21-27)	814	6.6 (5-9)	865	9.5 (8-12)	785	3.9 (3-6)
Romania	23	82.6 (61-95)	33	24.2 (11-42)	34	20.6 (9-38)	33	12.1 (3-28)	32	6.3 (1-21)
Slovenia	941	48.0 (45-51)	952	19.3 (17-22)	952	6.6 (5-8)	952	8.8 (7-11)	952	3.8 (3-5)
Spain	5696	64.5 (63-66)	5696	32.8 (32-34)	5696	12.1 (11-13)	5696	14.2 (13-15)	5696	5.5 (5-6)
Sweden	1727	34.7 (32-37)	2130	10.8 (9-12)	3883	2.6 (2-3)	3665	2.7 (2-3)	1925	0.9 (1-1)
United Kingdom	4429	62.3 (61-64)	4815	17.3 (16-18)	4547	9.0 (8-10)	4929	8.3 (8-9)	4192	4.0 (3-5)

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

growing family of ESBLs is the OXA- type enzymes that confer resistance to ampicillin and cephalothin and are characterised by their high hydrolytic activity against oxacillin and cloxacillin and the fact that they are poorly inhibited by clavulanic acid.

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 AAC(6')-Ib-cr enzyme, which inactivates some fluoroquinolones by acetylation, and the QepA efflux pump, which effluxes hydrophilic quinolones. These mechanisms are a concern because of transferability and their frequent association with CTX-M and CMY-type enzymes inactivating third-generation cephalosporins.

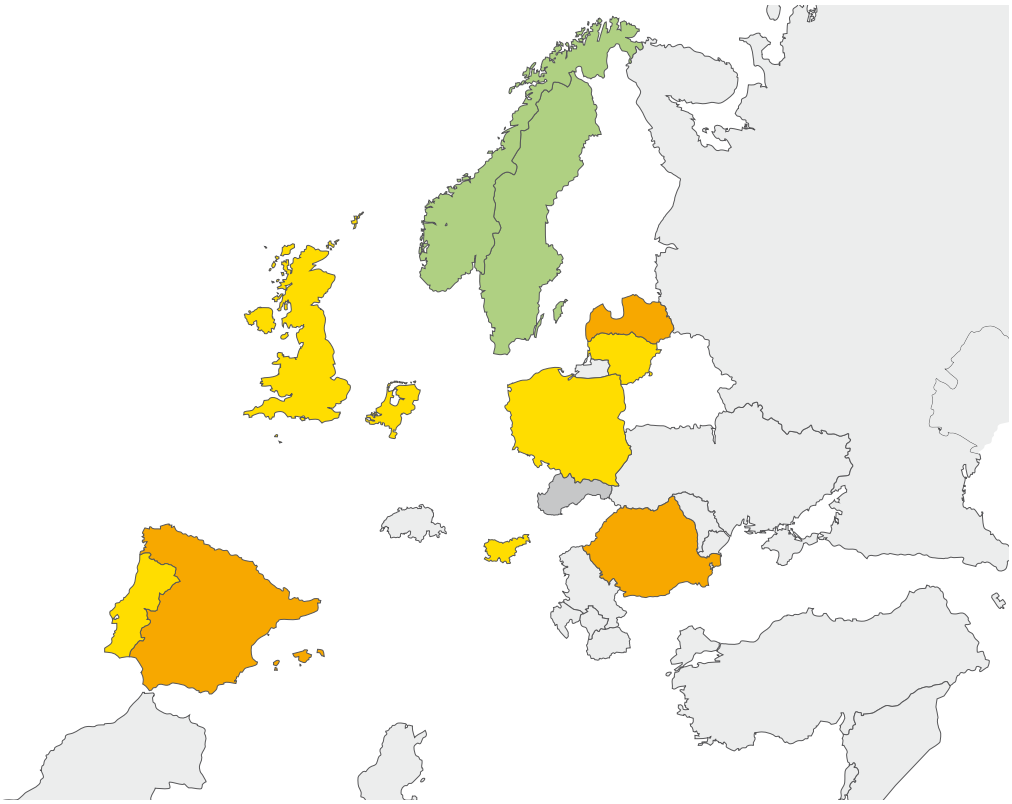
Table 5.6: Number of invasive *E. coli* isolates resistant to third-generation cephalosporins (CREC) and proportion of ESBL-positive (%ESBL) among these isolates, as ascertained by the participating laboratories in 2010

Country	Number of laboratories	Number of CREC	%ESBL
Austria	30	139	89.9
Bulgaria	12	35	91.4
Czech Republic	40	257	87.5
France	40	361	64.8
Germany	12	184	92.9
Ireland	26	133	82
Italy	1	23	100
Lithuania	7	20	95
Poland	20	56	87.5
Portugal	8	34	88.2
Slovenia	9	63	90.5
Spain	41	690	91.3

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.

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.

Figure 5.14: *Escherichia coli*: proportion of invasive isolates with resistance to third-generation cephalosporins in 2010



5.4.3 Results

Aminopenicillins

- Twenty-eight countries reported 53463 isolates of which 28961 (54.2%) were resistant to aminopenicillins, and the proportions of resistant isolates in the reporting countries ranged from 33.8% to 82.6%.
- The majority of countries (21 of 28) reported resistance proportions from 45.8% to 66.8%. Among nine countries reporting proportions below 50%, the lowest proportions were reported by Finland (33.8%), Sweden (34.7%) and Estonia (37.5%) (Table 5.5).
- Trends for the period 2007–2010 were calculated for 28 countries. During the past four years, a significant increase was observed in six of 28 countries. In two of these countries, the trends were still significant when considering only data from laboratories reporting consistently for all four years (Figure 5.17).
- Among the six countries with increasing trends, four countries reported proportions of resistance to aminopenicillin in 2010 of between 60% and 70%, while two countries reported resistance proportions between 50% and 60%.
- Two countries (Austria and Estonia) reported significant decreasing trends of resistance to aminopenicillin, with resistance proportions in 2010 of 50.6% and 37.5% respectively (Figure 5.17).

Third-generation cephalosporins

- Twenty-eight countries reported 55446 isolates of which 4705 (8.5%) were resistant to third-generation cephalosporins, and the proportions of resistant isolates in the reporting countries ranged from 2.6% to 24.8%.
- Ten of 28 countries reported resistance to third-generation cephalosporins in more than 10% of isolates. Among the 18 countries reporting less than 10% resistance, the lowest proportions were reported by Sweden (2.6%), Norway (3.7%), and Finland (3.7%) (Table 5.5 and Figure 5.14).
- Trends for the period 2007–2010 were calculated for 28 countries. During the past four years, a significant increase was observed in half (14 of 28) of the countries. In 11 of these, the trends were still significant when considering only data from laboratories reporting consistently for all four years (Figure 5.18). Among the 14 countries with increasing trends for 2007–2010, one country reported resistance to third-generation cephalosporins in more than 20% of isolates, four countries reported between 10% and 20%, seven reported between 5% and 10%, and two reported below 5% (Table 5.5).
- Two countries (Portugal and Austria) reported decreasing trends of resistance to third-generation cephalosporins. However, only for Portugal was the trend still significant when considering only data from laboratories reporting consistently for all four years.

Figure 5.15: *Escherichia coli*: proportion of invasive isolates with resistance to fluoroquinolones in 2010

Extended-spectrum beta-lactamase (ESBL)

- Among *E. coli* isolates resistant to third-generation cephalosporins, a large proportion was ascertained as ESBL-positive by the participating laboratories in 2010. Ten of 12 countries reported between 85 % and 100 % ESBL-positive isolates among isolates resistant to third-generation cephalosporins (Table 5.6).

Fluoroquinolones

- Twenty-eight countries reported 54 483 isolates of which 11 295 (20.7 %) were resistant to fluoroquinolones, and the proportions of resistant isolates in the reporting countries ranged from 8.4 % to 42.8 %.
- The majority of countries (16 of 28) reported resistant proportions higher than 20 %. Nine countries reported between 10 % and 20 %, while three countries reported below 10 %; Estonia (8.4 %), Norway (8.7 %), and Finland (9.2 %) (Table 5.5 and Figure 5.15).
- Trends for the period 2007–2010 were calculated for 28 countries. A significant increase was observed for eight countries. In five of these countries the trends were still significant when considering only data from laboratories reporting consistently during all four years (Figure 5.19).
- Among the eight countries with increasing trends for 2007–2010, two reported proportions of resistance to fluoroquinolones above 30%, three reported between 20 % and 30 %, and three countries reported below 20 % (Table 5.5).
- Only two countries (Austria and Germany) reported significant decreasing trends in resistance to fluoroquinolones, with resistance proportions of 20.9 % and 24.8 % respectively in 2010 (Figure 5.19).

Aminoglycosides

- Twenty-eight countries reported 56 237 isolates of which 4 911 (8.7 %) were resistant to aminoglycosides, and the proportions of resistant isolates in the reporting countries ranged from 2.7 % to 22.4 %.
- Eleven of 28 countries reported proportions of resistant isolates higher than 10 %, and 13 countries reported between 5 % and 10 %. The lowest proportions (below 5 %) of resistant isolates were reported by Sweden (2.7 %), Iceland (2.9 %), Finland (3.8 %) and Norway (4.3 %) (Table 5.5 and Figure 5.16).
- Trends for the period 2007–2010 were calculated for 28 countries. A significant increase in the proportion of isolates resistant to aminoglycosides was observed for ten countries. Among these, four countries reported proportions higher than 10 %, five countries reported between 5 % and 10 %, and one country reported below 5 % (Figure 5.20).
- For three countries (Austria, Romania and Portugal) the proportions of resistance to aminoglycosides has decreased significantly over the last four years. For Portugal, the trend remained significant when considering only data from laboratories consistently reporting for all four years (Figure 5.20).

Figure 5.16: *Escherichia coli*: proportion of invasive isolates with resistance to aminoglycosides in 2010

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

- In 2010, 28 countries reported 49 847 isolates tested for aminopenicillins, third-generation cephalosporins, fluoroquinolones and aminoglycosides. Of these isolates, 57.3 % were resistant to one or more of these four antibiotic classes.
- The proportion of multiresistant isolates (resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides) was higher than 10 % in three countries, between 5 % and 10 % in seven countries, between 1 % and 5 % in seventeen countries, and below 1 % in one country (Table 5.5 and Figure 5.21).
- Trends for the period 2007–2010 were calculated for 28 countries. A significant increase in proportions of multiresistant isolates was observed for 10 countries. In six of these countries the trends remained significant when considering only data from laboratories reporting consistently for all four years (Figure 5.21).
- Among the 10 countries with significantly increasing proportions of multiresistant isolates over the period 2007–2010, four countries reported above 5 % and six countries reported between 1 % and 5 %. One country (Austria) had a decreasing trend of proportions of multiresistance in *E. coli* in 2007–2010, yet this was not significant when considering only the data from laboratories reporting throughout all four years.
- The most frequent resistance phenotypes in *E. coli* were single aminopenicillin resistance (32.6 %), followed by combined resistance to aminopenicillins and fluoroquinolones (8.6 %). Combined resistance to all four antimicrobials was reported for 4 % 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 2010. Resistance in *E. coli* is increasing in several countries; both multiresistance and resistance to the single antimicrobials under surveillance.

The highest proportions of resistant *E. coli* were reported for aminopenicillins ranging up to 82.6 %. Irrespective of the high level of resistance, proportions continue to increase in several countries. The proportion of reported *E. coli* isolates resistant to third-generation cephalosporins has increased significantly during the last four years in half of the reporting countries and has decreased in only one country. Among these isolates resistant to third-generation cephalosporins, a high proportion (65–100 %) 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 to increase as in previous years. The situation becomes progressively dire and more than half of the countries are reporting resistance proportions higher than 20 %. In two countries, however, a decreasing resistance trend has been observed.

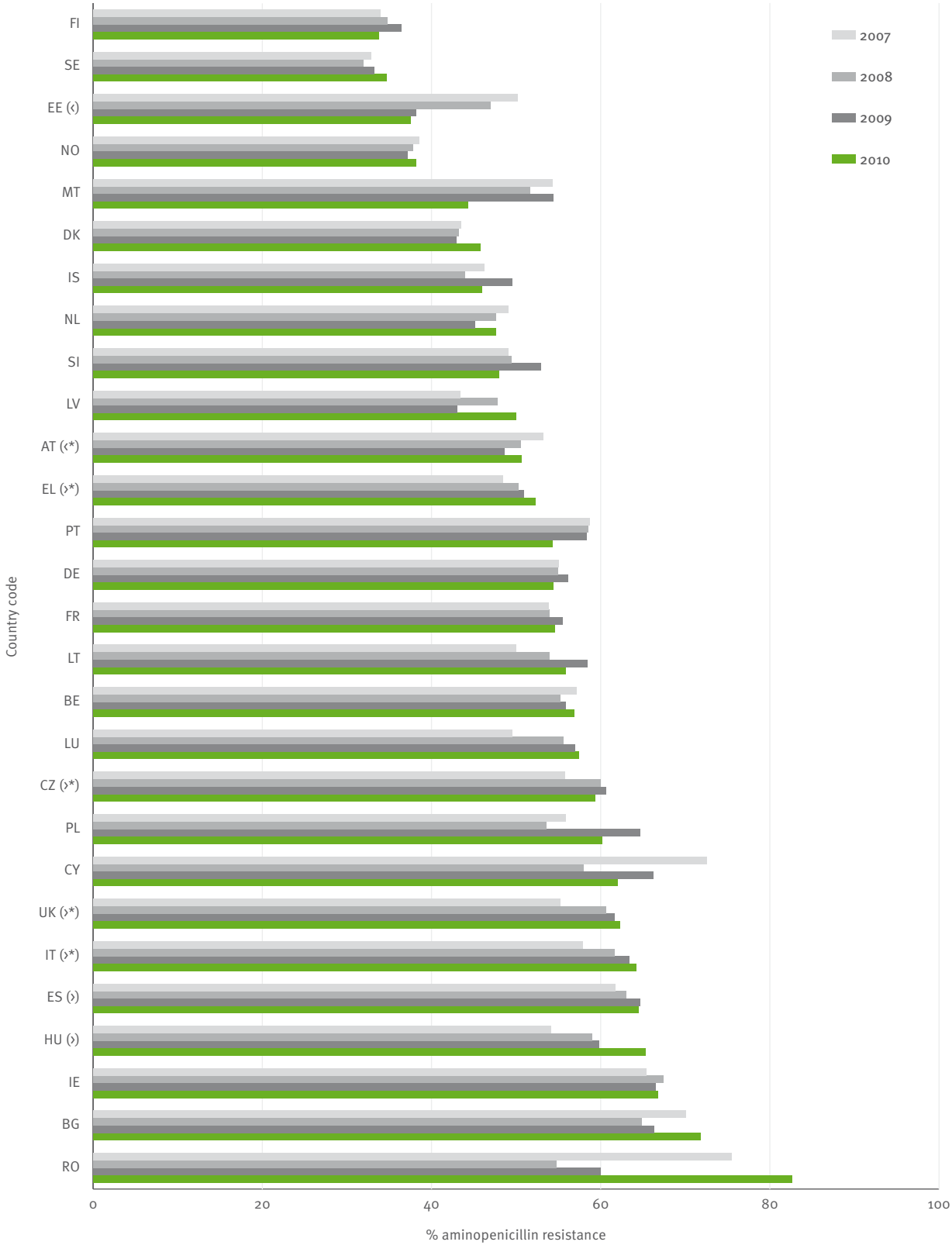
Ten countries had significant increases in the proportion of isolates resistant to aminoglycosides and four of these countries reported proportions higher than 10 %. This indicates that resistance to aminoglycosides is increasing even among the countries already reporting high levels of resistance.

Combined resistance to all four antimicrobials was reported in 4% of the isolates and combined resistance to aminopenicillins, fluoroquinolones and aminoglycosides was 3.2 %. These results show that antimicrobial susceptibility in *E. coli* requires continued close surveillance.

Table 5.7: Overall resistance and resistance combinations among invasive *E. coli* isolates tested against aminopenicillins, fluoroquinolones, third-generation cephalosporins and aminoglycosides (n= 49 847) in Europe, 2010

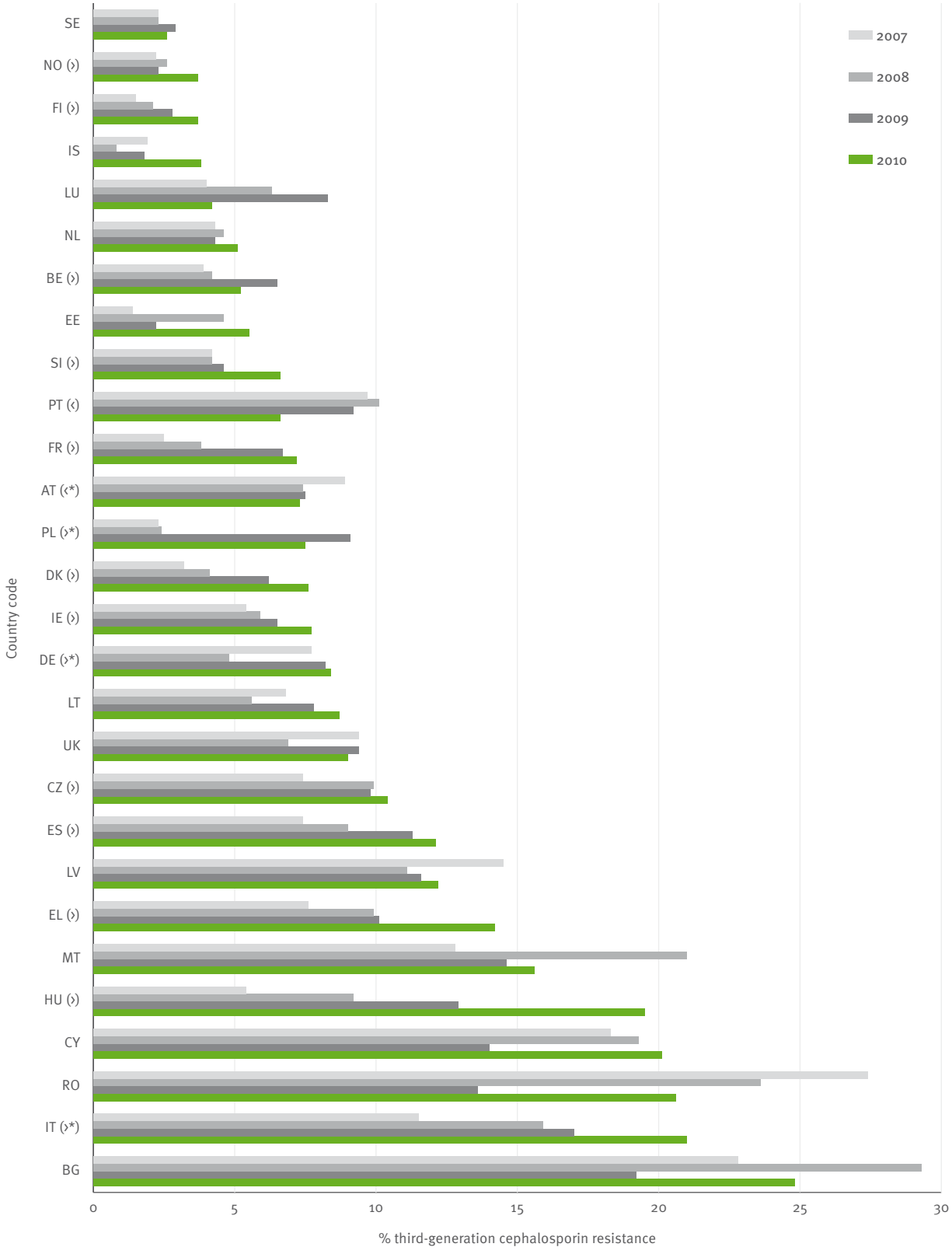
Resistance pattern	Number of isolates	% of total
Fully susceptible	21264	42.7
Single resistance (to indicated drug classes)		
Aminopenicillins	16 244	32.6
Fluoroquinolones	1138	2.3
Aminoglycosides	118	0.2
Resistance to two classes of antimicrobial drugs		
Aminopenicillins + fluoroquinolones	4276	8.6
Aminopenicillins + third-generation cephalosporins	804	1.6
Aminopenicillins + aminoglycosides	686	1.4
Fluoroquinolones + aminoglycosides	88	0.2
Resistance to three classes of antimicrobial drugs		
Aminopenicillins + fluoroquinolones + aminoglycosides	1571	3.2
Aminopenicillins + third-generation cephalosporins + fluoroquinolones	1531	3.1
Aminopenicillins + third-generation cephalosporins + aminoglycosides	132	0.3
Resistance to four classes of antimicrobial drugs		
Aminopenicillins + third-generation cephalosporins + fluoroquinolones + aminoglycosides	1995	4.0

Figure 5.17: *Escherichia coli*: trends of resistance to aminopenicillin by country, 2007–2010



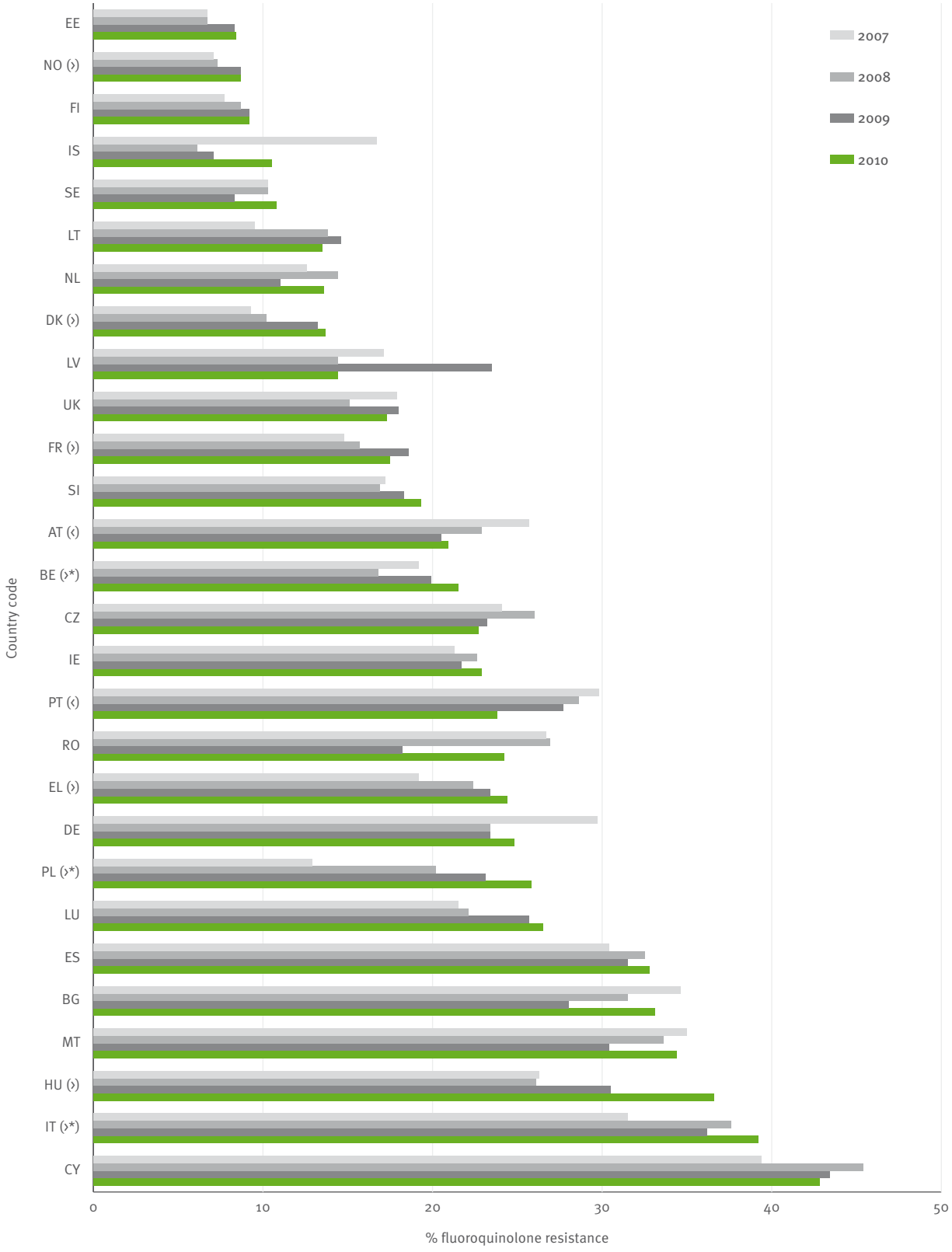
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for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

Figure 5.18: ***Escherichia coli*****: trends of resistance to third-generation cephalosporins by country, 2007–2010**



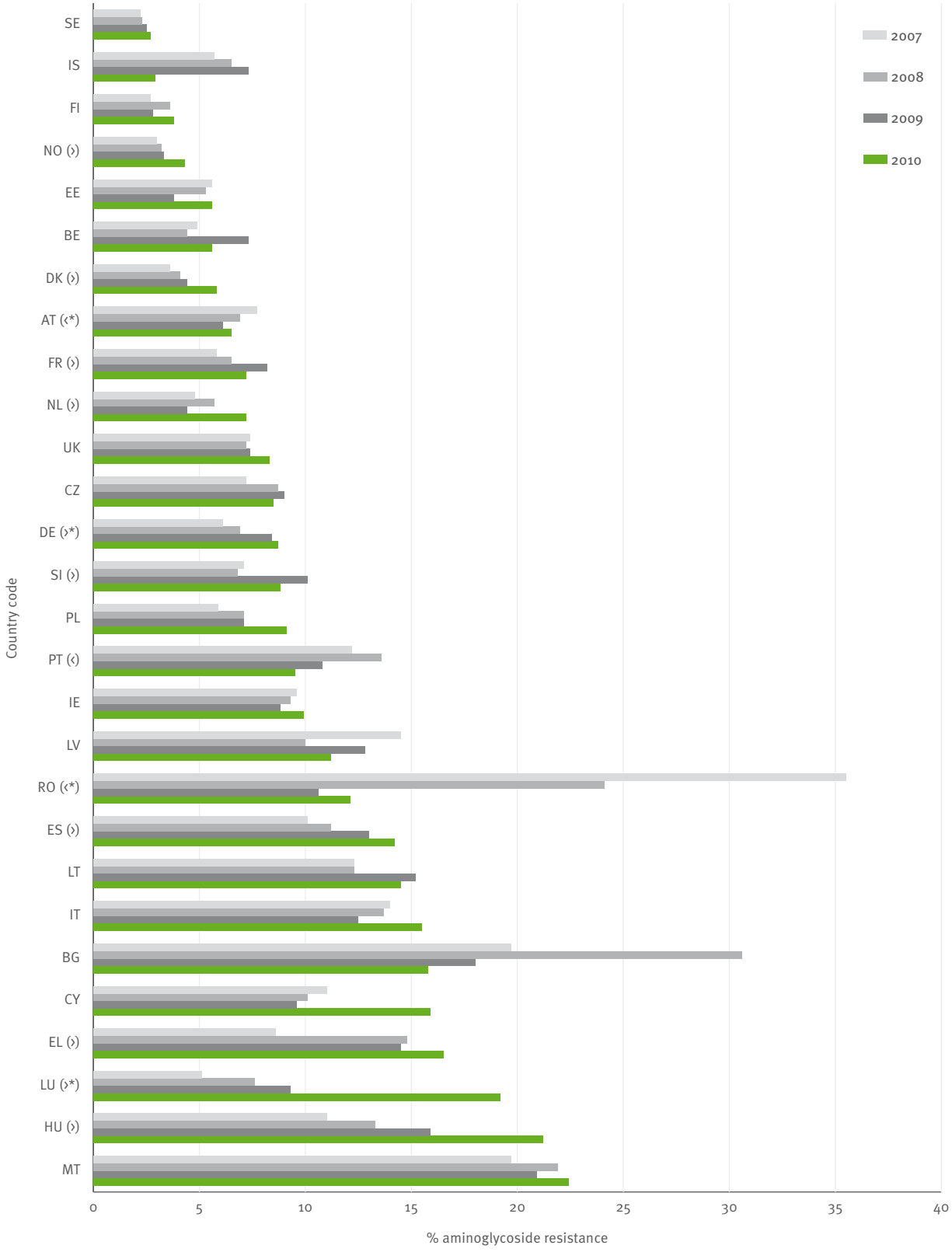
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for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

Figure 5.19: ***Escherichia coli*****: trends of resistance to fluoroquinolones by country, 2007–2010**



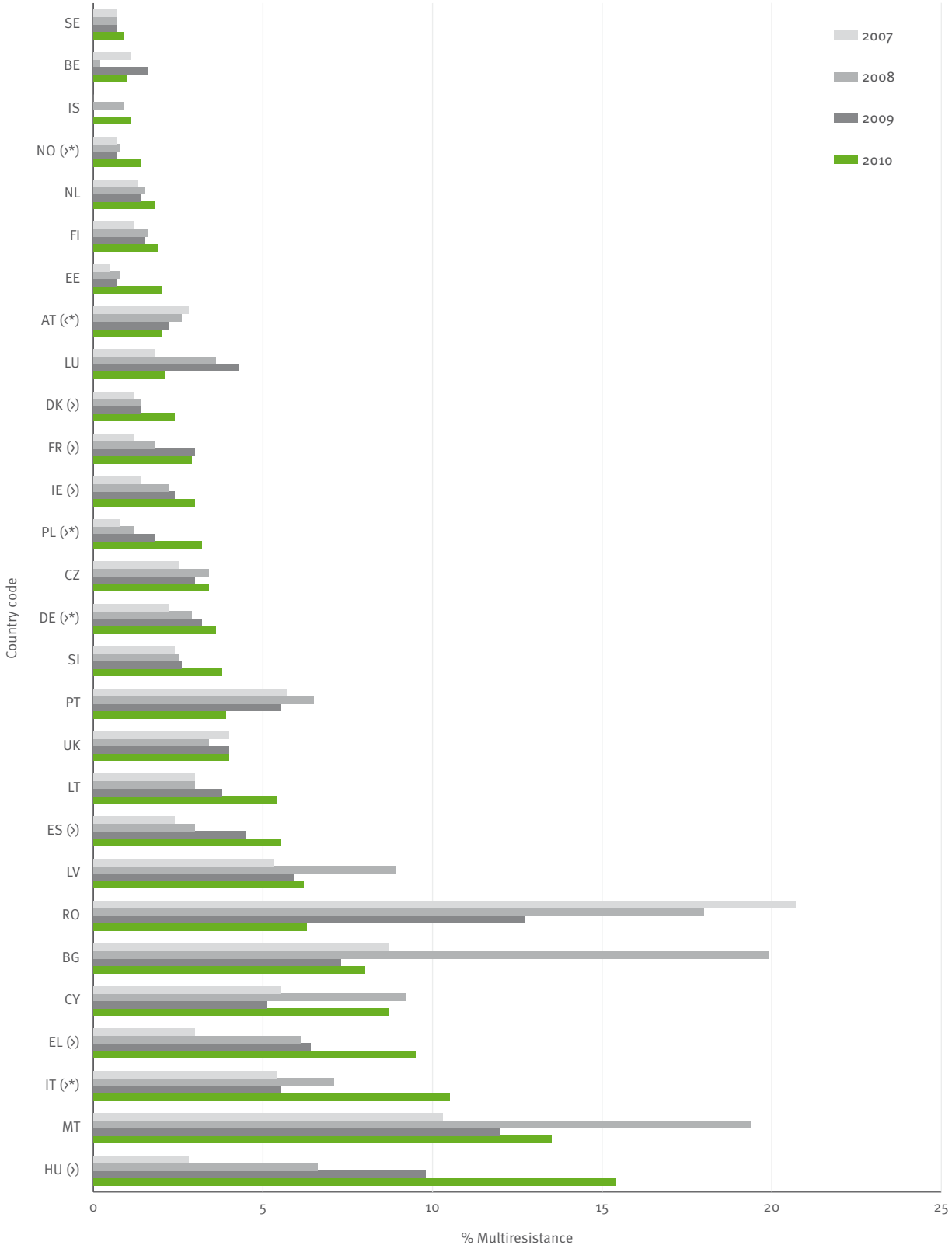
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for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

Figure 5.20: ***Escherichia coli*****: trends of resistance to aminoglycosides by country, 2007–2010**



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, 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, 2007–2010**



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, 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*

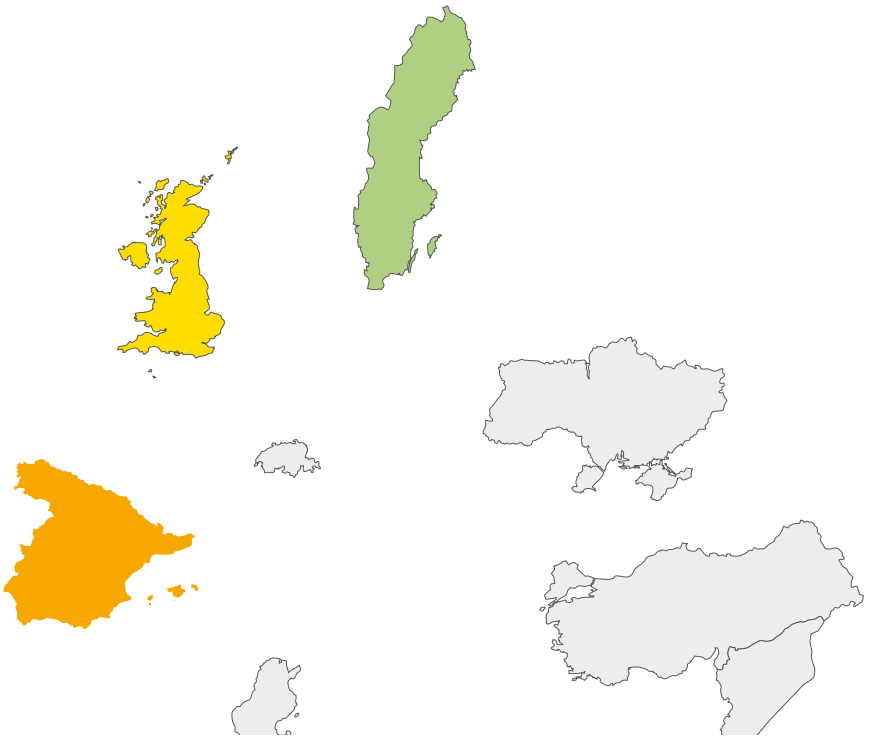
5.5.1 Clinical and epidemiological importance

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 systems, 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 colonise 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, this 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 and Greece and similar strains are now spreading in several European countries 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, while the OXA-48 gene, which codes for an oxacillinase and causes resistance to penicillin and reduces susceptibility to carbapenems but not to cephalosporins, is thus frequently missed in laboratories using automated AST systems. A combination of OXA-48 with ESBLs such as CTX-M15 can occur in *Klebsiella* and can bring about an extensively drug-resistant phenotype. Single clones with these combinations have caused hospital outbreaks in several European countries.

Figure 5.22: *Klebsiella pneumoniae*: proportion of invasive isolates resistant to third-generation cephalosporins in 2010



5.5.3 Results

Third-generation cephalosporins

- Twenty-eight countries reported 13240 isolates of which 3635 (27.5%) were resistant to third-generation cephalosporins.
- The proportions of isolates found to be resistant ranged from 1.7% (Sweden) to 75.6% (Bulgaria). Among the 28 countries, four countries reported proportions below 5%, four countries reported 5–10%, 10 countries reported 10–25%, five countries reported 25–50%, and five countries reported above 50% (Figure 5.22, Table 5.8).
- Trends for the period 2007–2010 were calculated for 25 countries (Figure 5.26). A significant increase was observed for nine countries. In seven of these (Austria, France, Estonia, Finland, Greece, Hungary and Lithuania), the trends were still significant when considering only data from laboratories reporting consistently for all four years (Figure 5.26).
- None of the countries reported a significant decreasing trend of proportions of resistance to third-generation cephalosporins (Figure 5.26).

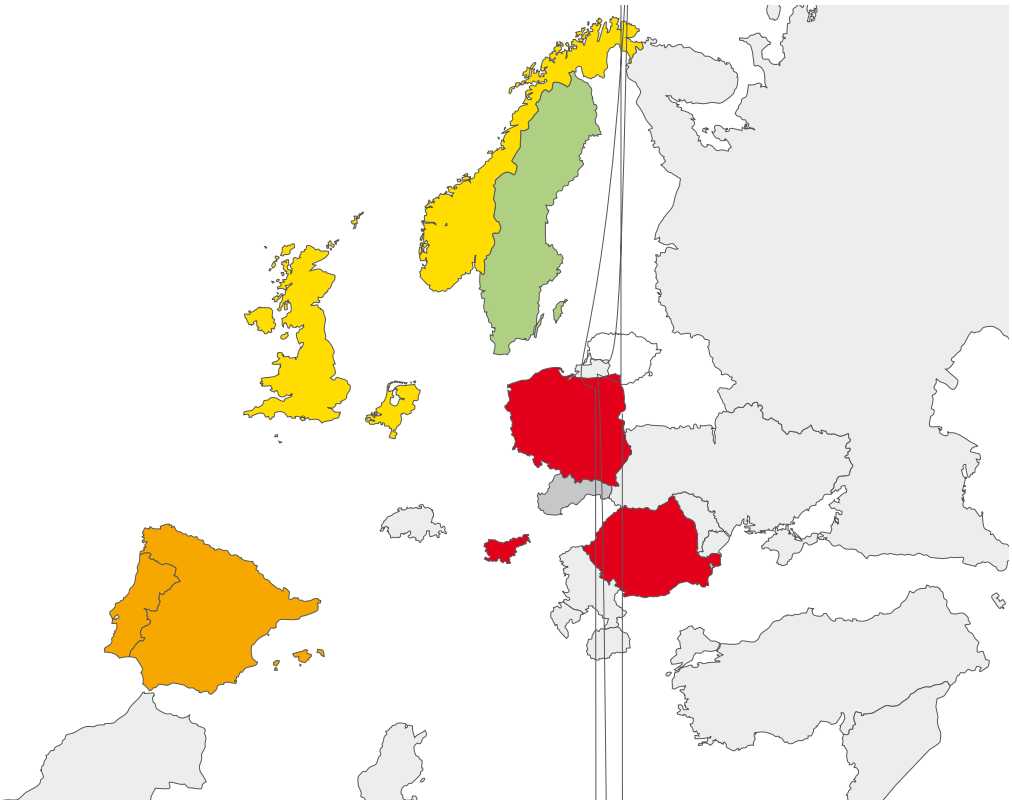
Extended-spectrum beta-lactamase (ESBL)

- Fifteen countries were included in the calculation of ESBL proportions for *K. pneumoniae*. Data were only included from laboratories reporting ESBL test results for all isolates identified as resistant to third-generation cephalosporins, and only from countries with at least 10 of such isolates.
- The proportion of *K. pneumoniae* isolates resistant to third-generation cephalosporins and ESBL producers, as ascertained by the participating laboratories, ranged from 59.3% to 100%. The proportion of ESBL producers was under 75% in one country, 75–85% in two countries, 85–95% in six countries, and above 95% in six countries (Table 5.9).

Fluoroquinolones

- Twenty-eight countries reported 13013 isolates of which 3706 (28.5%) were resistant to fluoroquinolones.
- The proportion of isolates found to be resistant ranged from 0.0% (Iceland) to 70.9% (Greece). One country reported below 1%, two countries 1–5%, five countries 5–10%, ten countries 10–25% (including Estonia and Slovenia with exactly 25%), 25–50% in six countries, and above 50% in four countries (Figure 5.23, Table 5.8).
- Trends for the period 2007–2010 were calculated for 23 countries. A significant increase was observed for eleven countries. In nine of these countries (Austria, Cyprus, Czech Republic, Estonia, France, Greece, Hungary, Lithuania and Norway) the trends were still significant when considering only data from laboratories which reported consistently for all four years (Figure 5.27).

Figure 5.23: *Klebsiella pneumoniae*: proportion of invasive isolates resistant to fluoroquinolones in 2010



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

- Twenty-eight countries reported 12 665 isolates tested for susceptibility to third-generation cephalosporins, fluoroquinolones and aminoglycosides. In 2010, 35 % of isolates were resistant to one or more of the three considered antibiotic classes. The most frequent pattern of resistance (19 %) was multiresistance (resistant (R) to all three antibiotic classes) (Table 5.10).
- Proportions of multiresistance ranged from 0.0 % (Iceland) to 57.4 % (Greece), and was reported as below 1 % in three countries, 1–5 % in eight countries, 5–10 % in three countries, 10–25 % in seven countries, 25–50 % in six countries and above 50 % in one country (Table 5.8).
- Trends for the period 2007–2010 were calculated for 25 countries. A significant increase of multiresistance was observed for nine countries. In seven of these countries (Czech Republic, Estonia, France, Greece, Hungary, Latvia, and Lithuania), the trends were significant even when considering only data from laboratories reporting consistently for all four years (Figure 5.30).
- Two countries (United Kingdom and Austria) reported a significant decreasing trend of proportions of multiresistance (Figure 5.30), with 2010 proportions of 3.6 % and 1.8 %, respectively. Both these trends were significant even when looking only at data from laboratories reporting throughout the 2007–2010 period.

5.5.4 Conclusions

Antimicrobial resistance in *K. pneumoniae* is a public health concern of increasing importance in Europe. In 2010, a high frequency of multidrug-resistant *K. pneumoniae* (combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides) was evident in southern, central and eastern Europe. In two thirds of the reporting countries, the proportions of resistance to third-generation cephalosporins and fluoroquinolones was higher than 10 %, and more than one third of the countries reported proportions higher than 25 %. The majority of isolates resistant to third-generation cephalosporins were also resistant to fluoroquinolones and aminoglycosides, which indicates that combined resistance was common. Proportions of multiresistance above 10 % were reported by half of the countries.

The occurrence of carbapenem-resistant *K. pneumoniae* has increased dramatically in a number of countries. In 2009, carbapenem resistance in *K. pneumoniae* was only established in Greece. In 2010, in addition to Greece, an increasing trend of carbapenem-resistant *K. pneumoniae* was also observed in Austria, Cyprus, Hungary and Italy. This increasing trend is a particularly worrying phenomenon as carbapenems are some of the few effective antimicrobials available for the treatment of infections caused by bacteria producing extended-spectrum beta-lactamases and resistance to carbapenems leaves very few therapeutic options.

Figure 5.25: *Klebsiella pneumoniae*: proportion of invasive isolates resistant to carbapenems in 2010

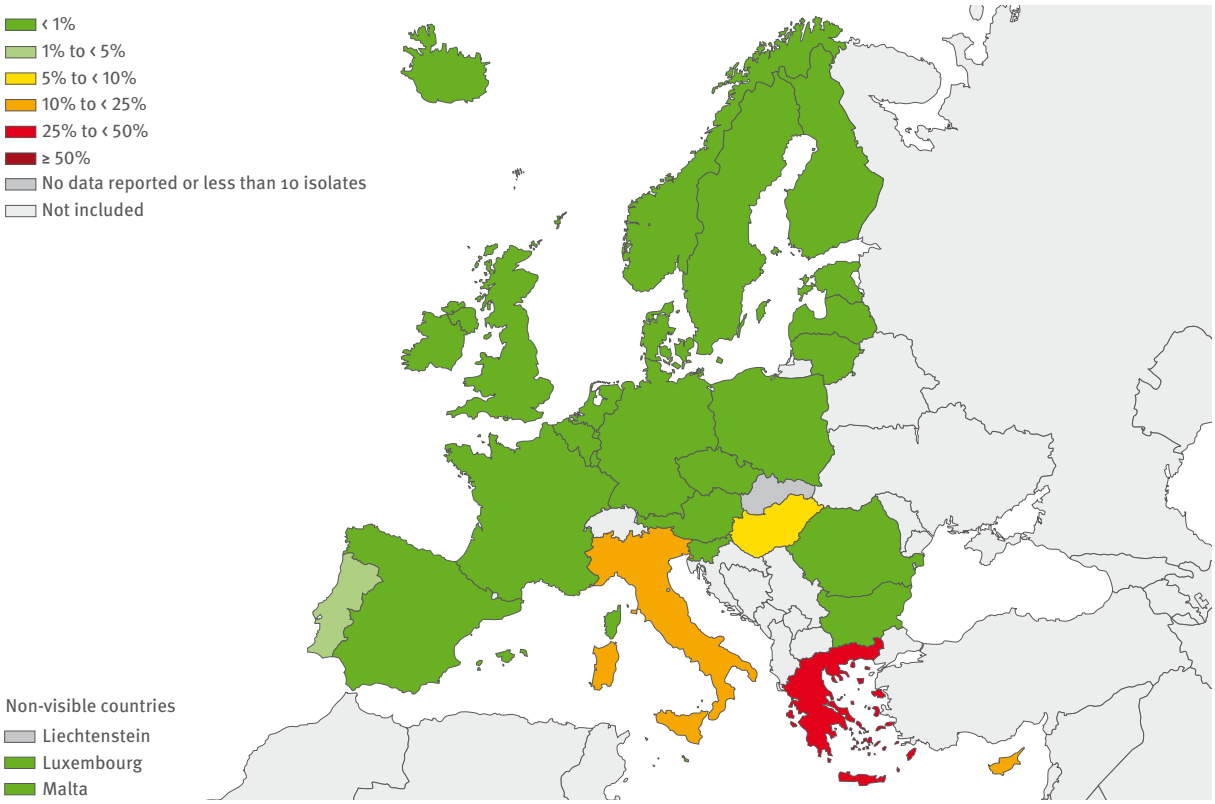
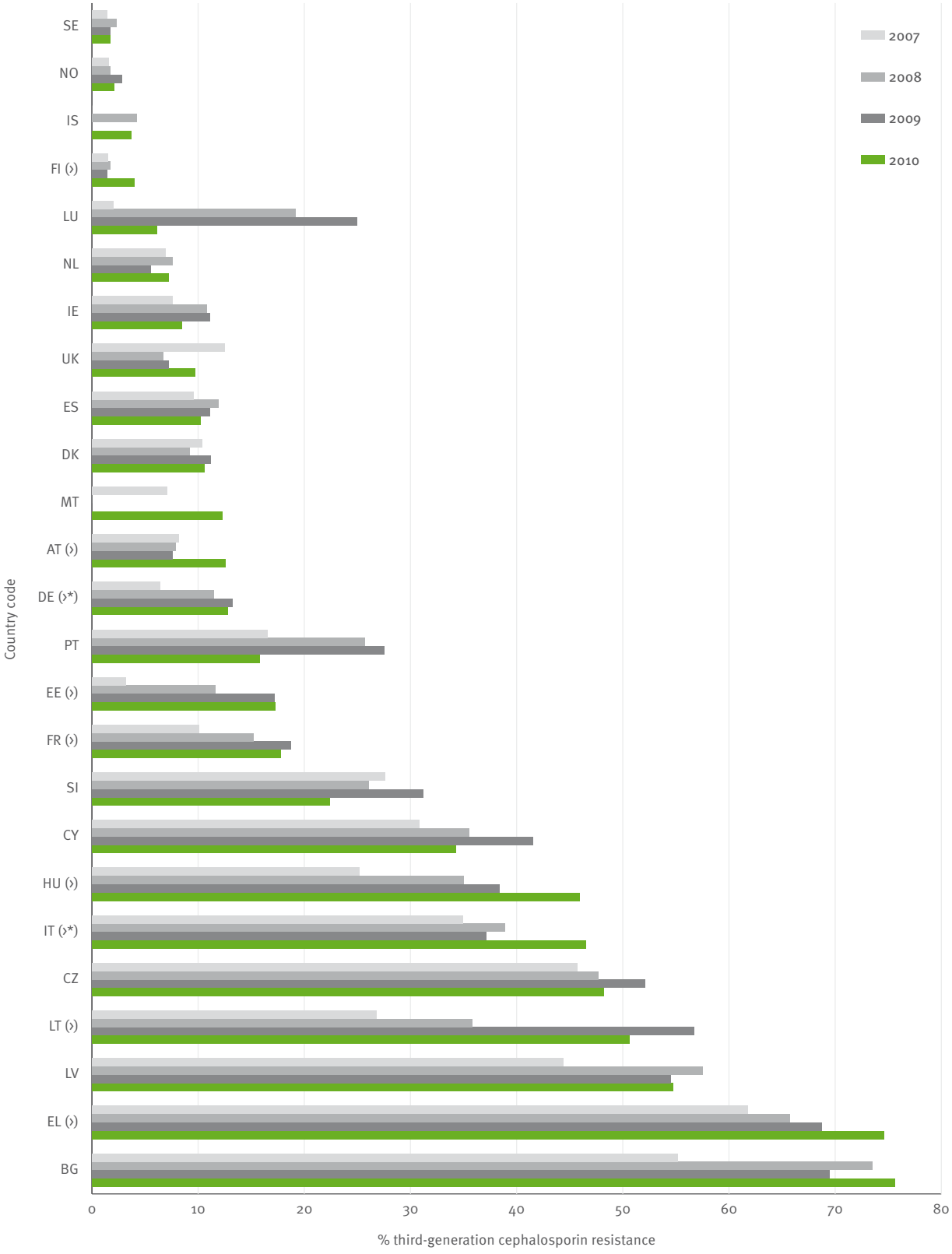
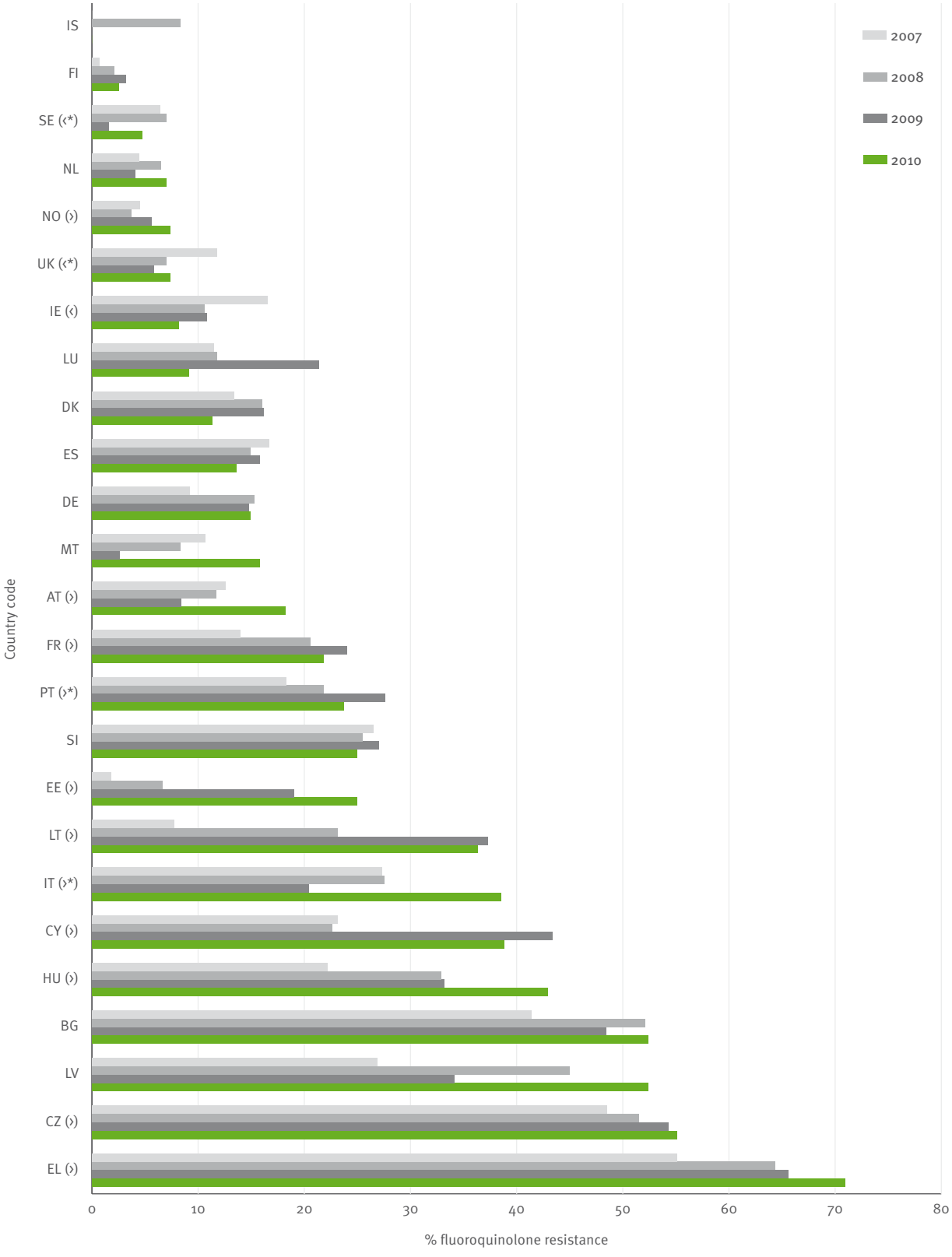


Figure 5.26: ***Klebsiella pneumoniae*****: trends of resistance to third-generation cephalosporins by country, 2007–2010**



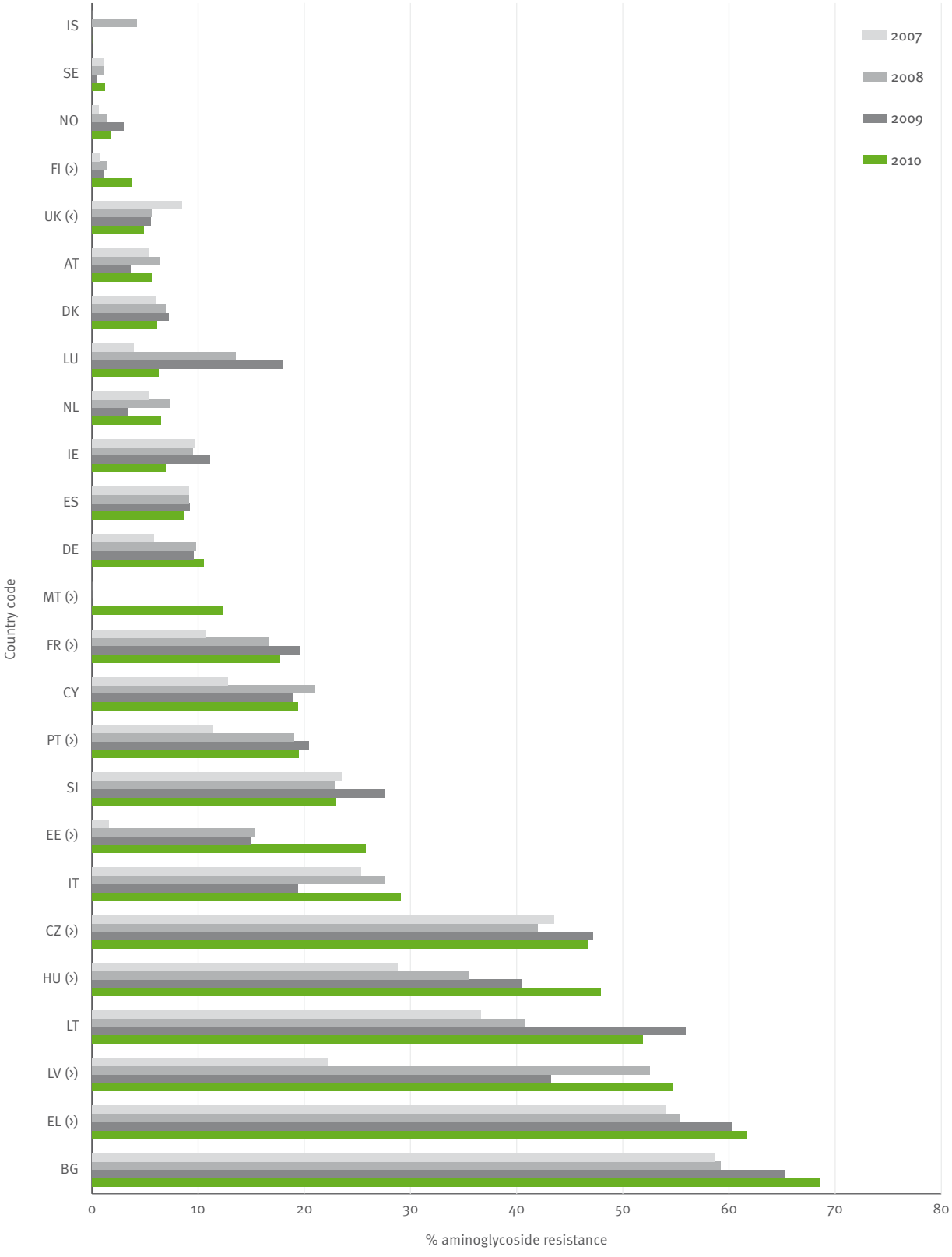
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for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

Figure 5.27: ***Klebsiella pneumoniae*: trends of resistance to fluoroquinolones by country, 2007–2010**



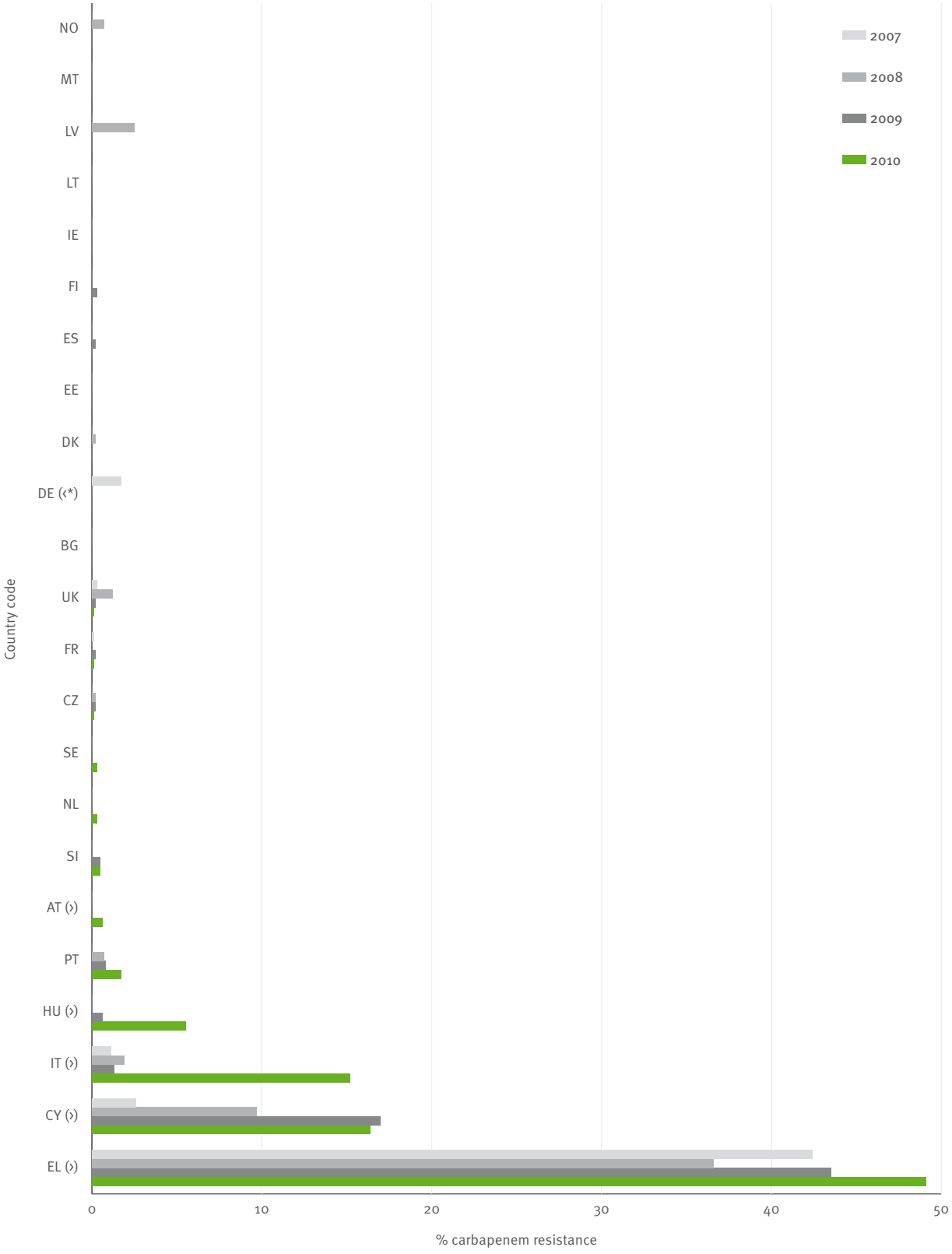
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for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

Figure 5.28: ***Klebsiella pneumoniae*****: trends of resistance to aminoglycosides by country, 2007–2010**



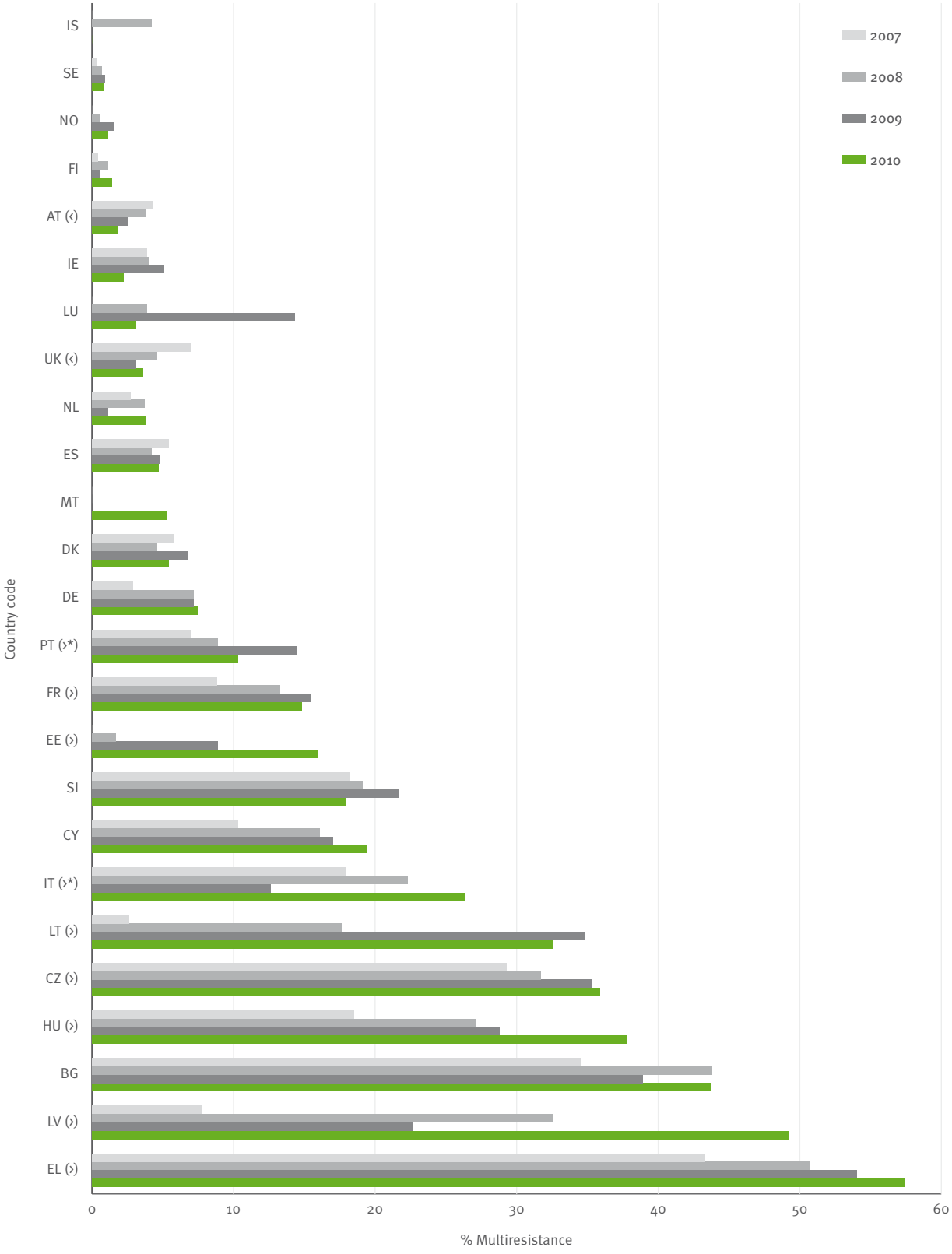
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, respectively.

Figure 5.29: ***Klebsiella pneumoniae*****: trends of resistance to carbapenems by country, 2007–2010**



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 5.30: ***Klebsiella pneumoniae*****: trends of multiresistance (third-generation cephalosporins, fluoroquinolones and aminoglycosides) by country, 2007–2010**



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 and proportion of invasive *K. pneumoniae* isolates resistant to fluoroquinolones, third-generation cephalosporins, aminoglycosides and multiresistant (%R), including 95% confidence intervals (95% CI), reported per country in 2010

Country	Fluoroquinolones		Third-gen. cephalosporins		Aminoglycosides		Multiresistance*	
	N	%R (95%CI)	N	%R (95%CI)	N	%R (95%CI)	N	%R (95%CI)
Austria	720	18.2 (15-21)	720	12.6 (10-15)	720	5.6 (4-7)	716	1.8 (1-3)
Belgium	144	12.5 (8-19)	143	12.6 (8-19)	133	2.3 (0-6)	132	0.8 (0-4)
Bulgaria	126	52.4 (43-61)	127	75.6 (67-83)	127	68.5 (60-76)	126	43.7 (35-53)
Cyprus	67	38.8 (27-51)	67	34.3 (23-47)	67	19.4 (11-31)	67	19.4 (11-31)
Czech Republic	1263	55.1 (52-58)	1263	48.2 (45-51)	1245	46.7 (44-49)	1244	35.9 (33-39)
Denmark	673	11.3 (9-14)	559	10.6 (8-13)	799	6.1 (5-8)	557	5.4 (4-8)
Estonia	64	25.0 (15-37)	81	17.3 (10-27)	66	25.8 (16-38)	63	15.9 (8-27)
Finland	401	2.5 (1-5)	397	4.0 (2-6)	372	3.8 (2-6)	368	1.4 (0-3)
France	1527	21.8 (20-24)	1542	17.8 (16-20)	1542	17.7 (16-20)	1527	14.8 (13-17)
Germany	478	14.9 (12-18)	478	12.8 (10-16)	478	10.5 (8-14)	478	7.5 (5-10)
Greece	1676	70.9 (69-73)	1686	74.6 (72-77)	1687	61.7 (59-64)	1668	57.4 (55-60)
Hungary	504	42.9 (38-47)	512	45.9 (42-50)	514	47.9 (43-52)	502	37.8 (34-42)
Iceland	24	0.0 (0-14)	27	3.7 (0-19)	27	0.0 (0-13)	24	0.0 (0-14)
Ireland	318	8.2 (5-12)	318	8.5 (6-12)	318	6.9 (4-10)	318	2.2 (1-4)
Italy	696	38.5 (35-42)	701	46.5 (43-50)	735	29.1 (26-33)	685	26.3 (23-30)
Latvia	63	52.4 (39-65)	64	54.7 (42-67)	64	54.7 (42-67)	63	49.2 (36-62)
Lithuania	80	36.3 (26-48)	81	50.6 (39-62)	81	51.9 (40-63)	80	32.5 (22-44)
Luxembourg	33	9.1 (2-24)	33	6.1 (1-20)	32	6.3 (1-21)	32	3.1 (0-16)
Malta	57	15.8 (7-28)	57	12.3 (5-24)	57	12.3 (5-24)	57	5.3 (1-15)
Netherlands	644	7.0 (5-9)	641	7.2 (5-9)	644	6.5 (5-9)	638	3.8 (2-6)
Norway	476	7.4 (5-10)	479	2.1 (1-4)	471	1.7 (1-3)	468	1.1 (0-2)
Poland	221	33.0 (27-40)	232	39.7 (33-46)	231	31.2 (25-38)	209	23.0 (17-29)
Portugal	211	23.7 (18-30)	215	15.8 (11-21)	231	19.5 (15-25)	204	10.3 (6-15)
Romania	17	29.4 (10-56)	17	70.6 (44-90)	17	70.6 (44-90)	17	23.5 (7-50)
Slovenia	196	25.0 (19-32)	196	22.4 (17-29)	196	23.0 (17-29)	196	17.9 (13-24)
Spain	1161	13.6 (12-16)	1161	10.2 (9-12)	1161	8.7 (7-10)	1161	4.7 (4-6)
Sweden	405	4.7 (3-7)	700	1.7 (1-3)	642	1.2 (1-2)	364	0.8 (0-2)
United Kingdom	768	7.4 (6-10)	743	9.7 (8-12)	797	4.9 (4-7)	701	3.6 (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 ESBL-positive (% ESBL) among these isolates, as ascertained by the participating laboratories in 2010

Country	Number of laboratories	Number of CRKP	%ESBL
Austria	27	73	78.1
Bulgaria	13	77	100
Czech Republic	43	609	86.4
France	19	65	87.7
Germany	6	32	96.9
Ireland	12	27	59.3
Italy	10	69	81.2
Latvia	5	15	93.3
Lithuania	7	35	100
Netherlands	6	13	92.3
Poland	21	92	98.9
Portugal	7	22	90.9
Romania	3	12	100
Slovenia	5	44	97.7
Spain	32	119	88.2

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 *K. pneumoniae* isolates tested against fluoroquinolones, third-generation cephalosporins and aminoglycosides (n= 12 665) in Europe, 2010

Resistance pattern	Number of isolates	% of total
Fully susceptible	8 297	65.5
Single resistance (to indicated drug classes)		
Fluoroquinolones	478	3.8
Third-generation cephalosporins	297	2.3
Aminoglycosides	135	1.1
Resistance to two classes of antimicrobial drugs		
Third-generation cephalosporins + fluoroquinolones	552	4.4
Third-generation cephalosporins + aminoglycosides	270	2.1
Fluoroquinolones + aminoglycosides	184	1.5
Resistance to three classes of antimicrobial drugs		
Third-generation cephalosporins + fluoroquinolones + aminoglycosides	2 452	19.4

5.6 *Pseudomonas aeruginosa*

5.6.1 Clinical and epidemiological importance

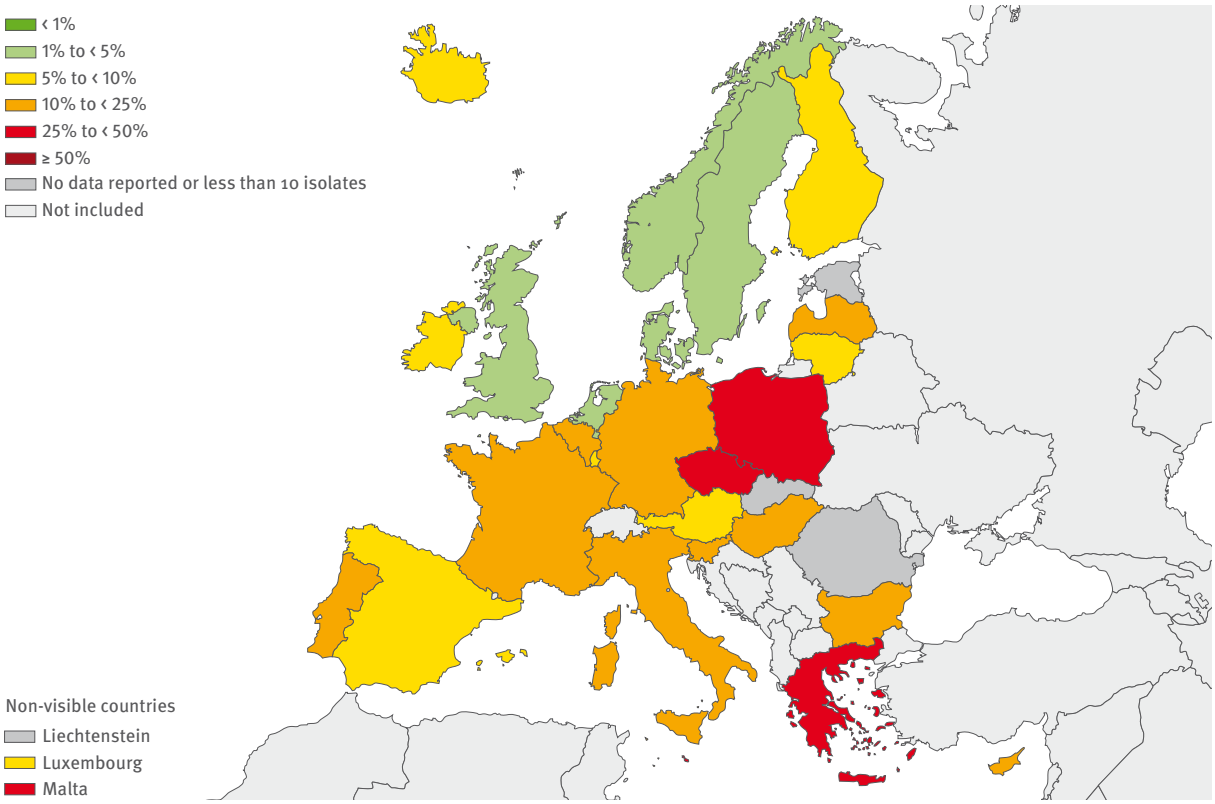
Pseudomonas aeruginosa is a non-fermenting Gram-negative bacterium that is ubiquitous in aquatic environments in nature. It is an opportunistic pathogen for plants, animals and humans, and is a major and dreaded cause of infection among hospitalised patients with localised or systemic impairment of immune defences, being a common cause of hospital-acquired pneumonia (including ventilator-associated pneumonia), bloodstream and urinary tract infections. Because of its ubiquity, 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 among recreational and competitive swimmers. In patients with cystic fibrosis, *P. aeruginosa* causes severe bacterial complication leading to chronic colonisation and intermittent exacerbation of the condition with, for example, bronchiolitis and acute respiratory distress syndrome. Finally, *P. aeruginosa* is commonly found in burns units, and in these locations it is almost impossible to eradicate colonising strains with classic 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 some fluoroquinolones (e.g. ciprofloxacin and levofloxacin), aminoglycosides (e.g. gentamicin, tobramicin and amikacin), some beta-lactams (piperacillin–tazobactam, ceftazidime, cefipime and carbapenems) and colistin. Resistance in *P. aeruginosa* is acquired through one or more of several mechanisms:

- mutational modification of antibiotic targets such as topoisomerases or ribosomal proteins, which confer resistance to fluoroquinolones and aminoglycosides, respectively;
- mutational derepression of the chromosomally coded AmpC beta-lactamase, that can confer resistance to penicillins and cephalosporins active against pseudomonas;
- 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.

Figure 5.31: *Pseudomonas aeruginosa*: proportion of invasive isolates resistant to piperacillin±tazobactam in 2010



5.6.3 Results

Piperacillin±tazobactam

- Twenty-eight countries reported 8203 isolates of which 1322 (16.1%) were resistant to piperacillin±tazobactam. One country reported fewer than 10 isolates and was therefore excluded from the map (Figure 5.31).
- Proportions of isolates found to be resistant ranged from 1.1% (Sweden) to 62.5% (Romania) and were reported less than 5% in five countries, 5–10% in seven countries, 10–25% in eleven countries, 25–50% in four countries and above 50% in one country (Figure 5.31, Table 5.11).
- Trends for the period 2007–2010 were calculated for 22 countries. A significant increase in resistance was observed for France, which in 2010 reported a proportion of resistance to piperacillin±tazobactam of 20.3%. This increasing trend remained significant even when including only data from laboratories reporting consistently throughout the period 2007–2010 (Figure 5.36).

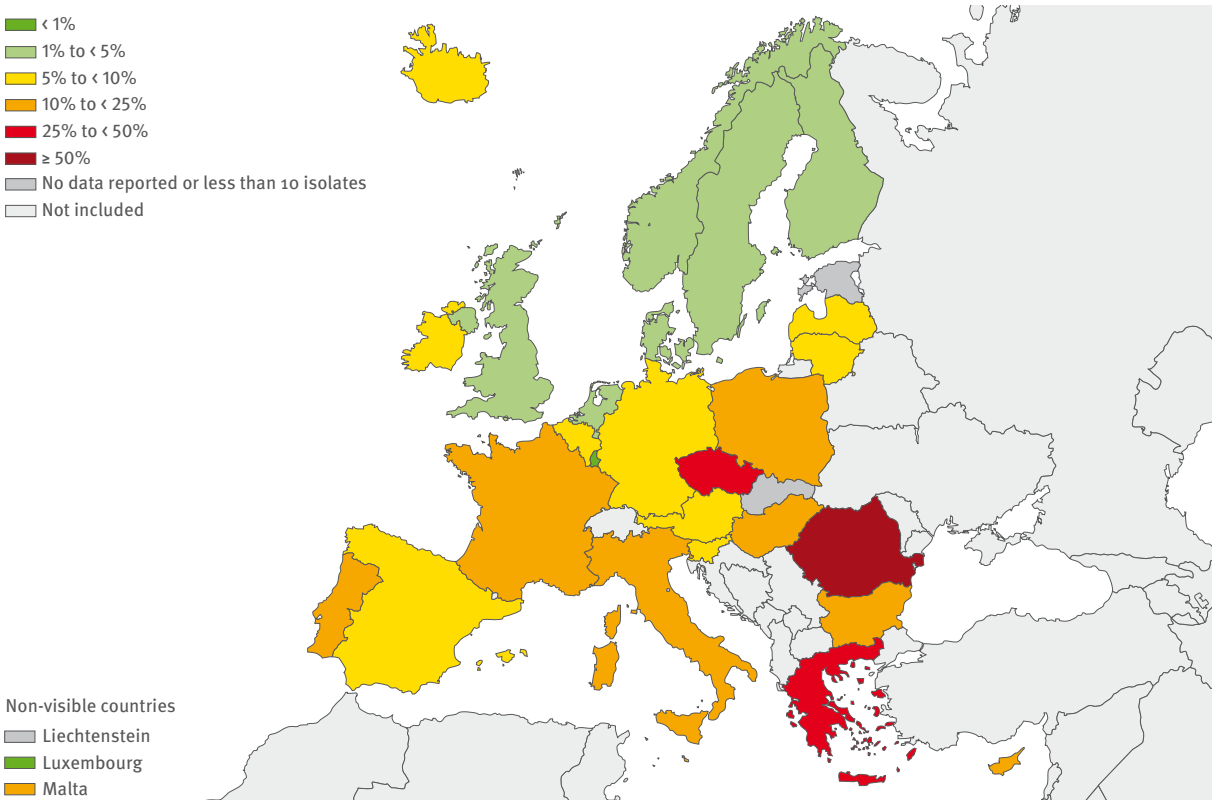
Ceftazidime

- Twenty-eight countries reported 8095 isolates of which 1103 (13.6%) were resistant to ceftazidime. One country (Estonia) reported fewer than 10 isolates and therefore was not included in the map (Figure 5.32).
- Proportions of isolates found to be resistant ranged from 0.0% (Luxembourg) to 60.0% (Romania), and was reported as less than 5% in seven countries, 5–10% in nine countries, 10–25% in nine countries and 25–50% in two countries, and over 50% in one country. (Figure 5.32, Table 5.11).
- Trends for the period 2007–2010 were calculated for 22 countries. A significant increasing trend was observed for France, which in 2010 reported a proportion of resistance to ceftazidime of 12.7%. This trend remained significant even when including only data from laboratories reporting consistently throughout the period 2007–2010. A significant decreasing trend was observed for the Czech Republic, Italy, Portugal and Germany (where proportions of resistance in 2010 were 28.5%, 17.7%, 12.0% and 8.1% respectively). However, this trend remained significant only for the Czech Republic and Italy when including only data from laboratories reporting consistently throughout the four years (Figure 5.37).

Fluoroquinolones

- Twenty-eight countries reported 8434 isolates of which 1878 (22.3%) were resistant to fluoroquinolones.
- Proportions of isolates found to be resistant ranged from 4.3% (Netherlands) to 55.6% (Romania) and was reported as less than 5% in two countries, 5–10% in four countries, 10–25% in sixteen countries, 25–50% in five countries, and above 50% in one country (Figure 5.33, Table 5.11).

Figure 5.32: *Pseudomonas aeruginosa*: proportion of invasive isolates resistant to ceftazidime in 2010



- Trends for the period 2007–2010 were calculated for 21 countries. No country reported a significant increase in proportions of resistance to fluoroquinolones. A significant decreasing trend was observed for Greece, Germany, Ireland and Slovenia, which in 2010 reported proportions of fluoroquinolone resistance of 45.7%, 18.4%, 10.6% and 9.5%, respectively. In three of these countries (Greece, Ireland and Slovenia) the trends were significant even when including only data from laboratories reporting consistently for all four years (Figure 5.38).

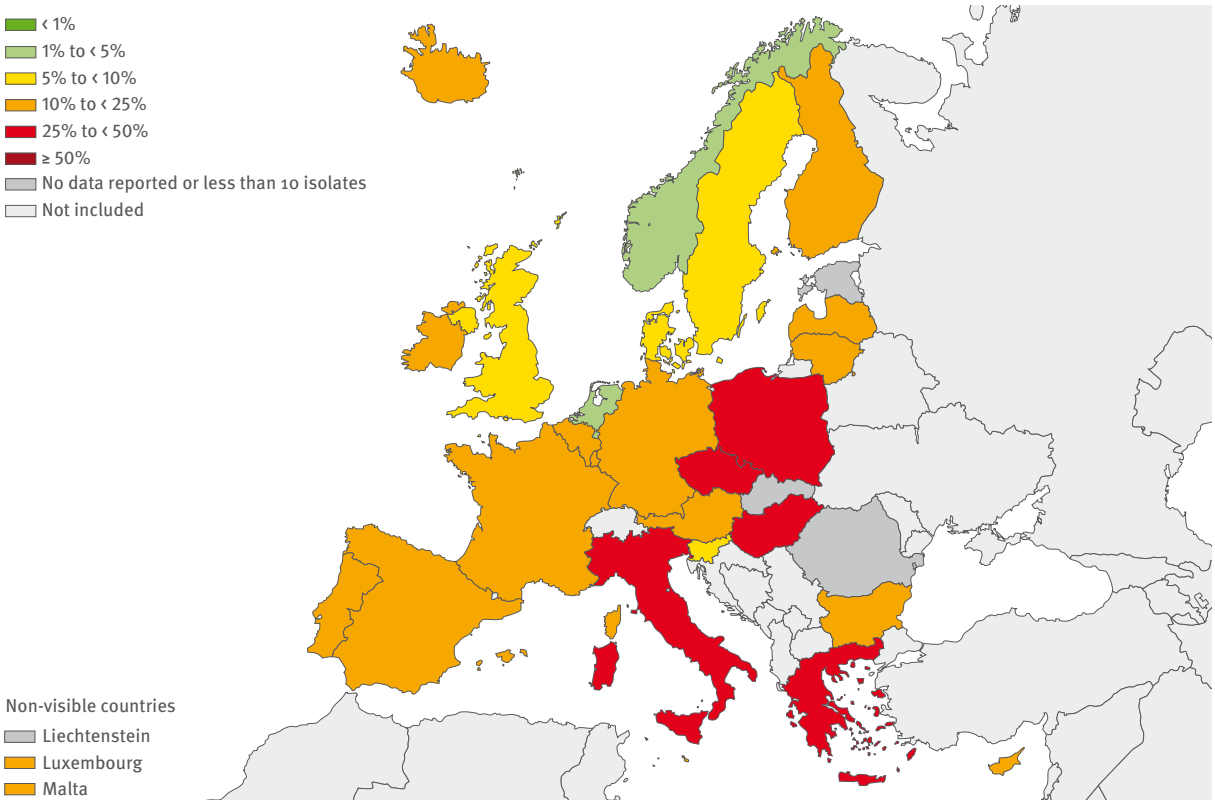
Aminoglycosides

- Twenty-eight countries reported 8338 isolates of which 1485 (17.8%) were resistant to aminoglycosides.
- Proportions of isolates found to be resistant ranged from 0.0% (Iceland) to 50.0% (Romania), and was reported as below 1% in three countries, 1–5% in five countries, 5–10% in two countries, 10–25% in eleven countries (including Austria with exactly 10%), 25–50% in six countries and exactly 50% in one country (Figure 5.34, Table 5.11).
- Trends for the period 2007–2010 were calculated for 22 countries. One country (Malta) reported a significant increasing trend with a proportion of aminoglycoside resistance of 31.0% in 2010 (Figure 5.39). This increasing trend remained significant even when examining data from laboratories which reported consistently throughout the 2007–2010 period.
- Significant decreasing trends were observed for four countries (Greece, Lithuania, Cyprus and the UK). For all of these, the trends remained significant even when considering only data from laboratories reporting consistently for all four years (Figure 5.39). In 2010, these four countries reported the following proportions of resistance to aminoglycosides: Greece with 41.8%, Lithuania with 12.9%, Cyprus with 10.4%, and the UK with 1.9%.

Carbapenems

- Twenty-eight countries reported 8448 isolates of which 1510 (17.9%) were resistant to carbapenems.
- Proportions of isolates found to be resistant ranged from 0.0% (Iceland) to 70.0% (Romania) and was reported as below 1% in one country, 1–5% in five countries, 5–10% in four countries, 10–25% in thirteen countries, 25–50% in four countries and above 50% in one country (Figure 5.35, Table 5.11).
- Trends for the period 2007–2010 were calculated for 22 countries. Two countries (Hungary and France) reported a significant increasing trend with proportions of resistance to carbapenems in 2010 of 24.9% and 17.8%, respectively. However, this increasing trend remained significant only in Hungary when considering only data from laboratories reporting consistently for all four years (Figure 5.40).

Figure 5.33: *Pseudomonas aeruginosa*: proportion of invasive isolates resistant to fluoroquinolones in 2010



- Significant decreasing trends were observed for Greece, Italy, the Czech Republic, Germany and Norway, with proportions of resistance to carbapenems in 2010 under 5 % in Norway, 10–25 % in Germany, the Czech Republic and Italy, and over 40 % in Greece. In the Czech Republic and Norway, the trend is still significant when considering only data from laboratories reporting consistently all four years (Figure 5.40).

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

- Twenty-eight countries reported 8 485 isolates tested for susceptibility to at least three antibiotic classes among piperacillin±tazobactam, ceftazidime, fluoroquinolones, aminoglycosides and carbapenems. In 2010, 33 % of the isolates were resistant to one or more of the five considered antibiotic classes, while 15 % were resistant to three or more. The most common pattern was resistance to all five antibiotic classes (5.2 %) (Table 5.12).
- Proportions of multiresistance (resistant (R) to at least three of the five considered antibiotic classes) were: below 1 % in two countries, 1–5 % in five countries (including two countries with exactly 5 %), 5–10 % in eight countries, 10–25 % in nine countries and 25–50 % in four countries (including Romania with exactly 50 %) (Table 5.11).
- Trends for the period 2007–2010 were calculated for 22 countries. Significant increasing trends of multiresistance were observed for two countries (Malta and France), which in 2010 reported proportions of multiresistance of 28.6 % and 14.7 % respectively (Figure 5.41).
- Significant decreasing trends of multiresistance have been observed for three countries (Greece, Italy and Germany), which in 2010 reported proportions of multiresistance of 42.5 %, 20.8 %, and 9.5 %, respectively. Only for Greece did the trend remain significant when including only data from laboratories consistently reporting all four years (Figure 5.41).

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. Combined resistance is also common with 15 % of the isolates resistant to at least three antimicrobial classes (multiresistance) and with 5 % of the isolates resistant to all five antimicrobial classes under surveillance. Despite the high proportions of resistance, the situation appears generally stable in Europe with few countries reporting significant increasing or decreasing trends of resistance to different antimicrobial agents.

Figure 5.34: *Pseudomonas aeruginosa*: proportion of invasive isolates resistant to aminoglycosides in 2010

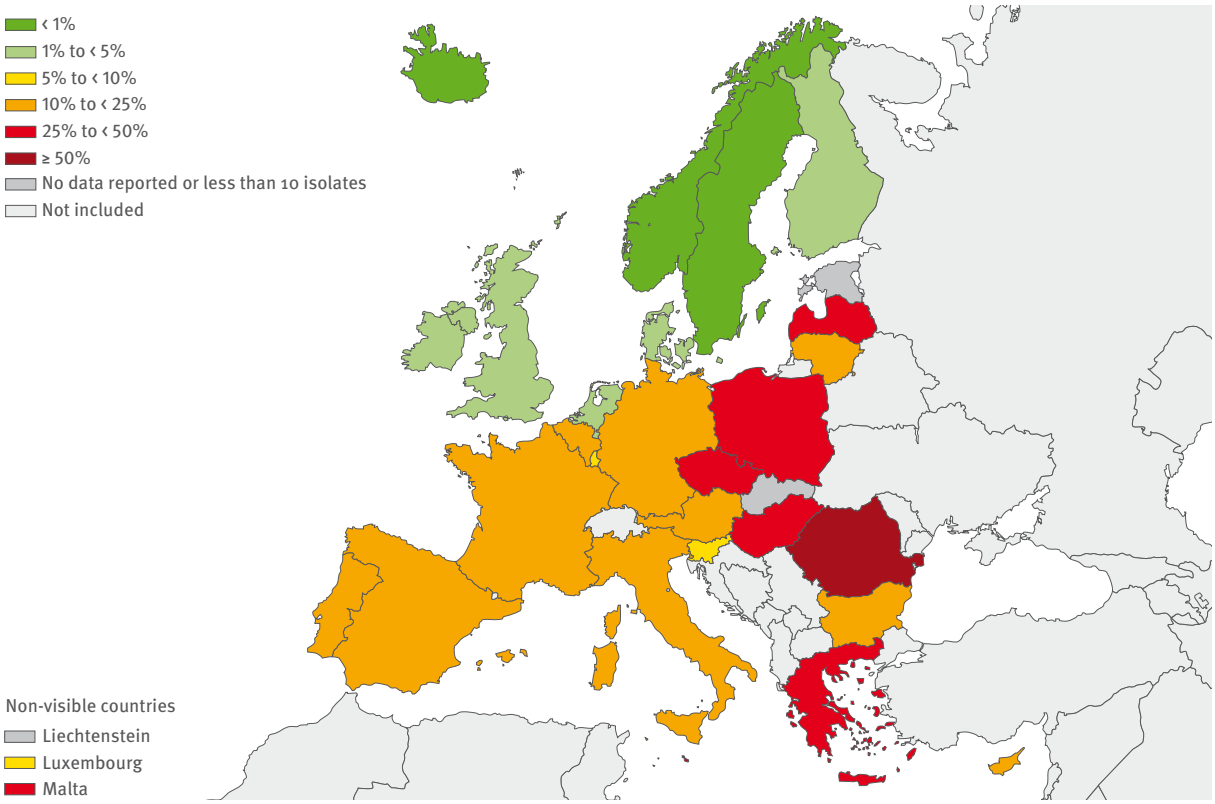


Figure 5.35: ***Pseudomonas aeruginosa*: proportion of invasive isolates resistant to carbapenems in 2010**

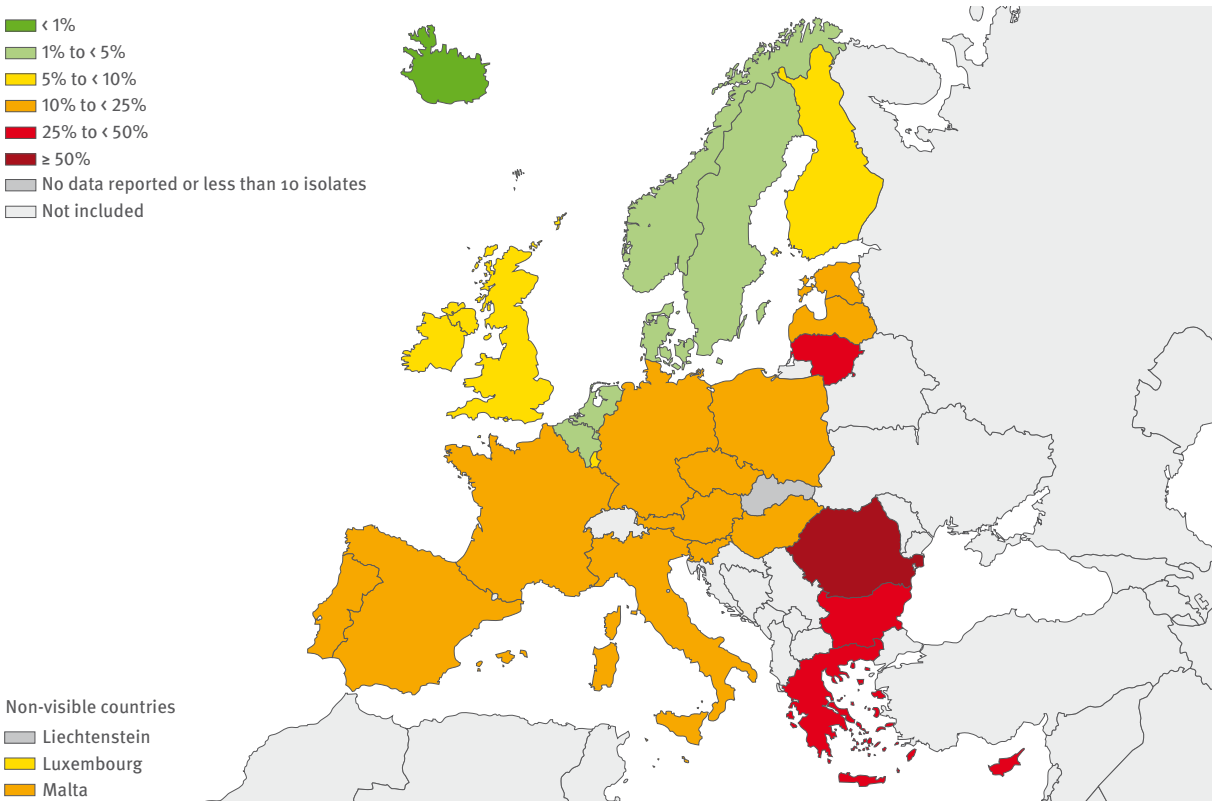
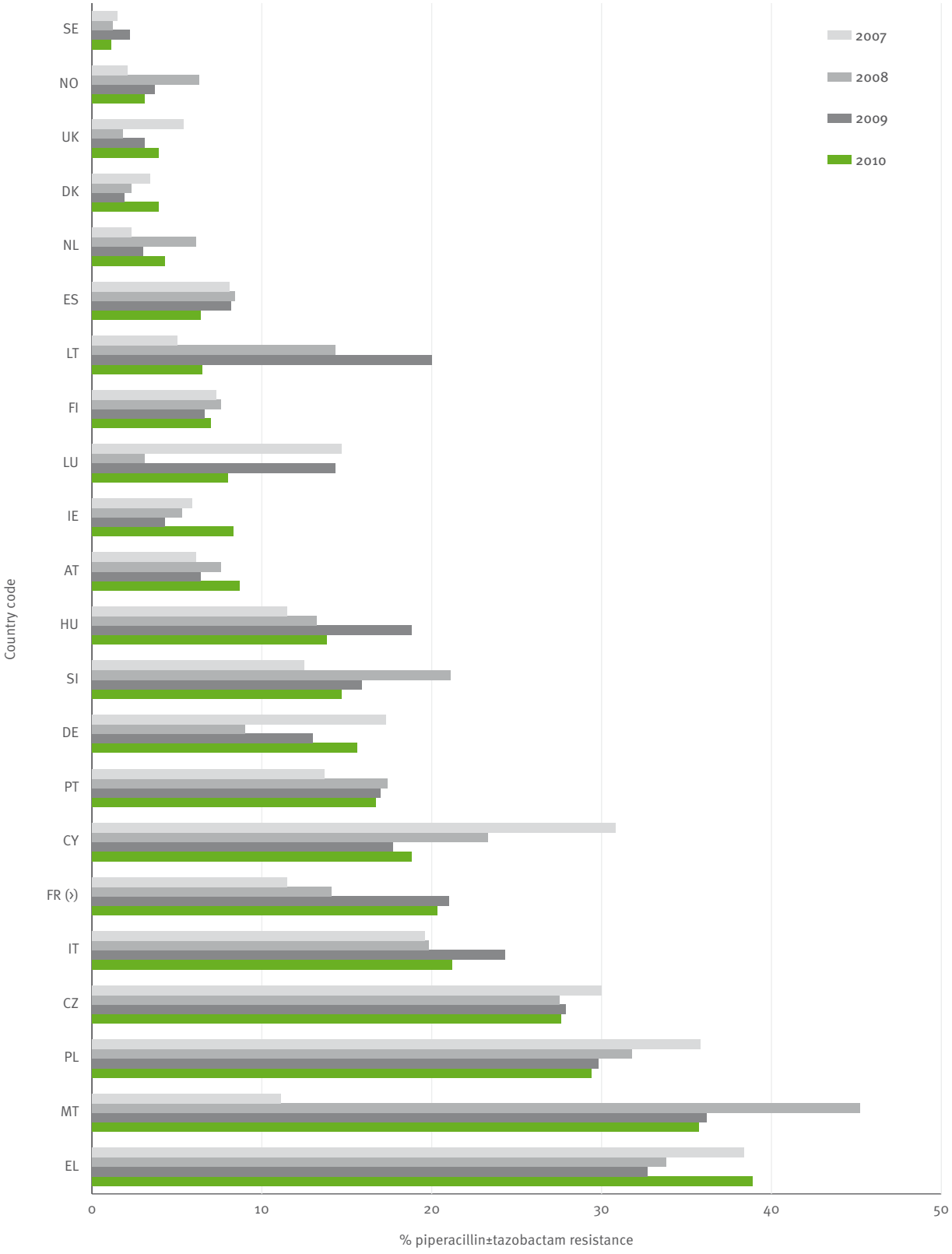


Table 5.11: Number and proportion of invasive *P. aeruginosa* isolates resistant to piperacillin±tazobactam, fluoroquinolones, ceftazidime, aminoglycosides, carbapenems and multiresistant (%R), including 95% confidence intervals (95% CI), reported per country in 2010

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	503	8.7 (6-12)	500	15.6 (13-19)	461	7.6 (5-10)	500	10.0 (8-13)	473	14.4 (11-18)	503	8.5 (6-11)
Belgium	121	11.6 (6-19)	121	12.4 (7-20)	120	6.7 (3-13)	94	13.8 (8-22)	130	4.6 (2-10)	121	5.0 (2-10)
Bulgaria	41	14.6 (6-29)	42	21.4 (10-37)	37	18.9 (8-35)	42	19.0 (9-34)	42	31.0 (18-47)	42	14.3 (5-29)
Cyprus	48	18.8 (9-33)	47	17.0 (8-31)	48	16.7 (7-30)	48	10.4 (3-23)	48	29.2 (17-44)	48	14.6 (6-28)
Czech Republic	510	27.6 (24-32)	510	40.8 (36-45)	509	28.5 (25-33)	510	32.4 (28-37)	510	16.5 (13-20)	510	29.4 (25-34)
Denmark	361	3.9 (2-6)	360	6.1 (4-9)	358	2.8 (1-5)	375	1.3 (0-3)	356	3.1 (2-5)	360	1.9 (1-4)
Estonia	7	14.3 (0-58)	9	11.1 (0-48)	8	12.5 (0-53)	9	11.1 (0-48)	41	22.0 (11-38)	9	11.1 (0-48)
Finland	270	7.0 (4-11)	280	11.1 (8-15)	281	2.8 (1-6)	270	4.1 (2-7)	275	9.8 (7-14)	281	5.3 (3-9)
France	1125	20.3 (18-23)	1181	22.8 (20-25)	1009	12.7 (11-15)	1121	18.6 (16-21)	1186	17.8 (16-20)	1191	14.7 (13-17)
Germany	315	15.6 (12-20)	315	18.4 (14-23)	309	8.1 (5-12)	315	10.2 (7-14)	311	12.5 (9-17)	315	9.5 (7-13)
Greece	998	38.9 (36-42)	985	45.7 (43-49)	967	40.2 (37-43)	994	41.8 (39-45)	999	43.1 (40-46)	981	42.5 (39-46)
Hungary	596	13.8 (11-17)	629	26.7 (23-30)	635	10.6 (8-13)	634	29.0 (26-33)	635	24.9 (22-28)	636	17.8 (15-21)
Iceland	12	8.3 (0-38)	12	16.7 (2-48)	12	8.3 (0-38)	12	0.0 (0-26)	12	0.0 (0-26)	12	8.3 (0-38)
Ireland	218	8.3 (5-13)	218	10.6 (7-15)	216	6.0 (3-10)	219	4.6 (2-8)	216	6.5 (4-11)	219	5.0 (3-9)
Italy	429	21.2 (17-25)	467	31.0 (27-35)	407	17.7 (14-22)	467	23.3 (20-27)	509	22.0 (18-26)	467	20.8 (17-25)
Latvia	21	19.0 (5-42)	21	19.0 (5-42)	21	9.5 (1-30)	21	28.6 (11-52)	21	14.3 (3-36)	21	9.5 (1-30)
Lithuania	31	6.5 (1-21)	31	16.1 (5-34)	31	9.7 (2-26)	31	12.9 (4-30)	30	26.7 (12-46)	31	9.7 (2-26)
Luxembourg	25	8.0 (1-26)	25	20.0 (7-41)	25	0.0 (0-14)	25	8.0 (1-26)	25	8.0 (1-26)	25	8.0 (1-26)
Malta	42	35.7 (22-52)	42	23.8 (12-39)	42	14.3 (5-29)	42	31.0 (18-47)	42	23.8 (12-39)	42	28.6 (16-45)
Netherlands	374	4.3 (2-7)	375	4.3 (2-7)	372	2.7 (1-5)	376	2.4 (1-4)	371	2.7 (1-5)	375	1.1 (0-3)
Norway	163	3.1 (1-7)	165	3.6 (1-8)	162	2.5 (1-6)	167	0.6 (0-3)	168	1.2 (0-4)	167	0.6 (0-3)
Poland	163	29.4 (23-37)	158	27.8 (21-36)	151	21.9 (16-29)	145	29.7 (22-38)	167	24.6 (18-32)	163	23.3 (17-31)
Portugal	215	16.7 (12-22)	203	21.2 (16-27)	216	12.0 (8-17)	216	13.9 (10-19)	203	16.3 (11-22)	217	13.8 (10-19)
Romania	8	62.5 (24-91)	9	55.6 (21-86)	10	60.0 (26-88)	10	50.0 (19-81)	10	70.0 (35-93)	10	50.0 (19-81)
Slovenia	95	14.7 (8-23)	95	9.5 (4-17)	95	5.3 (2-12)	93	8.6 (4-16)	89	19.1 (12-29)	95	9.5 (4-17)
Spain	749	6.4 (5-8)	749	24.8 (22-28)	749	7.5 (6-10)	749	18.2 (15-21)	749	17.8 (15-21)	749	12.3 (10-15)
Sweden	272	1.1 (0-3)	317	6.3 (4-10)	311	2.9 (1-5)	278	0.0 (0-1)	337	4.5 (3-7)	329	0.3 (0-2)
United Kingdom	491	3.9 (2-6)	568	6.7 (5-9)	533	4.9 (3-7)	575	1.9 (1-3)	493	6.5 (4-9)	566	2.1 (1-4)

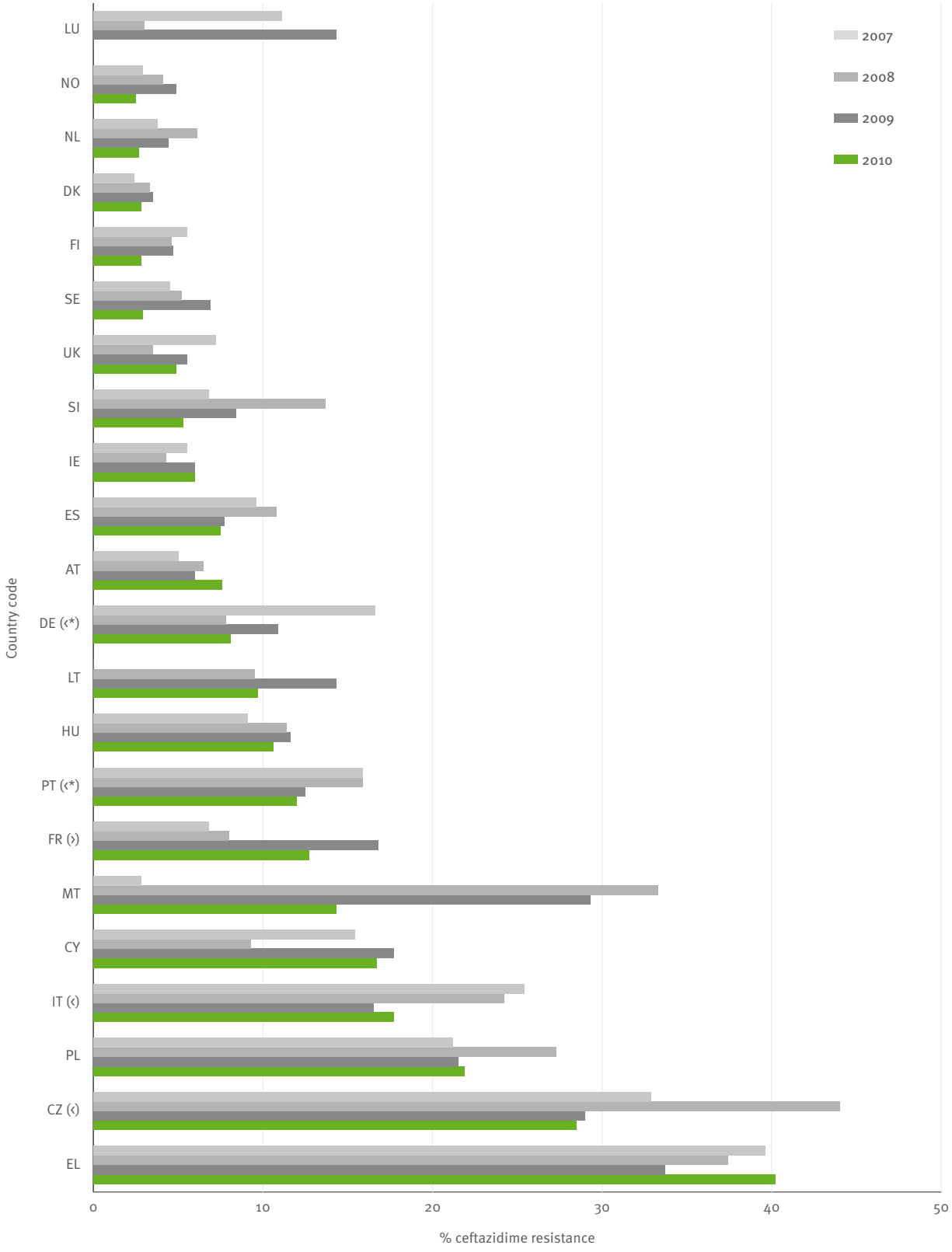
* Multiresistance defined as being resistant to three or more antibiotic classes among piperacillin±tazobactam, ceftazidime, fluoroquinolones, aminoglycosides and carbapenems.

Figure 5.36: ***Pseudomonas aeruginosa*: trends of resistance to piperacillin±tazobactam by country, 2007–2010**



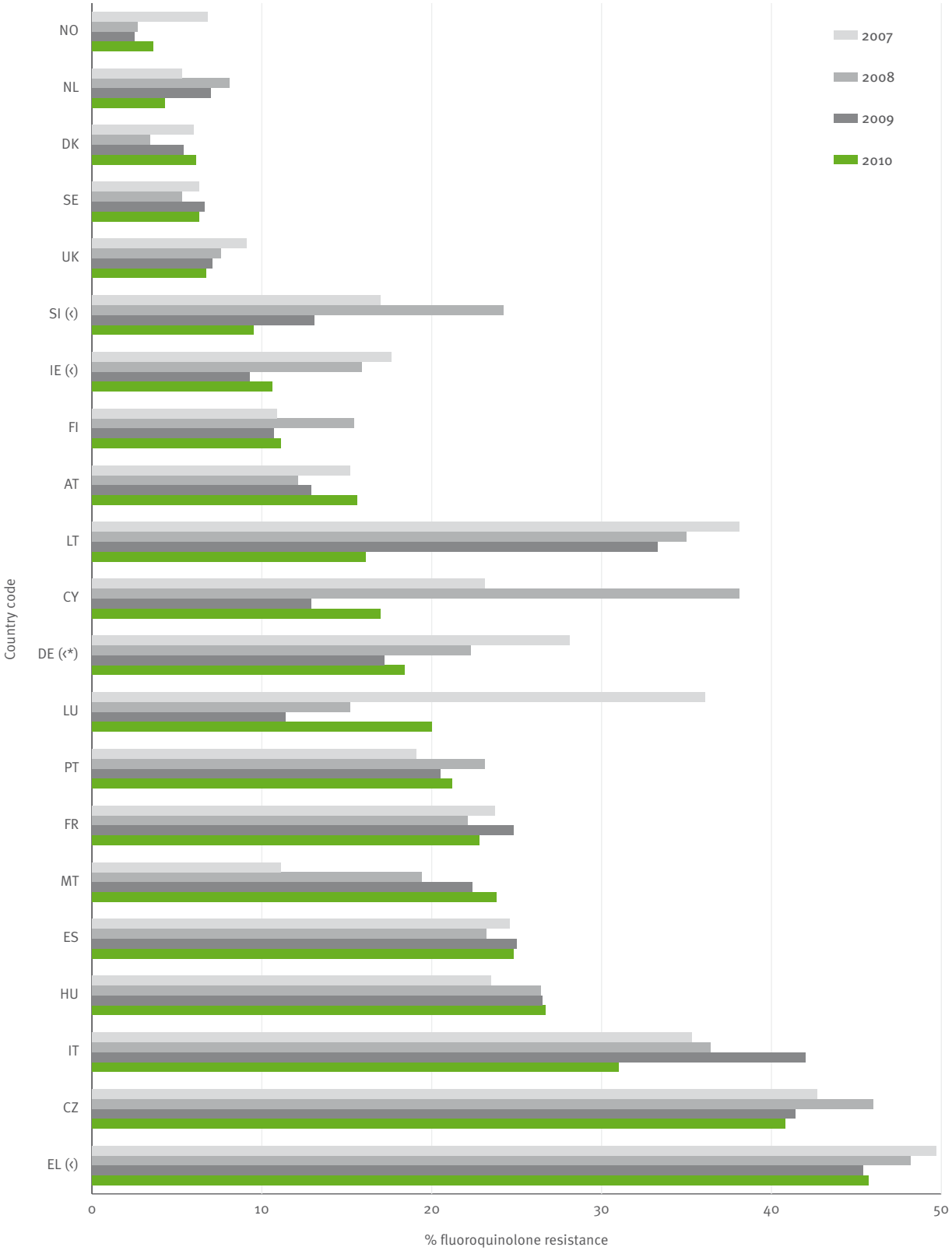
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, respectively.

Figure 5.37: ***Pseudomonas aeruginosa*: trends of resistance to ceftazidime by country, 2007–2010**



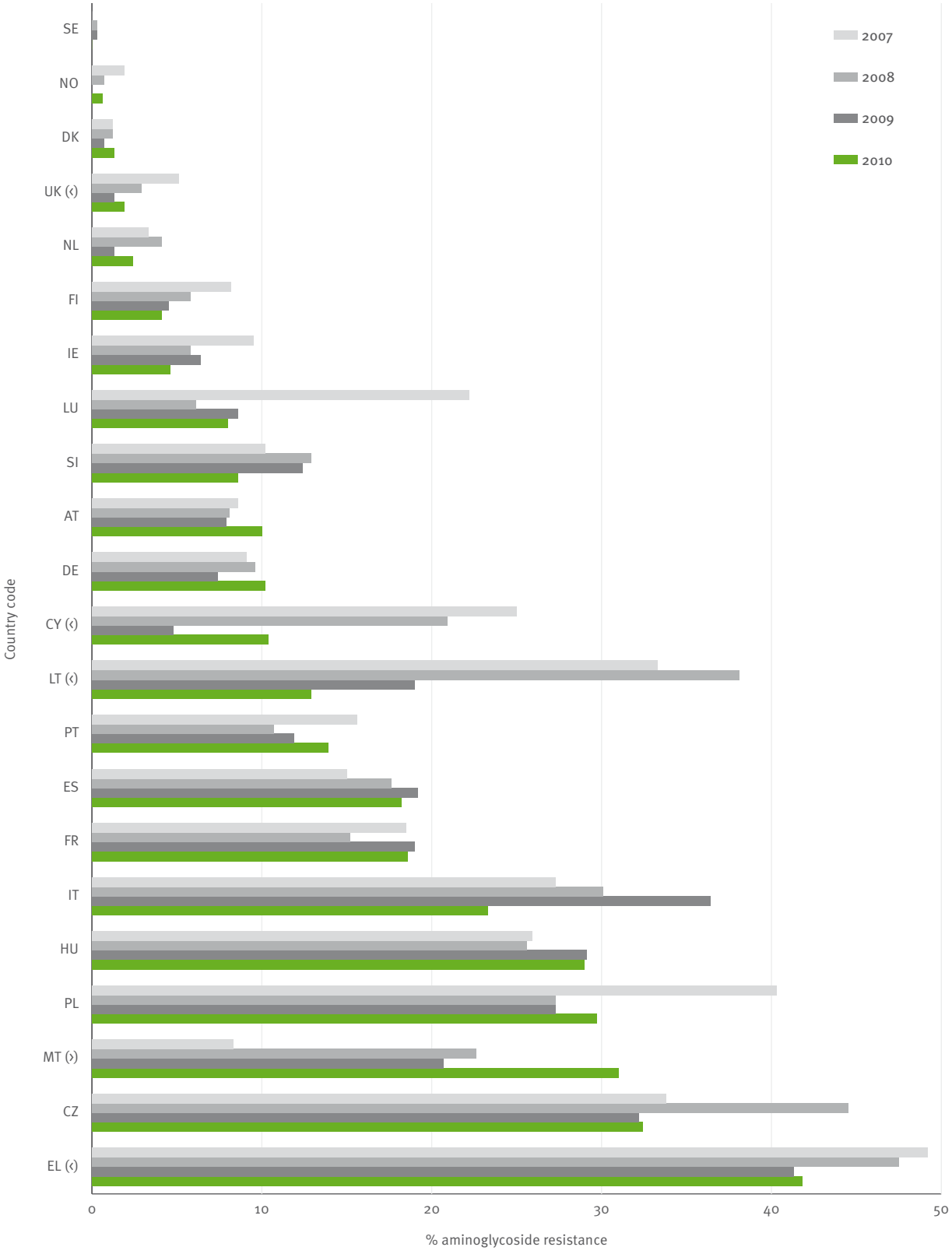
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for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

Figure 5.38: ***Pseudomonas aeruginosa*: trends of resistance to fluoroquinolones by country, 2007–2010**



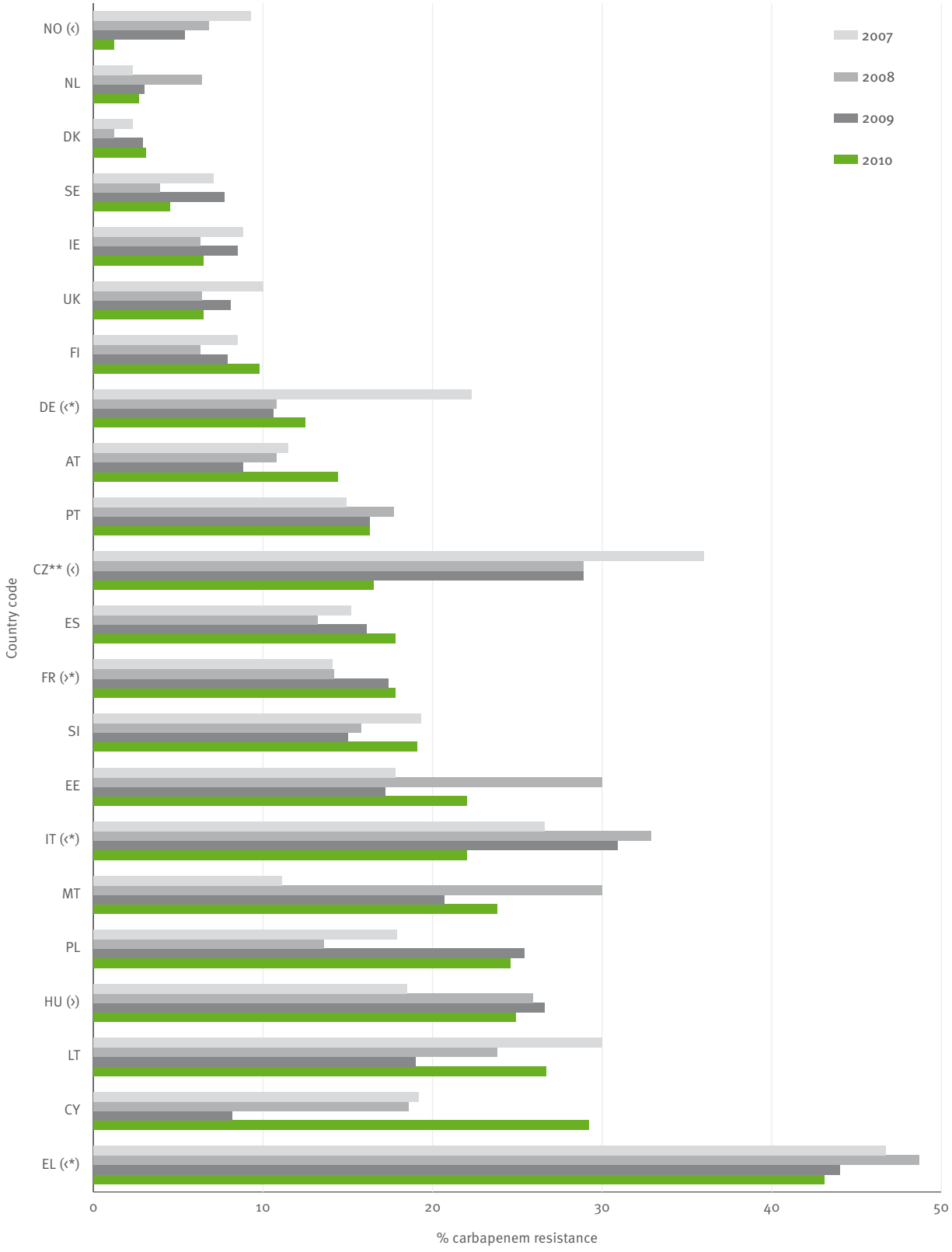
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for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

Figure 5.39: ***Pseudomonas aeruginosa*: trends of resistance to aminoglycosides by country, 2007–2010**



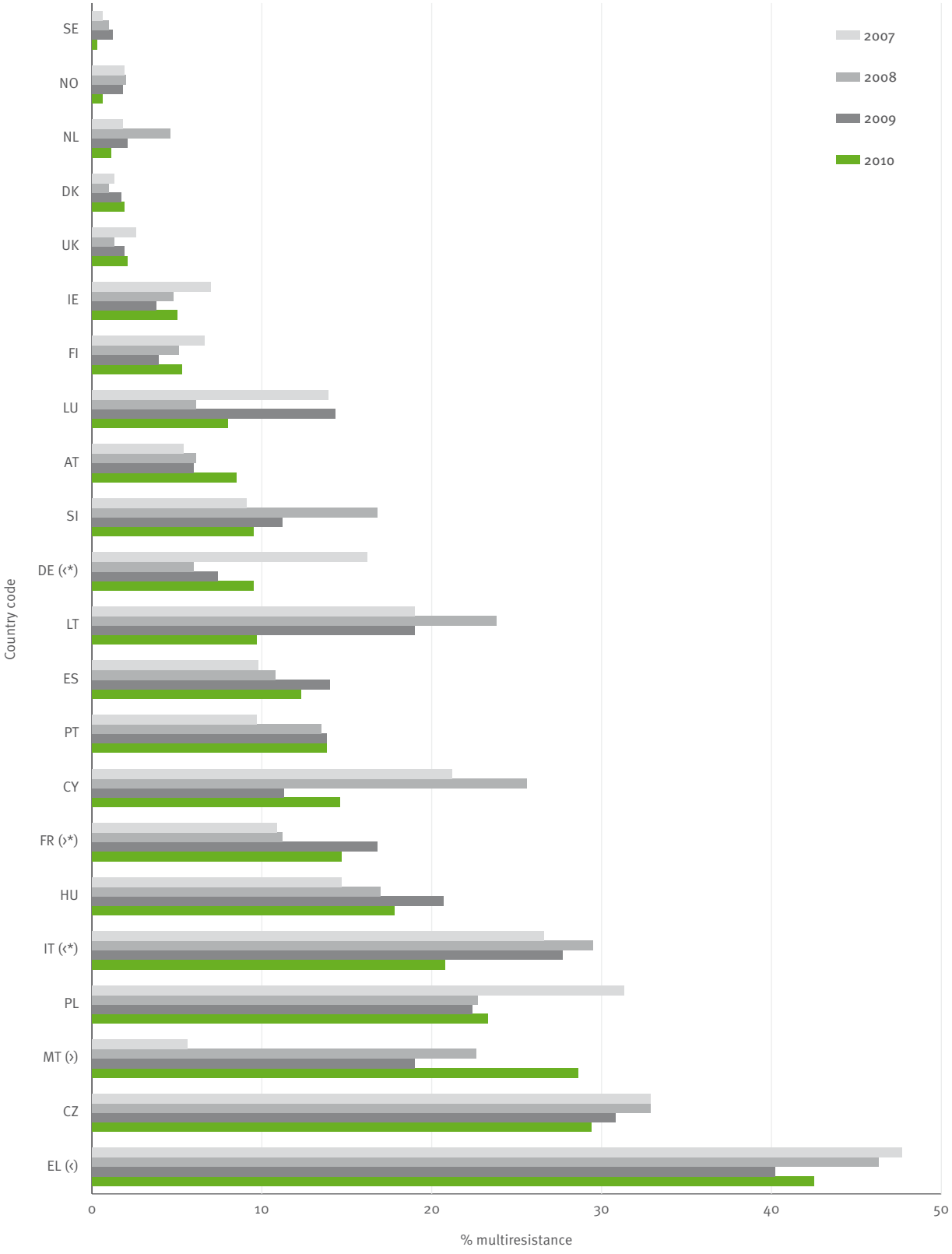
Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, respectively.

Figure 5.40: ***Pseudomonas aeruginosa*****: trends of resistance to carbapenems by country, 2007–2010**



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The asterisks indicate significant trends in the overall data that were not supported by data from laboratories consistently reporting for all four years.
** For Czech Republic there is a decreasing trend, but the drop in 2010 was caused by the adoption of the new EUCAST breakpoints.

Figure 5.41: ***Pseudomonas aeruginosa*: trends of multiresistance (R to three or more antibiotic classes among piperacillin±tazobactam, ceftazidime, fluoroquinolones, aminoglycosides and carbapenems) by country, 2007–2010**



Only countries that reported 20 isolates or more per year were included. The symbols › and ‹ indicate significant increasing and decreasing trends, 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 5.12: 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= 8 485) in Europe, 2010

Resistance pattern	Number of isolates	% of total
Fully susceptible (to the tested drugs)	5 684	67
Resistance to one class of antimicrobial drugs		
Fluoroquinolones	351	4.1
Carbapenems	300	3.5
Aminoglycosides	124	1.5
Ceftazidime	115	1.4
Piperacillin(±tazobactam)	60	0.7
Resistance to two classes of antimicrobial drugs		
Fluoroquinolones + aminoglycosides	207	2.4
Piperacillin(±tazobactam) + ceftazidime	138	1.6
Fluoroquinolones + carbapenems	88	1
Piperacillin(±tazobactam) + fluoroquinolones	30	0.4
Piperacillin(±tazobactam) + carbapenems	29	0.3
Piperacillin(±tazobactam) + aminoglycosides	23	0.3
Aminoglycosides + carbapenems	17	0.2
Ceftazidime + carbapenems	17	0.2
Fluoroquinolones + ceftazidime	8	0.1
Ceftazidime + aminoglycosides	4	0
Resistance to three classes of antimicrobial drugs		
Fluoroquinolones + aminoglycosides + carbapenems	168	2
Piperacillin(±tazobactam) + fluoroquinolones + aminoglycosides	74	0.9
Piperacillin(±tazobactam) + ceftazidime + carbapenems	49	0.6
Piperacillin(±tazobactam) + fluoroquinolones + ceftazidime	35	0.4
Fluoroquinolones + ceftazidime + aminoglycosides	32	0.4
Piperacillin(±tazobactam) + fluoroquinolones + carbapenems	19	0.2
Fluoroquinolones + ceftazidime + carbapenems	18	0.2
Piperacillin(±tazobactam) + aminoglycosides + carbapenems	12	0.1
Piperacillin(±tazobactam) + ceftazidime + aminoglycosides	9	0.1
Ceftazidime + aminoglycosides + carbapenems	4	0
Resistance to four classes of antimicrobial drugs		
Piperacillin(±tazobactam) + fluoroquinolones + aminoglycosides + carbapenems	145	1.7
Fluoroquinolones + ceftazidime + aminoglycosides + carbapenems	115	1.4
Piperacillin(±tazobactam) + fluoroquinolones + ceftazidime + aminoglycosides	81	1
Piperacillin(±tazobactam) + fluoroquinolones + ceftazidime + carbapenems	61	0.7
Piperacillin(±tazobactam) + ceftazidime + aminoglycosides + carbapenems	23	0.3
Resistance to five classes of antimicrobial drugs		
Piperacillin(±tazobactam) + fluoroquinolones + ceftazidime + aminoglycosides + carbapenems	445	5.2

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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 fewer 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 pathogen–antimicrobial 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 2003–2010.

Antibiotic resistance 2003–2010

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 2009–2010.

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 <1.

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 2009 and 2010, 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 2003–2010

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	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
2010	35	375	39	1840	39	2937	39	944	39	722	39	504

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	1	1	<1	<1	2	<1	3	2
Penicillin RI	9	5	5	5	5	5	5	4
Macrolides RI	13	13	15	13	13	12	14	11
Staphylococcus aureus								
Oxacillin/Meticillin R	15	14	14	9	11	8	6	7
Escherichia coli								
Aminopenicilins R	41	46	49	53	53	50	49	51
Aminoglycosides R	5	6	6	8	8	7	6	6
Fluoroquinolones R	14	17	19	22	26	23	20	21
Third-gen. cephalosporins R	2	3	4	7	9	7	8	7
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	1	<1	1	2	2	2	1	2
HL Gentamicin R	33	23	29	29	30	21	31	32
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	85	85	85	89	82	91	88	92
HL Gentamicin R	22	22	30	21	28	19	31	42
Vancomycin R	<1	<1	1	<1	2	2	4	4
Klebsiella pneumoniae								
Aminoglycosides R	-	-	3	5	5	6	4	6
Fluoroquinolones R	-	-	11	8	13	12	8	18
Third-gen. cephalosporins R	-	-	6	6	8	8	8	13
Carbapenems R	-	-	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	13	8	6	8	6	9
Ceftazidime R	-	-	7	9	5	6	6	8
Carbapenems R	-	-	10	15	12	11	9	14
Aminoglycosides R	-	-	6	9	9	8	8	10
Fluoroquinolones R	-	-	14	15	15	12	13	16

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=703		*S. aureus* n=3552		*E. coli* n=5541		*E. faecalis* n=1083		*E. faecium* n=664		*K. pneumoniae* n=1335		*P. aeruginosa* n=986	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	97	4	100	7	100	21	100	1	100	4	100	10	100	11
CSF	3	13	-	-	<1	67	-	-	-	-	<1	33	<1	0
Gender														
Male	56	5	58	7	41	25	61	1	60	5	54	13	59	11
Female	44	3	41	6	58	18	38	0	39	3	45	7	39	12
Unknown	<1	0	1	13	1	29	1	0	1	0	1	10	1	21
Age (years)														
0–4	6	5	1	4	1	6	3	0	1	0	1	18	1	0
5–19	4	3	2	7	1	11	<1	0	1	0	1	0	1	0
20–64	41	4	33	5	26	20	31	1	36	5	32	12	31	16
65 and over	49	4	64	8	72	21	66	0	62	4	66	10	67	10
Hospital department														
ICU	19	7	10	9	8	25	15	1	27	6	13	13	16	18
Internal med.	50	4	47	6	54	19	39	1	34	3	41	9	34	9
Surgery	2	0	9	14	6	18	9	1	11	4	9	12	9	9
Other	27	4	29	6	28	24	31	0	25	4	33	11	37	13
Unknown	2	0	5	4	4	18	6	0	4	4	5	3	4	5

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. pneumoniae* by laboratory (2009–2010)

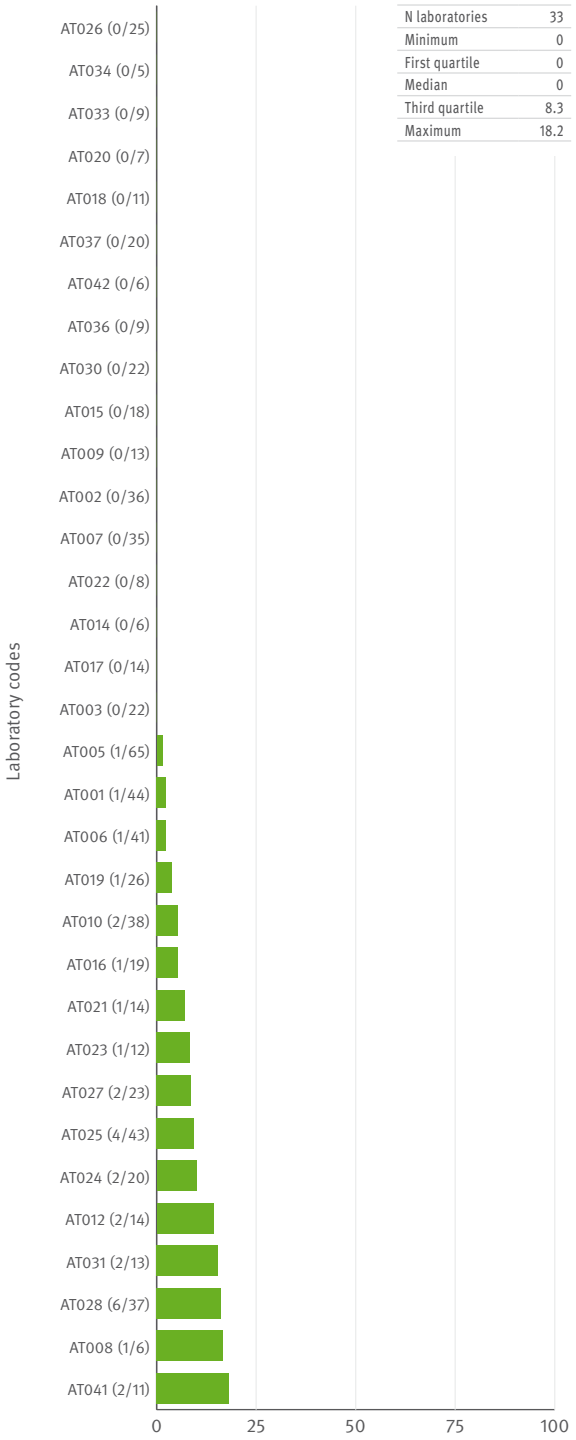


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

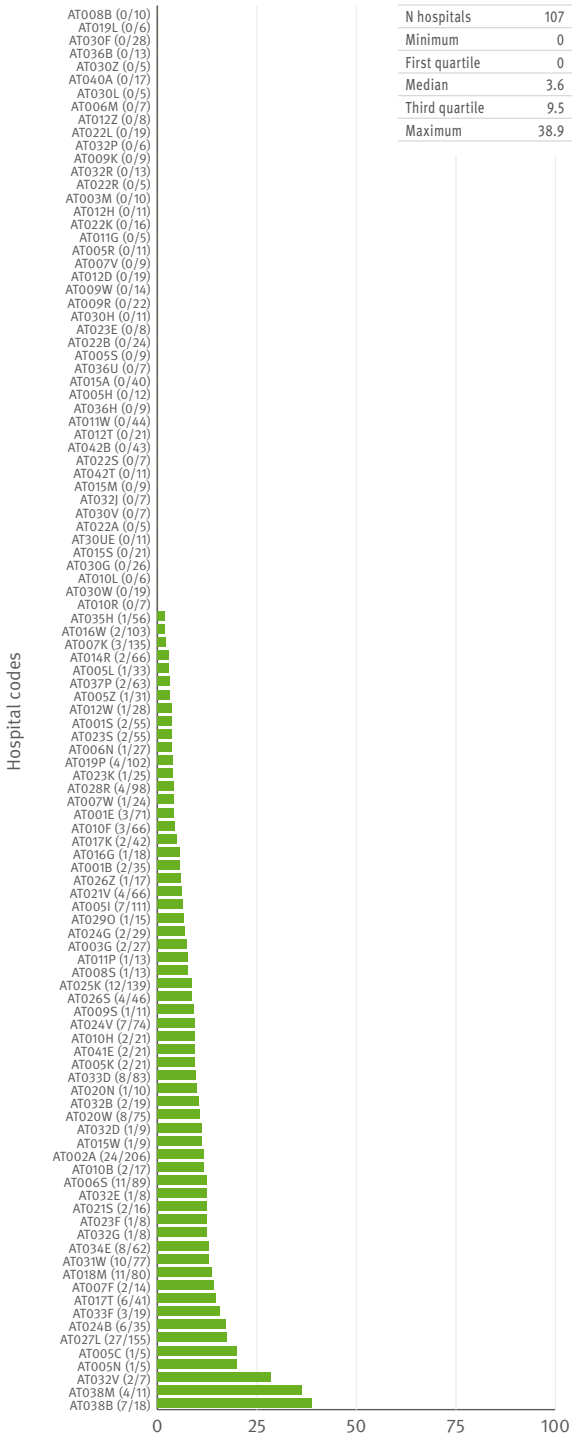


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

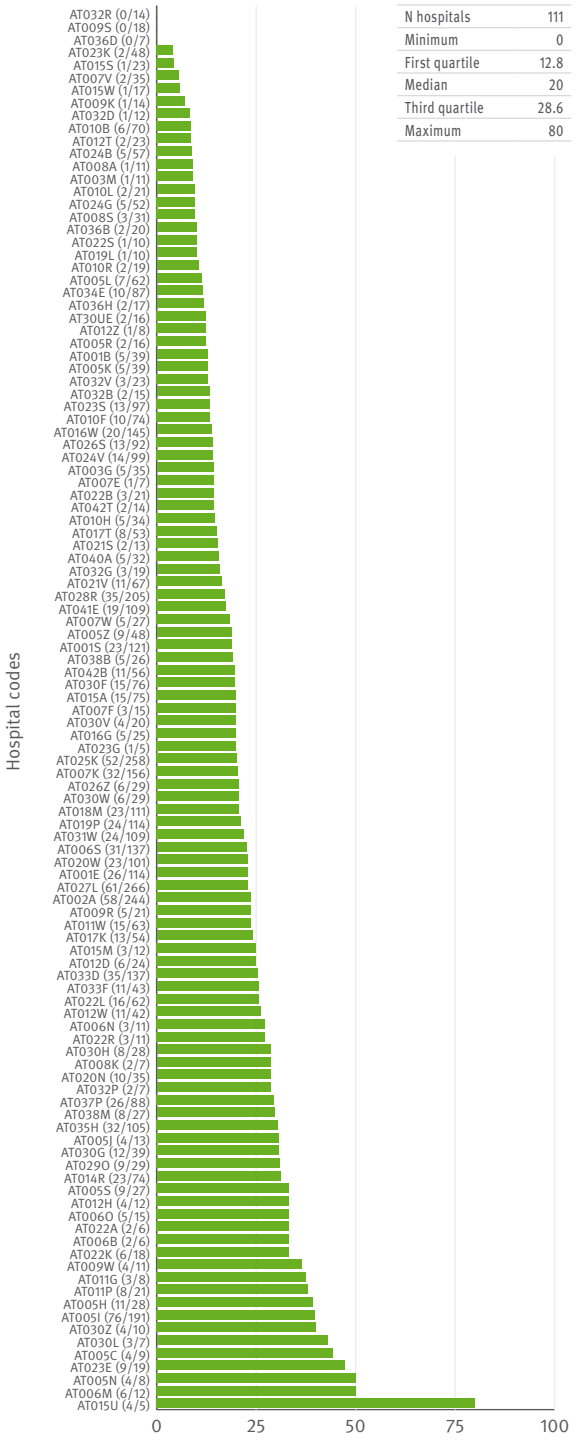
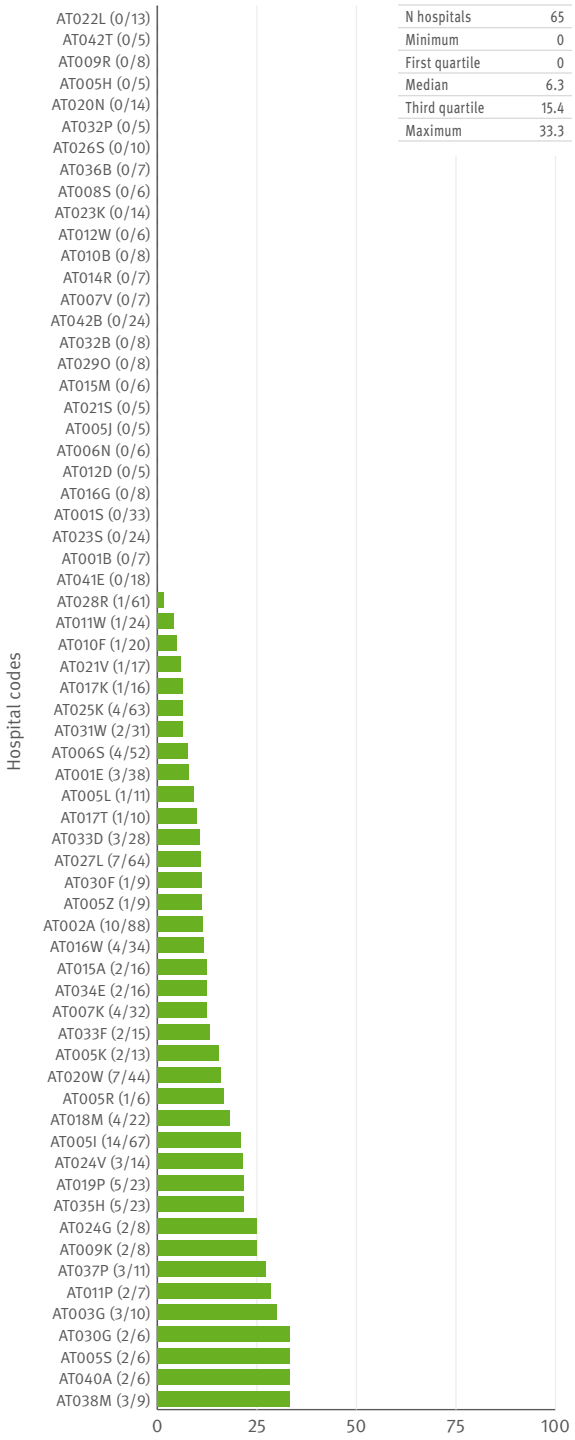


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Belgium

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	97	1797	40	1088	23	1966	22	323	14	145	15	130

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	<1	<1	3	4	3	<1	<1	<1
Penicillin RI	12	9	12	10	9	8	<1	<1
Macrolides RI	34	33	31	31	25	24	23	25
Staphylococcus aureus								
Oxacillin/Meticillin R	30	33	31	22	23	21	21	21
Escherichia coli								
Aminopenicilins R	50	50	53	54	57	55	56	57
Aminoglycosides R	5	5	4	6	5	4	7	6
Fluoroquinolones R	12	15	17	19	19	17	20	22
Third-gen. cephalosporins R	3	3	4	3	4	4	6	5
Carbapenems R	-	-	-	-	-	-	-	<1
Enterococcus faecalis								
Aminopenicilins RI	1	2	<1	<1	<1	3	1	2
HL Gentamicin R	17	22	26	30	26	30	23	18
Vancomycin R	1	<1	<1	<1	1	<1	1	<1
Enterococcus faecium								
Aminopenicilins RI	78	63	61	67	68	76	90	89
HL Gentamicin R	<1	11	22	19	23	17	32	30
Vancomycin R	<1	5	14	4	<1	5	4	3
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	-	-	-	10	2
Fluoroquinolones R	-	-	-	-	-	-	13	13
Third-gen. cephalosporins R	-	-	-	-	-	-	15	13
Carbapenems R	-	-	-	-	-	-	1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	-	-	-	7	12
Ceftazidime R	-	-	-	-	-	-	6	7
Carbapenems R	-	-	-	-	-	-	9	5
Aminoglycosides R	-	-	-	-	-	-	10	14
Fluoroquinolones R	-	-	-	-	-	-	16	12

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=3 682		*S. aureus* n=2 006		*E. coli* n=3 286		*E. faecalis* n=389		*E. faecium* n=146		*K. pneumoniae* n=285		*P. aeruginosa* n=264	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	96	0	100	21	100	21	100	1	100	3	100	14	100	7
CSF	4	8	-	-	<1	0	-	-	-	-	<1	0	<1	0
Gender														
Male	55	0	62	22	46	24	64	1	56	5	57	13	68	4
Female	44	0	37	19	53	18	35	0	42	2	42	15	32	13
Unknown	1	0	1	7	<1	40	1	0	1	0	<1	0	-	-
Age (years)														
0–4	17	1	4	16	2	11	3	0	1	0	5	13	3	0
5–19	5	1	2	9	1	26	<1	0	-	-	-	-	2	0
20–64	37	0	34	17	30	17	28	0	33	2	29	15	25	9
65 and over	41	0	59	24	67	23	68	1	64	4	65	13	71	6
Unknown	-	-	-	-	-	-	1	0	1	0	-	-	-	-
Hospital department														
ICU	7	1	1	4	1	37	7	0	7	0	-	-	-	-
Internal med.	15	0	2	16	1	27	10	3	10	0	-	-	-	-
Surgery	1	0	1	27	<1	29	3	0	1	0	-	-	-	-
Other	15	0	5	16	1	67	5	0	7	0	-	-	-	-
Unknown	63	0	91	21	97	20	75	0	76	5	100	14	100	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*.

Belgium

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumoniae* by laboratory (2009–2010)

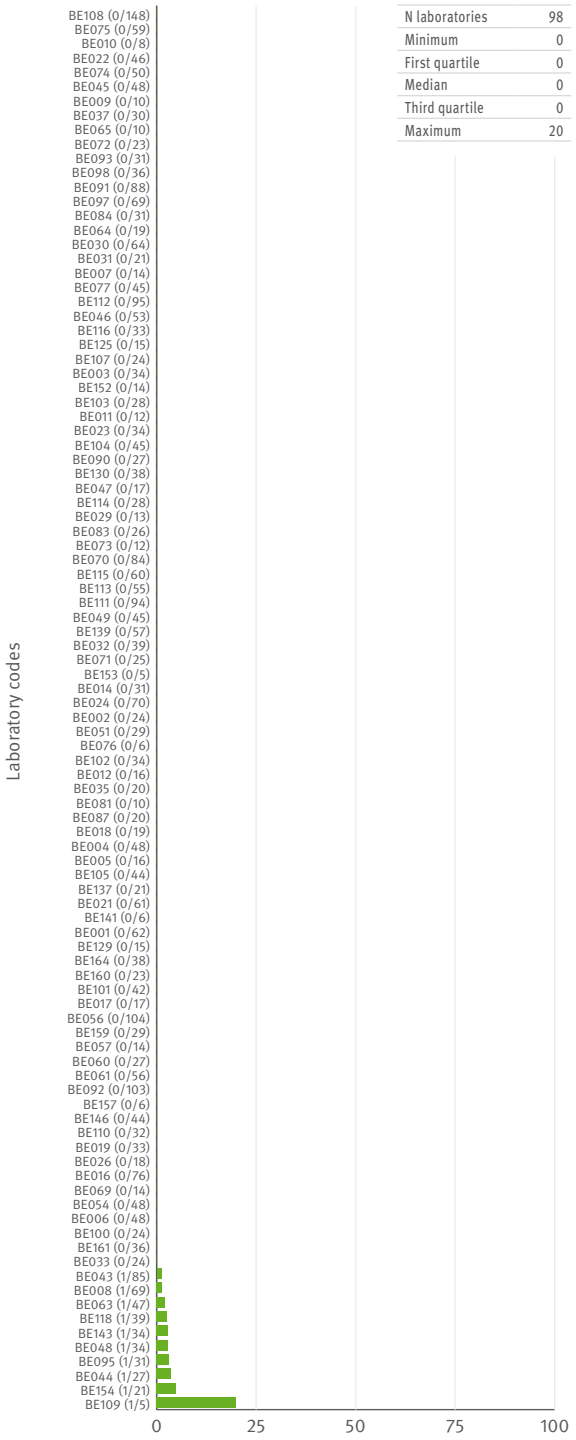


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

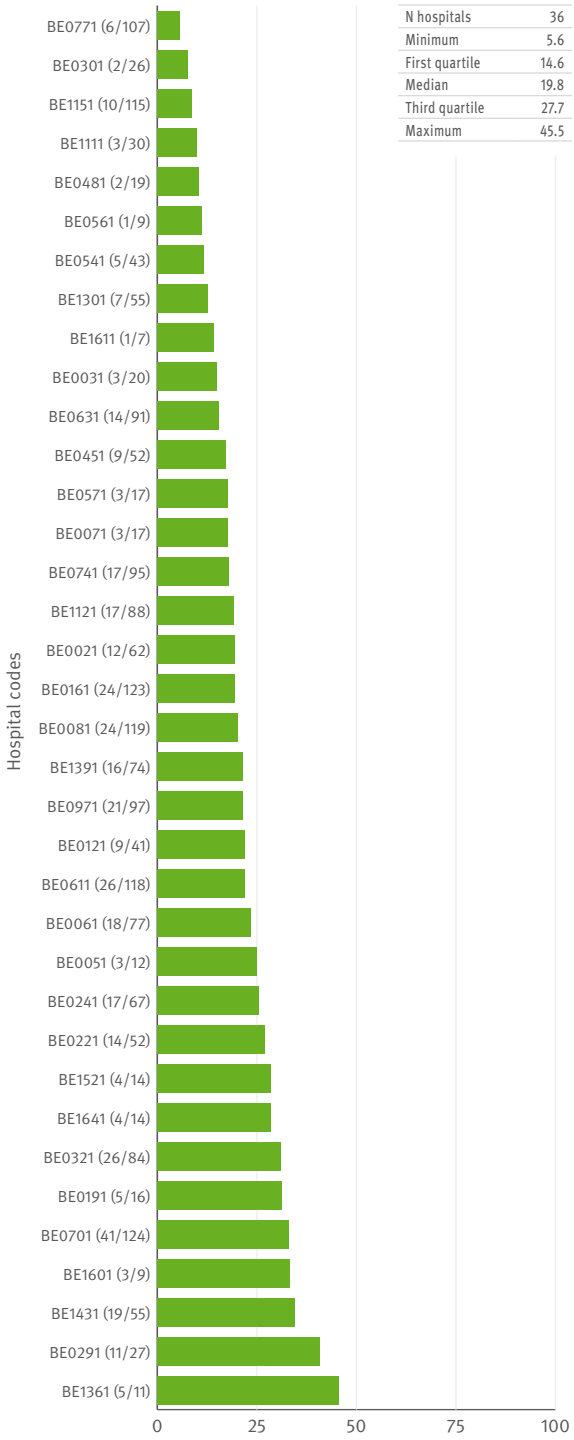


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

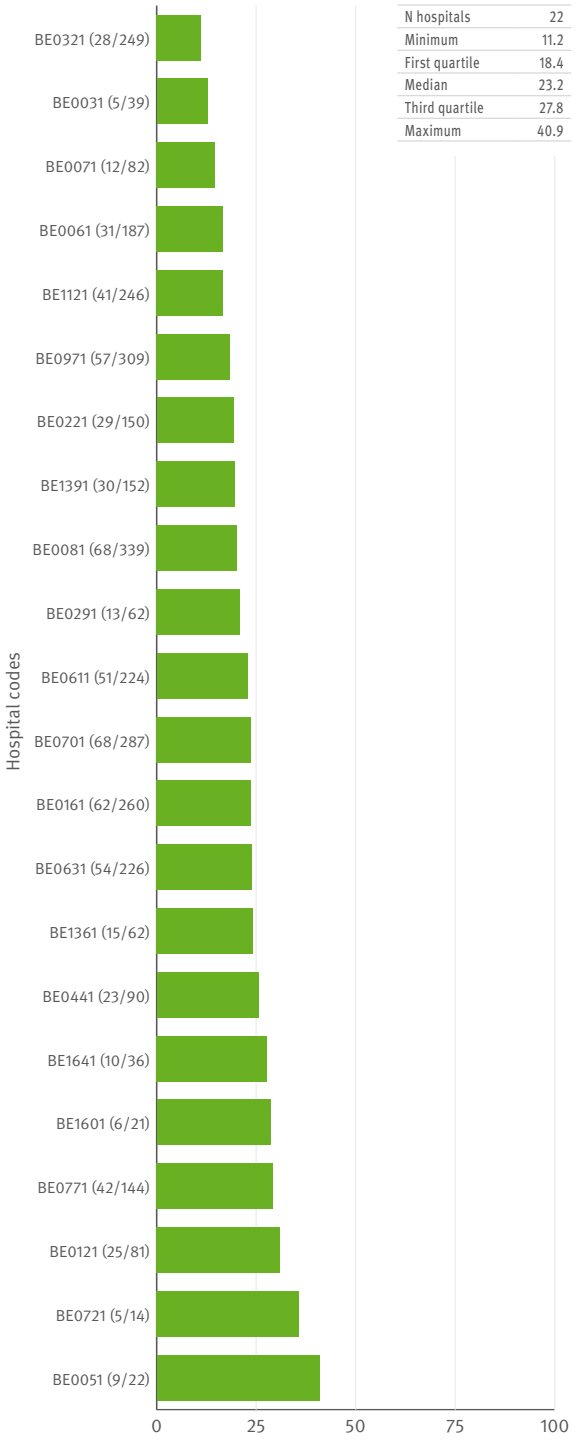
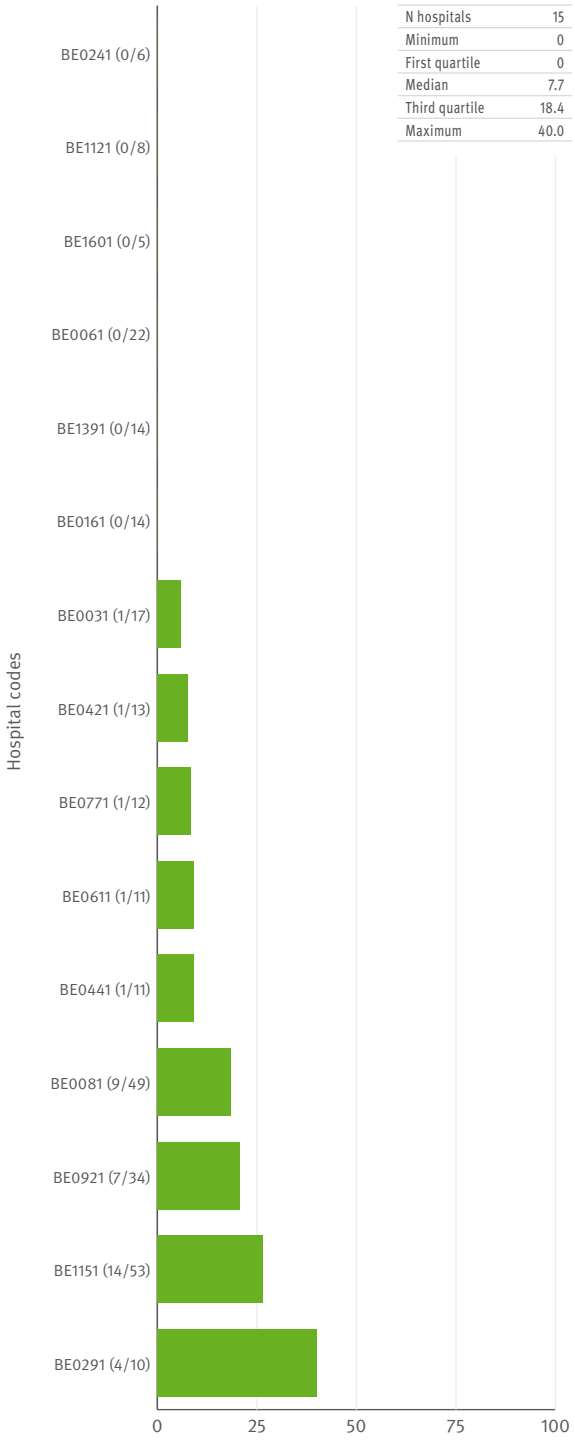


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Bulgaria

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	13	22	20	200	21	153	16	108	15	127	11	42

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	9	22	30	7	9	21	22	18
Penicillin RI	14	22	33	7	16	21	37	18
Macrolides RI	11	17	8	15	17	4	27	25
Staphylococcus aureus								
Oxacillin/Meticillin R	31	23	29	28	13	25	16	19
Escherichia coli								
Aminopenicilins R	54	64	69	64	70	65	66	72
Aminoglycosides R	22	20	24	28	20	31	18	16
Fluoroquinolones R	19	24	29	26	35	32	28	33
Third-gen. cephalosporins R	18	22	28	29	23	29	19	25
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	7	15	8	31	13	8	16	5
HL Gentamicin R	36	33	24	53	29	44	36	41
Vancomycin R	<1	2	<1	2	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	60	59	96	97	100	93	96	100
HL Gentamicin R	60	62	56	79	75	84	65	71
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	53	60	59	59	65	69
Fluoroquinolones R	-	-	26	24	41	52	48	52
Third-gen. cephalosporins R	-	-	50	60	55	73	69	76
Carbapenems R	-	-	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	50	33	14	48	33	15
Ceftazidime R	-	-	45	13	21	55	23	19
Carbapenems R	-	-	38	14	7	17	24	31
Aminoglycosides R	-	-	53	42	29	48	33	19
Fluoroquinolones R	-	-	47	17	14	36	33	21

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=49		*S. aureus* n=421		*E. coli* n=344		*E. faecalis* n=143		*E. faecium* n=49		*K. pneumoniae* n=222		*P. aeruginosa* n=76	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	65	34	100	17	99	31	100	0	100	0	100	73	97	27
CSF	35	18	-	-	1	0	-	-	-	-	<1	0	3	50
Gender														
Male	59	28	65	19	48	34	66	0	67	0	64	68	64	22
Female	41	30	35	13	52	27	34	0	33	0	36	81	36	37
Unknown	-	-	<1	100	-	-	-	-	-	-	-	-	-	-
Age (years)														
0–4	18	44	5	45	2	17	7	0	10	0	13	83	11	25
5–19	4	50	4	25	2	0	1	0	4	0	3	83	-	-
20–64	45	23	47	14	43	32	44	0	47	0	36	73	51	23
65 and over	24	25	32	19	41	30	37	0	27	0	29	70	25	21
Unknown	8	25	12	12	13	32	11	0	12	0	20	68	13	60
Hospital department														
ICU	14	14	17	27	13	30	22	0	43	0	22	76	29	50
Internal med.	27	31	41	9	49	26	30	0	10	0	19	42	18	7
Surgery	-	-	9	32	10	42	13	0	16	0	18	90	11	25
Other	59	31	33	18	28	33	36	0	31	0	41	79	42	22

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. pneumoniae* by laboratory (2009–2010)

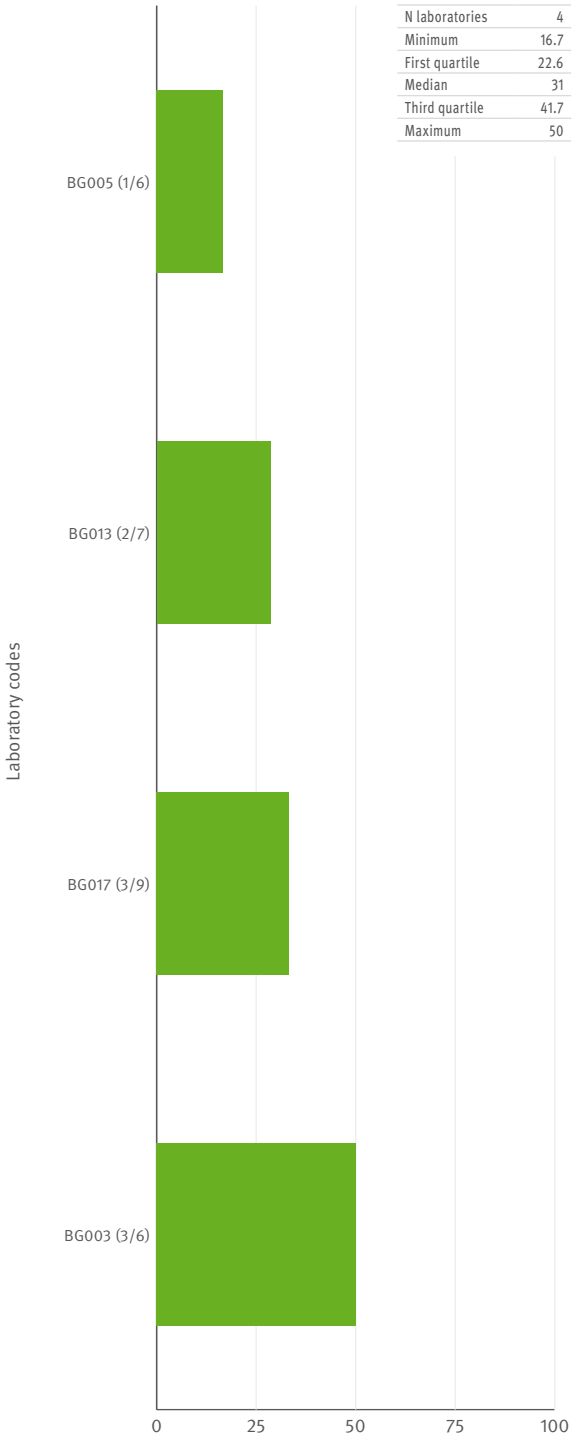


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

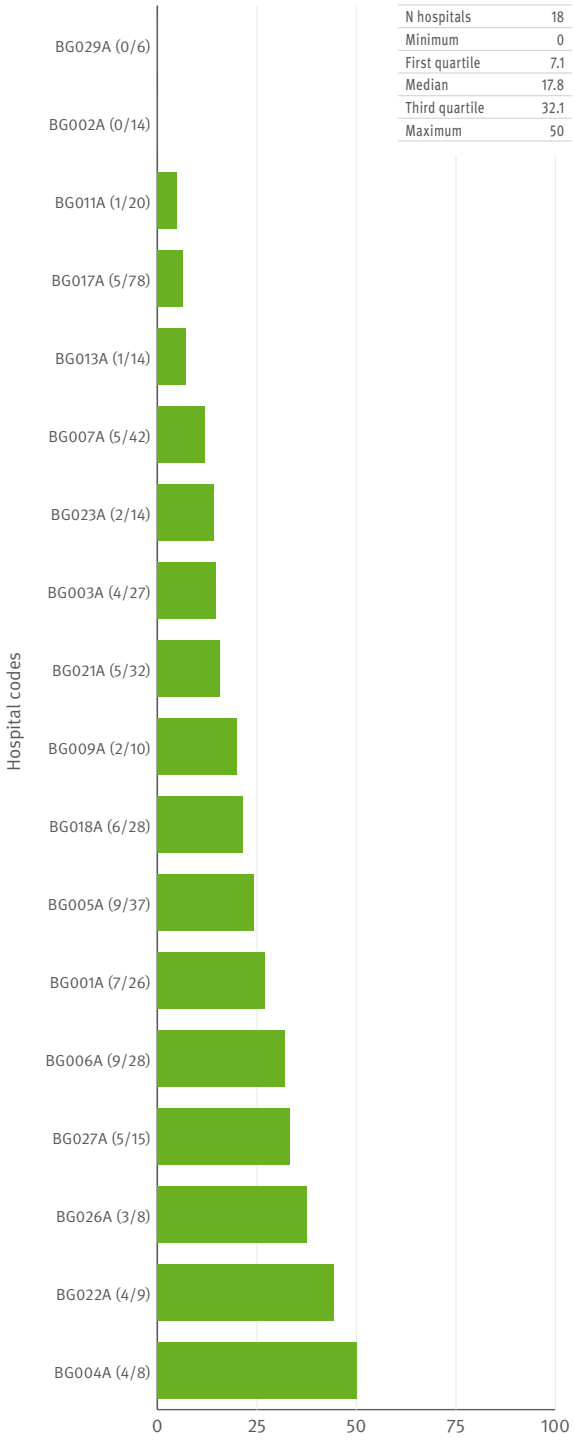


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

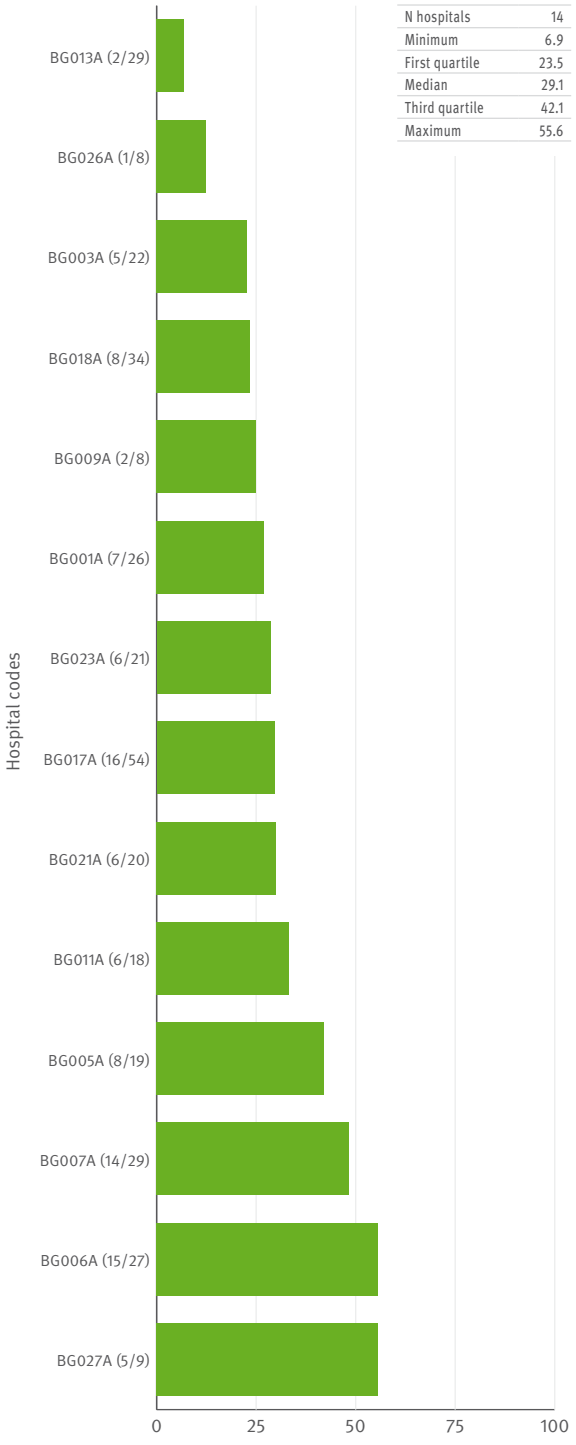
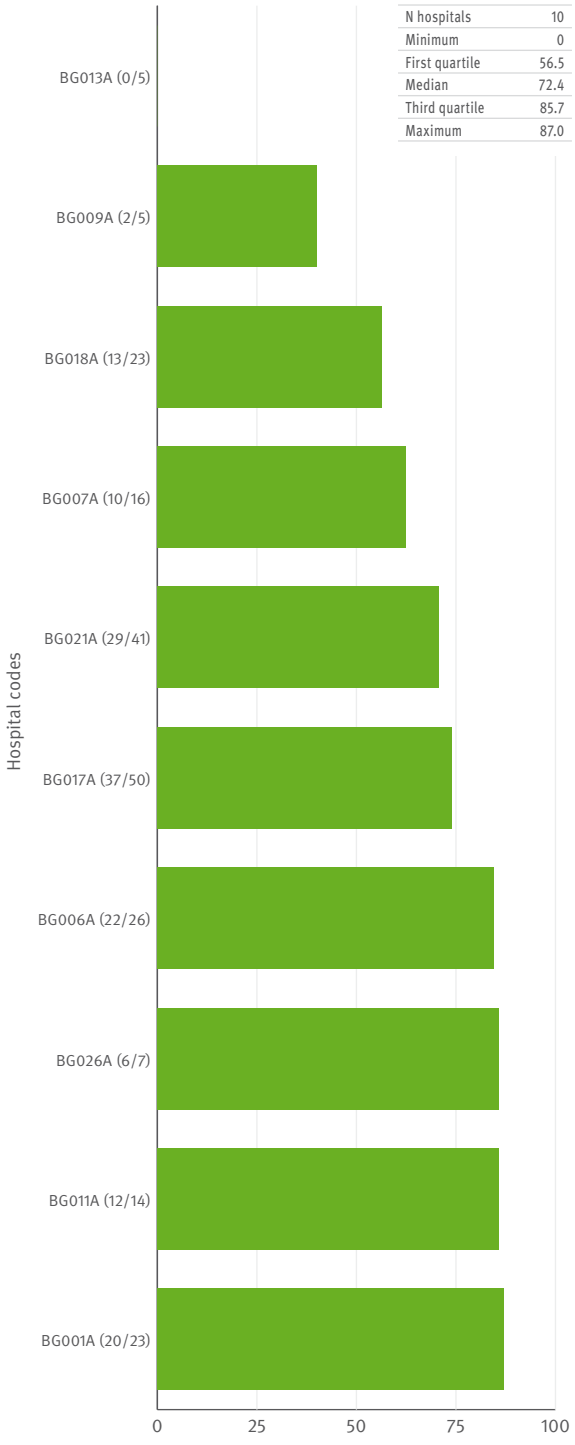


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Cyprus

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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
2010	4	12	5	99	5	139	5	91	4	67	5	48

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	31	7	21	18	33
Penicillin RI	<1	14	19	38	33	43	36	42
Macrolides RI	33	<1	13	31	27	29	36	55
Staphylococcus aureus								
Oxacillin/Meticillin R	64	49	56	34	48	46	33	32
Escherichia coli								
Aminopenicilins R	63	61	72	62	72	58	66	62
Aminoglycosides R	11	11	13	10	11	10	10	16
Fluoroquinolones R	32	22	29	35	39	45	43	43
Third-gen. cephalosporins R	11	9	16	16	18	19	14	20
Carbapenems R	<1	<1	<1	<1	2	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	<1	3	3	5	2	16	32	6
HL Gentamicin R	43	77	71	44	61	65	66	24
Vancomycin R	<1	3	<1	<1	<1	1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	100	100	80	43	92	60	80	78
HL Gentamicin R	-	33	<1	14	33	10	13	<1
Vancomycin R	<1	33	40	14	25	20	13	<1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	11	12	13	21	19	19
Fluoroquinolones R	-	-	22	12	23	23	43	39
Third-gen. cephalosporins R	-	-	33	27	31	35	42	34
Carbapenems R	-	-	<1	<1	3	10	17	16
Pseudomonas aeruginosa								
Piperacillin R	-	-	13	27	31	23	18	19
Ceftazidime R	-	-	38	24	15	9	18	17
Carbapenems R	-	-	13	11	19	19	8	29
Aminoglycosides R	-	-	13	11	25	21	5	10
Fluoroquinolones R	-	-	13	27	23	38	13	17

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=23		*S. aureus* n=188		*E. coli* n=274		*E. faecalis* n=133		*E. faecium* n=38		*K. pneumoniae* n=120		*P. aeruginosa* n=109	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	91	38	100	32	100	43	100	0	100	5	99	38	99	18
CSF	9	50	-	-	-	-	-	-	-	-	1	0	1	0
Gender														
Male	74	41	64	34	46	53	62	0	63	8	56	37	60	20
Female	26	33	34	30	53	35	37	0	37	0	43	37	34	14
Unknown	-	-	2	25	1	0	1	0	-	-	2	50	6	14
Age (years)														
0–4	4	100	8	20	3	11	4	0	5	0	6	0	7	13
5–19	13	33	2	0	1	50	1	0	-	-	2	0	-	-
20–64	17	75	23	32	16	51	27	0	37	0	35	33	28	19
65 and over	30	29	39	42	45	48	49	0	50	5	38	48	40	18
Unknown	35	25	28	25	34	35	20	0	8	33	19	39	24	15
Hospital department														
ICU	4	100	16	35	10	48	44	0	47	11	32	53	39	31
Internal med.	70	25	47	30	62	44	26	0	16	0	32	26	25	11
Surgery	-	-	14	46	7	50	12	0	11	0	13	31	10	9
Other	26	67	22	27	20	36	18	0	24	0	23	36	25	4
Unknown	-	-	1	50	1	33	-	-	3	0	-	-	2	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*.

Cyprus

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumoniae* by laboratory (2009–2010)

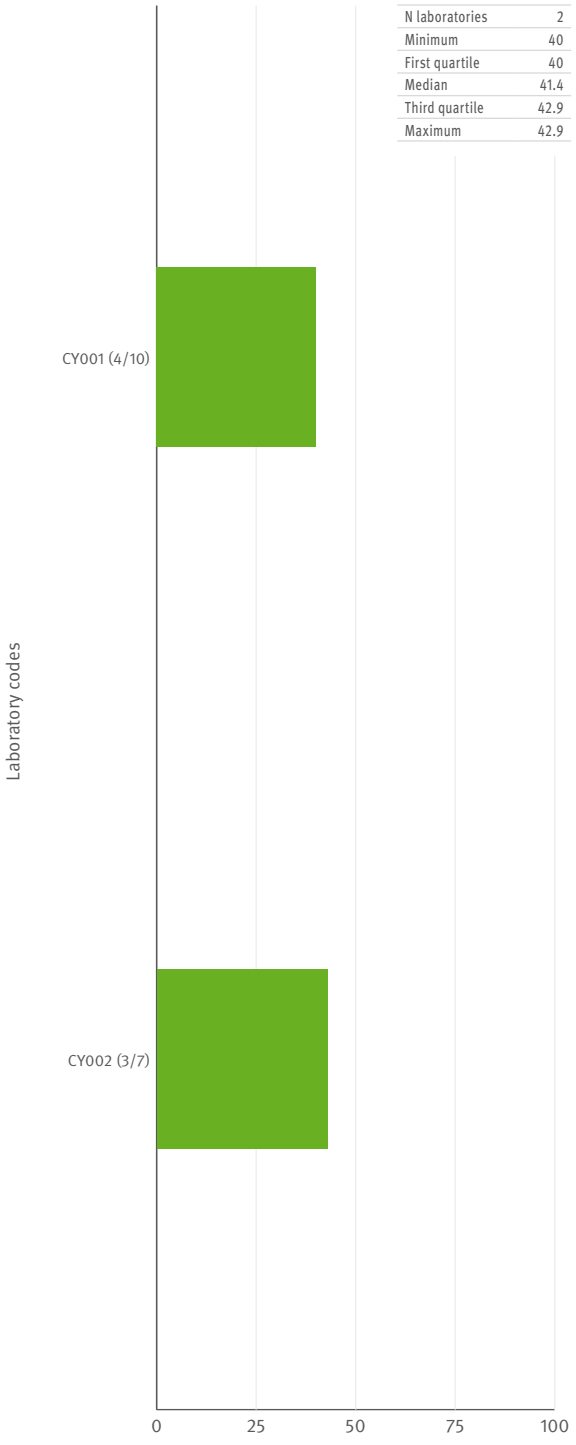


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

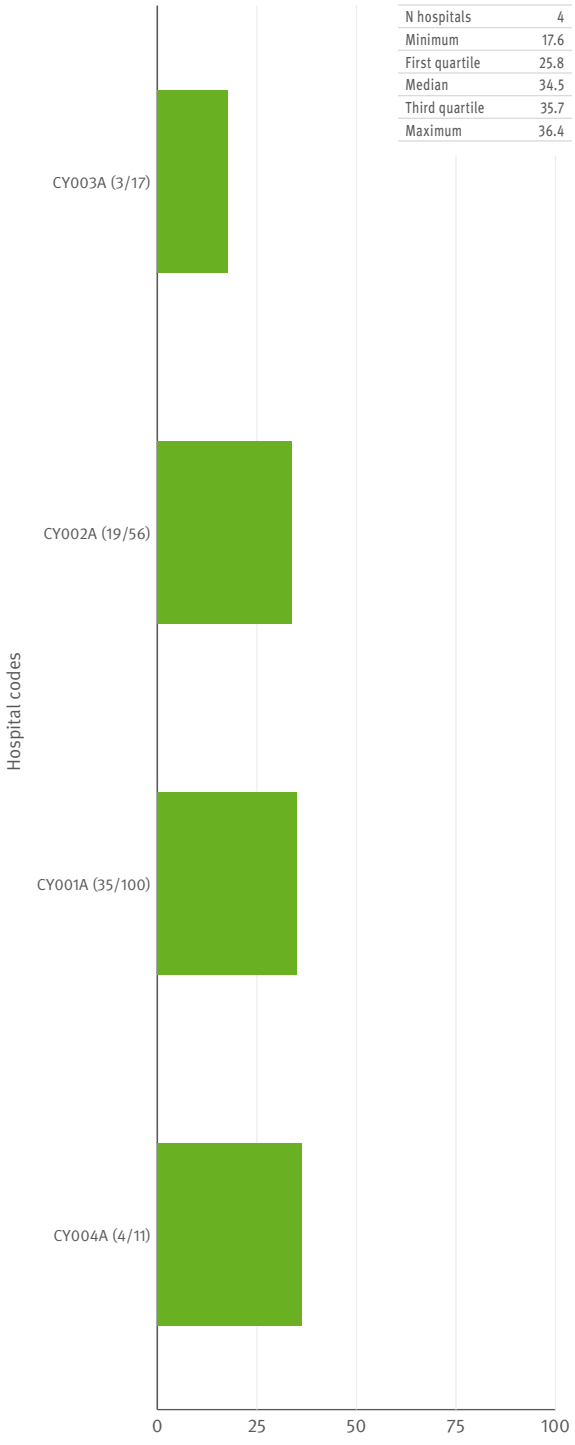


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

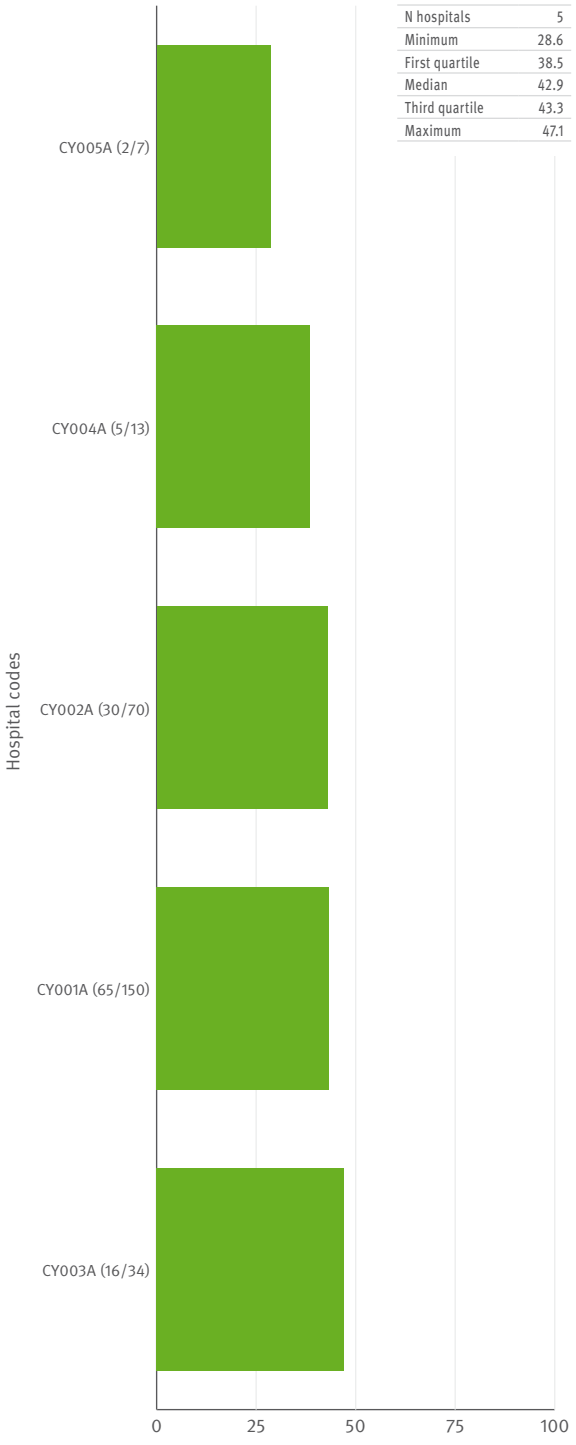
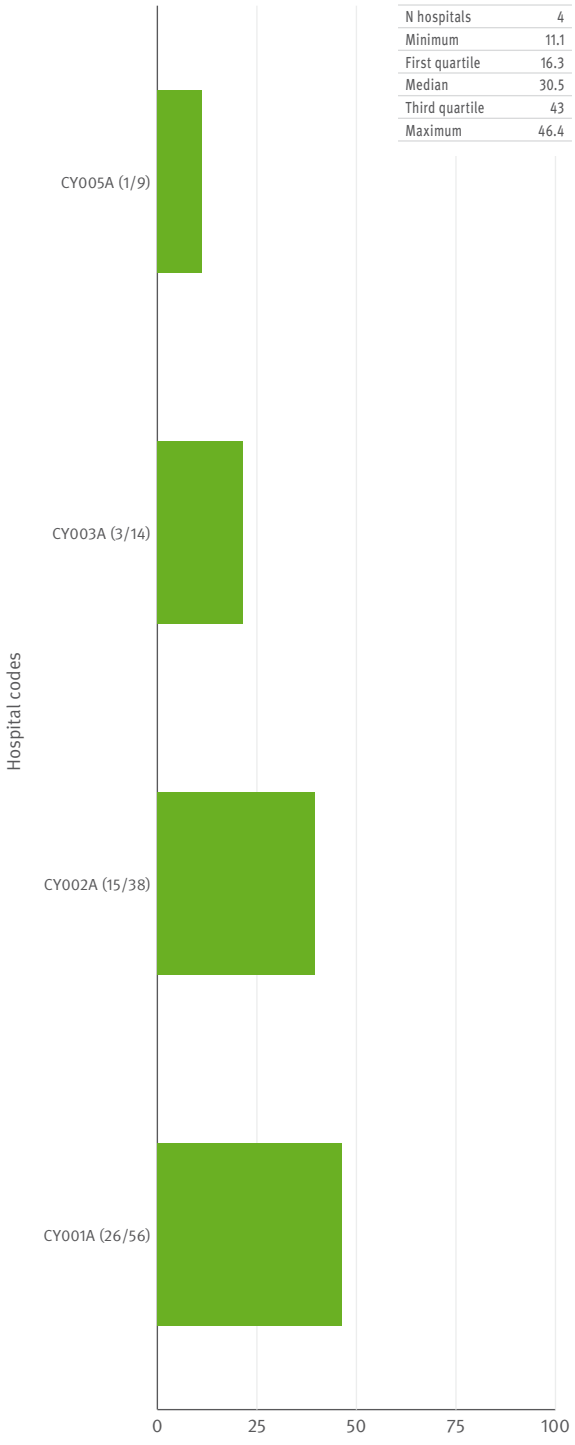


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Czech Republic

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	41	288	44	1593	43	2484	41	759	44	1264	41	511

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	<1	2	<1	<1	<1	<1	<1	<1
Penicillin RI	2	6	4	2	4	3	4	5
Macrolides RI	2	4	2	3	5	3	5	6
Staphylococcus aureus								
Oxacillin/Meticillin R	6	9	13	12	13	14	15	13
Escherichia coli								
Aminopenicilins R	45	47	50	56	56	60	61	59
Aminoglycosides R	5	5	6	8	7	9	9	8
Fluoroquinolones R	13	16	20	23	24	26	23	23
Third-gen. cephalosporins R	1	2	2	5	7	10	10	10
Carbapenems R	-	-	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	4	<1	<1	2	3	2	<1	8
HL Gentamicin R	44	43	45	43	49	49	47	48
Vancomycin R	<1	<1	<1	<1	1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	80	81	92	90	91	94	98	98
HL Gentamicin R	48	43	69	74	79	75	65	54
Vancomycin R	3	3	14	4	6	8	6	5
Klebsiella pneumoniae								
Aminoglycosides R	-	-	36	38	43	42	47	47
Fluoroquinolones R	-	-	38	47	48	52	54	55
Third-gen. cephalosporins R	-	-	32	35	46	48	52	48
Carbapenems R	-	-	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	21	29	30	27	28	28
Ceftazidime R	-	-	40	30	33	44	29	28
Carbapenems R	-	-	31	33	36	29	29	16
Aminoglycosides R	-	-	28	30	34	45	32	32
Fluoroquinolones R	-	-	45	47	43	46	41	41

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=585		*S. aureus* n=3288		*E. coli* n=5239		*E. faecalis* n=1196		*E. faecium* n=397		*K. pneumoniae* n=2678		*P. aeruginosa* n=1085	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	87	5	100	14	100	23	100	0	100	5	100	50	99	23
CSF	13	4	-	-	<1	9	-	-	-	-	<1	18	1	50
Gender														
Male	56	3	61	14	43	27	65	0	63	6	61	52	62	25
Female	44	7	39	14	57	20	35	0	37	4	39	47	38	20
Unknown	-	-	-	-	<1	100	-	-	-	-	-	-	-	-
Age (years)														
0–4	6	6	4	0	2	5	3	0	2	0	2	26	1	8
5–19	5	4	2	1	1	29	1	0	1	0	1	50	2	35
20–64	48	5	41	12	31	21	41	1	46	9	43	53	45	26
65 and over	42	5	53	17	66	24	55	0	51	2	54	49	51	20
Unknown	-	-	<1	0	<1	0	-	-	-	-	<1	20	<1	0
Hospital department														
ICU	25	3	25	16	20	25	46	0	44	1	41	56	47	25
Internal med.	37	5	44	15	49	22	27	0	19	4	34	44	25	17
Surgery	1	17	9	15	6	24	7	1	7	0	8	54	6	29
Other	32	4	22	10	25	24	19	0	31	13	17	47	21	24
Unknown	4	12	1	30	<1	25	<1	0	-	-	1	65	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*.

Czech Republic

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumoniae* by laboratory (2009–2010)

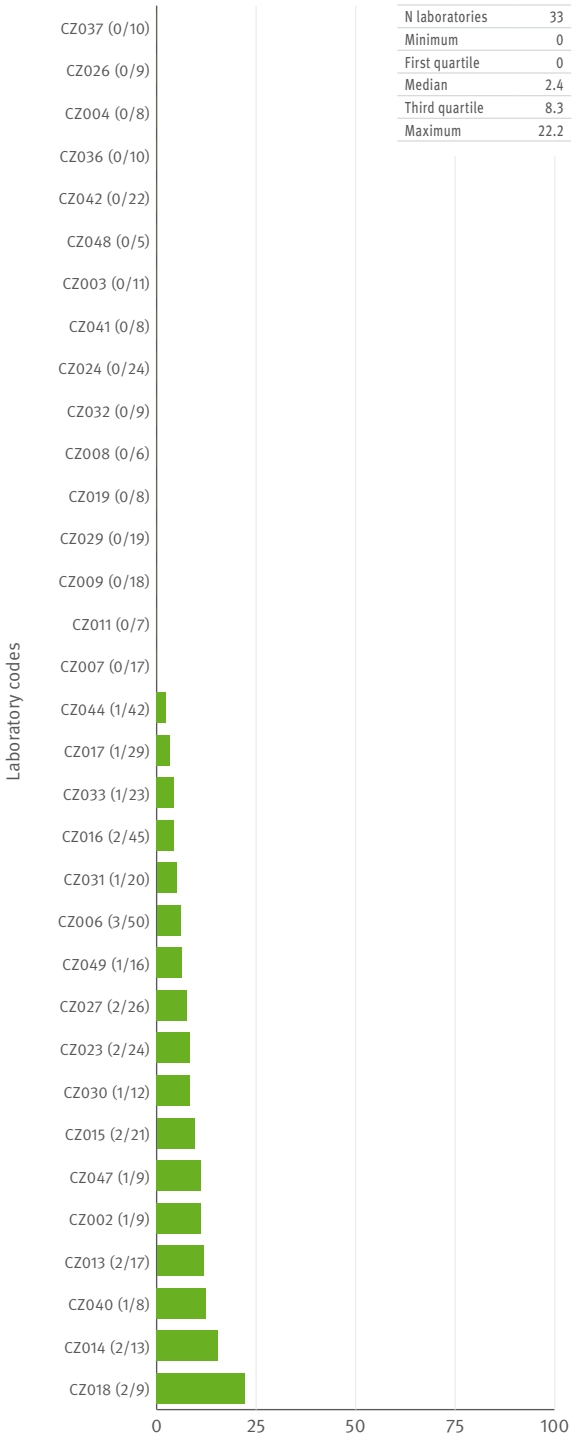


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

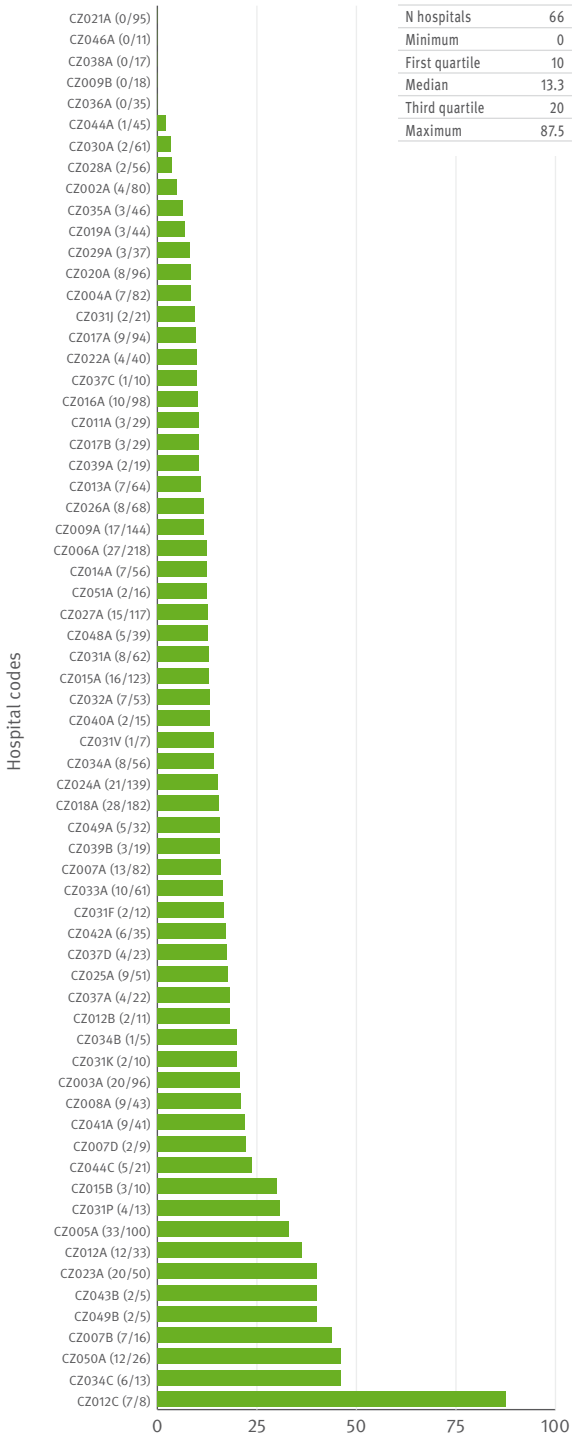


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

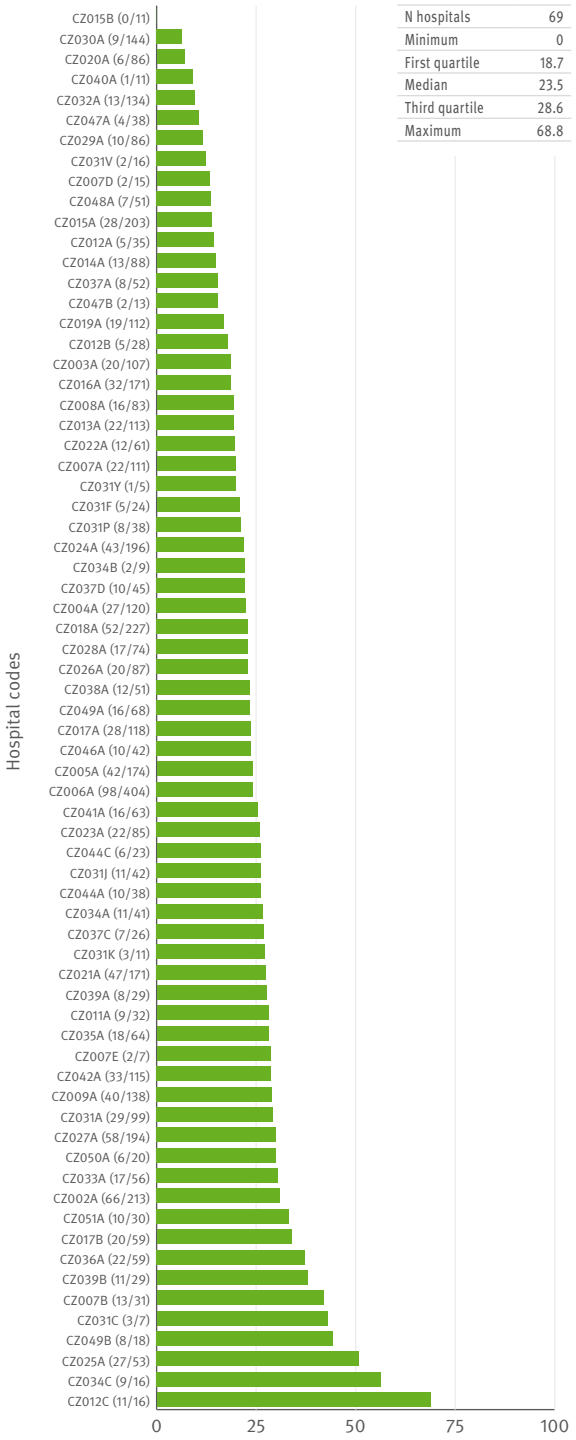
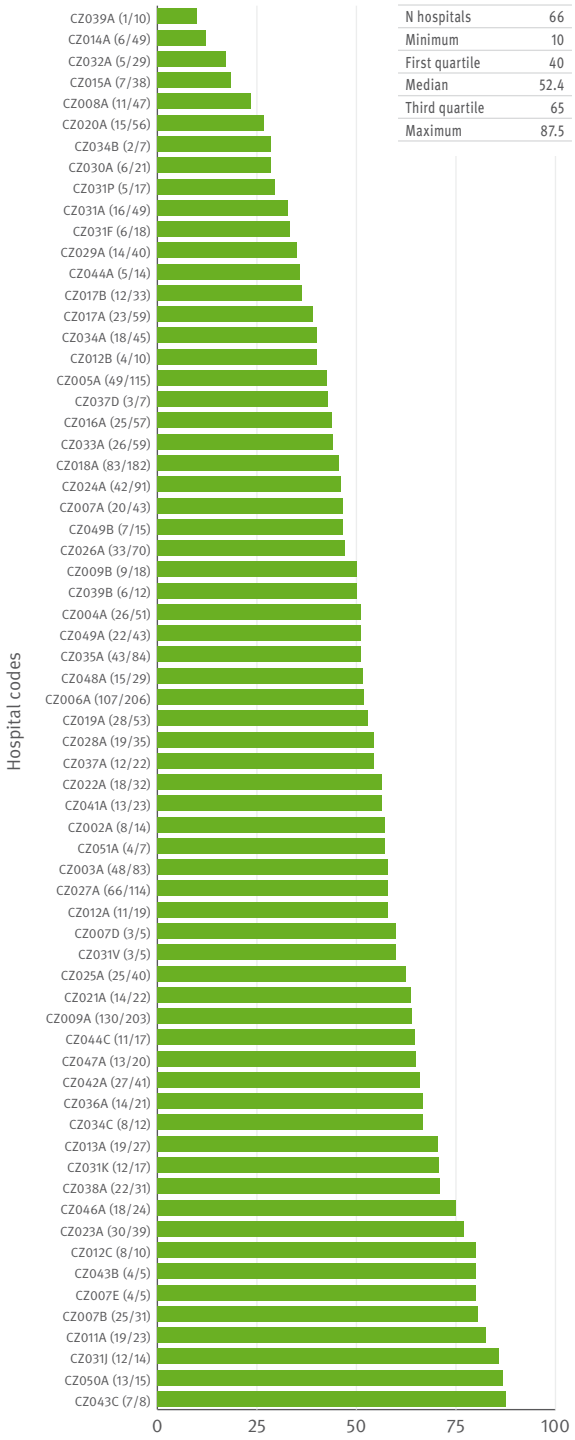


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Denmark

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	15	954	15	1362	14	3418	14	1112	14	799	14	376

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	<1	<1	<1	<1	<1
Penicillin RI	3	3	4	4	3	3	4	4
Macrolides RI	5	5	6	6	6	7	4	4
Staphylococcus aureus								
Oxacillin/Meticillin R	<1	1	2	2	<1	2	2	1
Escherichia coli								
Aminopenicilins R	-	-	40	42	43	43	43	46
Aminoglycosides R	-	-	2	3	4	4	4	6
Fluoroquinolones R	-	-	5	7	9	10	13	14
Third-gen. cephalosporins R	-	-	1	2	3	4	6	8
Carbapenems R	-	-	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	-	-	-	<1	2	2	1	<1
HL Gentamicin R	-	-	-	.	.	37	33	36
Vancomycin R	-	-	-	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	-	-	-	87	88	88	88	93
HL Gentamicin R	-	-	-	.	.	61	52	74
Vancomycin R	-	-	-	<1	<1	<1	2	2
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	2	6	7	7	6
Fluoroquinolones R	-	-	-	6	13	16	16	11
Third-gen. cephalosporins R	-	-	-	4	10	9	11	11
Carbapenems R	-	-	-	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	-	3	2	2	4
Ceftazidime R	-	-	-	-	2	3	4	3
Carbapenems R	-	-	-	-	2	1	3	3
Aminoglycosides R	-	-	-	-	1	1	<1	1
Fluoroquinolones R	-	-	-	-	6	3	5	6

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=1950		*S. aureus* n=2757		*E. coli* n=6572		*E. faecalis* n=950		*E. faecium* n=849		*K. pneumoniae* n=1182		*P. aeruginosa* n=703	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	93	4	100	2	100	13	100	0	100	2	100	11	99	3
CSF	7	3	-	-	<1	29	-	-	-	-	<1	0	1	0
Gender														
Male	23	4	63	2	49	16	72	0	60	1	59	13	64	3
Female	25	3	37	1	51	11	28	0	40	2	41	8	36	3
Unknown	51	4	-	-	<1	33	<1	33	<1	0	<1	0	-	-
Age (years)														
0–4	5	2	4	2	2	10	3	0	1	0	2	10	2	0
5–19	2	0	3	3	1	8	1	0	2	7	1	7	1	13
20–64	40	3	39	2	28	16	30	0	42	2	34	13	31	5
65 and over	53	4	54	2	70	13	66	1	55	2	63	10	66	2
Hospital department														
ICU	-	-	<1	8	3	18	13	1	29	2	4	19	7	13
Internal med.	-	-	7	1	40	13	40	0	22	0	43	10	31	1
Surgery	-	-	2	0	15	11	18	1	17	2	21	10	13	3
Other	-	-	5	1	22	14	23	0	20	3	26	9	28	4
Unknown	100	4	85	2	20	14	7	0	11	2	7	18	21	1

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. pneumoniae* by laboratory (2009–2010)

Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

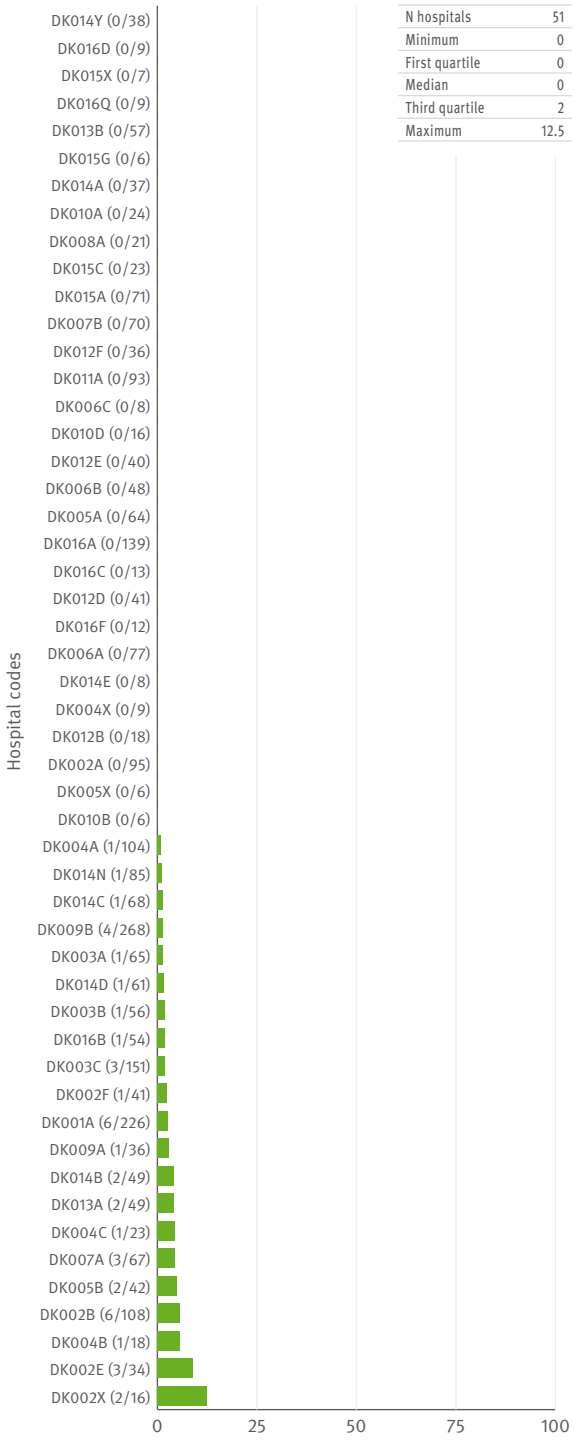


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

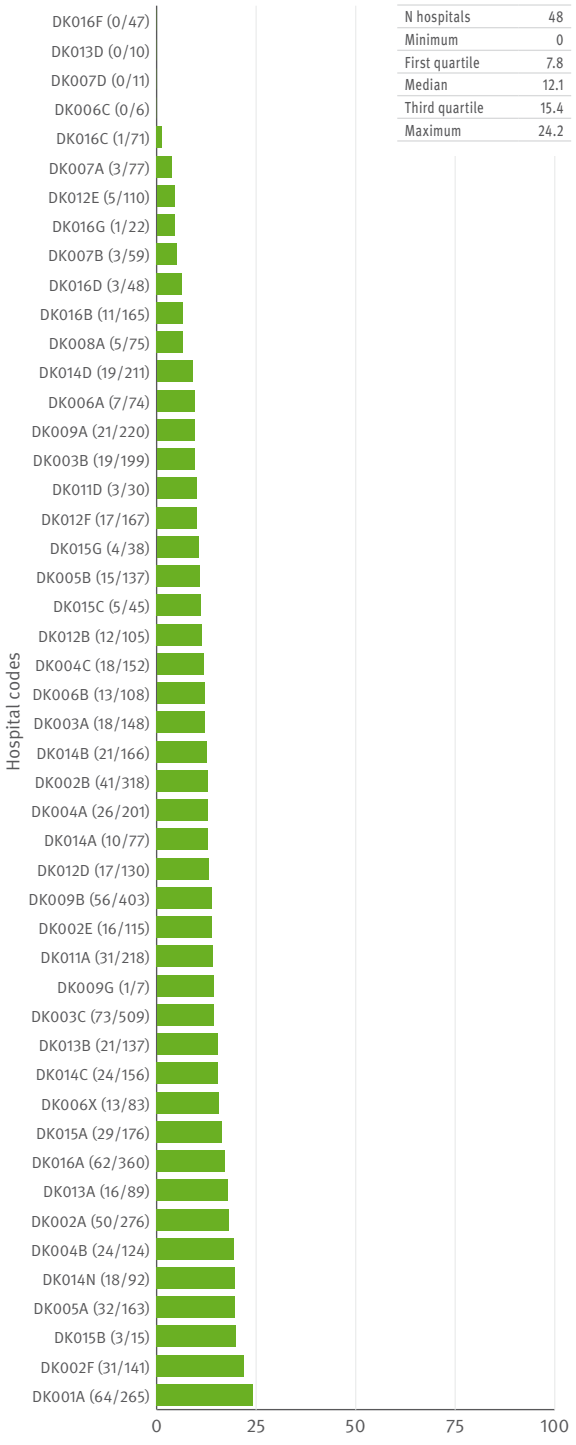
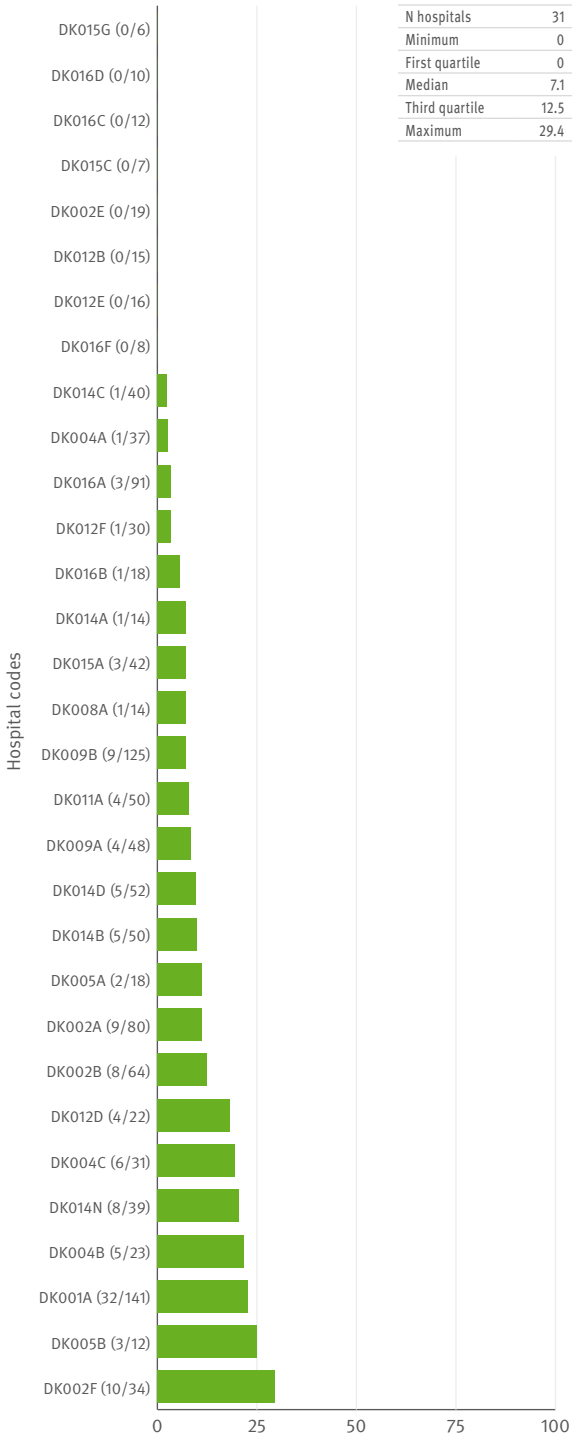


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Estonia

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	10	64	9	152	11	317	8	66	9	82	8	42

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	<1	<1	<1	<1	2
Penicillin RI	<1	<1	2	2	<1	5	1	2
Macrolides RI	10	6	<1	3	2	4	2	4
Staphylococcus aureus								
Oxacillin/Meticillin R	4	5	2	3	9	4	3	<1
Escherichia coli								
Aminopenicilins R	42	55	45	52	50	47	38	37
Aminoglycosides R	3	2	4	2	6	5	4	6
Fluoroquinolones R	5	6	5	7	7	7	8	8
Third-gen. cephalosporins R	1	4	1	<1	1	5	2	6
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	4	14	14	9	<1	9	9	14
HL Gentamicin R	22	32	50	35	23	27	43	27
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	75	79	83	84	94	85	90	90
HL Gentamicin R	50	79	74	78	89	75	79	67
Vancomycin R	<1	<1	<1	<1	<1	3	<1	<1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	8	9	2	15	15	26
Fluoroquinolones R	-	-	<1	5	2	7	19	25
Third-gen. cephalosporins R	-	-	8	9	3	12	17	17
Carbapenems R	-	-	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	27	12	9	18	13	14
Ceftazidime R	-	-	18	7	7	13	7	13
Carbapenems R	-	-	38	29	18	30	17	22
Aminoglycosides R	-	-	28	8	7	17	10	11
Fluoroquinolones R	-	-	14	10	9	18	19	11

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=146		*S. aureus* n=358		*E. coli* n=565		*E. faecalis* n=72		*E. faecium* n=63		*K. pneumoniae* n=139		*P. aeruginosa* n=70	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	92	1	100	2	99	8	100	0	100	0	100	17	99	20
CSF	8	0	-	-	1	0	-	-	-	-	-	-	1	0
Gender														
Male	58	1	57	2	37	11	64	0	44	0	51	23	57	25
Female	42	2	42	3	62	7	36	0	56	0	49	12	43	13
Unknown	-	-	1	0	1	0	-	-	-	-	-	-	-	-
Age (years)														
0–4	8	9	8	0	2	0	17	0	3	0	9	8	1	0
5–19	3	0	4	7	2	8	3	0	.	.	2	0	6	0
20–64	61	1	49	1	38	10	33	0	46	0	40	18	39	11
65 and over	28	0	39	4	58	7	46	0	51	0	49	19	54	29
Unknown	-	-	<1	0	-	-	1	0	-	-	-	-	-	-
Hospital department														
ICU	29	0	24	5	16	6	28	0	51	0	34	23	41	31
Internal med.	28	2	33	3	47	6	24	0	8	0	32	16	21	20
Surgery	1	0	7	0	4	21	11	0	6	0	7	10	3	0
Other	42	2	37	1	33	12	36	0	35	0	27	13	34	8
Unknown	-	-	-	-	-	-	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. pneumoniae* by laboratory (2009–2010)

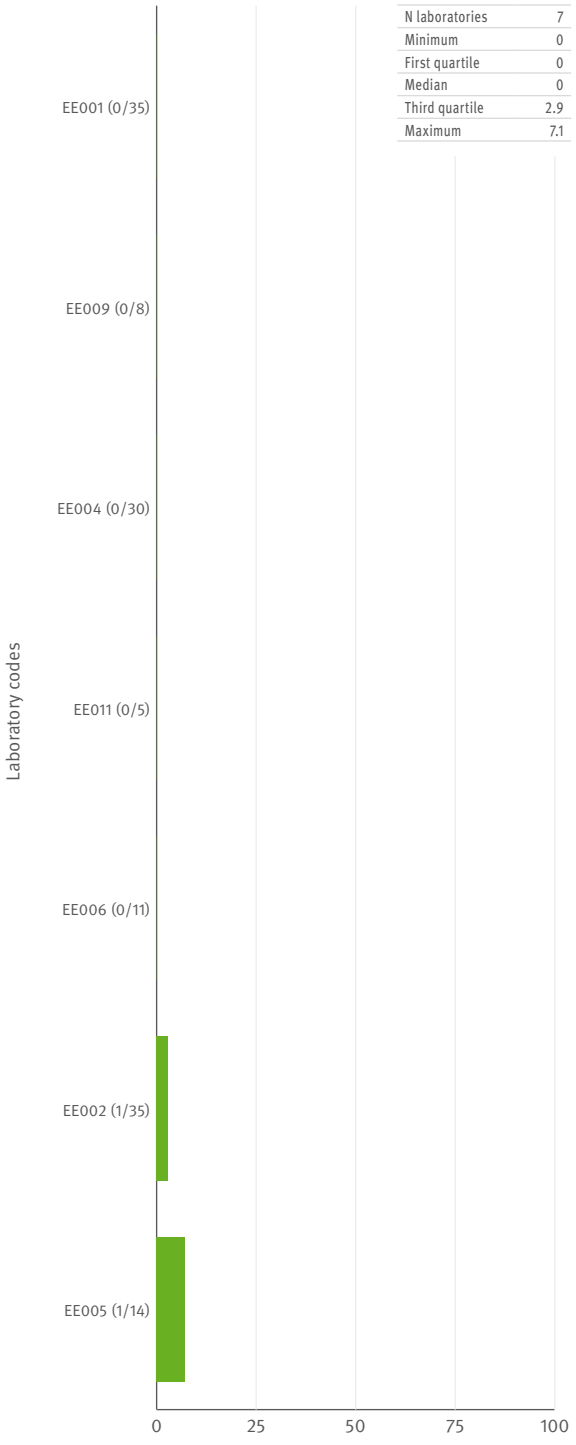


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

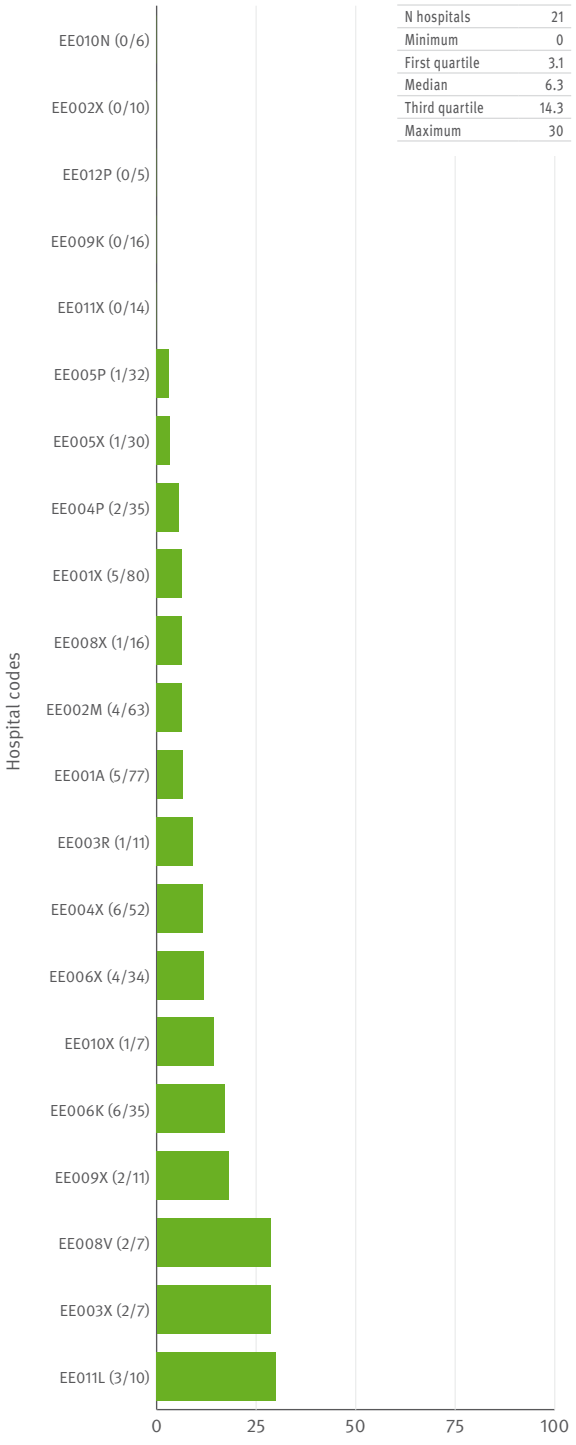
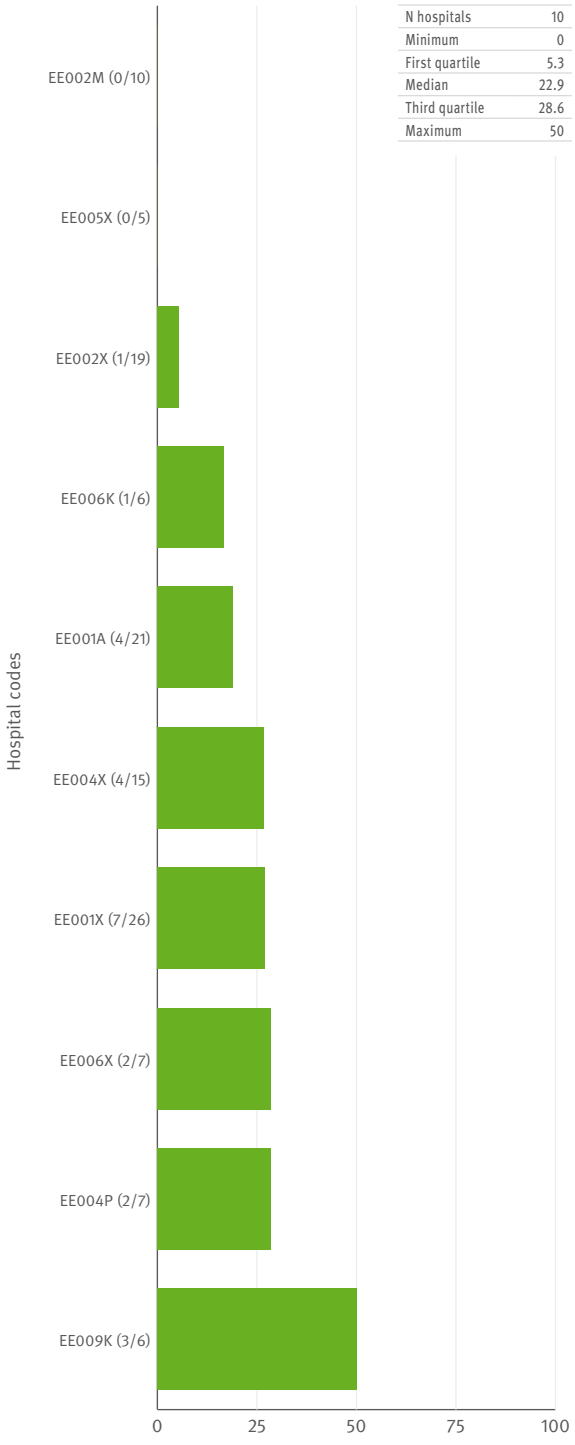


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Finland

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	20	622	20	1094	20	2551	20	521	20	401	20	281

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	2	<1	<1	2	1	<1	2	1
Penicillin RI	10	8	7	12	13	11	13	14
Macrolides RI	20	20	20	24	25	24	28	28
Staphylococcus aureus								
Oxacillin/Meticillin R	1	3	3	3	2	3	2	2
Escherichia coli								
Aminopenicilins R	33	33	35	36	34	35	36	34
Aminoglycosides R	1	2	2	2	3	4	3	4
Fluoroquinolones R	5	7	7	8	8	9	9	9
Third-gen. cephalosporins R	1	2	2	2	2	2	3	4
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	<1	<1	<1	<1	2	<1	<1	<1
HL Gentamicin R	39	39	27	25	22	13	-	-
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	79	69	78	80	87	87	87	82
HL Gentamicin R	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	4
Fluoroquinolones R	-	-	3	4	<1	2	3	2
Third-gen. cephalosporins R	-	-	2	<1	1	2	1	4
Carbapenems R	-	-	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	8	8	7	8	7	7
Ceftazidime R	-	-	5	3	5	5	5	3
Carbapenems R	-	-	15	8	9	6	8	10
Aminoglycosides R	-	-	11	8	8	6	4	4
Fluoroquinolones R	-	-	16	17	11	15	11	11

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=1263		*S. aureus* n=2072		*E. coli* n=4773		*E. faecalis* n=541		*E. faecium* n=482		*K. pneumoniae* n=764		*P. aeruginosa* n=504	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	96	14	100	2	100	9	100	0	100	0	100	3	98	9
CSF	4	11	-	-	<1	13	-	-	-	-	<1	0	2	8
Gender														
Male	54	13	62	2	37	13	70	0	61	0	54	4	61	10
Female	46	14	38	2	63	7	30	0	39	0	46	2	39	7
Age (years)														
0–4	15	24	3	1	2	5	6	0	2	0	1	20	1	20
5–19	4	8	4	0	1	5	1	0	2	0	1	0	2	27
20–64	46	11	39	2	28	9	27	0	32	0	28	4	27	13
65 and over	35	13	53	3	69	9	65	0	63	0	70	2	70	7
Hospital department														
ICU	1	13	1	0	1	4	1	0	2	0	<1	0	2	18
Internal med.	6	7	6	1	5	10	4	0	7	0	4	0	5	0
Surgery	<1	50	2	3	1	8	2	0	5	0	2	7	2	20
Other	22	12	16	3	16	9	15	0	10	0	15	4	9	4
Unknown	71	14	74	2	77	9	78	0	76	0	80	3	81	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*.

Finland

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumoniae* by laboratory (2009–2010)

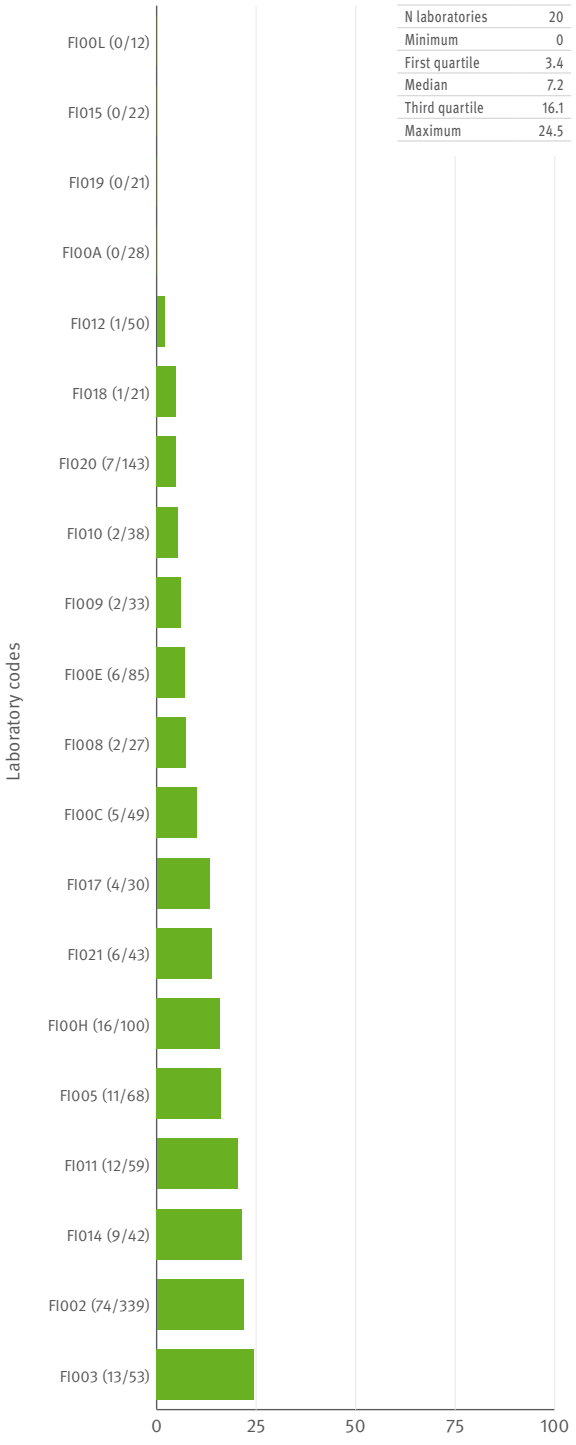


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

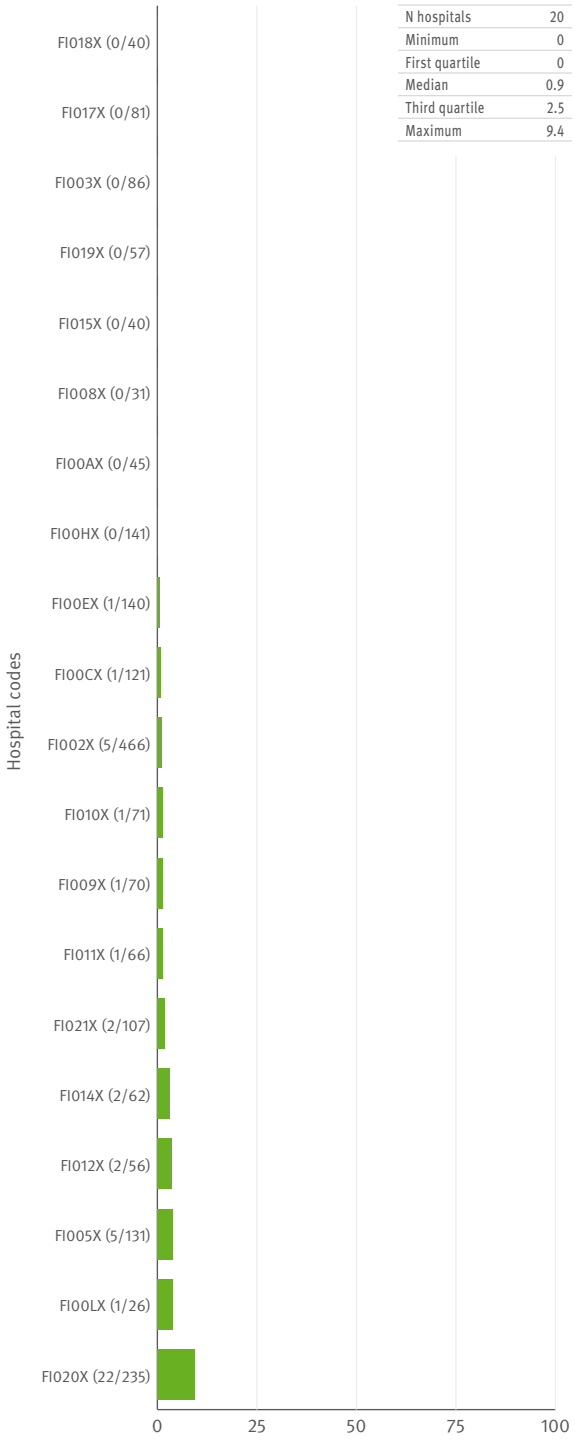


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

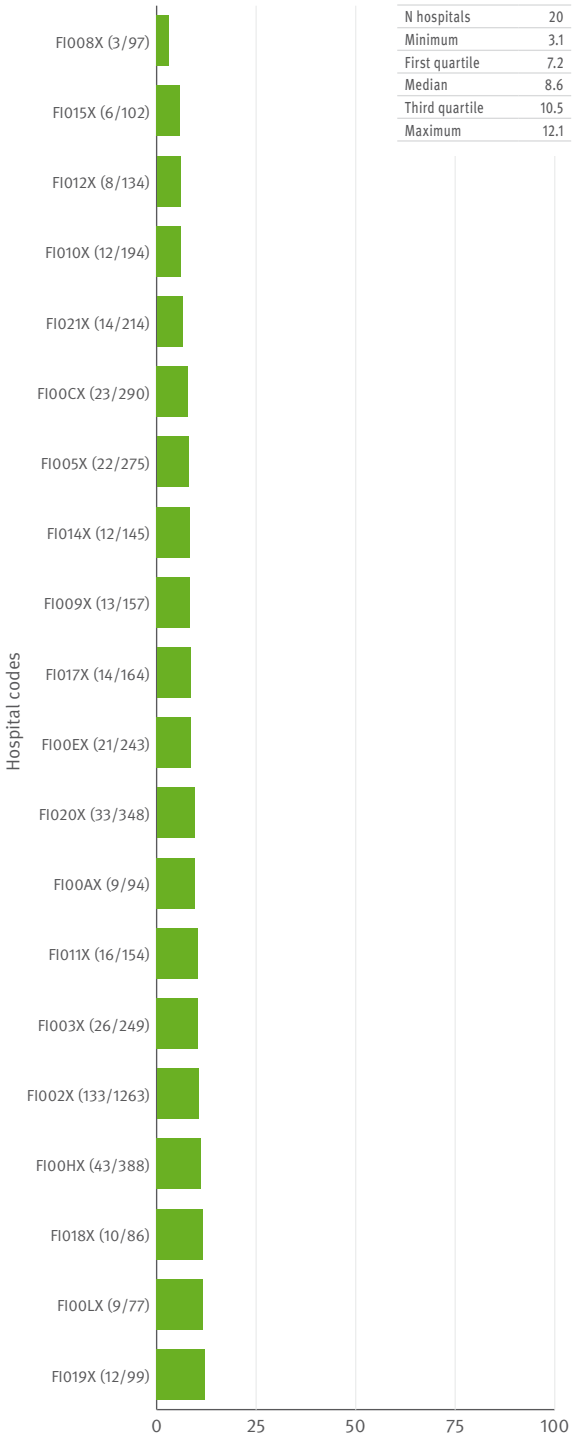
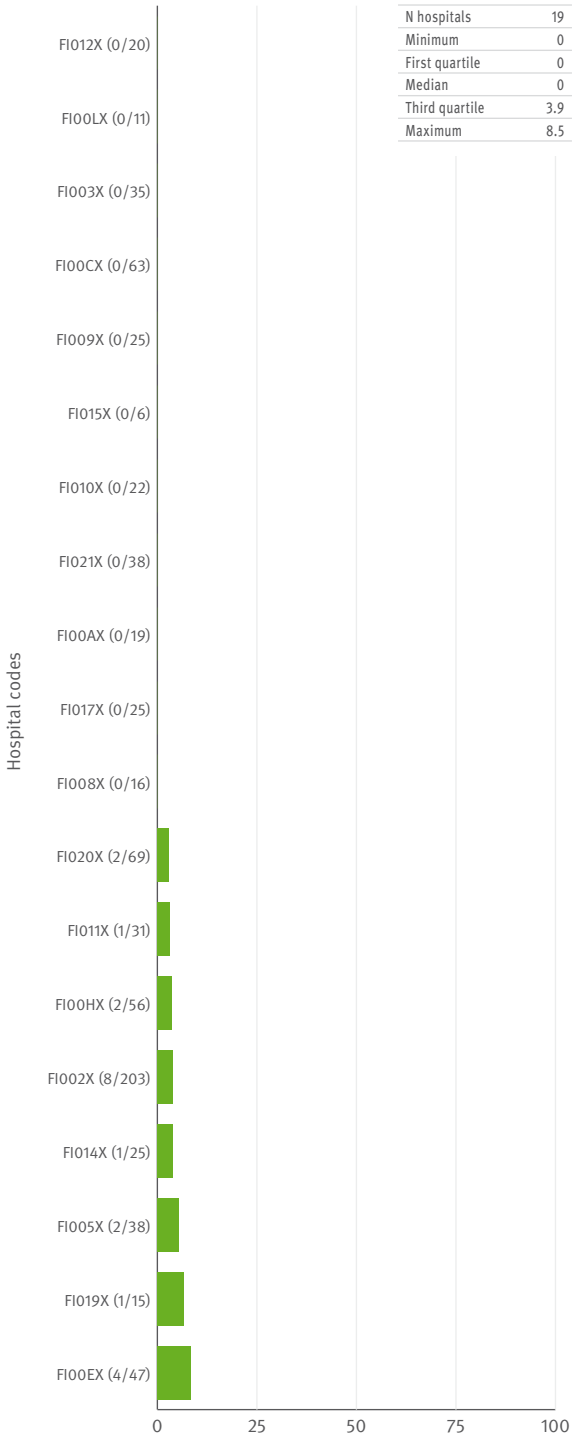


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



France

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	-	-	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
2010	181	1127	56	4883	56	9028	54	1970	56	1542	36	1191

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	-	-	5	4	4	7	6	<1
Penicillin RI	-	-	36	32	34	30	27	28
Macrolides RI	-	-	41	36	37	31	27	30
Staphylococcus aureus								
Oxacillin/Meticillin R	29	29	27	27	26	24	23	22
Escherichia coli								
Aminopenicilins R	50	47	50	53	54	54	55	55
Aminoglycosides R	5	4	5	6	6	7	8	7
Fluoroquinolones R	9	8	11	14	15	16	19	18
Third-gen. cephalosporins R	<1	<1	1	2	2	4	7	7
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	3	1	<1	1	1	<1	1	<1
HL Gentamicin R	16	17	15	16	15	18	18	18
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	30	56	64	69	67	68	63	78
HL Gentamicin R	23	21	24	30	30	30	38	41
Vancomycin R	<1	5	3	3	1	<1	<1	1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	5	7	11	17	20	18
Fluoroquinolones R	-	-	7	9	14	21	24	22
Third-gen. cephalosporins R	-	-	4	6	10	15	19	18
Carbapenems R	.	.	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	15	11	11	14	21	20
Ceftazidime R	-	-	9	6	7	8	17	13
Carbapenems R	-	-	14	12	14	14	17	18
Aminoglycosides R	-	-	22	16	18	15	19	19
Fluoroquinolones R	-	-	27	23	24	22	25	23

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=1953		*S. aureus* n=9579		*E. coli* n=17360		*E. faecalis* n=2788		*E. faecium* n=1131		*K. pneumoniae* n=2920		*P. aeruginosa* n=2405	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	66	27	100	22	100	18	100	0	100	1	100	18	100	18
CSF	34	29	-	-	-	-	-	-	-	-	-	-	-	-
Gender														
Male	55	27	62	22	47	20	65	0	60	1	59	21	62	17
Female	45	28	37	22	51	16	33	0	38	0	40	14	38	18
Unknown	<1	0	2	22	2	16	2	0	2	0	1	13	<1	60
Age (years)														
0–4	24	31	5	10	2	6	4	0	2	0	2	23	2	9
5–19	9	14	3	6	1	11	1	0	1	0	1	29	2	13
20–64	35	22	39	16	34	18	37	0	45	1	47	22	50	22
65 and over	32	34	53	29	62	19	57	0	51	1	50	14	45	13
Unknown	-	-	<1	0	<1	25	<1	0	<1	0	<1	0	<1	0
Hospital department														
ICU	-	-	13	23	8	21	19	0	26	2	15	36	27	25
Internal med.	-	-	34	24	26	20	30	0	27	0	28	17	22	14
Surgery	-	-	14	20	10	18	15	0	14	1	15	24	14	19
Other	-	-	35	20	51	17	31	0	31	1	36	10	32	14
Unknown	100	27	4	21	5	17	5	0	2	0	6	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*.

France

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumoniae* by laboratory (2009–2010)

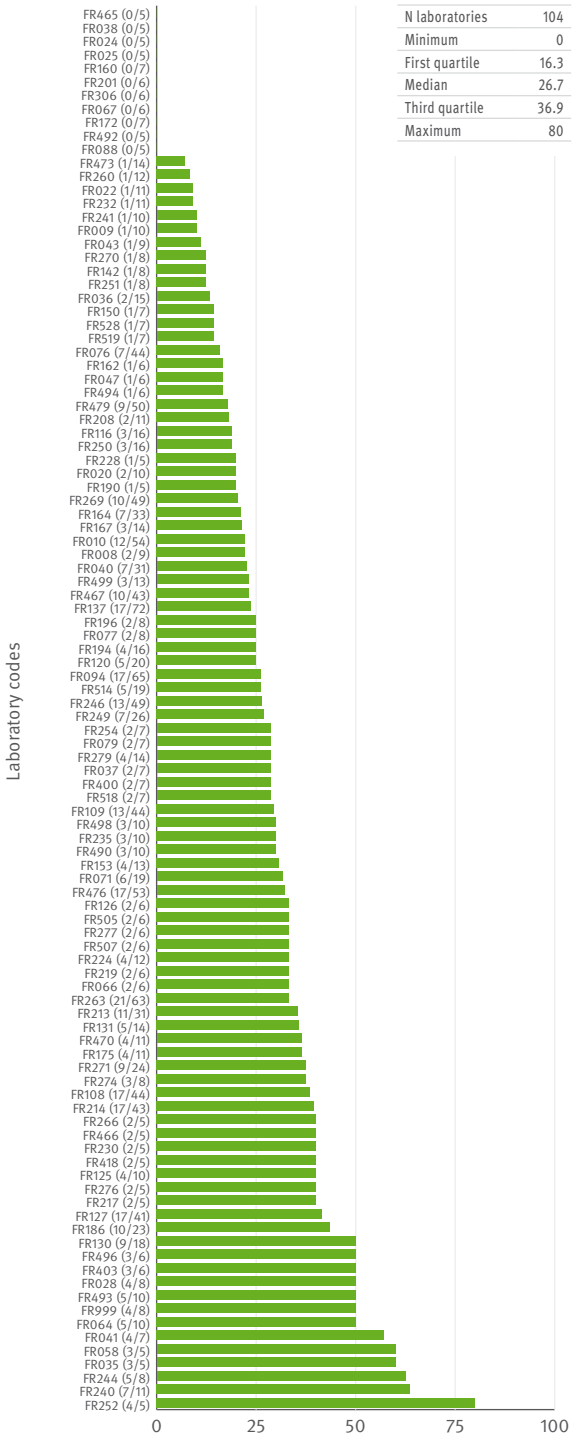


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

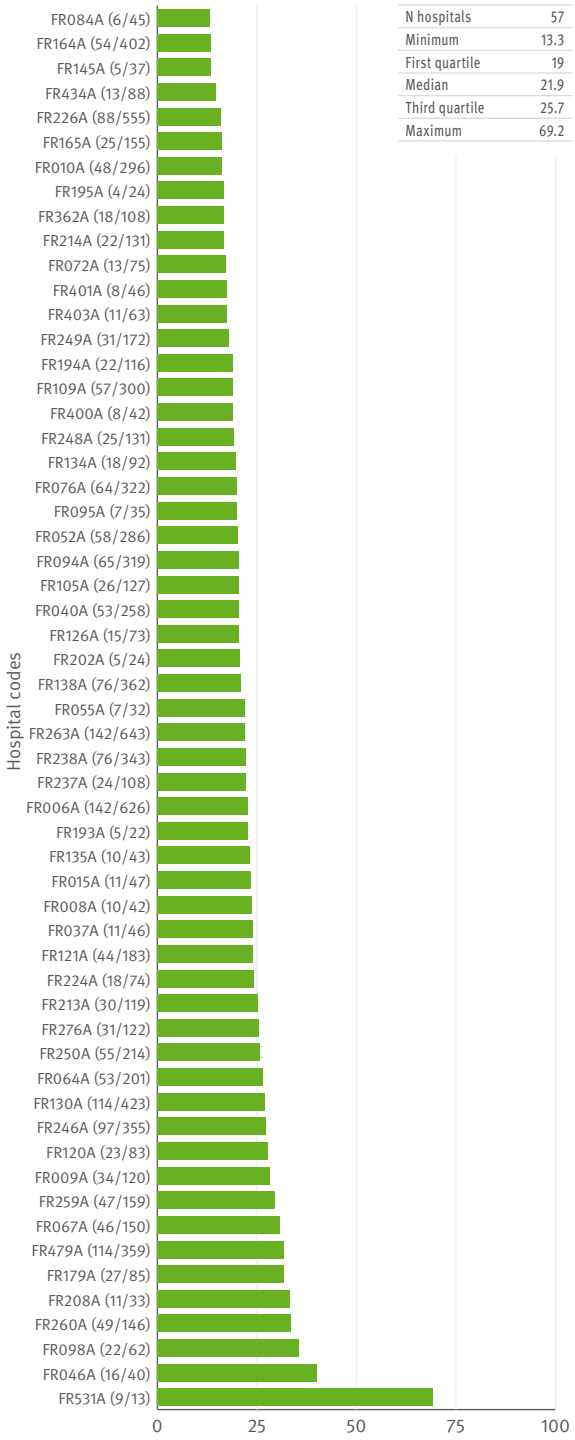


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

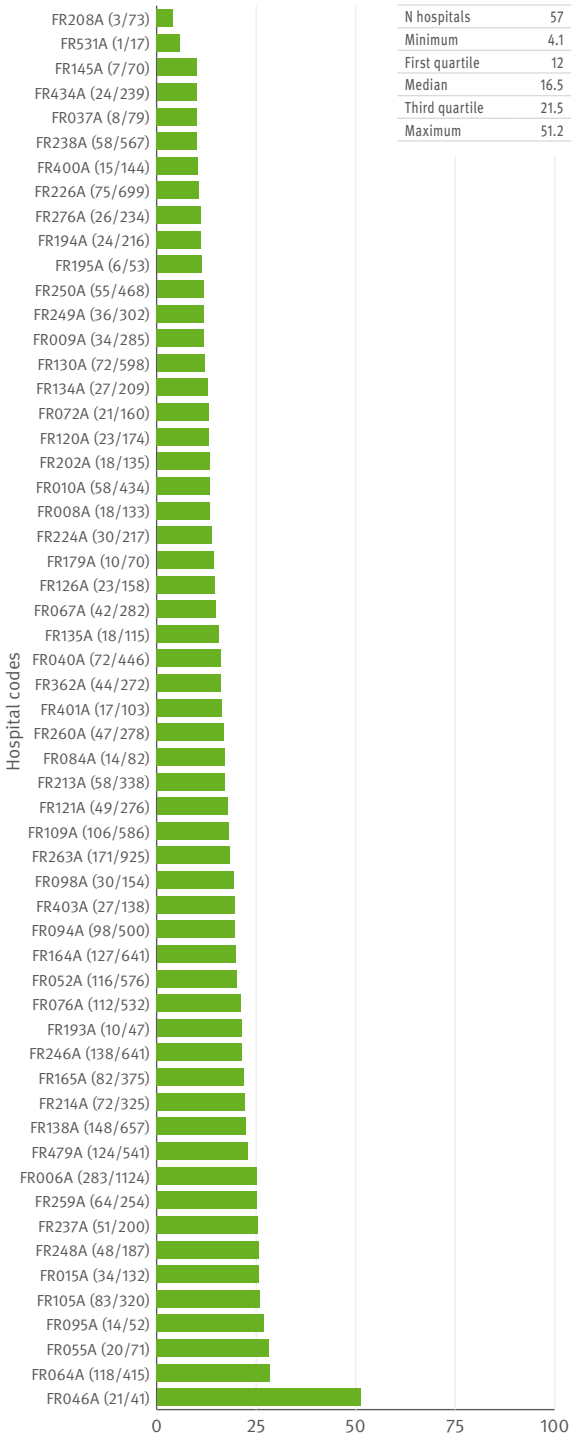
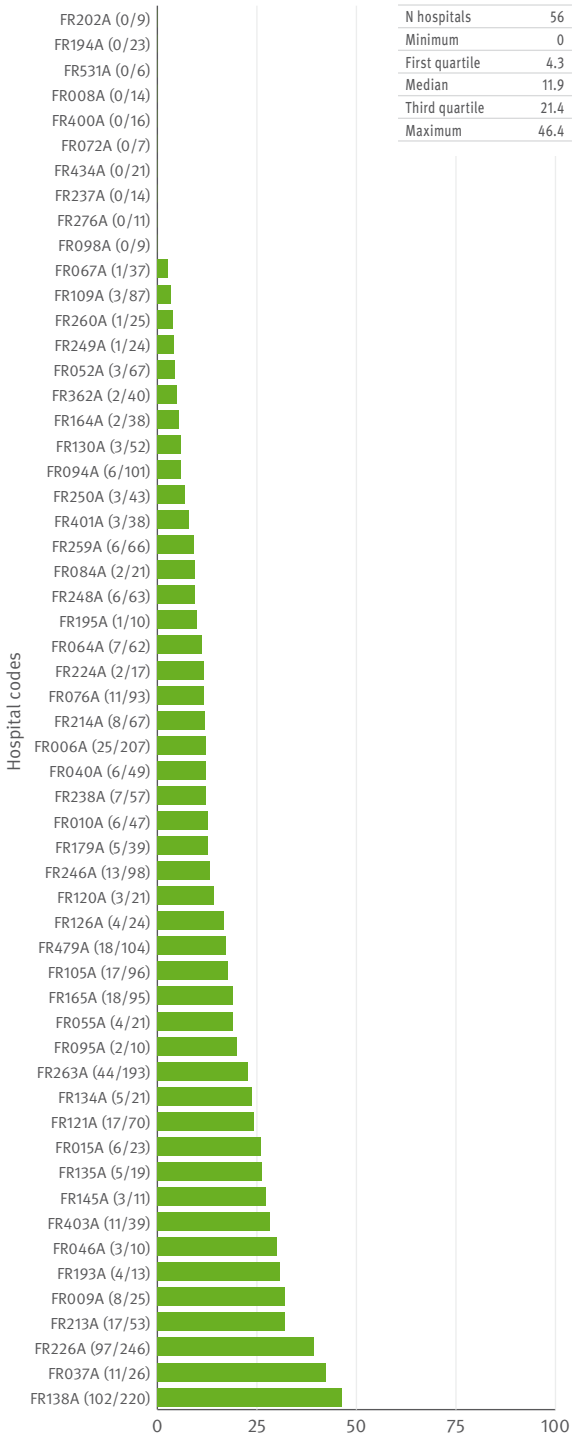


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Germany

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	17	175	20	920	19	997	17	347	-	-	-	-
2004	16	145	22	1107	22	1217	22	606	-	-	1	1
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	1893	17	2803	17	952	15	479	16	287
2010	16	363	17	1980	17	3024	16	1009	15	478	15	315

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	1	<1	<1	<1	<1
Penicillin RI	1	1	4	5	3	5	2	4
Macrolides RI	11	13	17	12	8	10	8	9
Staphylococcus aureus								
Oxacillin/Meticillin R	18	20	21	20	16	19	18	21
Escherichia coli								
Aminopenicilins R	47	55	54	60	55	55	56	54
Aminoglycosides R	5	4	6	10	6	7	8	9
Fluoroquinolones R	14	24	23	29	30	23	23	25
Third-gen. cephalosporins R	<1	2	2	4	8	5	8	8
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	7	7	3	3	7	<1	3	<1
HL Gentamicin R	47	42	34	29	67	39	40	47
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	78	93	96	94	95	95	94	94
HL Gentamicin R	47	61	52	38	73	35	45	45
Vancomycin R	3	11	10	8	15	6	6	8
Klebsiella pneumoniae								
Aminoglycosides R	-	-	10	12	6	10	10	10
Fluoroquinolones R	-	-	6	12	9	15	15	15
Third-gen. cephalosporins R	-	-	7	14	6	11	13	13
Carbapenems R	-	-	2	<1	2	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	<1	18	17	17	9	13	16
Ceftazidime R	-	<1	11	12	17	8	11	8
Carbapenems R	-	<1	25	17	22	11	11	13
Aminoglycosides R	-	<1	12	18	9	10	7	10
Fluoroquinolones R	-	<1	23	28	28	22	17	18

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=682		*S. aureus* n=3865		*E. coli* n=5803		*E. faecalis* n=1106		*E. faecium* n=845		*K. pneumoniae* n=949		*P. aeruginosa* n=594	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	91	3	100	20	100	24	100	0	100	7	99	13	99	12
CSF	9	3	-	-	<1	8	-	-	-	-	1	29	1	13
Gender														
Male	35	3	42	19	31	28	48	1	47	6	44	15	48	11
Female	30	4	24	20	37	22	24	0	29	7	31	10	24	16
Unknown	35	3	34	20	32	22	28	0	23	10	26	13	28	8
Age (years)														
0–4	8	4	2	3	1	9	2	0	3	5	3	8	2	0
5–19	2	7	1	4	1	24	<1	0	1	0	<1	0	1	13
20–64	37	4	27	17	22	28	26	1	35	7	28	18	29	19
65 and over	52	2	69	22	76	23	71	0	62	8	69	11	68	9
Unknown	-	-	-	-	<1	0	-	-	-	-	-	-	-	-
Hospital department														
ICU	24	2	18	22	13	25	22	1	42	7	19	20	22	21
Internal med.	51	3	47	20	55	21	45	0	29	7	43	9	37	8
Surgery	3	0	12	22	7	27	11	0	11	3	11	9	10	10
Other	20	4	21	17	22	31	21	0	18	10	24	18	27	10
Unknown	2	0	1	20	3	27	2	0	1	0	3	4	4	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*.

Germany

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumoniae* by laboratory (2009–2010)

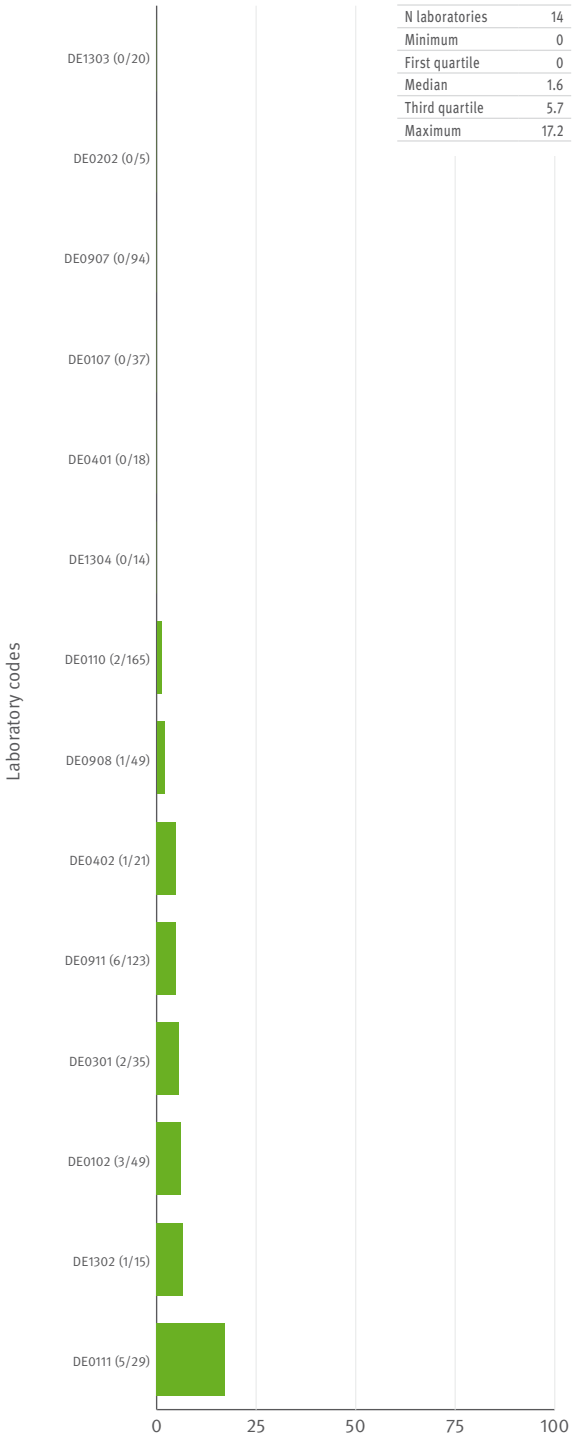
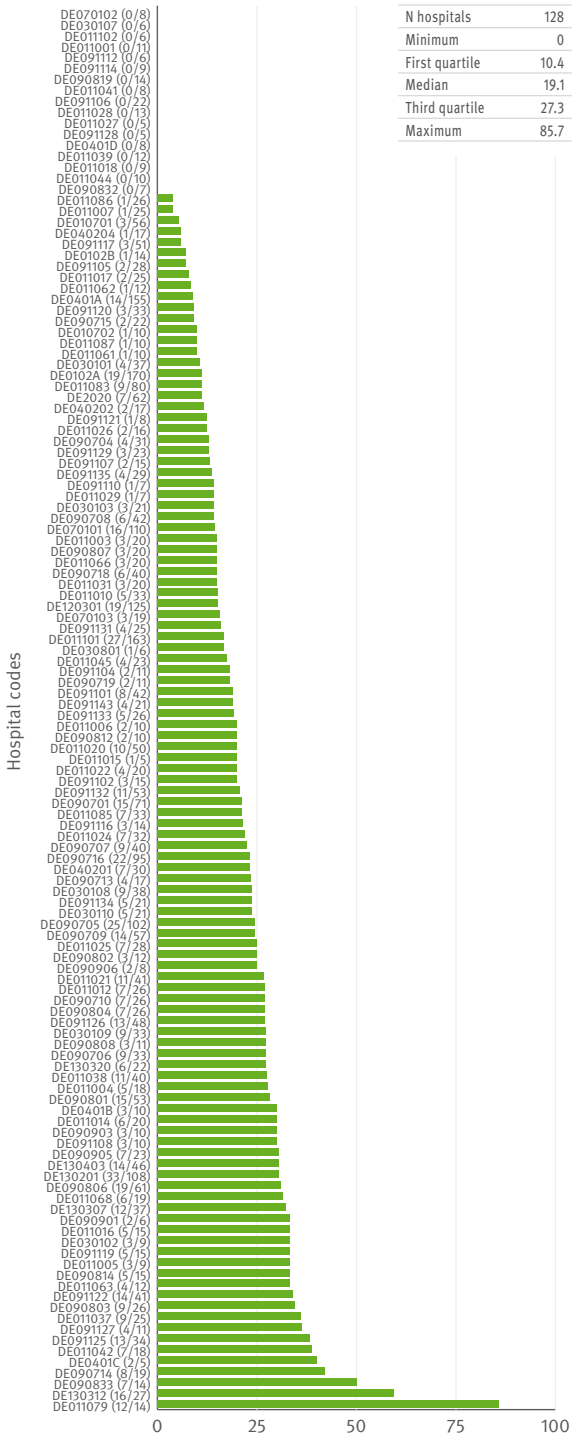


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)



Note. Individual laboratories may serve a large number of hospitals over a wide geographical area within Germany.

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

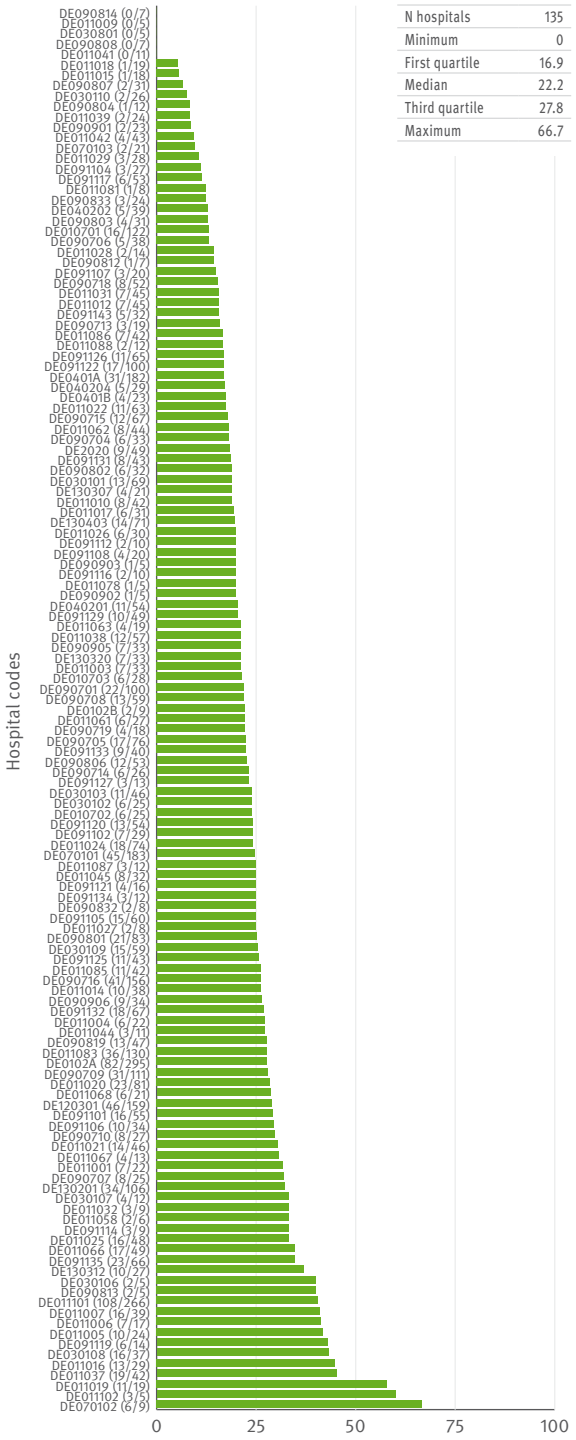
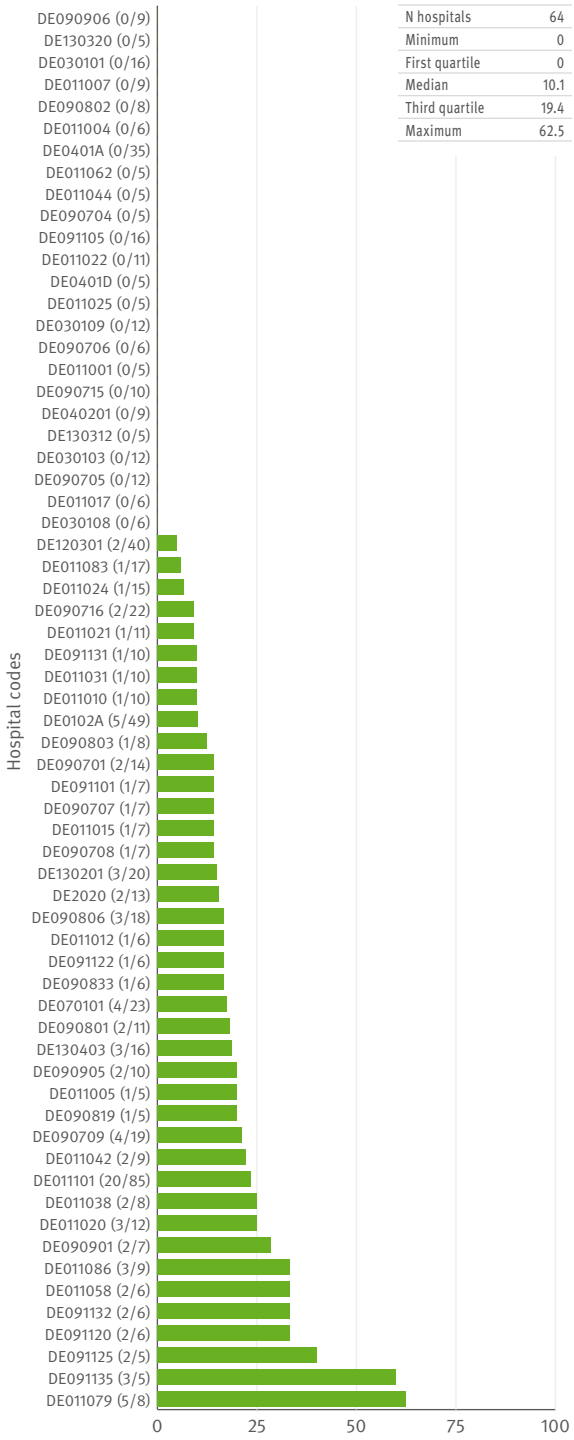


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Greece

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	-	-	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
2010	-	-	44	902	45	1549	43	1105	40	1703	42	1014

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	-	-	-	-	-	-	-	-
Penicillin RI	-	-	-	-	-	-	-	-
Macrolides RI	-	-	-	-	-	-	-	-
Staphylococcus aureus								
Oxacillin/Meticillin R	45	44	42	43	48	41	40	39
Escherichia coli								
Aminopenicilins R	44	46	46	46	48	50	51	52
Aminoglycosides R	6	6	7	7	9	15	14	16
Fluoroquinolones R	12	12	12	14	19	22	23	24
Third-gen. cephalosporins R	6	6	7	6	8	10	10	14
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	4	4	3	5	4	3	4	3
HL Gentamicin R	52	59	54	57	65	52	61	43
Vancomycin R	7	4	4	5	7	7	6	3
Enterococcus faecium								
Aminopenicilins RI	89	84	85	88	91	85	86	93
HL Gentamicin R	40	52	34	35	44	52	63	53
Vancomycin R	18	20	37	42	37	28	27	23
Klebsiella pneumoniae								
Aminoglycosides R	-	-	60	54	54	55	60	62
Fluoroquinolones R	-	-	54	50	55	64	66	71
Third-gen. cephalosporins R	-	-	61	58	62	66	69	75
Carbapenems R	-	-	28	33	42	37	44	49
Pseudomonas aeruginosa								
Piperacillin R	-	-	30	39	38	34	33	39
Ceftazidime R	-	-	27	34	40	37	34	40
Carbapenems R	-	-	39	48	47	49	44	43
Aminoglycosides R	-	-	40	47	49	48	41	42
Fluoroquinolones R	-	-	39	45	50	48	45	46

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=.		*S. aureus* n=1863		*E. coli* n=3322		*E. faecalis* n=1372		*E. faecium* n=870		*K. pneumoniae* n=3320		*P. aeruginosa* n=2094	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	-	-	100	40	100	24	100	5	100	25	97	71	97	43
CSF	-	-	-	-	<1	7	-	-	-	-	3	89	3	68
Gender														
Male	-	-	8	35	8	23	6	3	9	25	5	65	6	38
Female	-	-	4	34	8	17	4	0	7	31	4	57	4	32
Unknown	-	-	88	41	84	25	89	5	84	24	91	73	90	44
Age (years)														
0–4	-	-	6	36	7	21	9	9	8	20	8	79	6	43
5–19	-	-	-	-	<1	14	-	-	-	-	<1	0	<1	0
20–64	-	-	3	25	3	12	1	0	3	33	2	44	2	22
65 and over	-	-	3	31	5	29	3	0	3	26	3	57	3	27
Unknown	-	-	88	41	86	24	86	4	86	25	88	72	89	45
Hospital department														
ICU	-	-	13	51	6	31	31	10	33	30	46	91	47	56
Internal med.	-	-	73	37	77	23	51	2	49	24	37	53	39	34
Surgery	-	-	10	52	10	32	14	3	15	15	13	68	12	34
Other	-	-	3	28	4	8	2	0	3	17	4	35	2	18
Unknown	-	-	2	48	3	16	2	7	1	20	1	41	1	6

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. pneumoniae* by laboratory (2009–2010)

No data reported

Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

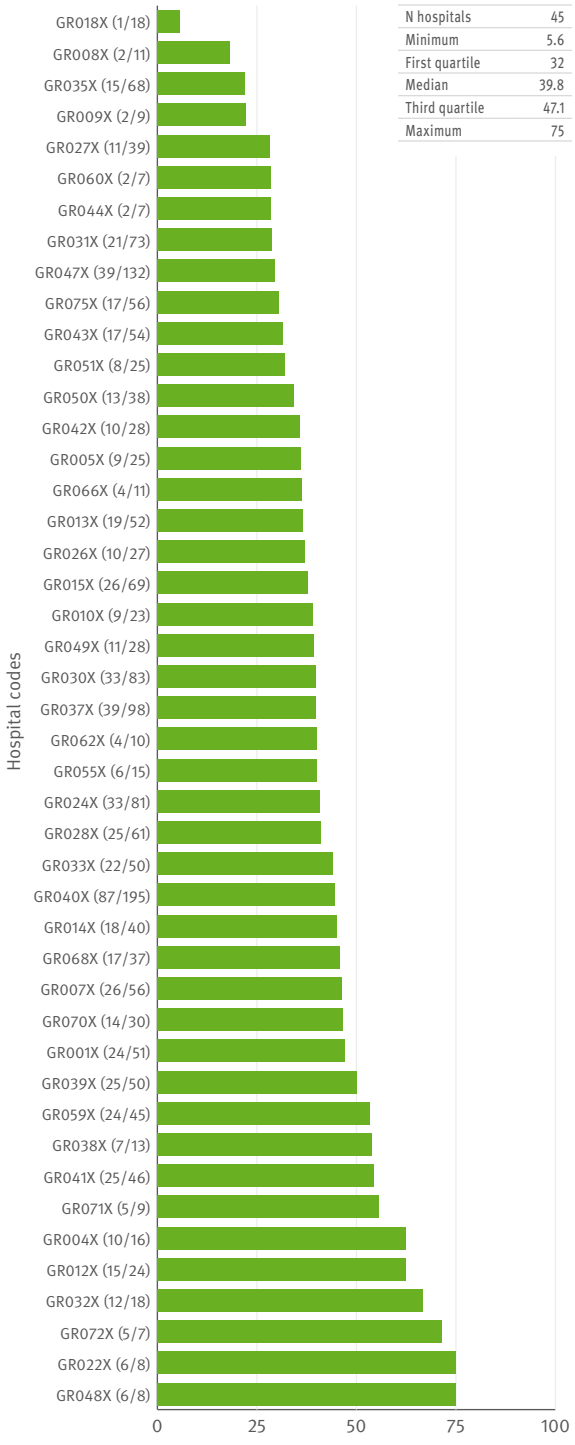


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

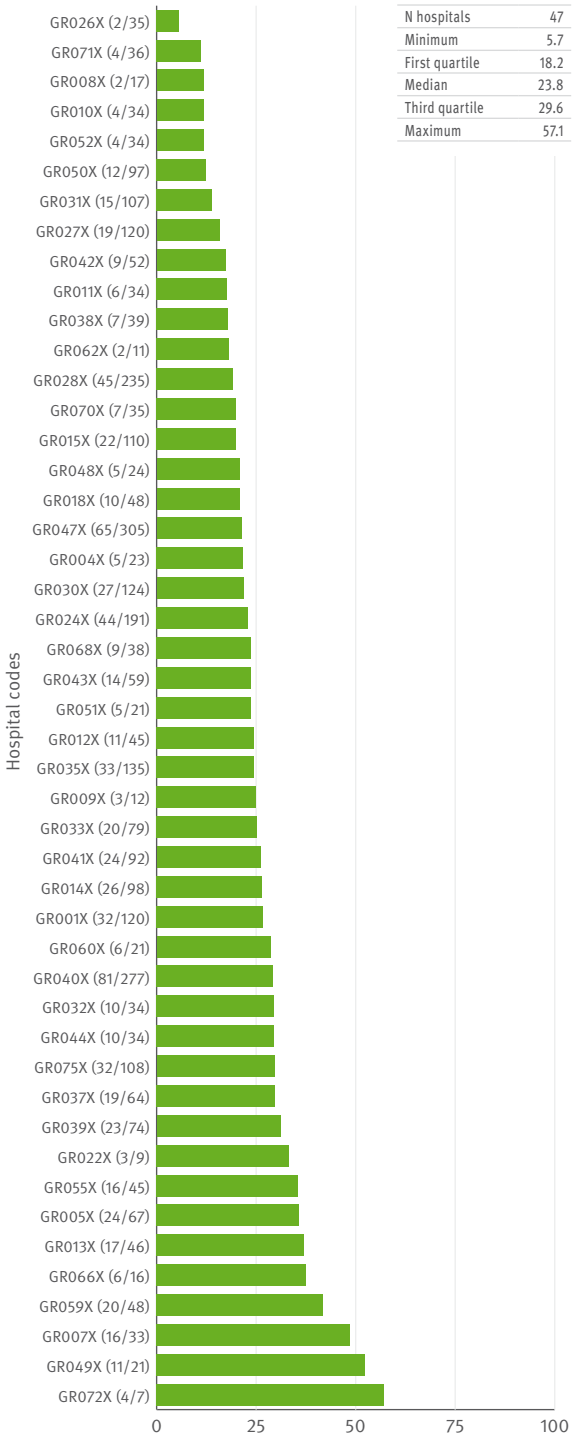
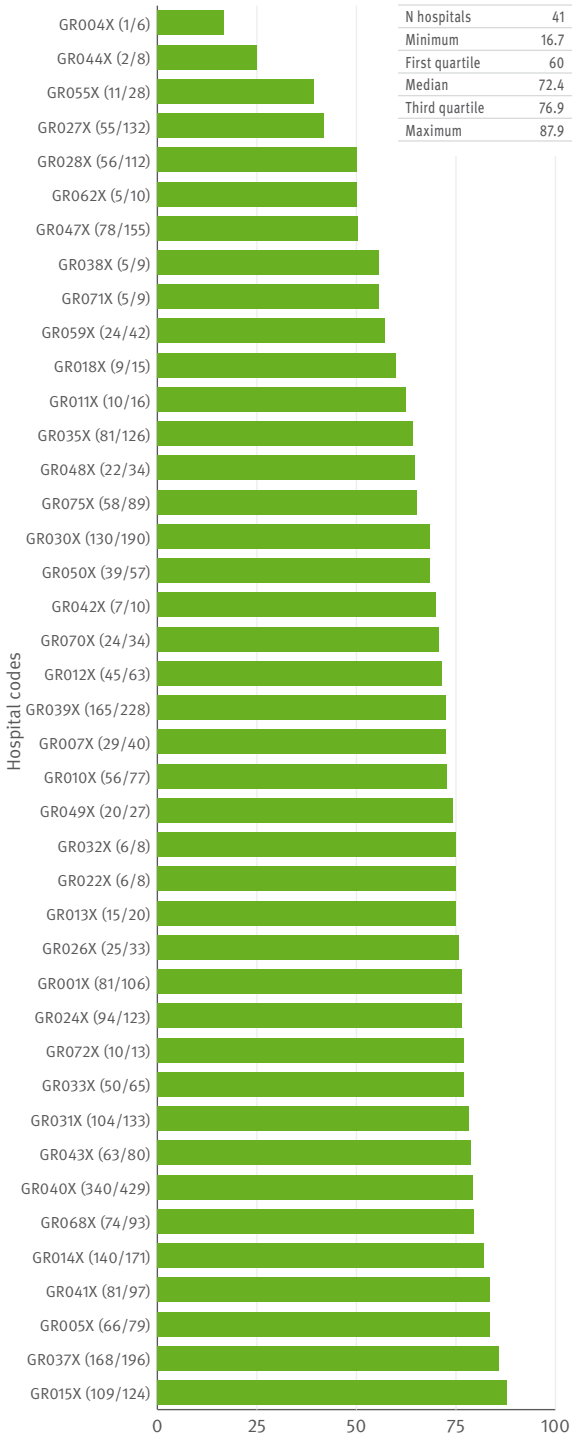


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Hungary

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	27	140	30	1224	29	1385	29	591	29	514	28	636

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	3	<1	4	1	5	8	3	6
Penicillin RI	24	16	21	18	23	27	12	15
Macrolides RI	25	25	32	19	36	32	19	24
Staphylococcus aureus								
Oxacillin/Meticillin R	15	17	20	25	23	23	29	30
Escherichia coli								
Aminopenicilins R	49	55	51	53	54	59	60	65
Aminoglycosides R	8	10	9	12	11	13	16	21
Fluoroquinolones R	15	19	22	27	26	26	30	37
Third-gen. cephalosporins R	<1	3	4	5	5	9	13	19
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	<1	2	1	3	2	3	2	1
HL Gentamicin R	87	57	43	47	48	53	51	51
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	91	95	91	88	88	96	97	97
HL Gentamicin R	96	80	64	67	53	62	70	62
Vancomycin R	<1	<1	<1	<1	<1	3	1	2
Klebsiella pneumoniae								
Aminoglycosides R	-	-	26	20	29	36	40	48
Fluoroquinolones R	-	-	21	13	22	33	33	43
Third-gen. cephalosporins R	-	-	28	20	25	35	38	46
Carbapenems R	.	.	<1	<1	<1	<1	<1	5
Pseudomonas aeruginosa								
Piperacillin R	-	-	10	9	11	13	19	14
Ceftazidime R	-	-	10	8	9	11	12	11
Carbapenems R	-	-	18	16	19	26	27	25
Aminoglycosides R	-	-	32	23	26	26	29	29
Fluoroquinolones R	-	-	28	21	24	26	27	27

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=283		*S. aureus* n=2292		*E. coli* n=2413		*E. faecalis* n=848		*E. faecium* n=181		*K. pneumoniae* n=871		*P. aeruginosa* n=1151	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	73	13	100	30	100	34	100	0	100	2	99	43	97	26
CSF	27	16	-	-	-	-	-	-	-	-	1	14	3	14
Gender														
Male	61	14	63	29	49	36	66	0	61	3	60	46	63	27
Female	38	13	36	30	51	33	33	0	38	0	39	38	34	25
Unknown	1	0	1	47	1	17	2	0	1	0	<1	67	2	14
Age (years)														
0–4	8	13	2	10	2	7	3	0	4	0	7	46	5	12
5–19	7	19	1	6	1	23	1	0	1	0	1	42	1	20
20–64	52	14	46	28	39	34	41	0	49	2	46	42	49	30
65 and over	33	12	51	33	57	35	55	0	47	1	46	44	45	23
Hospital department														
ICU	27	13	19	37	13	32	35	0	41	3	30	46	39	32
Internal med.	18	15	21	29	22	29	18	0	13	0	15	32	9	17
Surgery	1	0	9	35	6	29	6	0	4	0	7	37	9	13
Other	39	10	33	23	41	31	26	0	22	3	29	41	24	22
Unknown	14	22	17	33	19	49	14	0	20	0	20	51	18	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*.

Hungary

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumoniae* by laboratory (2009–2010)

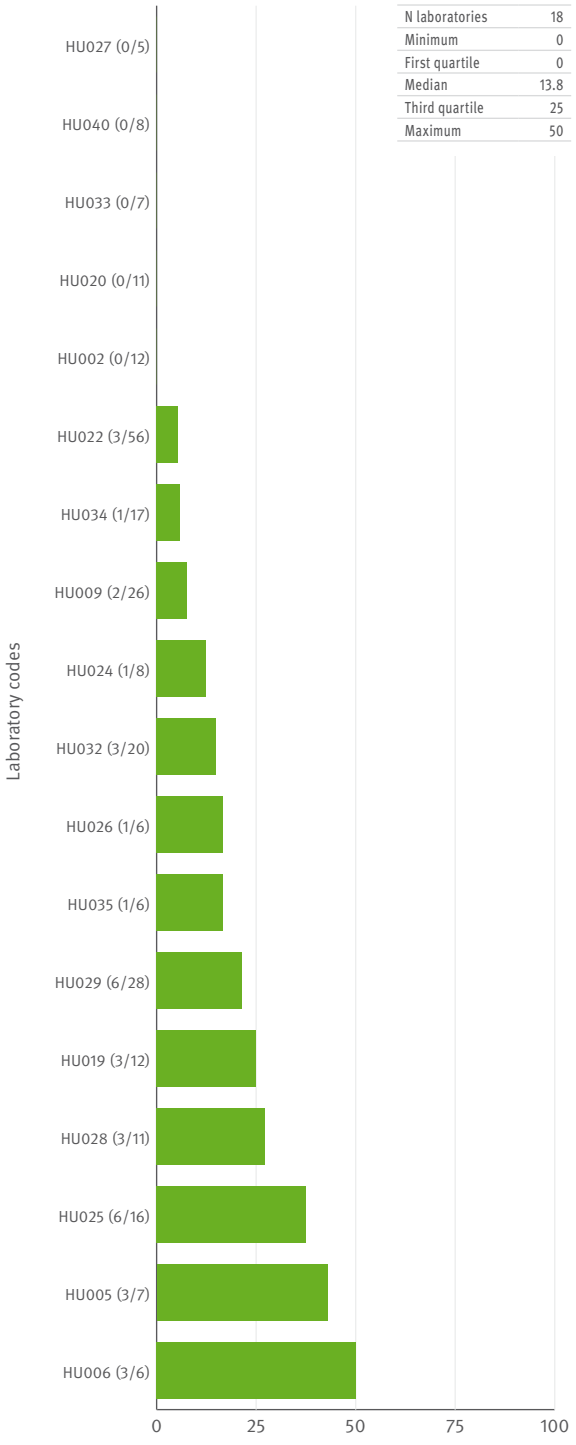


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

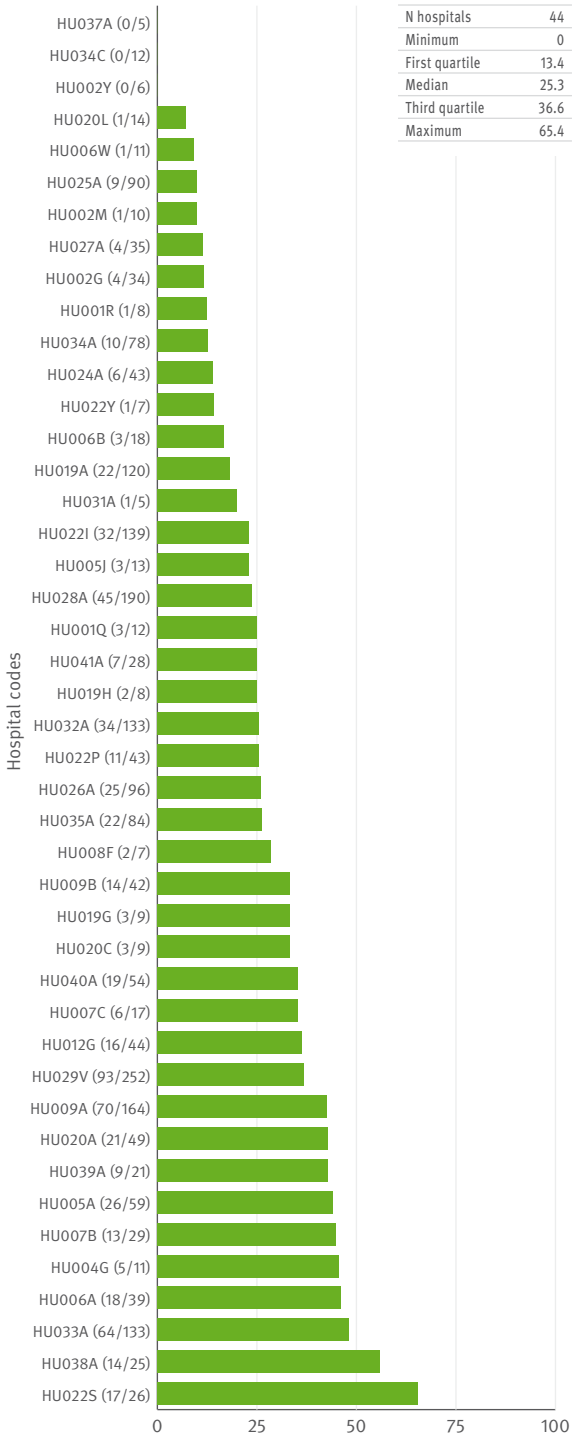


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

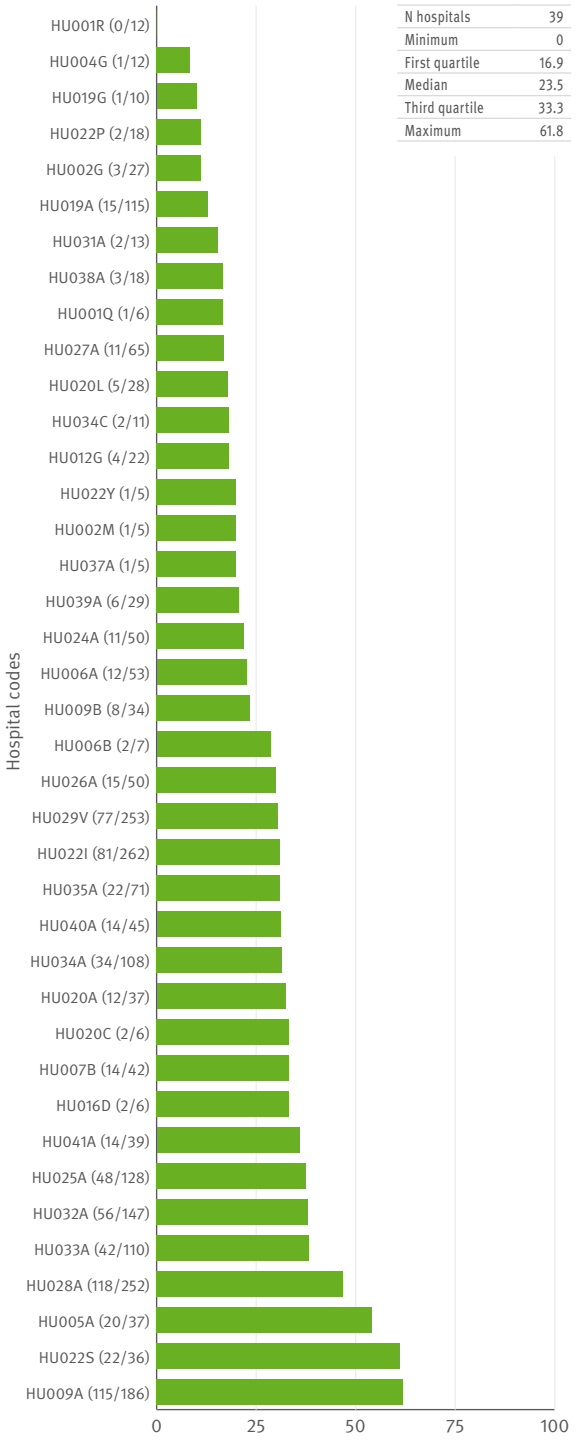
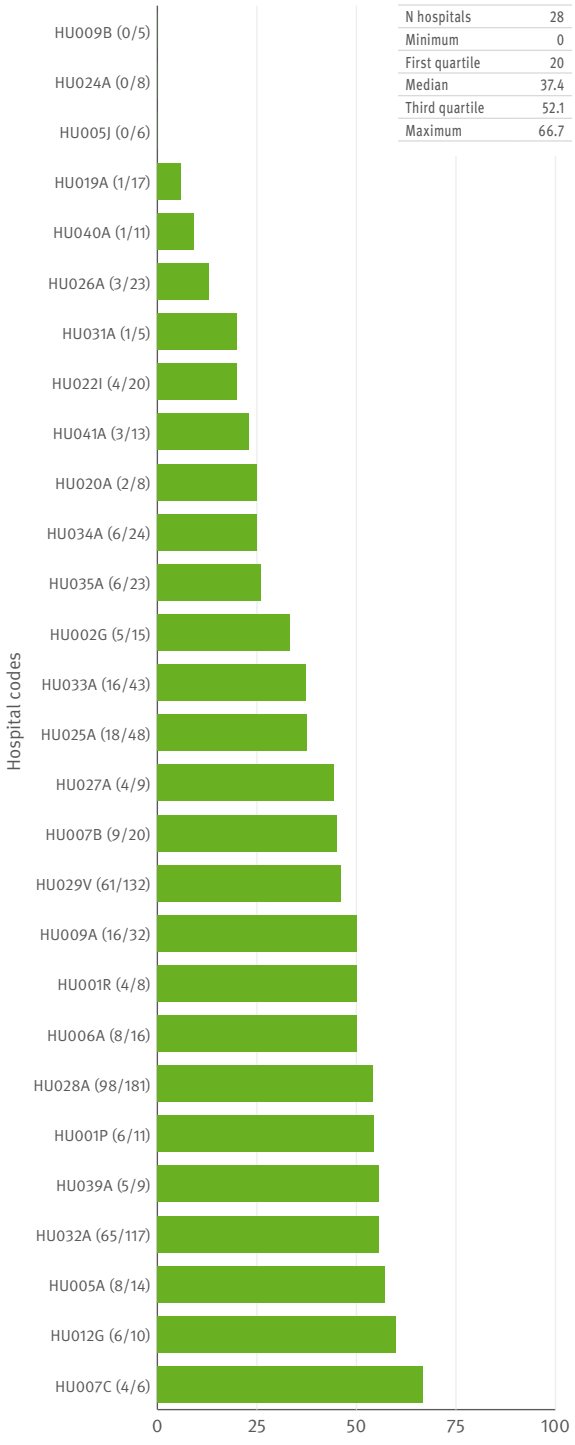


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Iceland

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	2	37	2	65	2	104	2	31	2	27	2	12

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	<1	2	<1	<1	2	<1	<1	3
Penicillin RI	9	17	8	6	7	9	<1	5
Macrolides RI	20	8	17	10	17	22	3	11
Staphylococcus aureus								
Oxacillin/Meticillin R	<1	<1	<1	<1	<1	2	<1	2
Escherichia coli								
Aminopenicilins R	42	43	38	45	46	44	50	46
Aminoglycosides R	2	<1	<1	7	6	7	7	3
Fluoroquinolones R	6	2	3	12	17	6	7	11
Third-gen. cephalosporins R	1	<1	<1	<1	2	<1	2	4
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	<1	<1	<1	7	<1	<1	<1	<1
HL Gentamicin R	<1	5	<1	3	13	30	15	13
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	57	63	80	56	57	43	68	38
HL Gentamicin R	<1	13	<1	14	14	43	36	13
Vancomycin R	<1	<1	<1	<1	<1	<1	8	6
Klebsiella pneumoniae								
Aminoglycosides R	-	-	<1	<1	<1	4	<1	<1
Fluoroquinolones R	-	-	<1	<1	<1	8	<1	<1
Third-gen. cephalosporins R	-	-	<1	<1	<1	4	<1	4
Carbapenems R	-	-	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	8	<1	<1	<1	13	8
Ceftazidime R	-	-	8	<1	<1	<1	6	8
Carbapenems R	-	-	8	<1	<1	<1	<1	<1
Aminoglycosides R	-	-	<1	<1	<1	<1	<1	<1
Fluoroquinolones R	-	-	<1	<1	<1	<1	13	17

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=72		*S. aureus* n=124		*E. coli* n=194		*E. faecalis* n=41		*E. faecium* n=41		*K. pneumoniae* n=54		*P. aeruginosa* n=28	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	96	3	100	1	99	9	100	0	100	7	100	2	100	0
CSF	4	0	-	-	1	0	-	-	-	-	-	-	-	-
Gender														
Male	53	3	62	1	46	11	76	0	56	13	57	3	71	0
Female	47	3	38	0	54	7	24	0	44	0	43	0	29	0
Age (years)														
0–4	15	18	3	0	4	0	5	0	-	-	-	-	4	0
5–19	4	0	4	0	2	0	-	-	2	0	-	-	-	-
20–64	43	0	40	2	30	16	32	0	37	7	39	0	32	0
65 and over	38	0	53	0	64	6	63	0	61	8	61	3	64	0
Hospital department														
ICU	3	0	2	0	2	33	10	0	10	0	-	-	4	0
Internal med.	15	9	25	0	20	3	15	0	10	0	15	0	25	0
Surgery	-	-	5	0	3	17	10	0	15	0	4	0	7	0
Other	78	2	67	1	73	10	63	0	59	13	80	2	61	0
Unknown	4	0	1	0	3	0	2	0	7	0	2	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. pneumoniae* by laboratory (2009–2010)

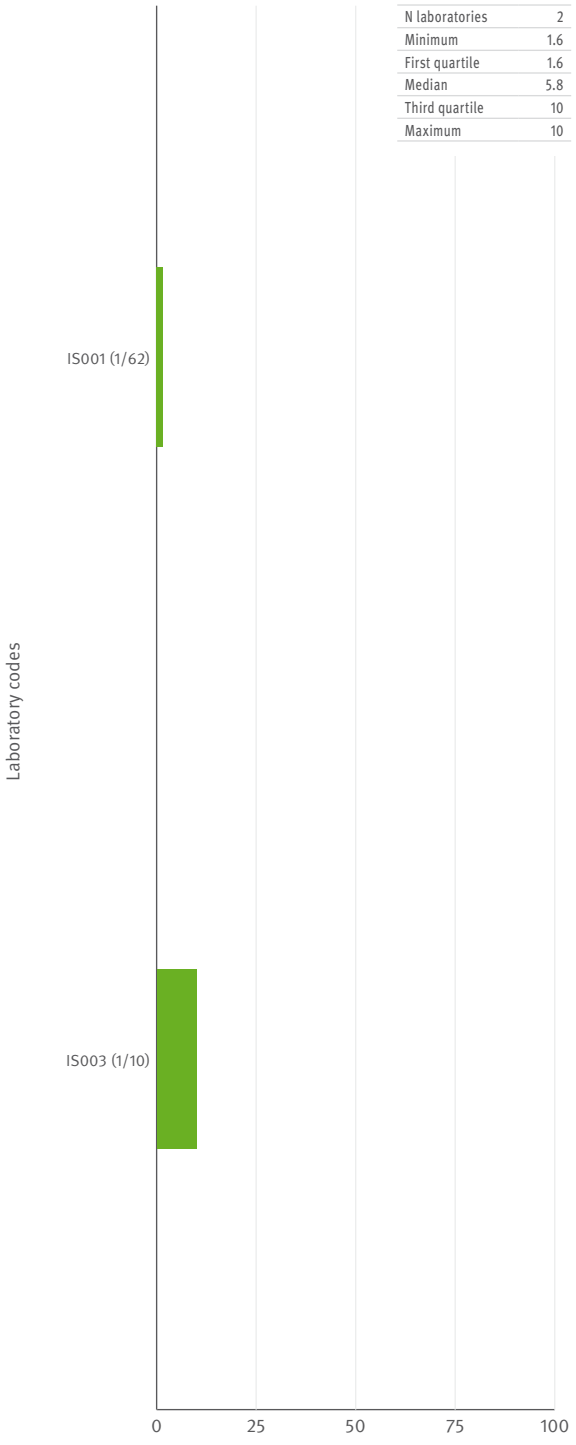


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

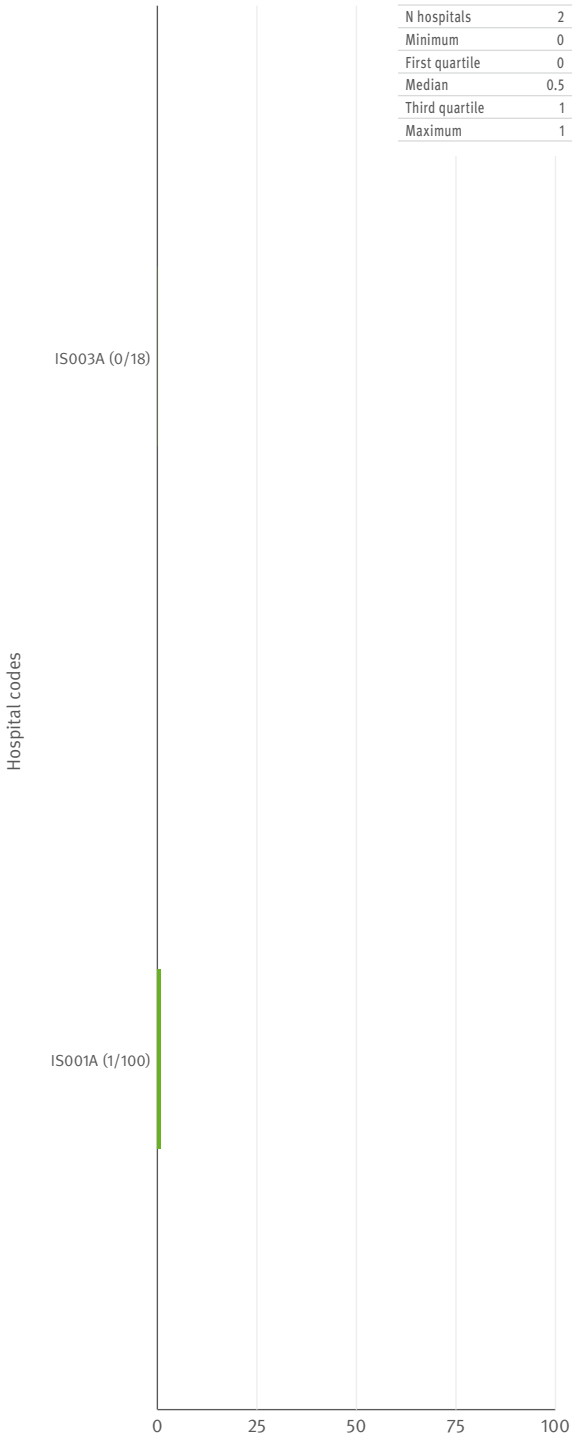


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

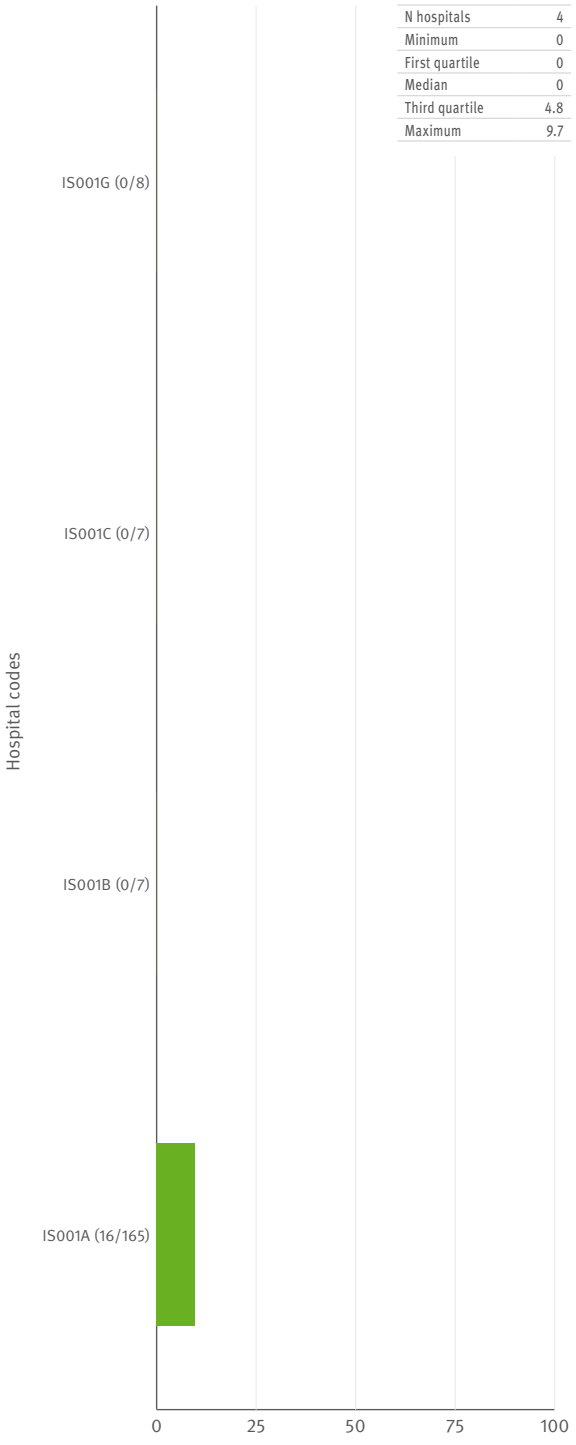
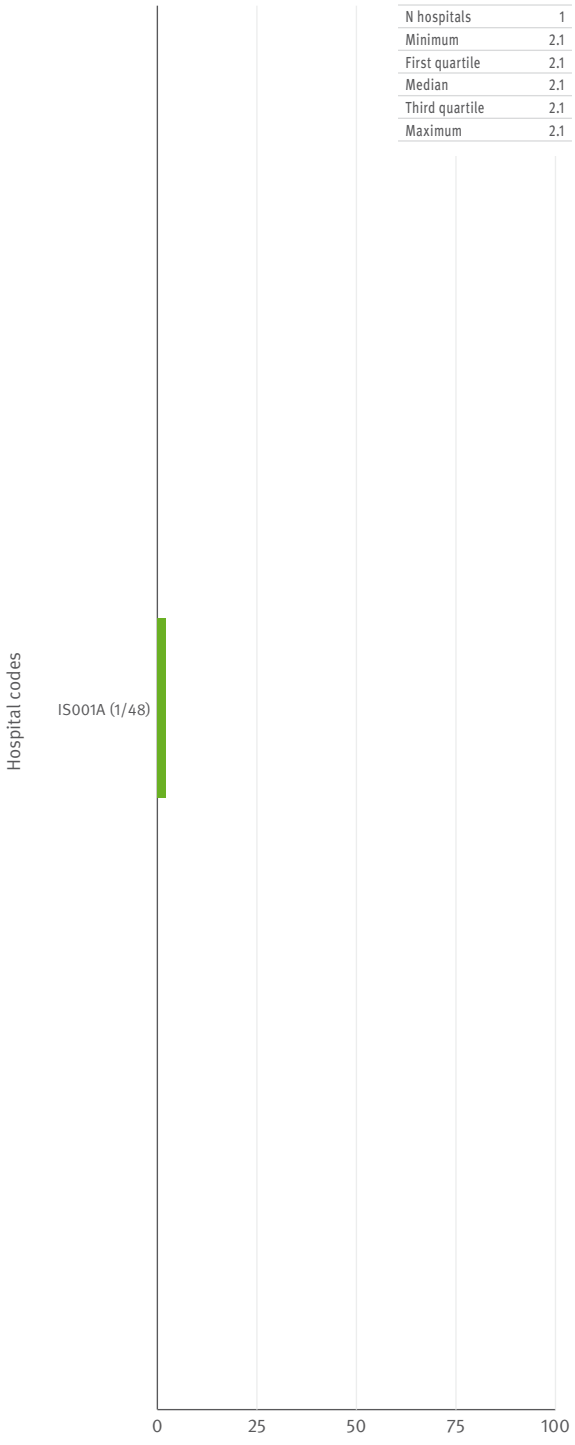


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Ireland

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	32	310	39	1207	40	2121	38	670	34	318	30	219

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	3	3	3	3	6	6	6	5
Penicillin RI	12	10	11	16	17	23	20	18
Macrolides RI	12	14	12	16	17	17	17	16
Staphylococcus aureus								
Oxacillin/Meticillin R	42	41	42	42	38	33	27	24
Escherichia coli								
Aminopenicilins R	61	65	67	69	65	67	66	67
Aminoglycosides R	4	5	7	7	10	9	9	10
Fluoroquinolones R	10	12	17	21	21	23	22	23
Third-gen. cephalosporins R	2	2	4	4	5	6	6	8
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	5	<1	4	5	2	<1	3	2
HL Gentamicin R	32	42	42	43	38	31	34	29
Vancomycin R	<1	1	3	3	3	3	<1	<1
Enterococcus faecium								
Aminopenicilins RI	91	96	93	94	93	95	93	96
HL Gentamicin R	54	56	52	44	36	27	38	39
Vancomycin R	19	22	31	36	33	35	38	39
Klebsiella pneumoniae								
Aminoglycosides R	-	-	5	9	10	9	11	7
Fluoroquinolones R	-	-	3	16	17	11	11	8
Third-gen. cephalosporins R	-	-	7	9	8	11	11	8
Carbapenems R	-	-	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	7	7	6	5	4	8
Ceftazidime R	-	-	10	6	5	4	6	6
Carbapenems R	-	-	11	9	9	6	8	6
Aminoglycosides R	-	-	7	9	10	6	6	5
Fluoroquinolones R	-	-	14	17	18	16	9	11

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=666		*S. aureus* n=2 468		*E. coli* n=4 122		*E. faecalis* n=571		*E. faecium* n=768		*K. pneumoniae* n=632		*P. aeruginosa* n=440	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	97	20	100	25	100	22	100	1	100	38	100	10	99	8
CSF	3	5	-	-	<1	11	-	-	-	-	-	-	1	0
Gender														
Male	54	18	64	26	45	26	59	0	57	40	55	11	55	7
Female	46	20	36	25	55	19	41	0	43	36	45	9	45	8
Unknown	-	-	-	-	<1	0	<1	100	-	-	-	-	-	-
Age (years)														
0–4	12	21	9	7	3	4	10	0	3	13	4	18	4	6
5–19	4	8	4	10	1	8	1	0	2	20	1	0	3	31
20–64	37	15	38	21	30	19	35	1	41	50	45	9	36	11
65 and over	47	22	49	33	65	25	54	1	54	32	49	10	57	4
Unknown	-	-	-	-	<1	0	-	-	-	-	-	-	-	-
Hospital department														
ICU	4	8	3	37	3	24	4	0	7	33	3	0	6	12
Internal med.	13	23	12	39	13	26	13	0	7	38	8	6	12	6
Surgery	1	29	6	30	6	25	5	0	5	31	4	8	6	7
Other	30	16	21	17	23	17	18	1	12	29	19	4	15	13
Unknown	53	20	58	24	55	23	60	1	69	41	67	12	61	6

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. pneumoniae* by laboratory (2009–2010)

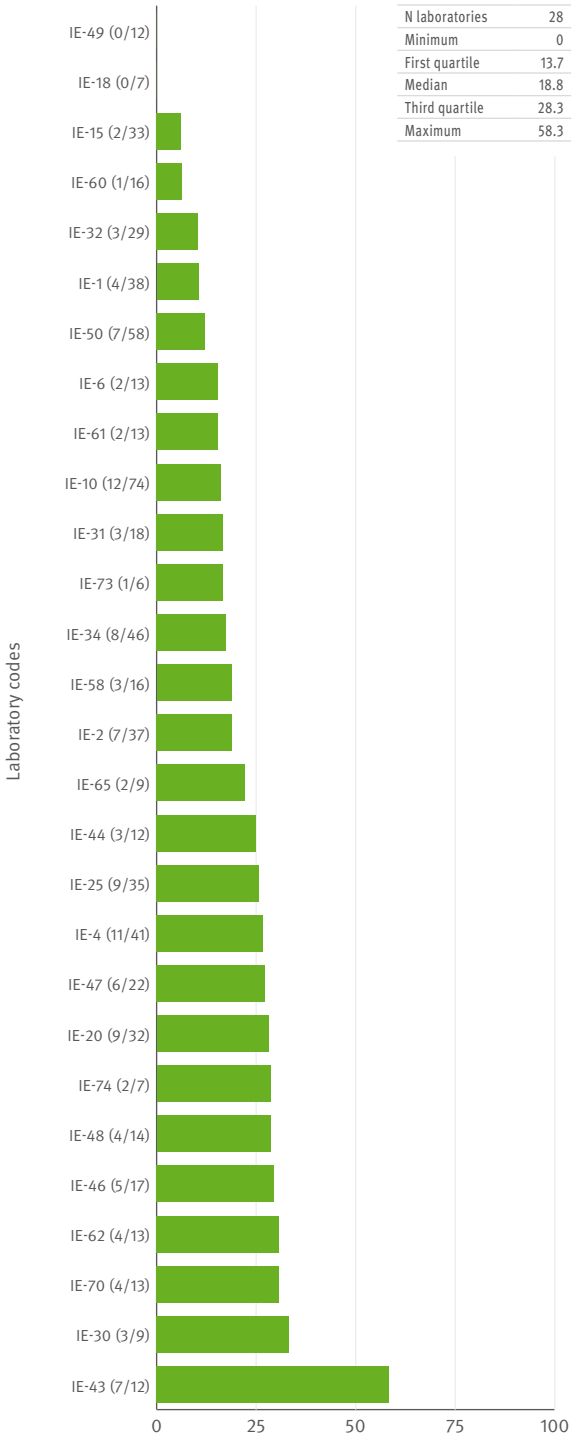


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

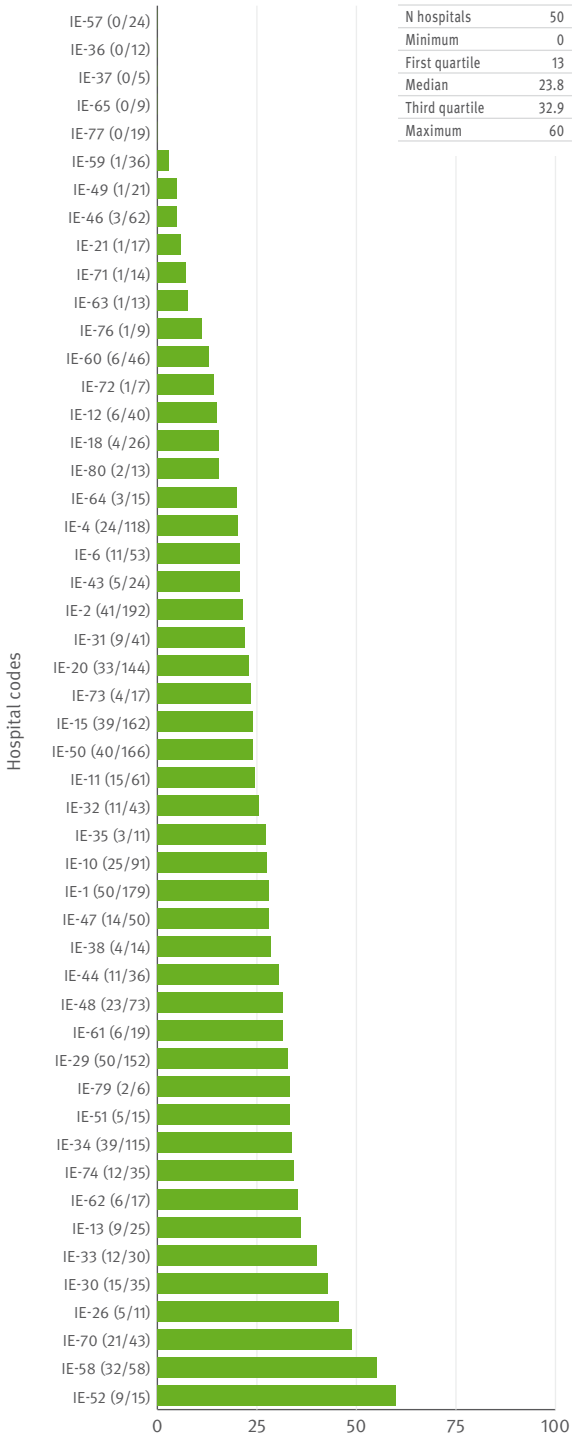


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

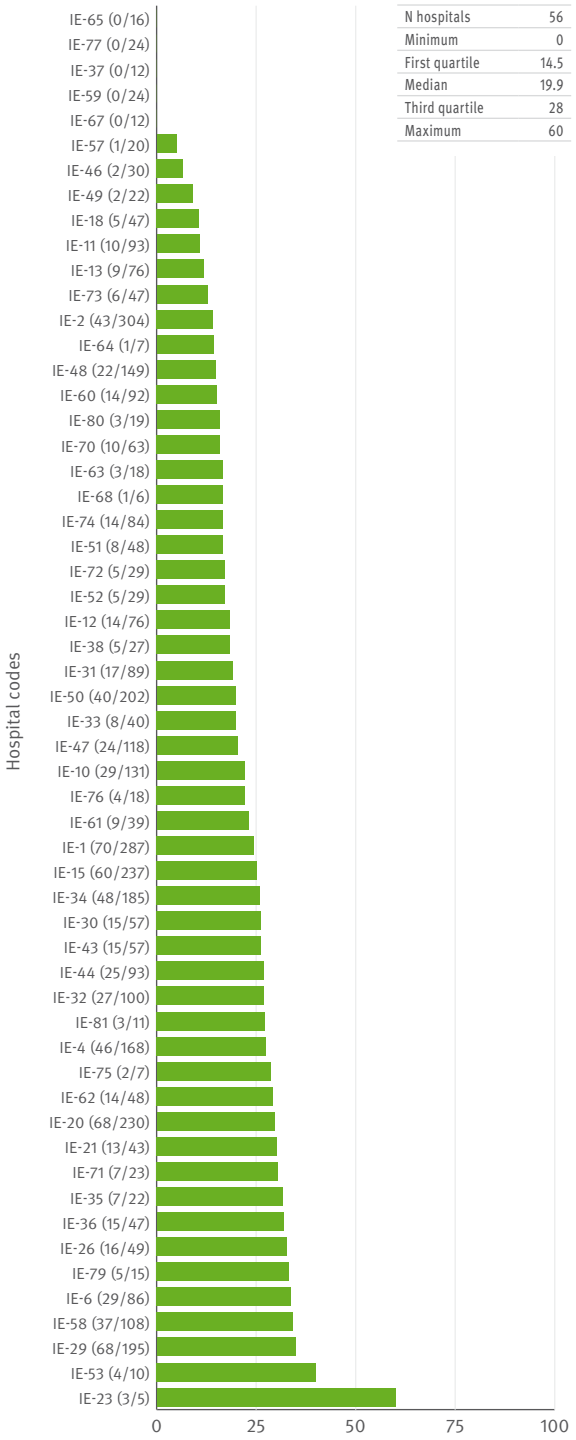
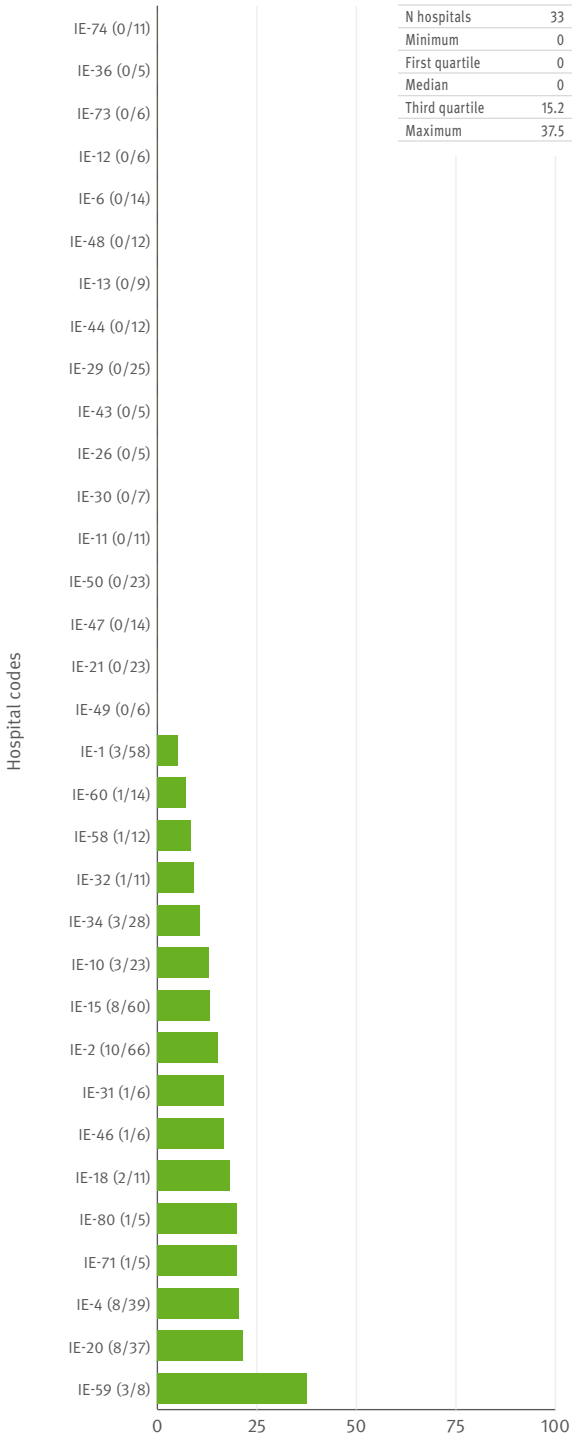


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Italy

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	33	323	35	1886	23	2623	35	1106	34	739	23	517

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	5	5	5	<1	4	3	3	5
Penicillin RI	13	14	9	7	15	10	6	9
Macrolides RI	37	29	31	33	31	26	21	29
Staphylococcus aureus								
Oxacillin/Meticillin R	39	40	37	38	33	34	37	37
Escherichia coli								
Aminopenicilins R	52	53	55	56	58	62	63	64
Aminoglycosides R	10	9	11	8	14	14	13	15
Fluoroquinolones R	25	28	28	27	32	38	36	39
Third-gen. cephalosporins R	6	5	8	7	11	16	17	21
Carbapenems R	-	-	-	-	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	4	4	4	4	4	13	20	13
HL Gentamicin R	39	36	38	38	39	47	49	50
Vancomycin R	2	2	3	3	2	2	3	2
Enterococcus faecium								
Aminopenicilins RI	80	78	77	86	73	64	60	70
HL Gentamicin R	44	39	36	48	53	49	52	59
Vancomycin R	24	21	19	18	11	6	4	4
Klebsiella pneumoniae								
Aminoglycosides R	-	-	8	26	25	28	19	29
Fluoroquinolones R	-	-	11	23	27	28	20	39
Third-gen. cephalosporins R	-	-	20	33	35	39	37	47
Carbapenems R	-	-	-	1	1	2	1	15
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	23	20	20	24	21
Ceftazidime R	-	-	-	20	25	24	16	18
Carbapenems R	-	-	-	21	27	33	31	22
Aminoglycosides R	-	-	-	30	27	30	36	23
Fluoroquinolones R	-	-	-	36	35	36	42	31

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=431		*S. aureus* n=2744		*E. coli* n=3299		*E. faecalis* n=956		*E. faecium* n=600		*K. pneumoniae* n=973		*P. aeruginosa* n=697	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	90	8	100	37	100	38	100	2	100	4	98	44	98	24
CSF	10	7	-	-	<1	27	-	-	-	-	2	56	2	27
Gender														
Male	47	8	54	39	44	46	58	3	54	4	54	49	58	24
Female	39	9	36	37	46	33	34	1	35	4	37	42	34	25
Unknown	14	3	10	24	10	34	8	1	11	3	9	21	8	25
Age (years)														
0–4	8	6	2	25	1	8	4	0	1	0	3	45	1	20
5–19	2	0	1	13	1	21	<1	0	1	0	1	50	<1	67
20–64	24	5	22	27	17	36	18	2	19	3	22	44	20	37
65 and over	41	6	47	41	44	38	51	2	47	3	45	48	41	17
Unknown	24	15	28	39	37	42	28	3	33	6	28	37	37	25
Hospital department														
ICU	6	8	7	41	4	42	13	2	13	4	13	57	17	35
Internal med.	21	9	34	38	30	38	32	2	28	5	30	47	26	19
Surgery	2	13	8	42	11	42	10	2	10	3	11	35	10	16
Other	35	10	17	29	25	39	13	2	18	3	16	34	15	19
Unknown	35	5	34	37	30	36	31	3	32	4	30	43	31	28

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. pneumoniae* by laboratory (2009–2010)

Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

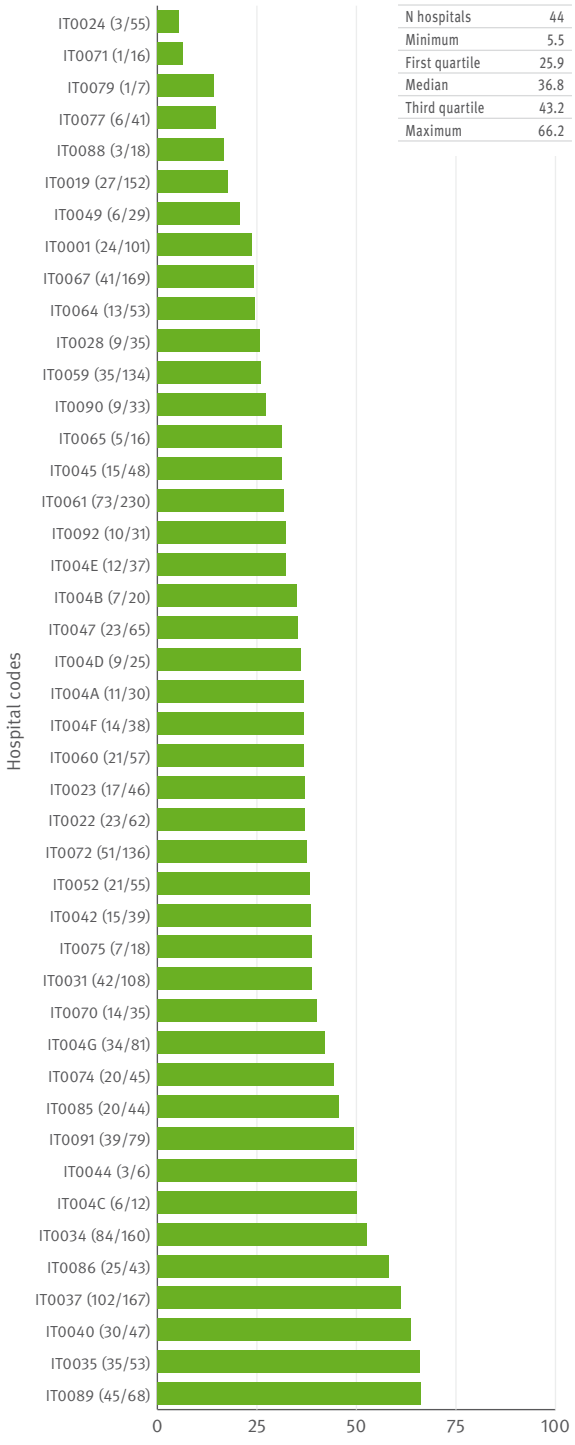


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

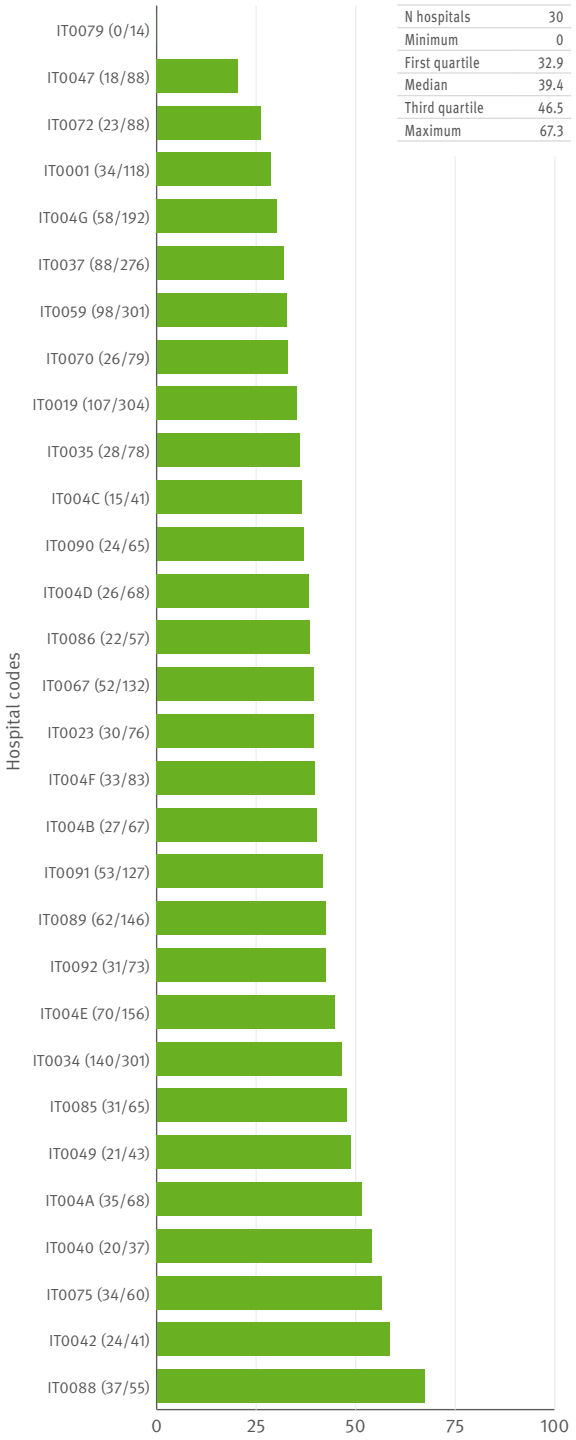
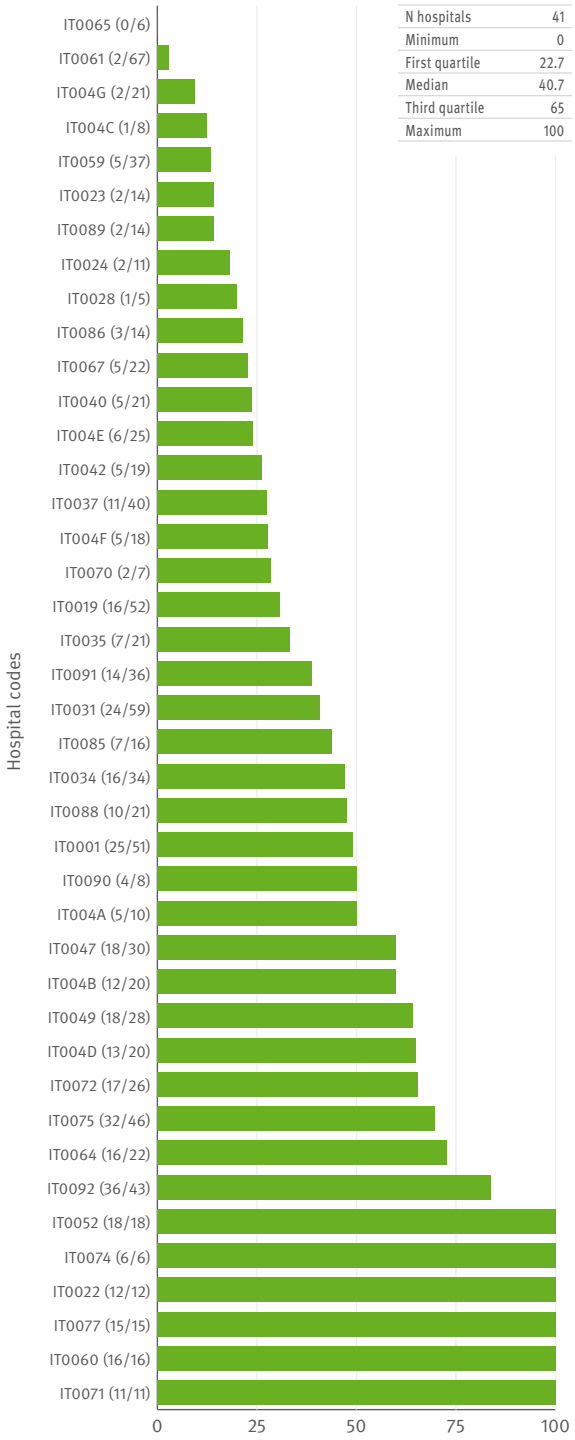


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Latvia

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
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
2010	4	38	10	155	8	98	8	61	8	64	6	21

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	-	<1	<1	<1	<1	6	<1	5
Penicillin RI	-	<1	<1	<1	<1	6	<1	5
Macrolides RI	-	7	3	3	<1	<1	3	5
Staphylococcus aureus								
Oxacillin/Meticillin R	-	26	20	19	8	12	9	14
Escherichia coli								
Aminopenicilins R	-	-	-	44	43	48	43	50
Aminoglycosides R	-	-	-	5	14	10	13	11
Fluoroquinolones R	-	-	-	10	17	14	24	14
Third-gen. cephalosporins R	-	-	-	6	14	11	12	12
Carbapenems R	-	-	-	<1	<1	<1	2	<1
Enterococcus faecalis								
Aminopenicilins RI	-	-	-	9	30	5	12	5
HL Gentamicin R	-	-	-	50	-	27	38	47
Vancomycin R	-	-	-	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	-	-	-	94	77	90	82	100
HL Gentamicin R	-	-	-	73	<1	78	79	83
Vancomycin R	-	-	-	<1	<1	7	18	13
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	25	22	52	43	55
Fluoroquinolones R	-	-	-	26	27	45	34	52
Third-gen. cephalosporins R	-	-	-	36	44	58	55	55
Carbapenems R	-	-	-	<1	<1	3	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	17	31	30	17	19
Ceftazidime R	-	-	-	29	13	36	17	10
Carbapenems R	-	-	-	13	6	40	7	14
Aminoglycosides R	-	-	-	47	31	44	22	29
Fluoroquinolones R	-	-	-	33	13	45	12	19

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=67		*S. aureus* n=339		*E. coli* n=182		*E. faecalis* n=64		*E. faecium* n=45		*K. pneumoniae* n=108		*P. aeruginosa* n=35	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	79	4	100	11	100	19	100	0	100	16	98	54	97	12
CSF	21	0	-	-	-	-	-	-	-	-	2	100	3	0
Gender														
Male	52	0	50	13	28	25	59	0	51	9	55	54	60	14
Female	48	6	50	10	72	16	41	0	49	23	45	55	40	7
Age (years)														
0–4	7	20	8	4	5	10	13	0	7	0	22	50	11	0
5–19	-	-	2	0	4	13	-	-	-	-	1	100	-	-
20–64	69	2	47	16	46	19	41	0	56	12	46	58	49	18
65 and over	24	0	40	8	42	17	45	0	33	20	31	52	37	8
Unknown	-	-	2	13	2	75	2	0	4	50	-	-	3	0
Hospital department														
ICU	58	0	21	13	25	30	36	0	64	21	37	75	54	16
Internal med.	4	33	36	10	24	14	16	0	11	20	13	36	17	0
Surgery	3	0	9	20	6	36	6	0	11	0	6	67	3	0
Other	18	0	26	13	24	19	30	0	11	0	26	50	23	13
Unknown	16	9	9	0	21	5	13	0	2	0	19	30	3	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. pneumoniae* by laboratory (2009–2010)

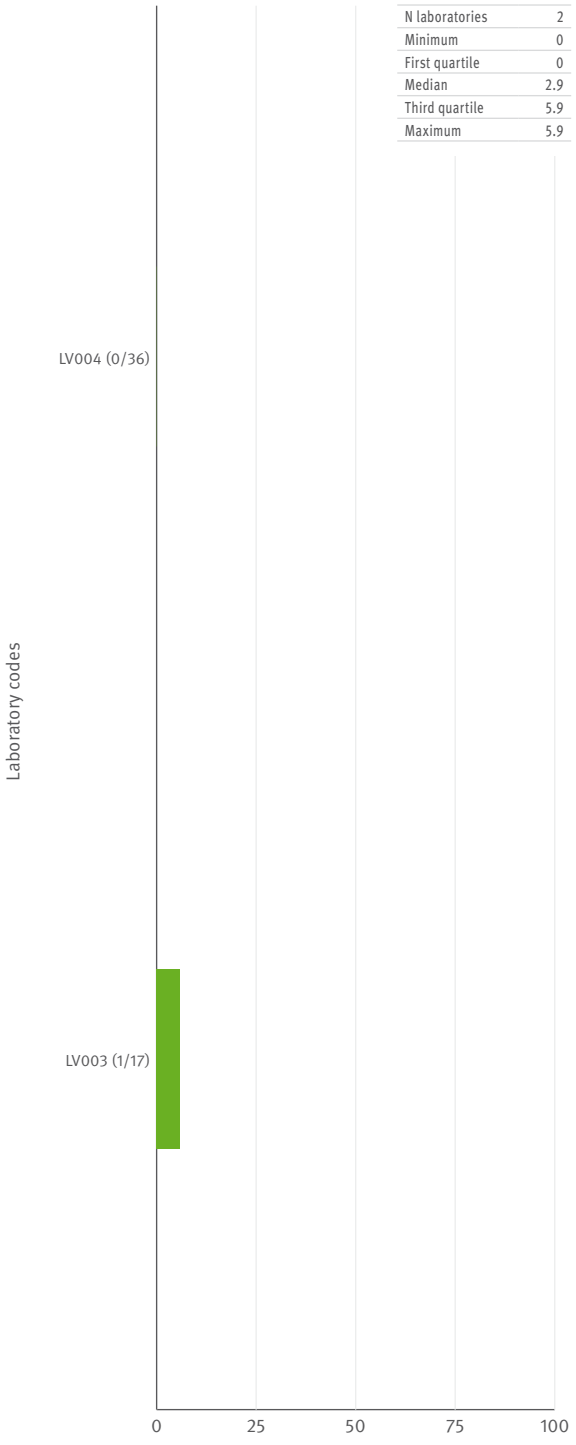


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

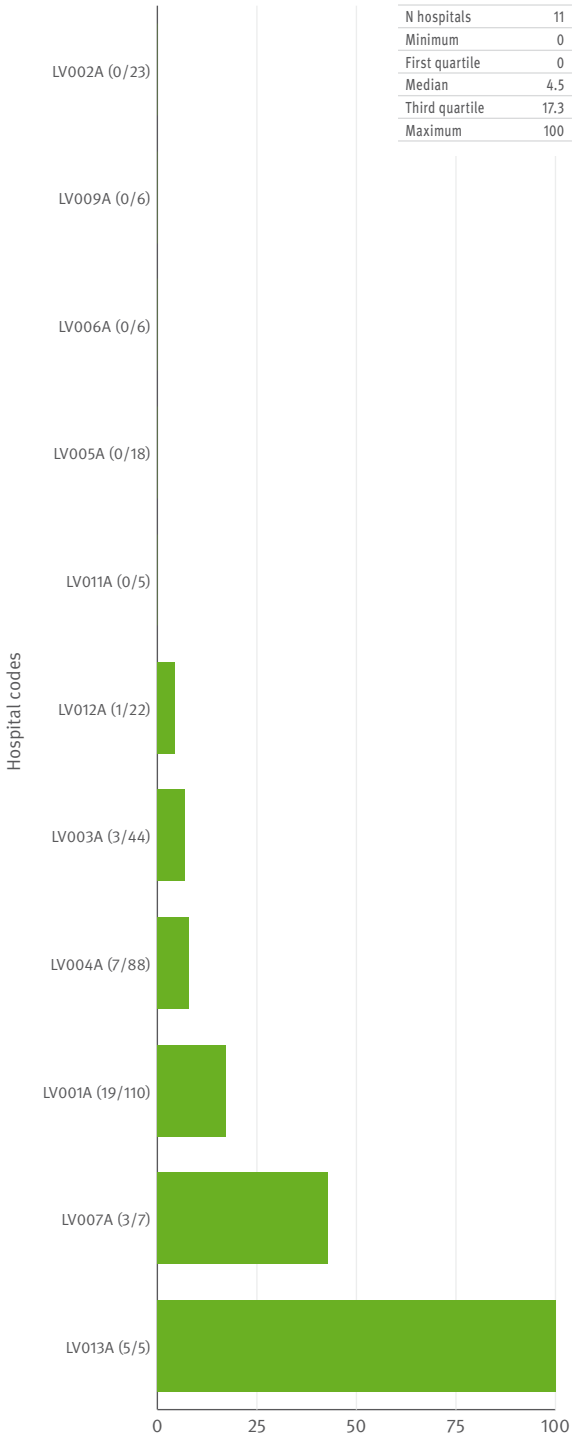


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

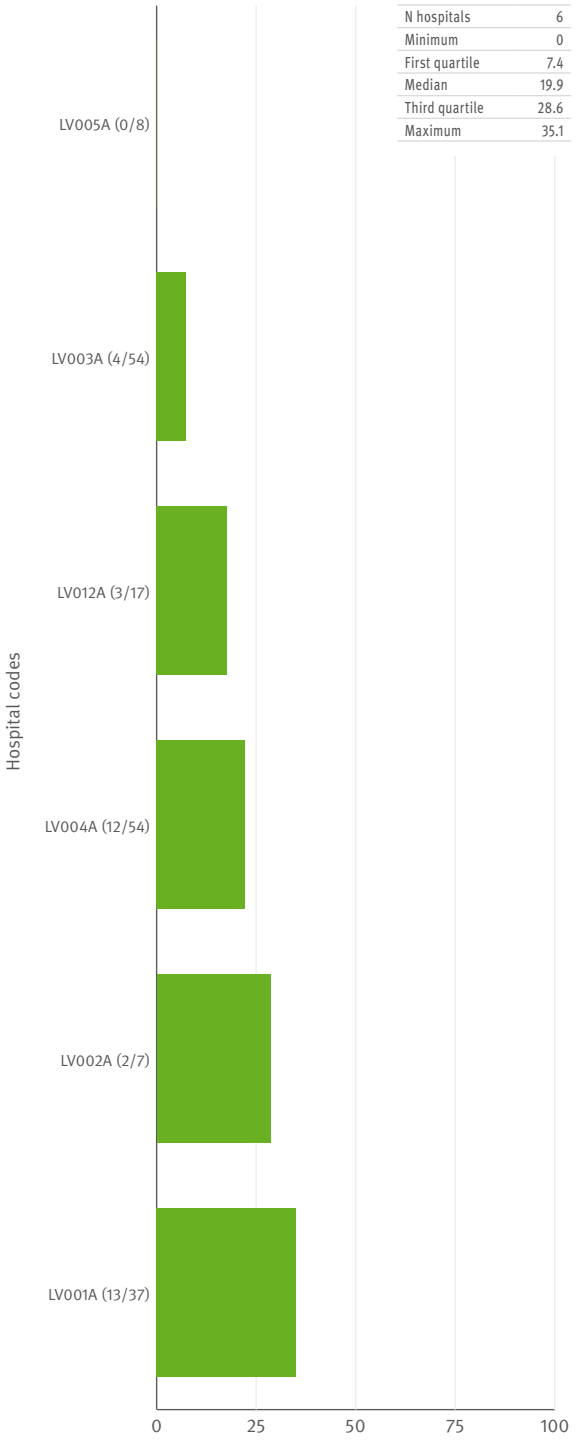
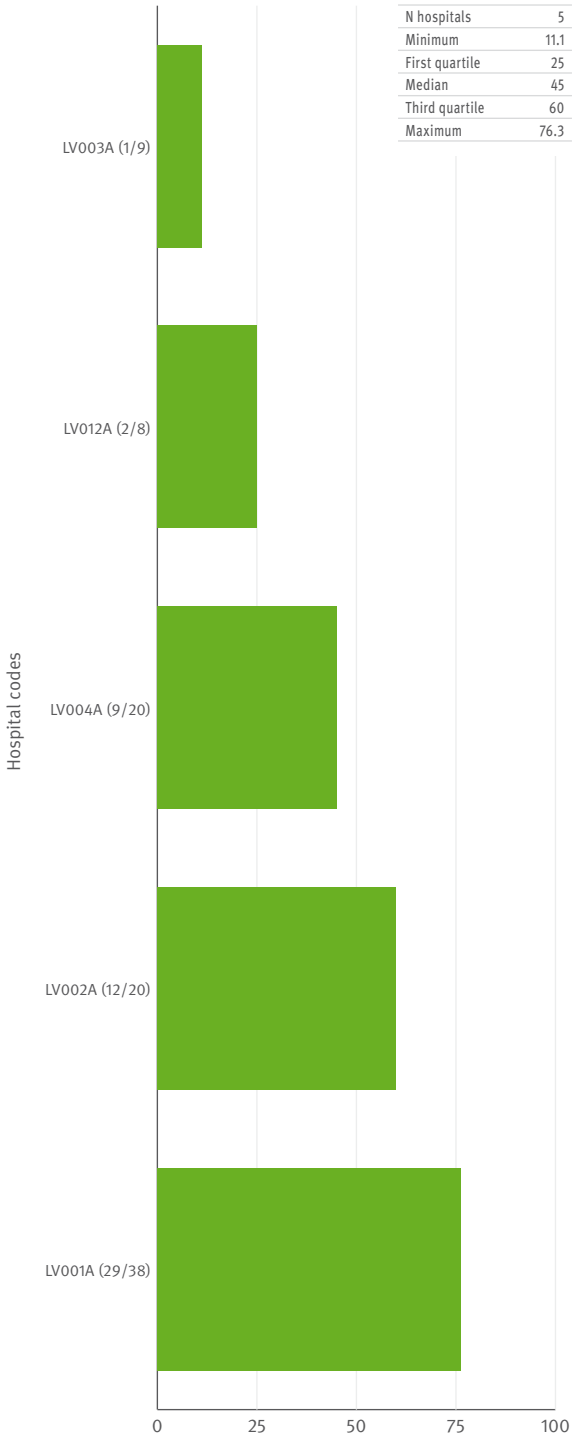


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Lithuania

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterecocci		*K. pneumoniae*		*P. aeruginosa*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
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
2010	9	40	11	257	10	333	10	59	9	81	8	31

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	-	-	-	<1	1	<1	7	8
Penicillin RI	-	-	-	16	4	2	9	13
Macrolides RI	-	-	-	<1	9	6	7	<1
Staphylococcus aureus								
Oxacillin/Meticillin R	-	-	-	13	9	11	11	14
Escherichia coli								
Aminopenicilins R	-	-	-	55	50	54	58	56
Aminoglycosides R	-	-	-	15	12	12	15	15
Fluoroquinolones R	-	-	-	12	9	14	15	14
Third-gen. cephalosporins R	-	-	-	5	7	6	8	9
Carbapenems R	-	-	-	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	-	-	-	5	3	5	3	13
HL Gentamicin R	-	-	-	50	41	33	48	41
Vancomycin R	-	-	-	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	-	-	-	75	100	88	95	88
HL Gentamicin R	-	-	-	75	81	78	64	87
Vancomycin R	-	-	-	<1	<1	<1	11	8
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	26	37	41	56	52
Fluoroquinolones R	-	-	-	3	8	23	37	36
Third-gen. cephalosporins R	-	-	-	23	27	36	57	51
Carbapenems R	-	-	-	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	21	5	14	20	6
Ceftazidime R	-	-	-	31	<1	10	14	10
Carbapenems R	-	-	-	21	30	24	19	27
Aminoglycosides R	-	-	-	29	33	38	19	13
Fluoroquinolones R	-	-	-	46	38	35	33	16

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=85		*S. aureus* n=509		*E. coli* n=628		*E. faecalis* n=72		*E. faecium* n=43		*K. pneumoniae* n=148		*P. aeruginosa* n=51	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	94	11	100	13	100	14	100	0	100	9	100	53	100	24
CSF	6	0	-	-	<1	33	-	-	-	-	-	-	-	-
Gender														
Male	68	3	54	12	39	16	69	0	53	17	59	53	63	25
Female	31	27	44	14	61	12	29	0	47	0	41	53	37	21
Unknown	1	0	1	0	<1	33	1	0	-	-	-	-	-	-
Age (years)														
0–4	25	14	5	4	5	10	14	0	14	0	11	88	4	0
5–19	6	20	8	5	2	8	-	-	5	0	1	100	2	0
20–64	49	10	45	10	39	19	33	0	37	6	39	49	39	35
65 and over	20	6	41	19	54	11	53	0	44	16	49	48	55	18
Unknown	-	-	1	0	<1	0	-	-	-	-	1	100	-	-
Hospital department														
ICU	48	5	21	10	20	17	26	0	35	20	40	64	43	23
Internal med.	20	18	43	12	37	9	36	0	19	0	27	40	27	21
Surgery	1	0	10	13	7	9	6	0	5	50	11	44	2	0
Other	29	16	25	16	35	18	29	0	40	0	20	57	25	31
Unknown	1	0	1	0	1	14	3	0	2	0	2	33	2	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. pneumoniae* by laboratory (2009–2010)

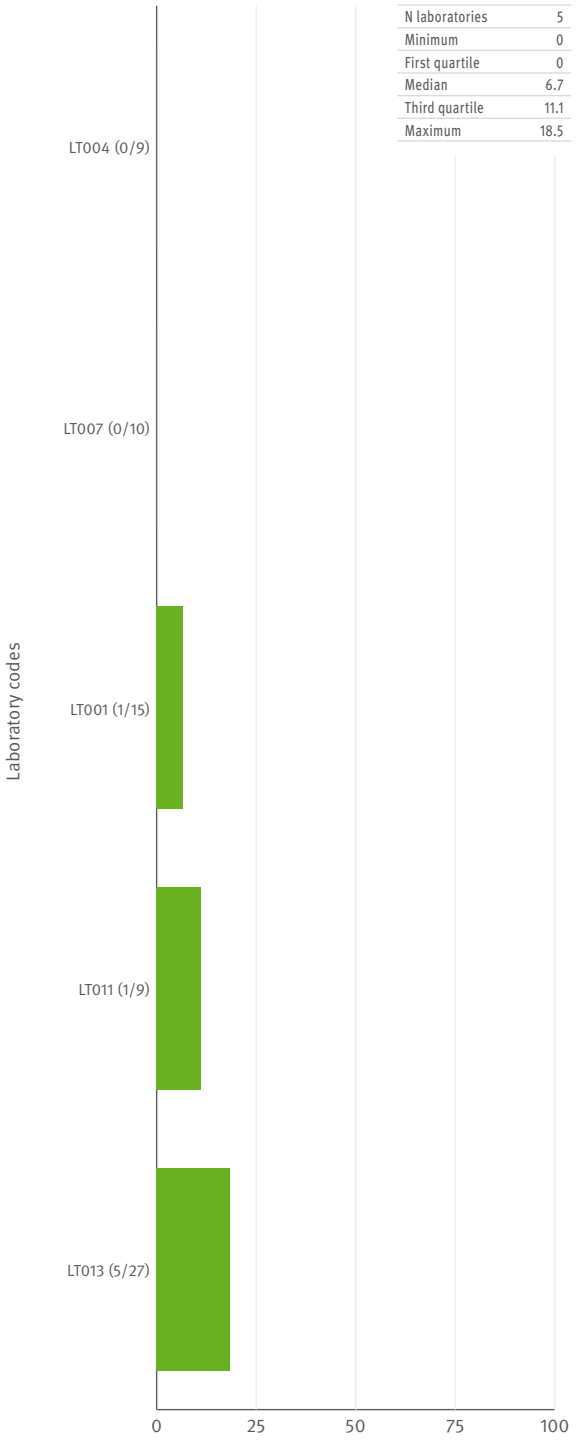


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

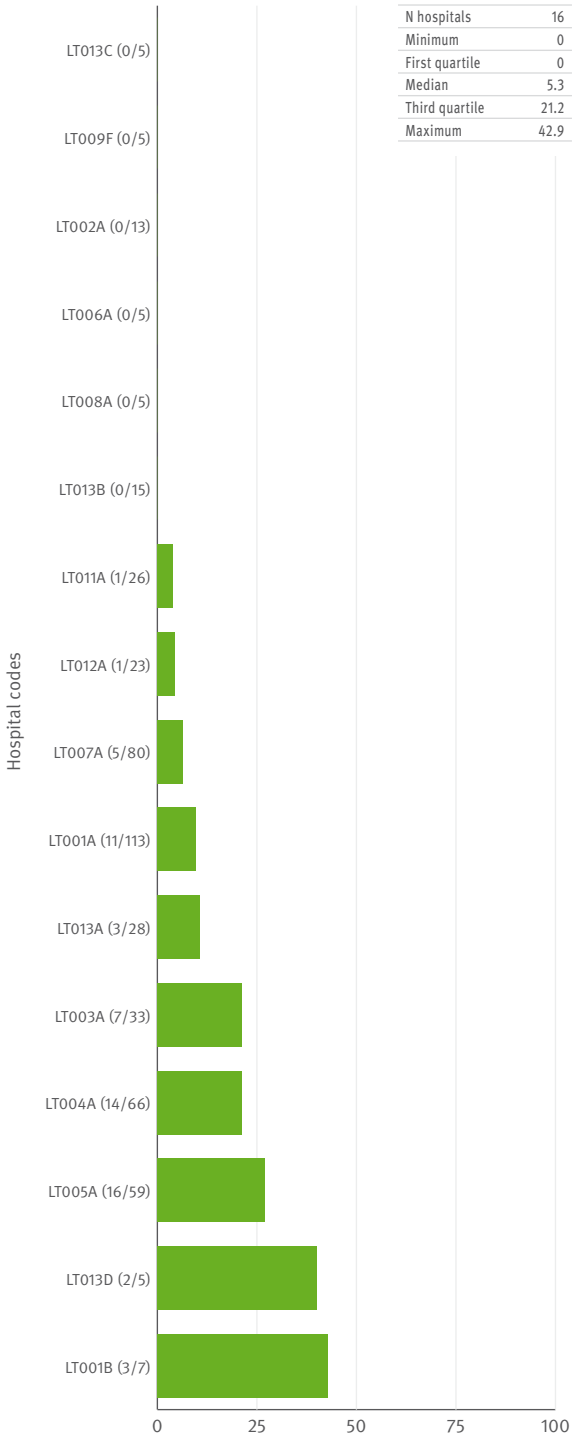


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

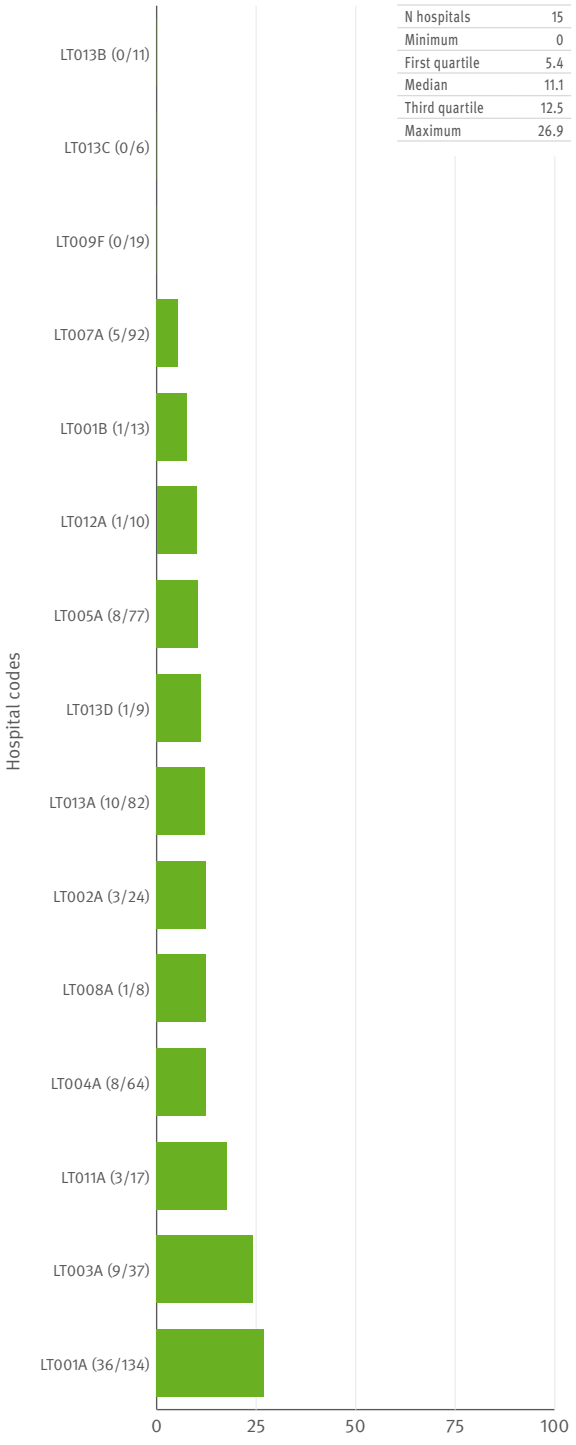
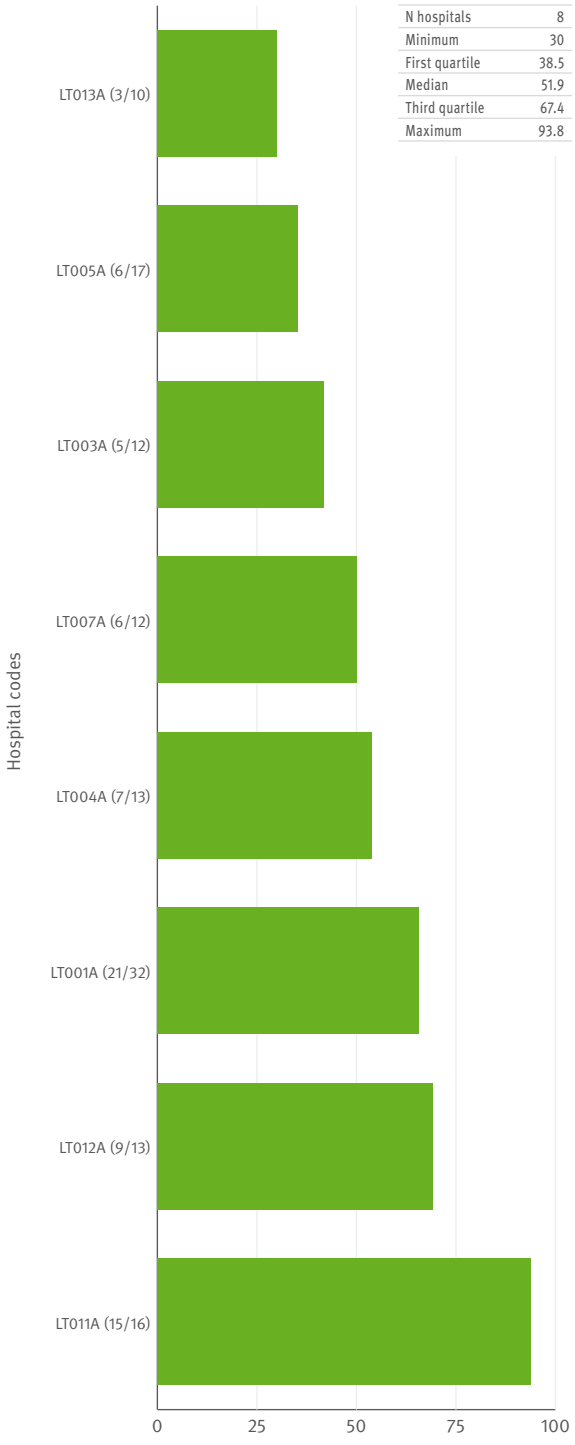


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Luxembourg

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	6	47	5	104	3	56	4	21	4	33	4	25

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	<1	6	7	5	3	5	11	4
Penicillin RI	15	11	12	5	6	11	19	13
Macrolides RI	28	33	24	26	24	14	16	19
Staphylococcus aureus								
Oxacillin/Meticillin R	21	16	13	19	20	9	13	17
Escherichia coli								
Aminopenicilins R	49	49	49	46	49	56	57	57
Aminoglycosides R	4	4	7	6	5	8	9	19
Fluoroquinolones R	12	18	19	20	21	22	26	27
Third-gen. cephalosporins R	<1	<1	3	2	4	6	8	4
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	5	<1	<1	<1	<1	3	10	18
HL Gentamicin R	32	18	24	32	44	17	28	25
Vancomycin R	<1	<1	<1	<1	<1	3	10	<1
Enterococcus faecium								
Aminopenicilins RI	100	50	36	75	67	76	93	100
HL Gentamicin R	<1	<1	23	30	10	21	29	40
Vancomycin R	<1	<1	<1	<1	<1	5	36	11
Klebsiella pneumoniae								
Aminoglycosides R	-	-	-	<1	4	13	18	6
Fluoroquinolones R	-	-	-	6	12	12	21	9
Third-gen. cephalosporins R	-	-	-	10	2	19	25	6
Carbapenems R	-	-	-	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	<1	9	15	3	14	8
Ceftazidime R	-	-	<1	10	11	3	14	<1
Carbapenems R	-	-	<1	7	20	25	15	8
Aminoglycosides R	-	-	<1	4	22	6	9	8
Fluoroquinolones R	-	-	<1	10	36	15	11	20

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=110		*S. aureus* n=217		*E. coli* n=349		*E. faecalis* n=50		*E. faecium* n=23		*K. pneumoniae* n=61		*P. aeruginosa* n=58	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	93	16	100	15	99	26	100	8	100	26	95	16	100	12
CSF	7	25	-	-	1	50	-	-	-	-	5	0	-	-
Gender														
Male	55	16	59	12	45	26	68	9	52	33	54	15	67	13
Female	45	16	41	20	55	26	32	6	48	18	46	14	33	11
Age (years)														
0–4	9	20	2	0	2	0	2	0	-	-	2	0	2	0
5–19	4	0	2	40	<1	0	-	-	4	0	-	-	-	-
20–64	41	13	39	8	28	27	22	9	22	20	28	18	28	25
65 and over	46	20	57	20	69	26	76	8	74	29	70	14	71	7
Hospital department														
ICU	4	75	7	33	1	50	4	0	-	-	11	14	9	0
Internal med.	3	0	3	17	1	0	2	0	-	-	2	0	-	-
Surgery	1	0	3	17	1	33	2	0	4	0	11	0	2	100
Other	16	11	27	14	5	25	12	0	26	17	26	6	22	0
Unknown	76	15	60	14	93	26	80	10	70	31	49	23	67	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*.

Luxembourg

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumoniae* by laboratory (2009–2010)

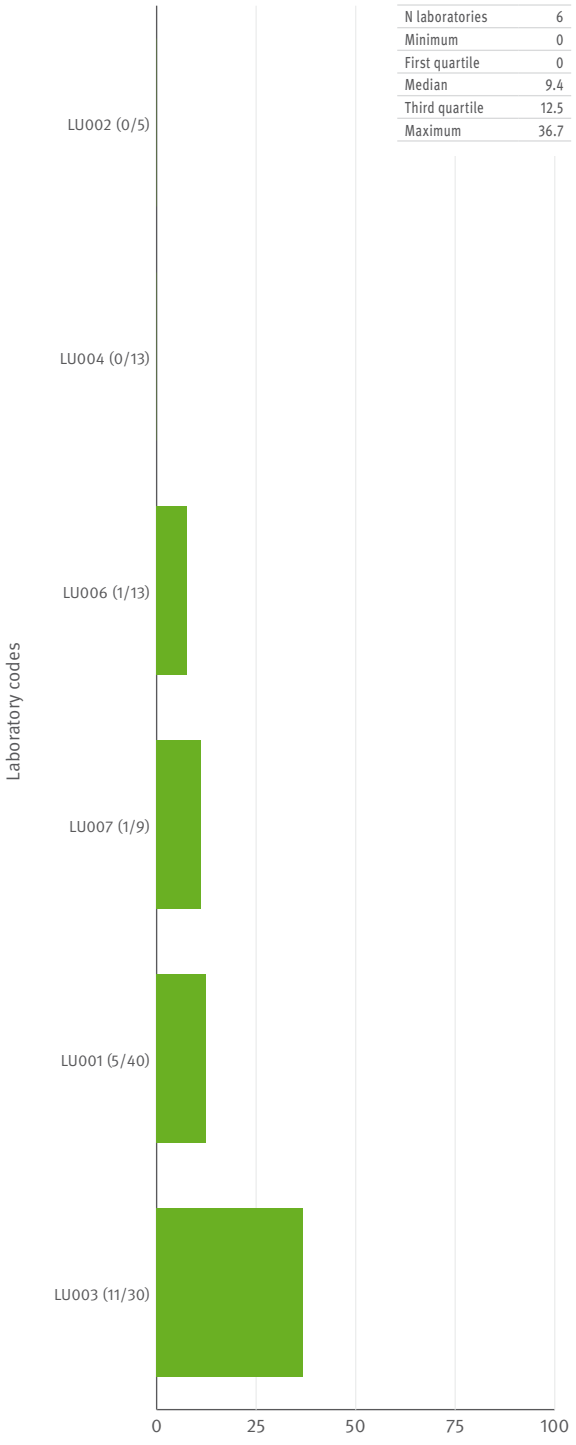


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

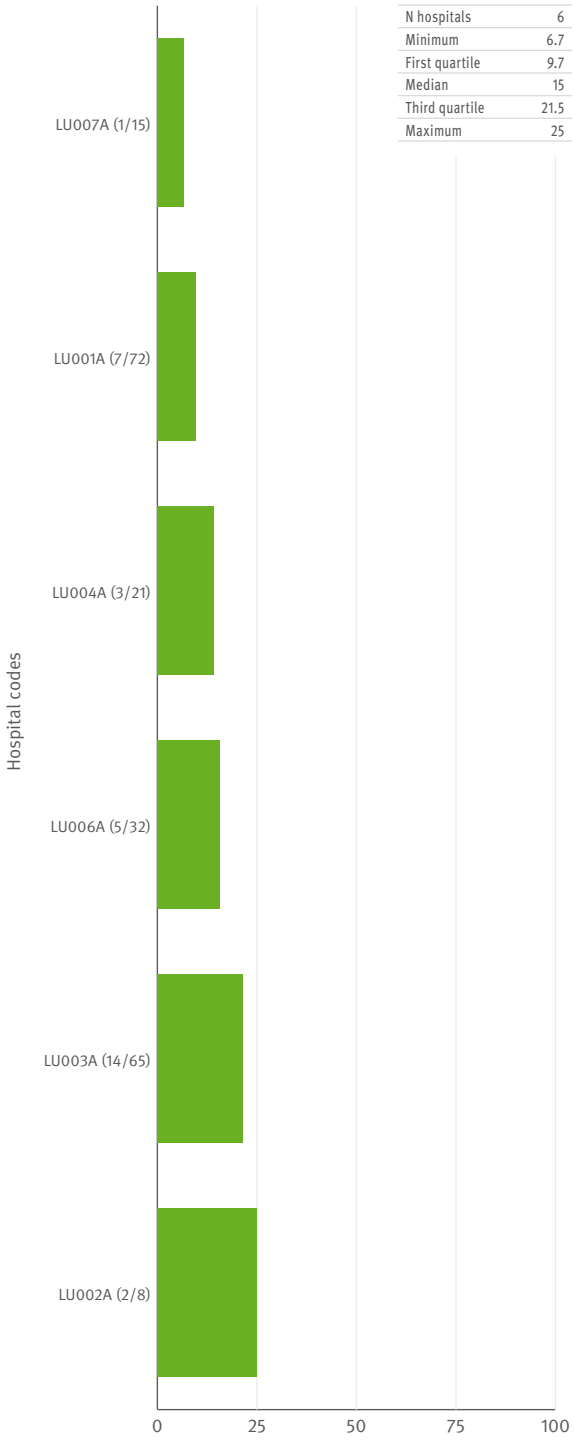


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

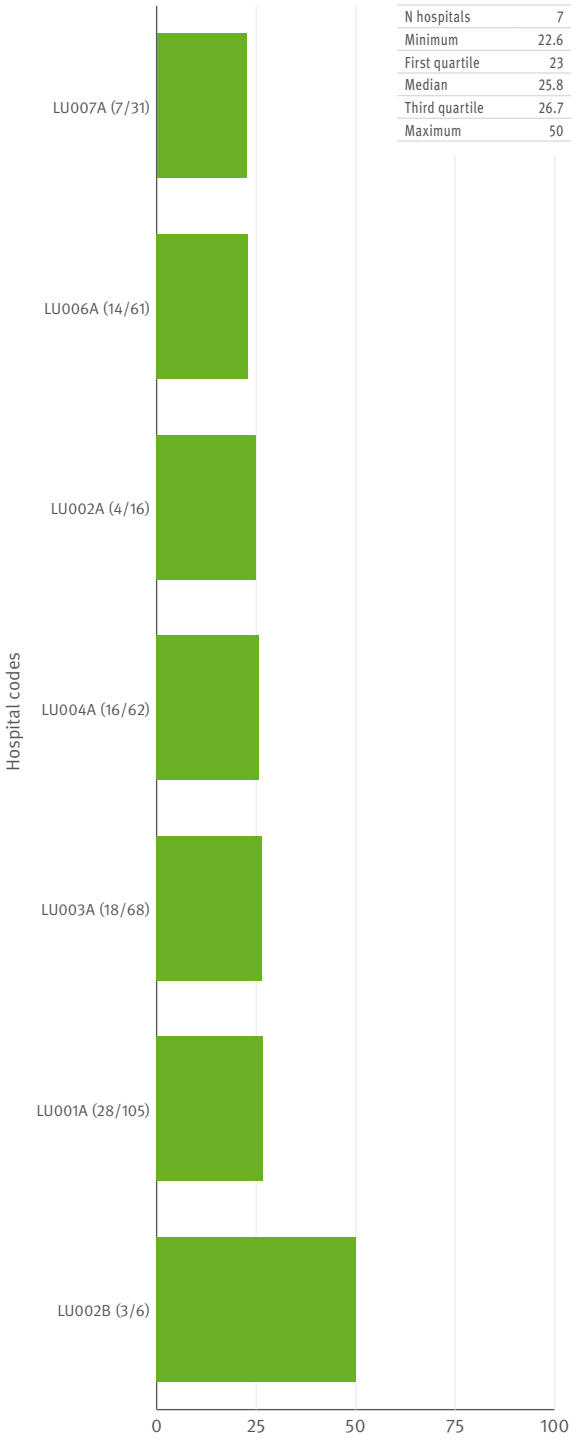
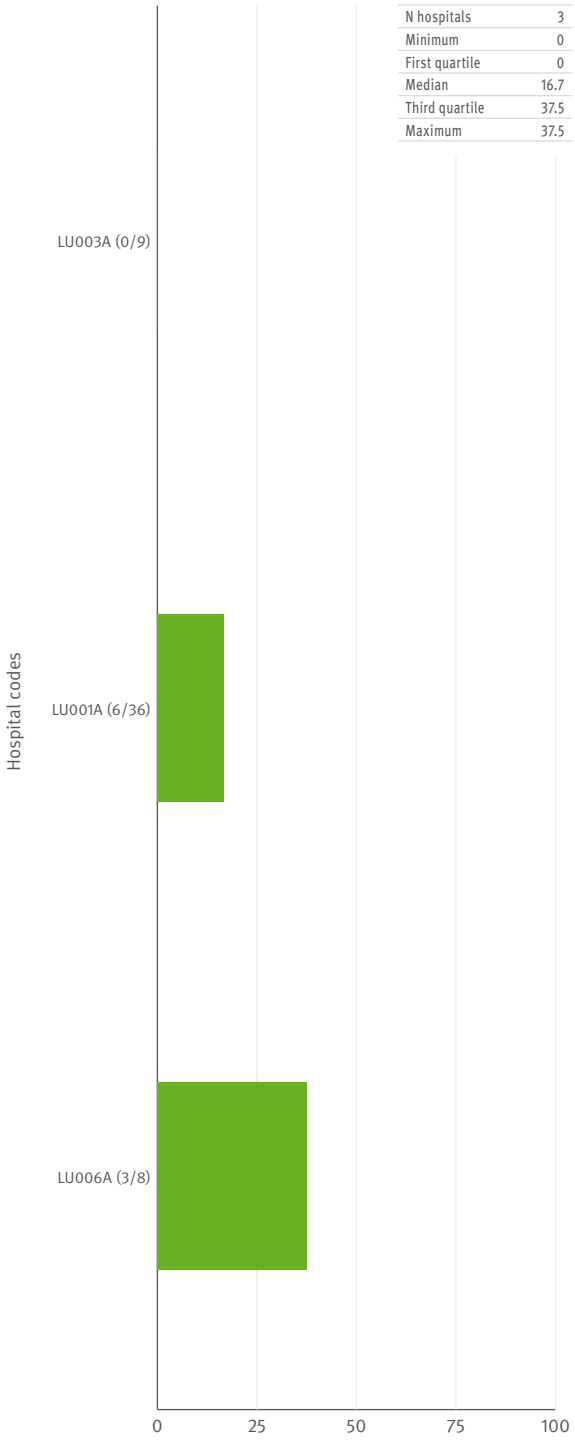


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Malta

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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	85	1	158	1	36	1	38	1	58
2010	1	11	1	108	1	192	1	37	1	57	1	42

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	<1	<1	8	3	<1	24	<1	11
Penicillin RI	<1	<1	15	7	<1	47	14	22
Macrolides RI	38	25	46	45	8	35	13	18
Staphylococcus aureus								
Oxacillin/Meticillin R	43	56	56	67	52	56	59	48
Escherichia coli								
Aminopenicilins R	39	48	51	56	54	52	54	44
Aminoglycosides R	18	20	7	15	20	22	21	22
Fluoroquinolones R	24	36	31	32	35	34	30	34
Third-gen. cephalosporins R	2	4	1	4	13	21	15	16
Carbapenems R	<1	<1	<1	<1	<1	<1	1	<1
Enterococcus faecalis								
Aminopenicilins RI	5	<1	3	2	3	<1	5	<1
HL Gentamicin R	29	44	32	-	-	-	-	-
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	33	43	25	14	40	60	75	100
HL Gentamicin R	50	<1	<1	-	-	-	-	-
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	17	6	<1	<1	<1	12
Fluoroquinolones R	-	-	11	6	11	8	3	16
Third-gen. cephalosporins R	-	-	6	6	7	<1	<1	12
Carbapenems R	-	-	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	22	47	11	45	36	36
Ceftazidime R	-	-	11	30	3	33	29	14
Carbapenems R	-	-	18	20	11	30	21	24
Aminoglycosides R	-	-	16	8	8	23	21	31
Fluoroquinolones R	-	-	44	24	11	19	22	24

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=16		*S. aureus* n=193		*E. coli* n=350		*E. faecalis* n=55		*E. faecium* n=18		*K. pneumoniae* n=95		*P. aeruginosa* n=100	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	100	19	100	53	100	33	100	0	100	0	100	7	95	23
CSF	-	-	-	-	<1	0	-	-	-	-	-	-	5	0
Gender														
Male	50	13	68	56	50	37	62	0	72	0	55	8	67	22
Female	50	25	32	47	50	28	38	0	28	0	45	7	33	21
Age (years)														
0–4	6	0	6	67	2	0	11	0	6	0	5	0	4	0
5–19	-	-	2	25	<1	0	2	0	-	-	4	0	5	20
20–64	44	0	38	45	27	31	33	0	67	0	34	16	33	30
65 and over	50	38	53	58	70	34	55	0	28	0	57	4	58	19
Hospital department														
ICU	13	0	7	43	2	43	29	0	33	0	13	0	31	39
Other	-	-	2	100	4	64	2	0	-	-	5	0	1	0
Unknown	88	21	91	53	94	31	69	0	67	0	82	9	68	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*.

Malta

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumoniae* by laboratory (2009–2010)

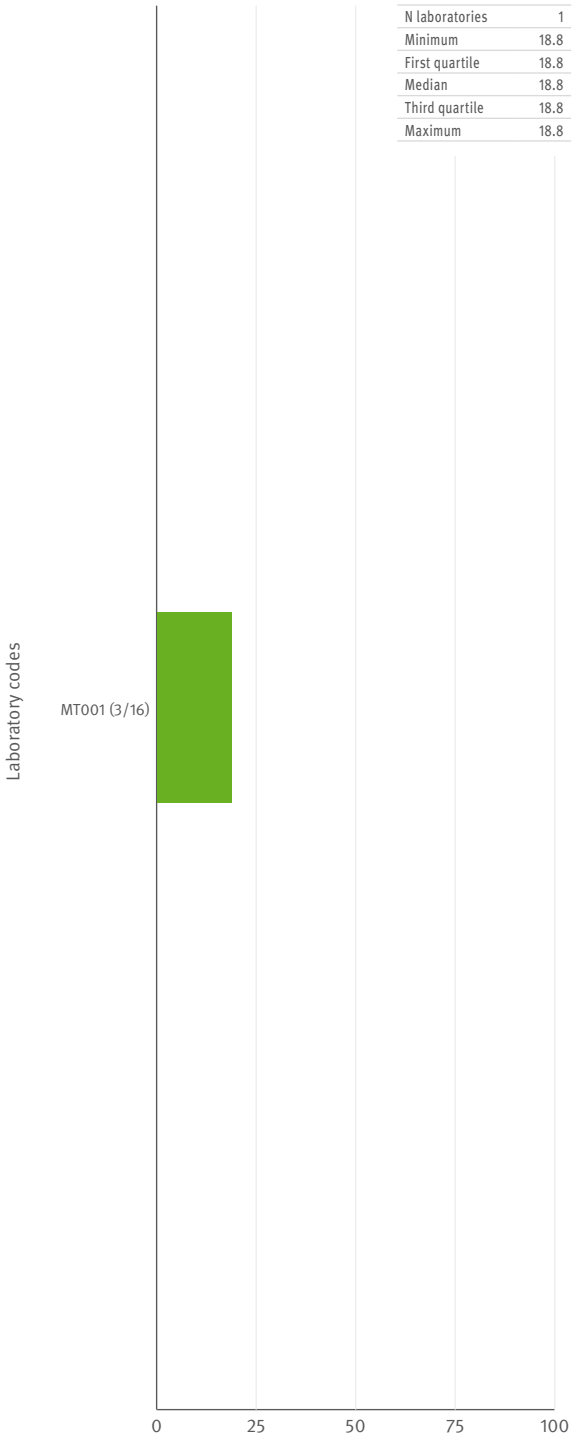


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

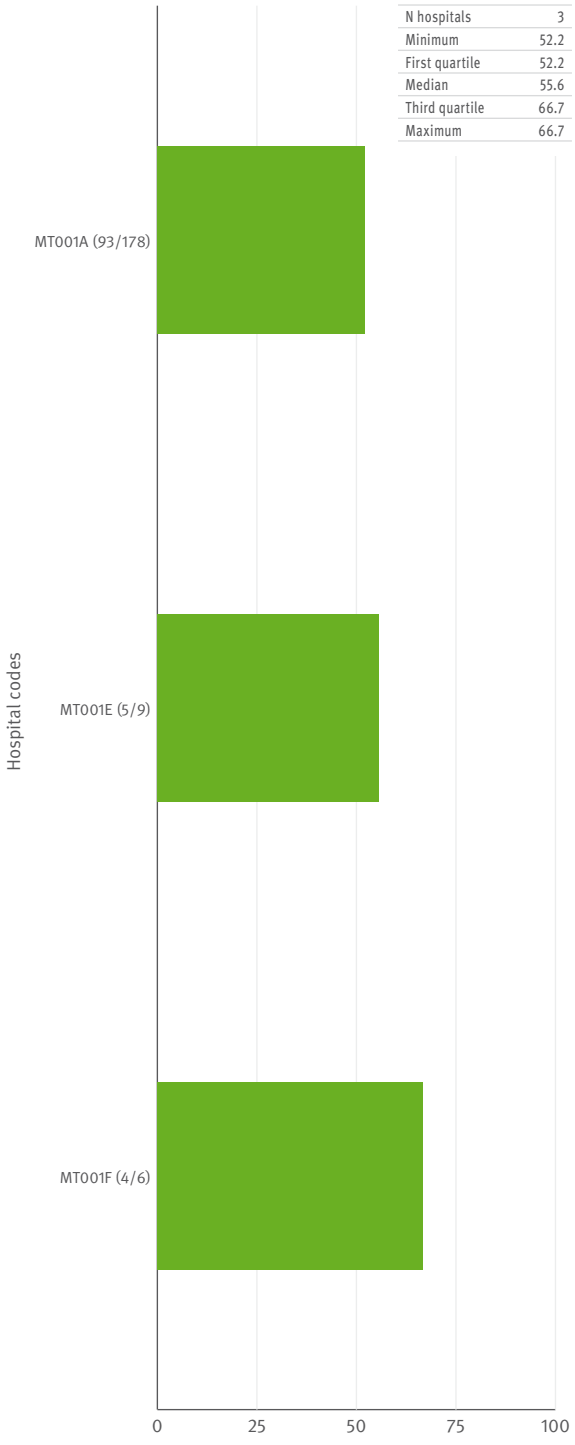


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

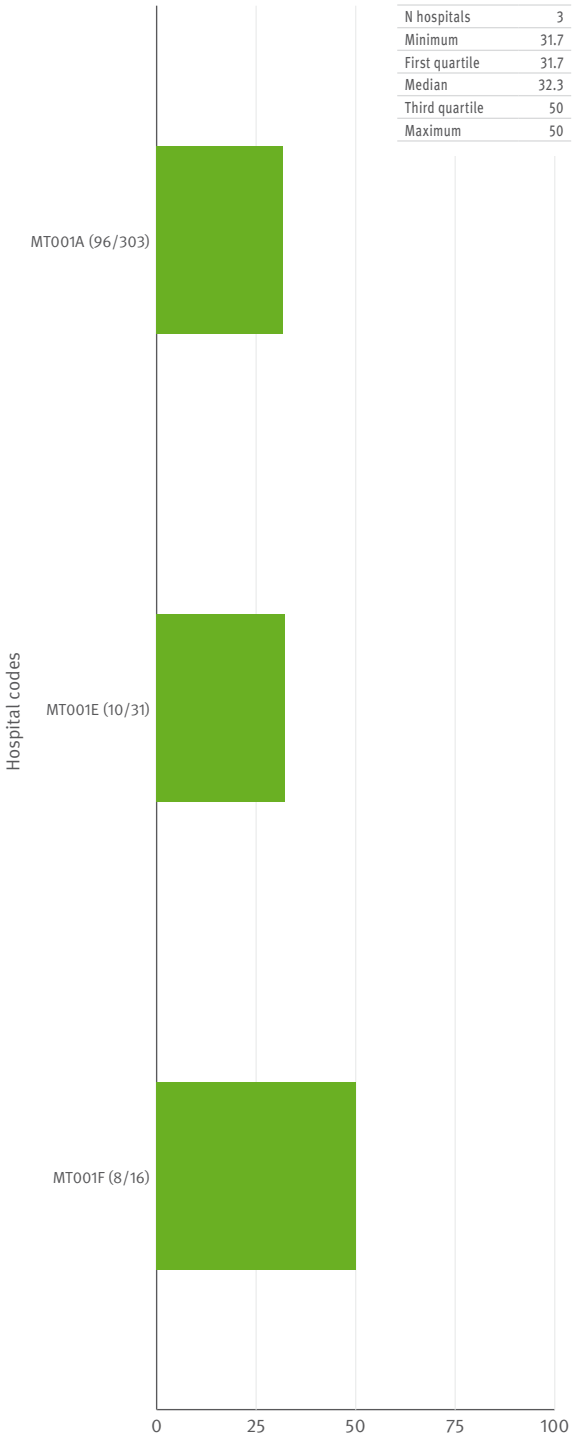
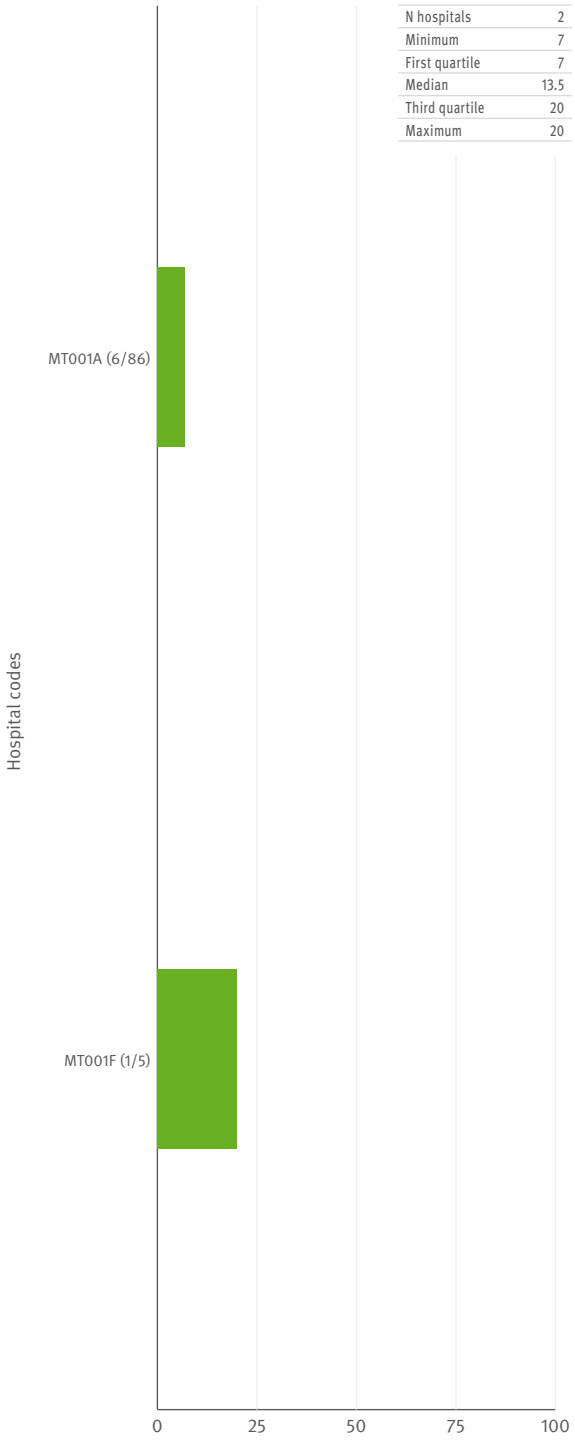


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Netherlands

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	22	971	21	1565	21	3422	20	834	20	647	21	376

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	<1	<1	<1	<1	<1
Penicillin RI	1	2	1	1	2	2	1	2
Macrolides RI	5	8	11	8	7	7	5	6
Staphylococcus aureus								
Oxacillin/Meticillin R	1	1	<1	<1	2	<1	<1	1
Escherichia coli								
Aminopenicilins R	45	43	48	47	49	48	45	48
Aminoglycosides R	3	3	4	3	5	6	4	7
Fluoroquinolones R	7	7	10	11	13	14	11	14
Third-gen. cephalosporins R	1	1	2	3	4	5	4	5
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	4	3	3	5	5	<1	2	3
HL Gentamicin R	29	37	38	28	38	34	31	34
Vancomycin R	1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	30	42	61	73	83	86	89	89
HL Gentamicin R	20	20	40	50	62	53	76	65
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	5	4	5	7	3	7
Fluoroquinolones R	-	-	6	4	4	7	4	7
Third-gen. cephalosporins R	-	-	4	4	7	8	6	7
Carbapenems R	-	-	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	4	2	2	6	3	4
Ceftazidime R	-	-	5	5	4	6	4	3
Carbapenems R	-	-	5	2	2	6	3	3
Aminoglycosides R	-	-	7	4	3	4	1	2
Fluoroquinolones R	-	-	9	9	5	8	7	4

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=1325		*S. aureus* n=2599		*E. coli* n=5786		*E. faecalis* n=770		*E. faecium* n=572		*K. pneumoniae* n=1041		*P. aeruginosa* n=605	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	93	2	100	1	100	13	100	0	100	1	100	6	98	3
CSF	7	0	-	-	<1	18	-	-	-	-	<1	20	2	10
Gender														
Male	52	2	59	1	49	16	70	0	63	1	55	9	70	3
Female	48	1	41	1	51	9	30	0	37	0	45	4	30	2
Age (years)														
0–4	4	3	5	0	2	7	4	0	3	0	2	5	2	10
5–19	2	0	2	3	1	17	1	0	2	0	1	10	1	0
20–64	41	2	34	1	27	13	27	0	38	0	30	7	31	4
65 and over	52	1	59	1	70	12	68	0	57	1	67	6	66	2
Hospital department														
ICU	9	2	11	3	9	12	18	0	43	1	11	16	19	6
Internal med.	11	1	12	0	18	12	13	0	12	0	17	2	16	4
Surgery	3	7	7	2	5	12	6	0	4	0	5	4	7	0
Other	46	1	33	1	32	13	30	0	22	1	28	6	24	1
Unknown	30	2	38	1	36	13	33	0	20	1	39	6	34	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. pneumoniae* by laboratory (2009–2010)

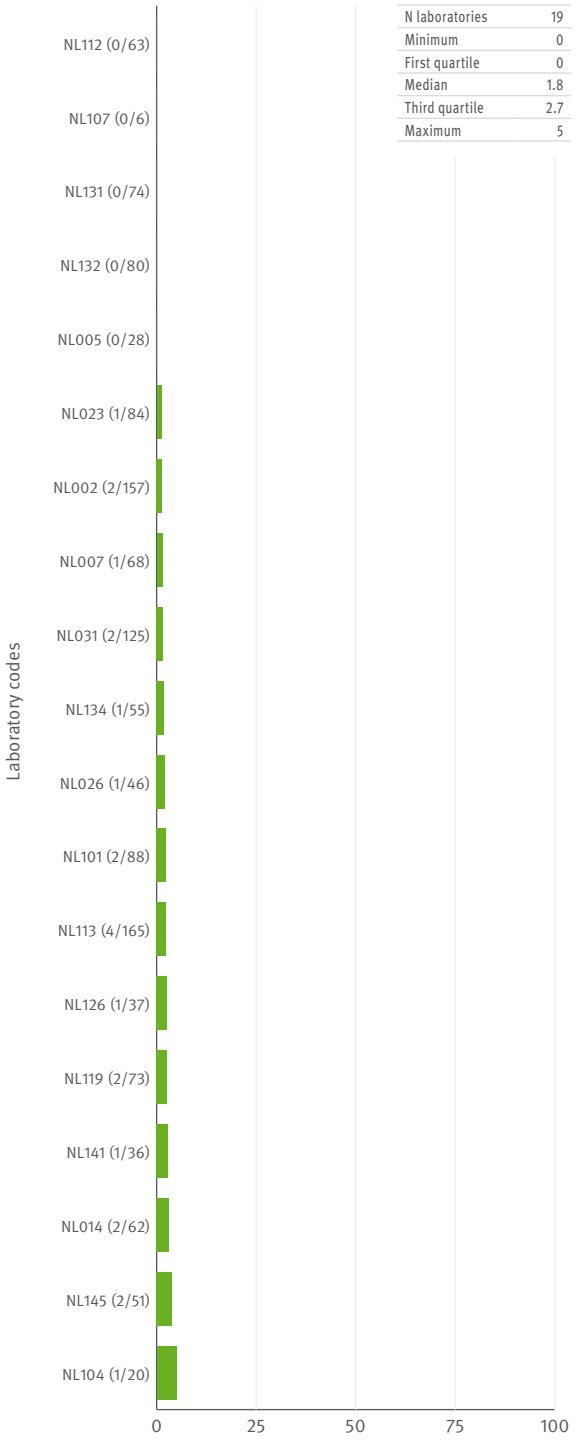


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

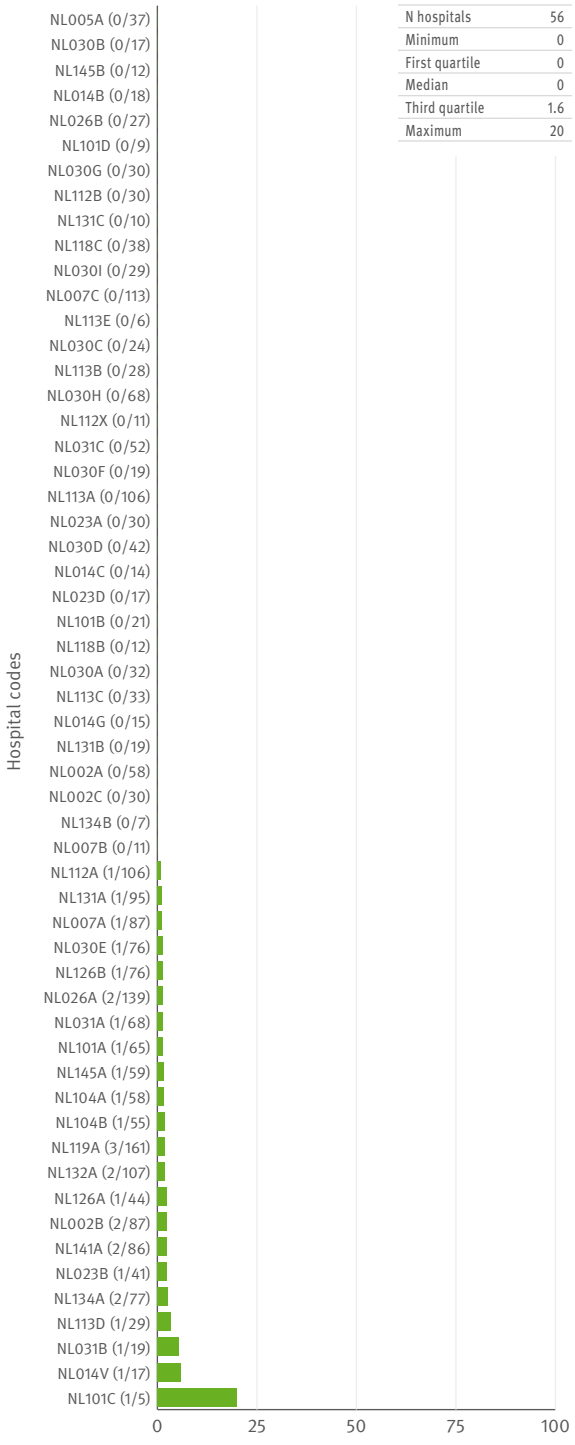


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

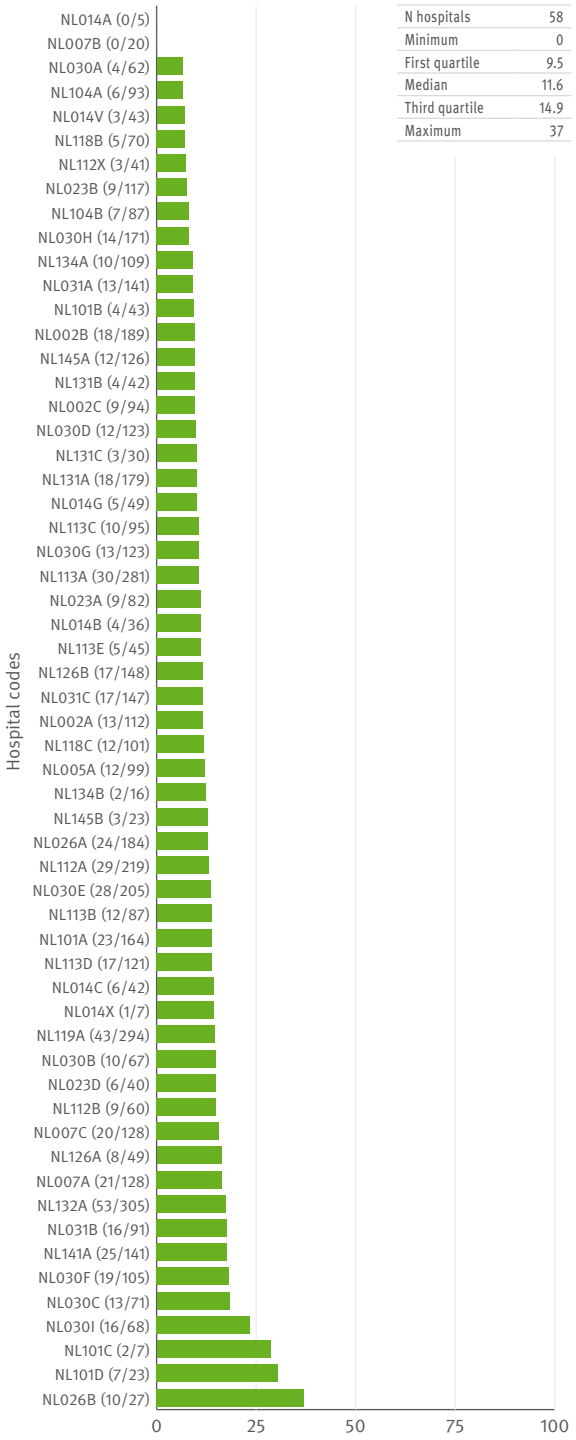
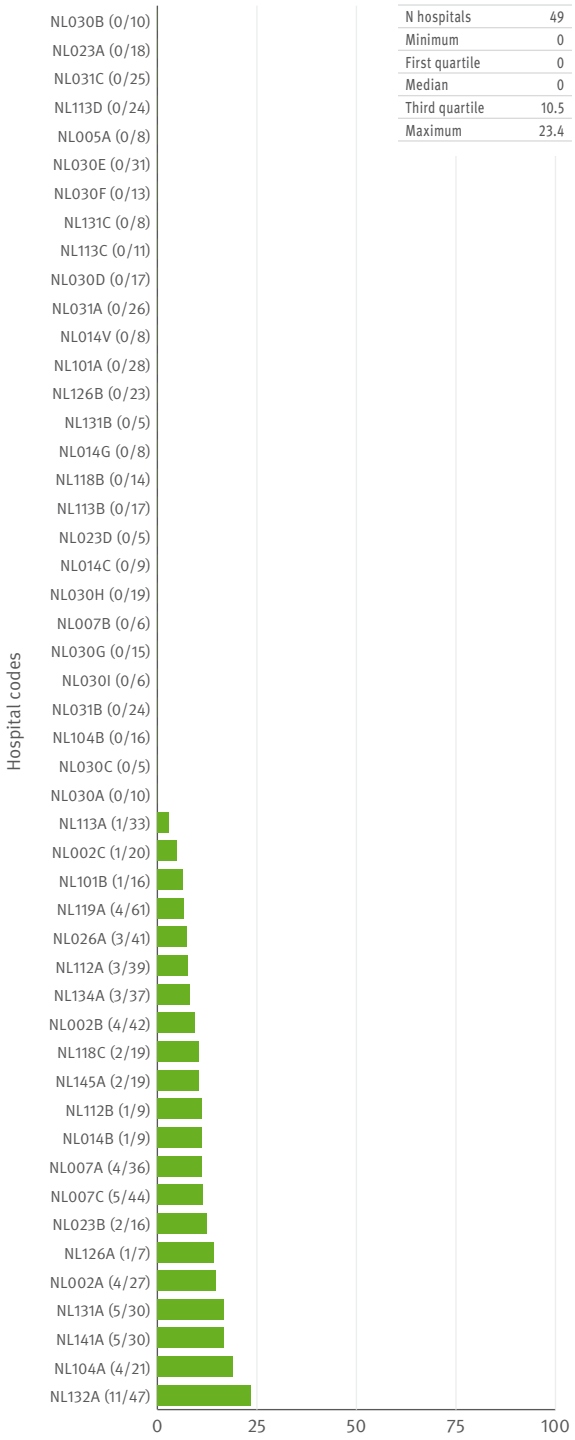


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Norway

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	15	576	15	1050	15	2277	15	563	15	479	15	168

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	<1	<1	<1	<1	<1
Penicillin RI	<1	2	2	2	2	2	2	4
Macrolides RI	8	8	14	12	10	7	6	4
Staphylococcus aureus								
Oxacillin/Meticillin R	<1	<1	<1	<1	<1	<1	<1	<1
Escherichia coli								
Aminopenicilins R	34	32	34	35	38	38	37	38
Aminoglycosides R	<1	<1	2	2	3	3	3	4
Fluoroquinolones R	2	4	5	5	7	7	9	9
Third-gen. cephalosporins R	<1	<1	<1	1	2	3	2	4
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	4	<1	3	3	2	2	<1	<1
HL Gentamicin R	38	27	32	33	34	29	36	34
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	43	80	72	75	81	78	76	85
HL Gentamicin R	14	25	44	45	52	54	38	57
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	1
Klebsiella pneumoniae								
Aminoglycosides R	<1	2	3	<1	<1	1	3	2
Fluoroquinolones R	<1	<1	1	7	5	4	6	7
Third-gen. cephalosporins R	<1	<1	2	2	2	2	3	2
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	<1	13	3	3	2	6	4	3
Ceftazidime R	<1	<1	3	5	3	4	5	2
Carbapenems R	<1	4	3	9	9	7	5	1
Aminoglycosides R	<1	4	<1	1	2	<1	<1	<1
Fluoroquinolones R	4	5	4	9	7	3	2	4

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=1129		*S. aureus* n=1954		*E. coli* n=4097		*E. faecalis* n=727		*E. faecium* n=236		*K. pneumoniae* n=875		*P. aeruginosa* n=334	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	97	3	100	0	100	9	100	0	100	1	100	2	100	3
CSF	3	6	-	-	<1	0	-	-	-	-	<1	0	<1	100
Gender														
Male	49	4	65	1	45	11	76	0	61	1	59	3	69	3
Female	51	2	35	0	55	7	24	0	39	0	41	1	30	4
Unknown	<1	0	<1	0	<1	67	<1	0	<1	100	<1	0	<1	0
Age (years)														
0–4	5	6	3	0	2	6	3	0	2	20	1	0	1	0
5–19	2	0	4	1	1	4	<1	0	1	0	1	0	2	0
20–64	41	2	34	1	26	10	24	0	33	1	29	5	27	4
65 and over	51	4	59	0	72	8	72	0	64	0	69	1	70	3
Hospital department														
ICU	9	4	7	1	5	13	9	0	14	0	7	0	8	12
Internal med.	37	3	34	1	36	8	34	0	28	0	31	3	30	4
Surgery	4	0	13	0	13	11	17	0	16	0	17	3	13	5
Other	47	3	43	0	44	8	37	0	41	2	43	3	47	1
Unknown	4	0	3	0	2	5	3	0	2	0	2	0	3	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*.

Norway

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumoniae* by laboratory (2009–2010)

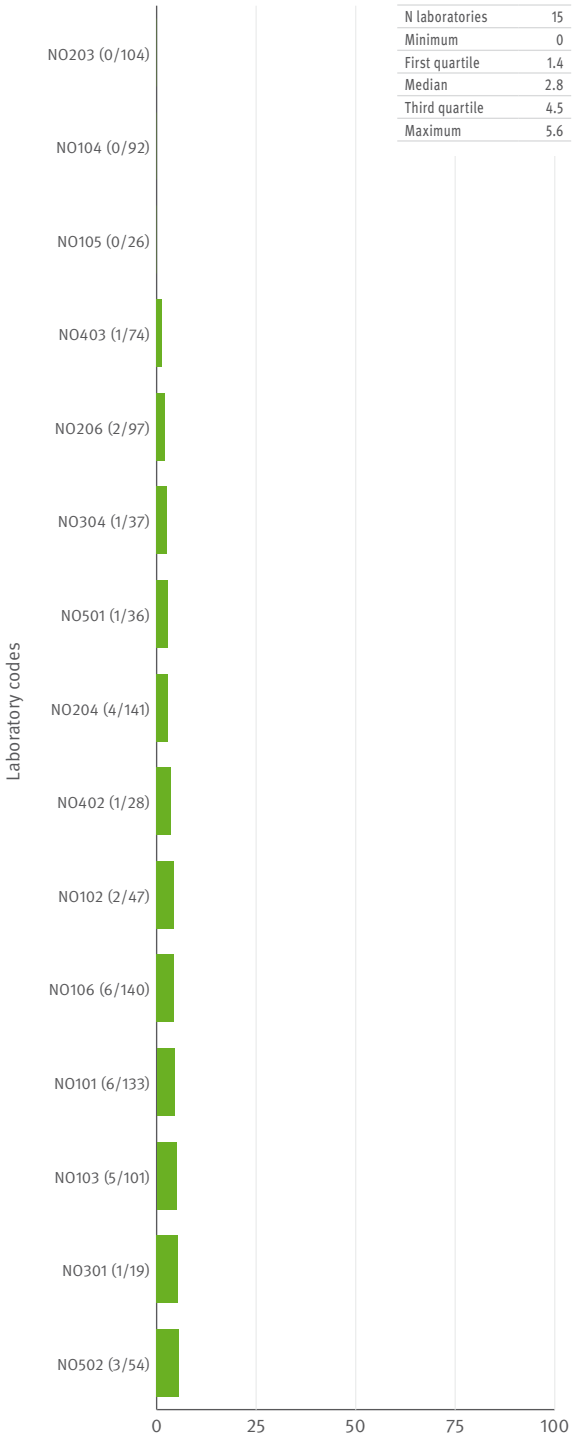


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

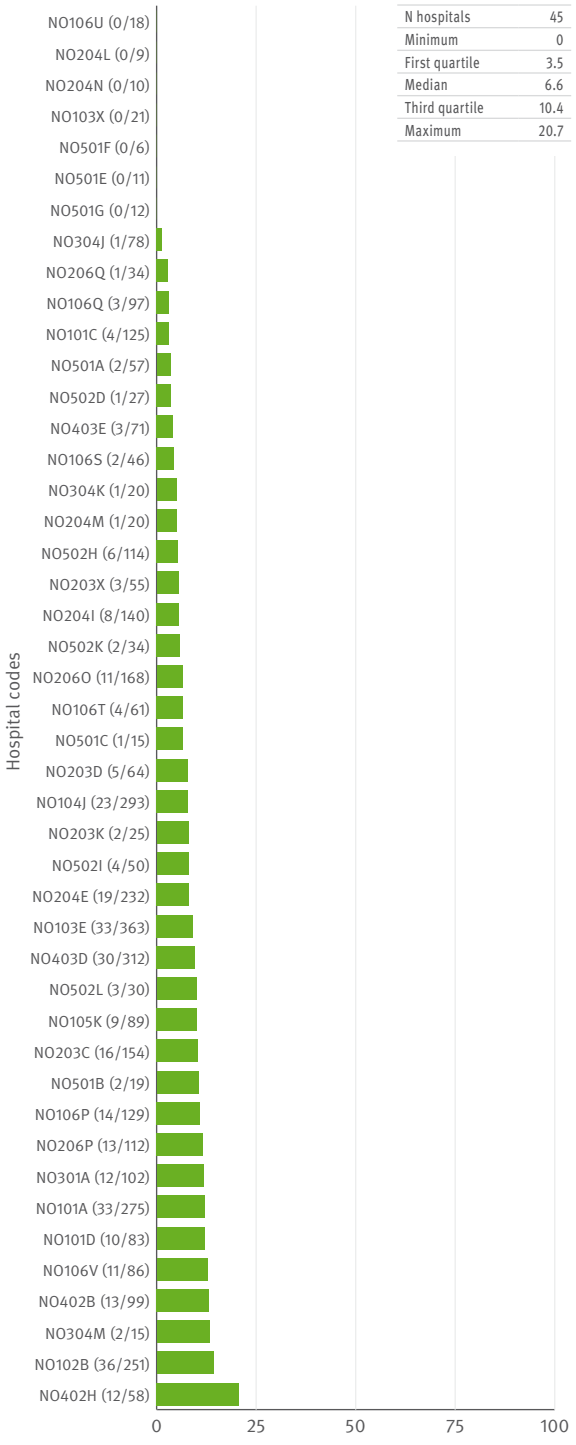
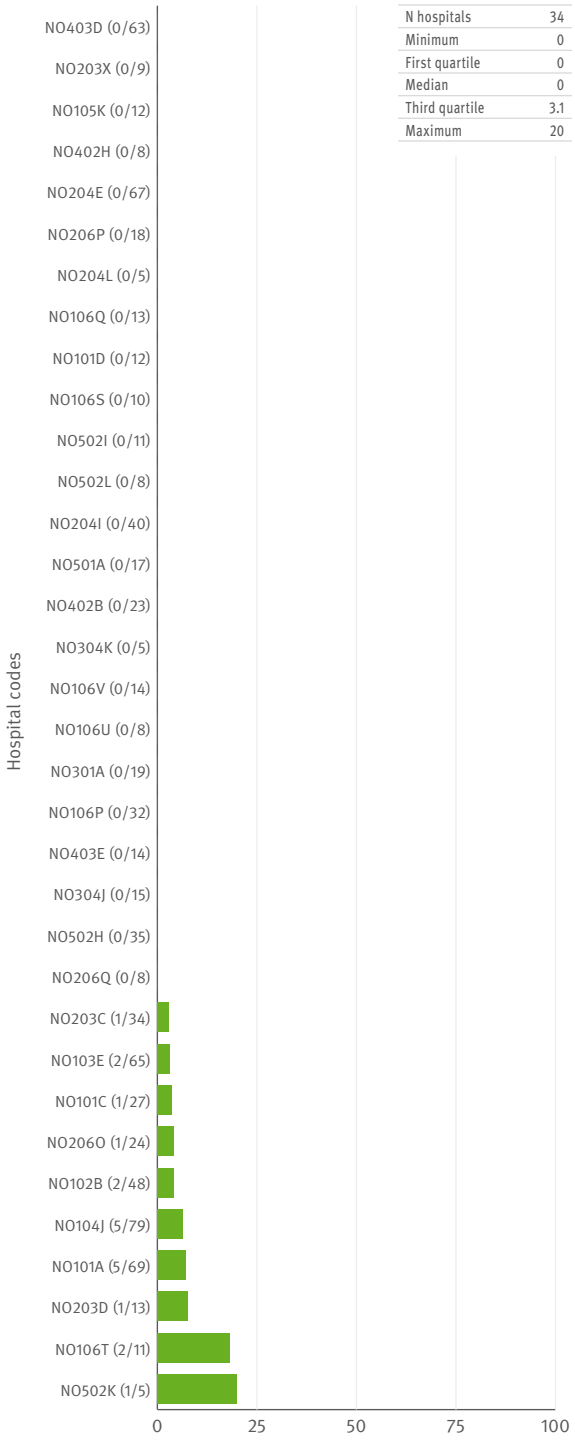


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Poland

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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	21	71	30	551	29	625	28	267	25	151	27	153
2010	26	76	35	527	35	771	32	286	33	246	29	169

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	19	<1	17	<1	10	12	30	24
Penicillin RI	19	<1	33	<1	29	13	30	24
Macrolides RI	14	19	33	11	.	50	19	39
Staphylococcus aureus								
Oxacillin/Meticillin R	19	19	24	20	15	12	20	13
Escherichia coli								
Aminopenicilins R	50	45	56	55	56	54	65	60
Aminoglycosides R	10	5	7	11	6	7	7	9
Fluoroquinolones R	7	9	20	20	13	20	23	26
Third-gen. cephalosporins R	4	5	5	4	2	2	9	8
Carbapenems R	-	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	<1	2	9	2	4	6	<1	3
HL Gentamicin R	48	33	48	50	46	29	39	36
Vancomycin R	<1	<1	<1	<1	2	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	91	86	95	95	88	78	98	95
HL Gentamicin R	55	100	62	85	84	67	75	65
Vancomycin R	<1	<1	5	<1	<1	<1	1	8
Klebsiella pneumoniae								
Aminoglycosides R	-	-	57	36	31	26	29	31
Fluoroquinolones R	-	-	34	29	3	32	32	33
Third-gen. cephalosporins R	-	-	66	38	34	37	49	40
Carbapenems R	-	-	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	50	43	36	32	30	29
Ceftazidime R	-	-	31	42	21	27	21	22
Carbapenems R	-	-	27	30	18	14	25	25
Aminoglycosides R	-	-	56	46	40	27	27	30
Fluoroquinolones R	-	-	31	41	37	13	26	28

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=132		*S. aureus* n=1032		*E. coli* n=1258		*E. faecalis* n=312		*E. faecium* n=187		*K. pneumoniae* n=375		*P. aeruginosa* n=309	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	88	26	100	17	99	25	100	0	100	5	99	43	98	25
CSF	12	31	-	-	1	22	-	-	-	-	1	40	2	14
Gender														
Male	58	24	58	16	39	31	55	0	57	5	61	43	59	27
Female	40	30	40	18	58	21	43	0	40	5	36	43	37	22
Unknown	2	33	2	9	3	6	2	0	4	0	3	40	4	27
Age (years)														
0–4	9	58	7	8	4	9	7	0	5	0	7	29	3	13
5–19	6	13	3	10	1	8	2	0	2	100	2	25	4	33
20–64	51	19	45	15	42	25	40	0	48	4	49	41	51	32
65 and over	31	32	42	21	49	26	48	0	40	3	38	51	33	18
Unknown	3	25	3	7	4	20	3	0	5	0	4	38	9	10
Hospital department														
ICU	27	14	19	24	20	25	27	0	29	0	33	61	36	33
Internal med.	21	29	14	14	18	22	9	0	5	0	11	23	3	0
Surgery	2	0	7	24	6	39	14	0	15	4	18	46	7	18
Other	44	34	44	12	43	23	33	0	30	11	30	33	38	19
Unknown	7	22	15	20	13	26	16	0	20	5	8	28	16	28

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. pneumoniae* by laboratory (2009–2010)

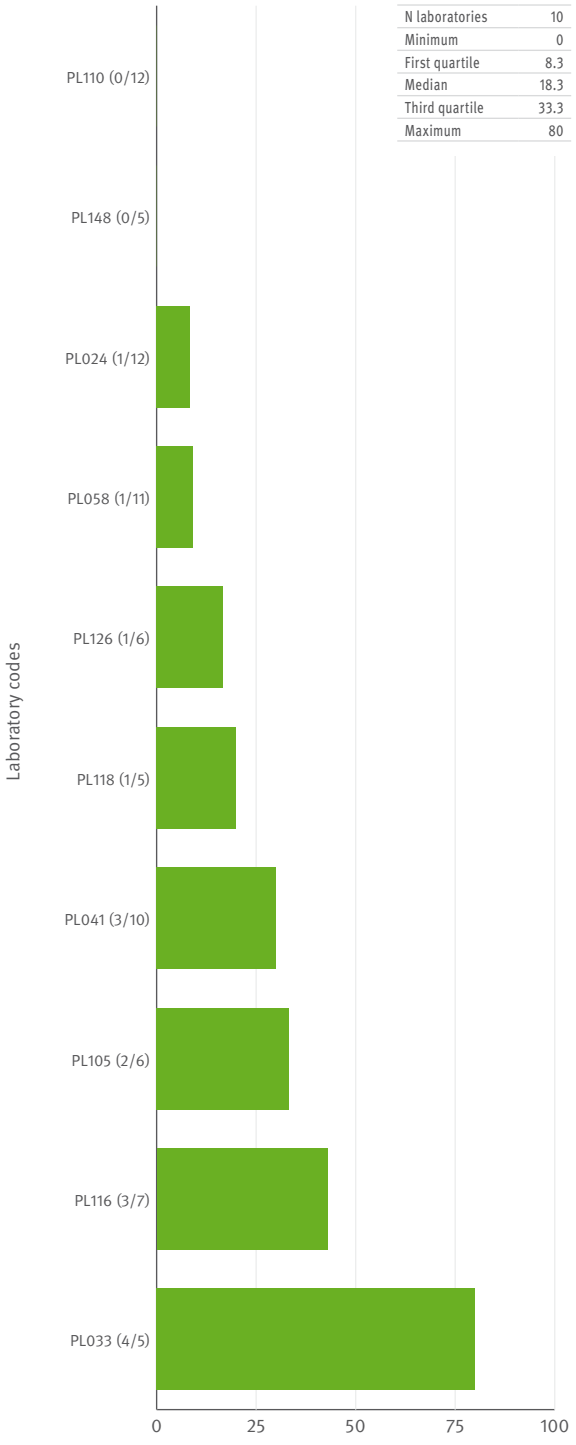


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

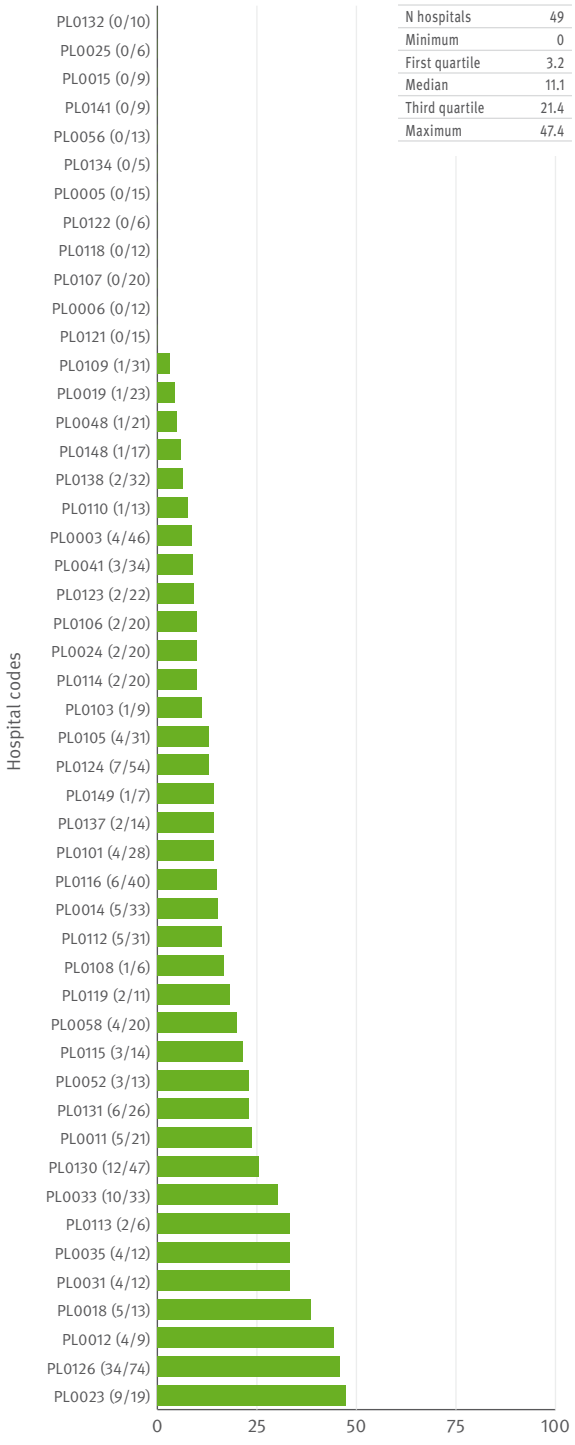


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

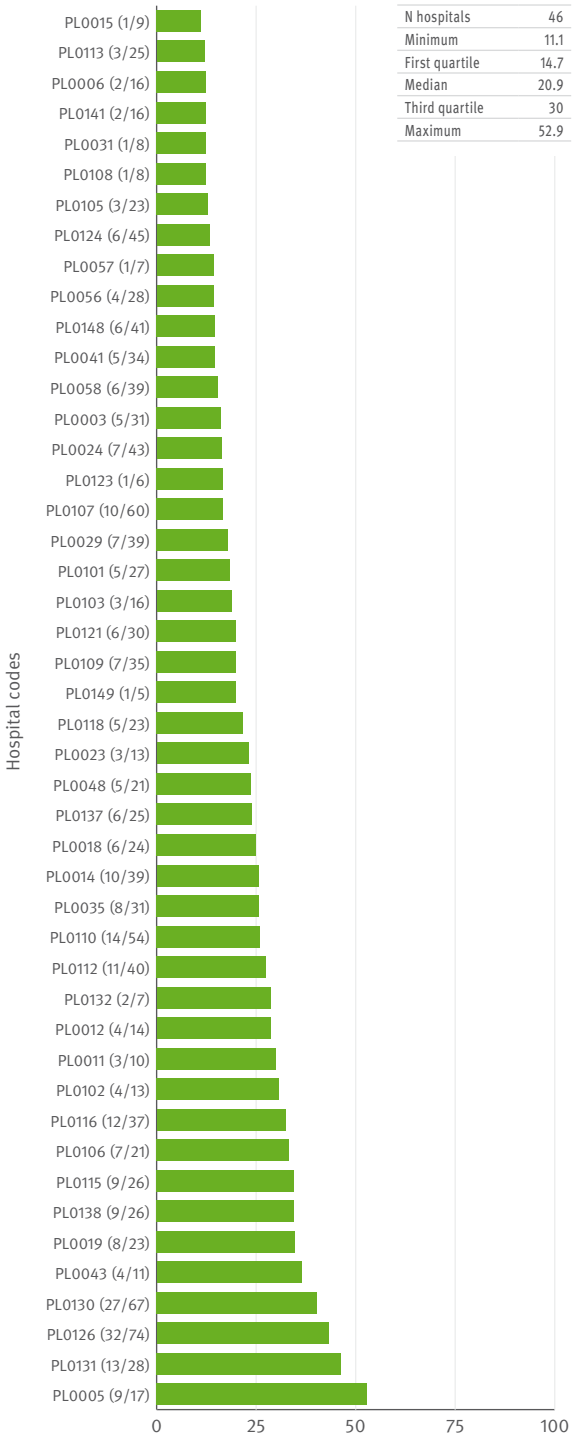
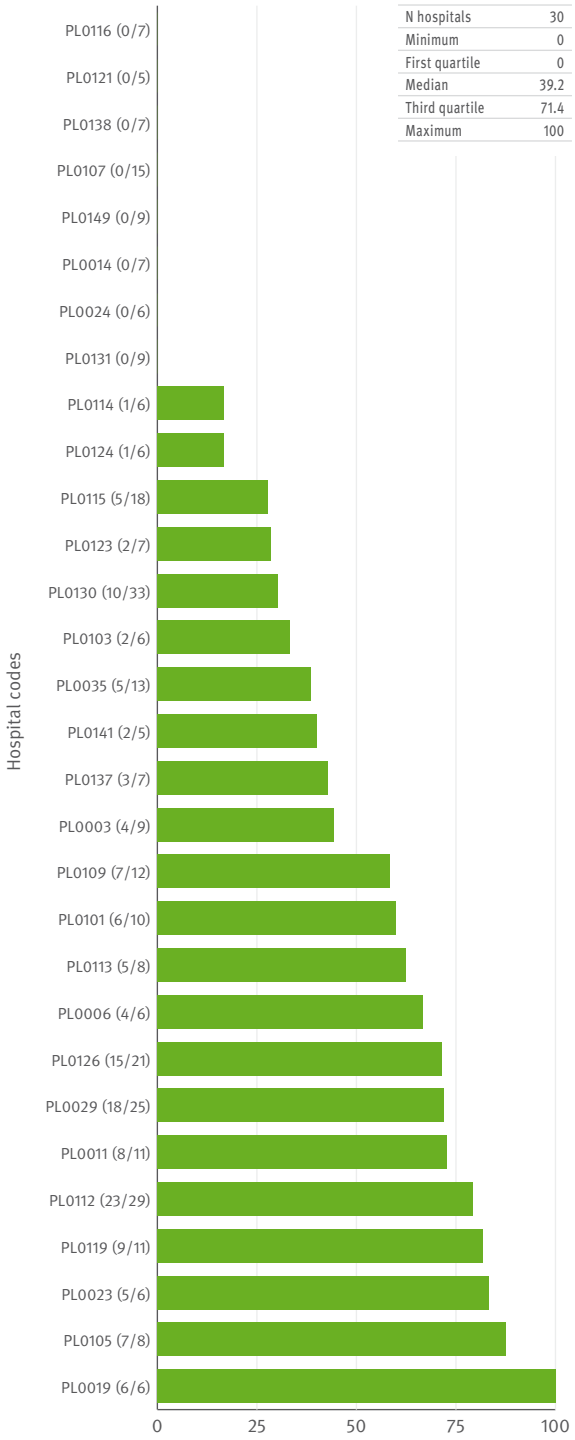


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Portugal

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	12	156	18	1633	19	1980	19	621	19	596	19	548

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	<1	<1	<1	18	15
Penicillin RI	20	27	17	17	16	18	18	15
Macrolides RI	-	20	19	21	23	22	22	22
Staphylococcus aureus								
Oxacillin/Meticillin R	45	46	47	48	48	53	49	53
Escherichia coli								
Aminopenicilins R	53	58	58	59	59	58	58	56
Aminoglycosides R	9	13	12	12	12	14	11	12
Fluoroquinolones R	26	27	29	28	30	29	28	27
3rd gen. Cephalosporins R	7	8	12	10	10	10	9	10
Carbapenems R	-	-	-	-	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	4	5	<1	2	4	4	7	17
HL Gentamicin R	34	29	38	41	41	43	34	39
Vancomycin R	3	6	5	5	4	4	4	2
Enterococcus faecium								
Aminopenicilins RI	88	83	92	76	93	86	91	91
HL Gentamicin R	55	66	68	53	49	28	49	53
Vancomycin R	47	42	34	26	29	24	23	23
Klebsiella pneumoniae								
Aminoglycosides R	-	-	<1	13	11	19	20	27
Fluoroquinolones R	-	-	<1	20	18	22	28	31
3rd gen. Cephalosporins R	-	-	-	21	17	26	28	28
Carbapenems R	-	-	-	-	<1	<1	<1	1
Pseudomonas aeruginosa								
Piperacillin R	-	-	-	15	14	17	17	18
Ceftazidime R	-	-	-	19	16	16	13	12
Carbapenems R	-	-	-	21	15	18	16	16
Aminoglycosides R	-	-	-	17	16	11	12	14
Fluoroquinolones R	-	-	-	21	19	23	21	20

Note. The data in this Country Report were updated after the analyses were completed for the main report.

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=393		*S. aureus* n=3457		*E. coli* n=3894		*E. faecalis* n=833		*E. faecium* n=405		*K. pneumoniae* n=1136		*P. aeruginosa* n=1054	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	93	17	100	51	100	28	100	3	100	23	100	28	99	16
CSF	7	17	-	-	<1	11	-	-	-	-	<1	67	1	0
Gender														
Male	58	17	62	50	44	31	56	3	54	19	55	28	59	19
Female	41	17	38	53	56	25	44	2	45	27	45	28	41	13
Unknown	<1	0	<1	0	<1	18	<1	0	<1	100	<1	0	-	-
Age (years)														
0–4	8	19	5	17	2	10	4	3	2	0	3	31	2	5
5–19	6	22	2	13	1	17	1	0	2	29	1	27	2	18
20–64	43	16	31	41	33	24	28	3	41	21	39	27	42	14
65 and over	43	17	59	61	62	30	65	3	56	25	54	29	53	18
Unknown	1	0	3	49	2	23	2	0	-	-	3	30	1	21
Hospital department														
ICU	2	25	8	60	4	23	16	5	17	20	12	35	17	21
Internal med.	10	11	24	61	19	30	18	3	14	29	15	25	17	17
Surgery	<1	0	9	63	5	33	12	2	17	26	10	21	9	19
Other	88	17	58	44	70	27	53	2	52	21	63	28	57	14
Unknown	-	-	1	50	1	24	1	0	-	-	1	33	<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*.

Portugal

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumoniae* by laboratory (2009–2010)

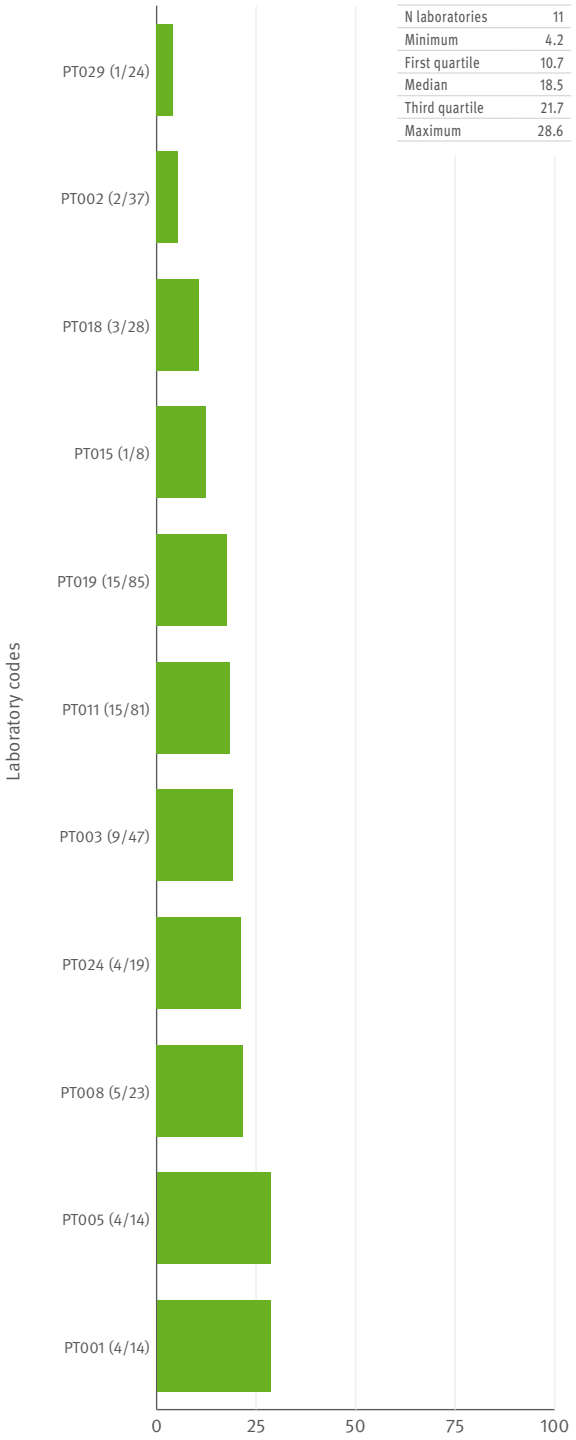
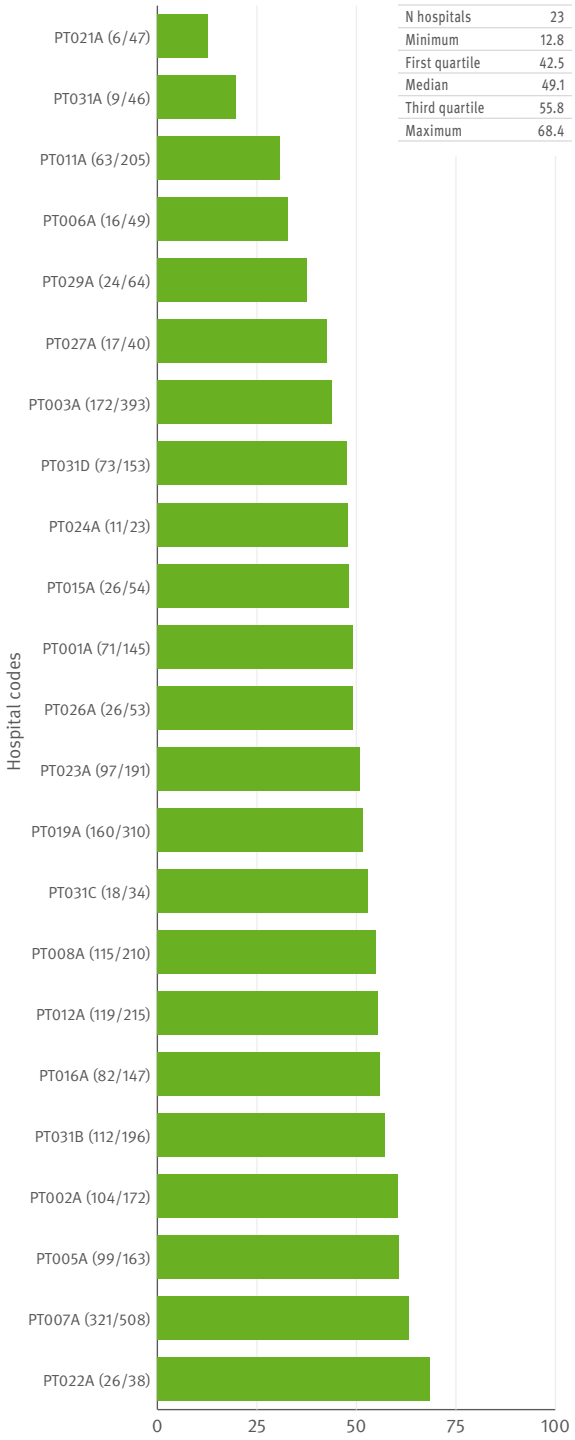


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)



Note. The data in this Country Report were updated after the analyses were completed for the main report.

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

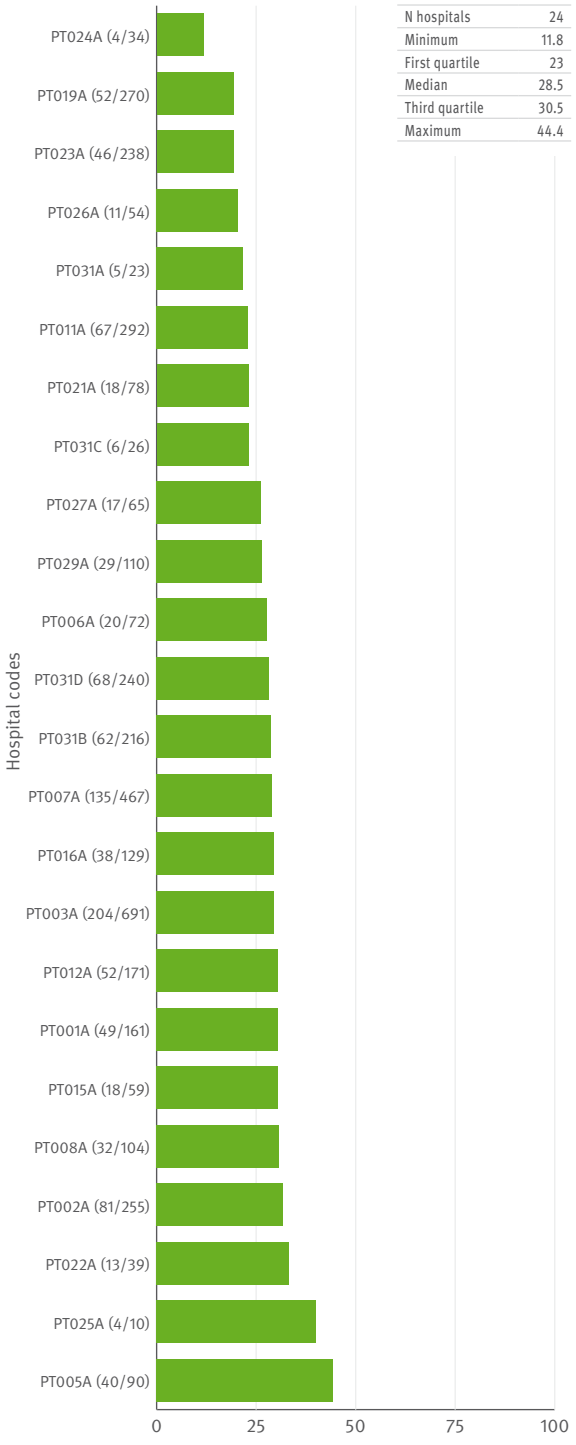
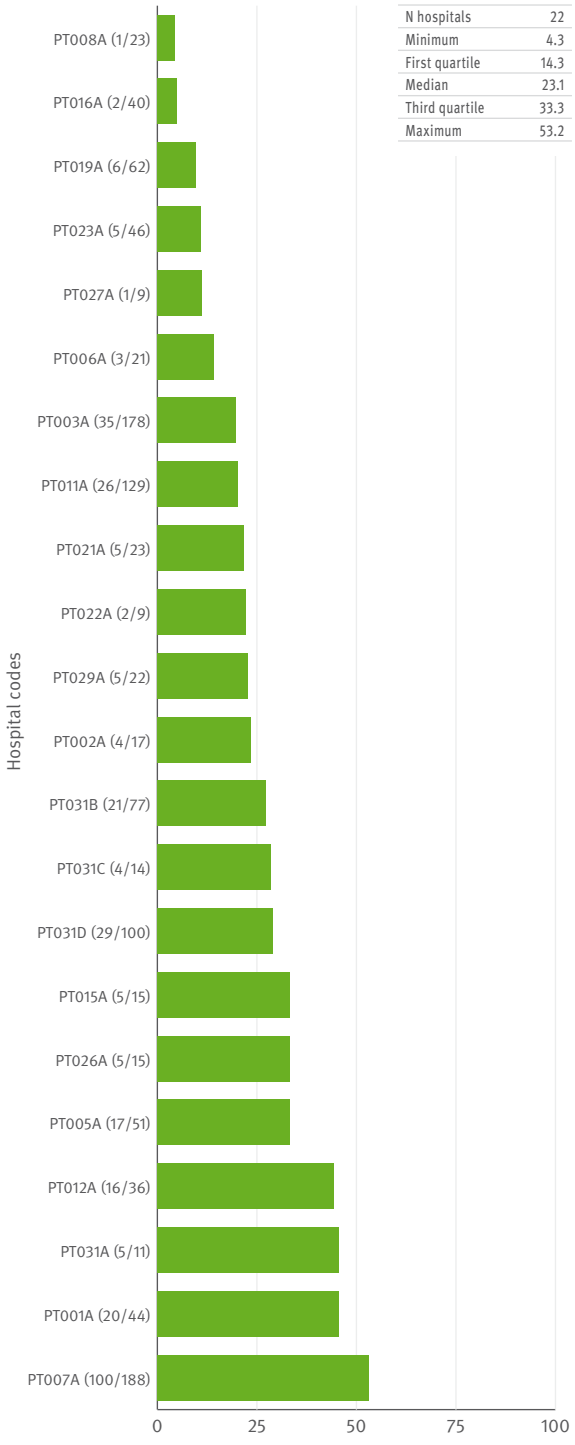


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Romania

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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	6	48	7	90	5	27	4	27	4	24
2010	2	13	5	47	5	35	2	19	3	17	5	10

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	21	11	22	10	22	54	24	31
Penicillin RI	33	11	39	28	33	69	29	31
Macrolides RI	29	<1	31	25	19	27	33	36
Staphylococcus aureus								
Oxacillin/Meticillin R	46	71	60	54	26	33	34	39
Escherichia coli								
Aminopenicilins R	70	79	78	85	76	55	60	83
Aminoglycosides R	21	33	14	41	35	24	11	12
Fluoroquinolones R	14	21	9	41	27	27	18	24
Third-gen. cephalosporins R	19	23	17	41	27	24	14	21
Carbapenems R	<1	3	<1	3	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	<1	29	<1	<1	25	10	13	<1
HL Gentamicin R	25	<1	50	15	50	22	42	-
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	86	100	100	100	100	100	100	80
HL Gentamicin R	63	100	70	80	67	50	71	-
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	100	91	80	60	32	71
Fluoroquinolones R	-	-	33	34	23	20	11	29
Third-gen. cephalosporins R	-	-	100	94	80	50	65	71
Carbapenems R	-	-	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	61	33	25	25	31	63
Ceftazidime R	-	-	52	<1	<1	13	30	60
Carbapenems R	-	-	61	<1	<1	13	46	70
Aminoglycosides R	-	-	64	33	25	38	38	50
Fluoroquinolones R	-	-	64	33	25	25	31	56

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=30		*S. aureus* n=93		*E. coli* n=88		*E. faecalis* n=24		*E. faecium* n=17		*K. pneumoniae* n=34		*P. aeruginosa* n=23	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	57	29	100	37	100	20	100	0	100	0	100	68	96	59
CSF	43	31	-	-	-	-	-	-	-	-	-	-	4	0
Gender														
Male	50	33	63	34	53	28	58	0	71	0	56	68	57	69
Female	50	27	35	42	47	12	42	0	29	0	44	67	43	40
Unknown	-	-	1	0	-	-	-	-	-	-	-	-	-	-
Age (years)														
0–4	30	44	20	37	11	20	21	0	65	0	47	94	26	17
5–19	13	50	9	25	1	100	-	-	-	-	9	67	9	100
20–64	40	8	53	41	43	16	46	0	35	0	29	40	43	60
65 and over	17	40	18	29	44	23	33	0	-	-	15	40	22	80
Hospital department														
ICU	-	-	5	100	5	25	4	0	6	0	6	0	35	88
Internal med.	-	-	9	38	11	0	4	0	-	-	9	33	9	0
Surgery	-	-	4	0	-	-	-	-	-	-	6	100	-	-
Other	100	30	77	36	82	24	92	0	94	0	79	74	57	46
Unknown	-	-	4	0	2	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*.

Romania

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumoniae* by laboratory (2009–2010)

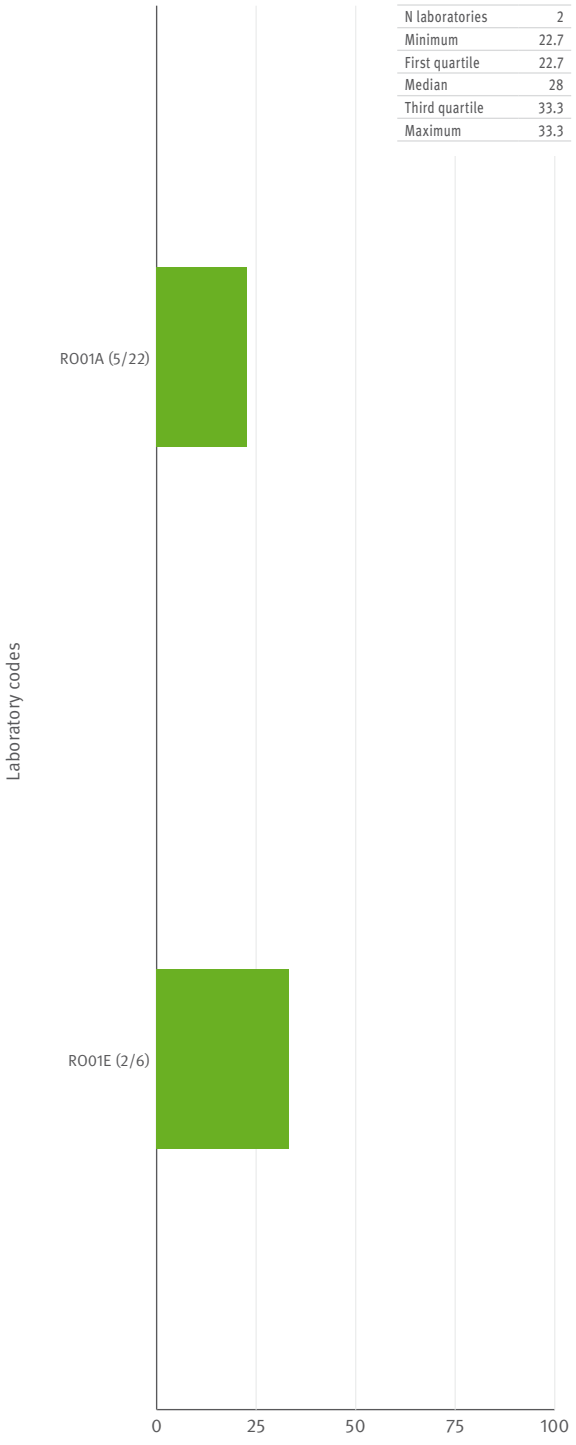


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

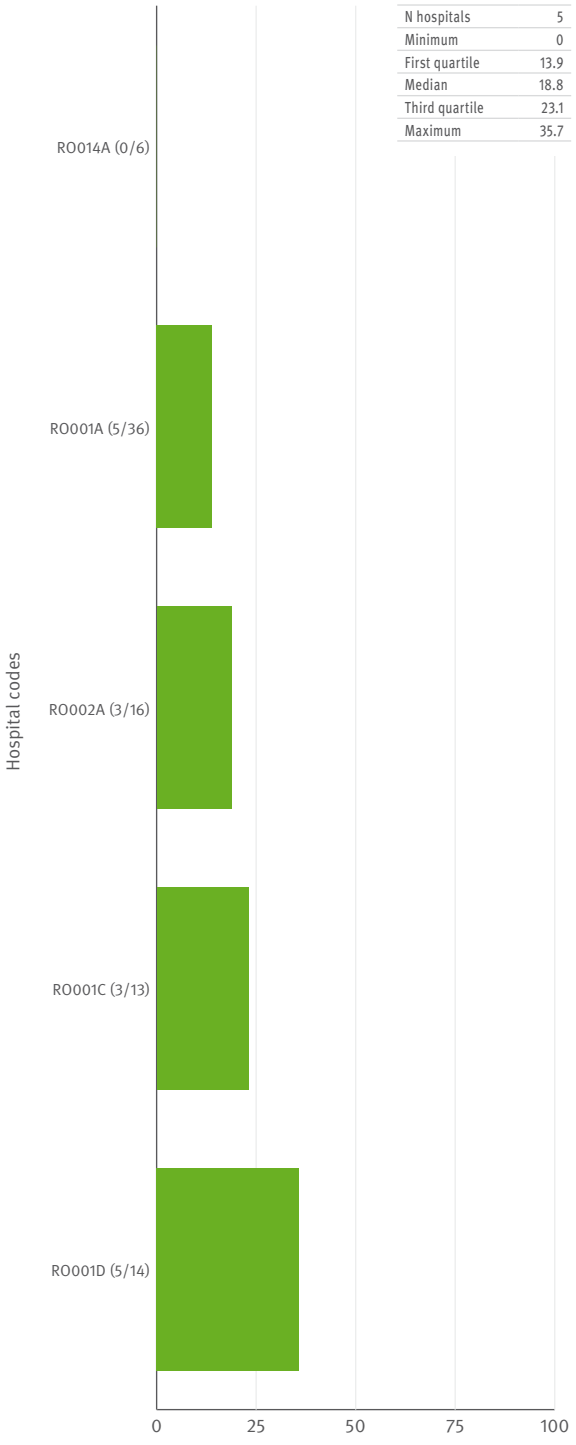
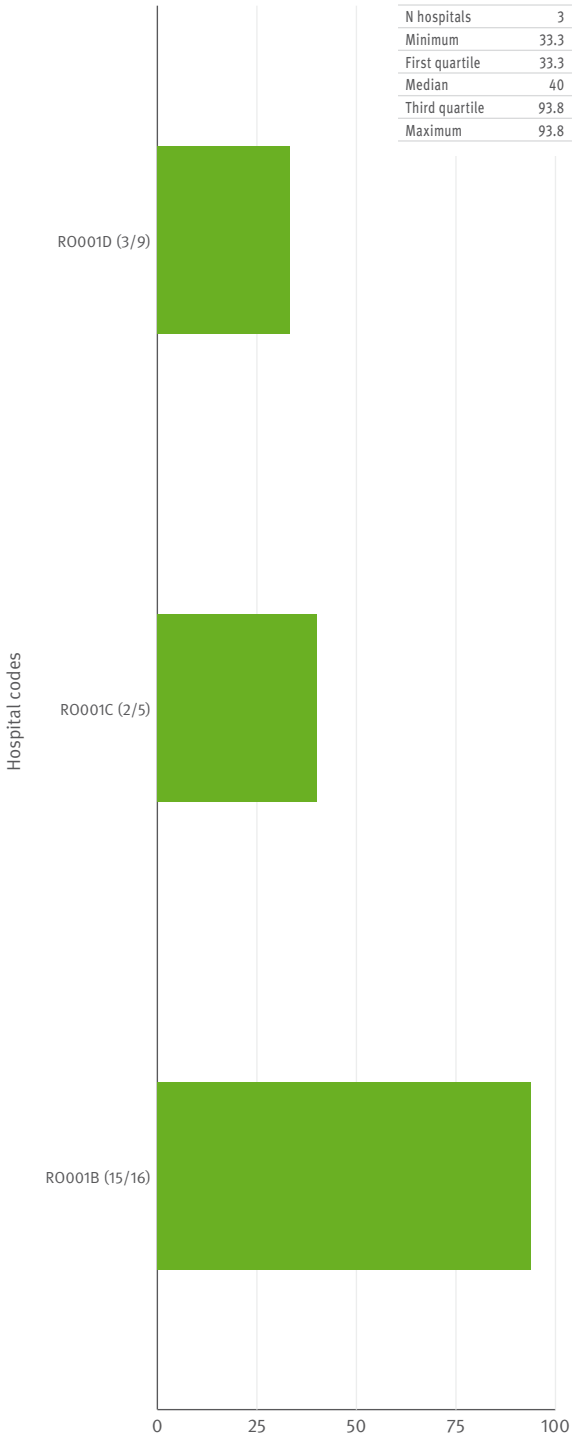


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Slovenia

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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	10	253	10	471	10	893	10	198	10	189	10	107
2010	10	232	10	476	10	952	10	196	10	196	10	95

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	2	2	2	5	4	3	1	<1
Penicillin RI	15	25	11	19	17	15	15	16
Macrolides RI	9	11	11	13	17	16	17	17
Staphylococcus aureus								
Oxacillin/Meticillin R	13	12	10	7	8	7	10	12
Escherichia coli								
Aminopenicilins R	41	40	42	44	49	49	53	48
Aminoglycosides R	2	5	4	7	7	7	10	9
Fluoroquinolones R	11	12	12	15	17	17	18	19
Third-gen. cephalosporins R	<1	1	2	2	4	4	5	7
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	<1	<1	1	1	<1	<1	<1	2
HL Gentamicin R	49	37	46	40	50	40	43	43
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	83	76	93	86	92	96	94	95
HL Gentamicin R	82	56	47	54	63	57	56	66
Vancomycin R	<1	<1	<1	6	5	13	4	2
Klebsiella pneumoniae								
Aminoglycosides R	-	-	17	19	24	23	28	23
Fluoroquinolones R	-	-	14	21	26	25	27	25
Third-gen. cephalosporins R	-	-	19	24	28	26	31	22
Carbapenems R	.	.	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	21	18	13	21	16	15
Ceftazidime R	-	-	11	8	7	14	8	5
Carbapenems R	-	-	13	6	19	16	15	19
Aminoglycosides R	-	-	18	15	10	13	12	9
Fluoroquinolones R	-	-	29	21	17	24	13	9

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=485		*S. aureus* n=947		*E. coli* n=1845		*E. faecalis* n=264		*E. faecium* n=130		*K. pneumoniae* n=385		*P. aeruginosa* n=196	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	92	15	100	11	100	19	100	0	100	3	99	26	98	17
CSF	8	13	-	-	<1	0	-	-	-	-	1	100	2	33
Gender														
Male	59	16	61	11	42	21	61	0	60	3	61	30	69	20
Female	41	14	39	10	58	17	39	0	40	4	39	22	31	10
Age (years)														
0–4	22	15	3	4	2	2	3	0	2	0	3	10	3	0
5–19	3	7	2	0	1	0	-	-	-	-	1	20	1	0
20–64	36	16	37	10	27	20	29	0	48	5	34	29	37	29
65 and over	39	15	58	12	70	19	68	0	50	2	63	27	60	10
Hospital department														
ICU	14	14	10	16	10	19	11	0	22	0	19	45	21	33
Internal med.	38	16	43	9	47	18	38	0	28	0	40	14	33	6
Surgery	1	33	12	23	6	24	20	0	18	4	15	34	18	23
Other	47	15	35	7	37	19	30	0	32	7	25	29	28	13

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. pneumoniae* by laboratory (2009–2010)

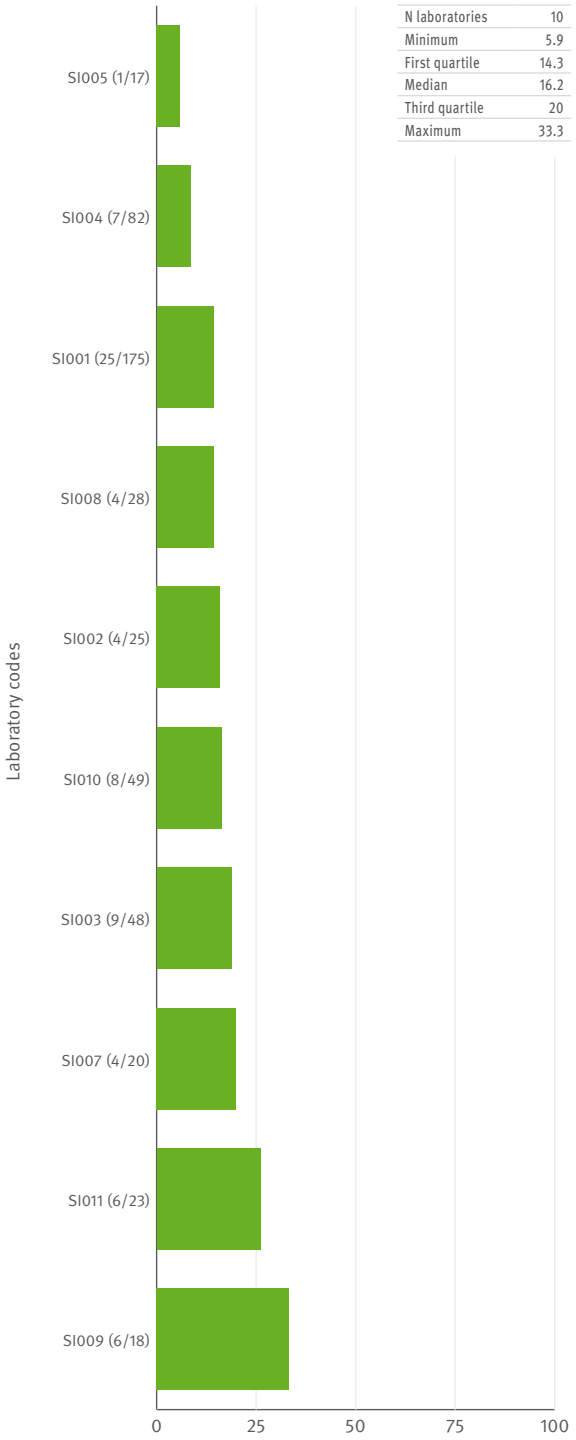


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

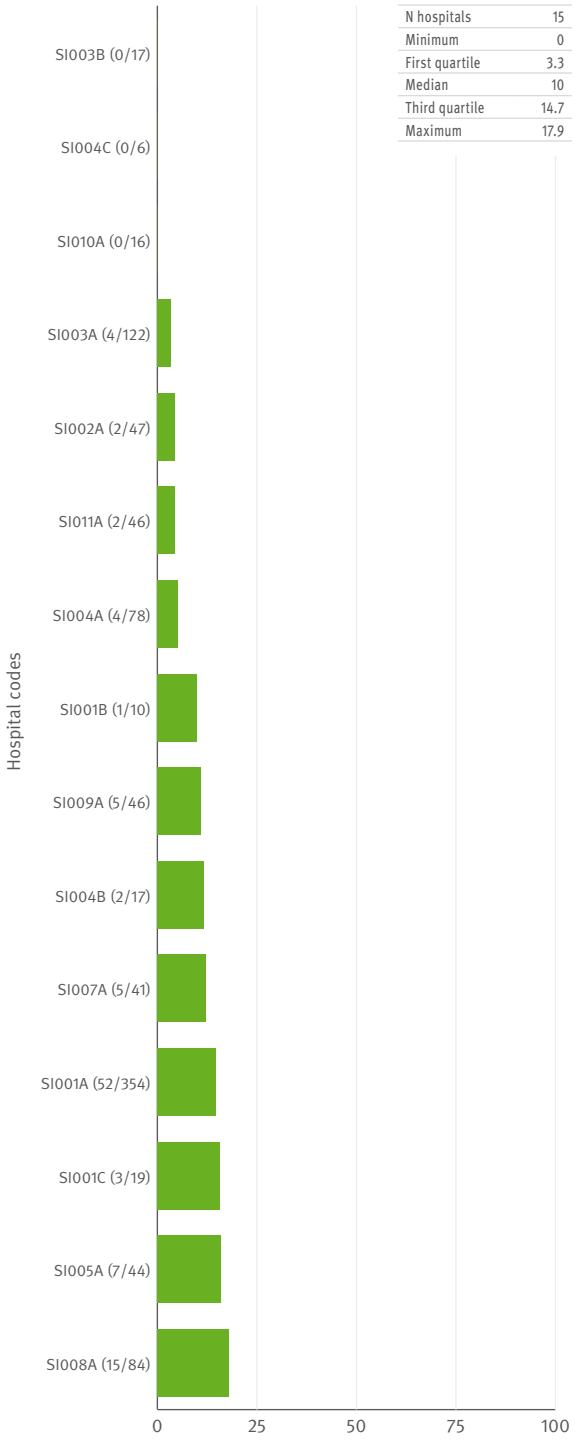


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

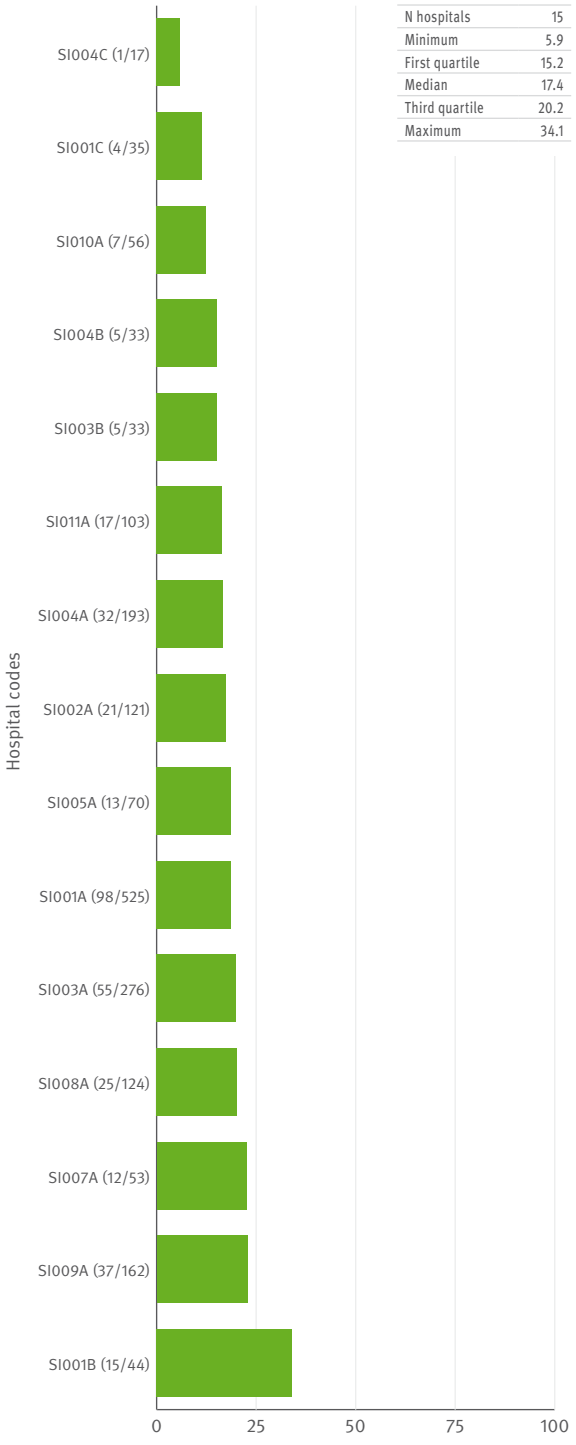
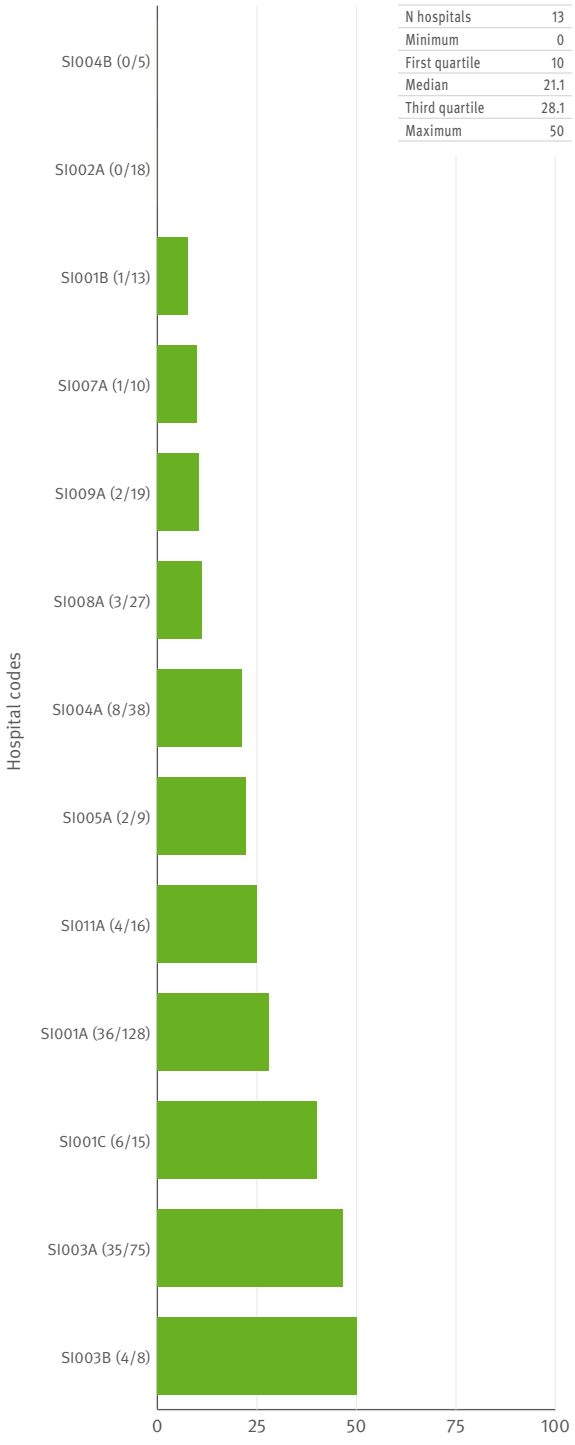


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Spain

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	41	862	41	1986	41	5696	41	1467	41	1161	41	749

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	7	9	9	8	8	7	8	10
Penicillin RI	32	29	25	27	22	23	22	30
Macrolides RI	27	27	23	22	18	22	19	27
Staphylococcus aureus								
Oxacillin/Meticillin R	24	26	27	25	25	27	26	25
Escherichia coli								
Aminopenicilins R	58	60	62	64	62	63	65	65
Aminoglycosides R	7	7	10	9	10	11	13	14
Fluoroquinolones R	21	25	28	28	30	33	31	33
Third-gen. cephalosporins R	4	7	8	7	7	9	11	12
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	1	2	<1	2	1	3	3	1
HL Gentamicin R	36	36	36	36	42	41	43	41
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	64	66	67	73	79	79	83	83
HL Gentamicin R	11	17	16	21	40	35	38	27
Vancomycin R	3	2	3	3	2	1	3	1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	4	7	9	9	9	9
Fluoroquinolones R	-	-	11	8	17	15	16	14
Third-gen. cephalosporins R	-	-	7	9	10	12	11	10
Carbapenems R	.	.	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	4	9	8	8	8	6
Ceftazidime R	-	-	6	7	10	11	8	7
Carbapenems R	-	-	17	12	15	13	16	18
Aminoglycosides R	-	-	4	11	15	18	19	18
Fluoroquinolones R	-	-	14	19	25	23	25	25

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=1570		*S. aureus* n=3701		*E. coli* n=9506		*E. faecalis* n=1746		*E. faecium* n=813		*K. pneumoniae* n=1789		*P. aeruginosa* n=1289	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	95	27	100	26	100	32	100	0	100	2	99	11	99	17
CSF	5	20	-	-	<1	19	-	-	-	-	1	0	1	17
Gender														
Male	57	26	63	26	51	36	61	0	60	2	58	11	68	18
Female	39	27	34	26	46	28	35	1	37	1	38	10	30	16
Unknown	4	16	3	24	3	38	3	0	3	0	4	15	2	7
Age (years)														
0–4	13	39	5	12	4	9	13	0	5	0	8	10	4	9
5–19	4	23	3	8	1	21	1	0	1	13	1	7	2	17
20–64	41	19	34	19	27	29	30	1	34	3	33	11	35	21
65 and over	40	30	58	32	67	35	54	0	59	2	57	11	59	15
Unknown	2	23	1	23	1	22	2	0	<1	0	1	0	<1	20
Hospital department														
ICU	12	25	10	24	6	35	17	0	18	2	12	14	23	28
Internal med.	31	26	51	29	41	37	40	0	52	3	42	10	45	15
Surgery	1	24	9	30	7	29	11	1	14	1	10	15	9	18
Other	55	27	29	20	46	28	31	0	15	0	36	9	24	11
Unknown	1	23	1	27	<1	19	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*.

Spain

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumoniae* by laboratory (2009–2010)

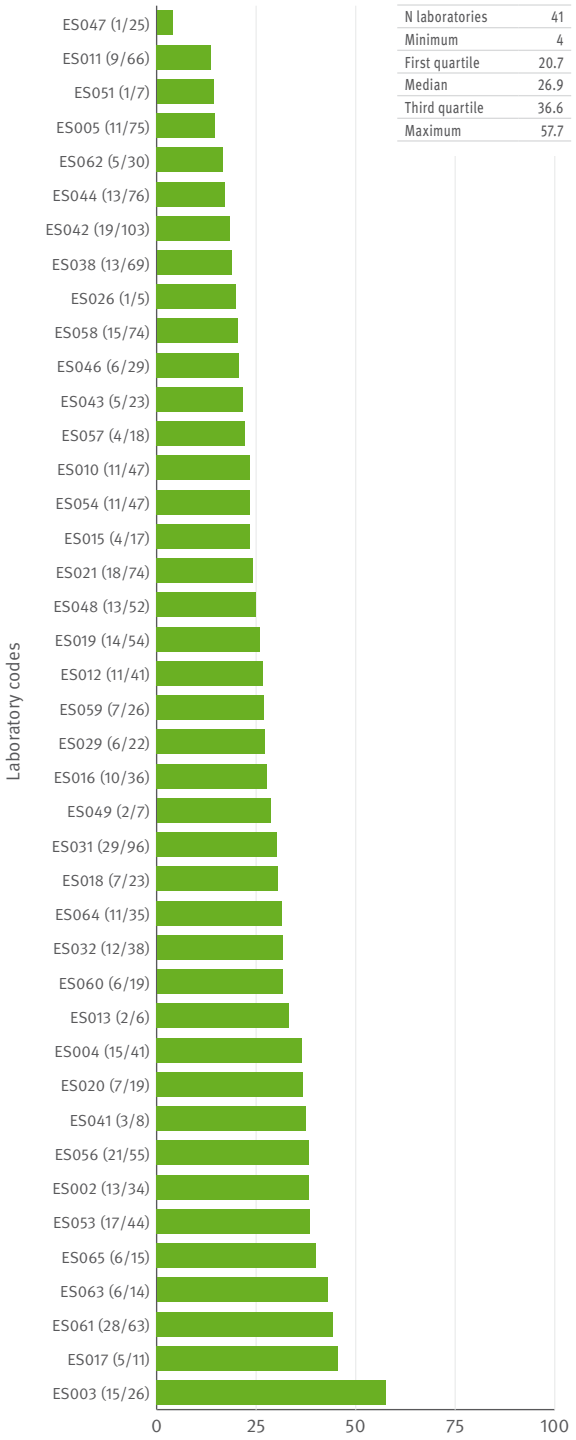


Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

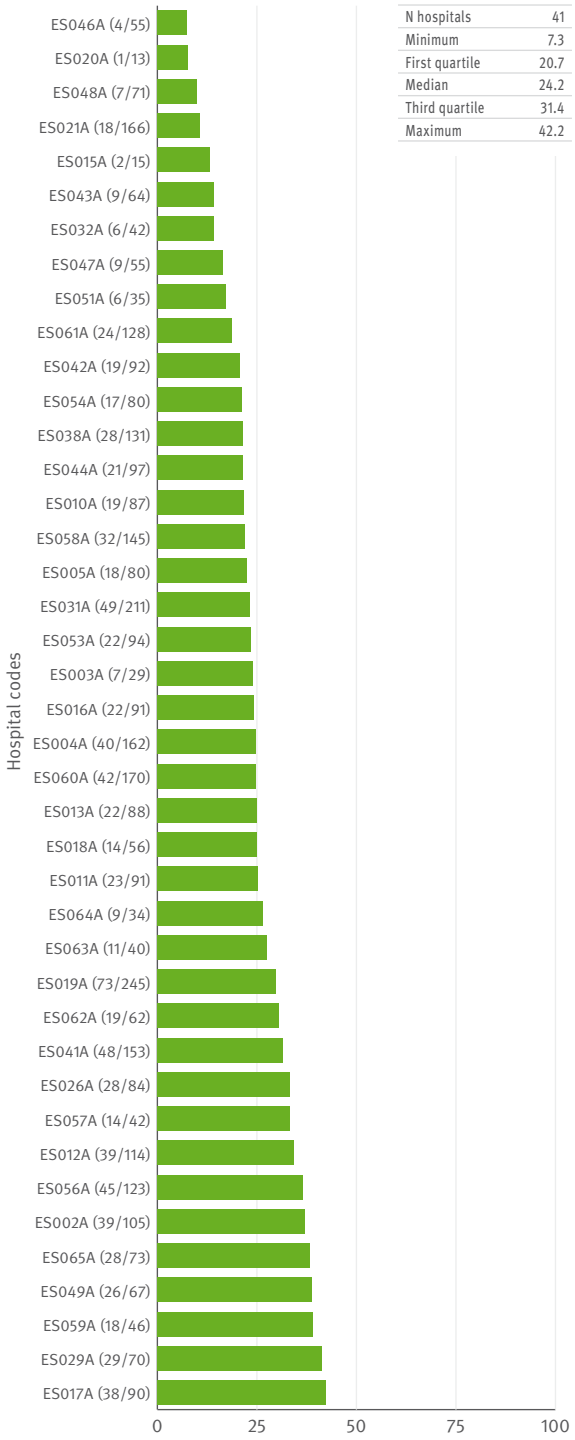


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

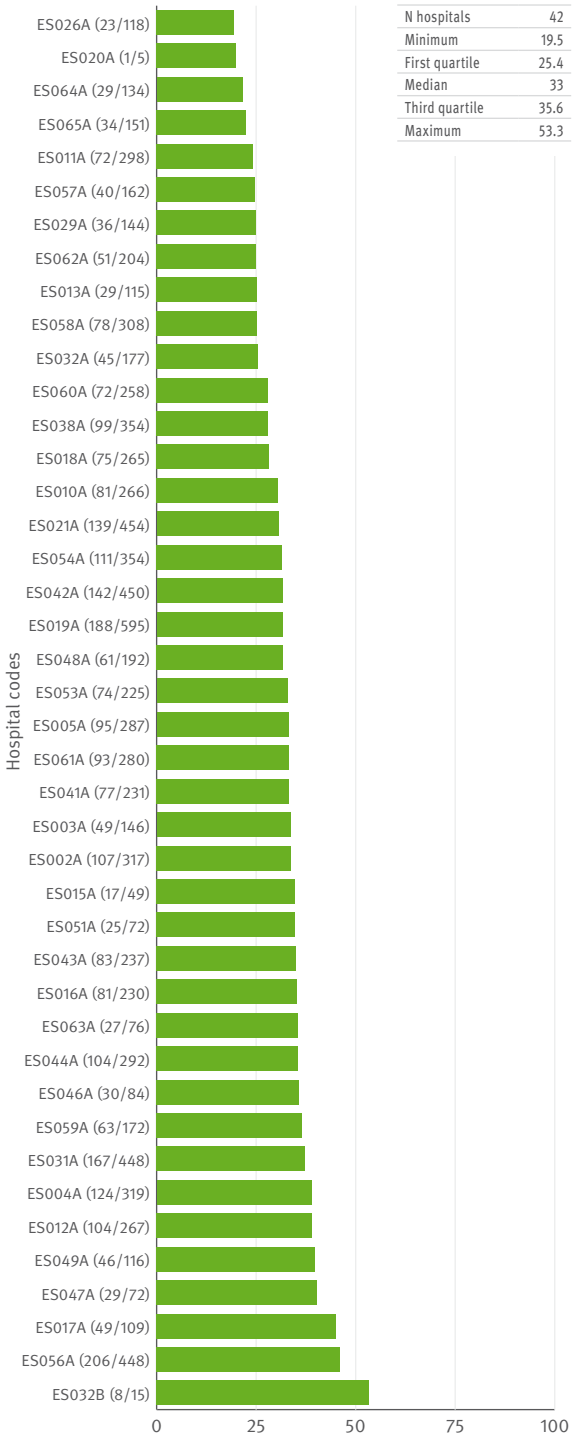
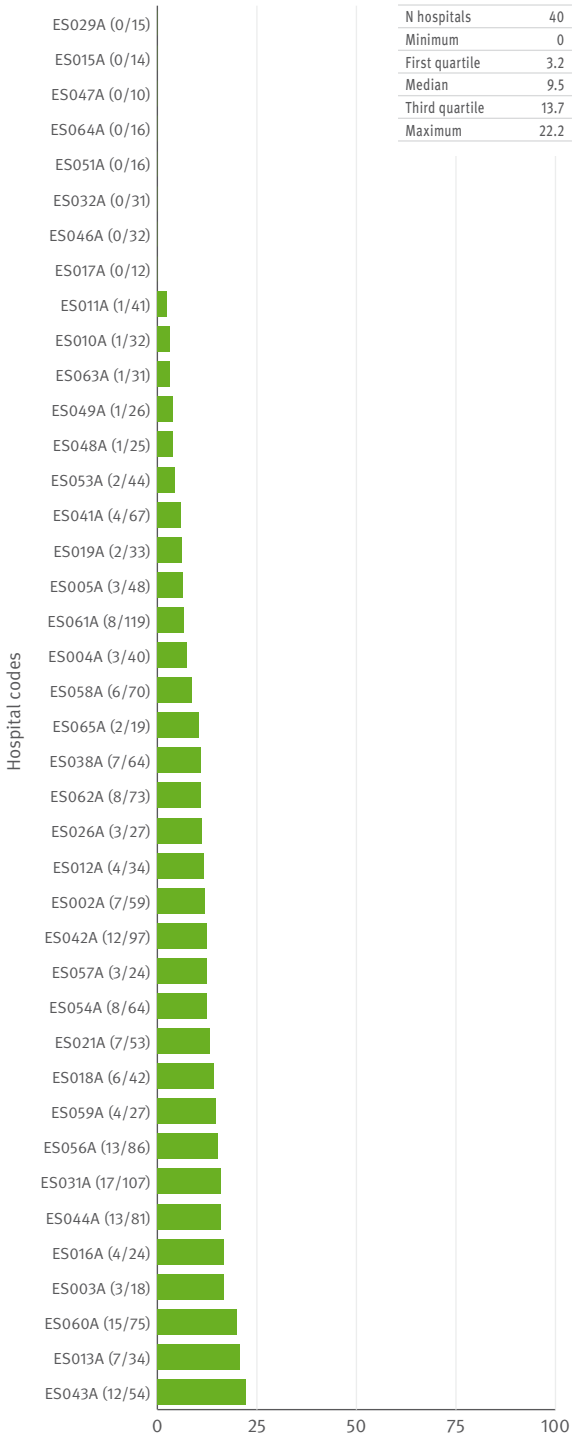


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



Sweden

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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	1063	19	2460	18	4247	19	967	18	706	18	338
2010	19	1008	19	2865	18	4846	18	1038	18	878	18	377

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	<1	<1	<1	<1	<1	<1	2	2
Penicillin RI	5	3	4	2	3	2	3	4
Macrolides RI	5	5	6	5	5	6	4	4
Staphylococcus aureus								
Oxacillin/Meticillin R	<1	<1	1	<1	<1	<1	1	<1
Escherichia coli								
Aminopenicilins R	29	23	26	28	33	32	33	35
Aminoglycosides R	1	1	1	2	2	2	3	3
Fluoroquinolones R	7	8	6	8	10	10	8	11
Third-gen. cephalosporins R	<1	<1	1	2	2	2	3	3
Carbapenems R	.	.	<1	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	<1	<1	<1	<1	<1	<1	<1	<1
HL Gentamicin R	17	16	19	20	16	20	19	15
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium								
Aminopenicilins RI	77	78	74	76	79	82	76	82
HL Gentamicin R	11	7	4	12	14	25	24	22
Vancomycin R	2	1	<1	<1	<1	2	<1	<1
Klebsiella pneumoniae								
Aminoglycosides R	-	-	1	<1	1	1	<1	1
Fluoroquinolones R	-	-	5	5	6	7	2	5
Third-gen. cephalosporins R	-	-	1	1	1	2	2	2
Carbapenems R	.	.	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	9	<1	2	1	2	1
Ceftazidime R	-	-	5	6	4	5	7	3
Carbapenems R	-	-	18	5	7	4	8	4
Aminoglycosides R	-	-	<1	<1	<1	<1	<1	<1
Fluoroquinolones R	-	-	6	5	6	5	7	6

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=2020		*S. aureus* n=5313		*E. coli* n=3728		*E. faecalis* n=1235		*E. faecium* n=514		*K. pneumoniae* n=1402		*P. aeruginosa* n=663	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	98	4	100	1	100	10	100	0	100	0	100	2	100	6
CSF	2	3	-	-	<1	0	-	-	-	-	<1	0	-	-
Gender														
Male	52	4	63	1	48	13	71	0	61	0	61	2	71	5
Female	48	3	37	1	52	6	29	0	39	0	39	1	29	8
Age (years)														
0–4	4	5	4	0	1	16	4	0	3	0	1	0	2	21
5–19	1	7	3	1	1	4	1	0	2	0	1	0	2	7
20–64	38	4	31	1	24	13	23	0	28	1	24	3	24	7
65 and over	56	3	62	1	74	9	73	0	68	0	74	1	72	5
Unknown	<1	0	<1	0	<1	25	<1	0	-	-	<1	0	-	-
Hospital department														
ICU	5	4	4	1	3	11	5	0	12	2	3	5	5	17
Internal med.	35	4	33	0	31	7	27	0	24	0	29	1	32	7
Surgery	3	5	12	1	16	10	18	0	23	0	21	0	13	2
Other	54	3	47	1	43	11	44	0	37	0	41	2	47	4
Unknown	3	2	4	0	7	7	5	0	4	0	5	3	4	17

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. pneumoniae* by laboratory (2009–2010)

Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)

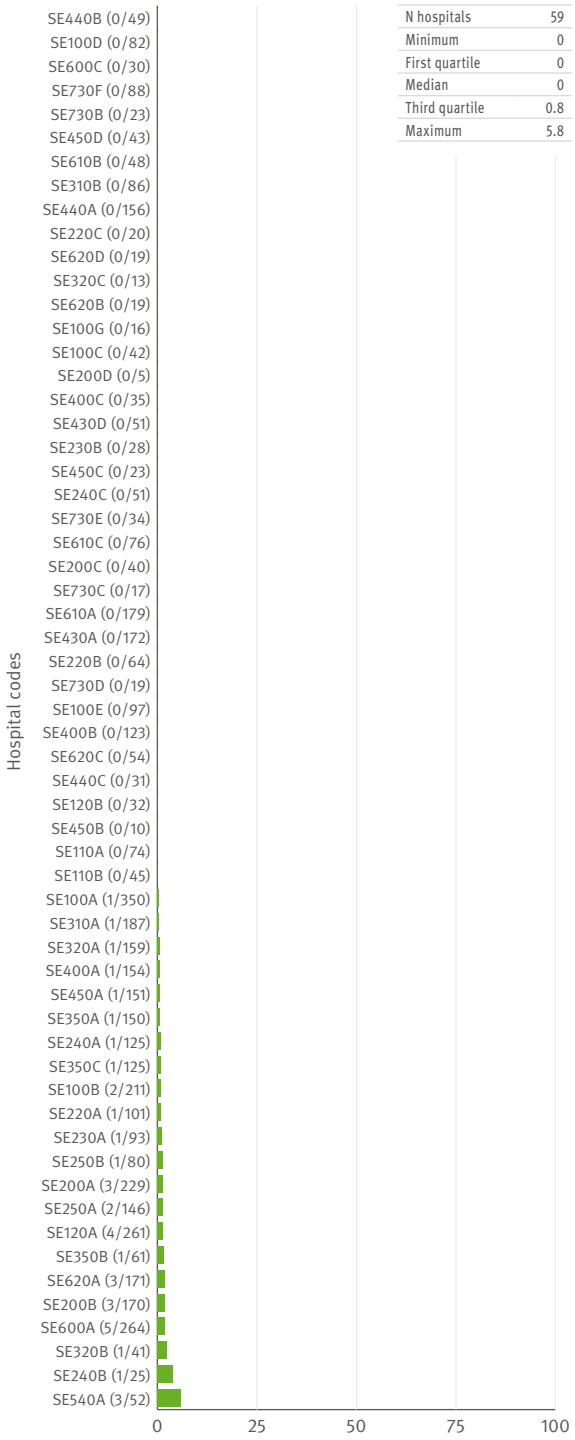


Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

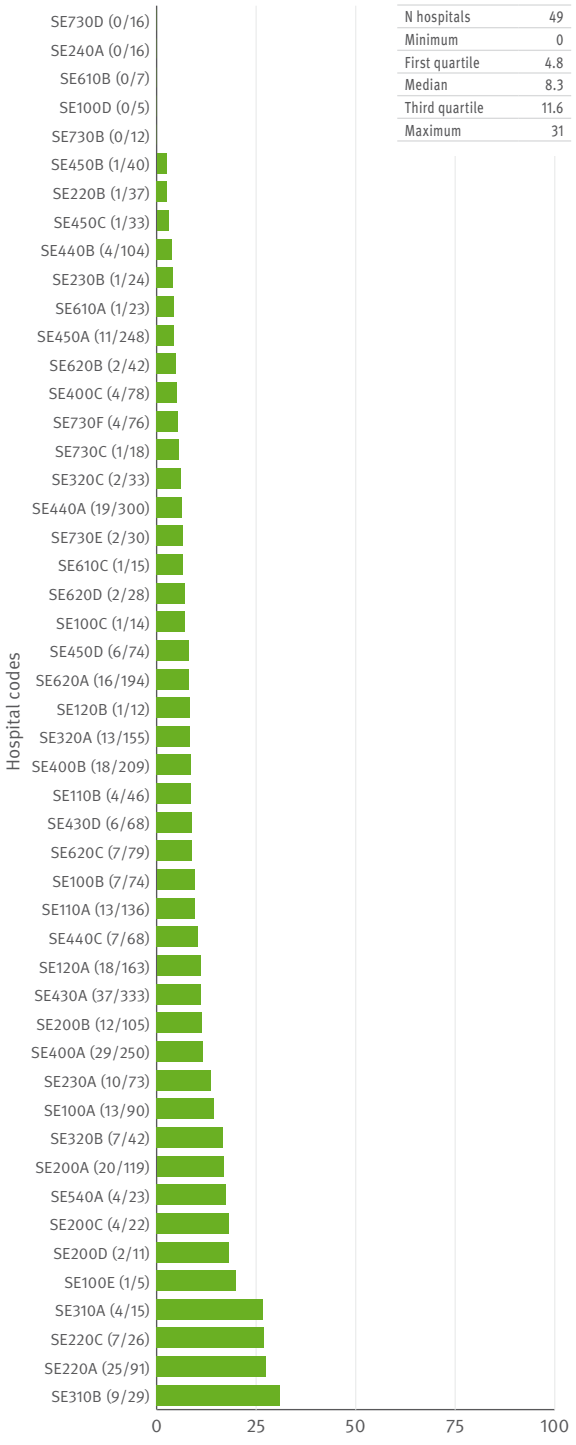
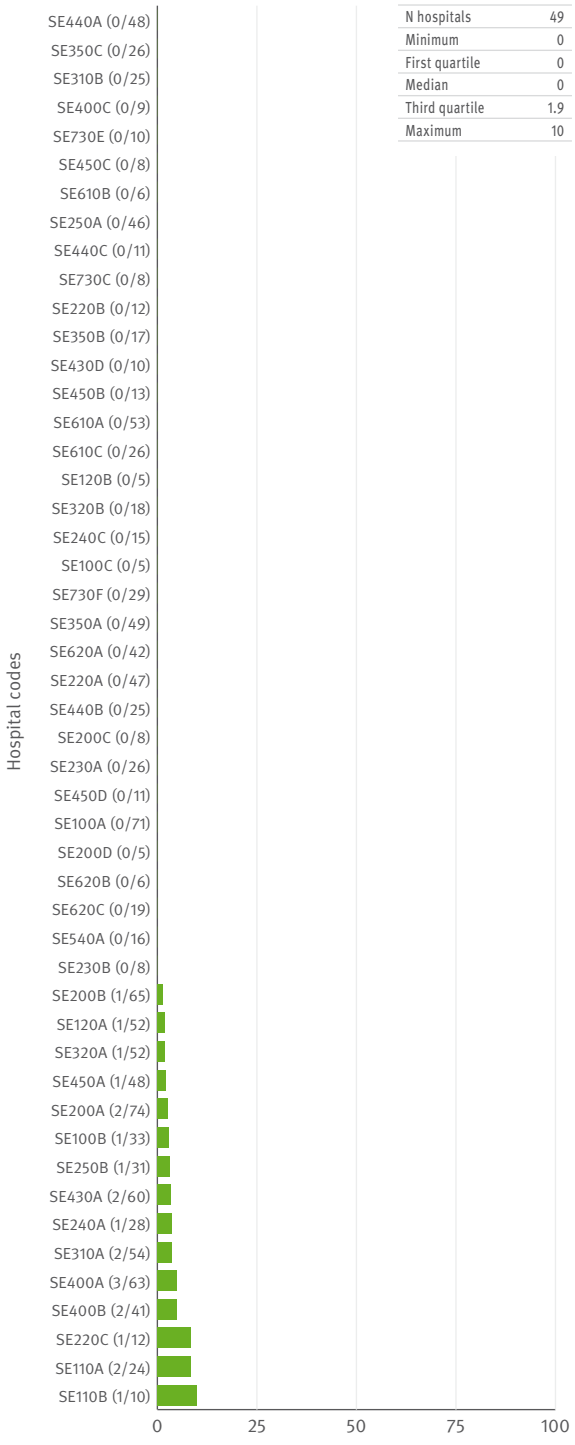


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



United Kingdom

General information about EARS-Net participating laboratories

Table 1: Number of laboratories and number of isolates reported for the period 2003–2010

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	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
2010	50	1459	55	2730	29	5389	28	651	28	840	28	588

Antibiotic resistance from 2003 to 2010

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

Pathogens by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010
Streptococcus pneumoniae								
Penicillin R	1	<1	2	<1	2	1	1	<1
Penicillin RI	5	3	4	3	4	5	3	3
Macrolides RI	13	13	11	12	10	6	4	5
Staphylococcus aureus								
Oxacillin/Meticillin R	44	44	44	42	36	31	28	22
Escherichia coli								
Aminopenicilins R	55	53	56	57	55	61	62	62
Aminoglycosides R	4	6	8	7	7	7	7	8
Fluoroquinolones R	11	14	17	20	18	15	18	17
Third-gen. cephalosporins R	3	3	6	8	9	7	9	9
Carbapenems R	-	-	-	<1	<1	<1	<1	<1
Enterococcus faecalis								
Aminopenicilins RI	-	-	2	3	4	2	2	6
HL Gentamicin R	-	-	47	52	31	42	38	39
Vancomycin R	-	-	2	1	2	4	2	1
Enterococcus faecium								
Aminopenicilins RI	-	-	84	78	82	83	91	84
HL Gentamicin R	-	-	53	18	35	7	38	31
Vancomycin R	-	-	33	18	21	28	13	10
Klebsiella pneumoniae								
Aminoglycosides R	-	-	6	8	9	6	5	5
Fluoroquinolones R	-	-	12	13	12	7	6	7
Third-gen. cephalosporins R	-	-	12	11	13	7	7	10
Carbapenems R	-	-	<1	<1	<1	1	<1	<1
Pseudomonas aeruginosa								
Piperacillin R	-	-	2	1	5	2	3	4
Ceftazidime R	-	-	3	3	7	4	5	5
Carbapenems R	-	-	9	6	10	6	8	6
Aminoglycosides R	-	-	3	3	5	3	1	2
Fluoroquinolones R	-	-	8	8	9	8	7	7

Demographic characteristics

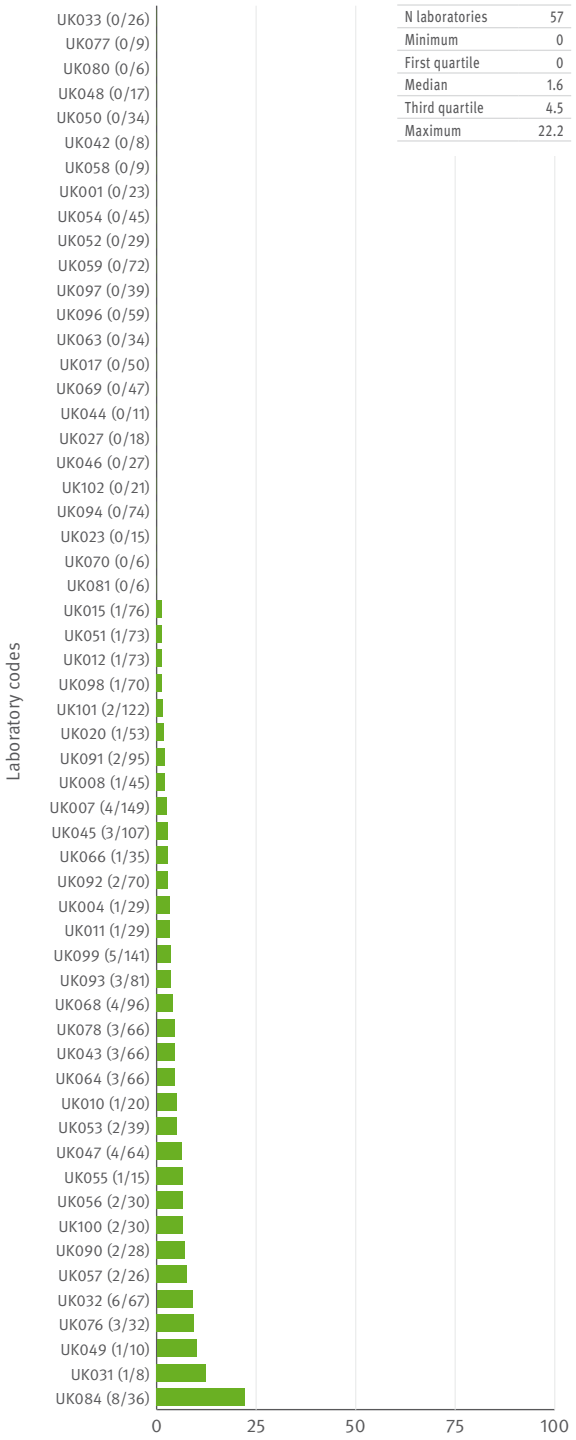
Table 3: Selected details on invasive isolates from the reporting period 2009 and 2010

Characteristic	*S. pneumoniae* n=2636		*S. aureus* n=5567		*E. coli* n=8945		*E. faecalis* n=779		*E. faecium* n=516		*K. pneumoniae* n=1398		*P. aeruginosa* n=1001	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% CRKP	% total	% CRPA
Isolate source														
Blood	99	3	100	25	100	18	100	2	100	12	100	9	100	7
CSF	1	6	-	-	-	-	-	-	-	-	-	-	-	-
Gender														
Male	52	3	61	26	47	20	62	1	57	8	59	9	62	6
Female	47	3	38	23	53	16	38	2	41	16	41	7	38	10
Unknown	1	0	1	29	<1	23	<1	0	2	20	<1	33	<1	25
Age (years)														
0–4	7	3	5	9	2	10	11	0	6	3	3	20	3	12
5–19	4	4	3	9	1	10	2	0	2	9	1	8	2	6
20–64	45	2	39	19	26	17	26	3	38	18	31	7	29	10
65 and over	44	4	52	32	71	18	61	1	52	8	65	9	64	6
Unknown	1	5	1	15	<1	0	1	0	2	8	<1	0	1	0
Hospital department														
ICU	5	1	3	34	-	-	-	-	-	-	-	-	-	-
Internal med.	17	4	11	35	-	-	-	-	-	-	-	-	-	-
Surgery	1	3	3	31	-	-	-	-	-	-	-	-	-	-
Other	30	3	21	25	-	-	-	-	-	-	-	-	-	-
Unknown	48	3	62	22	100	18	100	2	100	12	100	9	100	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*.

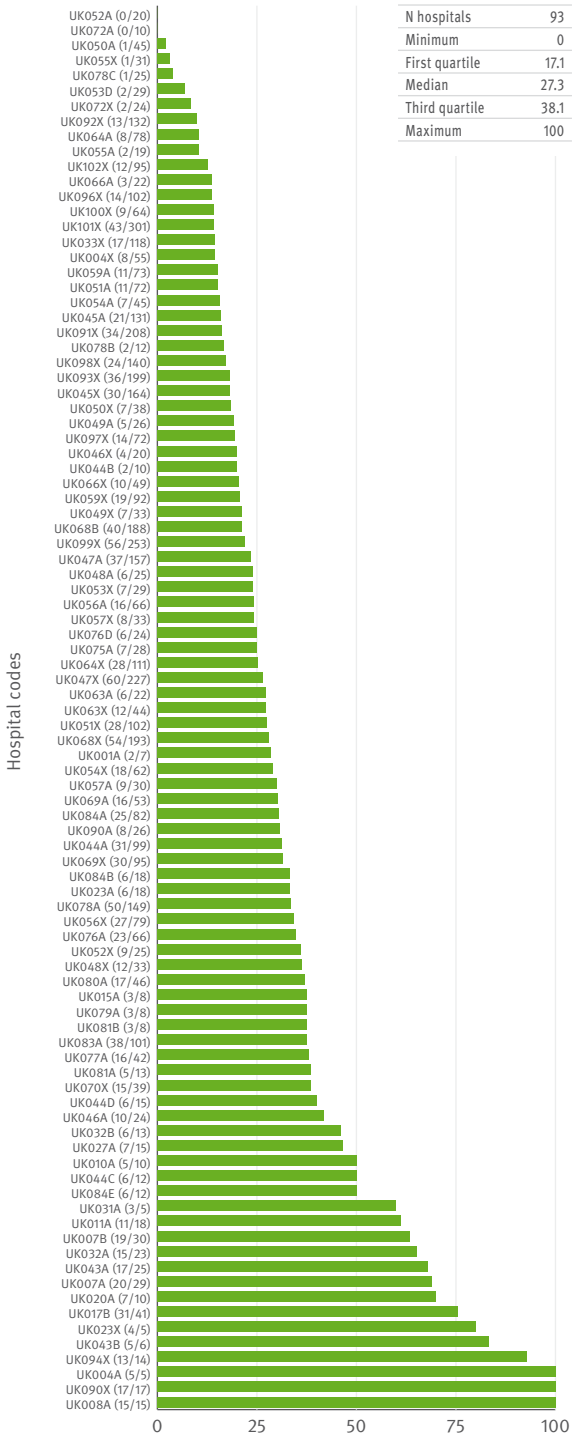
United Kingdom

Figure 1: Proportion (%) of penicillin-non-susceptible *S. pneumoniae* by laboratory (2009–2010)



N laboratories	57
Minimum	0
First quartile	0
Median	1.6
Third quartile	4.5
Maximum	22.2

Figure 2: Proportion (%) of meticillin-resistant *S. aureus* by hospital (2009–2010)



N hospitals	93
Minimum	0
First quartile	17.1
Median	27.3
Third quartile	38.1
Maximum	100

100% meticillin resistance rates for isolates of *S. aureus* reflect reporting of MRSA only.

Figure 3: Proportion (%) of fluoroquinolone-resistant *E. coli* by hospital (2009–2010)

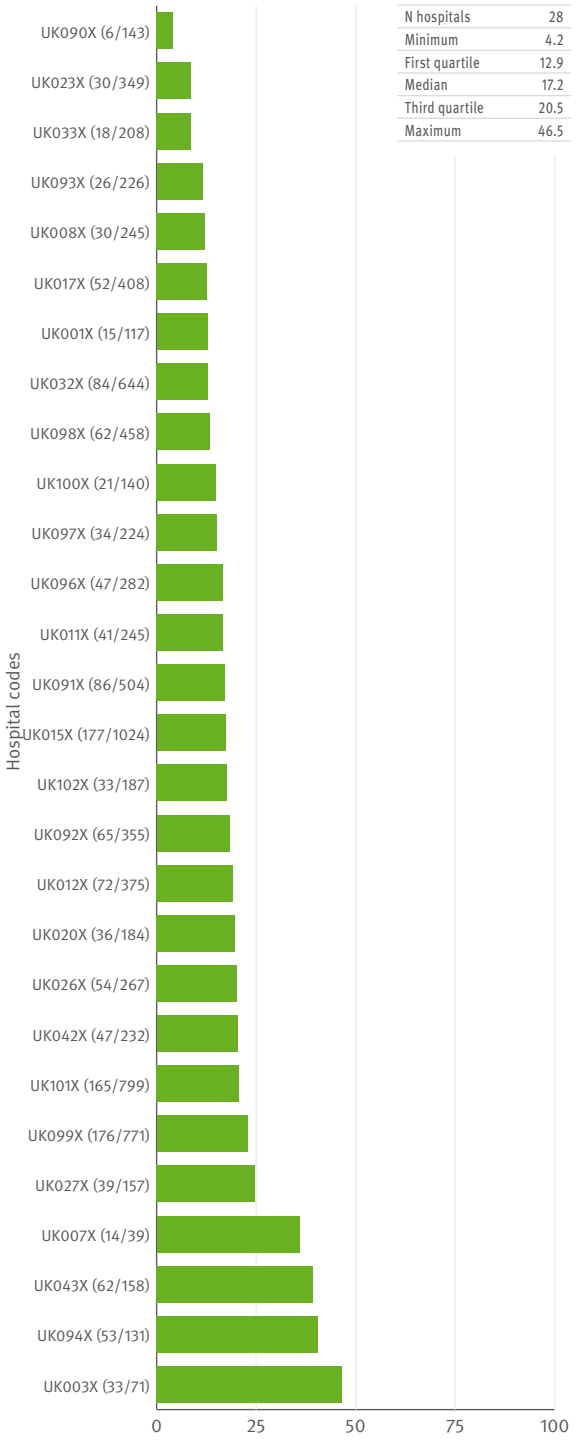
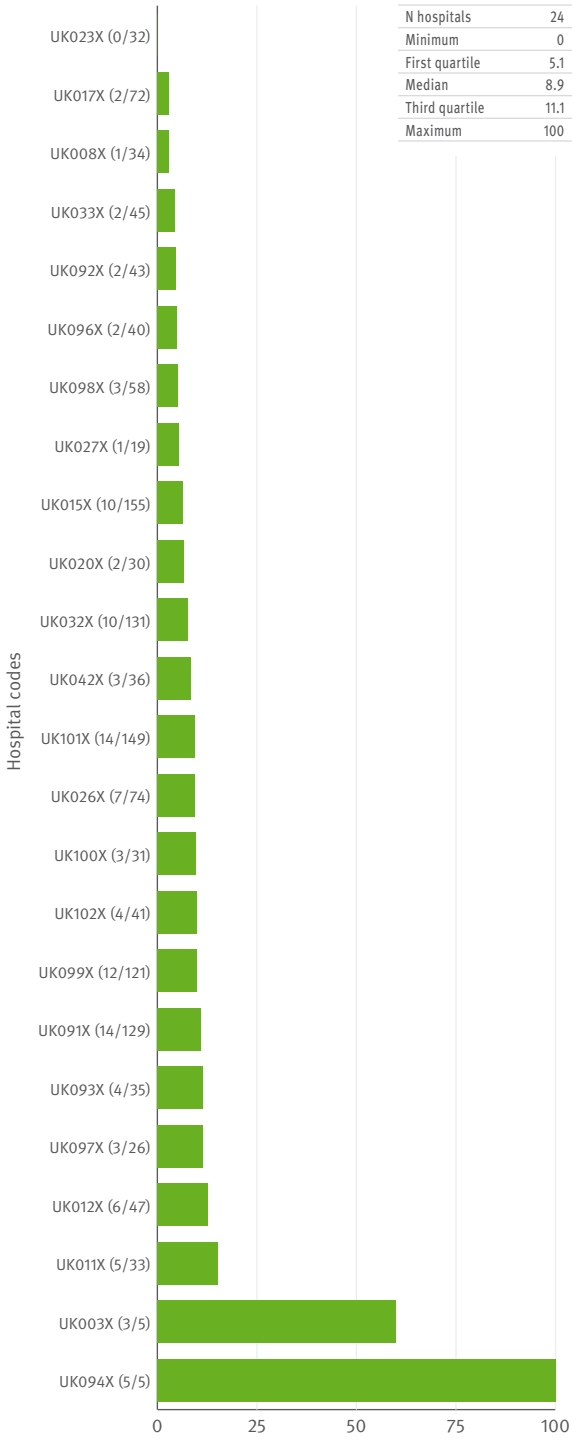


Figure 4: Proportion (%) of third-generation cephalosporin-resistant *K. pneumoniae* by hospital (2009–2010)



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European Centre for Disease Prevention and Control (ECDC)

Postal address:
ECDC, 171 83 Stockholm, Sweden

Visiting address:
Tomtebodavägen 11A, Solna, Sweden

Phone +46 (0)8 58 60 1000
Fax +46 (0)8 58 60 1001
www.ecdc.europa.eu

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