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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)

2013

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Abbreviations and acronyms

3GCREC	Third-generation cephalosporin-resistant *Escherichia coli*
3GCRKP	Third generation cephalosporin-resistant *Klebsiella pneumoniae*
AMR	Antimicrobial resistance
AST	Antimicrobial susceptibility testing
BSAC	British Society for Antimicrobial Chemotherapy
BSI	Bloodstream infection
CC	Clonal complex
CLSI	Clinical and Laboratory Standards Institute
CMY	Cephamycinase
CPA	Carbapenemase-producing *Acinetobacter* spp
CPE	Carbapenemase-producing *Enterobacteriaceae*
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
EEA	European Economic Area
EU	European Union
EuSCAPE	European survey on carbapenemase-producing Enterobacteriaceae
EQA	External quality assessment
ESBL	Extended-spectrum beta-lactamase
ESGARS	ESCMID Study Group for Antimicrobial Resistance Surveillance
ICU	Intensive care unit
IPD	Invasive pneumococcal disease
KPC	*Klebsiella pneumoniae* carbapenemase
MIC	Minimum inhibitory concentration
MLS	Macrolide, lincosamide and streptogramin
MRSA	Meticillin-resistant *Staphylococcus aureus*
MSSA	Meticillin-susceptible S*taphylococcus aureus*
NDM	New Delhi metallo-beta-lactamase
OXA	Oxacillinase gene
PBP	Penicillin-binding protein
PCV	Pneumococcal conjugate vaccine
RNA	Ribonucleic acid
SFM	Comité de l'Antibiogramme de la Société Française de Microbiologie (French)
SIR	Susceptible, intermediate, resistant
SHV	Sulfhydryl-variable extended-spectrum beta-lactamase gene
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
VIM	Verona integron-encoded metallo-beta-lactamase

National institutions/organisations participating in EARS-Net

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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

Croatia
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Zagreb University Hospital for Infectious Diseases 'Dr. Fran Mihaljević'

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.oek.hu

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

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

Italy
National Institute of 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
www.nvspl.lt
Institute of Hygiene
www.hi.lt

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
www.rivm.nl

Norway
University Hospital of North Norway
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Public Health Authority of Slovakia
Regional Public Health Authority Banska Bystrica

Slovenia
National Institute of Public Health
University of Ljubljana

Spain
Health Institute Carlos lll
www.isciii.es
National Centre of Microbiology

Sweden
The Public Health Agency of Sweden
www.folkhalsomyndigheten.se

United Kingdom
Public Health England
www.gov.uk/government/organisations/public-health-england
Health Protection Scotland
Public Health Agency Northern Ireland

Summary

The results presented in this report are based on antimicrobial resistance data from invasive isolates reported to EARS-Net by 30 EU/EEA countries in 2014 (data referring to 2013), and on trend analyses of EARS-Net data reported by the participating countries during the period 2010 to 2013.

The antimicrobial resistance situation in Europe displays large variations depending on bacteria, antimicrobial group and geographical region. For several antimicrobial group and bacterium combinations, a north-to-south and west-to-east gradient is evident in Europe. In general, lower resistance percentages are reported by countries in the north and higher percentages reported by countries in the south and east of Europe.

Overall, the most concerning trends in Europe in 2013 were related to the occurrence of resistance in gram-negative bacteria (*Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa* and *Acinetobacter* species). For *E. coli* and *K. pneumoniae*, a continuous increase in resistance to key antimicrobial groups was noted. A majority of the isolates reported to EARS-Net in 2013 was resistant to at least one of the antimicrobial groups under surveillance, and many of these showed combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides. Over the last four years (2010 to 2013), resistance to third-generation cephalosporins in *K. pneumoniae* and *E. coli* increased significantly at EU/EEA level, as well as in many of the individual Members States. Many of the isolates resistant to third-generation cephalosporins were ESBL-positive and showed resistance to additional antimicrobial groups. In addition, resistance to fluoroquinolones, aminoglycosides and carbapenems, as well as combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides increased significantly at EU/EEA level for *K. pneumoniae*, but not for *E. coli*.

Interestingly, there was a decrease in fluoroquinolone resistance in *P. aeruginosa*, which was seen for both the EU/EEA population-weighted mean percentage as well as in the trends for several individual countries, whereas fluoroquinolone resistance increased in *K. pneumoniae*.

While the EU/EEA population-weighted mean for carbapenem resistance was 8.3% for *K. pneumoniae*, carbapenem resistance remained very low in *E. coli* (0.2%). However, five countries reported trends of increasing carbapenem resistance in *E. coli* in 2013; four of them belonging to the countries with the highest levels of resistance. Carbapenem resistance and resistance to multiple antimicrobial groups were also common in *Pseudomonas aeruginosa* and *Acinetobacter* spp. isolates. Data for polymyxin resistance (colistin and polymyxin B) were limited but indicated the presence of polymyxin resistance in all gram-negative bacterial species included in EARS-Net reporting, especially in countries with already high levels of carbapenem resistance.

Resistance trends for gram-positive bacteria showed a more diverse pattern across Europe. For meticillin-resistance in *Staphylococcus aureus* (MRSA), the population-weighted EU/EEA mean has decreased significantly over the last four years. The decrease has, however, been less pronounced compared with the previous four-year period. The trends for *Streptococcus pneumoniae* were generally stable, but with large inter-country variations in the percentage of resistant isolates. Macrolide non-susceptibility in *S. pneumoniae* was, for most countries, higher than the percentages for penicillin-non-susceptibility.

For enterococci, the population-weighted EU/EEA mean percentage for vancomycin resistance in *E. faecium* increased significantly between 2010 and 2013. The decrease in the percentage of high-level aminoglycoside resistant *E. faecalis* observed in a number of countries in recent years continued in 2013, although the population-weighted EU/EEA mean showed no significant change.

Overall discussion and conclusions

Antibiotic resistance is a serious threat to public health in Europe, leading to increasing healthcare costs, prolonged hospital stays, treatment failures and deaths. For invasive bacterial infections, prompt treatment with effective antimicrobial agents is especially important and is one of the single most effective interventions to reduce the risk of fatal outcome. The ongoing decrease in susceptibility to a number of key antimicrobial groups in invasive bacterial isolates reported to EARS-Net is therefore a great concern and constitutes a serious threat to patient safety in Europe.

The high percentages of ESBL production and of combined resistance in Gram-negative bacteria are especially worrisome because they mean that only few treatment alternatives are available for patients with serious infections. Besides its impact on treatment outcome of individual patients, the frequent resistance of gram-negative bacteria has led to an increased use of carbapenems, thus further favouring the emergence and spread of carbapenemase-producing bacteria. The increase in carbapenem resistance observed in the EARS-Net surveillance data is most likely a result of the increase in carbapenemase-producing bacteria in Europe that has previously been reported in scientific literature and in targeted studies such as the

ECDC-funded European survey on carbapenemase-producing Enterobacteriaceae (EuSCAPE).

Treatment alternatives for patients infected with bacteria showing combined resistance to carbapenems and other key antimicrobials are confined to combination therapy and to older antimicrobials such as polymyxins. Moreover, although data on polymyxin susceptibility test results as part of EARS-Net are limited, the reporting of isolates with polymyxin resistance, especially in countries with already high levels of carbapenem resistance, is an indication of the further loss of effective antimicrobial treatment options for gram-negative bacterial infections.

There are, however, encouraging examples that increasing resistance trends can be reversed. Among gram-positive bacteria, a continuous decrease in the MRSA percentage can be noted at EU/EEA level as well as in several individual countries in recent years. Several studies have indicated the importance of targeted patient screening and changes in antimicrobial use to achieve such reductions. Despite this, MRSA remains a public health challenge in Europe in 2013 as the EU/EEA population-weighted mean percentage was 18.0 % and seven countries reported MRSA percentages above 25 %.

The geographical differences noted in EARS-Net are most likely related to differences in antimicrobial use, infection control and healthcare utilisation practices in these countries. Prudent antimicrobial use and comprehensive infection control strategies targeting all healthcare sectors are the cornerstones of effective interventions aiming to prevent selection and transmission of antibiotic-resistant bacteria. The importance of these interventions has been further emphasised by two ECDC risk assessments targeting carbapenemase-producing Enterobacteriaceae (CPE). A number of countries have recently developed national guidelines for CPE, many of which are available through the ECDC directory of online resources for prevention and control of antimicrobial resistance and healthcare-associated infections, including CPE. Moreover, most interventions recommended in the guidelines listed in the online directory would not only target CPE, but would be likely to affect other multidrug-resistant bacteria and the general spread of antimicrobial resistance in Europe.

1 Introduction

Antimicrobial resistance (AMR) is a serious threat to public health in Europe, leading to mounting healthcare costs, treatment failure, and deaths. Previous analyses from the European Centre for Disease Prevention and Control (ECDC) have estimated that infections caused by a subset of drug-resistant bacteria are responsible for about 25 000 deaths in Europe annually. In addition to these avoidable deaths, this also translates into extra healthcare costs and productivity losses of at least EUR 1.5 billion [1].

The issue calls for concerted efforts at Member State level but also close international cooperation in order to preserve future antimicrobial effectiveness and access to effective treatment for bacterial infections. In 2008, the European Council adopted conclusions calling upon the European Commission to promote cooperation between the Commission, Agencies and the Member States against AMR [2]. In the Action Plan issued by the Commission in 2011, surveillance of AMR is pointed out as one of the areas where measures are most necessary, together with appropriate use of antimicrobials, infection prevention and control and development of new effective antimicrobials or alternatives for treatment [3].

About EARS-Net

The European Antimicrobial Resistance Surveillance Network (EARS-Net) is the continuation of the European Antimicrobial Resistance Surveillance System (EARSS), which was hosted by the Dutch National Institute for Public Health and the Environment (RIVM). Established in 1998, EARSS successfully created a multistate network for AMR surveillance and demonstrated how international AMR data could be provided to inform decisions and raise awareness among stakeholders and policy makers. By 1 January 2010, the management and administration of EARSS was transferred from RIVM to the European Centre for Disease Prevention and Control (ECDC), and the network was renamed EARS-Net. Data collected from EU/EEA Member States by the network since 1999 were transferred to The European Surveillance System (TESSy) database at ECDC.

EARS-Net is based on a network of representatives from the Member States collecting routine clinical antimicrobial susceptibility data from national AMR surveillance initiatives (for details, please refer to the list of national institutions and organisations participating in EARS-Net: page vii). Scientific guidance and support to the network is provided by the EARS-Net Coordination Committee. This group is composed of individual experts selected among the nominated disease-specific contact points and experts from other organisations that are involved in surveillance of antimicrobial resistance. EARS-Net activities are coordinated in close collaboration with two other major ECDC 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 European Committee on Antimicrobial Susceptibility Testing (EUCAST) which is supported by ECDC/ESCMID.

The objectives of EARS-Net are:

- to collect comparable, representative and accurate AMR data;
- to analyse the temporal and spatial trends of AMR in Europe;
- to provide timely AMR data that constitute a basis for policy decisions;
- to encourage the implementation, maintenance and improvement of national AMR surveillance programmes; and
- to support national systems in their efforts to improve diagnostic accuracy in the surveillance chain by offering an annual External Quality Assessment (EQA).

Since 1998, the participating laboratories have collected AMR data on more than one million unique invasive bacterial isolates. Being the largest publicly funded system for surveillance of antimicrobial resistance in Europe, data from 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 with the general public. All participating countries have open access to the EARS-Net database. Public access to descriptive data (maps, graphs and tables) is available through a web-based data query tool [4] and more detailed analyses are presented in the annual reports and in scientific publications.

2 Data collection and analysis

EARS-Net performs surveillance of AMR in eight bacterial pathogens of public health importance:

- *Escherichia coli*
- *Klebsiella pneumoniae*
- *Pseudomonas aeruginosa*
- *Acinetobacter* species (pilot project data for 2012 and 2013)
- *Streptococcus pneumoniae*
- *Staphylococcus aureus*
- *Enterococcus faecalis*
- *Enterococcus faecium*

All 28 EU Member states and two EEA countries (Norway and Iceland) reported AMR data for 2013 to EARS-Net. The number of participating laboratories and unique isolates has increased in recent years, indicating improved population coverage of the network. Only data from invasive (blood and cerebrospinal fluid) isolates are included. The panels of antimicrobial agent combinations under surveillance for each bacterium are defined in the EARS-Net Reporting Protocol [5].

In addition, the EUCAST guidelines for detection of resistance mechanisms and specific types of resistance of clinical and/or epidemiological importance have been developed. They describe the mechanisms of resistance, and set out recommended methods of detection for key EARS-Net bacterium–antimicrobial group combinations [6].

Routine antimicrobial susceptibility test results are collected from clinical laboratories by the national representative in each participating country. National data are uploaded directly by the national data manager to The European Surveillance System (TESSy) at ECDC on a yearly basis. TESSy is a web-based system for collection, validation and cleaning of data and is intended to be the single point for Member States to submit and retrieve data on all communicable diseases under EU surveillance. TESSy filters the uploaded records according to the list of bacteria/specimen/antimicrobials included in the AMR surveillance protocol and obtains one record per patient, bacteria, antimicrobial and year (for details, please refer to the EARS-Net Reporting Protocol). After uploading data, the national data manager receives a validation report and each country approves its own data before they are included for analysis. Please note that data presented by EARS-Net might diverge slightly from the data presented by the Member States themselves, as data cleaning routines might differ.

2.1 Data analysis

For the analysis, an isolate is considered resistant to an antimicrobial agent when tested and interpreted as resistant (R) in accordance with the clinical breakpoint criteria used by the local laboratory. An isolate is considered non-susceptible to an antimicrobial agent when tested and found resistant (R) or with intermediate susceptibility (I) using the same clinical breakpoints as interpretive criteria. EARS-Net encourages the use of EUCAST breakpoints but results based on other interpretive criteria used by the reporting countries are accepted for the analysis.

As a general rule, data were expressed as a resistance percentage, i.e. the percentage of R isolates out of all isolates with antimicrobial susceptibility testing (AST) information on that specific bacteria–antimicrobial class, and for some bacteria as the percentage of non-susceptible (I+R) isolates out of all isolates with the relevant information. For selected analyses, a 95 % confidence interval was determined.

A population-weighted EU/EEA mean percentage was determined by applying population-based weights to each country's data before calculating the arithmetic mean for all reporting countries. Country weights were used to adjust for imbalances in reporting propensity and population coverage, as the total number of reported isolates per country in most cases does not reflect the population size. The weight applied to each national data point represented the proportion of the country's population out of the total population of all countries included in the calculation. Annual population data were retrieved from the Eurostat online database [7].

If fewer than 10 isolates were reported for a specific organism–antimicrobial agent combination in a country, the resistance percentage was not calculated and the results were not displayed on the maps presented in this report.

The statistical significance of temporal trends of antimicrobial resistance percentages by country was calculated based on data from the last four years. Countries reporting fewer than 20 isolates per year, or not providing data for all years within the considered period, were not included in the analysis. Statistical significance of trends was assessed by the Cochran–Armitage test. An additional sensitivity analysis was performed by repeating the Cochran–Armitage test only including laboratories which consistently reported for the full four-year period in order to exclude selection bias when assessing the significance of the trends.

2.2 Interpretation of the results

The results, both for inter-country comparison and in some cases national trends, should be interpreted with caution. A number of factors might influence and introduce bias to the data, resulting in over- as well as underestimation of resistance percentages. Some of the most important potential sources of bias in EARS-Net are explained below.

Population coverage

Population coverage varies among reporting countries. Some countries report data from large national surveillance systems with a high national coverage, while other countries report data from a smaller subset of local laboratories and hospitals.

For countries reporting data from only a small number of hospitals and laboratories located in one specific geographical area, the sample may not be representative for the whole country. Likewise, national trends may not be representative of regional situations as pooled data could mask variations at local level.

For some countries, the population under surveillance is not constant and may change over the years due to variations in the number of participating laboratories. To control for this potential bias in trend analyses, an additional sensitivity analysis including a subset of data originating only from laboratories reporting for all the previous four years is provided for all national trend analyses.

For an overview of the number of reporting laboratories and characteristics of reported data, see the Country Summary Sheets.

Sampling

EARS-Net data are exclusively based on invasive isolates from blood or cerebrospinal fluid. The clinical relevance of indicator organisms isolated from these sites is undisputable. This restriction prevents some of the inconsistencies that arise from differences in clinical case definitions, different sampling frames or heterogeneous healthcare utilisation that would otherwise confound the data analysis if isolates from all anatomical sites were accepted. However, invasive isolates may not be representative of isolates of the same bacterial species from sites of other infections, i.e. urinary tract infections, pneumonia, wound infections, etc.

Case ascertainment of patients with bloodstream infections (BSIs) is strongly linked to diagnostic practices and the frequency with which blood cultures are taken. Therefore, variations in blood culture frequency (non-differential sampling) result in an increasing uncertainty when comparing resistance percentages between hospitals and countries. Extrapolations of EARS-Net data as a measure of BSI incidence could therefore underestimate the true value in countries with low blood culture frequency.

Differential sampling can occur if blood cultures are typically only performed after empirical treatment shows no adequate therapeutic response. Predictably, this will lead to a serious overestimation of the resistance percentage by not including susceptible BSI isolates in the denominator.

Laboratory routines and capacity

The use of guidelines for clinical breakpoints varies among countries in Europe, and in some instances even between laboratories in the same country. At present, many European laboratories are changing from using Clinical and Laboratory Standards Institute (CLSI) to EUCAST clinical guidelines (please see the Annex for further information). As a result, the interpretation of AST results may vary, at least for resistance mechanisms resulting in minimum inhibitory concentrations (MICs) close to the breakpoints. In addition, clinical breakpoints may change over time, as breakpoints may be revised. As quantitative data (i.e. disk diffusion zone diameters or MIC values) are not provided by all participating laboratories, only the reported S, I, and R results are considered for the analyses.

The ability to identify the microorganism and its associated antimicrobial susceptibility pattern may differ among laboratories. All laboratories providing data for EARS-Net are offered participation in an annual External Quality Assessment (EQA) to assess the reliability of the laboratory test results. For more information on the EARS-Net EQA and laboratory performance, see Annex.

3 Antimicrobial resistance in Europe

3.1 *Escherichia coli*

3.1.1 Clinical and epidemiological importance

Escherichia coli is the gram-negative bacterium most frequently isolated from blood cultures. It is one of the most frequent causes of bloodstream infections, community- and hospital-acquired urinary tract infections. It is associated with spontaneous and post-surgical peritonitis and with skin and soft tissue infections of polymicrobial aetiology, causes neonatal meningitis and is one of the leading causative agents in food-borne infections worldwide.

3.1.2 Resistance mechanisms

In *E. coli*, resistance to beta-lactams is mostly due to production of beta-lactamases. These enzymes hydrolyse the beta-lactam ring of beta-lactam antimicrobials that is crucial for inhibition of the penicillin-binding protein (PBP) targets. 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, (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). The most common resistance mechanisms detected in amoxicillin-clavulanic-acid resistant *E. coli* are OXA-1 production, hyperproduction of penicillinase, production of plasmidic AmpC, hyperproduction of chromosomal AmpC and production of inhibitor-resistant TEM (IRT). The first ESBLs spreading in *E. coli* were variants of the TEM or SHV enzymes, in which single or multiple amino acid substitutions expand their hydrolysing ability to include third-generation cephalosporins (in this report referring to cefotaxime, ceftriaxone and ceftazidime), fourth-generation cephalosporins, and monobactams. During the past decade, however, these enzymes have largely been replaced by the CTX-M-type ESBLs, which are now the most common ESBLs in *E. coli*. Most ESBLs can be inhibited by beta-lactamase inhibitors such as clavulanic acid, sulbactam or tazobactam. Hundreds of ESBL variants are known to date. An important factor in their global dominance is the wide dissemination of bacterial clones producing CTX-M-type ESBLs (e.g. the ST131 pandemic clone producing CTX-M-15). Other enzymes affecting susceptibility to third-generation cephalosporins include plasmid-encoded variants derived from some chromosomal AmpC-type beta-lactamases. CMY-2 is the most widespread enzyme belonging to this group, which remains less common than ESBLs in *E. coli* in Europe, but is more frequently seen in the United States. An important threat, that will require close surveillance in the future, is the emergence of carbapenem resistance in *E. coli*, mediated by metallo-beta-lactamases (such as the VIM, and NDM enzymes) or serine-carbapenemases (such as the KPC enzymes), providing resistance to most or all available beta-lactam agents. Another growing family of beta-lactamases comprises the OXA-type enzymes that confer resistance to ampicillin and cefalotin and are characterised by their high hydrolytic activity against oxacillin and cloxacillin and the fact that they are poorly inhibited by clavulanic acid. This family also includes some enzymes with carbapenemase activity (OXA-48-like enzymes), which have emerged in *E. coli* and other Enterobacteriaceae. When produced alone, they confer reduced susceptibility to carbapenems and resistance to penicillins, but not to the expanded-spectrum cephalosporins. Unfortunately, the finding of *E. coli* strains which produce multiple beta-lactamases are becoming increasingly common, also leading to additional resistance to the latter cephalosporins.

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 the irreversible inhibition of the enzyme activity followed by DNA fragmentation and eventually to cell death. Resistance to fluoroquinolones arises through stepwise mutations in some specific regions (the so-called quinolone-resistance determining regions – QRDRs) of the DNA gyrase subunits (*gyrA* and *gyrB*) and DNA topoisomerase IV subunits (*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 and OqxAB efflux pumps, which reduce the intracellular concentration of hydrophilic quinolones. These mechanisms are a concern because this type of resistance is transferable and because of their frequent association with CTX-M and CMY-type enzymes inactivating third-generation cephalosporins. Additionally, their presence is believed to facilitate evolution to resistance by chromosomal mutations.

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 bacteria. Resistance to aminoglycosides can be due to targeted modification (methylation) of the 16S ribosomal RNA (rRNA), which prevents aminoglycoside molecules from binding the

Figure 3.1. ***Escherichia coli*****. Percentage (%) of invasive isolates with resistance to fluoroquinolones, by country, EU/EEA countries, 2013**

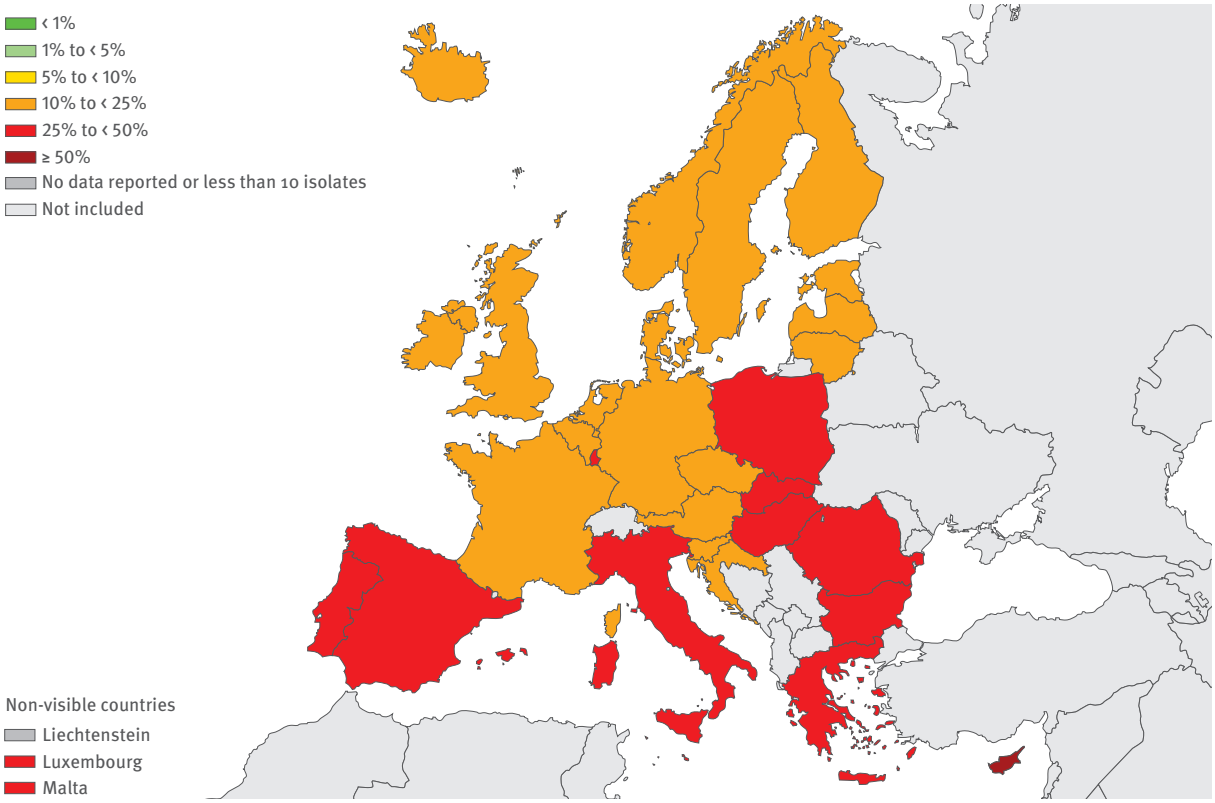
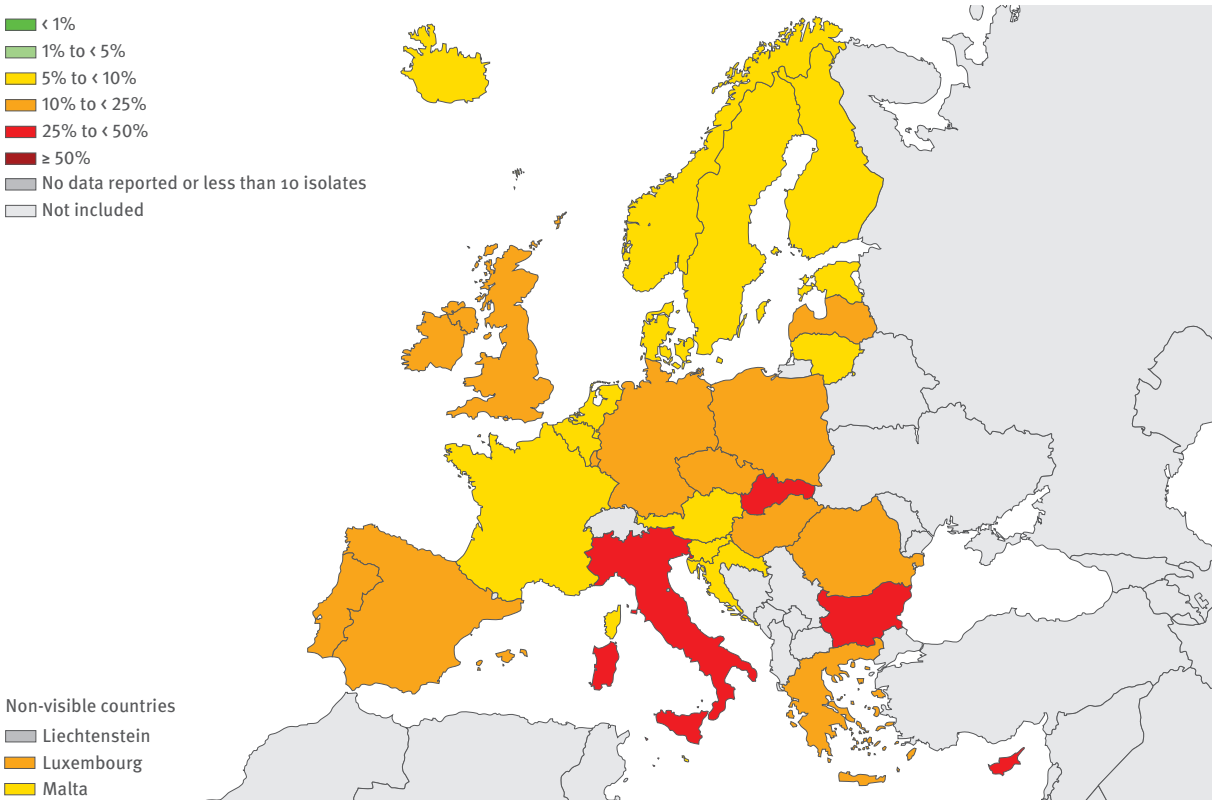


Figure 3.2. ***Escherichia coli*****. Percentage (%) of invasive isolates with resistance to third-generation cephalosporins, by country, EU/EEA countries, 2013**



small ribosomal subunit, or by aminoglycoside-modifying enzymes that acetylate, adenylate or phosphorylate their target molecules and thereby neutralise the biological effect of aminoglycosides. Of particular concern are the 16S ribosomal methylases that confer resistance to all aminoglycosides and frequently accompany carbapenemases.

3.1.3 Antimicrobial susceptibility

- More than half of the *E. coli* isolates reported to EARS-Net in 2013 were resistant to at least one antimicrobial group under surveillance. Resistance to aminopenicillins and fluoroquinolones were most commonly reported, both as single resistance and in combinations with other antimicrobial groups.
- The EU/EEA population-weighted mean percentage for third-generation cephalosporin resistance in *E. coli* increased significantly between 2010 and 2013. A significant increase was also observed in 17 of the 29 reporting countries. Many of the isolates resistant to third-generation cephalosporins were ESBL-positive and showed resistance to additional antimicrobial groups.
- Carbapenem resistance in *E. coli* remains very uncommon in Europe, but five countries reported increasing trends between 2010 and 2013. The four countries with the highest carbapenem resistance percentages in Europe all reported increasing trends.

Aminopenicillins

- For 2013, 30 countries reported 69 082 isolates with AST information for aminopenicillins. The number of isolates reported per country ranged from 121 to 10 146 (Table 3.2).
- Aminopenicillin resistance was very common. The EU/EEA population-weighted mean percentage for aminopenicillin resistance was 57.8 % in 2013. The percentages of resistant isolates in the reporting countries ranged from 34.1 % (Sweden) to 77.2 % (Cyprus). Seven countries reported resistance percentages of 25–50 %, while the remaining 23 countries reported resistance percentages above 50 % (Table 3.2).
- Trends for the period 2010–2013 were calculated for 27 countries reporting data for at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for six countries (Cyprus, Finland, Greece, Malta, Norway and Portugal). For Finland, Greece and Portugal, the trends were not significant when considering only data from laboratories reporting consistently for all four years.
- Significantly decreasing trends were observed for three countries (the Czech Republic, Hungary and Luxembourg).

Fluoroquinolones

- For 2013, 30 countries reported 80 272 isolates with AST information for fluoroquinolones. The number of isolates reported per country ranged from 116 to 10 069 (Table 3.3).
- The EU/EEA population-weighted mean percentage for fluoroquinolone resistance was 22.5 % in 2013. The percentages of resistant isolates in the reporting countries ranged from 10.9 % (Norway) to 51.9 % (Cyprus). Eighteen countries reported resistance percentages of 10–25 %, while the remaining twelve countries reported resistance percentages above 25 % (Table 3.3 and Figure 3.1).
- Trends for the period 2010–2013 were calculated for 29 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for seven countries (Finland, Greece, Italy, Norway, Portugal, Spain and Sweden). For Italy, Portugal and Spain, the trends were not significant when considering only data from laboratories reporting consistently for all four years.
- Significantly decreasing trends were observed for three countries (the Czech Republic, Germany and Hungary).

Third-generation cephalosporins

- For 2013, 30 countries reported 78 963 isolates with AST information for third-generation cephalosporins. The number of isolates reported per country ranged from 121 to 10 154 (Table 3.4).
- The EU/EEA population-weighted mean percentage for third-generation cephalosporin resistance was 12.6 % in 2013. The percentages of resistant isolates in the reporting countries ranged from 5.0 % (Iceland) to 39.6 % (Bulgaria). Fourteen countries reported resistance percentages below 10 %, twelve reported 10–25 % and four countries reported resistance percentages above 25 % (Table 3.4 and Figure 3.2).
- Trends for the period 2010–2013 were calculated for 29 countries reporting data for at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for 17 countries. For one country (Italy), the trend was not significant when considering only data from laboratories reporting consistently for all four years. The EU/EEA population-weighted mean percentage increased significantly from 9.5 % to 12.6 % over the four-year period.
- No country had a significantly decreasing trend during the period.

Extended-spectrum beta-lactamase (ESBL) production

- ESBL percentages for *E. coli* were calculated for 22 countries. Only data from laboratories reporting ESBL results for all isolates identified as resistant to third-generation cephalosporins, and only data from countries reporting at least 10 such isolates were included. There are national differences in the

Figure 3.3. ***Escherichia coli*****. Percentage (%) of invasive isolates with resistance to aminoglycosides, by country, EU/EEA countries, 2013**

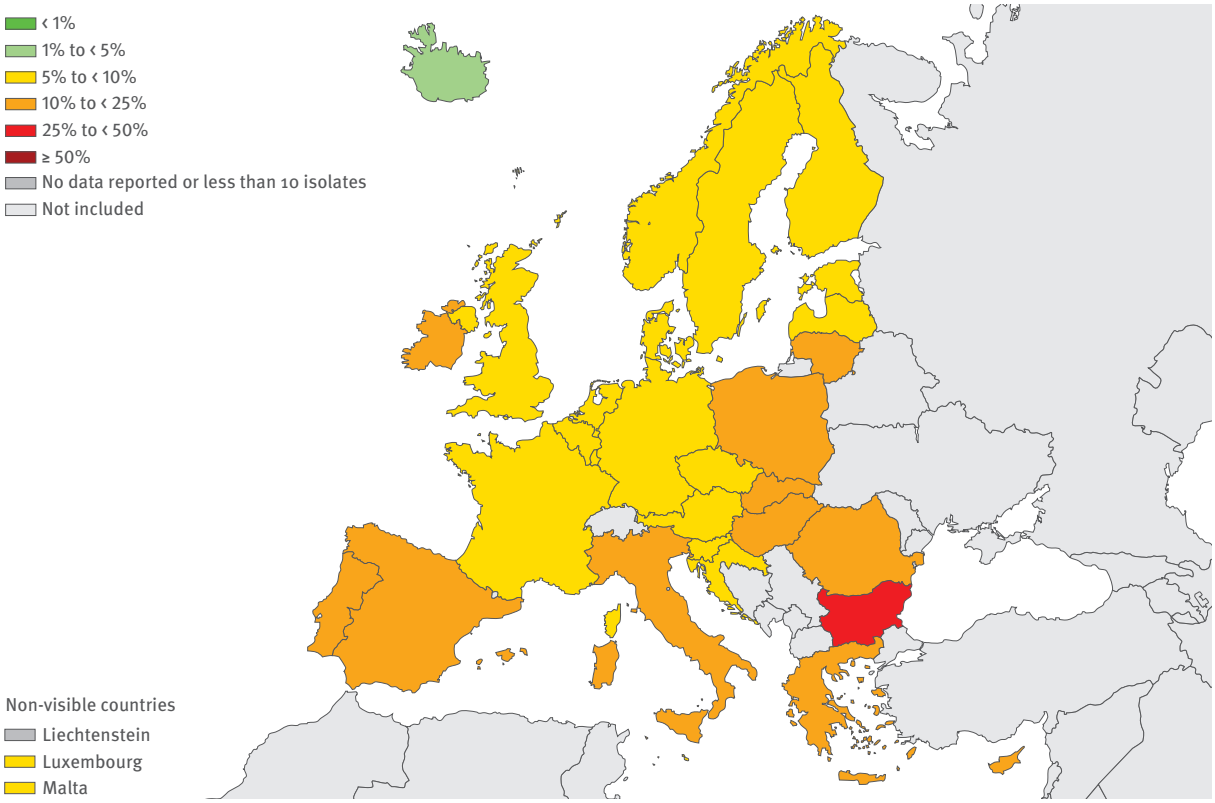


Figure 3.4. ***Escherichia coli*****. Percentage (%) of invasive isolates resistant to carbapenems, by country, EU/EEA, 2013**

Table 3.1. *Escherichia coli*. Number of reporting laboratories, total numbers of invasive isolates resistant to third-generation cephalosporins (3GCREC) and percentage of these isolates positive for extended-spectrum beta-lactamase (ESBL), as ascertained by the participating laboratories, EU/EEA countries, 2013

Country	Number of laboratories	Number of 3GCREC	%ESBL
Denmark	5	121	73.6
Slovakia	14	240	74.6
France	51	861	76.5
Austria	21	196	81.6
Estonia	6	25	84
Spain	33	672	86.3
Poland	36	113	87.6
Netherlands	12	111	88.3
Latvia	5	18	88.9
Ireland	32	245	89.8
Bulgaria	11	66	90.9
Croatia	14	91	91.2
Czech Republic	44	387	91.2
Slovenia	10	107	91.6
Portugal	26	328	92.1
Finland	18	263	93.5
Italy	3	33	93.9
Romania	11	56	94.6
Luxembourg	5	22	95.5
Sweden	16	382	97.4
Hungary	7	40	100
Lithuania	8	33	100

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 such isolates were included in the analysis.

Please note that there are national differences in the definition of ESBL, and some countries might report AmpC-positive isolates as ESBL.

definition of ESBL, and some countries might report AmpC-positive isolates as ESBL.

- Among *E. coli* isolates resistant to third-generation cephalosporins, large proportions were ascertained as ESBL-positive by the countries in 2013. Seventeen of 22 countries reported between 85 % and 100 % ESBL-positive isolates (Table 3.1).

Aminoglycosides

- For 2013, 30 countries reported 80 466 isolates with AST information for aminoglycosides. The number of isolates reported per country ranged from 121 to 10 156 (Table 3.5).
- The EU/EEA population-weighted mean for aminoglycoside resistance was 9.9 % in 2013. The percentages of resistant isolates in the reporting countries ranged from 4.1 % (Iceland) to 32.1 % (Bulgaria). Eighteen countries reported resistance percentages of below 10 %, eleven countries reported 10–25 % and one country reported above 25 % (Table 3.1 and Figure 3.3).
- Trends for the period 2010–2013 were calculated for 29 countries reporting data for at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for eight countries (Bulgaria, Finland, Italy, Norway, Poland, Portugal, Spain and Sweden). For Italy and Portugal, the trend was not significant when considering only data from laboratories reporting consistently for all four years.
- Significantly decreasing trends were observed for five countries (Belgium, Germany, Hungary, Malta and the Netherlands). For Belgium, the trend was not significant when considering only data from laboratories reporting consistently for all four years.
- Resistance estimates for the aminoglycoside group were mainly based on gentamicin or tobramycin AST results. Susceptibility data for amikacin were less frequently reported than gentamicin and tobramycin, and generally showed lower resistance percentages.

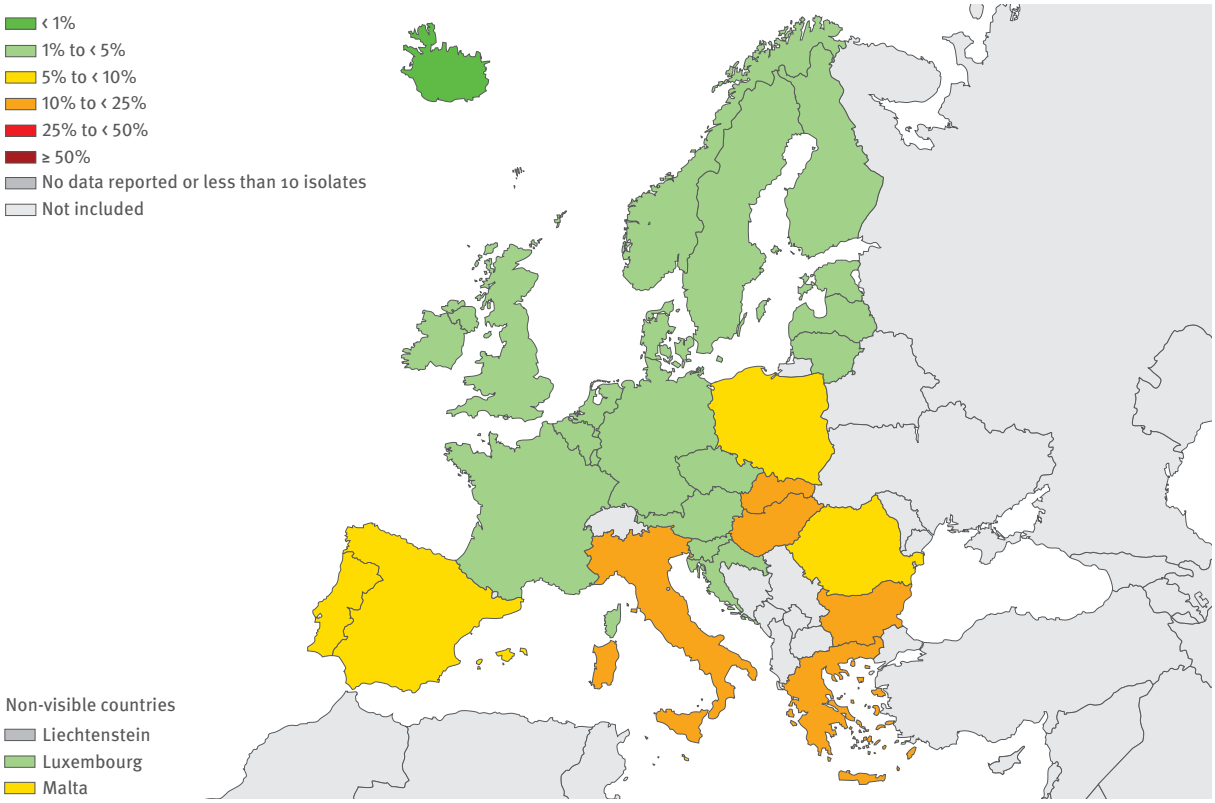
Carbapenems

- For 2013, 30 countries reported 76 596 isolates with AST information for carbapenems. The number of isolates reported per country ranged from 121 to 9 585 (Table 3.6).
- The EU/EEA population-weighted mean percentage for carbapenem resistance was 0.2 % in 2013, and remained lower than 0.5 % in most countries.
- Trends for the period 2010–2013 were calculated for 27 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for five countries (Bulgaria, France, Greece, Italy and Spain). For Italy, the trend was not significant when considering only data from laboratories reporting consistently for all four years.
- A significantly decreasing trend was observed for Croatia.

Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides

- For 2013, 30 countries reported 77 256 isolates with AST information necessary to determine combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides. The number of isolates reported per country ranged from 116 to 10 068 (Table 3.7).
- The EU/EEA population-weighted mean percentage for combined resistance was 4.6 % in 2013. The percentages of resistant isolates in the reporting countries ranged from 0.9 % (Iceland) to 20.4 % (Cyprus). Nineteen countries reported resistance percentages below 5 %, five countries reported 5–10 % and six reported 10–25 % (Table 3.7 and Figure 3.5).
- Trends for the period 2010–2013 were calculated for 29 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for thirteen countries. For Italy and Portugal, the trend was not significant when considering only data from laboratories reporting consistently for all four years.
- Significantly decreasing trends were observed for four countries (Germany, Hungary, Lithuania and Malta).

Figure 3.5. ***Escherichia coli*****. Percentage (%) of invasive isolates with combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides, by country, EU/ EEA countries, 2013**



Other resistance combinations and resistance to other antimicrobial groups

- Of the 61951 isolates tested for all antimicrobial groups under regular EARS-Net surveillance (aminopenicillins, fluoroquinolones, third-generation cephalosporins, aminoglycosides and carbapenems), 41.2% were fully susceptible to all tested antimicrobial groups. Among the remaining isolates, single resistance to one antimicrobial group (mainly aminopenicillins) was the most common (34.6% of the isolates). Of those with resistance to two antimicrobial groups, combined aminopenicillin and fluoroquinolone resistance was most common, and for those with resistance to three antimicrobial groups, aminopenicillin, fluoroquinolone and third-generation cephalosporin resistance accounted for the majority (Table 3.8).
- As carbapenem resistance remained uncommon in *E. coli*, resistance combinations including this antimicrobial group were rare. A total of 24 isolates with resistance to all antimicrobial groups under EARS-Net surveillance were reported, fifteen of these originating from Bulgaria, Greece or Italy.
- Eighteen countries reported AST data for polymyxins for a total of 12254 isolates (15% of all reported *E. coli* isolates in 2013). Only five countries reported polymyxin data for more than half of the reported *E. coli* isolates. Overall, 0.5% of the isolates were resistant to polymyxins. No *E. coli* isolate resistant to all five other antimicrobial groups under EARS-Net surveillance was also resistant to polymyxins. Among carbapenem-resistant isolates, 7.1% were resistant to polymyxins, whereas only 0.5% of carbapenem-susceptible isolates were polymyxin-resistant. However, the small number of tested isolates, the relatively high proportion of isolates from high-resistance areas and differences in the use of laboratory methodology used to determine susceptibility mean that these findings should be interpreted with caution and are not representative for Europe as whole.

3.1.4 Discussion and conclusions

E. coli is one of the most common causes of blood stream infections in Europe, and prompt access to effective antimicrobial treatment is essential to reduce the health-related and economic burden caused by this type of infection. The increasing frequency of resistance in *E. coli* to key antibiotics such as third-generation cephalosporins is of serious concern, and reflects a continuous loss of effectiveness in the treatment of patients with *E. coli* infections.

Carbapenem resistance in *E. coli* remains very uncommon with resistance percentages of <0.1% reported by the majority of countries. However, carbapenem resistance in Europe requires close monitoring. Increasing resistance is mainly seen in the countries with the highest rates of carbapenem resistance, situated in southern and south-eastern Europe. These countries are also those reporting comparatively high rates of carbapenem resistance in *K. pneumoniae*.

Comprehensive infection control measures and prudent antimicrobial use are fundamental to prevent selection and transmission of resistant *E. coli*. Increases in combined resistance to more antimicrobial groups and the high frequency of ESBL-producing isolates may lead to an increased use of carbapenems, thus favouring the further dissemination of carbapenemase-producing Enterobacteriaceae (CPE) [8].

ECDC has recently launched a directory of online resources for prevention and control of antimicrobial resistance and healthcare-associated infections, initially focusing on CPE [9]. The directory includes documents published by ECDC, EU/EEA Member States, international and national agencies and scientific societies to support healthcare professionals, hospital administrators and public health professionals responding to the increasing threat of antimicrobial resistance in Europe.

Table 3.2. ***Escherichia coli*. Total number of invasive isolates tested (N) and percentage resistant to aminopenicillins (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Sweden	1727	34.7	(32–37)	1023	34.8	(32–38)	–	–	(–)	452	34.1	(30–39)		N/A	
Finland	2165	33.8	(32–36)	2264	37.3	(35–39)	2090	39.7	(38–42)	2124	37.3	(35–39)		39.7 36.7 33.8	›*
Norway	2268	38.2	(36–40)	2617	39.1	(37–41)	2995	43.2	(41–45)	3016	43.0	(41–45)		43.2 40.7 38.2	›
Denmark	3412	45.8	(44–47)	3638	47.9	(46–50)	3708	45.2	(44–47)	3965	46.3	(45–48)		47.9 46.5 45.2	
Iceland	100	46.0	(36–56)	129	48.1	(39–57)	131	44.3	(36–53)	121	46.3	(37–56)		48.1 46.1 44.3	
Estonia	259	37.5	(32–44)	–	–	(–)	216	48.1	(41–55)	235	46.4	(40–53)		N/A	
Netherlands	3404	47.6	(46–49)	4425	48.5	(47–50)	4697	49.0	(48–50)	4656	47.5	(46–49)		49.0 48.2 47.5	
Austria	2928	50.6	(49–52)	3148	50.3	(49–52)	3625	50.6	(49–52)	4379	51.3	(50–53)		51.3 50.7 50.3	
Slovenia	941	48.0	(45–51)	1002	53.9	(51–57)	1168	50.4	(48–53)	1224	51.5	(49–54)		53.9 50.9 48.0	
Latvia	98	50.0	(40–60)	130	54.6	(46–63)	153	54.2	(46–62)	135	51.9	(43–61)		54.5 52.3 50.0	
Germany	3022	54.4	(53–56)	3638	52.3	(51–54)	4162	49.6	(48–51)	5220	53.0	(52–54)		54.4 52.0 49.6	
Croatia	625	53.0	(49–57)	975	55.3	(52–58)	904	51.4	(48–55)	1036	53.7	(51–57)		55.3 53.3 51.4	
Lithuania	329	55.9	(50–61)	383	47.8	(43–53)	461	52.5	(48–57)	432	54.2	(49–59)		55.9 51.8 47.8	
Luxembourg	353	63.2	(58–68)	353	52.1	(47–57)	335	50.7	(45–56)	299	54.5	(49–60)		63.2 56.9 50.7	‹
Malta	192	44.3	(37–52)	219	53.0	(46–60)	207	54.6	(48–62)	248	54.8	(48–61)		54.8 49.5 44.3	›
Czech Republic	2481	59.3	(57–61)	2683	60.7	(59–63)	2811	56.8	(55–59)	2954	54.9	(53–57)		60.7 57.8 54.9	‹
France	9017	54.6	(54–56)	8784	55.1	(54–56)	9599	55.2	(54–56)	10146	55.1	(54–56)		55.2 54.9 54.5	
Greece	1474	52.3	(50–55)	1297	54.5	(52–57)	1270	55.0	(52–58)	1149	56.4	(53–59)		56.4 54.3 52.3	›*
Belgium	1957	56.9	(55–59)	3507	58.7	(57–60)	3898	56.3	(55–58)	4350	56.8	(55–58)		58.7 57.5 56.3	
EU/EEA (population-weighted mean)		**57.7**	**(56–59)**		**57.8**	**(56–59)**		**57.5**	**(56–59)**		**57.8**	**(56–59)**		57.8 57.6 57.5	
Portugal	1976	55.8	(54–58)	1963	56.5	(54–59)	2152	59.4	(57–62)	2677	59.4	(58–61)		59.4 57.6 55.8	›*
Hungary	1328	65.3	(63–68)	991	64.7	(62–68)	1328	63.9	(61–67)	1411	60.9	(58–64)		65.3 63.1 60.9	‹
Slovakia	–	–	(–)	610	68.4	(65–72)	596	64.9	(61–69)	786	61.5	(58–65)		N/A	
United Kingdom	4429	62.3	(61–64)	5074	62.8	(61–64)	5846	62.7	(61–64)	6648	63.1	(62–64)		63.1 62.6 62.3	
Spain	5696	64.5	(63–66)	5592	65.6	(64–67)	5672	65.4	(64–67)	5720	65.1	(64–66)		65.6 65.0 64.5	
Poland	616	60.2	(56–64)	934	62.0	(59–65)	736	63.3	(60–67)	277	65.3	(59–71)		65.3 62.7 60.2	
Italy	2288	64.2	(62–66)	1530	67.1	(65–69)	2123	67.5	(66–70)	2356	65.7	(64–68)		67.5 65.8 64.2	
Romania	23	82.6	(61–95)	24	70.8	(49–87)	185	58.9	(51–66)	279	67.4	(62–73)		82.6 70.7 58.9	
Ireland	2121	66.8	(65–69)	2118	69.5	(68–72)	2329	67.4	(65–69)	2465	69.4	(68–71)		69.5 68.1 66.8	
Bulgaria	142	71.8	(64–79)	152	60.5	(52–68)	207	71.0	(64–77)	160	74.4	(67–81)		74.4 67.4 60.5	
Cyprus	137	62.0	(53–70)	134	77.6	(70–84)	176	70.5	(63–77)	162	77.2	(70–83)		77.6 69.8 62.0	›

–: No data

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data, which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.3. ***Escherichia coli*. Total number of invasive isolates tested (N) and percentage resistant to fluoroquinolones (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013			Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		Comment**
Norway	2267	8.7	(8–10)	2505	9.0	(8–10)	2843	11.3	(10–13)	2975	10.9	(10–12)	11.3 10.0 8.7	›
Sweden	2130	10.8	(9–12)	4367	9.5	(9–10)	5540	11.2	(10–12)	7356	11.6	(11–12)	11.6 10.5 9.5	›
Estonia	263	8.4	(5–12)	312	9.9	(7–14)	304	14.1	(10–19)	338	11.8	(9–16)	14.1 11.2 8.4	
Denmark	3166	13.7	(13–15)	3583	14.1	(13–15)	3923	14.1	(13–15)	3963	12.4	(11–14)	14.1 13.3 12.4	
Finland	2550	9.2	(8–10)	3020	11.0	(10–12)	3162	11.7	(11–13)	3594	13.3	(12–14)	13.3 11.3 9.2	›
Netherlands	3409	13.6	(12–15)	4427	14.3	(13–15)	4697	15.5	(14–17)	4730	14.1	(13–15)	15.5 14.6 13.6	
Iceland	95	10.5	(5–19)	121	14.0	(8–22)	134	9.7	(5–16)	116	14.7	(9–22)	14.7 12.2 9.7	
Lithuania	333	13.5	(10–18)	381	12.9	(10–17)	456	14.7	(12–18)	431	16.0	(13–20)	16.0 14.5 12.9	
United Kingdom	4815	17.3	(16–18)	5564	17.5	(17–19)	6241	16.6	(16–18)	6998	16.3	(15–17)	17.5 16.9 16.3	
France	9007	17.5	(17–18)	8694	17.9	(17–19)	9470	17.8	(17–19)	10069	16.7	(16–17)	17.9 17.3 16.7	
Latvia	97	14.4	(8–23)	131	16.8	(11–24)	152	14.5	(9–21)	134	18.7	(12–26)	18.7 16.6 14.5	
Slovenia	952	19.3	(17–22)	1002	20.7	(18–23)	1168	21.4	(19–24)	1224	19.9	(18–22)	21.4 20.3 19.3	
Croatia	876	17.0	(15–20)	952	20.3	(18–23)	892	17.0	(15–20)	1026	20.2	(18–23)	20.3 18.6 17.0	
Czech Republic	2481	22.7	(21–24)	2682	23.5	(22–25)	2809	21.0	(19–23)	2953	20.8	(19–22)	23.5 22.2 20.8	‹
Austria	2925	20.9	(19–22)	3162	22.3	(21–24)	3610	20.6	(19–22)	4279	22.0	(21–23)	22.3 21.5 20.6	
Germany	3017	24.8	(23–26)	3636	23.7	(22–25)	4188	21.1	(20–22)	5254	22.1	(21–23)	24.8 23.0 21.1	‹
EU/EEA (population-weighted mean)		**22.7**	**(21–24)**		**22.5**	**(21–24)**		**22.3**	**(21–24)**		**22.5**	**(21–24)**	22.7 22.5 22.3	
Belgium	1782	21.5	(20–24)	3549	21.5	(20–23)	3515	22.2	(21–24)	4113	23.0	(22–24)	23.0 22.3 21.5	
Ireland	2117	22.9	(21–25)	2153	22.9	(21–25)	2380	24.3	(23–26)	2478	24.2	(22–26)	24.3 23.6 22.9	
Poland	691	25.8	(23–29)	1141	27.3	(25–30)	1033	29.3	(27–32)	1035	27.3	(25–30)	29.3 27.5 25.8	
Luxembourg	354	26.3	(22–31)	353	24.1	(20–29)	334	24.0	(19–29)	295	27.8	(23–33)	27.8 25.9 24.0	
Malta	192	34.4	(28–42)	219	32.0	(26–39)	216	31.9	(26–39)	248	29.8	(24–36)	34.4 32.1 29.8	
Hungary	1367	36.6	(34–39)	1213	31.2	(29–34)	1393	28.9	(27–31)	1432	30.3	(28–33)	36.6 32.7 28.9	‹
Greece	1516	24.4	(22–27)	1433	26.6	(24–29)	1372	29.1	(27–32)	1240	30.9	(28–34)	30.9 27.7 24.4	›
Romania	33	24.2	(11–42)	50	28.0	(16–42)	186	29.0	(23–36)	300	31.0	(26–37)	31.0 27.6 24.2	
Portugal	1921	27.3	(25–29)	1917	27.2	(25–29)	2158	30.3	(28–32)	2685	31.6	(30–33)	31.6 29.4 27.2	›*
Spain	5696	32.8	(32–34)	5597	34.5	(33–36)	5654	33.9	(33–35)	5926	34.9	(34–36)	34.9 33.9 32.8	›*
Bulgaria	151	33.1	(26–41)	179	30.2	(24–37)	223	34.1	(28–41)	187	37.4	(30–45)	37.4 33.8 30.2	
Slovakia	–	–	(–)	739	41.8	(38–45)	695	41.3	(38–45)	808	40.3	(37–44)	N/A	
Italy	2436	39.2	(37–41)	1899	40.5	(38–43)	2920	42.1	(40–44)	3928	42.2	(41–44)	42.2 40.7 39.2	›*
Cyprus	138	42.8	(34–51)	137	47.4	(39–56)	176	42.0	(35–50)	162	51.9	(44–60)	51.9 47.0 42.0	

–: No data

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data, which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.4. ***Escherichia coli*****. Total number of invasive isolates tested (N) and percentage resistant to third-generation cephalosporins (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Iceland	104	3.8	(1–10)	130	6.2	(3–12)	138	5.1	(2–10)	121	5.0	(2–10)			
Sweden	3883	2.6	(2–3)	5011	3.6	(3–4)	5536	4.4	(4–5)	7532	5.2	(5–6)			›
Norway	2275	3.7	(3–5)	2523	3.6	(3–4)	3019	4.9	(4–6)	3077	5.5	(5–6)			›
Netherlands	3387	5.1	(4–6)	4408	5.7	(5–6)	4702	6.0	(5–7)	4740	5.8	(5–7)			
Finland	2509	3.7	(3–5)	3020	5.0	(4–6)	3162	6.2	(5–7)	3689	7.1	(6–8)			›
Estonia	309	5.5	(3–9)	90	12.2	(6–21)	305	7.9	(5–11)	340	7.4	(5–11)			
Lithuania	333	8.7	(6–12)	385	7.0	(5–10)	462	4.8	(3–7)	432	7.6	(5–11)			
Belgium	1952	5.2	(4–6)	3985	6.0	(5–7)	4097	6.9	(6–8)	4051	8.0	(7–9)			›
Denmark	2408	7.6	(7–9)	2532	8.5	(7–10)	2519	7.9	(7–9)	2451	8.1	(7–9)			
Slovenia	952	6.6	(5–8)	1002	8.8	(7–11)	1168	9.5	(8–11)	1224	8.7	(7–10)			
Croatia	882	8.7	(7–11)	983	9.6	(8–12)	906	7.5	(6–9)	1040	8.8	(7–11)			
Malta	192	15.6	(11–22)	219	12.8	(9–18)	216	13.9	(10–19)	248	8.9	(6–13)			
France	9022	7.2	(7–8)	8479	8.2	(8–9)	9563	10.0	(9–11)	10154	9.5	(9–10)			›
Austria	2922	7.3	(6–8)	3160	9.1	(8–10)	3710	8.7	(8–10)	4376	9.8	(9–11)			›
Ireland	2119	7.7	(7–9)	2166	9.0	(8–10)	2288	9.2	(8–10)	2480	10.6	(9–12)			›
Luxembourg	354	9.3	(7–13)	353	8.2	(6–12)	334	11.4	(8–15)	301	10.6	(7–15)			
Germany	3015	8.4	(7–9)	3642	8.0	(7–9)	4186	8.8	(8–10)	5249	10.8	(10–12)			›
Poland	744	7.5	(6–10)	938	11.7	(10–14)	1037	12.9	(11–15)	1036	10.9	(9–13)			›
EU/EEA (population-weighted mean)		**9.5**	**(9–10)**		**9.6**	**(9–11)**		**11.9**	**(11–13)**		**12.6**	**(12–14)**			›
Czech Republic	2482	10.4	(9–12)	2684	11.4	(10–13)	2812	11.5	(10–13)	2954	13.1	(12–14)			›
Spain	5696	12.1	(11–13)	5600	12.0	(11–13)	5672	13.5	(13–14)	5932	13.3	(12–14)			›
Latvia	98	12.2	(6–20)	132	15.9	(10–23)	154	13.0	(8–19)	136	14.0	(9–21)			
United Kingdom	4547	9.0	(8–10)	5182	9.6	(9–10)	5663	13.1	(12–14)	6586	14.7	(14–16)			›
Portugal	1928	10.4	(9–12)	1901	11.3	(10–13)	2154	13.5	(12–15)	2678	14.9	(14–16)			›
Greece	1507	14.2	(12–16)	1435	14.9	(13–17)	1393	16.2	(14–18)	1255	17.2	(15–19)			›
Hungary	1383	19.5	(17–22)	1224	15.1	(13–17)	1411	17.4	(15–20)	1437	18.9	(17–21)			
Romania	34	20.6	(9–38)	95	21.1	(13–31)	191	25.1	(19–32)	298	22.8	(18–28)			
Italy	2419	21.0	(19–23)	1870	19.8	(18–22)	2997	26.3	(25–28)	3990	26.2	(25–28)			›*
Slovakia	–	–	(–)	740	30.9	(28–34)	693	30.7	(27–34)	807	29.7	(27–33)		N/A	
Cyprus	139	20.1	(14–28)	138	36.2	(28–45)	176	31.8	(25–39)	162	38.9	(31–47)			›
Bulgaria	153	24.8	(18–32)	179	22.9	(17–30)	223	38.1	(32–45)	187	39.6	(33–47)			›

–: No data

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data, which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.5. ***Escherichia coli.*** **Total number of invasive isolates tested (N) and percentage resistant to aminoglycosides (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Iceland	104	2.9	(1–8)	129	6.2	(3–12)	138	3.6	(1–8)	121	4.1	(1–9)		6.2 4.6 2.9	
Sweden	3665	2.7	(2–3)	4274	4.5	(4–5)	5538	5.0	(4–6)	7101	6.0	(5–7)		6.0 4.4 2.7	›
Belgium	1584	5.6	(5–7)	3831	9.3	(8–10)	3689	5.9	(5–7)	4093	6.1	(5–7)		9.3 7.5 5.6	‹*
Netherlands	3408	7.2	(6–8)	4431	7.8	(7–9)	4708	7.2	(6–8)	4743	6.2	(6–7)		7.8 7.0 6.2	‹
Norway	2246	4.3	(4–5)	2470	4.1	(3–5)	3023	5.8	(5–7)	3 079	6.4	(6–7)		6.4 5.3 4.1	›
Denmark	3412	5.8	(5–7)	3638	6.4	(6–7)	3687	7.3	(6–8)	3887	6.5	(6–7)		7.3 6.6 5.8	
Finland	2356	3.8	(3–5)	3020	5.2	(4–6)	2993	6.1	(5–7)	3530	6.5	(6–7)		6.5 5.2 3.8	›
Latvia	98	11.2	(6–19)	132	11.4	(7–18)	154	11.7	(7–18)	136	6.6	(3–12)		11.7 9.2 6.6	
Luxembourg	354	6.5	(4–10)	354	8.2	(6–12)	334	6.3	(4–9)	308	6.8	(4–10)		8.2 7.3 6.3	
Germany	3021	8.7	(8–10)	3645	7.6	(7–9)	4190	7.1	(6–8)	5253	7.0	(6–8)		8.7 7.9 7.0	‹
Austria	2915	6.5	(6–7)	3144	7.4	(7–8)	3713	6.5	(6–7)	4369	7.3	(7–8)		7.4 7.0 6.5	
Estonia	269	5.6	(3–9)	314	4.8	(3–8)	306	7.5	(5–11)	341	7.6	(5–11)		7.6 6.2 4.8	
France	9025	7.2	(7–8)	8742	7.9	(7–8)	5750	8.2	(7–9)	10156	7.8	(7–8)		8.2 7.7 7.2	
Croatia	882	6.7	(5–9)	979	7.6	(6–9)	905	7.1	(5–9)	1028	7.9	(6–10)		7.9 7.3 6.7	
Czech Republic	2449	8.5	(7–10)	2674	8.8	(8–10)	2812	8.4	(7–10)	2957	9.1	(8–10)		9.1 8.8 8.4	
United Kingdom	4929	8.3	(8–9)	5661	8.2	(7–9)	6390	8.6	(8–9)	7167	9.2	(9–10)		9.2 8.7 8.2	
Malta	192	22.4	(17–29)	219	15.5	(11–21)	216	13.9	(10–19)	248	9.7	(6–14)		22.4 16.1 9.7	‹
Slovenia	952	8.8	(7–11)	1002	9.8	(8–12)	1168	8.6	(7–10)	1224	9.7	(8–12)		9.8 9.2 8.6	
EU/EEA (population-weighted mean)		**9.4**	**(9–10)**		**9.6**	**(9–11)**		**10.4**	**(10–11)**		**9.9**	**(9–11)**		10.4 9.9 9.4	
Poland	704	9.1	(7–11)	1171	8.4	(7–10)	1046	11.9	(10–14)	1070	11.0	(9–13)		11.9 10.2 8.4	›
Lithuania	331	14.5	(11–19)	382	9.7	(7–13)	461	9.5	(7–13)	430	11.2	(8–15)		14.5 12.0 9.5	
Ireland	2118	9.9	(9–11)	2158	10.2	(9–12)	2378	11.1	(10–12)	2482	11.4	(10–13)		11.4 10.7 9.9	
Romania	33	12.1	(3–28)	50	18.0	(9–31)	185	24.3	(18–31)	298	14.8	(11–19)		24.3 18.2 12.1	
Spain	5696	14.2	(13–15)	5603	14.8	(14–16)	5675	15.6	(15–17)	5930	15.4	(14–16)		15.6 14.9 14.2	›
Portugal	1979	12.0	(11–14)	1962	16.1	(14–18)	2155	16.3	(15–18)	2685	15.8	(14–17)		16.3 14.2 12.0	›*
Greece	1530	16.5	(15–18)	1434	16.8	(15–19)	1372	17.9	(16–20)	1240	17.0	(15–19)		17.9 17.2 16.5	
Hungary	1384	21.2	(19–23)	1226	14.8	(13–17)	1409	17.2	(15–19)	1431	17.1	(15–19)		21.2 18.0 14.8	‹
Italy	2609	15.5	(14–17)	1985	18.3	(17–20)	3093	21.4	(20–23)	4002	18.5	(17–20)		21.4 18.5 15.5	›*
Slovakia	–	–	(–)	740	17.8	(15–21)	694	21.2	(18–24)	808	24.3	(21–27)		N/A	
Cyprus	138	15.9	(10–23)	138	23.9	(17–32)	176	21.0	(15–28)	162	24.7	(18–32)		24.7 20.3 15.9	
Bulgaria	152	15.8	(10–23)	179	17.3	(12–24)	223	26.5	(21–33)	187	32.1	(25–39)		32.1 23.9 15.8	›

–: No data

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data, which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.6. ***Escherichia coli*. Total number of invasive isolates tested (N) and percentage resistant to carbapenems (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Croatia	872	0.3	(0–1)	983	0	(0–0)	900	0	(0–0)	1038	0	(0–0)			‹
Cyprus	138	0.7	(0–4)	138	0.7	(0–4)	176	‹0.1	(0–2)	162	0	(0–2)			
Czech Republic	1647	0.1	(0–0)	1675	0	(0–0)	1729	0.1	(0–0)	1733	0	(0–0)			
Estonia	225	‹0.1	(0–2)	233	‹0.1	(0–2)	252	‹0.1	(0–1)	283	0	(0–1)			
Finland	2471	0	(0–0)	3020	0	(0–0)	3161	0	(0–0)	3690	0	(0–0)			
Iceland	104	0	(0–4)	129	0	(0–3)	138	0	(0–3)	121	0	(0–3)			
Latvia	96	‹0.1	(0–4)	131	‹0.1	(0–3)	153	‹0.1	(0–2)	135	0	(0–3)			
Lithuania	238	‹0.1	(0–2)	1	‹0.1	(0–98)	450	‹0.1	(0–1)	431	0	(0–1)		N/A	
Luxembourg	340	‹0.1	(0–1)	351	‹0.1	(0–1)	333	‹0.1	(0–1)	295	0	(0–1)			
Malta	192	‹0.1	(0–2)	219	‹0.1	(0–2)	216	‹0.1	(0–2)	248	0	(0–1)			
Poland	703	0.1	(0–1)	1064	0.1	(0–1)	970	0	(0–0)	938	0	(0–0)			
Romania	31	‹0.1	(0–11)	47	‹0.1	(0–8)	182	0	(0–2)	299	0	(0–1)		N/A	
Slovakia	–	–	(–)	705	‹0.1	(0–1)	659	0.9	(0–2)	588	0	(0–1)		N/A	
Austria	2465	0	(0–0)	2712	0	(0–0)	3340	0.1	(0–0)	4257	‹0.1	(0–0)			
Belgium	1014	0	(0–0)	3989	0	(0–0)	4119	0	(0–0)	4246	‹0.1	(0–0)			
Denmark	2011	0	(0–0)	2265	0	(0–0)	2865	0	(0–0)	2832	‹0.1	(0–0)			
Ireland	1940	0	(0–0)	2149	0	(0–0)	2369	0	(0–0)	2476	‹0.1	(0–0)			
Netherlands	3380	0	(0–0)	4405	0	(0–0)	4701	0	(0–0)	4726	‹0.1	(0–0)			
Sweden	3586	0	(0–0)	5949	0	(0–0)	5532	0	(0–0)	7347	‹0.1	(0–0)			
United Kingdom	4025	0	(0–0)	4640	0.1	(0–0)	5182	0.2	(0–0)	6251	‹0.1	(0–0)			
France	8164	0	(0–0)	8503	0	(0–0)	9091	0	(0–0)	9585	0.1	(0–0)			›
Germany	2931	0	(0–0)	3593	0	(0–0)	4184	0	(0–0)	5247	0.1	(0–0)			
Hungary	1311	0.2	(0–1)	1151	0.1	(0–0)	1307	0	(0–0)	1355	0.1	(0–1)			
Norway	2089	0	(0–0)	2588	0	(0–0)	3023	0	(0–0)	3079	0.1	(0–0)			
Portugal	1443	0.3	(0–1)	1755	0	(0–0)	2041	0.1	(0–0)	2668	0.1	(0–0)			
Slovenia	922	0	(0–0)	1002	0	(0–0)	1168	0	(0–0)	1224	0.1	(0–0)			
EU/EEA (population-weighted mean)		**0**	**(0.0–0.2)**		**0**	**(0.0–0.2)**		**0.1**	**(0.0–0.2)**		**0.2**	**(0.1–0.6)**			
Italy	2593	0.1	(0–0)	1854	0.2	(0–0)	3021	0.3	(0–1)	3989	0.6	(0–1)			›*
Spain	5696	0	(0–0)	5593	0	(0–0)	5670	0.1	(0–0)	5921	0.7	(1–1)			›
Greece	1519	0.4	(0–1)	1127	0.9	(0–2)	1396	1.4	(1–2)	1256	1.4	(1–2)			›
Bulgaria	146	‹0.1	(0–2)	145	‹0.1	(0–3)	191	2.6	(1–6)	176	2.8	(1–7)			›

–: No data

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data, which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.7. ***Escherichia coli*. Total number of isolates tested (N) and percentage combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Iceland	95	1.1	(0–6)	120	0.8	(0–5)	134	1.5	(0–5)	116	0.9	(0–5)			
Netherlands	3371	1.8	(1–2)	4400	2.2	(2–3)	4675	1.8	(1–2)	4722	1.9	(2–2)			
Sweden	1925	0.9	(1–1)	3915	1.4	(1–2)	5532	1.8	(1–2)	7094	2.0	(2–2)			›
Lithuania	331	5.4	(3–8)	378	2.4	(1–4)	455	1.3	(0–3)	429	2.1	(1–4)			‹
Luxembourg	354	1.7	(1–4)	353	2.8	(1–5)	334	2.7	(1–5)	287	2.1	(1–4)			
Denmark	2403	2.4	(2–3)	2529	3.0	(2–4)	2285	2.6	(2–3)	2377	2.2	(2–3)			
Belgium	1562	1.0	(1–2)	3331	1.4	(1–2)	3330	1.8	(1–2)	3748	2.3	(2–3)			›
Norway	2236	1.4	(1–2)	2259	1.2	(1–2)	2835	1.9	(1–3)	2971	2.5	(2–3)			›
Germany	3009	3.6	(3–4)	3631	3.6	(3–4)	4179	3.2	(3–4)	5241	2.7	(2–3)			‹
Austria	2889	2.0	(2–3)	3121	2.6	(2–3)	3579	2.5	(2–3)	4260	3.2	(3–4)			›
Finland	2315	1.9	(1–3)	3020	2.5	(2–3)	2993	3.1	(3–4)	3433	3.2	(3–4)			›
France	9000	2.9	(3–3)	8428	2.6	(2–3)	5655	3.3	(3–4)	10068	3.2	(3–4)			›
Estonia	255	2.0	(1–5)	89	1.1	(0–6)	303	1.7	(1–4)	335	3.3	(2–6)			
Croatia	874	2.6	(2–4)	947	2.6	(2–4)	889	2.8	(2–4)	1015	3.5	(2–5)			
United Kingdom	4192	4.0	(3–5)	5005	3.6	(3–4)	5577	4.2	(4–5)	6536	4.4	(4–5)			
Latvia	97	6.2	(2–13)	131	9.2	(5–15)	152	6.6	(3–12)	134	4.5	(2–9)			
EU/EEA (population-weighted mean)		**4.3**	**(4–5)**		**3.8**	**(3–4)**		**4.9**	**(4–6)**		**4.6**	**(4–5)**			
Slovenia	952	3.8	(3–5)	1002	4.1	(3–6)	1168	5.1	(4–7)	1224	4.8	(4–6)			
Czech Republic	2447	3.4	(3–4)	2667	3.7	(3–4)	2809	4.5	(4–5)	2953	4.9	(4–6)			›
Ireland	2112	3.0	(2–4)	2148	3.6	(3–4)	2283	4.0	(3–5)	2478	4.9	(4–6)			›
Malta	192	13.5	(9–19)	219	9.6	(6–14)	216	8.3	(5–13)	248	5.2	(3–9)			‹
Poland	661	3.2	(2–5)	902	4.0	(3–5)	1011	5.8	(4–7)	999	5.2	(4–7)			›
Spain	5696	5.5	(5–6)	5594	4.9	(4–6)	5651	5.9	(5–7)	5922	5.8	(5–6)			
Portugal	1898	6.5	(5–8)	1891	7.5	(6–9)	2152	9.2	(8–11)	2677	8.5	(7–10)			›*
Romania	32	6.3	(1–21)	50	10.0	(3–22)	179	15.6	(11–22)	292	9.2	(6–13)			
Greece	1490	9.5	(8–11)	1431	10.8	(9–13)	1368	10.7	(9–12)	1235	10.4	(9–12)			
Hungary	1366	15.4	(14–17)	1209	8.3	(7–10)	1387	10.5	(9–12)	1422	11.0	(9–13)			‹
Italy	2395	10.5	(9–12)	1745	10.3	(9–12)	2686	14.4	(13–16)	3884	12.2	(11–13)			›*
Slovakia	–	–	(–)	739	12.9	(11–15)	692	13.6	(11–16)	807	17.2	(15–20)		N/A	
Bulgaria	150	8.0	(4–14)	179	10.1	(6–15)	223	16.1	(12–22)	187	19.8	(14–26)			›
Cyprus	138	8.7	(5–15)	137	18.2	(12–26)	176	14.8	(10–21)	162	20.4	(14–27)			›

–: No data

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data, which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.8. *Escherichia coli*. Total number of tested isolates* and resistance combinations among invasive isolates tested against aminopenicillins, third-generation cephalosporins, fluoroquinolones, aminoglycosides and carbapenems (n=61 951), EU/EEA countries, 2013

Resistance pattern	Number of isolates	% of total**
Fully susceptible	25 493	41.2
Single resistance (to indicated drug classes)		
Total	21 423	34.6
Aminopenicillins	19 839	32.0
Fluoroquinolones	1 457	2.4
Aminoglycosides	115	0.2
Carbapenems	12	0
Resistance to two classes of antimicrobial drugs		
Total	7 487	12.1
Aminopenicillins + fluoroquinolones	4 864	7.9
Aminopenicillins + third-generation cephalosporins	1 562	2.5
Aminopenicillins + aminoglycosides	928	1.5
Fluoroquinolones + aminoglycosides	116	0.2
Aminopenicillins + carbapenems	15	0
Aminoglycosides + carbapenems	2	0
Resistance to three classes of antimicrobial drugs		
Total	4 632	7.5
Aminopenicillins + third-generation cephalosporins + fluoroquinolones	2 495	4.0
Aminopenicillins + fluoroquinolones + aminoglycosides	1 835	3.0
Aminopenicillins + third-generation cephalosporins + aminoglycosides	285	0.5
Aminopenicillins + fluoroquinolones + carbapenems	10	0
Aminopenicillins + third-generation cephalosporin + carbapenems	5	0
Aminopenicillins + aminoglycosides + carbapenems	2	0
Resistance to four classes of antimicrobial drugs		
Total	2 892	4.7
Aminopenicillins + third-generation cephalosporins+ fluoroquinolones + aminoglycosides	2 876	4.6
Aminopenicillins + third-generation cephalosporins + fluoroquinolones + carbapenems	6	0
Aminopenicillins + third-generation cephalosporins + aminoglycosides + carbapenems	5	0
Aminopenicillins + fluoroquinolones + aminoglycosides + carbapenems	5	0
Resistance to five classes of antimicrobial drugs		
Aminopenicillins + third-generation cephalosporins + fluoroquinolones + aminoglycosides + carbapenems	24	<0.1

* Only data from isolates tested against all five antimicrobial groups were included in the analysis.

** Not adjusted for population differences in the reporting countries.

3.2 *Klebsiella pneumoniae*

3.2.1 Clinical and epidemiological importance

Klebsiella pneumoniae are frequent colonisers of the gastrointestinal tract in humans as well as other vertebrates, but may also be found on skin, in the oropharynx and upper airways in hospitalised individuals. *K. pneumoniae* consists of three genetically distinct clades of which two have medical importance. One is associated with severe invasive infection, often causing liver abscess or necrotising pneumonia (mainly in east Asian countries), and the other is associated with opportunistic infections in individuals with impaired immune systems, such as newborns, cancer patients, diabetics, alcoholics and hospitalised patients with indwelling devices. The most common sites of infection are the urinary and respiratory tracts and the blood stream. Organisms such as *K. pneumoniae* can spread rapidly between colonised or infected patients and via the hands of hospital personnel, leading to nosocomial outbreaks. *K. pneumoniae* is the second most frequent cause of gram-negative bloodstream infections after *E. coli*.

3.2.2 Resistance mechanisms

Similar to *E. coli*, *K. pneumoniae* can be resistant to multiple antimicrobial agents, and resistance traits are frequently acquired through plasmids. In contrast to *E. coli*, *K. pneumoniae* has a chromosomally encoded SHV beta-lactamase and is thus intrinsically resistant to 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 differ significantly from those described for *E. coli*, readers should refer to the *E. coli* section (3.1, above) for further details. Carbapenems have been widely used in many countries due to the increasing rate of ESBL-producing Enterobacteriaceae, resulting in the emergence of resistance to these agents, especially in *K. pneumoniae*. KPC-producing clones of *K. pneumoniae* have been observed in the United States, Greece, Italy, Israel, China and countries in South America, and similar strains are now spreading in several European countries, while strains producing the VIM metallo-carbapenemase are frequently found in Greece. More recently, strains producing the NDM metallo-carbapenemase have been observed in patients returning from the Indian subcontinent and have been reported in the Balkan region. The bla_{OXA-48} gene codes for an oxacillinase (OXA-48) that causes resistance to penicillin and reduces susceptibility to carbapenems, but (when produced alone), not to expanded-spectrum cephalosporins. The level of resistance is often low and such strains are thus frequently missed in laboratories that do not screen for carbapenem-susceptible isolates with reduced carbapenem susceptibility. A combination of OXA-48-like enzymes (OXA-48 and some closely related variants with similar properties) with ESBLs such as CTX-M15 can occur in *Klebsiella* spp. and can result in a highly drug-resistant phenotype. Single clones with such combinations have caused hospital outbreaks in several European countries. OXA-48-producing isolates have often been observed in patients returning from endemic areas (Turkey, North Africa and the Middle-East). OXA-48 has become the most common carbapenemase in carbapenem-resistant Enterobacteriaceae in some European countries including Belgium, France, Germany and Spain.

3.2.3 Antimicrobial susceptibility

- More than a third of the *K. pneumoniae* isolates reported to EARS-Net in 2013 were resistant to at least one antimicrobial group under surveillance. The most common resistance phenotype was combined resistance to three key antimicrobial groups: fluoroquinolones, third-generation cephalosporins and aminoglycosides.
- A north-to-east/south gradient was noted for most antimicrobial groups, with lower resistance percentages reported from northern countries and higher percentages from the eastern and southern parts of Europe.
- The EU/EEA population-weighted mean percentages of resistance in *K. pneumoniae* to fluoroquinolones, third-generation cephalosporins, aminoglycosides and carbapenems, as well as combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides, all increased significantly between 2010 and 2013.

Fluoroquinolones

- For 2013, 30 countries reported 18 597 isolates with AST information for fluoroquinolones. The number of isolates reported per country ranged from 28 to 1 916 (Table 3.10).
- The EU/EEA population-weighted mean percentage for fluoroquinolone resistance was 29.2 % in 2013. The percentages of resistant isolates in the reporting countries ranged from 0 % (Iceland) to 70.1 % (Poland). Seven countries reported resistance percentages below 10 %, seven countries reported 10–25 %, 11 countries reported 25–50 % and the remaining five countries reported resistance percentages above 50 % (Table 3.10 and Figure 3.6).
- Trends for the period 2010–2013 were calculated for 27 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for nine countries (Belgium, France, Ireland, Italy, Luxembourg, Malta, Poland, Spain and the United Kingdom). For Belgium and Luxembourg, the trends were not significant when considering only data from laboratories reporting consistently for all four years. The EU/EEA population-weighted mean showed a significantly increasing trend from 23.4 % in 2010 to 29.2 % in 2013.

Figure 3.6. ***Klebsiella pneumoniae*. Percentage (%) of invasive isolates with resistance to fluoroquinolones, by country, EU/EEA countries, 2013**

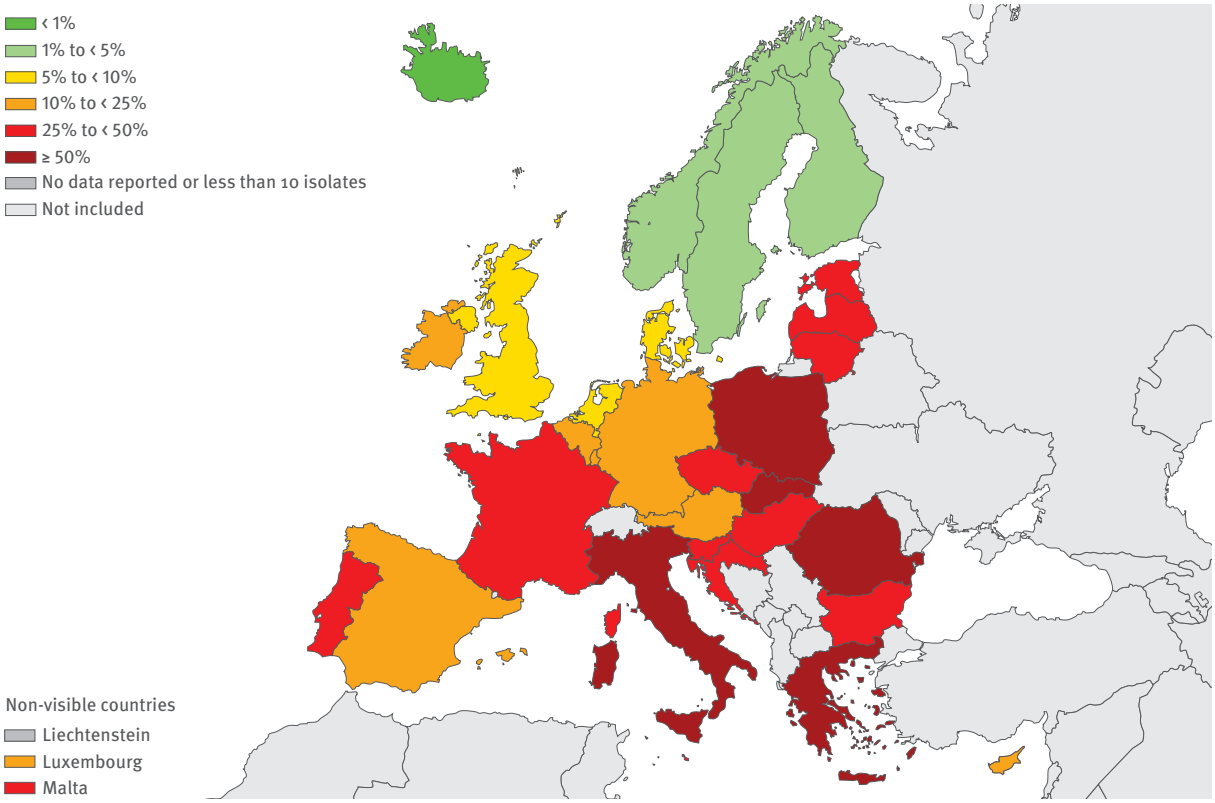


Figure 3.7. ***Klebsiella pneumoniae*. Percentage (%) of invasive isolates with resistance to third-generation cephalosporins, by country, EU/EEA countries, 2013**

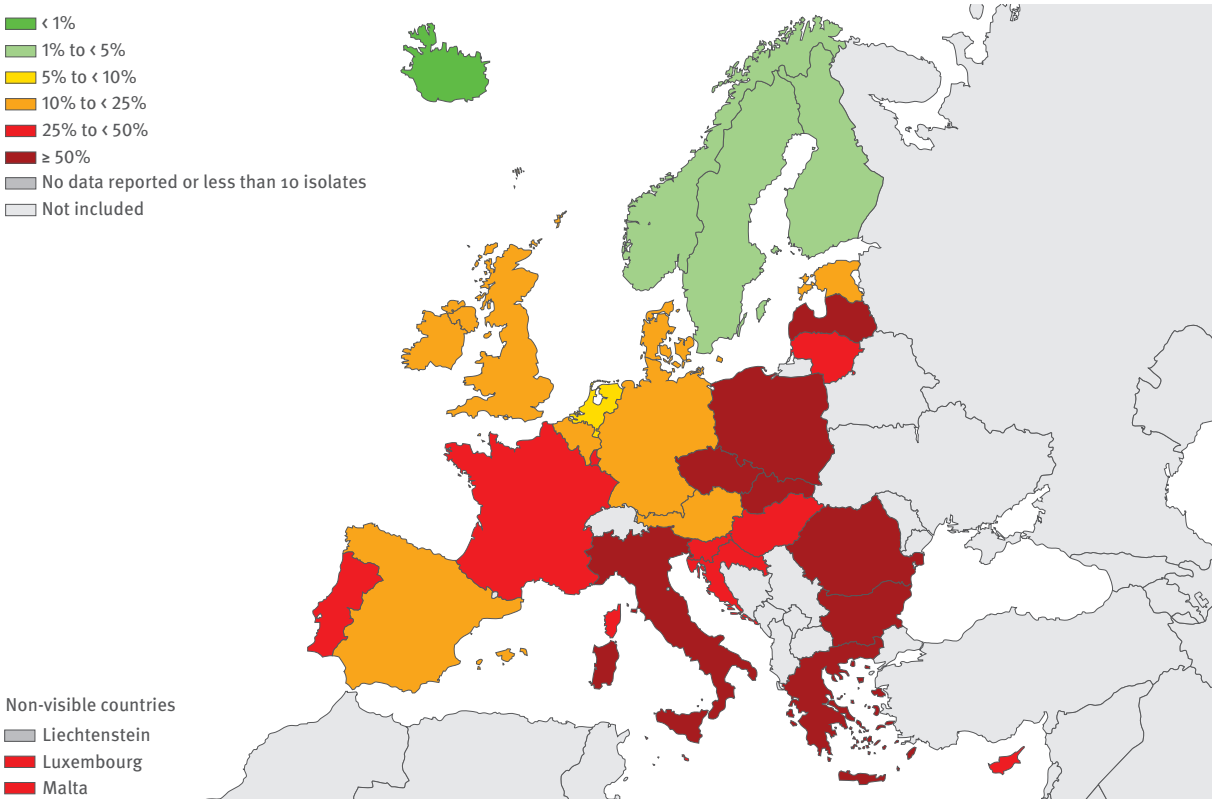


Table 3.9. *Klebsiella pneumoniae*. Number of invasive isolates resistant to third-generation cephalosporins (3GCRKP) and percentage of these isolates positive for extended-spectrum beta-lactamase (ESBL), as ascertained by participating laboratories, by country, EU/EEA countries, 2013

Country	Number of laboratories	Number of 3GCRKP	%ESBL
Denmark	4	35	51.4
Italy	8	79	58.2
France	47	422	68.2
Estonia	5	21	71.4
Slovakia	14	324	78.7
Austria	20	47	83.0
Spain	27	185	83.8
Netherlands	12	25	84.0
Sweden	10	47	89.4
Ireland	18	61	90.2
Slovenia	9	71	93.0
Czech Republic	42	606	93.6
Portugal	21	265	94.0
Latvia	5	48	95.8
Croatia	18	188	97.9
Romania	8	56	98.2
Poland	34	236	99.2
Bulgaria	8	33	100
Finland	9	12	100
Hungary	10	47	100
Lithuania	11	64	100

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 such isolates were included in the analysis.

Please note that there are national differences in the definition of ESBL, and some countries might report AmpC-positive isolates as ESBL.

- Significantly decreasing trends were observed for five countries (Cyprus, the Czech Republic, Denmark, Greece and Hungary). For Denmark, the trend was not significant when considering only data from laboratories reporting consistently for all four years.

Third-generation cephalosporins

- For 2013, 30 countries reported 18309 isolates with AST information for third-generation cephalosporins. The number of isolates reported per country ranged from 30 to 1938 (Table 3.11).
- The EU/EEA population-weighted mean percentage for third-generation cephalosporin resistance was 30.0% in 2013. The percentages of resistant isolates in the reporting countries ranged from 0% (Iceland) to 70.1% (Greece). Five countries reported resistance percentages below 10%, eight countries reported 10–25%, eight countries reported 25–50% and the remaining nine countries reported resistance percentages of 50% or higher (Table 3.11 and Figure 3.7).
- Trends for the period 2010–2013 were calculated for 27 countries reporting data for at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for 12 countries. For Latvia, the trend was not significant when considering only data from laboratories reporting consistently for all four years. The EU/EEA population-weighted mean showed a significantly increasing trend from 22.8% in 2010 to 30.0% in 2013.
- Significantly decreasing trends were observed for two countries (Greece and Hungary).

Extended-spectrum beta-lactamase (ESBL)

- Twenty-one countries were included in the calculation of ESBL percentages for *K. pneumoniae*. Only data from laboratories reporting ESBL results for all isolates identified as resistant to third-generation cephalosporins, and only data from countries reporting at least 10 such isolates were included.
- Among *K. pneumoniae* isolates resistant to third-generation cephalosporins, a large proportion was ascertained as ESBL-positive by the countries. In 2013, 13 of 21 countries reported between 85% and 100% ESBL-positive isolates (Table 3.9).

Aminoglycosides

- For 2013, 30 countries reported 18625 isolates with AST information for aminoglycosides. The number of isolates reported per country ranged from 30 to 1938 (Table 3.12).
- The EU/EEA population-weighted mean for aminoglycoside resistance was 24.5% in 2013. The percentages of resistant isolates in the reporting countries ranged from 0% (Iceland) to 64.0% (Slovakia). Eleven countries reported resistance percentages below 10%, three countries reported 10–25%, nine countries reported 25–50%, and the remaining seven countries reported resistance percentages above 50% (Table 3.12 and Figure 3.8).
- Trends for the period 2010–2013 were calculated for 27 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for 12 countries. For one country (Belgium), the trend was not significant when considering only data from laboratories reporting consistently for all four years. The EU/EEA population-weighted mean showed a significantly increasing trend from 18.5% in 2010 to 24.5% in 2013.
- Significantly decreasing trends were observed for five countries (Bulgaria, Estonia, Finland, Greece and Hungary).
- Resistance estimates for the aminoglycoside group were mainly based on gentamicin or tobramycin AST results. Susceptibility data for amikacin were less frequently reported than gentamicin and tobramycin, and generally showed lower resistance percentages.

Carbapenems

- For 2013, 30 countries reported 17910 isolates with AST information for carbapenems. The number of isolates reported per country ranged from 30 to 1842 (Table 3.13).
- The EU/EEA population-weighted mean for carbapenem resistance was 8.3% in 2013. The percentages of resistant isolates in the reporting countries ranged from 0% (Bulgaria, Finland, Iceland, Latvia, Lithuania and Sweden) to 59.4% (Greece). (Table 3.13 and Figure 3.9).
- Trends for the period 2010–2013 were calculated for 26 countries reporting at least 20 isolates per year

Figure 3.8. ***Klebsiella pneumoniae*. Percentage (%) of invasive isolates with resistance to aminoglycosides, by country, EU/EEA countries, 2013**

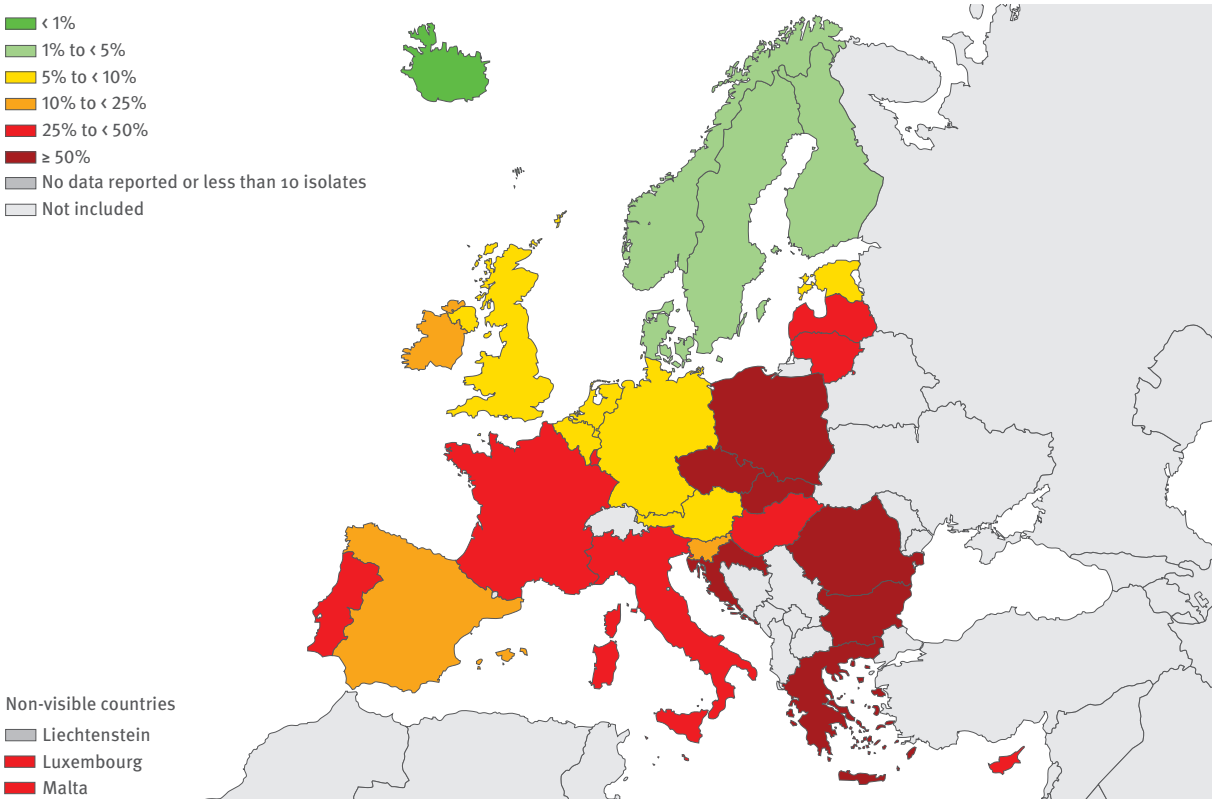
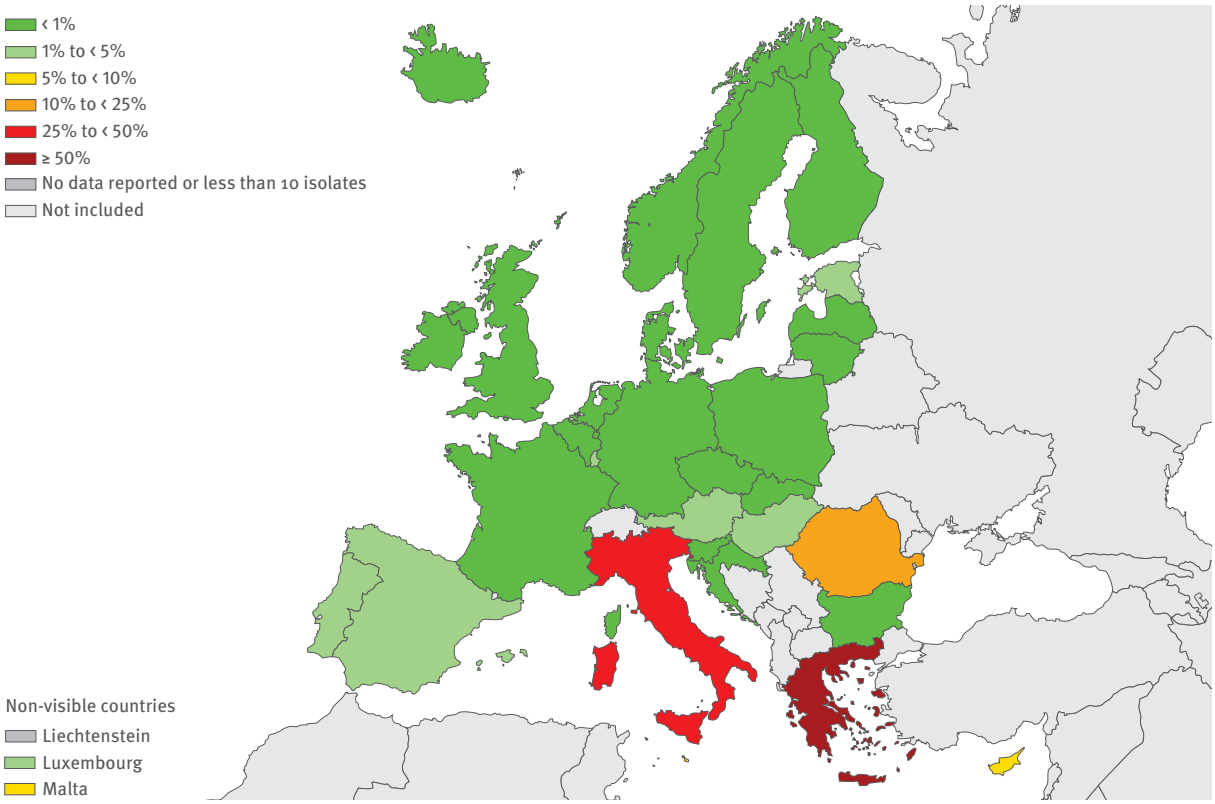


Figure 3.9. ***Klebsiella pneumoniae*. Percentage (%) of invasive isolates with resistance to carbapenems, by country, EU/EEA countries, 2013**



during the full four-year period. Significantly increasing trends were observed for six countries (the Czech Republic, France, Germany, Greece, Italy and Spain). For Germany, the trend was not significant when considering only data from laboratories reporting consistently for all four years. The EU/EEA population-weighted mean showed a significantly increasing trend from 4.6 % in 2010 to 8.3 % in 2013.

- Significantly decreasing trends were observed for four countries (Croatia, Cyprus, Hungary and Sweden).

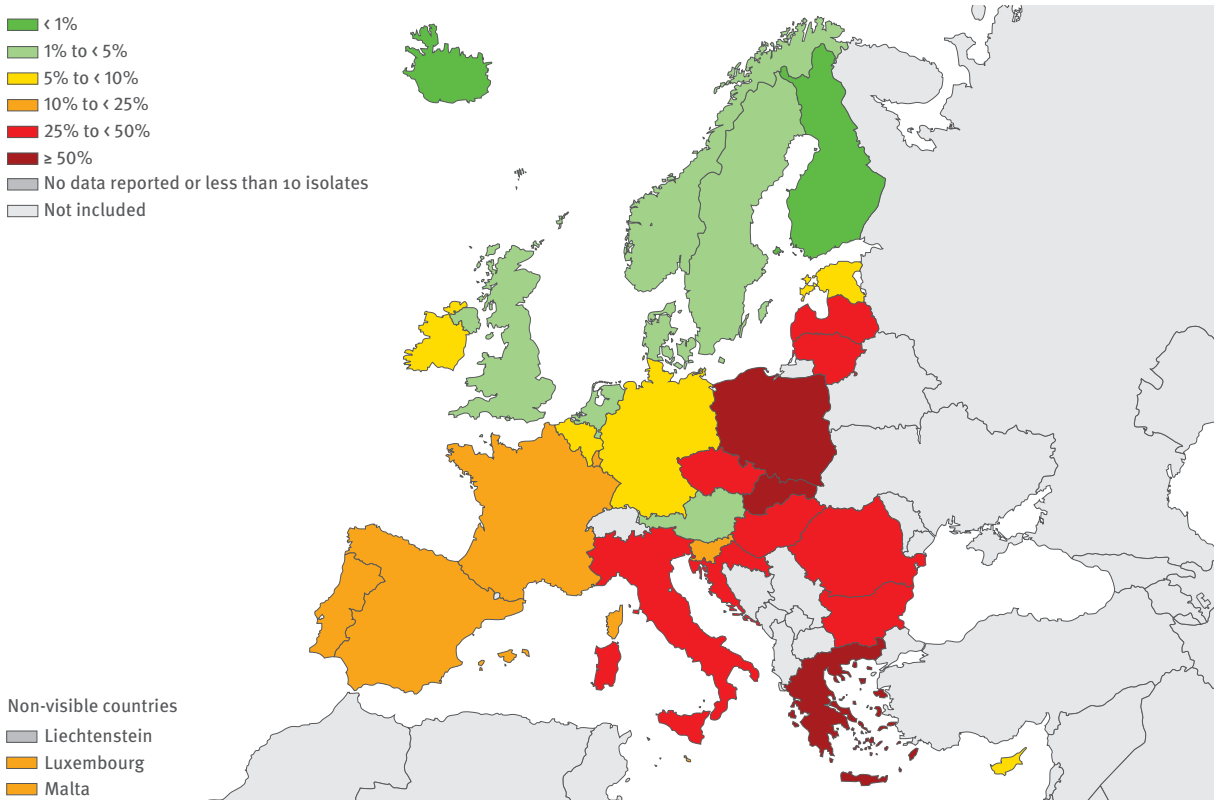
Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides

- For 2013, 30 countries reported 17 948 isolates with AST information for fluoroquinolones, third-generation cephalosporins and aminoglycosides. The number of isolates reported per country ranged from 28 to 1 916 (Table 3.14).
- The EU/EEA population-weighted mean for combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides was 20.9 % in 2013. The percentages of resistant isolates in the reporting countries ranged from 0 % (Iceland) to 57.9 % (Slovakia). Thirteen countries reported resistance percentages below 10 %, six countries reported 10–25 %, eight countries reported 25–50 %, and the remaining three countries reported resistance percentages above 50 % (Table 3.14 and Figure 3.10).
- Trends for the period 2010–2013 were calculated for 27 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for nine countries. For one country (Belgium), the trend was not significant when considering only data from laboratories reporting consistently for all four years. The EU/EEA population-weighted mean showed a significantly increasing trend, from 15.1 % in 2010 to 20.9 % in 2013.
- Significantly decreasing trends were observed for five countries (Cyprus, Denmark, Finland, Hungary and the Netherlands). For Denmark and the Netherlands, the trend was not significant when considering only data from laboratories reporting consistently for all four years.

Other resistance combinations and resistance to other antimicrobial groups

- Of the total number of *K. pneumoniae* isolates tested for all antimicrobial groups under regular EARS-Net surveillance (fluoroquinolones, third-generation cephalosporins, aminoglycosides and carbapenems), combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides was the most common resistance phenotype, more frequent than isolates with single resistance to one antimicrobial class or two antimicrobial groups together (Table 3.15).

Figure 3.10. *Klebsiella pneumoniae*. Percentage (%) of invasive isolates with combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides, by country, EU/EEA countries, 2013



- Around 6 % of all *K. pneumoniae* isolates were resistant to all groups under regular EARS-Net surveillance. Ninety per cent of these isolates were reported from Greece and Italy.
- Only 26.4 % of all *K. pneumoniae* isolates had AST results for polymyxins. Not all countries reported data, and for some countries data on only very few isolates were available, hence the following results should be interpreted with caution. Overall, 8.8 % of the *K. pneumoniae* isolates were resistant to polymyxins. A majority of these isolates originated from Greece, Italy, Romania and Hungary. Among carbapenem-resistant isolates, 32 % were resistant to polymyxins, whereas only 3 % of carbapenem-susceptible isolates were polymyxin-resistant. However, the small number of tested isolates, the relatively high proportion of isolates from high-resistance areas and differences in the use of laboratory methodology used to determine susceptibility mean that these findings should be interpreted with caution and are not representative for Europe as a whole.
- Around 27 % of the isolates tested for all antimicrobial groups under regular EARS-Net surveillance were also tested for polymyxins. Of these, 5.6 % of the isolates with resistance to fluoroquinolones, third-generation cephalosporins, aminoglycosides and carbapenems were also reported to be resistant to polymyxins. These isolates were almost exclusively reported from Greece and Italy.

3.2.4 Discussion and conclusion

Antimicrobial resistance in *K. pneumoniae* is continuing to increase, both for resistance to key antimicrobial groups such as fluoroquinolones, third-generation cephalosporins and aminoglycosides, as well as for combined resistance to all three antimicrobial groups. More than a third of the *K. pneumoniae* isolates reported in 2013 were resistant to at least one of these antimicrobial groups. Among the resistant isolates, the most common phenotype was combined resistance to all three groups. In addition, the EU/EEA population-weighted mean showed significantly increasing trends for all individual antimicrobial groups under EARS-Net surveillance.

For most countries, percentages of combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides were generally higher for *K. pneumoniae* than for *E. coli*. However, for the countries reporting the lowest percentages of combined resistance in *K. pneumoniae* (Finland, Iceland, Norway and Sweden) the relationship was reversed, with the highest resistance percentages for *E. coli*. The reason for this remains to be explained but could be attributed to differences in the distribution of multidrug-resistant clones in Europe.

Data from EARS-Net have documented increasing percentages of carbapenem resistance in *K. pneumoniae* from progressively more countries since 2005. Although carbapenem resistance remains at relatively low levels for most countries, the continuous increase of the EU/EEA population-weighted mean is a cause for great concern and indicates that carbapenem resistance is a threat to healthcare and patient safety in Europe. Very few therapeutic options are left for patients infected with multidrug-resistant *K. pneumoniae* with additional resistance to carbapenems, and mortality is high [10, 11]. Especially in countries with high percentages of carbapenem resistance, resistance to polymyxins is an important warning that the treatment arsenal is soon exhausted.

Although information on carbapenemase production is very limited in the EARS-Net data, scientific publications and data from enhanced surveillance established by some EU Member States, indicate an increase in the spread of carbapenemase-producing Enterobacteriaceae (CPE) in Europe in recent years. In addition, the European survey on CPE (EuSCAPE) has documented its continuing spread in Europe and highlighted the urgent need for coordinated European efforts on early diagnosis, active surveillance and guidance on infection control measures [12].

ECDC issued two risk assessments targeting CPE during 2011 [8,13] emphasising the need for implementation of infection control measures such as active patient screening and additional hygiene precautions for the care of CPE-positive patients. In addition, countries are encouraged to develop national guidance on how to stop the spread of CPE within their country, and to make confirmed cases of CPE notifiable to national public health authorities. These interventions would not only target CPE, but also affect the general spread of AMR. However, results from EuSCAPE indicated that in early 2013, national guidelines and laboratory reference services were not available in all countries. The online directory of resources for guidance on prevention and control of CPE, often also including ESBL, recently made available through the ECDC web portal, lists a selection of these EU/EEA Member State guidelines available in a large number of European languages [9].

Table 3.10. ***Klebsiella pneumoniae*. Total number of invasive isolates tested (N) and percentage resistant to fluoroquinolones (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Iceland	24	0	(0–14)	24	4.2	(0–21)	14	7.1	(0–34)	28	0	(0–12)		N/A	
Finland	401	2.5	(1–5)	404	2.7	(1–5)	536	2.1	(1–4)	533	2.4	(1–4)			
Sweden	405	4.7	(3–7)	822	2.3	(1–4)	976	3.7	(3–5)	1270	3.9	(3–5)			
Norway	476	7.4	(5–10)	427	3.5	(2–6)	596	4.0	(3–6)	616	4.9	(3–7)			
Netherlands	644	7.0	(5–9)	728	7.3	(6–9)	670	5.4	(4–7)	638	6.1	(4–8)			
United Kingdom	768	7.4	(6–10)	985	4.6	(3–6)	1036	7.4	(6–9)	1155	8.7	(7–10)			›
Denmark	673	11.3	(9–14)	888	11.6	(10–14)	941	8.8	(7–11)	874	8.9	(7–11)			‹*
Ireland	318	8.2	(5–12)	303	8.9	(6–13)	338	7.4	(5–11)	316	14.6	(11–19)			›
Germany	478	14.9	(12–18)	519	14.1	(11–17)	663	13.7	(11–17)	745	14.8	(12–18)			
Austria	720	18.2	(15–21)	797	16.6	(14–19)	829	15.4	(13–18)	925	15.8	(13–18)			
Spain	1161	13.6	(12–16)	1145	17.0	(15–19)	1150	16.5	(14–19)	1241	21.8	(20–24)			›
Belgium	144	12.5	(8–19)	663	14.9	(12–18)	532	17.3	(14–21)	639	22.2	(19–26)			›*
Luxembourg	59	6.8	(2–16)	48	33.3	(20–48)	50	32.0	(20–47)	53	22.6	(12–36)			›*
Cyprus	67	38.8	(27–51)	83	36.1	(26–47)	65	21.5	(12–33)	68	23.5	(14–35)			‹
Estonia	64	25.0	(15–37)	91	22.0	(14–32)	87	17.2	(10–27)	90	26.7	(18–37)			
Malta	57	15.8	(7–28)	52	13.5	(6–26)	57	26.3	(16–40)	69	27.5	(17–40)			›
EU/EEA (population-weighted mean)		**23.4**	**(20–22)**		**25.4**	**(22–28)**		**25.1**	**(22–28)**		**29.2**	**(26–32)**			**›**
France	1527	21.8	(20–24)	1683	28.0	(26–30)	1691	24.4	(22–27)	1916	29.4	(27–32)			›
Slovenia	196	25.0	(19–32)	232	35.3	(29–42)	254	33.1	(27–39)	245	32.7	(27–39)			
Portugal	574	31.4	(28–35)	617	36.3	(33–40)	777	35.8	(32–39)	911	35.7	(33–39)			
Hungary	504	42.9	(38–47)	420	51.0	(46–56)	485	41.6	(37–46)	555	37.7	(34–42)			‹
Croatia	278	47.5	(41–54)	292	42.5	(37–48)	331	42.9	(38–48)	373	43.2	(38–48)			
Latvia	63	52.4	(39–65)	63	38.1	(26–51)	78	46.2	(35–58)	88	43.2	(33–54)			
Lithuania	80	36.3	(26–48)	137	54.7	(46–63)	184	55.4	(48–63)	144	45.1	(37–54)			
Bulgaria	126	52.4	(43–61)	121	51.2	(42–60)	127	47.2	(38–56)	138	45.7	(37–54)			
Czech Republic	1263	55.1	(52–58)	1287	52.8	(50–56)	1399	50.4	(48–53)	1291	47.7	(45–50)			‹
Romania	17	29.4	(10–56)	10	30.0	(7–65)	100	50.0	(40–60)	213	51.6	(45–59)		N/A	
Italy	696	38.5	(35–42)	597	45.7	(42–50)	835	49.9	(46–53)	1428	54.4	(52–57)			›
Slovakia	–	–	(–)	465	70.8	(66–75)	376	66.8	(62–72)	489	66.9	(63–71)		N/A	
Greece	1676	70.9	(69–73)	1635	72.2	(70–74)	1428	69.7	(67–72)	1172	67.6	(65–70)			‹
Poland	221	33.0	(27–40)	369	57.7	(53–63)	359	60.2	(55–65)	374	70.1	(65–75)			›

–: No data

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.11. ***Klebsiella pneumoniae*. Total number of invasive isolates tested (N) and percentage resistant to third-generation cephalosporins (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Iceland	27	3.7	(0–19)	26	7.7	(1–25)	14	21.4	(5–51)	30	0	(0–12)		N/A	
Finland	397	4.0	(2–6)	404	2.5	(1–5)	536	1.7	(1–3)	546	2.2	(1–4)			
Sweden	700	1.7	(1–3)	934	2.1	(1–3)	976	2.8	(2–4)	1300	3.6	(3–5)			›
Norway	479	2.1	(1–4)	421	2.9	(1–5)	621	3.2	(2–5)	645	4.0	(3–6)			
Netherlands	641	7.2	(5–9)	720	8.1	(6–10)	683	6.7	(5–9)	644	7.5	(6–10)			
Austria	720	12.6	(10–15)	795	13.3	(11–16)	859	11.8	(10–14)	941	10.7	(9–13)			
Denmark	559	10.6	(8–13)	637	11.1	(9–14)	621	10.5	(8–13)	529	11.5	(9–15)			
United Kingdom	743	9.7	(8–12)	935	5.3	(4–7)	931	11.8	(10–14)	1077	13.6	(12–16)			›
Belgium	143	12.6	(8–19)	668	13.6	(11–16)	540	16.5	(13–20)	594	15.3	(13–18)			
Germany	478	12.8	(10–16)	519	12.5	(10–16)	664	13.0	(10–16)	746	16.0	(13–19)			
Ireland	318	8.5	(6–12)	304	7.6	(5–11)	326	9.5	(7–13)	316	19.3	(15–24)			›
Spain	1161	10.2	(9–12)	1145	13.4	(11–15)	1153	16.7	(15–19)	1241	19.8	(18–22)			›
Estonia	81	17.3	(10–27)	43	39.5	(25–56)	90	17.8	(11–27)	90	23.3	(15–33)			
Malta	57	12.3	(5–24)	52	13.5	(6–26)	57	26.3	(16–40)	69	27.5	(17–40)			›
France	1542	17.8	(16–20)	1654	25.3	(23–28)	1711	22.6	(21–25)	1938	28.0	(26–30)			›
Slovenia	196	22.4	(17–29)	232	30.2	(24–37)	254	28.3	(23–34)	245	29.0	(23–35)			
EU/EEA (population-weighted mean)		**22.8**	**(20–26)**		**24.2**	**(22–28)**		**25.6**	**(22–28)**		**30.0**	**(26–32)**			**›**
Cyprus	67	34.3	(23–47)	83	41.0	(30–52)	65	23.1	(14–35)	68	30.9	(20–43)			
Luxembourg	59	5.1	(1–14)	48	35.4	(22–51)	50	34.0	(21–49)	53	34.0	(22–48)			›
Portugal	580	28.3	(25–32)	616	35.4	(32–39)	781	38.7	(35–42)	911	37.0	(34–40)			›
Hungary	512	45.9	(42–50)	431	53.1	(48–58)	500	43.0	(39–47)	557	37.3	(33–42)			‹
Lithuania	81	50.6	(39–62)	137	60.6	(52–69)	186	64.0	(57–71)	145	44.1	(36–53)			
Croatia	281	55.5	(49–61)	299	48.2	(42–54)	332	52.1	(47–58)	376	50.0	(45–55)			
Czech Republic	1263	48.2	(45–51)	1287	48.3	(45–51)	1399	51.2	(49–54)	1291	52.0	(49–55)			›
Italy	701	46.5	(43–50)	627	45.9	(42–50)	852	47.9	(44–51)	1441	55.1	(52–58)			›
Poland	232	39.7	(33–46)	278	59.7	(54–66)	362	60.5	(55–66)	376	65.2	(60–70)			›
Latvia	64	54.7	(42–67)	65	38.5	(27–51)	78	62.8	(51–74)	92	66.3	(56–76)			›*
Slovakia	–	–	(–)	466	68.2	(64–72)	378	62.7	(58–68)	488	66.4	(62–71)		N/A	
Romania	17	70.6	(44–90)	25	44.0	(24–65)	102	60.8	(51–70)	214	67.3	(61–74)		N/A	
Bulgaria	127	75.6	(67–83)	121	81.0	(73–88)	127	74.8	(66–82)	138	69.6	(61–77)			
Greece	1686	74.6	(72–77)	1665	75.8	(74–78)	1459	70.9	(68–73)	1208	70.1	(67–73)			‹

–: No data

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

Countries not reporting data for all four years (Belgium and Slovakia) and countries reporting relevant AST data for 19 isolates or fewer per year (Poland and Romania) were excluded from the analysis. 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 3.12. ***Klebsiella pneumoniae*. Total number of invasive isolates tested (N) and percentage resistant to aminoglycosides (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

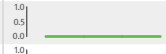
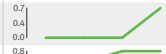
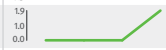
Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Iceland	27	0	(0–13)	26	0	(0–13)	16	0	(0–21)	30	0	(0–12)		N/A	
Finland	372	3.8	(2–6)	404	1.2	(0–3)	516	0.4	(0–1)	523	1.5	(1–3)			‹
Norway	471	1.7	(1–3)	426	2.8	(1–5)	622	2.4	(1–4)	644	2.3	(1–4)			
Sweden	642	1.2	(1–2)	800	1.8	(1–3)	976	2.5	(2–4)	1235	2.9	(2–4)			›
Denmark	799	6.1	(5–8)	908	5.8	(4–8)	902	6.0	(5–8)	864	4.4	(3–6)			
Austria	720	5.6	(4–7)	790	7.2	(6–9)	858	5.4	(4–7)	947	5.3	(4–7)			
Netherlands	644	6.5	(5–9)	729	8.1	(6–10)	685	6.3	(5–8)	653	6.1	(4–8)			
United Kingdom	797	4.9	(4–7)	979	4.3	(3–6)	1059	6.1	(5–8)	1163	6.5	(5–8)			›
Germany	478	10.5	(8–14)	518	8.9	(7–12)	663	8.3	(6–11)	743	9.6	(8–12)			
Belgium	133	2.3	(0–6)	608	8.1	(6–11)	503	10.7	(8–14)	600	9.8	(8–13)			›*
Estonia	66	25.8	(16–38)	90	12.2	(6–21)	91	13.2	(7–22)	91	9.9	(5–18)			‹
Spain	1161	8.7	(7–10)	1145	10.5	(9–12)	1153	14.1	(12–16)	1241	16.0	(14–18)			›
Ireland	318	6.9	(4–10)	304	7.6	(5–11)	338	9.2	(6–13)	317	17.4	(13–22)			›
Slovenia	196	23.0	(17–29)	232	22.0	(17–28)	254	20.5	(16–26)	245	20.0	(15–26)			
EU/EEA (population-weighted mean)		**18.5**	**(16–21)**		**20.9**	**(18–24)**		**22.2**	**(19–25)**		**24.5**	**(22–27)**			**›**
Cyprus	67	19.4	(11–31)	83	27.7	(18–39)	65	18.5	(10–30)	68	25.0	(15–37)			
Malta	57	12.3	(5–24)	52	9.6	(3–21)	57	26.3	(16–40)	69	26.1	(16–38)			›
France	1542	17.7	(16–20)	1688	23.6	(22–26)	1119	23.6	(21–26)	1938	26.7	(25–29)			›
Luxembourg	59	5.1	(1–14)	48	29.2	(17–44)	50	26.0	(15–40)	53	28.3	(17–42)			›
Portugal	596	26.8	(23–31)	619	31.5	(28–35)	780	31.8	(29–35)	912	30.3	(27–33)			
Hungary	514	47.9	(43–52)	430	53.0	(48–58)	500	41.0	(37–45)	556	36.9	(33–41)			‹
Italy	735	29.1	(26–33)	661	34.6	(31–38)	868	42.4	(39–46)	1438	44.9	(42–47)			›
Lithuania	81	51.9	(40–63)	137	55.5	(47–64)	186	63.4	(56–70)	145	47.6	(39–56)			
Latvia	64	54.7	(42–67)	65	33.8	(23–47)	78	51.3	(40–63)	92	48.9	(38–60)			
Croatia	281	49.5	(43–55)	300	44.0	(38–50)	332	46.1	(41–52)	376	50.5	(45–56)			
Czech Republic	1245	46.7	(44–49)	1283	44.7	(42–48)	1399	54.4	(52–57)	1291	51.0	(48–54)			›
Bulgaria	127	68.5	(60–76)	120	71.7	(63–80)	127	54.3	(45–63)	138	56.5	(48–65)			‹
Romania	17	70.6	(44–90)	10	50.0	(19–81)	99	54.5	(44–65)	213	57.3	(50–64)		N/A	
Poland	231	31.2	(25–38)	383	47.5	(42–53)	369	51.8	(47–57)	380	58.4	(53–63)			›
Greece	1687	61.7	(59–64)	1649	69.0	(67–71)	1432	62.9	(60–65)	1171	59.0	(56–62)			‹
Slovakia	–	–	(–)	466	66.3	(62–71)	378	63.0	(58–68)	489	64.0	(60–68)		N/A	

–: No data

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

Countries not reporting data for all four years (Belgium and Slovakia) and countries reporting relevant AST data for 19 isolates or fewer per year (Poland and Romania) were excluded from the analysis. 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 3.13. ***Klebsiella pneumoniae*****. Total number of invasive isolates tested (N) and percentage resistant to carbapenems (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Bulgaria	126	0	(0–3)	116	0	(0–3)	108	1.9	(0–7)	129	0	(0–3)			
Finland	391	0	(0–1)	404	0	(0–1)	536	0	(0–1)	546	0	(0–1)			
Latvia	63	0	(0–6)	65	0	(0–6)	77	0	(0–5)	92	0	(0–4)			
Lithuania	43	0	(0–8)	19	0	(0–18)	185	0	(0–2)	144	0	(0–3)		N/A	
Sweden	655	0.3	(0–1)	1099	0	(0–0)	976	0	(0–0)	1269	0	(0–0)			‹
Iceland	27	0	(0–12)	24	0	(0–13)	16	0	(0–19)	30	0	(0–11)		N/A	
Denmark	491	0	(0–1)	589	0	(0–1)	680	0.3	(0–1)	645	0.2	(0–1)			
Netherlands	640	0.3	(0–1)	722	0.3	(0–1)	684	0.1	(0–1)	646	0.2	(0–1)			
Norway	448	0	(0–1)	443	0	(0–1)	623	0.5	(0–1)	645	0.2	(0–1)			
Belgium	116	0	(0–3)	646	0.3	(0–1)	545	0.7	(0–2)	618	0.3	(0–1)			
Ireland	301	0	(0–1)	302	0.3	(0–2)	338	0	(0–1)	317	0.3	(0–2)			
Slovenia	195	0.5	(0–3)	232	0	(0–2)	254	0.4	(0–2)	245	0.4	(0–2)			
Czech Republic	1103	0.1	(0–1)	1193	0.1	(0–0)	1307	0.3	(0–1)	1133	0.5	(0–1)			›
Croatia	279	2.2	(1–5)	299	0	(0–1)	331	0	(0–1)	376	0.5	(0–2)			‹
United Kingdom	677	0.1	(0–1)	825	0.4	(0–1)	888	0.5	(0–1)	1051	0.5	(0–1)			
Slovakia	–	–	(–)	434	0.7	(0–2)	331	6.3	(4–10)	342	0.6	(0–2)		N/A	
France	1432	0.1	(0–0)	1640	0	(0–0)	1627	0.5	(0–1)	1842	0.7	(0–1)			›
Germany	464	0	(0–1)	512	0	(0–1)	661	0	(0–1)	743	0.7	(0–2)			›*
Poland	238	0	(0–2)	376	0.5	(0–2)	359	0.8	(0–2)	370	0.8	(0–2)			
Austria	509	0.6	(0–2)	610	0.2	(0–1)	738	0.8	(0–2)	910	1.2	(1–2)			
Spain	1161	0	(0–0)	1144	0.3	(0–1)	1152	0.8	(0–1)	1241	1.6	(1–2)			›
Hungary	491	5.5	(4–8)	413	1.9	(1–4)	481	2.9	(2–5)	531	1.7	(1–3)			‹
Portugal	443	1.4	(0–3)	580	0.3	(0–1)	749	0.7	(0–2)	904	1.8	(1–3)			
Luxembourg	57	0	(0–6)	48	0	(0–7)	48	0	(0–7)	53	1.9	(0–10)			
Estonia	66	0	(0–5)	73	0	(0–5)	79	1.3	(0–7)	74	2.7	(0–9)			
Malta	57	0	(0–6)	52	3.8	(0–13)	57	3.5	(0–12)	69	5.8	(2–14)			
Cyprus	67	16.4	(8–27)	83	15.7	(9–25)	65	9.2	(3–19)	68	5.9	(2–14)			‹
EU/EEA (population-weighted mean)		**4.6**	**(3–6)**		**5.8**	**(4–8)**		**6.2**	**(5–8)**		**8.3**	**(7–10)**			›
Romania	14	0	(0–23)	10	0	(0–31)	102	13.7	(8–22)	215	20.5	(15–26)		N/A	
Italy	731	15.2	(13–18)	615	26.7	(23–38)	845	29.1	(26–32)	1453	34.3	(32–37)			›
Greece	1687	49.1	(47–51)	1636	68.2	(66–70)	1460	60.5	(58–63)	1209	59.4	(57–62)			›

–: No data

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.14. ***Klebsiella pneumoniae*. Total number of isolates tested (N) and percentage of combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013			Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		Comment**
Iceland	24	0	(0–14)	24	0	(0–14)	14	0	(0–23)	28	0	(0–12)	N/A	
Finland	368	1.4	(0–3)	404	1.2	(0–3)	516	0.2	(0–1)	510	0.4	(0–1)		‹
Sweden	364	0.8	(0–2)	743	0.8	(0–2)	976	1.4	(1–2)	1235	1.7	(1–3)		
Norway	468	1.1	(0–2)	374	0.8	(0–2)	593	1.5	(1–3)	616	1.8	(1–3)		
Netherlands	638	3.8	(2–6)	720	4.3	(3–6)	667	2.7	(2–4)	631	2.2	(1–4)		‹*
Denmark	557	5.4	(4–8)	633	4.9	(3–7)	577	3.1	(2–5)	519	3.5	(2–5)		‹*
Austria	716	1.8	(1–3)	785	4.1	(3–6)	828	4.2	(3–6)	919	3.8	(3–5)		
United Kingdom	701	3.6	(2–5)	914	2.1	(1–3)	913	2.3	(1–3)	1070	4.9	(4–6)		›
Germany	478	7.5	(5–10)	518	6.9	(5–9)	663	6.2	(4–8)	742	6.9	(5–9)		
Belgium	132	0.8	(0–4)	587	4.9	(3–7)	477	8.2	(6–11)	555	7.0	(5–9)		›*
Ireland	318	2.2	(1–4)	303	3.3	(2–6)	326	3.4	(2–6)	316	7.9	(5–11)		›
Cyprus	67	19.4	(11–31)	83	25.3	(16–36)	65	10.8	(4–21)	68	8.8	(3–18)		‹
Estonia	63	15.9	(8–27)	42	19.0	(9–34)	86	10.5	(5–19)	89	9.0	(4–17)		
Spain	1161	4.7	(4–6)	1145	8.3	(7–10)	1150	8.9	(7–11)	1241	11.2	(9–13)		›
Slovenia	196	17.9	(13–24)	232	19.8	(15–26)	254	17.3	(13–23)	245	15.9	(12–21)		
Luxembourg	59	3.4	(0–12)	48	27.1	(15–42)	50	20.0	(10–34)	53	17.0	(8–30)		
Malta	57	5.3	(1–15)	52	3.8	(0–13)	57	19.3	(10–32)	69	20.3	(12–32)		›
EU/EEA (population–weighted mean)		**15.1**	**(13–18)**		**17.0**	**(15–20)**		**18.3**	**(16–21)**		**20.9**	**(18–24)**		›
Portugal	567	19.4	(16–23)	614	20.8	(18–24)	776	25.1	(22–28)	909	21.9	(19–25)		
France	1527	14.8	(13–17)	1647	19,5	(18–21)	1097	19.4	(17–22)	1916	22.9	(21–25)		›
Croatia	278	35.3	(30–41)	292	30.5	(25–36)	331	30.8	(26–36)	373	29.8	(25–35)		
Hungary	502	37.8	(34–42)	417	46.0	(41–51)	485	37.5	(33–42)	551	32.1	(28–36)		‹
Lithuania	80	32.5	(22–44)	137	43.1	(35–52)	184	52.2	(45–60)	144	33.3	(26–42)		
Bulgaria	126	43.7	(35–53)	120	45.8	(37–55)	127	36.2	(28–45)	138	36.2	(28–45)		
Czech Republic	1244	35.9	(33–39)	1283	36.0	(33–39)	1399	41.8	(39–44)	1291	38.3	(36–41)		›
Latvia	63	49.2	(36–62)	63	33.3	(22–46)	78	42.3	(31–54)	88	39.8	(29–51)		
Italy	685	26.3	(23–30)	566	32.9	(29–37)	758	40.2	(37–44)	1403	41.8	(39–44)		›
Romania	17	23.5	(7–50)	10	30.0	(7–65)	97	42.3	(32–53)	210	42.9	(36–50)	N/A	
Poland	209	23.0	(17–29)	259	37.1	(31–43)	353	48.4	(43–54)	366	52.5	(47–58)		›
Greece	1668	57.4	(55–60)	1630	64.1	(62–66)	1427	59.9	(57–62)	1166	55.4	(52–58)		
Slovakia	–	–	(–)	465	62.4	(58–67)	376	55.3	(50–60)	487	57.9	(53–62)	N/A	

–: No data

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.15. ***Klebsiella pneumoniae*. Total number of tested invasive isolates* and resistance combinations against third-generation cephalosporins, fluoroquinolones, aminoglycosides and carbapenems (n=17 211), EU/EEA countries, 2013**

Resistance pattern	Number of isolates	% of total**
Fully susceptible	10 935	63.5
Single resistance (to indicated drug classes)		
Total (all single resistance)	**1 145**	**6.7**
Fluoroquinolones	526	3.1
Third-generation cephalosporins	471	2.7
Aminoglycosides	140	0.8
Carbapenems	8	<0.1
Resistance to two classes of antimicrobial drugs		
Total (all two classes combinations)	**1 270**	**7.4**
Third-generation cephalosporins + fluoroquinolones	527	3.1
Third-generation cephalosporins + aminoglycosides	435	2.5
Fluoroquinolones + aminoglycosides	272	1.6
Third-generation cephalosporins + carbapenems	31	0.2
Fluoroquinolones + carbapenems	5	<0.1
Resistance to three classes of antimicrobial drugs		
Total (all three classes combinations)	**2 808**	**16.3**
Third-generation cephalosporins + fluoroquinolones + aminoglycosides	2 596	15.1
Third-generation cephalosporins + fluoroquinolones + carbapenems	193	1.1
Third-generation cephalosporin + aminoglycosides + carbapenems	17	0.1
Fluoroquinolones + aminoglycosides + carbapenems	2	<0.1
Resistance to four classes of antimicrobial drugs		
Third-generation cephalosporins + fluoroquinolones + aminoglycosides + carbapenems	1 053	6.1

* Only data from isolates tested against all five antimicrobial groups were included in the analysis.

** Not adjusted for population differences in the reporting countries.

3.3 *Pseudomonas aeruginosa*

3.3.1 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 cause of infection in hospitalised patients with localised or systemic impairment of immune defences. It commonly causes 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 external otitis 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.

3.3.2 Resistance mechanism

Pseudomonas aeruginosa is intrinsically resistant to the majority of antimicrobial agents due to its selective ability to prevent various molecules from penetrating its outer membrane. The antimicrobial groups that remain active include some fluoroquinolones (e.g. ciprofloxacin and levofloxacin), aminoglycosides (e.g. gentamicin, tobramycin and amikacin), some beta-lactams (piperacillin–tazobactam, ceftazidime, cefepime, imipenem, doripenem and meropenem) and polymyxins (polymyxin B and colistin). Resistance of *P. aeruginosa* to these agents can be acquired through one or more of several mechanisms:

- mutational modification of antimicrobial targets such as topoisomerases or ribosomal proteins, which confer resistance to fluoroquinolones and aminoglycosides, respectively;
- mutational derepression of the chromosomally encoded AmpC beta-lactamase, that can confer resistance to penicillins and cephalosporins active against *Pseudomonas* spp., and which is not inhibited by tazobactam;
- mutational loss of outer membrane proteins preventing the uptake of antimicrobial agents 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, or coding for 16S rRNA ribosomal methylases that can confer high-level resistance to all aminoglycosides.

3.3.3 Antimicrobial susceptibility

- Antimicrobial resistance in *P. aeruginosa* is common in Europe, with a majority of the countries reporting resistance percentages above 10 % for all antimicrobial groups under surveillance.
- Carbapenem resistance is common, with an EU/EEA population-weighted mean of 17.6 % and national estimates ranging between 2.9 % and 60.5 %.
- Combined resistance is common in *P. aeruginosa*: 14.3 % of the isolates were resistant to at least three antimicrobial groups and 4.6 % were resistant to all five groups.

Piperacillin + tazobactam

- For 2013, 30 countries reported 11 021 isolates with AST information for piperacillin + tazobactam. The number of isolates reported per country ranged from 11 to 1815 (Table 3.16).
- The EU/EEA population-weighted mean for piperacillin + tazobactam resistance was 16.2 % in 2013. The percentages of resistant isolates in the reporting countries ranged from 0 % (Iceland) to 55.0 % (Romania) (Table 3.16 and Figure 3.11). Ten countries reported resistance percentages below 10 %, 14 reported 10–25 %, five reported 25–50 % and one country reported a resistance percentage above 50 %. (Table 3.16 and Figure 3.11).
- Trends for the period 2010–2013 were calculated for 25 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for six countries (Austria, Hungary, Ireland, Italy, Norway and Sweden). For Italy, the trend was not significant when considering only data from laboratories reporting consistently for all four years.
- Significantly decreasing trends were observed for three countries (France, Greece and Malta).
- As the EUCAST clinical breakpoints for resistance to piperacillin + tazobactam in *P. aeruginosa* are considerably lower than those from CLSI, the ongoing shift from CLSI to EUCAST breakpoints in many European laboratories could impact on the trend analyses. Most countries with increasing trends have changed their clinical guidelines during the period. However, limited laboratory-specific information on use of guidelines and incomplete quantitative susceptibility data make the impact of this change difficult to assess.

Figure 3.11. ***Pseudomonas aeruginosa*. Percentage (%) of invasive isolates with resistance to piperacillin + tazobactam, by country, EU/EEA countries, 2013**

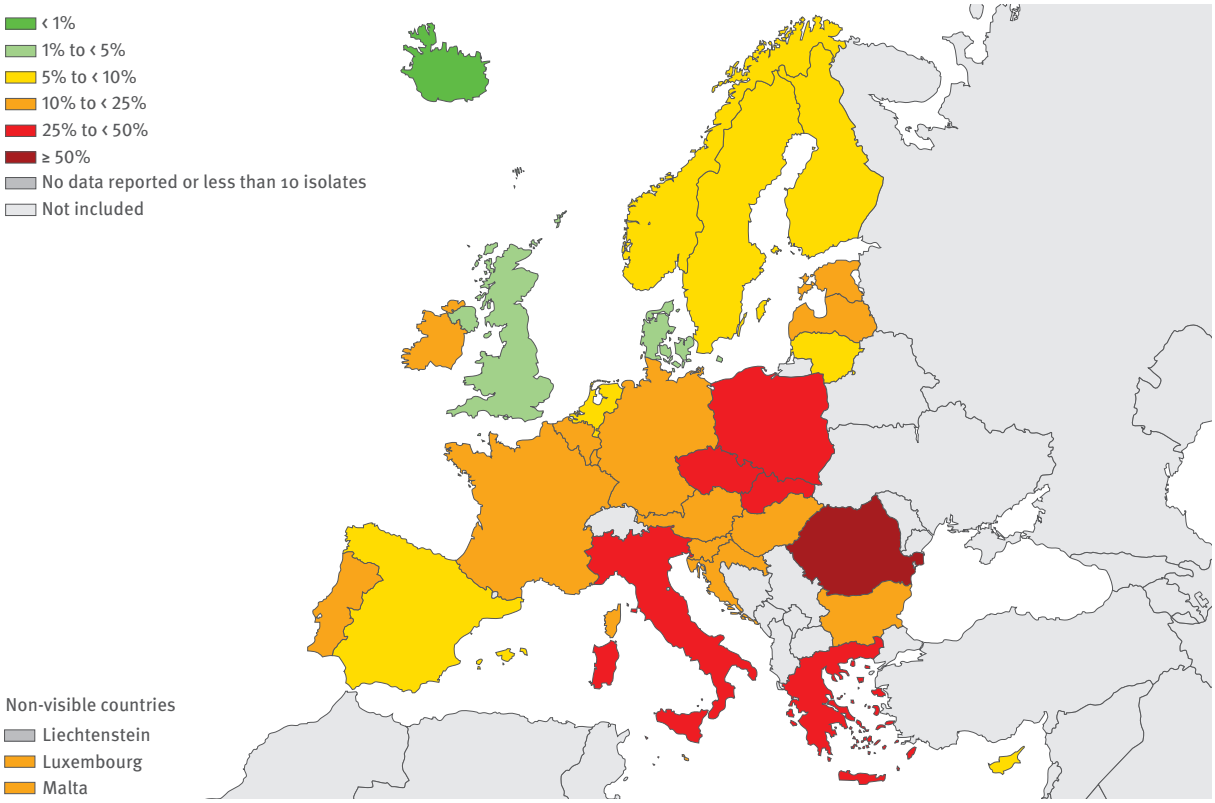
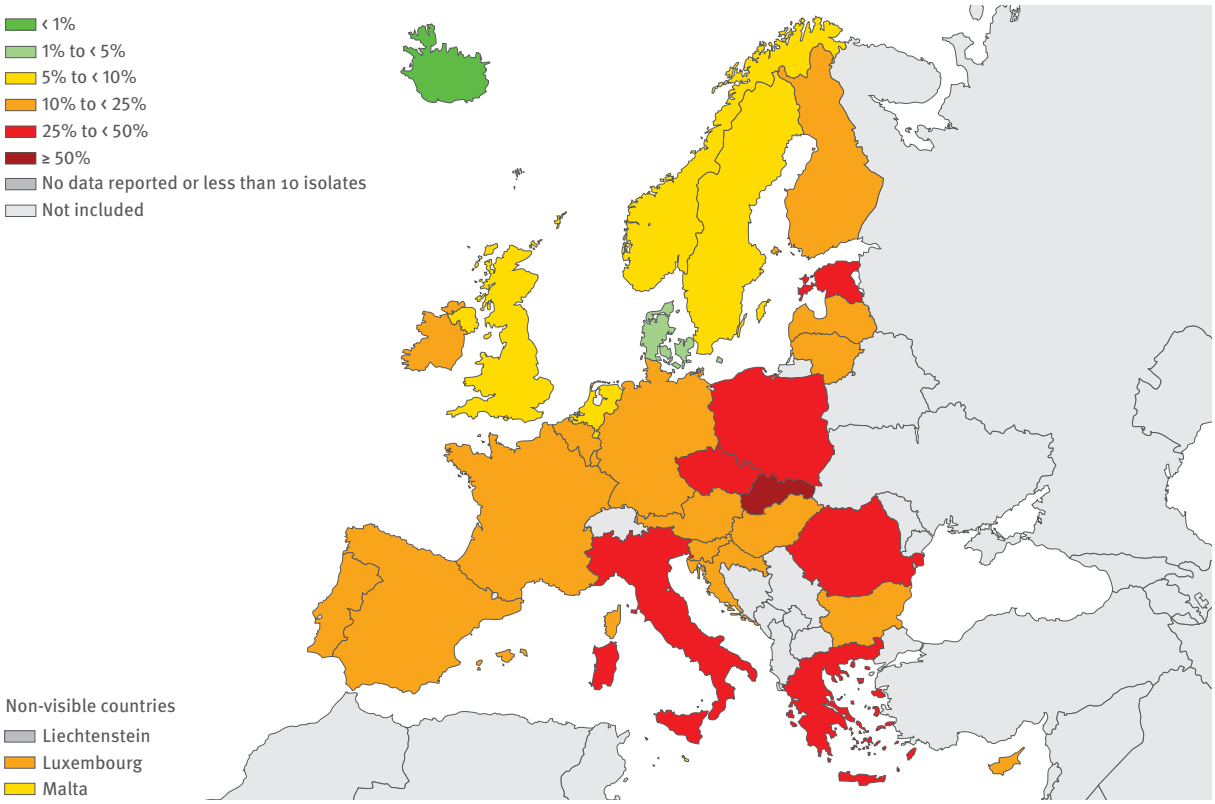


Figure 3.12. ***Pseudomonas aeruginosa*: Percentage (%) of invasive isolates with resistance to fluoroquinolones, by country, EU/EEA countries, 2013**



Fluoroquinolones

- For 2013, 30 countries reported 11800 isolates with AST information for fluoroquinolones. The number of isolates reported per country ranged from 11 to 1863 (Table 3.17).
- The EU/EEA population-weighted mean for fluoroquinolone resistance was 20.0 % in 2013. The percentages of resistant isolates in the reporting countries ranged from 0 % (Iceland) to 53.1 % (Slovakia). Seven countries reported resistance percentages below 10 %, 16 reported 10–25 % and the remaining seven reported fluoroquinolone resistance percentages above 25 %. (Table 3.17 and Figure 3.12).
- Trends for the period 2010–2013 were calculated for 25 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for one country (Norway). The trend was not significant when considering only data from laboratories reporting consistently for all four years.
- Significantly decreasing trends were observed for five countries (Croatia, the Czech Republic, Denmark, France and Malta). For Croatia, the trend was not significant when considering only data from laboratories reporting consistently for all four years. The EU/EEA population-weighted mean showed a small but significantly decreasing trend, from 21.7 % in 2010 to 20.0 % in 2013.

Ceftazidime

- For 2013, 30 countries reported 11549 isolates with AST information for ceftazidime. The number of isolates reported per country ranged from 11 to 1868 (Table 3.18).
- The EU/EEA population-weighted mean percentage for ceftazidime resistance was 12.2 % in 2013. The percentages of resistant isolates in the reporting countries ranged from 0 % (Estonia and Iceland) to 43.8 % (Romania). Fourteen countries reported resistance percentages below 10 %, 13 reported 10–25 % while the remaining three countries reported resistance percentages above 25 % (Table 3.18 and Figure 3.13).
- Trends for the period 2010–2013 were calculated for 25 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for four countries (Hungary, Italy, Slovenia and Sweden). For Italy and Sweden, the trend was not significant when considering only data from laboratories reporting consistently for all four years.
- Significantly decreasing trends were observed for three countries (the Czech Republic, France and Greece). For France, the trend was not significant when considering only data from laboratories reporting consistently for all four years.

Figure 3.13. *Pseudomonas aeruginosa*. Percentage (%) of invasive isolates with resistance to ceftazidime, by country, EU/EEA countries, 2013

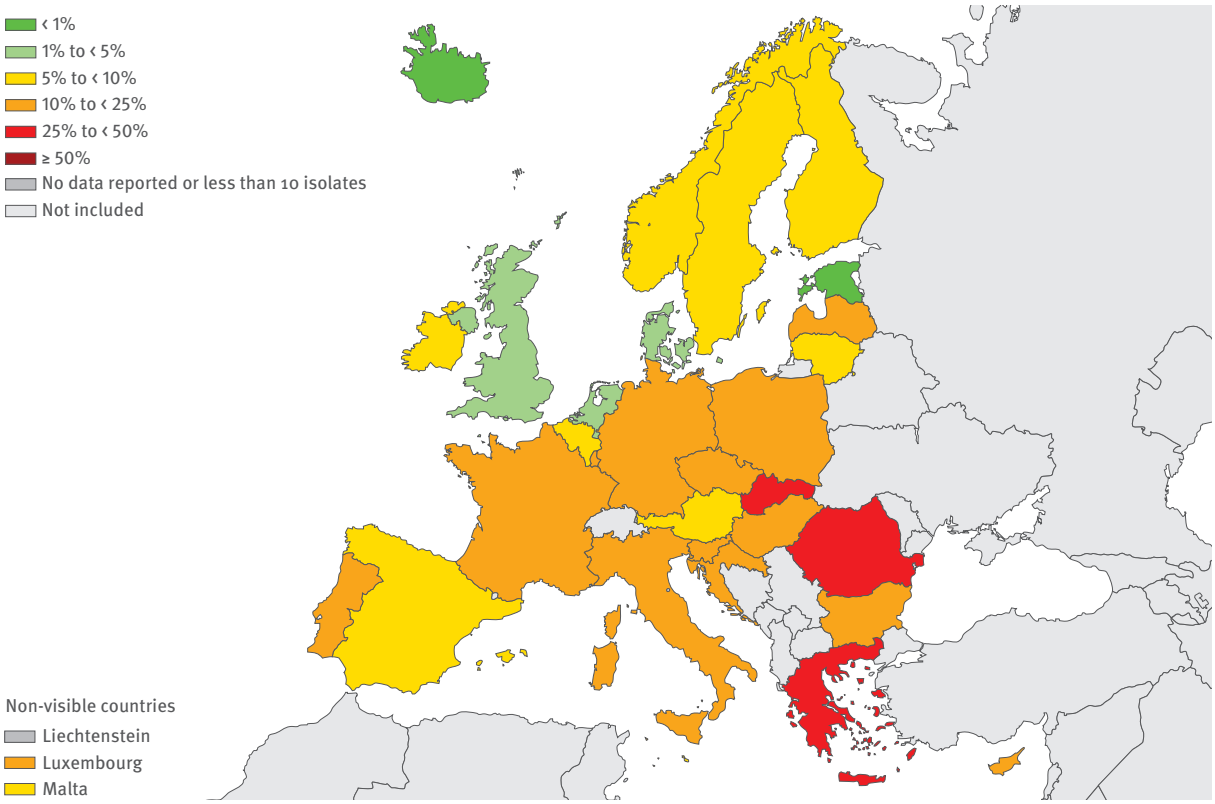


Figure 3.14. ***Pseudomonas aeruginosa*. Percentage (%) of invasive isolates with resistance to aminoglycosides, by country, EU/EEA countries, 2013**

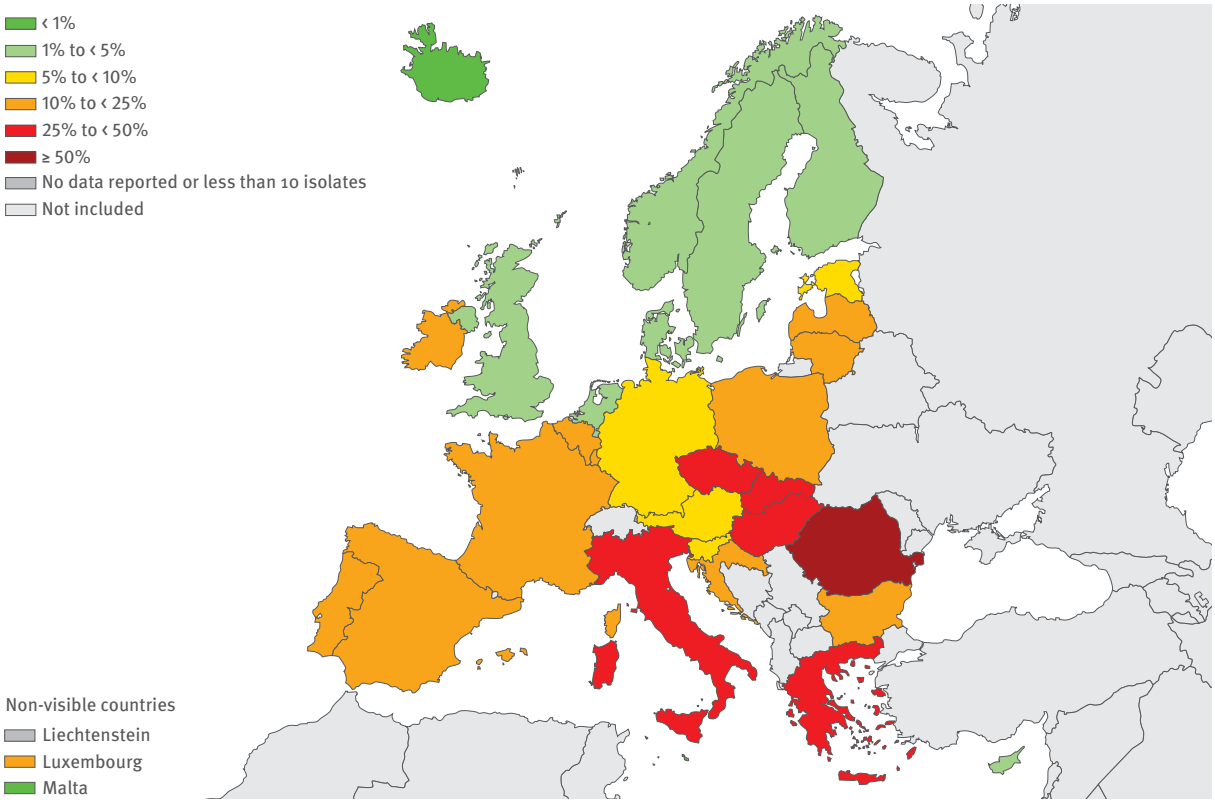
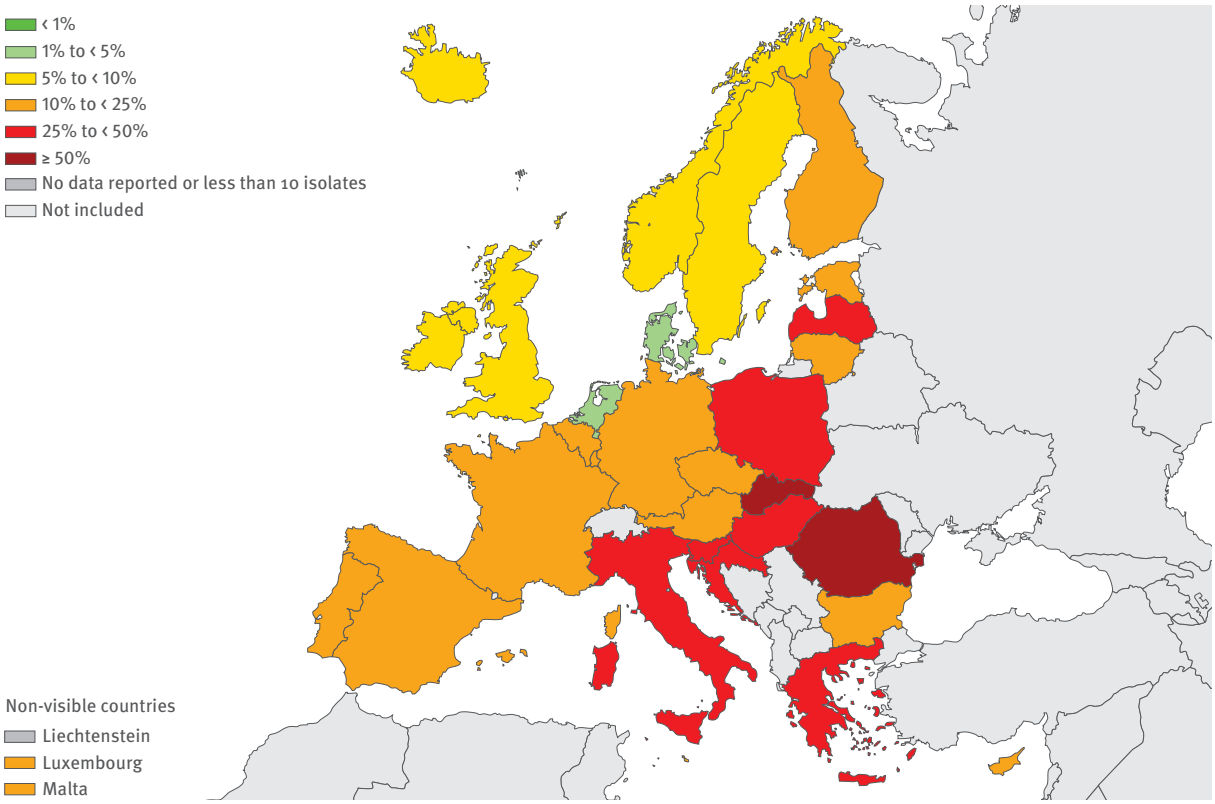


Figure 3.15. ***Pseudomonas aeruginosa*. Percentage (%) of invasive isolates with resistance to carbapenems, by country, EU/EEA countries, 2013**



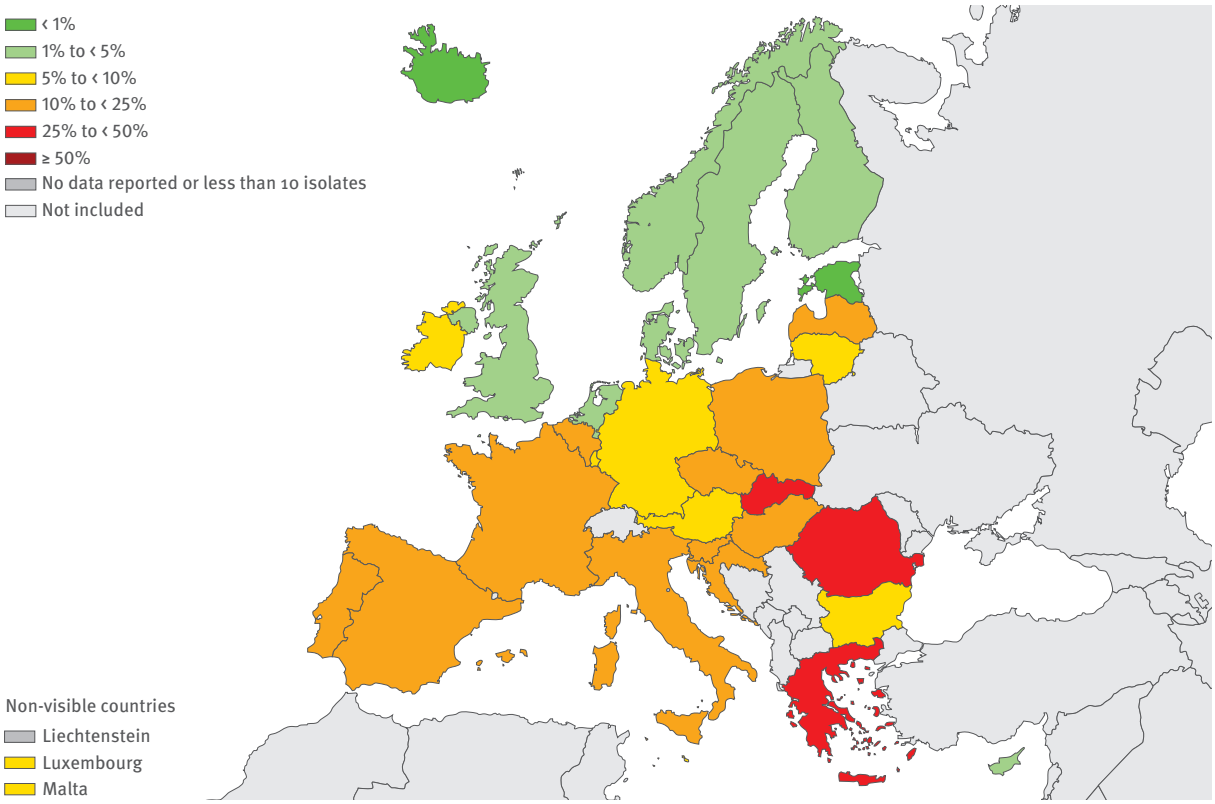
Aminoglycosides

- For 2013, 30 countries reported 11916 isolates with AST information for aminoglycosides. The number of isolates reported per country ranged from 11 to 1869 (Table 3.19).
- The EU/EEA population-weighted mean for aminoglycoside resistance was 15.9 % in 2013. The percentages of resistant isolates in the reporting countries ranged from 0 % (Iceland and Malta) to 51.2 % (Romania). Thirteen countries reported resistance percentages below 10 %, 11 reported 10–25 % and the remaining six reported aminoglycoside resistance percentages above 25 %. (Table 3.19 and Figure 3.14).
- Trends for the period 2010–2013 were calculated for 25 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for four countries (Denmark, Ireland, Italy and Sweden). For Italy, the trend was not significant when considering only data from laboratories reporting consistently for all four years.
- Significantly decreasing trends were observed for four countries (Austria, the Czech Republic, Malta and Spain). For Spain, the trend was not significant when considering only data from laboratories reporting consistently for all four years.

Carbapenems

- For 2013, 30 countries reported 11842 isolates with AST information for carbapenems. The number of isolates reported per country ranged from 11 to 1862 (Table 3.20).
- The EU/EEA population-weighted mean percentage for carbapenem resistance was 17.6 % in 2013. The percentages of resistant isolates in the reporting countries ranged from 2.9 % (Denmark) to 60.5 % (Romania). Seven countries reported resistance percentages below 10 %, 14 reported 10–25 % and the remaining nine reported carbapenem resistance percentages above 25 %. (Table 3.20 and Figure 3.15).
- Trends for the period 2010–2013 were calculated for 25 countries reporting least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for three countries (Hungary, Italy and Norway). For Italy, the trend was not significant when considering only data from laboratories reporting consistently for all four years.
- Significantly decreasing trends were not observed for any country.

Figure 3.16. *Pseudomonas aeruginosa*. Percentage (%) of invasive isolates with combined resistance (resistance to three or more antimicrobial groups among piperacillin + tazobactam, ceftazidime, fluoroquinolones, aminoglycosides and carbapenems), by country, EU/EEA, 2013



Combined resistance (resistance to at least three antimicrobial groups out of piperacillin + tazobactam, ceftazidime, fluoroquinolones, aminoglycosides and carbapenems)

- For 2013, 30 countries reported 11928 isolates with AST information for combined resistance. The number of isolates reported per country ranged from 11 to 1869 (Table 3.21).
- The EU/EEA population-weighted mean percentage for combined resistance was 13.0% in 2013. The percentages of resistant isolates in the reporting countries ranged from 0% (Estonia and Iceland) to 49.4% (Romania). Sixteen countries reported resistance percentages below 10%, 11 reported 10–25% and the remaining three reported combined resistance percentages above 25%. (Table 3.21 and Figure 3.16).
- Trends for the period 2010–2013 were calculated for 25 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for three countries (Norway, Italy and Sweden). For Italy, the trend was not significant when considering only data from laboratories reporting consistently for all four years.
- Significantly decreasing trends were observed for three countries (the Czech Republic, France and Malta). For France, the trend was not significant when considering only data from laboratories reporting consistently for all four years.

Other resistance combinations and resistance to other antimicrobial groups

- Of the total number of *P. aeruginosa* isolates tested for all antimicrobial groups under regular EARS-Net surveillance (piperacillin + tazobactam, ceftazidime, fluoroquinolones, aminoglycosides and carbapenems), single carbapenem or fluoroquinolone resistance was the most common resistance phenotype.
- Around 4% of all isolates were resistant to all groups under regular EARS-Net surveillance (Table 3.22).
- Nineteen countries reported AST data for polymyxins for a total of 4742 isolates (39% of all reported *P. aeruginosa* isolates in 2013). Overall, 1% of the isolates were resistant to polymyxins.

3.3.4 Discussion and conclusions

It is important to note that the ongoing change in use of antimicrobial susceptibility breakpoints in many European laboratories makes trend analysis difficult and sensitive to bias. For *P. aeruginosa*, the difference between EUCAST and CLSI clinical breakpoints for most antimicrobials under surveillance is just one dilution step and probably does not introduce major bias to the results. However, for piperacillin+tazobactam there were considerable differences between the breakpoints in the two guidelines and CLSI breakpoints have changed recently. The change in guidelines within a country is often gradual and not all laboratories change at the same time, hence it is difficult to fully assess its impact on the time series analysis. Not all data in EARS-Net are quantitative and adjusting for changes in interpretive criteria used is difficult.

However, despite use of various breakpoint guidelines, high resistance percentages have been reported from many European countries during the last couple of years. This is a concern as *P. aeruginosa* is intrinsically resistant to a number of antimicrobial groups and any additional acquired resistance severely limits the therapeutic options for treatment of infections caused by this pathogen.

The decrease in fluoroquinolone resistance reported from several countries in recent years was also reflected in a significantly decreasing EU/EEA population-weighted mean percentage. Similar reduction in national fluoroquinolone resistance rates has been reported recently from Canada [14] and from acute care hospitals in the United States [15]. The reason for this positive development remains to be explained, but it could not be a result of change of guidelines, as EUCAST has a more conservative breakpoint determining fluoroquinolone resistance in *P. aeruginosa*. Several studies have shown that reduced use of fluoroquinolones has a positive impact on trends of *P. aeruginosa* resistance in hospitalised patients [15][16]. It is notable that fluoroquinolone resistance in *E. coli* and *K. pneumoniae* reported to EARS-Net has not shown the same positive development in recent years.

Pseudomonas aeruginosa is recognised as a major cause of healthcare-associated infections. In the recent point prevalence survey (PPS) of healthcare-associated infections and antimicrobial use in European acute care hospitals 2011–2012, *P. aeruginosa* was among the five most common bacteria in health-care associated infections, and almost a third of the reported isolates were resistant to carbapenems [17]. Due to its ubiquitous nature and potential virulence, *P. aeruginosa* is a challenging pathogen to control in healthcare settings. Prudent antimicrobial use and high standards of infection control are essential to prevent the situation from deteriorating.

Table 3.16. ***Pseudomonas aeruginosa*. Total number of invasive isolates tested (N) and percentage resistant to piperacillin + tazobactam (%R), including 95 % confidence intervals (95 %CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Iceland	12	8.3	(0–38)	17	5.9	(0–29)	10	10.0	(0–45)	11	0	(0–28)		N/A	
Denmark	361	3.9	(2–6)	405	5.4	(3–8)	389	4.6	(3–7)	414	2.4	(1–4)			
United Kingdom	491	3.9	(2–6)	557	4.3	(3–6)	636	3.1	(2–5)	671	4.8	(3–7)			
Netherlands	374	4.3	(2–7)	391	6.4	(4–9)	386	5.2	(3–8)	381	6.6	(4–10)			
Sweden	272	1.1	(0–3)	386	4.4	(3–7)	271	5.9	(3–9)	531	7.3	(5–10)			›
Cyprus	48	18.8	(9–33)	51	19.6	(10–33)	50	10.0	(3–22)	47	8.5	(2–20)			
Finland	270	7.0	(4–11)	211	15.6	(11–21)	314	7.6	(5–11)	326	8.6	(6–12)			
Lithuania	31	6.5	(1–21)	30	13.3	(4–31)	28	10.7	(2–28)	35	8.6	(2–23)			
Spain	749	6.4	(5–8)	833	6.4	(5–8)	835	6.7	(5–9)	818	8.6	(7–11)			
Norway	163	3.1	(1–7)	142	4.9	(2–10)	198	7.1	(4–12)	198	9.1	(5–14)			›
Ireland	218	8.3	(5–13)	172	2.9	(1–7)	216	16.2	(12–22)	202	11.4	(7–17)			›
Estonia	8	#	#	3	#	#	31	16.1	(5–34)	17	11.8	(1–36)		N/A	
Luxembourg	32	6.3	(1–21)	32	15.6	(5–33)	31	16.1	(5–34)	34	11.8	(3–27)			
Belgium	121	11.6	(6–19)	376	15.4	(12–19)	342	9.6	(7–13)	431	13.2	(10–17)			
Austria	503	8.7	(6–12)	528	13.6	(11–17)	588	18.2	(15–22)	616	13.3	(11–16)			›
Slovenia	95	14.7	(8–23)	118	12.7	(7–20)	134	7.5	(4–13)	133	13.5	(8–21)			
Bulgaria	41	14.6	(6–29)	43	23.3	(12–39)	50	26	(15–40)	59	13.6	(6–25)			
France	1125	20.3	(18–23)	1572	22.5	(20–25)	1627	19.9	(18–22)	1815	15.4	(14–17)			‹
EU/EEA (population-weighted mean)		**15.7**	**(13–19)**		**16.2**	**(13–20)**		**16.6**	**(14–20)**		**16.2**	**(14–19)**			
Germany	315	15.6	(12–20)	386	14.8	(11–19)	432	15.5	(12–19)	608	18.4	(15–22)			
Hungary	596	13.8	(11–17)	599	10.7	(8–13)	610	19.2	(16–23)	657	19.8	(17–23)			›
Latvia	21	19.0	(5–42)	11	9.1	(0–41)	17	17.6	(4–43)	24	20.8	(7–42)		N/A	
Malta	42	35.7	(22–52)	42	23.8	(12–39)	31	9.7	(2–26)	24	20.8	(7–42)			‹
Croatia	208	15.9	(11–22)	224	23.2	(18–29)	194	21.6	(16–28)	233	23.6	(18–30)			
Portugal	546	17.6	(14–21)	522	19.0	(16–23)	586	19.8	(17–23)	87	24.1	(16–35)			
Czech Republic	510	27.6	(24–32)	448	22.1	(18–26)	489	26.4	(23–31)	516	27.5	(24–32)			
Greece	998	38.9	(36–42)	923	31.1	(28–34)	849	34.3	(31–38)	863	29.9	(27–33)			‹
Italy	429	21.2	(17–25)	233	21.9	(17–28)	541	30.1	(26–34)	754	30.9	(28–34)			›*
Poland	163	29.4	(23–37)	191	31.4	(25–39)	157	29.9	(23–38)	171	31.6	(25–39)			
Slovakia	–	–	(–)	266	41.4	(35–48)	195	38.5	(32–46)	265	41.5	(36–48)		N/A	
Romania	8	#	#	7	#	#	44	50.0	(35–65)	80	55.0	(43–66)		N/A	

–: No data

Resistance percentage not calculated as total number of isolates was ‹ 10.

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.17. ***Pseudomonas aeruginosa.*** **Total number of invasive isolates tested (N) and percentage resistant to fluoroquinolones (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Iceland	12	16.7	(2–48)	16	6.3	(0–30)	10	10.0	(0–45)	11	0	(0–28)		N/A	
Denmark	360	6.1	(4–9)	403	6.9	(5–10)	389	4.1	(2–7)	408	3.2	(2–5)			‹
United Kingdom	568	6.7	(5–9)	585	6.2	(4–8)	664	4.8	(3–7)	711	5.8	(4–8)			
Sweden	317	6.3	(4–10)	441	5.2	(3–8)	357	6.7	(4–10)	531	6.0	(4–8)			
Netherlands	375	4.3	(2–7)	434	7.1	(5–10)	395	6.1	(4–9)	370	6.2	(4–9)			
Malta	42	23.8	(12–39)	42	19.0	(9–34)	31	0	(0–11)	25	8.0	(1–26)			‹
Norway	165	3.6	(1–8)	147	5.4	(2–10)	209	5.7	(3–10)	205	8.8	(5–14)			›*
Cyprus	47	17.0	(8–31)	51	13.7	(6–26)	52	15.4	(7–28)	47	10.6	(4–23)			
Lithuania	31	16.1	(5–34)	30	16.7	(6–35)	28	10.7	(2–28)	37	10.8	(3–25)			
Slovenia	95	9.5	(4–17)	118	9.3	(5–16)	134	14.9	(9–22)	133	11.3	(6–18)			
Finland	280	11.1	(8–15)	233	15.5	(11–21)	327	8.0	(5–11)	316	11.4	(8–15)			
Ireland	218	10.6	(7–15)	179	6.1	(3–11)	215	14.9	(10–20)	205	12.2	(8–17)			
Austria	500	15.6	(13–19)	511	18.6	(15–22)	487	14.4	(11–18)	533	15.2	(12–19)			
Germany	315	18.4	(14–23)	385	18.2	(14–22)	434	19.6	(16–24)	607	16.3	(13–19)			
Belgium	121	12.4	(7–20)	397	21.2	(17–26)	329	18.2	(14–23)	486	16.9	(14–21)			
Bulgaria	42	21.4	(10–37)	47	29.8	(17–45)	52	32.7	(20–47)	60	18.3	(10–30)			
EU/EEA (population-weighted mean)		**21.7**	**(18–25)**		**22.1**	**(19–26)**		**20.8**	**(18–24)**		**20.0**	**(17–23)**			‹
Luxembourg	32	21.9	(9–40)	32	18.8	(7–36)	31	19.4	(7–37)	34	20.6	(9–38)			
France	1181	22.8	(20–25)	1554	27.0	(25–29)	1723	22.2	(20–24)	1863	21.2	(19–23)			‹
Croatia	208	26.4	(21–33)	225	35.1	(29–42)	194	23.7	(18–30)	240	21.7	(17–27)			‹*
Spain	749	24.8	(22–28)	838	24.2	(21–27)	848	21.0	(18–24)	825	22.7	(20–26)			
Hungary	629	26.7	(23–30)	599	20.4	(17–24)	618	22.3	(19–26)	667	23.4	(20–27)			
Portugal	533	20.3	(17–24)	516	25.6	(22–30)	587	25.6	(22–29)	735	23.9	(21–27)			
Latvia	21	19.0	(5–42)	12	25.0	(5–57)	18	22.2	(6–48)	25.0	24.0	(9–45)		N/A	
Estonia	10	20.0	(3–56)	16	6.3	(0–30)	32	15.6	(5–33)	20.0	25.0	(9–49)		N/A	
Italy	467	31.0	(27–35)	318	26.1	(21–31)	675	31.4	(28–35)	773	28.7	(26–32)			
Poland	158	27.8	(21–36)	194	30.4	(24–37)	175	26.9	(20–34)	194	29.4	(23–36)			
Czech Republic	510	40.8	(36–45)	448	33.9	(30–39)	489	30.9	(27–35)	516	33.7	(30–38)			‹
Greece	985	45.7	(43–49)	933	38.8	(36–42)	864	44.3	(41–48)	853	43.5	(40–47)			
Romania	9	#	#	9	#	#	45	53.3	(38–68)	84.0	45.2	(34–56)		N/A	
Slovakia	–	–	(–)	266	58.6	(52–65)	199	56.3	(49–63)	286	53.1	(47–59)		N/A	

–: No data

Resistance percentage not calculated as total number of isolates was ‹ 10.

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.18. ***Pseudomonas aeruginosa*. Total number of invasive isolates tested (N) and percentage resistant to ceftazidime (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Estonia	9	#	#	4	#	#	29	17.2	(6–36)	19	0	(0–18)		N/A	
Iceland	12	8.3	(0–38)	17	5.9	(0–29)	10	10.0	(0–45)	11	0	(0–28)		N/A	
Denmark	358	2.8	(1–5)	402	5.2	(3–8)	325	4.9	(3–8)	357	3.1	(2–5)			
United Kingdom	533	4.9	(3–7)	578	4.8	(3–7)	634	3.9	(3–6)	695	3.7	(2–5)			
Netherlands	372	2.7	(1–5)	434	4.6	(3–7)	398	2.8	(1–5)	371	3.8	(2–6)			
Finland	281	2.8	(1–6)	215	9.3	(6–14)	317	5.0	(3–8)	321	5.0	(3–8)			
Norway	162	2.5	(1–6)	146	3.4	(1–8)	202	6.4	(3–11)	193	6.2	(3–11)			
Sweden	311	2.9	(1–5)	475	5.1	(3–7)	357	6.2	(4–9)	531	6.8	(5–9)			›*
Ireland	216	6.0	(3–10)	181	4.4	(2–9)	210	14.3	(10–20)	204	7.8	(5–12)			
Malta	42	14.3	(5–29)	42	11.9	(4–26)	31	6.5	(1–21)	25	8.0	(1–26)			
Lithuania	31	9.7	(2–26)	29	20.7	(8–40)	28	7.1	(1–24)	37	8.1	(2–22)			
Spain	749	7.5	(6–10)	836	8.9	(7–11)	839	8.9	(7–11)	825	9.0	(7–11)			
Belgium	120	6.7	(3–13)	417	8.9	(6–12)	326	8.3	(6–12)	459	9.4	(7–12)			
Austria	461	7.6	(5–10)	498	10.6	(8–14)	572	14.0	(11–17)	608	9.5	(7–12)			
Germany	309	8.1	(5–12)	386	9.1	(6–12)	437	9.6	(7–13)	607	10.0	(8–13)			
France	1009	12.7	(11–15)	1466	16.0	(14–18)	1607	14.1	(12–16)	1868	11.5	(10–13)			‹*
Luxembourg	32	0	(0–11)	32	9.4	(2–25)	31	3.2	(0–17)	34	11.8	(3–27)			
EU/EEA (population-weighted mean)		**11.9**	**(9–15)**		**12.9**	**(10–16)**		**13.4**	**(11–16)**		**12.2**	**(10–15)**			
Bulgaria	37	18.9	(8–35)	39	30.8	(17–48)	52	34.6	(22–49)	56	12.5	(5–24)			
Cyprus	48	16.7	(7–30)	51	23.5	(13–37)	52	15.4	(7–28)	47	12.8	(5–26)			
Slovenia	95	5.3	(2–12)	118	7.6	(4–14)	134	6.7	(3–12)	133	13.5	(8–21)			›
Portugal	547	12.2	(10–15)	526	15.2	(12–19)	587	15.3	(13–19)	737	15.5	(13–18)			
Croatia	197	11.2	(7–16)	215	17.7	(13–23)	189	11.6	(7–17)	239	18.8	(14–24)			
Hungary	635	10.6	(8–13)	604	11.9	(9–15)	608	18.1	(15–21)	662	20.8	(18–24)			›
Poland	151	21.9	(16–29)	142	23.2	(17–31)	156	23.7	(17–31)	49	22.4	(12–37)			
Czech Republic	509	28.5	(25–33)	448	20.3	(17–24)	489	20.4	(17–24)	516	22.9	(19–27)			‹
Italy	407	17.7	(14–22)	303	16.2	(12–21)	603	25.5	(22–29)	722	23.7	(21–27)			›*
Latvia	21	9.5	(1–30)	11	9.1	(0–41)	18	22.2	(6–48)	25	24.0	(9–45)		N/A	
Greece	967	40.2	(37–43)	930	37.4	(34–41)	883	31.0	(28–34)	849	27.9	(25–31)			‹
Slovakia	–	–	(–)	250	25.2	(20–31)	154	35.1	(28–43)	285	30.9	(26–37)		N/A	
Romania	10	60.0	(26–88)	9	#	#	39	51.3	(35–68)	64	43.8	(31–57)		N/A	

–: No data

Resistance percentage not calculated as total number of isolates was ‹ 10.

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.19. ***Pseudomonas aeruginosa.*** **Total number of invasive isolates tested (N) and percentage resistant to aminoglycosides (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Iceland	12	0	(0–26)	17	0	(0–20)	10	0	(0–31)	11	0	(0–28)		N/A	
Malta	42	31.0	(18–47)	42	33.3	(20–50)	31	6.5	(1–21)	25	0	(0–14)			‹
Norway	167	0.6	(0–3)	147	0	(0–2)	197	2.0	(1–5)	194	1.5	(0–4)			
United Kingdom	575	1.9	(1–3)	590	3.4	(2–5)	667	2.2	(1–4)	715	2.5	(1–4)			
Netherlands	376	2.7	(1–5)	434	5.1	(3–8)	404	4.0	(2–6)	374	2.9	(1–5)			
Sweden	278	0	(0–1)	331	1.5	(0–3)	357	1.7	(1–4)	519	2.9	(2–5)			›
Finland	270	4.1	(2–7)	269	4.8	(3–8)	326	2.5	(1–5)	326	3.1	(1–6)			
Cyprus	48	10.4	(3–23)	51	15.7	(7–29)	52	15.4	(7–28)	47	4.3	(1–15)			
Denmark	375	1.3	(0–3)	404	2.2	(1–4)	372	3.8	(2–6)	408	4.9	(3–7)			›
Austria	501	11.0	(8–14)	536	13.4	(11–17)	592	11.5	(9–14)	618	7.4	(6–10)			‹
Slovenia	95	8.4	(4–16)	118	8.5	(4–15)	134	9.7	(5–16)	133	7.5	(4–13)			
Germany	315	10.2	(7–14)	386	11.7	(9–15)	436	10.6	(8–14)	609	7.6	(6–10)			
Estonia	10	20.0	(3–56)	16	0	(0–21)	33	24.2	(11–42)	21	9.5	(1–30)		N/A	
Ireland	219	4.6	(2–8)	181	3.9	(2–8)	215	9.8	(6–15)	205	10.7	(7–16)			›
Belgium	121	10.7	(6–18)	424	12.5	(10–16)	347	11.8	(9–16)	487	12.7	(10–16)			
Lithuania	31	12.9	(4–30)	30	13.3	(4–31)	28	14.3	(4–33)	37	13.5	(5–29)			
Portugal	547	14.1	(11–17)	526	15.4	(12–19)	586	14.7	(12–18)	737	14.2	(12–17)			
Spain	749	18.4	(16–21)	839	18.7	(16–22)	853	16.5	(14–19)	825	14.9	(13–18)			‹*
France	1138	18.4	(16–21)	1599	21.3	(19–23)	1259	24.5	(22–27)	1869	15.5	(14–17)			
EU/EEA (population-weighted mean)		**16.5**	**(14–20)**		**17.0**	**(14–20)**		**18.5**	**(16–22)**		**15.9**	**(13–19)**			
Bulgaria	42	21.4	(10–37)	48	37.5	(24–53)	52	32.7	(20–47)	60	20.0	(11–32)			
Latvia	21	28.6	(11–52)	12	25.0	(5–57)	18	22.2	(6–48)	25	20.0	(7–41)		N/A	
Luxembourg	32	9.4	(2–25)	32	15.6	(5–33)	31	6.5	(1–21)	34	23.5	(11–41)			
Croatia	210	26.2	(20–33)	227	35.2	(29–42)	197	25.4	(19–32)	246	23.6	(18–29)			
Poland	165	30.3	(23–38)	198	32.8	(26–40)	176	24.4	(18–31)	196	24.5	(19–31)			
Hungary	636	28.9	(25–33)	605	18.0	(15–21)	619	26.7	(23–30)	664	25.0	(22–28)			
Czech Republic	510	32.7	(29–37)	448	24.1	(20–28)	489	23.7	(20–28)	516	26.2	(22–30)			‹
Italy	511	22.5	(19–26)	335	17.6	(14–22)	701	30.2	(27–34)	783	27.2	(24–30)			›*
Slovakia	–	–	(–)	267	52.8	(47–59)	199	41.7	(35–49)	286	38.8	(33–45)		N/A	
Greece	997	42.8	(40–46)	935	38.2	(35–41)	897	40.7	(37–44)	860	41.6	(38–45)			
Romania	10	50.0	(19–81)	10	60.0	(26–88)	45	51.1	(36–66)	86	51.2	(40–62)		N/A	

–: No data

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.20. ***Pseudomonas aeruginosa*. Total number of invasive isolates tested (N) and percentage resistant to carbapenems (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

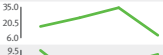
Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Denmark	356	3.1	(2–5)	403	5.5	(3–8)	355	3.7	(2–6)	410	2.9	(2–5)		5.5 4.2 2.9	
Netherlands	371	2.7	(1–5)	431	3.5	(2–6)	397	3.3	(2–6)	375	3.5	(2–6)		3.5 3.1 2.7	
United Kingdom	493	6.5	(4–9)	540	5.6	(4–8)	603	6.3	(4–9)	671	5.2	(4–7)		6.5 5.9 5.2	
Norway	168	1.2	(0–4)	148	4.1	(2–9)	208	6.7	(4–11)	206	5.8	(3–10)		7.0 4.0 1.0	›
Sweden	337	4.5	(3–7)	487	8.0	(6–11)	357	5.3	(3–8)	517	7.2	(5–10)		8.0 6.3 4.5	
Iceland	12	0	(0–26)	17	5.9	(0–29)	10	10.0	(0–45)	11	9.1	(0–41)		N/A	
Ireland	216	6.5	(4–11)	180	6.1	(3–11)	213	11.3	(7–16)	204	9.3	(6–14)		11.3 8.7 6.1	
Estonia	42	21.4	(10–37)	12	8.3	(0–38)	32	12.5	(4–29)	20	10.0	(1–32)		N/A	
Finland	275	9.8	(7–14)	269	10.8	(7–15)	327	6.1	(4–9)	326	10.4	(7–14)		11.0 8.5 6.0	
Belgium	130	4.6	(2–10)	459	10.7	(8–14)	391	9.7	(7–13)	518	11.0	(8–14)		11.0 7.8 4.6	
Austria	473	14.4	(11–18)	538	13.6	(11–17)	562	14.6	(12–18)	616	12.3	(10–15)		14.6 13.5 12.3	
Bulgaria	42	31.0	(18–47)	48	29.2	(17–44)	51	31.4	(19–46)	59	13.6	(6–25)		31.4 22.5 13.6	
Germany	311	12.5	(9–17)	386	9.8	(7–13)	438	10.7	(8–14)	609	15.3	(13–18)		15.3 12.6 9.8	
Czech Republic	510	16.5	(13–20)	448	13.2	(10–17)	489	15.1	(12–19)	516	15.7	(13–19)		16.5 14.9 13.2	
Malta	42	23.8	(12–39)	42	23.8	(12–39)	31	3.2	(0–17)	25	16.0	(5–36)		23.8 13.5 3.2	
France	1186	17.8	(16–20)	1622	20.0	(18–22)	1722	18.0	(16–20)	1862	17.2	(15–19)		20.0 18.5 17.0	
Luxembourg	32	9.4	(2–25)	32	15.6	(5–33)	31	6.5	(1–21)	34	17.6	(7–35)		17.6 12.1 6.5	
Spain	749	17.8	(15–21)	839	16.3	(14–19)	853	16.4	(14–19)	825	17.6	(15–20)		17.8 17.0 16.3	
EU/EEA (population-weighted mean)		**17.0**	**(14–20)**		**16.9**	**(14–20)**		**17.1**	**(14–20)**		**17.6**	**(14–20)**		17.6 17.3 16.9	
Lithuania	30	26.7	(12–46)	30	20.0	(8–39)	28	17.9	(6–37)	37	18.9	(8–35)		26.7 22.3 17.9	
Cyprus	48	29.2	(17–44)	51	43.1	(29–58)	52	19.2	(10–33)	47	19.1	(9–33)		43.1 31.1 19.1	
Portugal	534	16.1	(13–20)	505	19.8	(16–24)	568	20.4	(17–24)	733	20.6	(18–24)		20.6 18.4 16.1	
Croatia	210	28.6	(23–35)	226	29.6	(24–36)	195	26.2	(20–33)	241	25.3	(20–31)		29.6 27.5 25.3	
Slovenia	89	19.1	(12–29)	118	23.7	(16–32)	134	21.6	(15–30)	133	25.6	(18–34)		25.6 22.4 19.1	
Italy	509	22.0	(18–26)	316	20.6	(16–25)	682	25.1	(22–29)	788	25.9	(23–29)		25.9 23.3 20.6	›*
Latvia	21	14.3	(3–36)	12	8.3	(0–38)	18	11.1	(1–35)	25	28.0	(12–49)		N/A	
Hungary	635	24.9	(22–28)	604	21.2	(18–25)	619	27.5	(24–31)	668	30.2	(27–34)		30.2 25.7 21.2	›
Poland	167	24.6	(18–32)	184	24.5	(18–31)	171	22.8	(17–30)	189	32.3	(26–39)		32.3 27.5 22.8	
Greece	999	43.1	(40–46)	900	54.0	(51–57)	907	47.7	(44–51)	877	49.3	(46–53)		54.0 48.5 43.0	
Slovakia	–	–	(–)	249	30.5	(25–37)	179	40.8	(34–48)	214	58.9	(52–66)		N/A	
Romania	10	70.0	(35–93)	10	60.0	(26–88)	45	57.8	(42–72)	86	60.5	(49–71)		N/A	

–: No data

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.21. ***Pseudomonas aeruginosa.*** **Total number of invasive isolates tested (N) with combined resistance (resistance to three or more antimicrobial groups among piperacillin + tazobactam, ceftazidime, fluoroquinolones, aminoglycosides and carbapenems) including 95% confidence intervals (95% CI), by country, EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013			Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		Comment**
Estonia	10	20.0	(3–56)	13	0	(0–25)	33	9.1	(2–24)	21	0	(0–16)	N/A	
Iceland	12	8.3	(0–38)	17	5.9	(0–29)	10	10.0	(0–45)	11	0	(0–28)	N/A	
Denmark	360	1.9	(1–4)	404	3.2	(2–5)	388	1.8	(1–4)	414	1.7	(1–3)		
Netherlands	375	1.1	(0–3)	434	3.0	(2–5)	402	2.5	(1–5)	375	2.4	(1–5)		
United Kingdom	566	2.1	(1–4)	587	2.6	(1–4)	666	1.7	(1–3)	711	2.4	(1–4)		
Norway	167	0.6	(0–3)	148	1.4	(0–5)	209	3.3	(1–7)	205	3.4	(1–7)		›
Sweden	329	0.3	(0–2)	476	2.1	(1–4)	357	2.8	(1–5)	531	4.1	(3–6)		›
Cyprus	48	14.6	(6–28)	51	19.6	(10–33)	52	17.3	(8–30)	47	4.3	(1–15)		
Finland	281	5.3	(3–9)	233	7.7	(5–12)	327	4.6	(3–7)	326	4.6	(3–7)		
Luxembourg	32	9.4	(2–25)	32	15.6	(5–33)	31	6.5	(1–21)	34	5.9	(1–20)		
Ireland	219	5.0	(3–9)	181	3.3	(1–7)	215	10.2	(7–15)	205	7.3	(4–12)		
Malta	42	28.6	(16–45)	42	23.8	(12–39)	31	0	(0–11)	25	8.0	(1–26)		‹
Lithuania	31	9.7	(2–26)	30	10.0	(2–27)	28	14.3	(4–33)	37	8.1	(2–22)		
Austria	503	9.1	(7–12)	537	10.8	(8–14)	595	10.8	(8–14)	617	8.3	(6–11)		
Bulgaria	42	16.7	(7–31)	48	25.0	(14–40)	52	34.6	(22–49)	60	8.3	(3–18)		
Germany	315	9.5	(7–13)	387	7.2	(5–10)	438	8.4	(6–11)	609	9.2	(7–12)		
Belgium	121	5.0	(2–10)	424	10.8	(8–14)	346	8.7	(6–12)	487	11.3	(9–14)		
Slovenia	95	9.5	(4–17)	118	10.2	(5–17)	134	9.7	(5–16)	133	11.3	(6–18)		
Portugal	548	14.1	(11–17)	525	16.2	(13–20)	587	18.1	(15–21)	737	11.9	(10–15)		
Spain	749	12.3	(10–15)	839	12.6	(10–15)	853	10.8	(9–13)	825	12.2	(10–15)		
France	1191	14.7	(13–17)	1621	19.0	(17–21)	1723	14.7	(13–17)	1869	12.6	(11–14)		‹*
EU/EEA (population-weighted mean)		**13.8**	**(11–17)**		**14.3**	**(12–17)**		**13.6**	**(11–16)**		**13.0**	**(11–16)**		
Poland	163	25.2	(19–33)	195	26.2	(20–33)	176	21.6	(16–28)	189	14.3	(10–20)		
Croatia	210	19.0	(14–25)	227	26.9	(21–33)	197	20.3	(15–27)	245	18.4	(14–24)		
Hungary	636	17.8	(15–21)	604	12.4	(10–15)	619	17.6	(15–21)	668	18.9	(16–22)		
Czech Republic	510	29.4	(25–34)	448	21.2	(18–25)	489	21.7	(18–26)	516	23.3	(20–27)		‹
Latvia	21	9.5	(1–30)	12	8.3	(0–38)	18	11.1	(1–35)	25	24.0	(9–45)	N/A	
Italy	469	21.1	(18–25)	319	16.9	(13–22)	648	23.9	(21–27)	779	24.5	(22–28)		›*
Slovakia	–	–	(–)	267	40.1	(34–46)	199	39.2	(32–46)	285	36.1	(31–42)	N/A	
Greece	982	42.5	(39–46)	935	38.4	(35–42)	898	40.2	(37–43)	859	39.3	(36–43)		
Romania	10	50.0	(19–81)	10	60.0	(26–88)	45	48.9	(34–64)	83	49.4	(38–61)	N/A	

–: No data

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.22: *Pseudomonas aeruginosa*: Total number of tested isolates and resistance combinations among invasive isolates tested against at least three antimicrobial groups among piperacillin + tazobactam, ceftazidime, fluoroquinolones, aminoglycosides and carbapenems (n=11 928), EU/EEA countries, 2013

Resistance pattern	Number of isolates	% of total*
Fully susceptible (to tested antibiotics)	7695	64.5
Single resistance (to indicated drug classes)		
Total (all single resistance types)	**1608**	**13.6**
Carbapenems	583	4.9
Fluoroquinolones	488	4.1
Aminoglycosides	257	2.2
Piperacillin + tazobactam	189	1.6
Ceftazidime	91	0.8
Resistance to two classes of antimicrobial drugs		
Total (all two classes combinations)	**921**	**7.6**
Fluoroquinolones + aminoglycosides	266	2.2
Piperacillin + tazobactam + ceftazidime	242	2.0
Fluoroquinolones + carbapenems	160	1.3
Aminoglycosides + carbapenems	64	0.5
Piperacillin + tazobactam + carbapenems	61	0.5
Piperacillin + tazobactam + fluoroquinolones	39	0.3
Ceftazidime + carbapenems	27	0.2
Fluoroquinolones + ceftazidime	26	0.2
Piperacillin + tazobactam + aminoglycosides	23	0.2
Ceftazidime + aminoglycosides	13	0.1
Resistance to three classes of antimicrobial drugs		
Total (all three classes combinations)	**645**	**5.4**
Fluoroquinolones + aminoglycosides + carbapenems	210	1.8
Piperacillin + tazobactam + ceftazidime + carbapenems	112	0.9
Piperacillin + tazobactam + fluoroquinolones + aminoglycosides	97	0.8
Piperacillin + tazobactam + fluoroquinolones + ceftazidime	56	0.5
Piperacillin + tazobactam + fluoroquinolones + carbapenems	39	0.3
Fluoroquinolones + ceftazidime + aminoglycosides	34	0.3
Fluoroquinolones + ceftazidime + carbapenems	33	0.3
Piperacillin + tazobactam + aminoglycosides + carbapenems	27	0.2
Piperacillin + tazobactam + ceftazidime + aminoglycosides	25	0.2
Ceftazidime + aminoglycosides + carbapenems	12	0.1
Resistance to four classes of antimicrobial drugs		
Total (all four classes combinations)	**510**	**4.3**
Piperacillin + tazobactam + fluoroquinolones + aminoglycosides + carbapenems	155	1.3
Fluoroquinolones + ceftazidime + aminoglycosides + carbapenems	145	1.2
Piperacillin + tazobactam + fluoroquinolones + ceftazidime + aminoglycosides	102	0.9
Piperacillin + tazobactam + fluoroquinolones + ceftazidime + carbapenems	79	0.7
Piperacillin + tazobactam + ceftazidime + aminoglycosides + carbapenems	29	0.2
Resistance to five classes of antimicrobial drugs		
Piperacillin + tazobactam + fluoroquinolones + ceftazidime + aminoglycosides + carbapenems	550	4.6

* Not adjusted for population differences in the reporting countries

Figure 3.17. ***Acinetobacter*** **spp. *P*ercentage (%) of invasive isolates with resistance to fluoroquinolones, by country, EU/EEA countries, 2013**

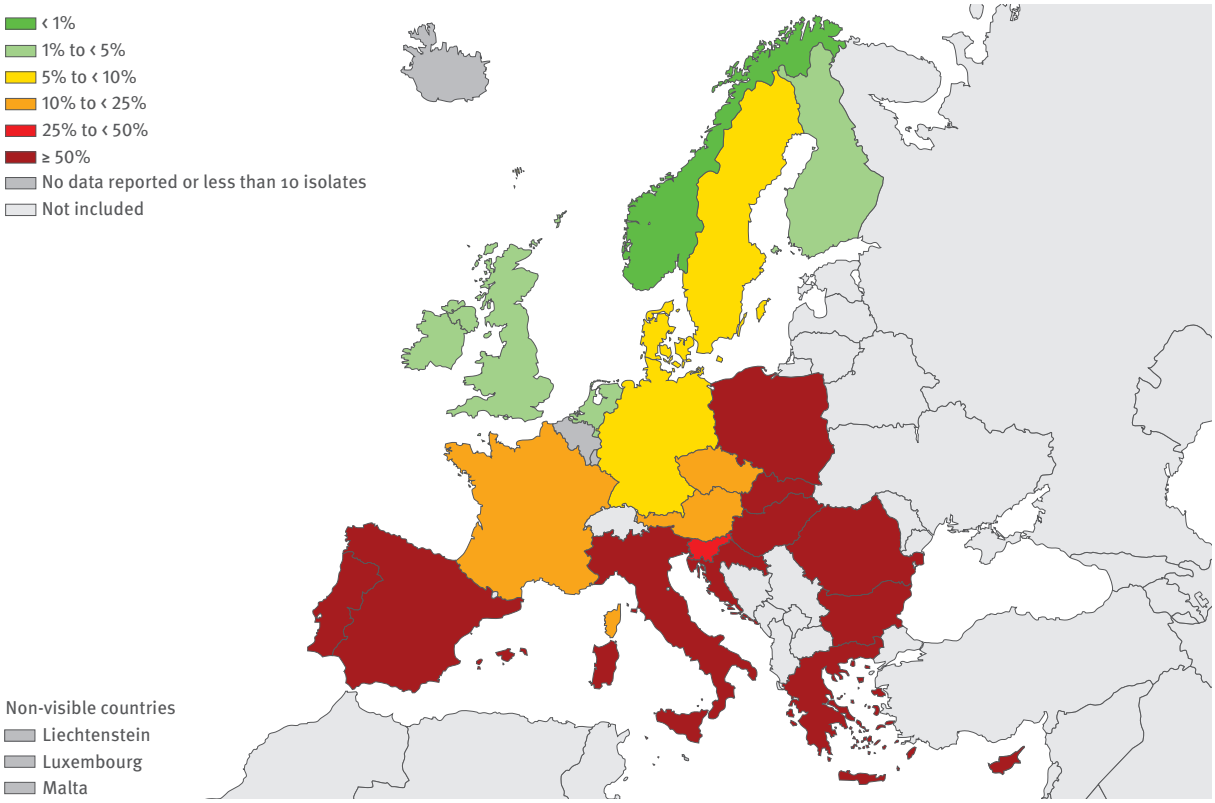
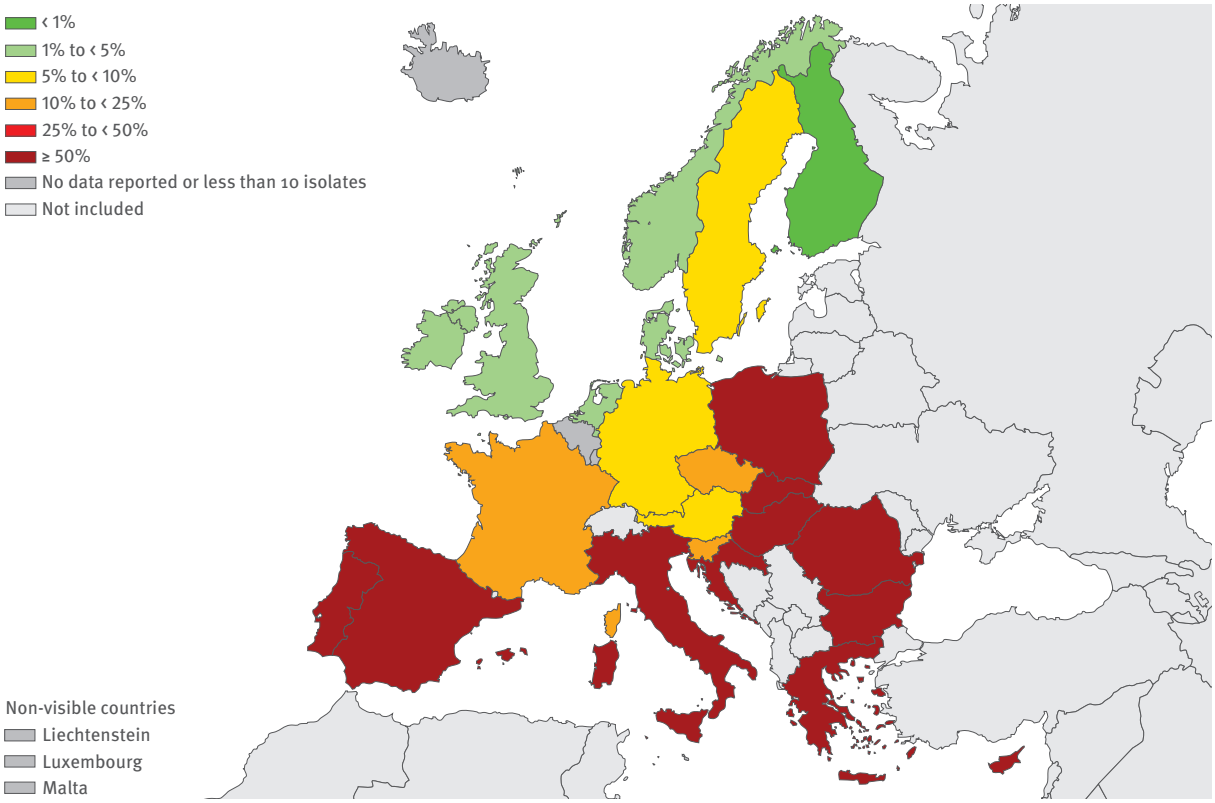


Figure 3.18. ***Acinetobacter*** **spp. Percentage (%) of invasive isolates with resistance to aminoglycosides, by country, EU/EEA countries, 2013**



3.4 *Acinetobacter* species

3.4.1 Clinical and epidemiological importance

The *Acinetobacter* genus consists of a large number of species that can be roughly divided between the *Acinetobacter baumannii* group (consisting of the species *A. baumannii*, *A. pittii* and *A. nosocomialis*), and the *Acinetobacter* non-*baumannii* group (consisting of a large number of environmental species with low pathogenicity). The correct identification of *Acinetobacter* isolates to species level is challenging and is usually only possible with genotypic methods. Recently, mass spectrometry has offered the possibility of at least identifying isolates that belong to the *A. baumannii* group, which is by far the most clinically important group of species within this genus.

Acinetobacter species are gram-negative, strictly aerobic, non-fastidious, non-fermentative opportunistic pathogens. Species belonging to the *A. baumannii* group have been identified as pathogens in nosocomial pneumonia (particularly ventilator-associated pneumonia), central line-associated bloodstream infections, urinary tract infections, surgical site infections and other types of wound infection. While many members of the *Acinetobacter* genus are considered ubiquitous in nature, this is not the case with the species that belong to the *A. baumannii* group. *Acinetobacter* species other than the non-*baumannii* group have been isolated from the skin and mucous membranes of people in the community; however, carriage rates of species belonging to the *A. baumannii* group on the skin and in the faeces have been reported as very low.

The *A. baumannii* group has a limited number of virulence factors, which is why infections due to this bacterium are more likely to occur in critically ill or otherwise debilitated individuals. In fact, outside of the organism's lipopolysaccharide layer, the majority of virulence factors, including bacteriocin, encapsulation and a prolonged viability under dry conditions, seem to favour a prolonged survival rather than invasive disease. Prolonged survival in the environment is likely to be a major contributing factor to nosocomial spread, particularly in intensive care units (ICUs).

Risk factors for infection with the *A. baumannii* group include advanced age, presence of serious underlying diseases, immune suppression, major trauma or burns injuries, invasive procedures, presence of indwelling catheters, mechanical ventilation, extended hospital stay and previous administration of antibiotics. The risks for acquiring a multidrug-resistant (MDR) strain of the *A. baumannii* group are similar; including prolonged mechanical ventilation, prolonged ICU or hospital stay, exposure to infected or colonised patients, increased frequency of interventions, increased disease severity and receipt of broad-spectrum agents, especially third-generation cephalosporins, fluoroquinolones and carbapenems.

3.4.2 Resistance mechanisms

Acinetobacter species, particularly those belonging in the *A. baumannii* group, are intrinsically resistant to most antimicrobial agents due to their selective ability to prevent various molecules from penetrating their outer membrane. The antimicrobial groups that remain active include some fluoroquinolones (e.g., ciprofloxacin and levofloxacin), aminoglycosides (e.g., gentamicin, tobramycin and amikacin), carbapenems (imipenem, doripenem and meropenem), polymyxins (polymyxin B and colistin) and, possibly, sulbactam and tigecycline. Resistance of *Acinetobacter* spp. to these agents can be acquired through one or more of the following mechanisms:

- mutational modification of antimicrobial targets such as topoisomerases or ribosomal proteins, which confers resistance to fluoroquinolones and aminoglycosides, respectively;
- mutational loss of outer membrane proteins preventing the uptake of antimicrobial agents such as carbapenems;
- mutational upregulation of efflux systems, that can confer resistance to beta-lactams, fluoroquinolones and aminoglycosides, and reduced susceptibility to tigecycline; and
- acquisition of plasmid-mediated resistance genes coding for various beta-lactamases, that can confer resistance to carbapenems (OXA carbapenemases and metallo-beta-lactamases), for aminoglycoside-modifying enzymes that may confer resistance to various aminoglycosides, or for 16S rRNA ribosomal methylases that can confer high-level resistance to all aminoglycosides.

3.4.3 Inclusion of *Acinetobacter* species in EARS-Net

For a test period of two years, *Acinetobacter* spp. was added to the list of bacterial species under surveillance in EARS-Net and data have been collected for 2012 and 2013. The value and feasibility of including this bacterium in EARS-Net surveillance permanently will now be evaluated. Surveillance has so far been restricted to genus level (i.e., *Acinetobacter* spp.) due to the difficulties of species identification, and the antibiotics under surveillance are limited to a panel for which clear guidelines on susceptibility testing and interpretive criteria exist.

Due to the fact that surveillance of *Acinetobacter* spp. is still in a test phase and due to the low number of isolates reported, the results should be interpreted with caution.

Figure 3.19. ***Acinetobacter*** **spp. Percentage (%) of invasive isolates with resistance to carbapenems, by country, EU/EEA countries, 2013**

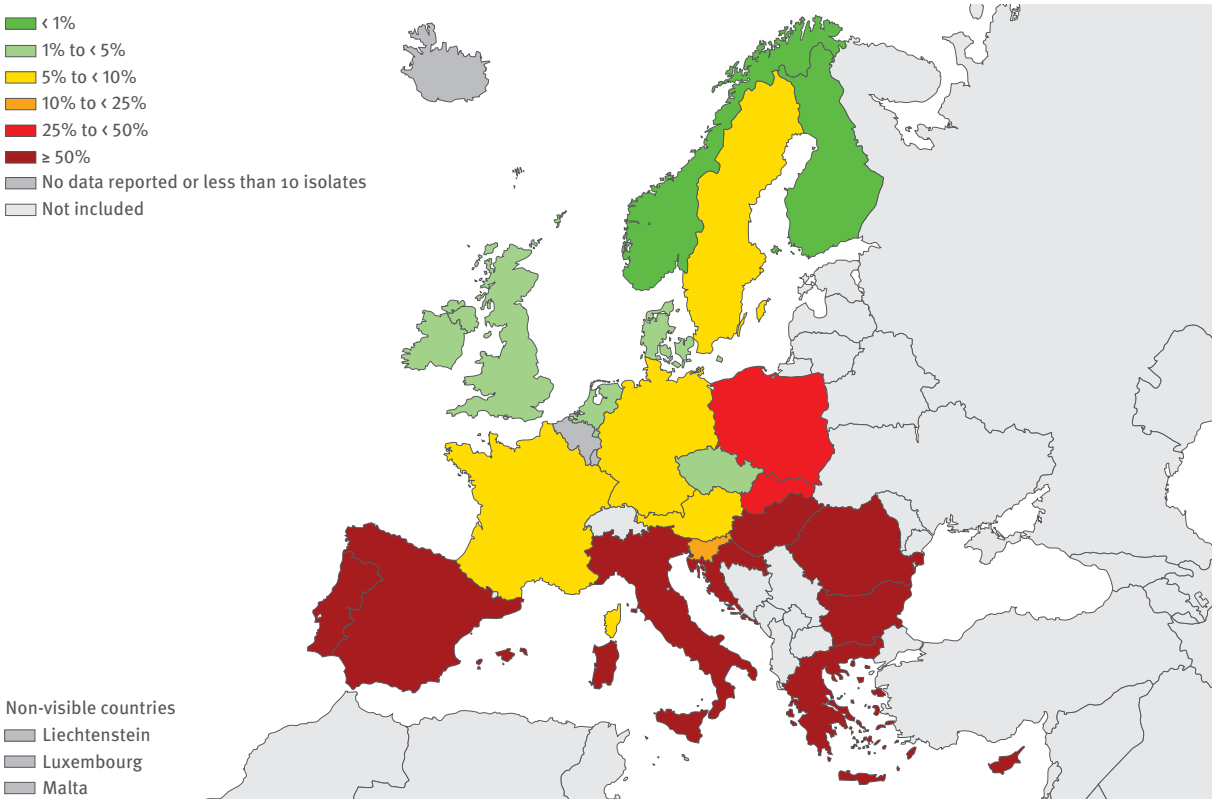
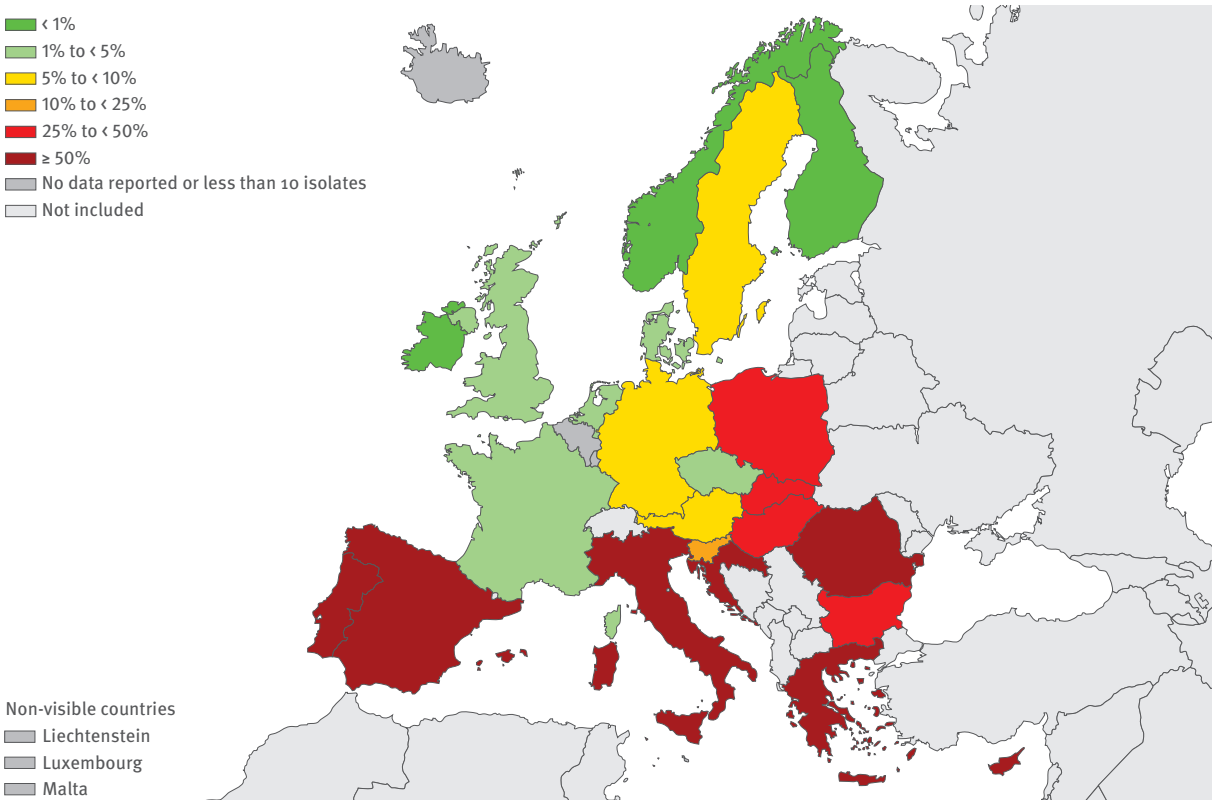


Figure 3.20. ***Acinetobacter*** **spp. Percentage (%) of invasive isolates with combined resistance to fluoroquinolones, aminoglycosides and carbapenems, by country, EU/EEA, 2013**



3.4.4 Antimicrobial susceptibility

- Large variations in antimicrobial resistance of *Acinetobacter* spp. isolates in Europe were reported, with generally higher resistance percentages reported from countries in the south of Europe than in the north.
- Carbapenem resistance was common, and in most cases combined with resistance to fluoroquinolones and aminoglycosides.

Fluoroquinolones

- For 2013, 26 countries reported 4106 isolates with AST information for fluoroquinolone resistance. The number of isolates reported per country ranged from 3 to 812 (Table 3.23).
- The percentages of resistant isolates in countries which reported more than 10 isolates ranged from 0% (Norway) to 95.0% (Greece) (Figure 3.17). Belgium, Luxembourg and Malta reported fewer than 10 isolates and are therefore not included in the figure or the table. Iceland detected no *Acinetobacter* spp. isolates in 2013.

Aminoglycosides

- For 2013, 26 countries reported 4120 isolates with AST information for aminoglycoside resistance. The number of isolates reported per country ranged from 0 to 814. Iceland detected no *Acinetobacter* spp isolates in 2013 (Table 3.24).
- The percentages of resistant isolates in countries which reported more than 10 isolates ranged from 0% (Finland) to 92.1% (Croatia) (Figure 3.18). Belgium, Luxembourg and Malta reported fewer than 10 isolates and are therefore not included in the figure or the table.

Carbapenems

- For 2013, 26 countries reported 4084 isolates with AST information for carbapenem resistance. The number of isolates reported per country ranged from 0 to 812. Iceland detected no *Acinetobacter* spp. isolates in 2013 (Table 3.25).
- The percentages of resistant isolates in countries that reported more than 10 isolates ranged from 0% (Finland and Norway) to 90.6% (Greece) (Figure 3.19). Belgium, Luxembourg and Malta reported fewer than 10 isolates and are therefore not included in the figure or the table.

Combined resistance (fluoroquinolones, aminoglycosides and carbapenems)

- For 2013, 26 countries reported 3949 isolates with sufficient AST information to determine combined resistance to fluoroquinolones, aminoglycosides and carbapenems. The number of isolates reported per country ranged from 0 to 810 (Table 3.26).
- Combined resistance to fluoroquinolones, aminoglycosides and carbapenems was the most common resistance phenotype, and was present in 47.6% of the isolates.
- The percentages of isolates with combined resistance in countries that reported more than 10 isolates ranged from 0% (Finland, Ireland and Norway) to 86.6% (Croatia). (Table 3.26, Figure 3.20). Belgium, Luxembourg and Malta reported fewer than 10 isolates and are therefore not included in the figure or the table.

Polymyxins

- Seventeen countries reported AST data for polymyxins for a total of 2217 isolates (52% of all reported *Acinetobacter* spp. isolates in 2013). Overall, 5% of the isolates were resistant to polymyxins. More than 80% of the polymyxin-resistant isolates were reported from Greece and Italy. Due to the low number of isolates tested, the relatively high proportion of isolates from high-resistance areas and differences in the use of laboratory methodology used to determine susceptibility, these findings should be interpreted with caution and are not representative of Europe as a whole.

3.4.5 Discussion and conclusions

Data from EARS-Net indicate large variation in antimicrobial resistance of *Acinetobacter* spp. isolates in Europe, with generally higher resistance percentages reported from countries in the south of Europe than in the north. For Croatia, Greece and Romania, resistance percentages were above 80% for any of the antimicrobial groups under surveillance (fluoroquinolones, aminoglycosides and carbapenems), and combined resistance to all three of these antimicrobial groups ranged between 74 and 86%. Many other countries reported resistance percentages well above 50%. This is a public health concern as it not only severely limits options for patient treatment, but also constitutes an infection control challenge. The presence of multi-drug resistant *Acinetobacter* spp. in the healthcare environment is a concern because the bacterium can persist in the environment for long periods and is notoriously difficult to eradicate once established.

Resistance to carbapenems is often associated with production of carbapenemases. Results from the EuSCAPE project show that carbapenemase-producing *Acinetobacter* spp. (CPA) might be more widely disseminated in Europe than CPE [12]. The high levels of carbapenem resistance reported from many countries in EARS-Net support this assumption. Further complicating the situation, the presence of polymyxin-resistant isolates indicates loss of the last-line treatment alternative.

However, the exact epidemiology of CPA in Europe remains uncertain. EuSCAPE results highlight that surveillance and reporting are not routinely carried out in some countries and fewer national reference laboratory structures for CPA exist than for CPE. *Acinetobacter* spp.

Table 3.23. ***Acinetobacter*** **spp. Total number of invasive isolates tested (N) and percentage resistant to fluoroquinolones (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2012–2013**

Country	2012			2013			
	N	%R	(95% CI)	N	%R	(95% CI)	
Norway	25	0	(0–14)	36	0	(0–10)	
Ireland	–	–	(–)	88	1.1	(0–6)	
Finland	–	–	(–)	36	2.8	(0–15)	
Netherlands	10	0	(0–31)	69	2.9	(0–10)	
United Kingdom	105	2.9	(1–8)	165	3.6	(1–8)	
Sweden	–	–	(–)	74	5.4	(1–13)	
Denmark	83	12.0	(6–21)	79	6.3	(2–14)	
Germany	121	8.3	(4–15)	173	9.8	(6–15)	
France	385	15.6	(12–20)	397	13.6	(10–17)	
Czech Republic	–	–	(–)	91	19.8	(12–29)	
Austria	–	–	(–)	51	21.6	(11–35)	
Slovenia	25	28.0	(12–49)	25	28.0	(12–49)	
Slovakia	–	–	(–)	188	58.5	(51–66)	
Cyprus	23	56.5	(34–77)	33	60.6	(42–77)	
Portugal	168	77.4	(70–83)	225	68.9	(62–75)	
Bulgaria	65	69.2	(57–80)	94	70.2	(60–79)	
Hungary	405	78.0	(74–82)	472	73.5	(69–77)	
Spain	–	–	(–)	76	74.6	(67–83)	
Poland	209	78.0	(72–83)	188	81.4	(75–87)	
Italy	–	–	(–)	472	83.1	(79–86)	
Romania	54	88.9	(77–96)	137	90.5	(84–95)	
Croatia	–	–	(–)	112	92.9	(86–97)	
Greece	1204	93.1	(92–94)	812	95.0	(93–96)	
Malta	6	#	#	7	#	#	
Belgium	–	–	(–)	3	#	#	
Luxembourg	6	#	#	3	#	#	
Iceland	2	#	#	0	#	#	

–: No data
Percentage resistance not calculated as number of isolates was below 10.

Table 3.24. ***Acinetobacter*** **spp. Total number of invasive isolates tested (N) and percentage resistant to aminoglycosides (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2012–2013**

Country	2012			2013			
	N	%R	(95% CI)	N	%R	(95% CI)	
Finland	–	–	(–)	36	0	(0–10)	
Ireland	–	–	(–)	88	1.1	(0–6)	
Denmark	77	10.4	(5–19)	75	1.3	(0–7)	
United Kingdom	108	2.8	(1–8)	163	2.5	(1–6)	
Norway	25	4.0	(0–20)	36	2.8	(0–15)	
Netherlands	59	1.7	(0–9)	67	4.5	(1–13)	
Germany	119	5.9	(2–12)	173	6.4	(3–11)	
Sweden	–	–	(–)	74	8.1	(3–17)	
Austria	–	–	(–)	51	9.8	(3–21)	
France	278	12.9	(9–17)	409	11.5	(9–15)	
Czech Republic	–	–	(–)	91	16.5	(10–26)	
Slovenia	25	20.0	(7–41)	25	20.0	(7–41)	
Slovakia	–	–	(–)	188	50.0	(43–57)	
Portugal	169	65.1	(57–72)	231	56.3	(50–63)	
Bulgaria	65	58.5	(46–71)	91	58.2	(47–68)	
Cyprus	23	52.2	(31–73)	33	60.6	(42–77)	
Spain	–	–	(–)	77	68.4	(68–84)	
Hungary	407	68.8	(64–73)	475	69.5	(65–74)	
Poland	205	63.4	(56–70)	191	73.8	(67–80)	
Romania	54	57.4	(43–71)	137	80.3	(73–87)	
Italy	–	–	(–)	468	82.9	(79–86)	
Greece	1234	78.1	(76–80)	814	88.5	(86–91)	
Croatia	–	–	(–)	114	92.1	(86–96)	
Belgium	–	–	(–)	3	#	#	
Luxembourg	6	#	#	3	#	#	
Malta	5	#	#	7	#	#	
Iceland	2	#	#	0	#	#	

–: No data
Percentage resistance not calculated as number of isolates was below 10.

were included in EARS-Net for a two-year test period and there are indications that surveillance activities are increasing in Europe. The number of countries reporting data on *Acinetobacter* spp. has increased from 17 in 2012 to 27 in 2013, and in parallel, several countries have an increasing number of laboratories reporting.

The number of isolates reported varied greatly between countries. This may be partially explained by differences in population size, but could also be attributed to national differences in the prevalence of *Acinetobacter* infections as well as availability of routine national surveillance data for *Acinetobacter* spp.

Table 3.25. ***Acinetobacter*** **spp. Total number of invasive isolates tested (N) and percentage resistant to carbapenems (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2012–2013**

Country	2012			2013			
	N	%R	(95% CI)	N	%R	(95% CI)	
Finland	–	–	(–)	35	0	(0–10)	
Norway	25	0	(0–14)	36	0	(0–10)	
Netherlands	67	6.0	(2–15)	65	1.5	(0–8)	
Denmark	64	9.4	(4–19)	61	1.6	(0–9)	
United Kingdom	80	2.5	(0–9)	149	2.0	(0–6)	
Ireland	–	–	(–)	85	2.4	(0–8)	
Czech Republic	–	–	(–)	91	4.4	(1–11)	
Sweden	–	–	(–)	72	5.6	(2–14)	
France	389	3.3	(2–6)	406	5.9	(4–9)	
Austria	–	–	(–)	51	7.8	(2–19)	
Germany	121	6.6	(3–13)	173	9.2	(5–15)	
Slovenia	25	24.0	(9–45)	25	24.0	(9–45)	
Slovakia	–	–	(–)	142	45.8	(37–54)	
Poland	209	38.3	(32–45)	189	49.7	(42–57)	
Hungary	418	48.1	(43–53)	481	50.1	(46–55)	
Bulgaria	58	60.3	(47–73)	89	59.6	(49–70)	
Cyprus	23	56.5	(34–77)	33	60.6	(42–77)	
Portugal	168	79.2	(72–85)	229	69.0	(63–75)	
Spain	–	–	(–)	94	75.5	(66–82)	
Italy	–	–	(–)	468	79.5	(76–83)	
Romania	54	81.5	(69–91)	137	85.4	(78–91)	
Croatia	–	–	(–)	114	89.5	(82–94)	
Greece	1254	87.8	(86–90)	848	90.6	(88–92)	
Belgium	–	–	(–)	3	#	#	
Luxembourg	5	#	#	1	#	#	
Malta	6	#	#	7	#	#	
Iceland	2	#	#	0	#	#	

–: No data
Percentage resistance not calculated as number of isolates was below 10.

Table 3.26. ***Acinetobacter*** **spp. Total number of isolates tested (N) and percentage combined resistance to fluoroquinolones, aminoglycosides and carbapenems (%R), including 95 % confidence intervals (95 % CI), by country, EU/EEA countries, 2012–2013**

Country	2012			2013			
	N	%R	(95% CI)	N	%R	(95% CI)	
Finland	–	–	(–)	34	0	(0–10)	
Ireland	–	–	(–)	84	0	(0–4)	
Norway	25	0	(0–14)	36	0	(0–10)	
United Kingdom	79	1.3	(0–7)	149	1.3	(0–5)	
Netherlands	10	0	(0–31)	64	1.6	(0–8)	
Denmark	58	8.6	(3–19)	57	1.8	(0–9)	
France	272	4.0	(2–7)	389	4.1	(2–7)	
Czech Republic	–	–	(–)	91	4.4	(1–11)	
Germany	119	4.2	(1–10)	172	5.2	(2–10)	
Sweden	–	–	(–)	71	5.6	(2–14)	
Austria	–	–	(–)	51	5.9	(1–16)	
Slovenia	25	12.0	(3–31)	25	20	(7–41)	
Slovakia	–	–	(–)	142	31.7	(24–40)	
Bulgaria	58	32.8	(21–46)	86	39.5	(29–51)	
Poland	197	35.0	(28–42)	184	46.7	(39–54)	
Hungary	394	41.6	(37–47)	466	48.7	(44–53)	
Portugal	168	64.3	(57–72)	222	56.3	(50–63)	
Cyprus	23	47.8	(27–69)	33	60.6	(42–77)	
Spain	–	–	(–)	70	70.0	(64–83)	
Romania	54	50.0	(36–64)	137	74.5	(66–82)	
Italy	–	–	(–)	453	79.0	(75–83)	
Greece	1203	74.5	(72–77)	810	85.2	(83–88)	
Croatia	–	–	(–)	112	86.6	(79–92)	
Belgium	–	–	(–)	3	#	#	
Luxembourg	5	#	#	1	#	#	
Malta	5	#	#	7	#	#	
Iceland	2	#	#	0	#	#	

–: No data
Percentage resistance not calculated as number of isolates was below 10.

Table 3.27. ***Acinetobacter*** **spp. Overall resistance and resistance combinations among invasive isolates tested to fluoroquinolones, aminoglycosides and carbapenems (n = 3 949), EU and EEA countries, 2013**

Resistance pattern	Number of isolates	% of total*
Fully susceptible	1483	37.6
Single resistance (to indicated drug classes)		
Total (any single resistance)	**169**	**4.3**
Fluoroquinolones	103	2.6
Aminoglycosides	36	0.9
Carbapenems	30	0.8
Resistance to two classes of antimicrobial drugs		
Total (any two classes combinations)	**416**	**10.5**
Fluoroquinolones + aminoglycosides	274	6.9
Fluoroquinolones + carbapenems	132	3.3
Aminoglycosides + carbapenems	10	0.3
Resistance to three classes of antimicrobial drugs		
Fluoroquinolones + aminoglycosides + carbapenems	1881	47.6

Only data from isolates tested against all five antimicrobial groups were included in the analysis.
* Not adjusted for population differences in the reporting countries.

3.5 *Streptococcus pneumoniae*

3.5.1 Clinical and epidemiological importance

Streptococcus pneumoniae is a common cause of disease, especially among young non-vaccinated 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, bloodstream infections and meningitis. Since *S. pneumoniae* is the most common cause of pneumonia worldwide, morbidity and mortality are high and approximately 3 million people are estimated to die of pneumococcal infections annually.

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. To date, almost 100 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 AMR. However, serotype replacement due to increased use of the pneumococcal conjugate vaccine (PCV) has been reported.

3.5.2 Resistance mechanisms

Beta-lactam antimicrobials bind to cell wall synthesising enzymes, the 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 to this antimicrobial group. Alterations in PBPs are due to transformation with PBP gene sequences originating from commensal streptococci and construction of mosaic PBP results in different degrees of resistance ranging from low-level clinical resistance, conventionally termed intermediate[i] (I), to full clinical resistance (R). However, in the absence of meningitis, infections with intermediate strains are often successfully treated with high doses of benzyl penicillin or aminopenicillins.

Macrolide, lincosamide and streptogramin (MLS) antimicrobials are chemically distinct, but all bind to a ribosomal subunit, inhibiting the initiation of mRNA binding and thus inhibiting protein synthesis. There are two predominant resistance mechanisms to MLS antimicrobials in *S. pneumoniae*:

- The acquisition of an erythromycin ribosomal methylation gene (erm) results in a post-transcriptional modification of the 23S subunit of rRNA, 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 macrolides, lincosamide and streptogramin B, termed MLS_B resistance.
- The acquisition of a macrolide efflux system gene (*mef*) 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 antimicrobials.

The two fluoroquinolones with acknowledged clinical activity against pneumococci are levofloxacin and moxifloxacin. Resistance to fluoroquinolones is mediated by mutations in *parC* (subunit of topoisomerase IV) and/or *gyrA* (subunit of DNA gyrase/topoisomerase IV). Additionally, resistance may be conferred by efflux.

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 effective against pneumococci and should take the local prevalence of AMR into account. Prescription of non-beta-lactam compounds is therefore typical in countries where penicillin non-susceptibility has been frequently reported. Such prescribing patterns increase the selection pressure of alternative antimicrobials such as macrolides and fluoroquinolones. It is therefore no surprise to see a dynamic AMR picture emerge in different European countries. At the same time, the existence of frequent dual beta-lactam/macrolide resistance, particularly among serotypes commonly found in children, means that in practice the use of agents from either of these groups will result in increasing percentages of resistance to the other class and frequent use of macrolides has been considered as a major driver for the increase in beta-lactam resistance.

Even though a small decrease in penicillin resistance had been detected in some countries before the introduction of the PCV, the widespread use of this vaccine is an important factor that may have influenced the decrease in AMR levels by eliminating infections (and more importantly, the carriage by children) with common 'classic' resistant serotypes (14, 6B, 19F and 23F), all of which are covered by the multivalent PCVs currently on the market.

[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.

3.5.3 Antimicrobial susceptibility

- Susceptibility of *S. pneumoniae* showed large variations between European countries. Macrolide non-susceptibility was, for most countries, higher than the percentages for penicillin non-susceptibility.
- As in previous years, serogroups 1, 3, 7 and 19 dominated among pneumococcal isolates reported to EARS-Net. A large majority of serogroups 1, 3 and 7 were susceptible to both penicillin and macrolides, but for serogroup 19, 52% of the isolates had decreased susceptibility to penicillins and/or macrolides.

Penicillin

- For 2013, 29 countries reported 11239 isolates with AST information for penicillin susceptibility. The number of isolates reported per country ranged from 7 to 1536 (Table 3.28).
- Among the countries reporting 10 isolates or more, the percentages of penicillin-non susceptible isolates ranged from 1.1% (the Netherlands) to 40.0% (Cyprus). Seven countries reported resistance percentages of below 5%, six reported 5–10%, eleven reported 10–25% while the remaining four reported over 25% (Table 3.28).
- Trends for the period 2010–2013 were calculated for 26 countries reporting data for at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for seven countries (Belgium, Denmark, Germany, Italy, Poland, Sweden and the United Kingdom). For Italy and Poland, the trend was not significant when considering only data from laboratories reporting consistently for all four years (Table 3.28).
- Significantly decreasing trends were observed for five countries (the Czech Republic, Hungary, France, Slovenia and Portugal). For the Czech Republic, France and Portugal, the trend was not significant when considering only data from laboratories reporting consistently for all four years.
- Data might not be comparable between all countries as the clinical breakpoints used to determine penicillin susceptibility in *S. pneumoniae* differ depending on guidelines used and the site of infection. As a consequence, a population-weighted EU/EEA mean percentage has not been calculated for *S. pneumoniae* and data are not displayed in a map.

Macrolides

- For 2013, 29 countries reported 11716 isolates with AST information for macrolide susceptibility. The number of isolates reported per country ranged from 9 to 1574 (Table 3.29).
- Among the countries reporting 10 isolates or more, the percentages of macrolide-non susceptible isolates in the reporting countries ranged from 1.5% (Latvia) to 38.1% (Romania). Five countries reported resistance percentages of below 5%, three reported 5–10%, 14 reported 10–25%, while the remaining six reported over 25% (Table 3.29 and Figure 3.21).
- Trends for the period 2010–2013 were calculated for 26 countries reporting data for at least 20 isolates per year during the full four-year period. Statistically increasing trends were observed for three countries (Lithuania, Sweden and the United Kingdom).
- Significantly decreasing trends were observed for two countries (Finland and Slovenia).

Non-susceptibility to penicillins and macrolides

- For 2013, 29 countries reported 10 585 isolates with AST information for both penicillins and macrolides. The number of isolates reported per country ranged from 7 to 1534 (Table 3.30).
- Among the countries reporting 10 isolates or more, the percentages of penicillin-non susceptible isolates in the reporting countries ranged from < 0.1% (Estonia and Latvia) to 26.7% (Cyprus). Fourteen countries reported resistance percentages of below 5%, four reported 5–10%, nine reported 10–25% while one country reported over 25% (Table 3.30).
- Trends for the period 2010–2013 were calculated for 26 countries reporting data for at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for three countries (Belgium, Denmark and Sweden).
- Significantly decreasing trends were observed for four countries (Hungary, France, Slovenia and Portugal). For Hungary, France and Portugal, the trend was not significant when considering only data from laboratories reporting consistently for all four years.

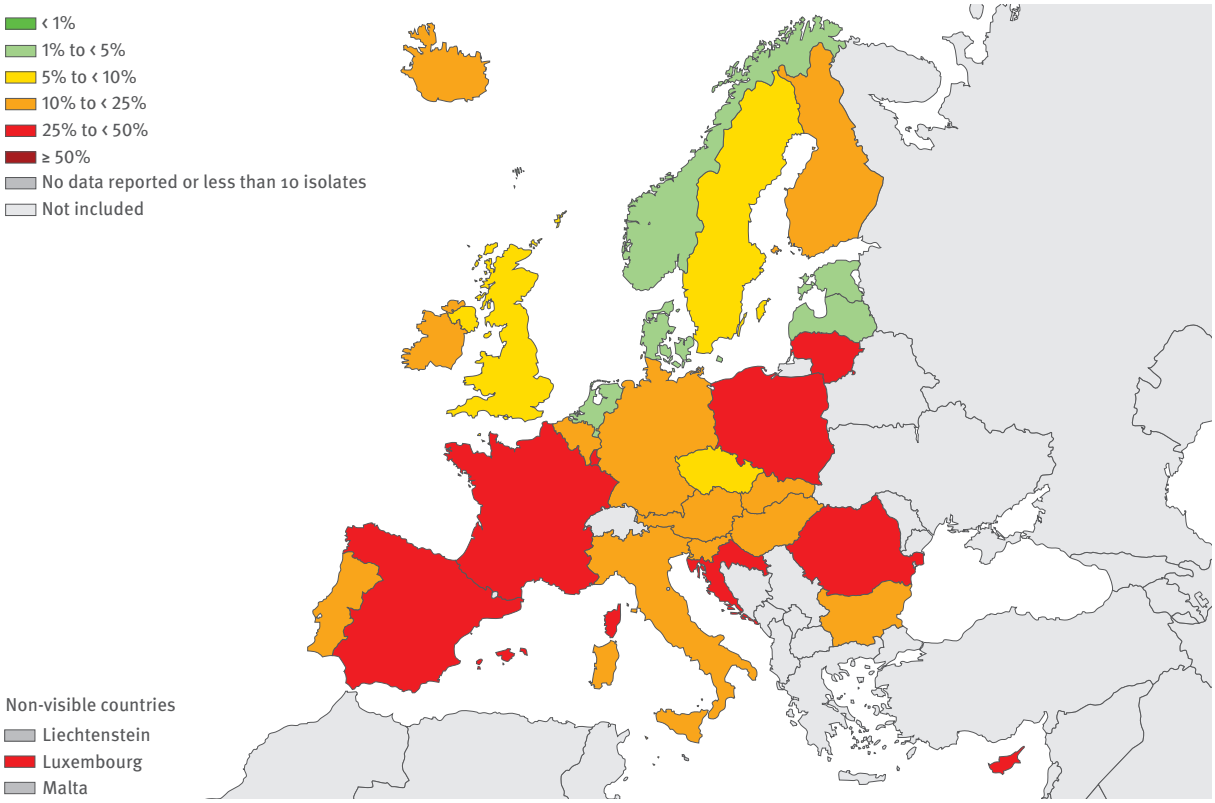
Fluoroquinolones

For 2013, 23 countries reported susceptibility data for fluoroquinolones in 7580 isolates (61% of all reported *S. pneumoniae* isolates). Among them, 4.9% were resistant to fluoroquinolones, and 8.7% of the fluoroquinolone-resistant isolates were also penicillin-non-susceptible.

Serogroups

- Twelve countries reported *S. pneumoniae* isolates with identification of the serotype/group for 2013.
- In 2013, serogroups 3 and 19 were the most prevalent (accounting for 8% and 7% of the isolates, respectively), followed by serogroup 1 (7%) and serogroup 7 (6%) (Figure 3.22). These four serogroups have been dominant among EARS-Net isolates during the last years.
- Among the most commonly reported serogroups, dual non-susceptibility to penicillins and macrolides was mainly observed in serogroups 19, 15, 6 and 14 (by

Figure 3.21. ***Streptococcus pneumoniae*. Percentage (%) of invasive isolates non-susceptible to macrolides, by country, EU/EEA countries, 2013**



order of decreasing percentage). Single non-susceptibility to penicillins was most common in serogroups 19, 14, 6 and 23, and single non-susceptibility to macrolides was most common in serogroups 19, 1, 6 and 14 (Figure 3.22).

3.5.4 Discussion and conclusions

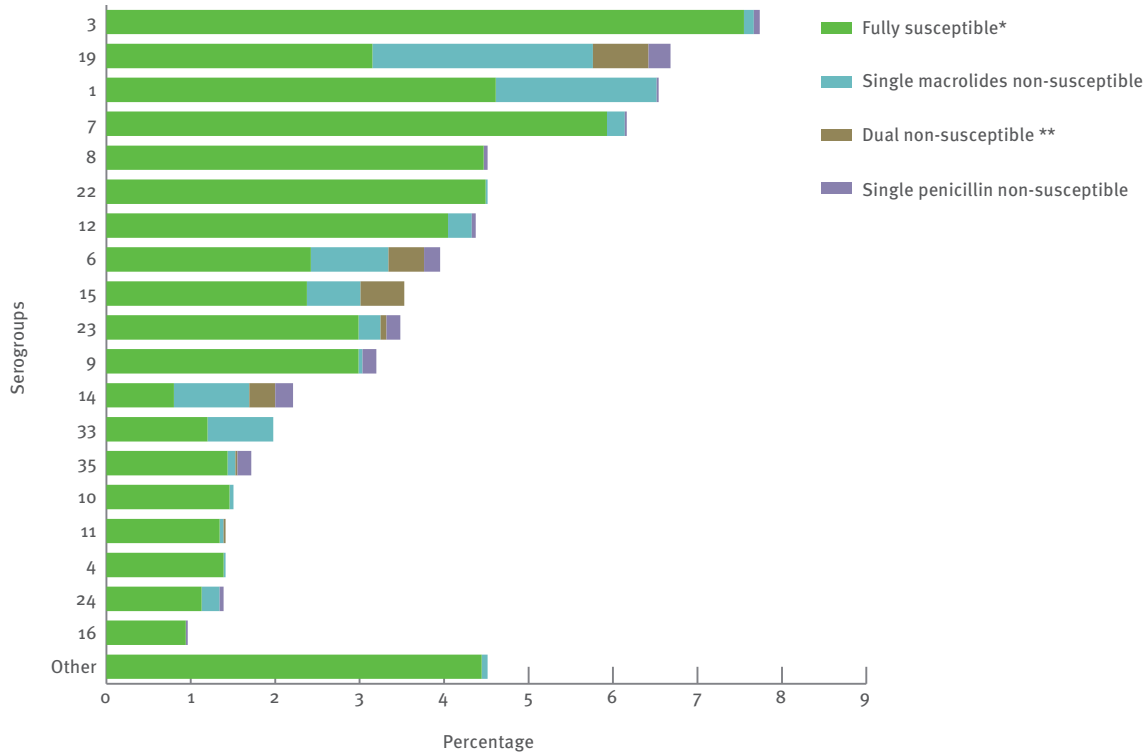
Large inter-country variations can be noted in *S. pneumoniae* susceptibility.

There is an ongoing shift among many European laboratories from using CLSI guidelines to EUCAST. It is important to note that the differences between the guidelines in clinical breakpoints used for determining penicillin susceptibility in *S. pneumoniae* might introduce bias when comparing national data reported to EARS-Net, but also when interpreting trends in countries that changed clinical breakpoints during the observation period. In addition, clinical breakpoints differ within the same guidelines depending on site of infection, e.g. between meningitis and non-meningitis infections. In the case of a shift from CLSI to EUCAST guidelines, resistance percentages could increase due to more restrictive breakpoints applied by EUCAST for non-meningitis cases. For a number of countries reporting significantly increasing trends (Denmark, Sweden and the United Kingdom), this would not be the explanation, as the same breakpoints have been applied between 2010 and 2013. However, limited information on use of guidelines and incomplete quantitative susceptibility data makes the impact of the change in guidelines difficult to assess.

In parallel to EARS-Net, the invasive pneumococcal disease (IPD) enhanced surveillance network, also coordinated by ECDC, is collecting additional data on IPD cases from reference laboratories throughout Europe [18]. For most countries, antimicrobial susceptibility testing results reported to EARS-Net correspond with the data reported to the IPD enhanced surveillance network, despite some differences in the sources of these data.

Although the number of countries reporting data on serotype distribution to EARS-Net is increasing, data remain incomplete. However, data reported for 2013 support previous observations that most penicillin non-susceptible isolates belong to just a few serogroups. Most EU/EEA Member States have implemented routine immunisation for children with the multivalent pneumococcal conjugate vaccine (PCV)s [19], which is likely to impact the epidemiology of IPD in Europe.

Figure 3.22. ***Streptococcus pneumoniae*. Distribution of serogroups and associated resistance profiles per serogroup, 2013**



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.

Table 3.28. ***Streptococcus pneumoniae*. Total number of tested isolates (N) and percentages non-susceptible to penicillin (%IR), including 95 % confidence intervals (95 % CI), by country, EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013			Trend 2010–2013	
	N	%IR	(95% CI)	N	%IR	(95% CI)	N	%IR	(95% CI)	N	%IR	(95% CI)		Comment**
Netherlands	753	2.0	(1–3)	1067	1.1	(1–2)	1063	1.5	(1–2)	1032	1.1	(1–2)		
Estonia	64	1.6	(0–8)	51	2.0	(0–10)	53	0	(0–7)	78	1.3	(0–7)		
Belgium	1797	0.4	(0–1)	1829	0.8	(0–1)	1658	1.5	(1–2)	1536	1.7	(1–2)		›
Austria	351	4.0	(2–7)	405	3.0	(2–5)	291	5.2	(3–8)	385	2.1	(1–4)		
Czech Republic	288	4.9	(3–8)	316	3.8	(2–7)	274	2.9	(1–6)	333	2.1	(1–4)		‹*
Norway	575	3.7	(2–6)	619	3.4	(2–5)	576	5.9	(4–8)	549	3.3	(2–5)		
United Kingdom	1336	3.1	(2–4)	1324	5.4	(4–7)	1153	4.9	(4–6)	1207	4.9	(4–6)		›
Hungary	140	15.0	(10–22)	139	11.5	(7–18)	160	10.0	(6–16)	154	5.8	(3–11)		‹
Denmark	954	3.6	(2–5)	896	4.8	(3–6)	867	5.1	(4–7)	789	6.6	(5–9)		›
Sweden	960	3.8	(3–5)	1193	4.1	(3–5)	1030	5.0	(4–6)	696	6.8	(5–9)		›
Germany	354	3.7	(2–6)	347	1.7	(1–4)	310	5.2	(3–8)	471	7.0	(5–10)		›
Portugal	156	14.7	(10–21)	439	10.5	(8–14)	299	8.4	(5–12)	475	7.6	(5–10)		‹*
Slovenia	232	15.5	(11–21)	253	12.3	(9–17)	251	10.0	(7–14)	279	7.9	(5–12)		‹
Slovakia	–	–	(–)	26	7.7	(1–25)	20	5.0	(0–25)	28	10.7	(2–28)	N/A	
Latvia	37	5.4	(1–18)	40	12.5	(4–27)	64	6.3	(2–15)	67	11.9	(5–22)		
Finland	611	14.2	(12–17)	634	12.9	(10–16)	553	17.0	(14–20)	597	14.1	(11–17)		
Italy	229	9.2	(6–14)	174	6.9	(4–12)	141	12.1	(7–19)	268	14.6	(11–19)		›*
Luxembourg	50	12.0	(5–24)	50	8.0	(2–19)	31	3.2	(0–17)	43	16.3	(7–31)		
Iceland	37	5.4	(1–18)	32	9.4	(2–25)	27	3.7	(0–19)	18	16.7	(4–41)		
Ireland	310	18.1	(14–23)	324	19.4	(15–24)	319	19.1	(15–24)	310	20.3	(16–25)		
Bulgaria	22	18.2	(5–40)	33	21.2	(9–39)	21	28.6	(11–52)	28	21.4	(8–41)		
France	1127	27.6	(25–30)	1413	23.8	(22–26)	824	23.4	(21–26)	919	22.4	(20–25)		‹*
Lithuania	39	12.8	(4–27)	48	18.8	(9–33)	37	16.2	(6–32)	59	23.7	(14–37)		
Romania	13	30.8	(9–61)	36	61.1	(43–77)	44	38.6	(24–55)	44	25.0	(13–40)		
Croatia	102	22.5	(15–32)	125	18.4	(12–26)	97	22.7	(15–32)	118	25.4	(18–34)		
Spain	862	29.8	(27–33)	736	30.2	(27–34)	604	27.0	(23–31)	569	27.6	(24–31)		
Poland	75	24.0	(15–35)	165	18.2	(13–25)	121	23.2	(16–31)	167	32.3	(25–40)		›*
Cyprus	12	41.7	(15–72)	12	25.0	(5–57)	8	#	#	15	40.0	(16–68)	N/A	
Malta	9	#	#	10	50.0	(19–81)	18	38.9	(17–64)	7	#	#	N/A	

–: No data

Resistance percentage not calculated as total number of isolates was <10.

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.29. ***Streptococcus pneumoniae*. Total number of tested isolates (N) and percentages non-susceptible to macrolides (%IR), including 95 % confidence intervals (95 % CI), by country, EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013			Trend 2010–2013	
	N	%IR	(95% CI)	N	%IR	(95% CI)	N	%IR	(95% CI)	N	%IR	(95% CI)		Comment**
Latvia	38	5.3	(1–18)	46	0	(0–8)	64	4.7	(1–13)	66	1.5	(0–8)		
Estonia	45	4.4	(1–15)	45	2.2	(0–12)	52	5.8	(1–16)	59	3.4	(0–12)		
Norway	547	3.8	(2–6)	570	4.2	(3–6)	533	5.3	(4–8)	499	4.4	(3–7)		
Denmark	954	4.2	(3–6)	896	5.1	(4–7)	867	6.0	(5–8)	789	4.8	(3–7)		
Netherlands	898	6.0	(5–8)	1200	4.5	(3–6)	1153	4.4	(3–6)	1155	4.8	(4–6)		
Sweden	955	4.0	(3–5)	1143	5.3	(4–7)	947	4.9	(4–6)	1164	6.5	(5–8)		›
United Kingdom	1289	4.7	(4–6)	1263	5.9	(5–7)	1114	6.8	(5–8)	935	7.5	(6–9)		›
Czech Republic	288	6.3	(4–10)	316	3.5	(2–6)	274	7.7	(5–11)	333	8.7	(6–12)		
Austria	323	10.5	(7–14)	373	11.5	(8–15)	319	17.9	(14–23)	421	10.2	(7–14)		
Slovenia	232	17.2	(13–23)	251	24.3	(19–30)	250	21.2	(16–27)	279	10.4	(7–15)		‹
Germany	358	9.2	(6–13)	353	7.9	(5–11)	324	7.4	(5–11)	477	10.7	(8–14)		
Hungary	133	24.1	(17–32)	129	14.7	(9–22)	147	19.7	(14–27)	139	14.4	(9–21)		
Iceland	37	10.8	(3–25)	32	21.9	(9–40)	27	7.4	(1–24)	18	16.7	(4–41)		
Slovakia	–	–	(–)	25	12.0	(3–31)	22	27.3	(11–50)	29	17.2	(6–36)	N/A	
Ireland	290	15.5	(12–20)	310	18.4	(14–23)	307	16.9	(13–22)	305	18.0	(14–23)		
Bulgaria	20	25.0	(9–49)	30	13.3	(4–31)	20	20.0	(6–44)	27	18.5	(6–38)		
Finland	607	27.5	(24–31)	638	24.5	(21–28)	586	22.0	(19–26)	650	18.6	(16–22)		‹
Portugal	156	21.8	(16–29)	417	14.9	(12–19)	308	18.5	(14–23)	496	20.6	(17–24)		
Belgium	1797	24.8	(23–27)	1829	26.0	(24–28)	1662	25.4	(23–28)	1574	22.9	(21–25)		
Italy	297	28.9	(24–34)	266	27.4	(22–33)	243	34.2	28–40	394	24.6	(20–29)		
Lithuania	35	0	(0–10)	41	26.8	(14–43)	35	25.7	(12–43)	56	25.0	(14–38)		›
Luxembourg	50	18.0	(9–31)	52	15.4	(7–28)	38	15.8	(6–31)	48	25.0	(14–40)		
Spain	862	26.7	(24–30)	746	24.8	(22–28)	579	26.4	(23–30)	560	25.7	(22–30)		
Cyprus	11	54.5	(23–83)	12	25.0	(5–57)	7	#	#	15	26.7	(8–55)	N/A	
France	1127	30.0	(27–33)	1413	26.0	(24–28)	824	28.9	(26–32)	919	29.8	(27–33)		
Poland	71	39.4	(28–52)	135	26.7	(19–35)	110	27.3	(19–37)	142	31.7	(24–40)		
Croatia	101	28.7	(20–39)	123	23.6	(16–32)	77	10.4	(5–19)	116	32.8	(24–42)		
Romania	11	36.4	(11–69)	18	44.4	(22–69)	43	39.5	(25–56)	42	38.1	(24–54)		
Malta	11	18.2	(2–52)	8	#	#	18	50.0	(26–74)	9	#	#	N/A	

–: No data

Resistance percentage not calculated as total number of isolates was ‹ 10.

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.30. ***Streptococcus pneumoniae*. Total number of tested isolates (N) and percentages non-susceptible to penicillins and macrolides (%IR), including 95 % confidence intervals (95 % CI), by country, EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013			Trend 2010–2013	
	N	%IR	(95% CI)	N	%IR	(95% CI)	N	%IR	(95% CI)	N	%IR	(95% CI)		Comment**
Estonia	45	0	(0–8)	42	0	(0–8)	34	0	(0–10)	59	0	(0–6)		
Latvia	37	2.7	(0–14)	38	0	(0–9)	64	1.6	(0–8)	66	0	(0–5)		
Netherlands	681	0.9	(0–2)	978	0.3	(0–1)	972	0.8	(0–2)	921	0.4	(0–1)		
Belgium	1797	0.3	(0–1)	1829	0.6	(0–1)	1614	1.2	(1–2)	1534	0.9	(0–2)		›
Czech Republic	288	1.7	(1–4)	316	1.9	(1–4)	274	1.8	(1–4)	333	1.2	(0–3)		
Norway	546	0.7	(0–2)	567	1.4	(1–3)	533	3.2	(2–5)	497	1.4	(1–3)		
Austria	310	1.9	(1–4)	355	2.3	(1–4)	262	4.2	(2–7)	380	1.6	(1–3)		
Germany	349	2.0	(1–4)	343	0	(0–1)	308	1.3	(0–3)	463	2.6	(1–4)		
Slovenia	232	6.5	(4–10)	251	6.0	(3–10)	250	4.8	(3–8)	279	2.9	(1–6)		‹
United Kingdom	1189	1.7	(1–3)	1126	3.6	(3–5)	627	2.2	(1–4)	867	3.1	(2–4)		
Sweden	907	1.7	(1–3)	1143	2.4	(2–4)	947	3.0	(2–4)	694	3.2	(2–5)		›
Hungary	133	9.8	(5–16)	129	8.5	(4–15)	147	7.5	(4–13)	139	3.6	(1–8)		‹*
Denmark	954	1.6	(1–3)	896	3.0	(2–4)	867	3.5	(2–5)	789	4.2	(3–6)		›
Portugal	156	10.3	(6–16)	402	5.2	(3–8)	278	6.5	(4–10)	467	4.3	(3–7)		‹*
Slovakia	–	–	(–)	25	4	(0–20)	20	5	(0–25)	28	7.1	(1–24)	N/A	
Finland	596	11.1	(9–14)	610	9	(7–12)	532	10.7	(8–14)	579	7.6	(6–10)		
Bulgaria	20	5	(0–25)	30	13.3	(4–31)	20	20.0	(6–44)	26	7.7	(1–25)		
Italy	222	6.3	(3–10)	162	4.3	(2–9)	116	10.3	(5–17)	248	8.1	(5–12)		
Luxembourg	50	6	(1–17)	50	6.0	(1–17)	30	3.3	(0–17)	43	11.6	(4–25)		
Ireland	290	12.4	(9–17)	310	13.5	(10–18)	307	12.4	(9–17)	305	13.1	(10–17)		
Lithuania	34	0	(0–10)	41	17.1	(7–32)	35	14.3	(5–30)	56	14.3	(6–26)		
Croatia	100	19.0	(12–28)	123	11.4	(6–18)	77	9.1	(4–18)	116	15.5	(9–23)		
Spain	862	17.2	(15–20)	720	16.9	(14–20)	551	15.1	(12–18)	556	16.0	(13–19)		
Iceland	37	5.4	(1–18)	32	9.4	(2–25)	26	3.8	(0–20)	18	16.7	(4–41)		
France	1127	22.7	(20–25)	1413	18.8	(17–21)	824	17.2	(15–20)	919	18.9	(16–22)		‹*
Romania	11	27.3	(6–61)	18	44.4	(22–69)	43	32.6	(19–49)	42	21.4	(10–37)		
Poland	70	21.4	(13–33)	134	14.9	(9–22)	110	16.4	(10–25)	139	24.5	(18–32)		
Cyprus	11	36.4	11–69)	12	16.7	(2–48)	7	#	#	15	26.7	(8–55)	N/A	
Malta	9	#	#	7	#	#	18	38.9	(17–64)	7	#	#	N/A	

–: No data.

Resistance percentage not calculated as total number of isolates was ‹ 10.

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data which was not observed when only data from laboratories consistently reporting for all four years were included.

3.6 *Staphylococcus aureus*

3.6.1 Clinical and epidemiological importance

Staphylococcus aureus is a gram-positive bacterium that colonises the skin of about 30 % of healthy humans. However, *S. aureus* is an opportunist and can cause severe infection. Its oxacillin-resistant form (meticillin-resistant *S. aureus*, MRSA) has been the most important cause of antimicrobial-resistant healthcare-associated infections worldwide. Healthcare-associated MRSA in Europe belong to only five clonal lineages which have distinctive geographical patterns of occurrence, whereas the background populations of meticillin-susceptible *S. aureus* (MSSA) are highly diverse, consisting of many lineages that have been widely disseminated. MRSA infections add to, rather than replace, infections caused by MSSA, and a high incidence of MRSA adds to the overall clinical and economic burden in hospitals, resulting in prolonged hospital stays and in higher mortality, mainly due to a delay in the initiation of appropriate therapy and the inferior effectiveness of alternative treatment regimens.

3.6.2 Resistance mechanisms

S. aureus acquires resistance to meticillin and all other beta-lactam agents through expression of the exogenous *mecA* gene that codes for a variant penicillin-binding protein PBP2' (PBP2a) with low affinity for beta-lactams, thus preventing the inhibition by beta-lactams of cell wall synthesis. In *mecA*-negative MRSA a novel *mec* gene, *mecC* (formerly called $mecA_{lga251}$) was described in 2010.

The level of meticillin resistance, as defined by the MIC, depends on the amount of PBP2' production. The PBP2' production is influenced by various genetic factors. Resistance levels of *mec*-positive strains can thus range from phenotypically susceptible to highly resistant. Upon challenge with beta-lactam agents, a highly resistant sub-population may rapidly be selected from a heterogeneously resistant MRSA population.

For rifampicin, the mechanism of resistance is mutation in the *rpoB* gene, leading to production of RNA polymerase with low affinity for rifampicin and other rifamycins. Such resistance easily occurs with rifampicin monotherapy, hence the advice to use the drug only in combination therapy.

Resistance to fluoroquinolones is mediated by the mutations in *parC* or *parE* (subunits of topoisomerase IV) and/or *gyrA* (subunit of DNA gyrase/topoisomerase IV). Additionally, resistance may be conferred by efflux.

The most common mechanism of linezolid resistance is mutation in the 23S rRNA target site. A more recent mechanism is non-mutational and involves acquisition of a natural resistance gene, *cfr* (chloramphenicol–florfenicol resistance). The *cfr* gene has been found primarily in plasmids that can be spread horizontally. The product of the cfr gene is a methyltransferase that catalyses methylation of the 23S rRNA gene.

3.6.3 Antimicrobial susceptibility

- Large inter-country variations in the occurrence of MRSA were evident across Europe, with percentages ranging from 0 % to 64.5 %. MRSA percentages were generally lower in northern Europe and higher in the southern and south-eastern parts.
- The EU/EEA mean was 18.0 % in 2013. Although a significantly decreasing trend was observed for the period 2010 to 2013, the decrease was less pronounced than in the previous four-year period.

Beta-lactams

- For 2013, 30 countries reported 40 893 isolates with sufficient AST and/or molecular information to discern MRSA. The number of isolates reported per country ranged from 69 to 5 431 (Table 3.31).
- The EU/EEA population-weighted mean percentage for MRSA was 18.0 % in 2013. The percentages of isolates reported as MRSA ranged from 0 % (Iceland) to 64.5 % (Romania). Two countries reported resistance percentages below 1 %, five countries reported 1–5 %, five countries reported 5–10 %, 11 countries reported 10–25 %, five countries 25–50 % and two countries reported above 50 % (Table 3.31 and Figure 3.23).
- Trends for the period 2010–2013 were calculated for 29 countries reporting at least 20 isolates per year during the four years. Significantly increasing trends were observed for four countries (Austria, Estonia, Romania and Sweden). However, for all four countries the trend was not significant when considering only data from laboratories reporting consistently for the four years.
- Significantly decreasing trends were observed for nine countries (Belgium, France, Germany, Hungary, Ireland, Latvia, Luxembourg, Portugal and the United Kingdom). For two of these countries (Belgium and Portugal), the trend was not significant when considering only data from laboratories reporting consistently for all four years. The EU/EEA population-weighted mean percentage also showed a significantly decreasing trend, from 22.2 % in 2010 to 18.0 % in 2013.

Rifampicin

- For 2013, 27 countries reported 30 812 isolates with AST information for rifampicin resistance. The percentage of rifampicin resistance was 6.7 % among the MRSA isolates and 0.4 % among the meticillin-susceptible *S. aureus* (MSSA) isolates.

Fluoroquinolones

- For 2013, 28 countries reported 34 954 isolates with AST information for resistance to fluoroquinolones. The percentage of fluoroquinolone resistance was

84.1% among the MRSA isolates and 5.7% among the MSSA isolates.

Linezolid

- For 2013, 28 countries reported 30528 isolates with AST information for linezolid resistance. The percentage of linezolid resistance was 1.2% among the MRSA isolates and 0.1% among the MSSA isolates.

3.6.4 Discussion and conclusions

The decline of MRSA has been less pronounced in recent years compared with that observed during the first decade of the century, but the trend for MRSA continues to decrease in nine out of 30 countries, both in countries with comparatively low and high national MRSA percentages.

Despite this positive development, MRSA remains a public health priority in Europe. The EU/EEA population-weighted mean remains at 18%, and seven out of the 30 reporting countries reported MRSA percentages of above 25%. In order to continue reducing the spread of MRSA in Europe, comprehensive MRSA strategies targeting all healthcare sectors (acute, long-term care facilities and ambulatory care) remain essential.

Figure 3.23. *Staphylococcus aureus*. Percentage (%) of invasive isolates resistant to meticillin (MRSA), by country, EU/EEA countries, 2013

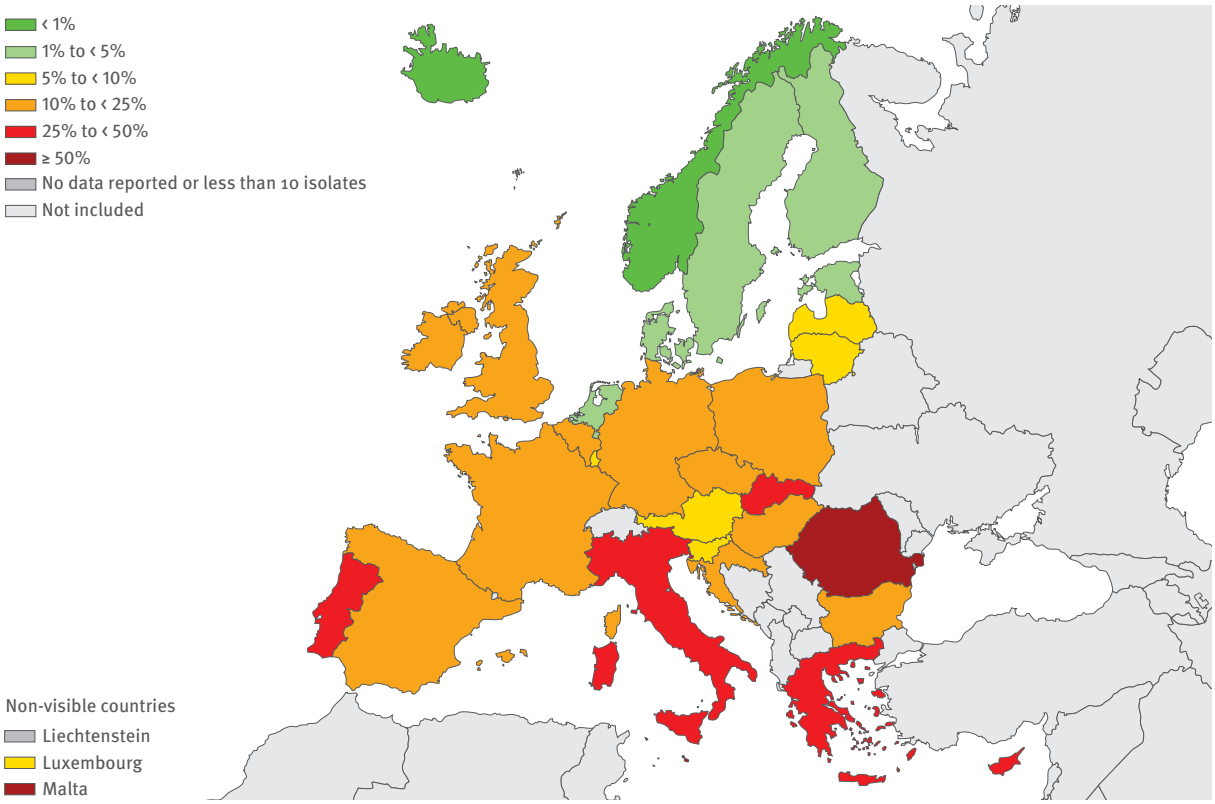


Table 3.31. ***Staphylococcus aureus*. Total number of invasive isolates tested (N) and percentage resistant to meticillin (MRSA) including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Iceland	65	1.5	(0–8)	71	2.8	(0–10)	58	1.7	(0–9)	69	0	(0–5)		2.8 1.4 0	
Norway	1047	0.6	(0–1)	1223	0.3	(0–1)	1430	1.3	(1–2)	1473	0.7	(0–1)		1.3 0.8 0.3	
Sweden	2858	0.5	(0–1)	3751	1.0	(1–1)	3262	0.7	(0–1)	4099	1.0	(1–1)		1.0 0.7 0.5	› *
Netherlands	1564	1.2	(1–2)	1801	1.4	(1–2)	1944	1.3	(1–2)	2062	1.2	(1–2)		1.4 1.3 1.2	
Denmark	1362	1.3	(1–2)	1452	1.2	(1–2)	1431	1.3	(1–2)	1685	1.7	(1–2)		1.7 1.5 1.2	
Finland	1094	2.3	(1–3)	1319	3.2	(2–4)	1409	2.1	(1–3)	1555	1.7	(1–3)		3.2 2.5 1.7	
Estonia	145	0.7	(0–4)	116	1.7	(0–6)	104	7.7	(3–15)	170	3.5	(1–8)		7.7 4.2 0.7	› *
Latvia	153	13.7	(9–20)	192	9.9	(6–15)	211	9.0	(6–14)	172	7.0	(4–12)		13.7 10.4 7.0	‹
Luxembourg	133	16.5	(11–24)	127	20.5	(14–29)	131	15.3	(10–23)	135	8.9	(5–15)		20.5 14.7 8.9	‹
Slovenia	476	12.0	(9–15)	464	7.1	(5–10)	445	10.3	(8–14)	465	9.0	(7–12)		12.0 9.6 7.1	
Austria	1813	7.4	(6–9)	1966	7.4	(6–9)	2164	7.7	(7–9)	2534	9.2	(8–10)		9.2 8.3 7.4	› *
Lithuania	255	14.1	(10–19)	278	5.4	(3–9)	323	10.2	(7–14)	267	9.7	(6–14)		14.1 9.8 5.4	
Germany	1980	20.9	(19–23)	2388	16.1	(15–18)	2563	15.4	(14–17)	3070	12.8	(12–14)		20.9 16.9 12.8	‹
Czech Republic	1593	13.5	(12–15)	1555	14.5	(13–16)	1611	13.0	(11–15)	1707	13.2	(12–15)		14.5 13.7 13.0	
United Kingdom	2684	21.6	(20–23)	3408	13.6	(13–15)	2679	14.0	(13–15)	2117	13.7	(12–15)		21.6 17.3 13.0	‹
Poland	526	13.1	(10–16)	860	24.3	(21–27)	781	25.5	(22–29)	743	16.0	(13–19)		29.2 21.2 13.1	
Belgium	1057	20.5	(18–23)	1744	17.4	(16–19)	1568	16.6	(15–19)	1612	16.9	(15–19)		20.5 18.5 16.6	‹ *
France	4859	21.6	(20–23)	4716	20.1	(19–21)	5228	19.2	(18–20)	5431	17.0	(16–18)		21.6 19.3 17.0	‹
EU/EEA (population-weighted mean)		**22.2**	**(20–24)**		**18.6**	**(17–20)**		**17.5**	**(16–19)**		**18.0**	**(17–20)**		22.2 19.9 17.5	**‹**
Bulgaria	200	19.0	(14–25)	214	22.4	(17–29)	227	19.8	(15–26)	214	19.2	(14–25)		22.4 20.7 19.0	
Ireland	1207	23.9	(21–26)	1057	23.7	(21–26)	1038	22.6	(20–25)	1069	19.9	(18–22)		23.9 21.9 19.9	‹
Spain	1986	25.3	(23–27)	1950	22.5	(21–24)	1899	24.2	(22–26)	1777	22.6	(21–25)		25.3 23.9 22.5	
Hungary	1224	30.2	(28–33)	1156	26.2	(24–29)	1143	24.8	(22–27)	1200	24.0	(22–27)		30.2 27.1 24.0	‹
Croatia	357	26.1	(22–31)	415	27.7	(23–32)	403	21.3	(17–26)	520	24.0	(20–28)		27.7 24.5 21.3	
Slovakia	–	–	(–)	566	26.1	(23–30)	474	21.7	(18–26)	552	27.0	(23–31)		N/A	
Cyprus	99	32.3	(23–42)	113	41.6	(32–51)	165	35.2	(28–43)	157	32.5	(25–40)		41.6 36.9 32.3	
Italy	1766	36.5	(34–39)	1261	38.2	(33–38)	1636	35.2	(33–38)	2394	35.8	(34–38)		38.2 36.7 35.2	
Greece	867	39.2	(36–43)	784	39.2	(36–43)	876	41.0	(38–44)	757	40.3	(37–44)		41.0 40.1 39.2	
Portugal	1633	53.4	(51–56)	1307	54.6	(52–57)	1455	53.8	(51–56)	2390	46.8	(45–49)		54.6 50.6 46.8	‹ *
Malta	108	48.1	(38–58)	130	49.2	(40–58)	102	47.1	(37–57)	114	51.8	(42–61)		51.8 49.4 47.1	
Romania	46	39.1	(25–55)	109	49.5	(40–59)	229	53.3	(47–60)	383	64.5	(59–69)		64.5 51.8 39.1	› *

–: No data

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data which was not observed when only data from laboratories consistently reporting for all four years were included.

3.7 Enterococci

3.7.1 Clinical and epidemiological importance

Enterococci belong to the normal bacterial microbiota of the gastrointestinal tract of humans, other mammals, birds and reptiles. Enterococci are regarded as harmless commensals; however, the recent recognition of high-risk clones suggests that some particular strains can act as true pathogens. Enterococci can cause a variety of infections, including endocarditis, bloodstream infections, and urinary tract infections, and are associated with peritonitis and intra-abdominal abscesses. In the United States, three to four nosocomial bloodstream infections per 10 000 hospital discharges are caused by enterococci, and contribute to patient mortality as well as additional hospital stays.

The vast majority of clinical enterococcal infections in humans are caused by *Enterococcus faecalis* and *E. faecium*. Epidemiological data collected over the last two decades have documented the emergence of enterococci as important nosocomial pathogens, exemplified by the expansion of a major hospital-adapted polyclonal subcluster clonal complex (CC)17 in *E. faecium*, and by CC2 and CC9 in *E. faecalis*. The latter clones have even been isolated from farm animals. The emergence of particular clones and clonal complexes of *E. faecalis* and *E. faecium* was paralleled by increases in resistance to glycopeptides and high-level resistance to aminoglycosides. These two antimicrobial groups represent the few remaining therapeutic options for treatment of human infections caused by *E. faecium* when resistance has emerged against penicillins. Besides the fact that infections caused by resistant strains are difficult to treat, enterococci are highly tenacious and thus easily disseminate in the hospital setting.

3.7.2 Resistance mechanisms

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

Beta-lactam antimicrobials

By nature, enterococci have low susceptibility to many beta-lactam antimicrobials as a consequence of their low-affinity PBPs. Two possible mechanisms of resistance of enterococci to beta-lactams have been reported: the production of beta-lactamase, which is an extremely rare finding, and the overproduction and modification of PBPs, particularly PBP5, that causes high-level penicillin resistance in *E. faecium*. Resistance to aminopenicillin is currently rare in *E. faecalis*. Therefore, the first choice for treatment of infections caused by this microorganism is still an aminopenicillin such as ampicillin. In *E. faecium*, ampicillin-resistance has increased significantly in recent years not the least due to the wide dissemination of ampicillin-resistant strains belonging to the polyclonal subcluster CC17.

Aminoglycosides

In addition to the intrinsic low-level resistance to aminoglycosides due to low uptake of the drug, enterococci have acquired genes conferring high-level resistance to aminoglycosides. High-level resistance to streptomycin can be mediated by single mutations within a protein of the 30S ribosomal subunit, the target of aminoglycoside activity. In addition, different aminoglycoside-modifying enzymes have been identified, targeting eight different aminoglycosides. The bi-functional APH(2'')/AAC(6') enzyme confers high-level resistance to all aminoglycosides except streptomycin and is now widespread across Europe. With high-level resistance, any synergistic effect between beta-lactams and glycopeptides is lost.

Glycopeptides

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

3.7.3 Antimicrobial susceptibility

- High levels of antimicrobial resistance in enterococci remain a major infection control challenge and an important cause of healthcare-associated infections in Europe.
- The decrease in the percentage of high-level aminoglycoside-resistant *E. faecalis* observed in a number of countries in recent years, continued in 2013, although the EU/EEA population-weighted mean showed no significant change over the last four years.
- The EU/EEA population-weighted mean percentage for vancomycin resistance in *E. faecium* showed a significantly increasing trend over the last four years.

3.7.3.1 *Enterococcus faecalis*

High-level aminoglycoside resistance

- For 2013, 28 countries reported 9755 isolates with AST information for high-level aminoglycoside resistance. The number of isolates reported per country ranged from 10 to 1639 (Table 3.32).

- The EU/EEA population-weighted mean percentage for high-level aminoglycoside resistance was 30.9% in 2013. The percentages of resistant isolates in the reporting countries ranged from 14.7% (France) to 61.1% (Latvia). Four countries reported resistance percentages in the interval 10–25%, 19 countries reported 25–50% and five countries reported resistance percentages of above 50% (Table 3.32 and Figure 3.24).
- Trends for the period 2010–2013 were calculated for 24 countries reporting at least 20 isolates per year during all four years. A significantly increasing trend was observed only for Belgium. However, the trend was not significant when considering only data from laboratories reporting consistently for all four years.
- Significantly decreasing trends were observed for five countries (the Czech Republic, France, Germany, Greece and Luxembourg). For Luxembourg, the trend was not significant when considering only data from laboratories reporting consistently for all four years.

3.7.3.2 *Enterococcus faecium*

Vancomycin

- For 2013, 30 countries reported 8278 isolates with AST information for resistance to vancomycin. The number of isolates reported per country ranged from 10 to 826 (Table 3.33).
- The EU/EEA population-weighted mean percentage for vancomycin resistance was 8.9% in 2013. The percentages of resistant isolates in the reporting countries ranged from 0% (Estonia, Lithuania, Malta and Sweden) to 42.7%, reported by Ireland. Eight countries reported resistance percentages below 1%, six countries reported 1–5%, seven countries reported 5–10%, eight countries reported 10–25% and one country reported 25–50% (Table 3.33 and Figure 3.25).
- Trends for the period 2010–2013 were calculated for 27 countries reporting for at least 20 isolates during all four years. Significantly increasing trends were observed for four countries (Denmark, Germany, Hungary and the United Kingdom). The EU/EEA population-weighted mean percentage also showed a significantly increasing trend, from 5.6% in 2010 to 8.9% in 2013.
- A significantly decreasing trend was observed only for Belgium, but the trend was not significant when considering only data from laboratories reporting consistently for all four years.

3.7.4 Discussion and conclusions

High levels of antimicrobial-resistant enterococci remain a major infection control challenge and an important cause of health-care associated infections in Europe. In the recent point-prevalence survey of healthcare-associated infections and antimicrobial use in European acute care hospitals 2011–2012, *Enterococcus* spp. were among the most commonly isolated microorganisms and resistance to vancomycin or high-level resistance to aminoglycoside was not unusual.

The decrease in the percentage of high-level aminoglycoside-resistant *E. faecalis* observed in a number of countries in recent years, continued in 2013, although the EU/EEA population-adjusted mean showed no significant change over the last four years. Nevertheless, a reduction of high-level aminoglycoside resistance was observed in individual countries and increasing trends remain rare. By contrast, the EU/EEA population-adjusted mean for vancomycin resistance in *E. faecium* showed a significantly increasing trend over the last four years. The change from the stable situation regarding vancomycin-resistant enterococci may indicate changing epidemiology of vancomycin-resistant *E. faecium* in Europe.

Figure 3.24. ***Enterococcus faecalis*****. Percentage (%) of invasive isolates with high-level resistance to aminoglycosides, by country, EU/EEA countries, 2013**

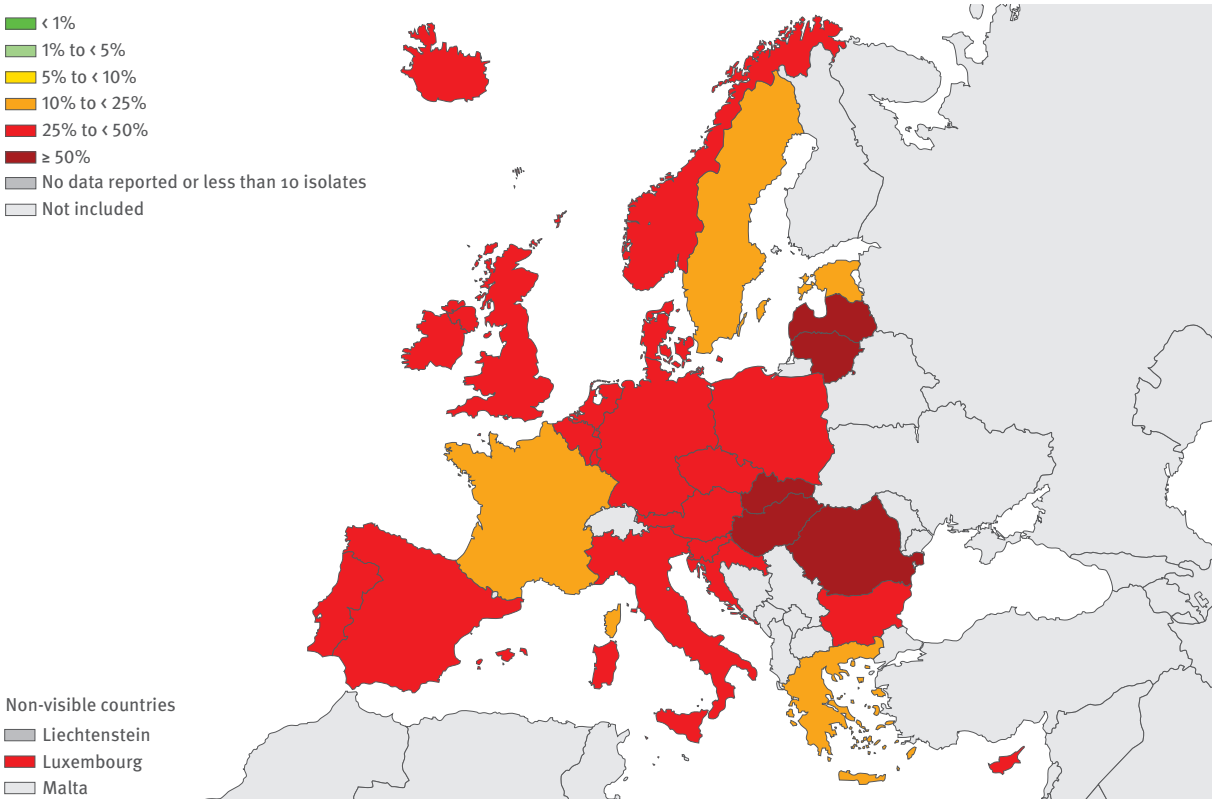


Figure 3.25. ***Enterococcus faecium*****. Percentage (%) of invasive isolates resistant to vancomycin, by country, EU/EEA countries, 2013**

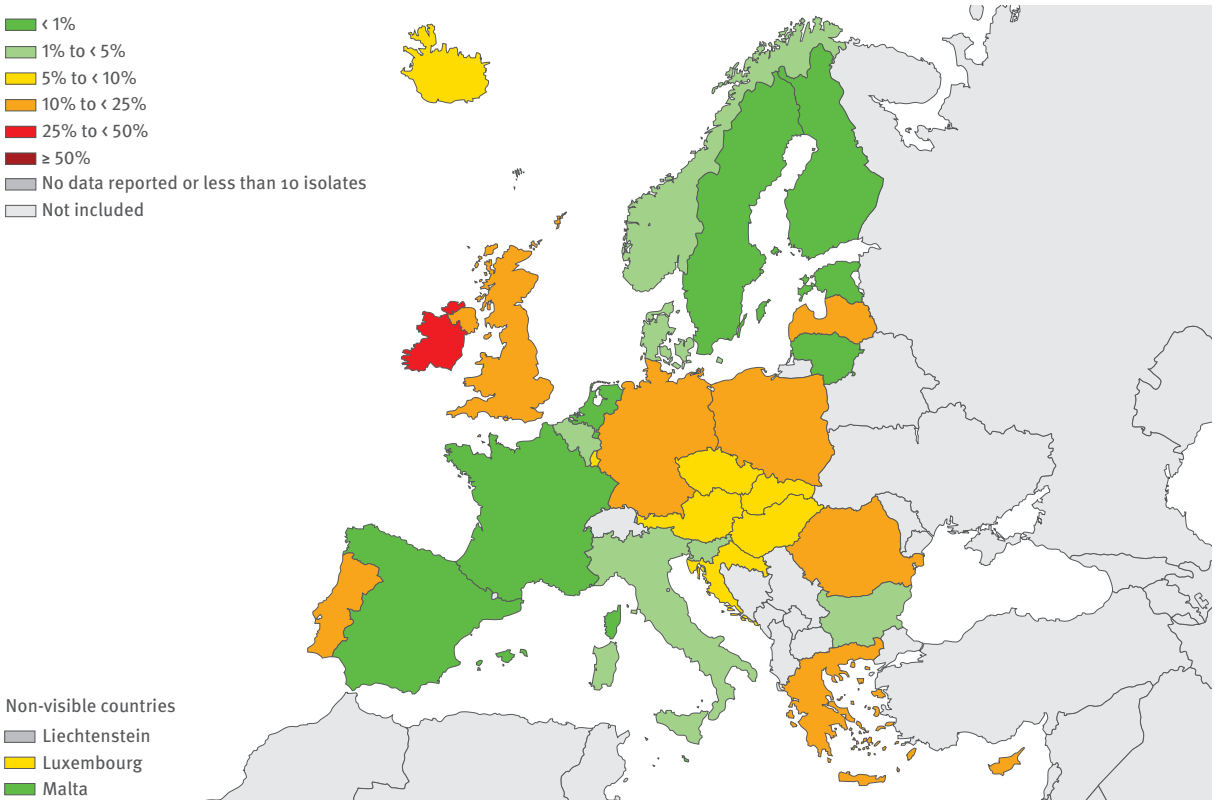


Table 3.32. ***Enterococcus faecalis*. Total number of invasive isolates tested (N) and percentage with high-level resistance to aminoglycosides including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013			Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		Comment**
France	1409	17.7	(16–20)	955	20.0	(18–23)	1528	16.7	(15–19)	1639	14.7	(13–17)		‹
Sweden	533	15.2	(12–19)	890	19.3	(17–22)	792	14.8	(12–17)	605	16.4	(14–20)		
Estonia	22	27.3	(11–50)	6	#	#	19	42.1	(20–67)	10	20.0	(3–56)	N/A	
Greece	620	42.6	(39–47)	653	37.4	(34–41)	667	28.3	(25–32)	548	23.5	(20–27)		‹
Norway	218	33.9	(28–41)	115	21.7	(15–30)	123	30.1	(22–39)	168	26.8	(20–34)		
Cyprus	67	23.9	(14–36)	54	18.5	(9–31)	77	10.4	(5–19)	67	26.9	(17–39)		
Netherlands	298	33.6	(28–39)	363	33.3	(28–38)	287	30.7	(25–36)	279	26.9	(22–32)		
Denmark	44	36.4	(22–52)	45	31.1	(18–47)	112	27.7	(20–37)	48	27.1	(15–42)		
Belgium	187	18.2	(13–24)	335	18.2	(14–23)	395	24.6	(20–9)	398	27.6	(23–32)		›*
Luxembourg	35	45.7	(29–63)	27	44.4	(25–65)	45	22.2	(11–37)	36	27.8	(14–45)		‹*
United Kingdom	61	39.3	(27–53)	75	16.0	(9–26)	135	29.6	(22–38)	136	30.9	(23–39)		
EU/EEA (population-weighted mean)		**33.2**	**(29–37)**		**33.8**	**(30–38)**		**29.4**	**(26–33)**		**30.9**	**(27–35)**		
Austria	312	32.1	(27–38)	327	30.9	(26–36)	425	29.2	(25–34)	503	31.4	(27–36)		
Ireland	268	28.7	(23–35)	244	29.9	(24–36)	279	32.6	(27–38)	277	32.1	(27–38)		
Slovenia	137	43.1	(35–52)	125	36.0	(28–45)	129	34.9	(27–44)	146	32.2	(25–40)		
Iceland	15	13.3	(2–40)	19	0	(0–18)	17	11.8	(1–36)	15	33.3	(12–62)	N/A	
Croatia	123	30.1	(22–39)	139	34.5	(27–43)	152	37.5	(30–46)	167	34.7	(28–42)		
Portugal	379	39.1	(34–44)	403	29.8	(25–35)	347	42.9	(38–48)	545	37.2	(33–41)		
Germany	457	46.8	(42–52)	578	41.0	(37–45)	680	35.6	(32–39)	807	39.3	(36–43)		‹
Czech Republic	571	48.0	(44–52)	556	46.2	(42–50)	581	41.7	(38–46)	603	40.0	(36–44)		‹
Spain	959	40.8	(38–44)	917	39.3	(36–43)	878	38.3	(35–42)	899	42.6	(39–46)		
Poland	158	36.1	(29–44)	190	48.4	(41–56)	122	45.9	(37–55)	184	45.1	(38–53)		
Italy	380	49.7	(44–55)	330	50.0	(44–56)	301	50.8	(45–57)	584	46.2	(42–50)		
Bulgaria	76	40.8	(30–53)	62	30.6	(20–44)	78	38.5	(28–50)	102	47.1	(37–57)		
Hungary	486	51.0	(46–56)	461	48.6	(44–53)	452	56.2	(51–61)	602	51.7	(48–56)		
Lithuania	29	41.4	(24–61)	48	43.8	(29–59)	59	50.8	(37–64)	44	54.5	(39–70)		
Slovakia	–	–	(–)	189	49.7	(42–57)	179	50.3	(43–58)	209	57.4	(50–64)	N/A	
Romania	–	–	(–)	–	–	(–)	51	56.9	(42–71)	80	58.8	(47–70)	N/A	
Latvia	38	47.4	(31–64)	34	26.5	(13–44)	55	29.1	(18–43)	54	61.1	(47–74)		

–: No data

Resistance percentage not calculated as total number of isolates was ‹ 10.

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data which was not observed when only data from laboratories consistently reporting for all four years were included.

Table 3.33. ***Enterococcus faecium.*** **Total number of invasive isolates tested (N) and percentage resistant to vancomycin, including 95 % confidence intervals (95 % CI), EU/EEA countries, 2010–2013**

Country	2010			2011			2012			2013				Trend 2010–2013	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Estonia	23	0	(0–15)	4	#	#	40	0	(0–9)	40	0	(0–9)		N/A	
Lithuania	24	8.3	(1–27)	26	7.7	(1–25)	36	5.6	(1–19)	25	0	(0–14)			
Malta	12	0	(0–26)	14	0	(0–23)	6	#	#	10	0	(0–31)		N/A	
Sweden	293	0	(0–1)	461	0	(0–1)	404	0	(0–1)	575	0	(0–1)			
France	540	1.1	(0–2)	569	1.4	(1–3)	614	0.8	(0–2)	733	0.1	(0–1)			
Finland	239	0	(0–2)	212	0.9	(0–3)	274	0.7	(0–3)	302	0.3	(0–2)			
Netherlands	365	0.5	(0–2)	481	1.0	(0–2)	484	0	(0–1)	439	0.5	(0–2)			
Spain	471	1.5	(1–3)	542	1.5	(1–3)	537	1.5	(1–3)	553	0.9	(0–2)			
Slovenia	59	1.7	(0–9)	83	0	(0–4)	95	0	(0–4)	102	1.0	(0–5)			
Belgium	79	2.5	(0–9)	215	7.0	(4–11)	212	1.4	(0–4)	235	1.7	(0–4)			‹*
Bulgaria	23	0	(0–15)	39	0	(0–9)	42	0	(0–8)	44	2.3	(0–12)			
Norway	135	1.5	(0–5)	165	1.8	(0–5)	168	0.6	(0–3)	211	2.4	(1–5)			
Denmark	501	1.8	(1–3)	615	1.3	(1–3)	593	2.0	(1–4)	644	3.4	(2–5)			›
Italy	412	3.9	(2–6)	236	4.2	(2–8)	435	6.0	(4–9)	565	4.4	(4–9)			
Luxembourg	22	31.8	(14–55)	24	4.2	(0–21)	20	0	(0–17)	19	5.3	(0–26)			
Austria	354	4.0	(2–7)	354	4.5	(3–7)	376	3.2	(2–6)	437	5.9	(4–9)			
Iceland	16	6.3	(0–30)	13	0	(0–25)	12	0	(0–26)	17	5.9	(0–29)			
Croatia	49	10.2	(3–22)	57	1.8	(0–9)	60	0	(0–6)	74	6.8	(2–15)			
Hungary	105	1.9	(0–7)	120	0.8	(0–5)	142	3.5	(1–8)	210	7.1	(4–12)			›
Slovakia	–	–	(–)	103	3.9	(1–10)	82	4.9	(1–12)	132	7.6	(4–13)			
EU/EEA (population-weighted mean)		**5.6**	**(4–9)**		**6.3**	**(4–9)**		**8.1**	**(6–11)**		**8.9**	**(7–12)**			**›**
Czech Republic	188	4.8	(2–9)	211	7.6	(4–12)	262	11.5	(8–16)	268	9.0	(6–13)			
Romania	10	0	(0–31)	12	0	(0–26)	34	2.9	(0–15)	54	11.1	(4–23)			
Latvia	23	13.0	(3–34)	22	9.1	(1–29)	18	5.6	(0–27)	25	12.0	(3–31)			
Poland	102	7.8	(3–15)	202	8.4	(5–13)	157	8.3	(4–14)	173	12.7	(8–19)			
Germany	437	8.5	(6–11)	535	11.4	(9–14)	647	16.2	(13–19)	826	14.5	(12–17)			›
Greece	435	22.5	(19–27)	424	23.1	(19–27)	418	17.2	(14–21)	345	21.2	(17–26)			
Portugal	188	23.4	(18–30)	208	20.2	(15–26)	257	23.3	(18–29)	350	22.0	(18–27)			
Cyprus	23	0	(0–15)	17	0	(0–20)	29	10.3	(2–27)	30	23.3	(10–42)		N/A	
United Kingdom	250	10.4	(7–15)	302	8.9	(6–13)	362	13.3	(10–17)	442	23.3	(19–28)			›
Ireland	382	38.7	(34–44)	347	34.9	(30–40)	386	44.0	(39–49)	398	42.7	(38–48)			

–: No data

Resistance percentage not calculated as total number of isolates was ‹ 10.

N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. Asterisks indicate a significant trend in the overall data which was not observed when only data from laboratories consistently reporting for all four years were included.

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Annex

External quality assessment 2013

Introduction

Since 2000, EARSS/EARS-Net have organised external quality assessment (EQA) of antimicrobial susceptibility testing in collaboration with UK NEQAS (United Kingdom National External Quality Assessment Service). UK NEQAS is based at Public Health England in London, and is a non-profit organisation with more than 40 years of experience in external quality assessment in different countries (www.ukneqasmicro.org.uk).

The purpose of the EARS-Net EQA exercises is:

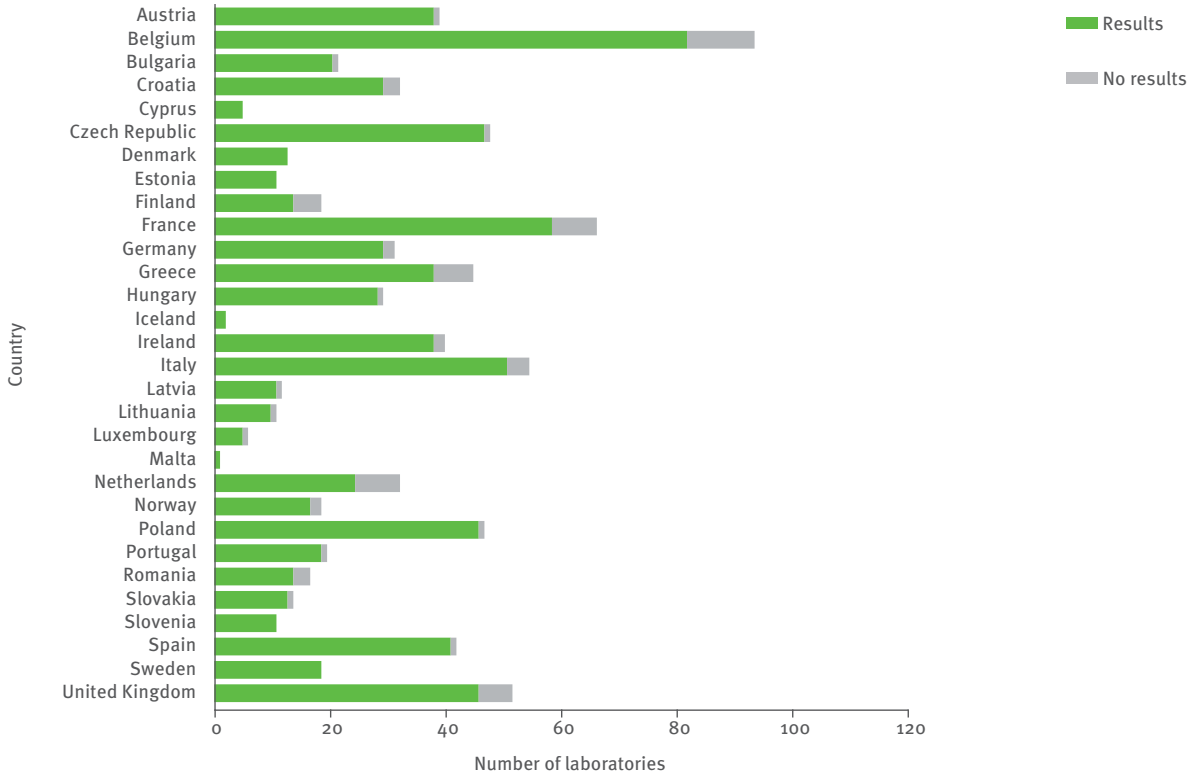
- to assess the ability of participating laboratories to identify antimicrobial resistance of clinical and public health importance;
- to determine the accuracy of susceptibility test results reported by individual laboratories;
- to estimate the overall comparability of routinely collected test results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

The strains used for the 2013 EQA were compatible with species under surveillance at ECDC, namely *Acinetobacter baumannii* complex, *Streptococcus pneumoniae*, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. The strains were characterised and tested in two reference laboratories: Specialist Antimicrobial Chemotherapy Unit, Cardiff (UK) and EUCAST Reference Laboratory, Växjö (Sweden). Both reference laboratories confirmed MICs and interpreted the results according to the most frequently used breakpoint criteria (CLSI and EUCAST), as indicated in the summary for each species outlined in the results section below.

Results

The six strains were distributed to 872 laboratories in 30 countries participating in EARS-Net. Participants were asked to report the identification of each organism and clinical susceptibility characterisation – susceptible, intermediate and resistant (S, I, R) – according to the guideline used. The return rate was comparable to previous years; 797 (92 %) laboratories returned reports. Figure A1 shows the percentage of participating laboratories returning results per country. Participants' results were analysed and considered 'concordant' if the reported categorisation agreed with the interpretation of the reference laboratories (Tables A1–A6).

Figure A1. Number of participating laboratories returning EQA reports 2013, per country



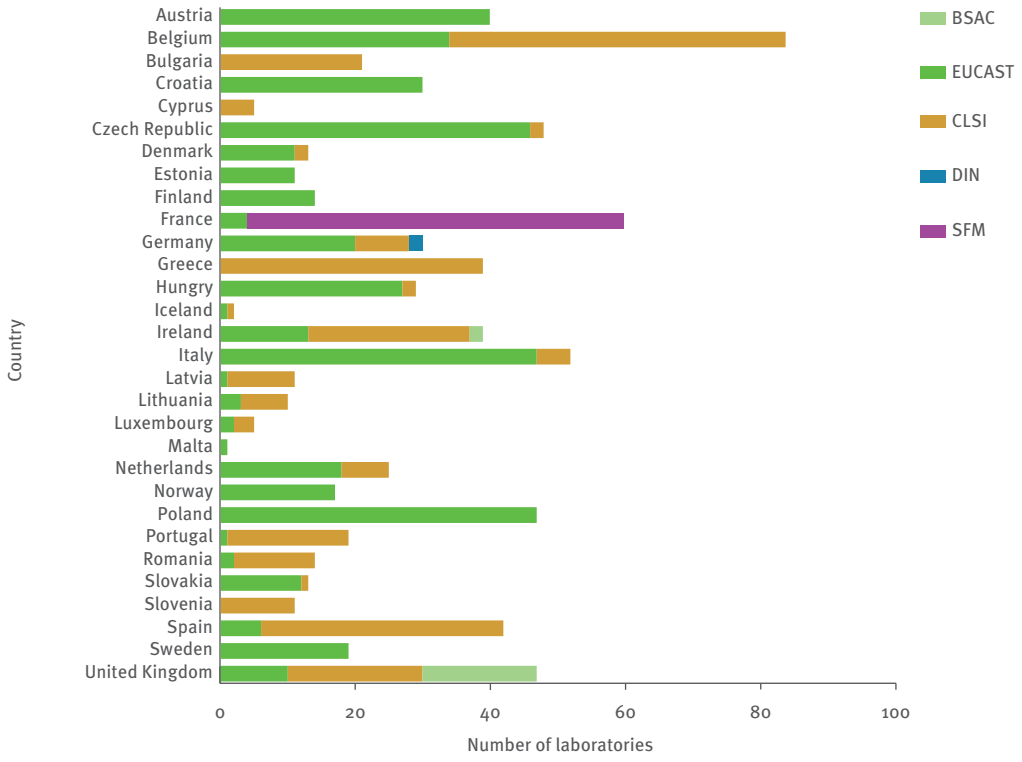
For the determination of AST results, laboratories used automated methods (44 %), disk diffusion tests (34 %), gradient strip MIC (7 %) or a combination of methods (15 %). For species identification, 56 % used automated and 44 % used conventional methods. Increased use of conventional methods was associated with identification of the *S. pneumoniae* strain.

About 36 % of laboratories used CLSI guidelines. This represented a further reduction from 2012 when the proportion was 39 %. EUCAST guidelines were reported by 286 (36 %) laboratories. However, the UK, Sweden, the Netherlands, Germany, France and Norway have been implementing EUCAST breakpoints in their national MIC breakpoint recommendations as harmonised breakpoints have been agreed, and have adjusted the interpretation of their disc diffusion method accordingly. Therefore, a combined total of about 64 % laboratories used EUCAST breakpoints. Figure A2 shows the distribution of the guidelines reported by participating laboratories in each country.

Specimen 1445 *Acinetobacter baumannii* group

This organism was an *Acinetobacter baumannii* susceptible to all reference agents tested. There were no significant problems with susceptibility testing of agents included in reference tests (Table A1).

Figure A2: Guidelines reported to be used by laboratories: number of laboratories per country, 2013



BSAC: British Society for Antimicrobial Chemotherapy; DIN: Deutsche Institut für Normung; EUCAST: European Committee on Antimicrobial Susceptibility Testing; CLSI: Clinical and Laboratory Standards institute; SFM: Societe Francaise de Microbiologie.

Swedish Reference Group for Antimicrobials and Norwegian Working Group on Antimicrobials are listed as EUCAST as they have harmonised guidelines.

Table A1. *Acinetobacter baumannii* group (1445). Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories

Agent	MIC range (mg/L) ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Amikacin	2	2	S	99.4
Ciprofloxacin	0.25	0.5	S	97.7
Colistin	0.25	0.5	S	99.2
Doripenem	–	–	S*	96.9
Gentamicin	0.5	0.5	S	99.3
Imipenem	0.12	0.25	S	100
Meropenem	0.25	0.25	S	98.8
Tobramycin	1	1	S	99.5

* Results based on participant consensus.

Specimen 1446 *Escherichia coli*

This organism was an *Escherichia coli* resistant to ampicillin/amoxicillin. Susceptibility to amoxicillin-clavulanic acid (co-amoxiclav) was borderline susceptible (MIC 8 mg/L) by EUCAST and CLSI breakpoints and 87.4 % of participants reported susceptible. Participants' reports of reduced susceptibility were more common among those using a disc diffusion method, with 7.7 % (21/272) of EUCAST/EUCAST-related guideline users reporting resistant, and 7.0 % (19/272) reporting intermediate even though there is no intermediate category in EUCAST guidelines. With CLSI guideline users, 12.7 % (9/71) using disc diffusion reported resistant and 5.6 % (4/71) reported intermediate. There were no significant problems with any of the other reference agents tested (Table A2).

Specimen 1447 *Klebsiella pneumoniae*

This organism was a *Klebsiella pneumoniae* which produces an OXA-48 carbapenemase. Isolates producing OXA-48 enzymes frequently show borderline resistance to carbapenems, and may appear fully susceptible to cephalosporins. In reference MIC tests this isolate was resistant to ertapenem by both EUCAST and CLSI breakpoints (ertapenem MIC 8–64 mg/L), and intermediate to both imipenem and meropenem by EUCAST breakpoints but resistant to both agents by CLSI breakpoints (imipenem and meropenem MICs both 4 mg/L). Doripenem reference MICs were 1–4 mg/L, which straddles the EUCAST susceptible/intermediate breakpoint and ranges from susceptible to resistant with CLSI breakpoints.

Participants' results were in line with reference results for ertapenem, with 98.6 % reporting the isolate resistant. However, reporting reduced susceptibility to other carbapenems was much less common. For imipenem (629 participants), 29.9 % reported susceptible, 35.0 % intermediate and 35.1 % resistant. For meropenem (734 participants) 34.9 % reported susceptible, 32.8 % intermediate and 32.3 % resistant. For doripenem (133 participants), 21.8 % reported susceptible, 40.6 % intermediate and 37.6 % resistant.

Erroneous reporting as susceptible to imipenem and meropenem with EUCAST and EUCAST-related guidelines was 30.7 % and 35.0 % respectively, compared with 27.9 % and 34.6 % with CLSI guidelines. Reports of susceptible to meropenem were more common among participants using automated methods (38.6 % of 311) than among those using disc diffusion methods (26.8 % of 250). The difference between methods was not so marked for imipenem, with 32.1 % of 221 participants using automated methods and 27.6 % of 217 using disc diffusion methods reporting susceptible.

The borderline susceptibility to particular cephalosporins caused some problems in testing by participants. The isolate was borderline susceptible to ceftazidime in reference MIC tests (MIC 1 mg/L) and 91.2 % participants reported susceptible. However, although the isolate was intermediate in susceptibility to cefotaxime in reference MIC tests (MIC 2 mg/L), most participants (65.4 %) reported susceptible, with 24.8 % reporting intermediate and 9.8 % resistant. With cefotaxime, reports of susceptible were more common among participants using automated methods (53.0 % of 313) than among those using disc diffusion methods (21.0 % of 257) (Table A3).

Identification of the presence of OXA-48-like enzymes by phenotypic methods is problematic. At present there are no available inhibitors for OXA-48 type enzymes. High-level resistance to temocillin (MIC › 32 mg/L) may indicate the presence of OXA-48 or similar carbapenemases, but temocillin is not commonly tested and is not specific for OXA-48-type carbapenemases as other resistance mechanisms might confer temocillin resistance. The presence of OXA-48-like enzymes therefore has to be confirmed with a genotypic method.

Table A2. *Escherichia coli* (1446). Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories

Agent	MIC range (mg/L) ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Amikacin	1	1	S	99.4
Amoxicillin	≥128	≥128	R	97.7
Ampicillin	≥128	≥128	S	98.7
Amoxicillin–clavulanic acid	8(8)**	8(8)**	R	87.4
Cefotaxime	0.015	0.06	S	99.2
Ceftazidime	0.06	0.12	S	99.6
Ceftriaxone	0.06	0.06	S	99.5
Ciprofloxacin	0.015	0.015	S	100
Doripenem	–	–	S*	100
Ertapenem	≤0.004	0.008	S	99.7
Gentamicin	≤0.06	0.5	S	100
Imipenem	0.12	0.12	S	100
Levofloxacin	–	–	S*	100
Meropenem	0.015	0.015	S	100
Ofloxacin	1	1	S	99.6
Piperacillin–tazobactam	–	–	S*	99.6
Tobramycin	1	1	S	99.2
ESBL	–	–	Neg	99.9

* Results based on participant consensus.

** Amoxicillin/clavulanic acid: fixed 2 mg/L (ratio).

Specimen 1448 *Staphylococcus aureus*

This organism was a meticillin-resistant *Staphylococcus aureus*. There were no significant problems with any of the reference agents tested (Table A4).

Specimen 1449 *Streptococcus pneumoniae*

This organism was a multi-resistant *Streptococcus pneumoniae*. The organism showed resistance to all reference agents tested except levofloxacin and moxifloxacin.

For *S. pneumoniae* with no mechanism of resistance to penicillin, MICs are ≤ 0.06 mg/L. For isolates with higher MICs the interpretation of susceptibility to penicillin depends on the site of infection. Patients with pneumonia caused by strains with intermediate susceptibility (MIC 0.12–2 mg/L) are, depending on the dosage, treatable with penicillin, ampicillin or amoxicillin. Hence, such strains may be reported susceptible if from pneumonia. Patients with meningitis caused by strains with penicillin MIC › 0.06 mg/L are unlikely to respond to therapy and such strains should be reported as resistant in this situation. Both EUCAST and CLSI guidelines include options for reporting susceptibility depending on the site of infection. Although EUCAST breakpoints for isolates other than meningitis are S ≤ 0.06 mg/L, R › 2 mg/L, notes indicate that isolates with MICs above 0.06 mg/L are susceptible with the higher doses used to treat pneumonia, the breakpoint depending on the dose. In this distribution we have used the lowest high dose quoted by EUCAST to define breakpoints for pneumonia as S ≤ 0.5 mg/L, R › 2 mg/L. However, the penicillin MIC of 4–8 mg/L for this isolate is resistant by EUCAST breakpoints irrespective of the type of infection, and borderline intermediate/resistant for pneumonia by CLSI breakpoints.

Of 592 participants using the oxacillin screen test for reduced susceptibility to penicillin, 99.2 % correctly reported resistant. For penicillin without a designated site of infection neither EUCAST nor CLSI provide breakpoints, but 741 participants reported susceptibility,

Table A3. *Klebsiella pneumoniae* (1447). Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories

Agent	MIC range (mg/L) ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Amikacin	0.5	2	S	100
Amoxicillin	≥128	≥128	R	100
Ampicillin	≥128(≥128)	≥128(≥128)	R	99.7
Amoxicillin–clavulanic acid	≥128**	≥128**	R	99.3
Cefotaxime	2	2	I	24.8
Ceftazidime	1	1	S	91.2
Ceftriaxone	1	1	S	86.5
Ciprofloxacin	0.03	0.03	S	99.2
Doripenem	–	–	S/I / S/R	N/A
Ertapenem	8	64	R	98.6
Gentamicin	0.25	0.5	S	99.9
Imipenem	4	4	I/R	35.0
Levofloxacin	–	–	S*	98.8
Meropenem	4	4	I/R	32.8
Ofloxacin	≥128	≥128	S	97.9
Piperacillin-tazobactam	–	–	R*	99.0
Tobramycin	0.25	0.25	S	98.9
ESBL	–	–	Neg	91.8

* Results based on participant consensus.
** Amoxicillin/clavulanic acid: fixed 2 mg/L (ratio).
N/A = not assigned.

Table A4. *Staphylococcus aureus* (1448). Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories

Agent	MIC range (mg/L) ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Cefoxitin	≥128	≥128	R	99.7
Ciprofloxacin	≥128	≥128	R	99.4
Clindamycin	≥128	≥128	R	99.6
Erythromycin	≥128	≥128	R	99.9
Fusidic acid	0.12	0.25	S	98.9
Gentamicin	0.25	0.5	S	99.6
Oxacillin	≥128	≥128	R	99.8
Penicillin	≥128	≥128	R	100
Rifampicin	≤0.004	0.008	S	97.4
Teicoplanin	0.5	1	S	99.7
Tetracycline	0.25	0.5	S	99.0
Vancomycin	0.5	1	S	99.6

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

presumably using breakpoints for infections other than meningitis, and 1.5% reported susceptible, 8.2% intermediate and 90.3% resistant. For pneumonia, 5% of participants using EUCAST or EUCAST-related guidelines reported penicillin susceptible, 7.4% intermediate and 78.6% resistant. CLSI breakpoints for pneumonia isolates are higher than EUCAST breakpoints and reporting as susceptible or intermediate was more common among participants using CLSI breakpoints; 9.5% reporting susceptible, 20.3% intermediate and 70.2% resistant. Participants' results were in line with reference results for penicillin susceptibility in meningitis, with 99.5% reporting the isolate resistant.

In reference MIC tests this isolate was resistant to cefotaxime and ceftriaxone by both EUCAST and CLSI breakpoints (cefotaxime MIC 8–16 mg/L, ceftriaxone MIC 8 mg/L). Most (98.0%) participants reported cefotaxime-resistant for meningitis, and 94.9% reported resistant for pneumonia, with 2.6% (16/604) and 2.5% (15/604) reporting susceptible and intermediate respectively. With ceftriaxone, 92.0% reported resistant for meningitis, with 1.4% (7/490) reporting susceptible and 6.6% (32/490) reporting intermediate, whereas for pneumonia 83.8% reported resistant, 3.3% (16/487) susceptible and 12.9% (63/487) intermediate.

There were no significant problems with any of the other reference agents tested (Table A5).

Specimen 1450 *Pseudomonas aeruginosa*

This organism was a *Pseudomonas aeruginosa* with carbapenem resistance typical of isolates with upregulated efflux and OprD porin loss. In addition, the organism produced a VEB ESBL. The organism was resistant to all reference agents tested except polymyxins and piperacillin–tazobactam. The piperacillin–tazobactam MIC (16 mg/L) is borderline susceptible and this was reflected in variable reporting among participants, with 63.4% reporting susceptible, 7.7% intermediate and 28.9% resistant. Reports of reduced susceptibility to piperacillin–tazobactam were more common among participants using an automated method with 57.2% reporting susceptible, 9.9% intermediate and 32.9% resistant compared to a disc susceptibility method, where 76.7% reported susceptible, 5.5% intermediate and 17.8% resistant. There were no significant problems with any of the other reference agents tested (Table A6).

Conclusions

Overall, the performance of the participating laboratories was very good and consistent with that seen in previous EQAs. Limitations associated with the design of the EQA panels are largely attributable to the restricted number of isolates distributed in the EARS-Net EQA. It is difficult to cover the full range of strains representative of the epidemiologically important AMR types currently circulating in Europe and, equally, to re-circulate isolates that participants previously found challenging in order to monitor improvements in resistance detection.

EQA is a valuable tool in the quality assurance of antimicrobial susceptibility testing and indicates the validity of comparing collated data between laboratories in resistance surveillance studies.

ECDC would like to thank UK NEQAS, the reference laboratories, the members of the EARS-Net Coordination Group and the country EQA coordinators for their efforts and contribution to the success of this EQA. Special thanks go to the all involved staff at the participating laboratories for providing timely and high quality responses to the assessment.

Table A5. *Streptococcus pneumoniae* (1449). Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories

Agent	MIC range (mg/L) ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Cefotaxime:				
meningitis	8	16	R	98.0
pneumonia				94.9
Ceftriaxone:				
meningitis	8	8	R	92.0
pneumonia				83.8
Clindamycin	>256	>256	R/–	99.7
Erythromycin	≥128	≥128	R	100
Levofloxacin	1	1	S	98.7
Moxifloxacin	0.06	0.12	S	99.4
Norfloxacin	Screen test	S/–	97.8	
Oxacillin	Screen test	R	99.2	
Penicillin:			–	
meningitis	4	8	R/R	99.5
pneumonia			R/I	81.7

Table A6. ***Pseudomonas aeruginosa*** **(1450). Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories and the overall concordance of the participating laboratories**

Agent	MIC range (mg/L) ref. lab.		Intended interpretation	
	from	to	EUCAST/CLSI	Overall concordance (%)
Amikacin	64	≥128	R	99.7
Cefipime	–	–	R*	99.8
Ceftazidime	≥128	≥128	R	99.9
Ciprofloxacin	32	32	R	99.7
Doripenem	–	–	R*	92.9
Gentamicin	≥128	≥128	R	99.9
Imipenem	16	16	R	98.7
Levofloxacin	–	–	R*	99.8
Meropenem	16	32	R	96.7
Piperacillin-tazobactam	16	16	S	63.4
Tobramycin	≥128	≥128	R	100

* Results based on participant consensus, as no reference laboratory results available for these organism/antibiotic combinations.

Country summary sheets

Explanation to the country summary sheets

General information on EARS-Net participating laboratories and hospitals

Table 1 gives the number of laboratories and isolates reported by year and by pathogen under EARSS/EARS-Net surveillance for the period 2003–2013. The total number of laboratories participating in EARS-Net could in some countries be higher than the number presented in Table 1, as only laboratories reporting at least one isolate during each specific year are included.

Antibiotic resistance 2003–2013

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/EARS-Net 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 percentage of resistance within the different groups, for the period 2012–2013.

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*;

3GCRKP = 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 3GCRKP at hospital level

Figures 1, 2, 3 and 4 show the local variation in the percentage of PNSP by laboratory and of MRSA, FREC and 3GCRKP by hospital. These figures are based on data from 2012 and 2013, 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 on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	39	438	40	1982	40	3174	40	894	40	799	40	544
2012	38	356	40	2173	40	3766	39	1049	40	859	39	596
2013	37	438	38	2543	38	4390	38	1113	38	947	38	618

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Note: National data analysis allows for a more accurate validation. Due to differences in the validation algorithms used by EARS-Net and Austria, there are small discrepancies in the data presented by EARS-Net.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	1	1	<1	<1	2	<1	3	2	2	1	<1
Penicillin RI	9	5	5	5	5	5	5	4	3	5	2
Macrolides RI	13	13	15	13	13	12	14	11	12	18	10
Staphylococcus aureus											
Oxacillin/meticillin R	15	14	14	9	11	8	6	7	7	8	9
Escherichia coli											
Aminopenicilins R	41	46	49	53	53	50	49	51	50	51	51
Aminoglycosides R	5	6	6	8	8	7	6	6	7	6	7
Fluoroquinolones R	14	17	19	22	26	23	20	21	22	21	22
Third-generation cephalosporins R	2	3	4	7	9	7	8	7	9	9	10
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	1	<1	1	2	2	2	1	2	<1	<1	1
HL gentamicin R	33	23	29	29	30	21	31	32	31	29	31
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	85	85	85	89	82	91	88	92	91	91	92
HL gentamicin R	22	22	30	21	28	19	31	42	49	38	45
Vancomycin R	<1	<1	1	<1	2	2	4	4	5	3	6
Klebsiella pneumoniae											
Aminoglycosides R	–	–	3	5	5	6	4	6	7	5	5
Fluoroquinolones R	–	–	11	8	13	12	8	18	17	15	16
Third-generation cephalosporins R	–	–	6	6	8	8	8	13	13	12	11
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	1
Pseudomonas aeruginosa											
Piperacillin R	–	–	13	8	6	8	6	9	14	18	13
Ceftazidime R	–	–	7	9	5	6	6	8	11	14	10
Carbapenems R	–	–	10	15	12	11	9	14	14	15	12
Aminoglycosides R	–	–	6	10	8	8	8	11	13	11	7
Fluoroquinolones R	–	–	14	15	15	12	13	16	19	14	15

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	97	3	100	8	100	21	100	0	100	5	100	11	100	13
CSF	3	5	–	–	<1	11	–	–	–	–	0	0	<1	20
Sex														
Male	54	3	59	9	42	26	65	0	56	5	56	12	62	14
Female	46	4	41	8	57	18	34	1	43	4	43	11	38	12
Unknown	0	0	1	10	1	20	1	0	1	17	1	15	1	17
Age (years)														
0 to 4 years	3	4	2	6	1	5	2	0	1	0	1	12	1	7
5 to 19 years	3	5	1	3	<1	7	0	0	<1	33	<1	33	1	11
20 to 64 years	34	3	32	7	25	21	27	0	33	6	31	13	32	20
65 years or older	60	4	65	9	73	22	71	0	66	4	68	10	66	11
Hospital department														
ICU	18	2	9	10	7	24	15	0	25	6	12	16	14	20
Internal med.	55	4	54	8	59	20	45	0	40	3	48	10	45	12
Surgery	1	0	8	12	7	20	9	2	12	1	10	8	10	16
Other	22	4	24	8	24	24	27	0	20	9	26	13	26	13
Unknown	4	0	4	7	4	21	4	0	2	0	4	9	5	8

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Austria

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

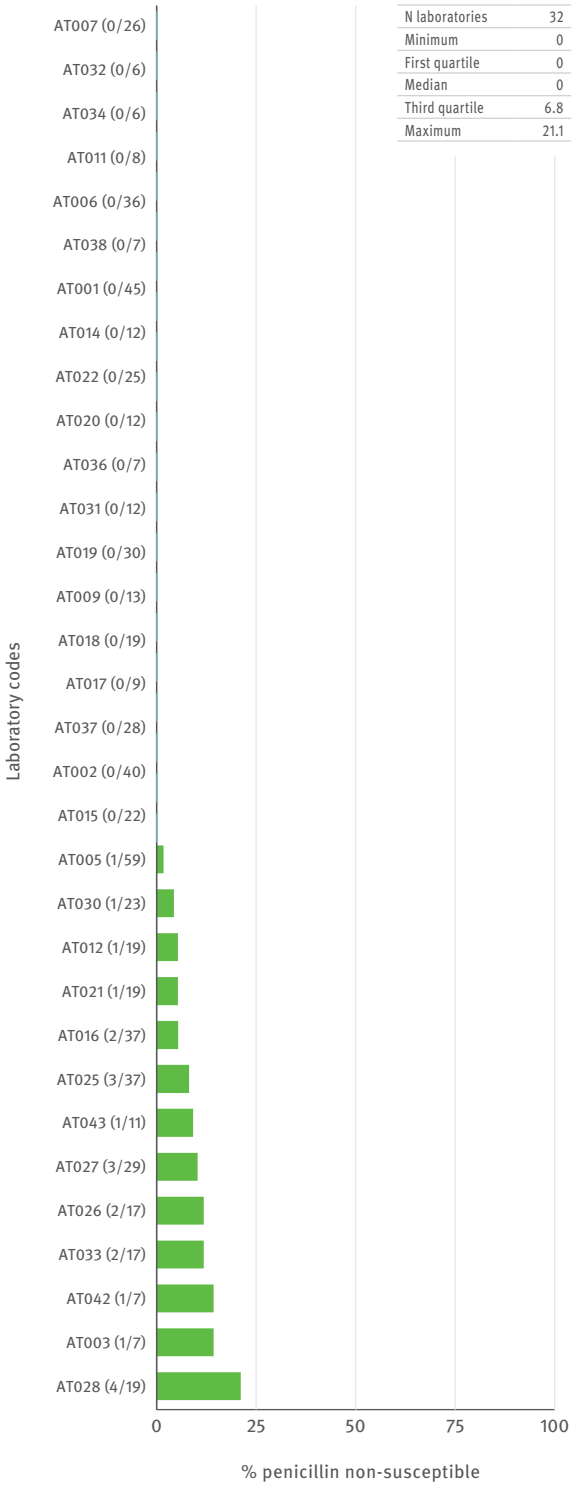


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

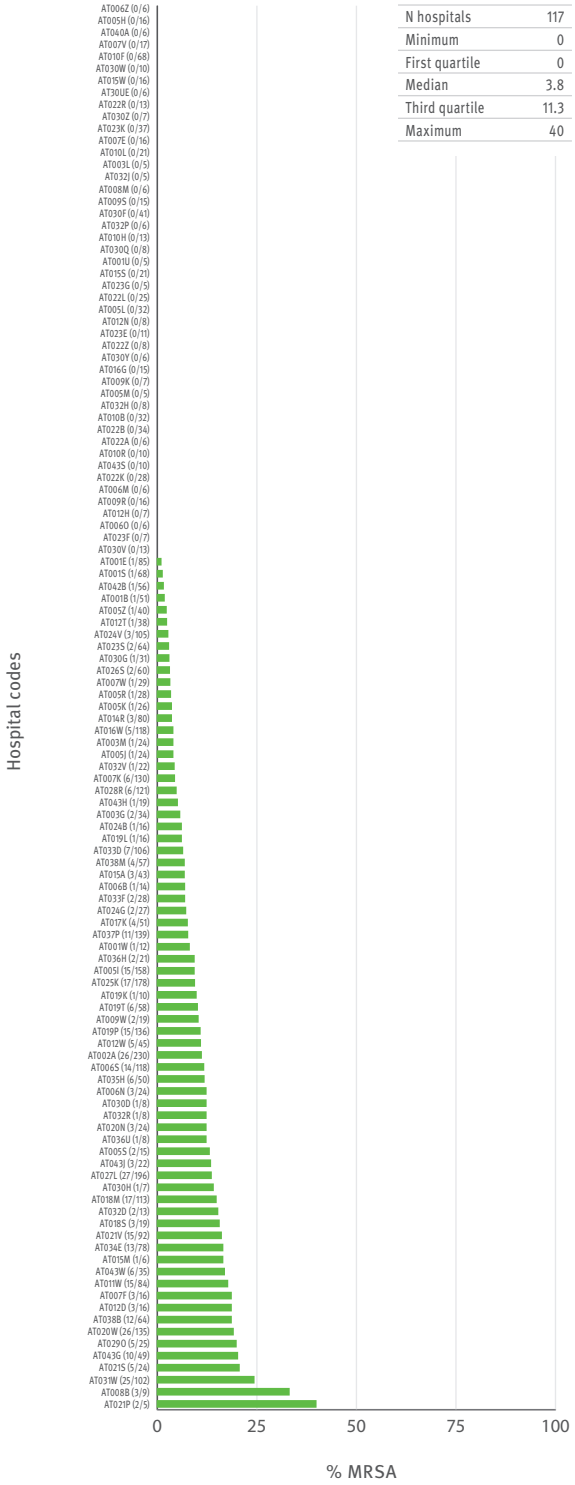


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

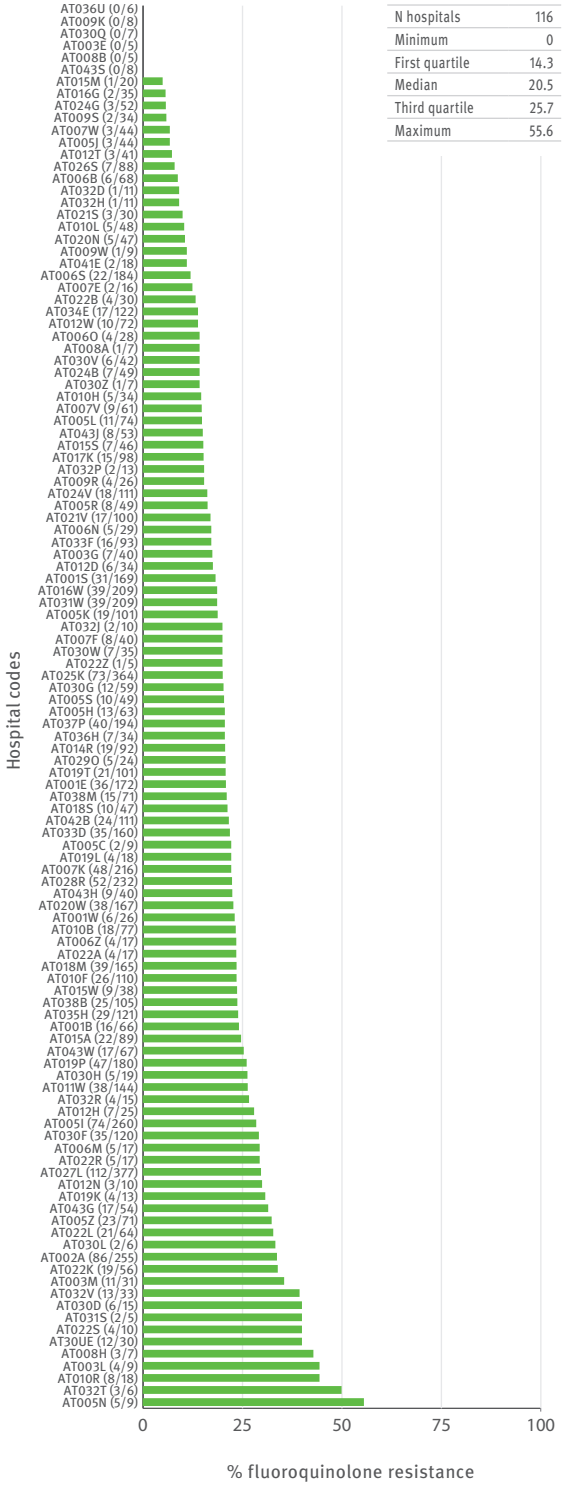
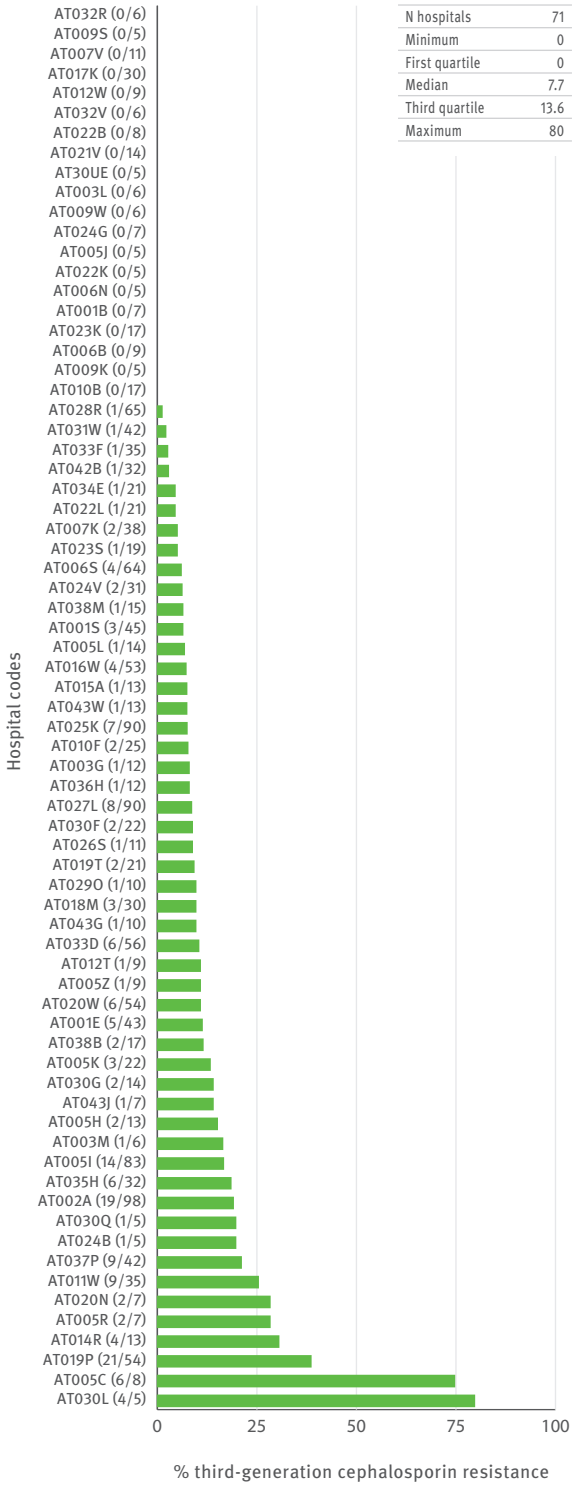


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Belgium

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	91	1829	50	1771	43	4039	46	754	44	676	43	460
2012	96	1739	44	1569	41	4137	41	742	41	549	40	392
2013	93	1612	41	1683	41	4408	39	922	41	639	40	518

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	<1	<1	3	4	3	<1	<1	<1	<1	<1	<1
Penicillin RI	12	9	12	10	9	8	<1	<1	<1	2	2
Macrolides RI	34	33	31	31	25	24	23	25	26	25	23
Staphylococcus aureus											
Oxacillin/meticillin R	30	33	31	22	23	21	21	21	17	17	17
Escherichia coli											
Aminopenicilins R	50	50	53	54	57	55	56	57	59	56	57
Aminoglycosides R	5	5	4	6	5	4	7	6	9	6	6
Fluoroquinolones R	12	15	17	19	19	17	20	22	22	22	23
Third-generation cephalosporins R	3	3	4	3	4	4	6	5	6	7	8
Carbapenems R	–	–	–	–	–	–	–	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	1	2	<1	<1	<1	3	1	2	2	2	3
HL gentamicin R	17	22	26	30	26	30	23	18	18	25	28
Vancomycin R	1	<1	<1	<1	1	<1	1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	78	63	61	67	68	76	90	89	83	78	74
HL gentamicin R	<1	11	22	19	23	17	32	30	33	39	29
Vancomycin R	<1	5	14	4	<1	5	4	3	7	1	2
Klebsiella pneumoniae											
Aminoglycosides R	–	–	–	–	–	–	10	2	8	11	10
Fluoroquinolones R	–	–	–	–	–	–	13	13	15	17	22
Third-generation cephalosporins R	–	–	–	–	–	–	15	13	14	16	15
Carbapenems R	–	–	–	–	–	–	1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	–	–	–	–	7	12	15	10	13
Ceftazidime R	–	–	–	–	–	–	6	7	9	8	9
Carbapenems R	–	–	–	–	–	–	9	5	11	10	11
Aminoglycosides R	–	–	–	–	–	–	10	11	13	12	13
Fluoroquinolones R	–	–	–	–	–	–	16	12	21	18	17

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	97	1	100	17	100	23	100	0	100	2	99	16	99	11
CSF	3	13	–	–	<0	29	–	–	–	–	1	29	1	0
Gender														
Male	54	2	61	17	47	26	65	0	62	1	58	18	64	11
Female	46	1	39	17	53	19	35	0	38	2	42	13	36	9
Unknown	1	0	–	–	–	–	–	–	–	–	–	–	–	–
Age (years)														
0–4	12	2	5	5	3	6	4	0	2	9	2	15	1	8
5–19	5	1	2	9	1	9	1	0	0	0	1	13	1	9
20–64	38	2	33	13	27	19	26	0	32	0	28	15	29	14
65 and over	46	2	60	20	70	25	69	0	65	2	69	16	69	9
Hospital department														
Unknown	100	2	100	17	100	23	100	0	100	2	100	16	100	10

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Belgium

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

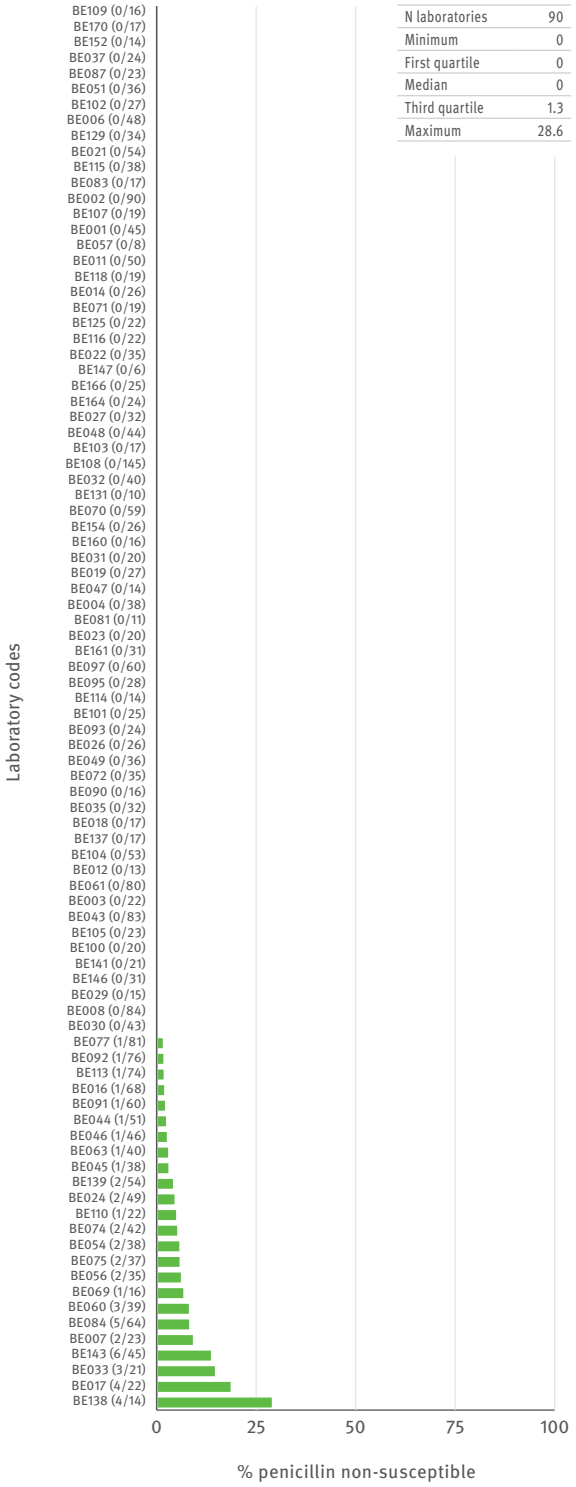


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

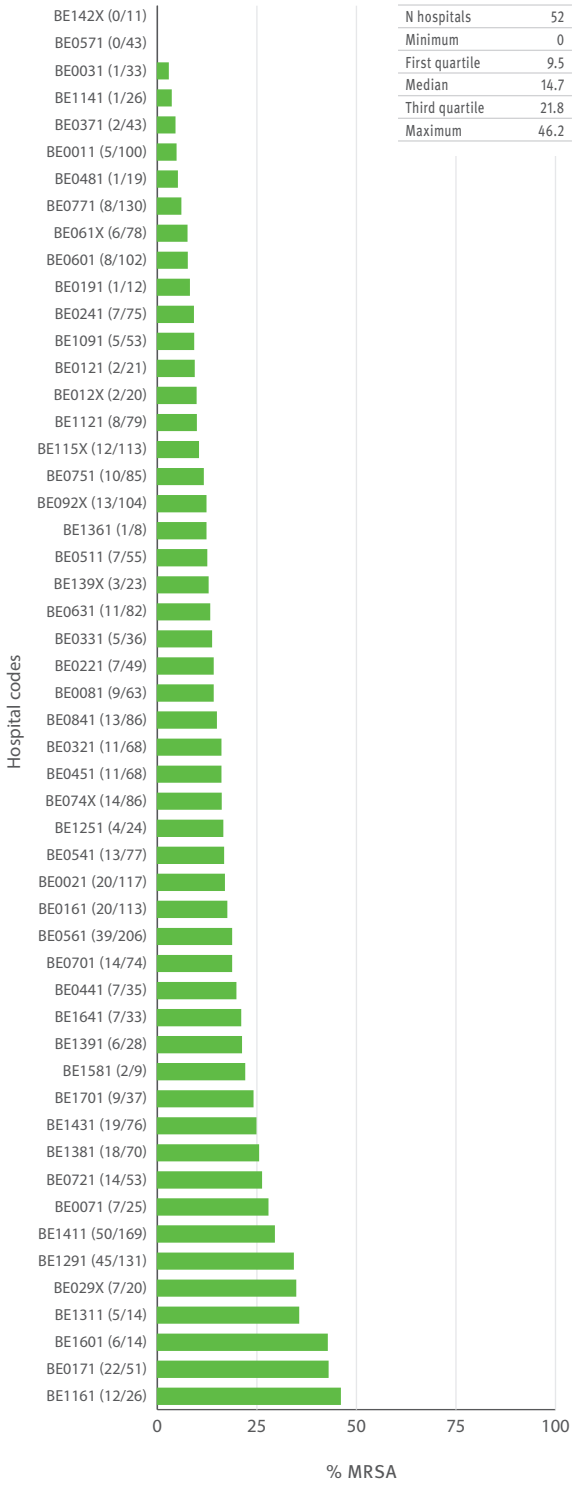


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

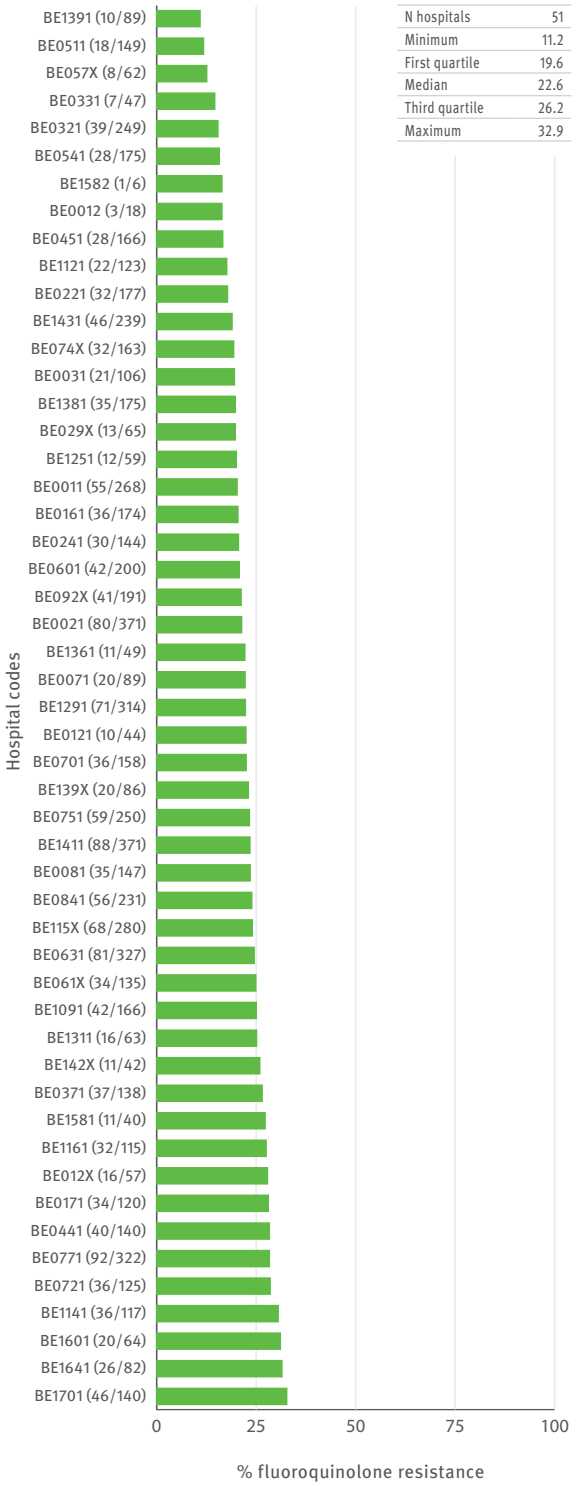
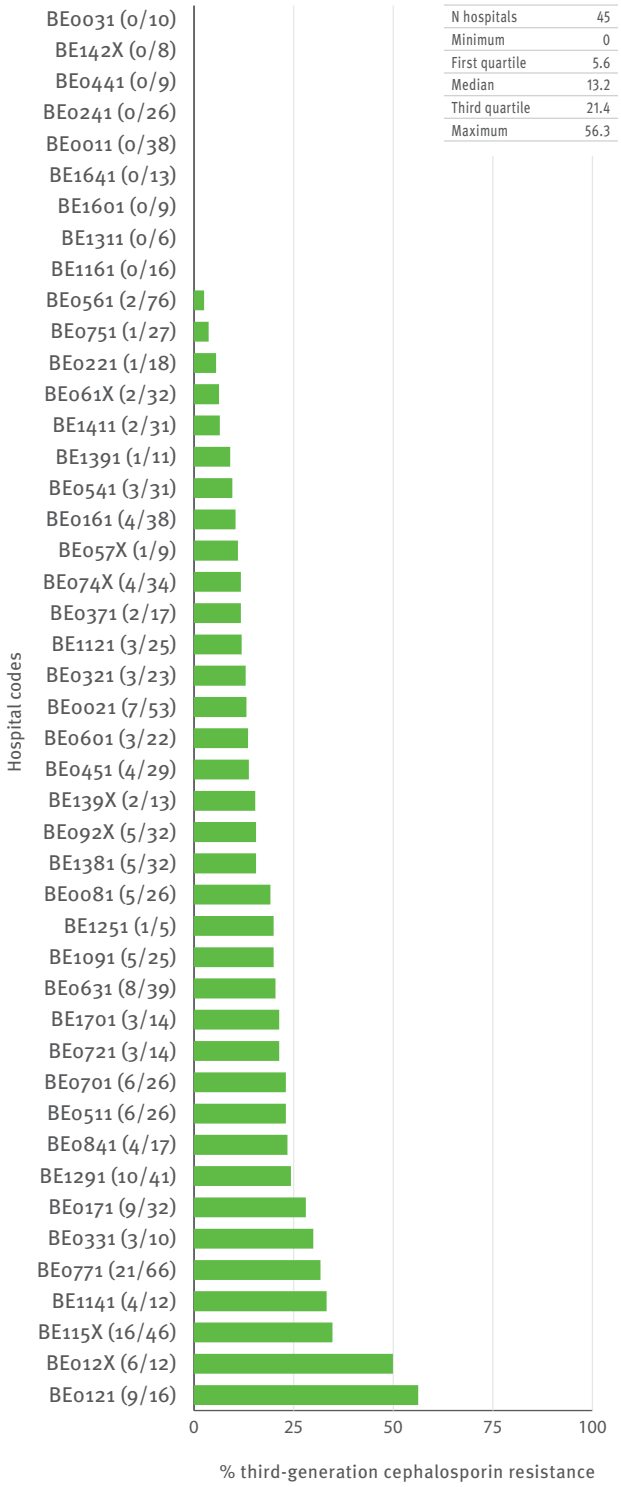


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Bulgaria

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	16	33	19	214	19	179	16	117	15	121	12	48
2012	12	21	19	227	19	223	20	129	14	127	11	52
2013	14	29	20	214	17	187	19	154	17	138	13	60

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	9	22	30	7	9	21	22	18	21	29	21
Penicillin RI	14	22	33	7	16	21	37	18	21	29	21
Macrolides RI	11	17	8	15	17	4	27	25	13	20	19
Staphylococcus aureus											
Oxacillin/meticillin R	31	23	29	28	13	25	16	19	22	20	19
Escherichia coli											
Aminopenicilins R	54	64	69	64	70	65	66	72	61	71	74
Aminoglycosides R	22	20	24	28	20	31	18	16	17	26	32
Fluoroquinolones R	19	24	29	26	35	32	28	33	30	34	37
Third-generation cephalosporins R	18	22	28	29	23	29	19	25	23	38	40
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	3	3
Enterococcus faecalis											
Aminopenicilins RI	7	15	8	31	13	8	16	5	6	12	2
HL gentamicin R	36	33	24	53	29	44	36	41	31	38	47
Vancomycin R	<1	2	<1	2	<1	<1	<1	<1	<1	<1	3
Enterococcus faecium											
Aminopenicilins RI	60	59	96	97	100	93	96	100	84	95	88
HL gentamicin R	60	62	56	79	75	84	65	71	79	71	77
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2
Klebsiella pneumoniae											
Aminoglycosides R	–	–	53	60	59	59	65	69	72	54	57
Fluoroquinolones R	–	–	26	24	41	52	48	52	51	47	46
Third-generation cephalosporins R	–	–	50	60	55	73	69	76	81	75	70
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	2	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	50	33	14	48	33	15	23	26	14
Ceftazidime R	–	–	45	13	21	55	23	19	31	35	13
Carbapenems R	–	–	38	14	7	17	24	31	29	31	14
Aminoglycosides R	–	–	53	42	29	48	31	21	38	33	20
Fluoroquinolones R	–	–	47	17	14	36	33	21	30	33	18

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	78	29	100	20	99	36	100	2	100	1	100	72	95	23
CSF	22	9	–	–	1	33	–	–	–	–	–	–	5	0
Gender														
Male	43	29	58	22	56	40	63	1	73	2	66	73	55	33
Female	57	21	41	16	44	30	37	3	27	0	34	70	45	8
Unknown	–	–	0	0	–	–	–	–	–	–	–	–	–	–
Age (years)														
0–4	8	50	2	80	4	18	3	0	6	0	8	86	7	0
5–19	6	0	4	47	1	33	2	0	1	0	3	63	3	0
20–64	49	25	52	20	40	32	41	1	45	3	35	68	36	33
65 and over	29	21	34	13	43	39	46	0	41	0	31	73	45	18
Unknown	8	25	7	15	12	41	8	13	7	0	23	73	8	22
Hospital department														
ICU	18	22	19	41	17	55	24	0	34	3	22	77	34	38
Internal med.	37	22	29	5	38	30	36	3	26	0	20	54	20	14
Surgery	2	0	13	28	13	33	9	0	16	0	18	68	15	18
Other	43	29	39	17	30	34	31	2	23	0	40	80	31	12
Unknown	–	–	–	–	1	0	–	–	1	0	1	50	–	–

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Bulgaria

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

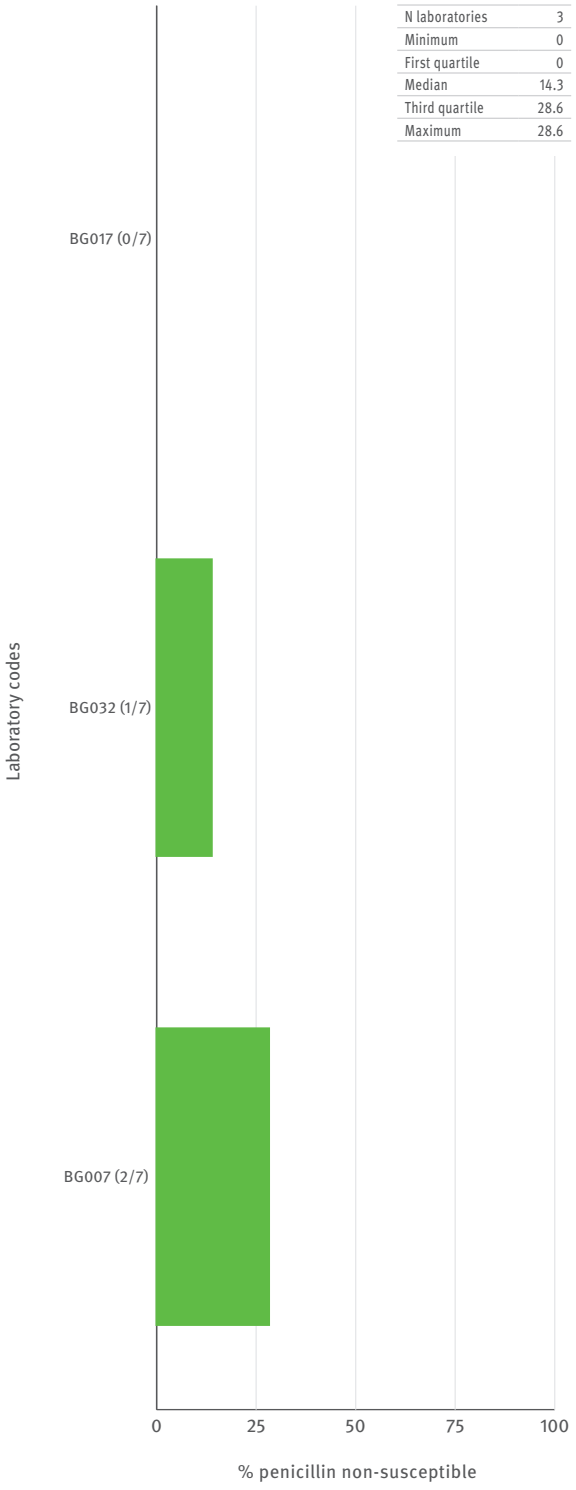


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

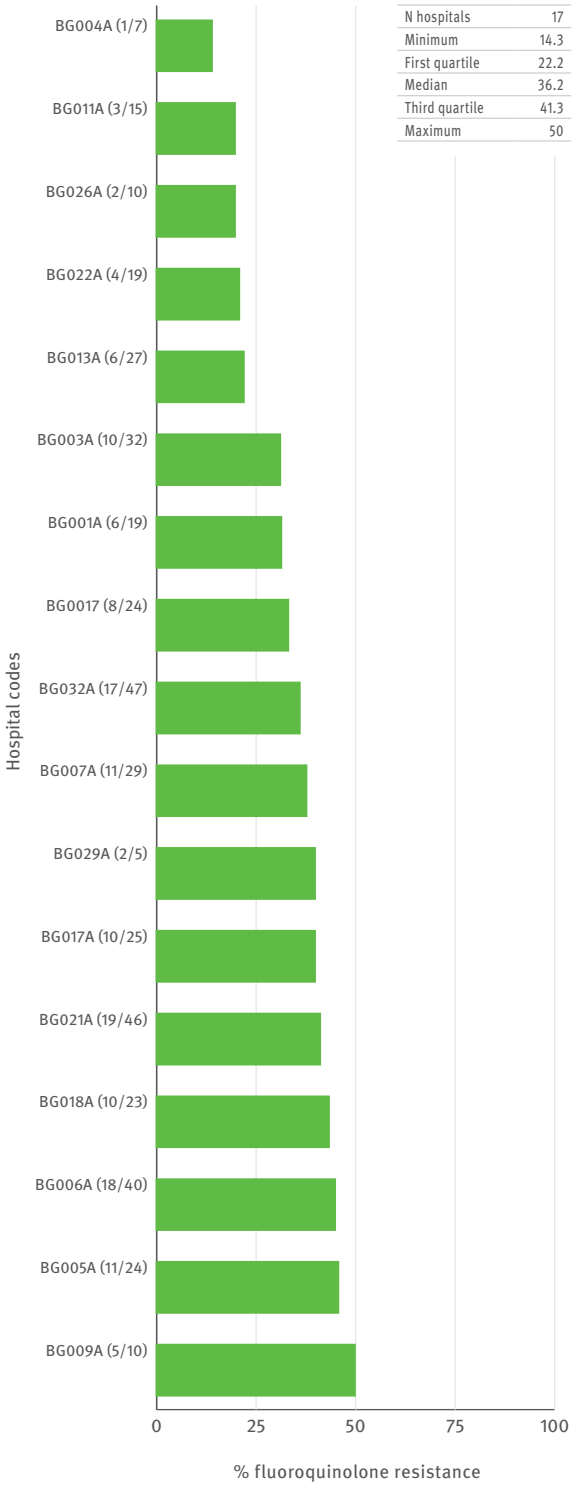
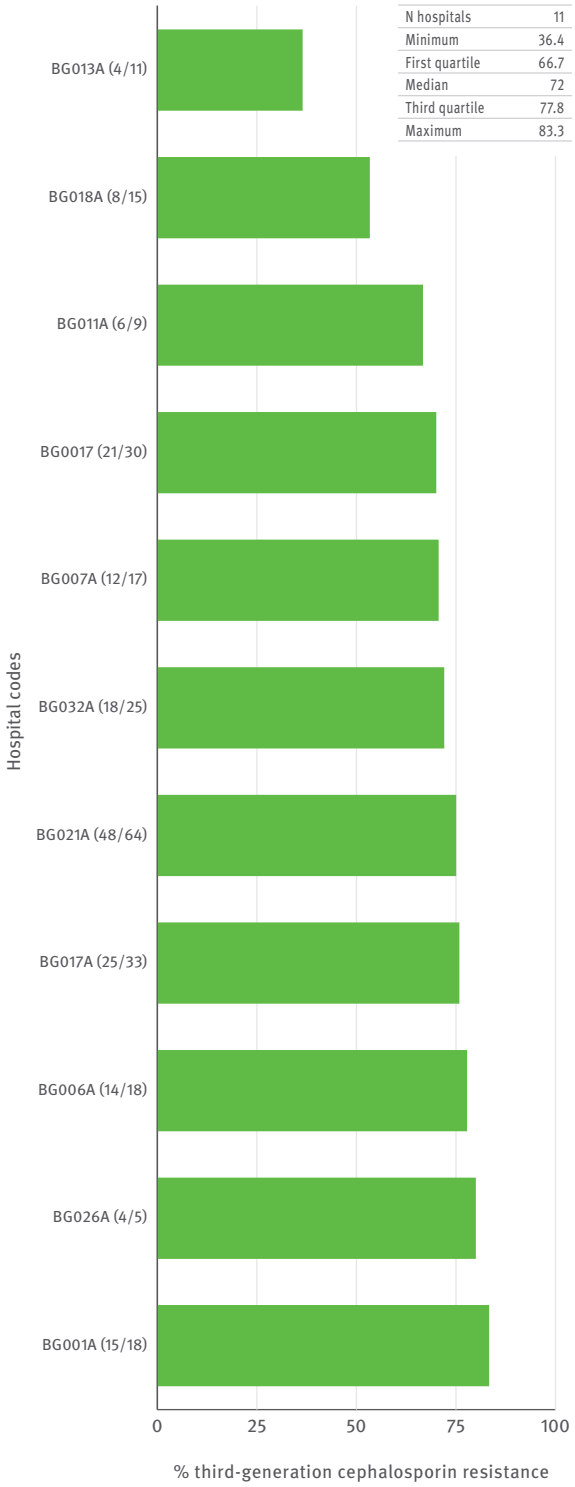


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Croatia

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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	–	–	–	–	–	–	–	–	–	–	–	–
2004	–	–	–	–	–	–	–	–	–	–	–	–
2005	–	–	–	–	–	–	–	–	–	–	–	–
2006	–	–	–	–	–	–	–	–	–	–	–	–
2007	–	–	–	–	–	–	–	–	–	–	–	–
2008	–	–	–	–	–	–	–	–	–	–	–	–
2009	–	–	–	–	–	–	–	–	–	–	–	–
2010	11	103	15	359	16	883	12	174	16	281	15	210
2011	16	125	13	417	15	986	14	226	13	300	14	227
2012	11	97	16	404	16	907	15	216	14	332	14	197
2013	16	118	19	520	18	1040	17	248	18	376	18	246

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	–	–	–	–	–	–	–	23	<1	1	3
Penicillin RI	–	–	–	–	–	–	–	23	18	23	25
Macrolides RI	–	–	–	–	–	–	–	29	24	10	33
Staphylococcus aureus											
Oxacillin/meticillin R	–	–	–	–	–	–	–	26	28	21	24
Escherichia coli											
Aminopenicilins R	–	–	–	–	–	–	–	53	55	51	54
Aminoglycosides R	–	–	–	–	–	–	–	7	8	7	8
Fluoroquinolones R	–	–	–	–	–	–	–	17	20	17	20
Third-generation cephalosporins R	–	–	–	–	–	–	–	9	10	8	9
Carbapenems R	–	–	–	–	–	–	–	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	–	–	–	–	–	–	–	5	1	5	10
HL gentamicin R	–	–	–	–	–	–	–	30	35	38	35
Vancomycin R	–	–	–	–	–	–	–	<1	1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	–	–	–	–	–	–	–	82	98	98	89
HL gentamicin R	–	–	–	–	–	–	–	60	63	60	56
Vancomycin R	–	–	–	–	–	–	–	10	2	<1	7
Klebsiella pneumoniae											
Aminoglycosides R	–	–	–	–	–	–	–	49	44	46	51
Fluoroquinolones R	–	–	–	–	–	–	–	47	42	43	43
Third-generation cephalosporins R	–	–	–	–	–	–	–	56	48	52	50
Carbapenems R	–	–	–	–	–	–	–	2	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	–	–	–	–	–	16	23	22	24
Ceftazidime R	–	–	–	–	–	–	–	11	18	12	19
Carbapenems R	–	–	–	–	–	–	–	29	30	26	25
Aminoglycosides R	–	–	–	–	–	–	–	26	35	25	24
Fluoroquinolones R	–	–	–	–	–	–	–	26	35	24	22

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	91	23	100	23	100	19	100	1	100	4	99	51	98	25
CSF	9	37	–	–	0	0	–	–	–	–	1	100	2	75
Gender														
Male	48	21	61	23	39	23	62	0	64	3	54	55	59	28
Female	50	27	35	23	57	15	33	1	33	5	42	45	35	20
Unknown	2	25	4	24	4	27	5	0	3	0	4	57	6	35
Age (years)														
0–4	30	27	3	4	3	8	9	0	4	0	11	69	3	29
5–19	6	23	3	14	1	6	2	0	–	–	1	67	3	43
20–64	36	18	35	19	33	19	35	2	40	6	38	54	35	36
65 and over	29	30	58	26	62	19	53	0	54	3	49	45	58	19
Unknown	–	–	1	20	1	18	1	0	2	0	1	50	0	0
Hospital department														
ICU	9	37	8	51	3	24	12	0	13	0	12	67	18	41
Internal med.	19	15	43	19	39	19	30	0	38	6	32	39	31	12
Surgery	1	100	7	49	8	32	15	2	11	0	13	71	14	25
Other	65	23	29	13	44	15	32	0	31	5	34	44	24	27
Unknown	6	38	13	26	7	23	10	3	7	0	9	69	13	36

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Croatia

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

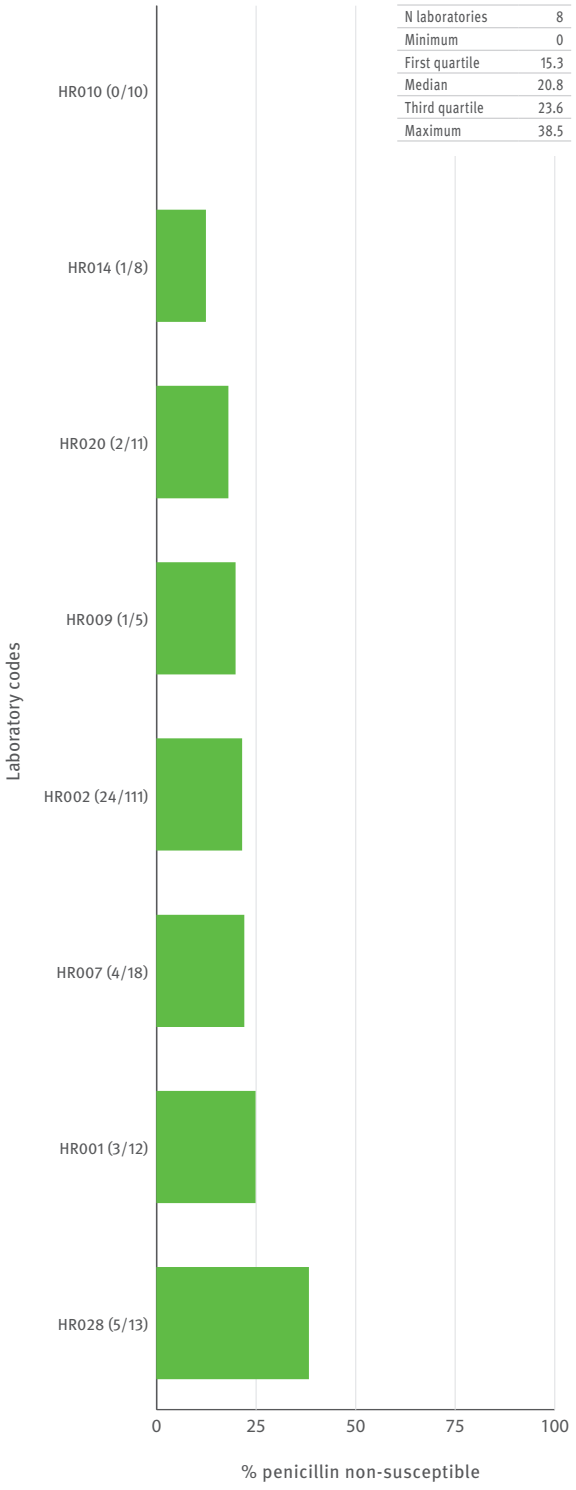


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

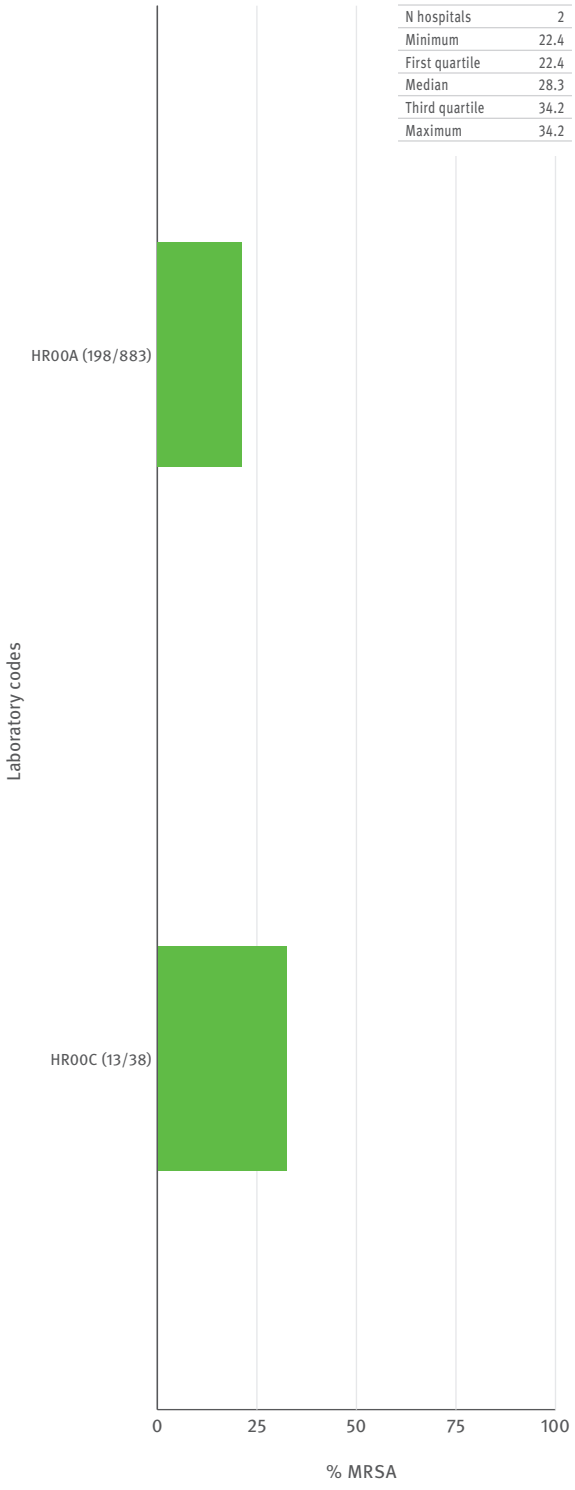


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

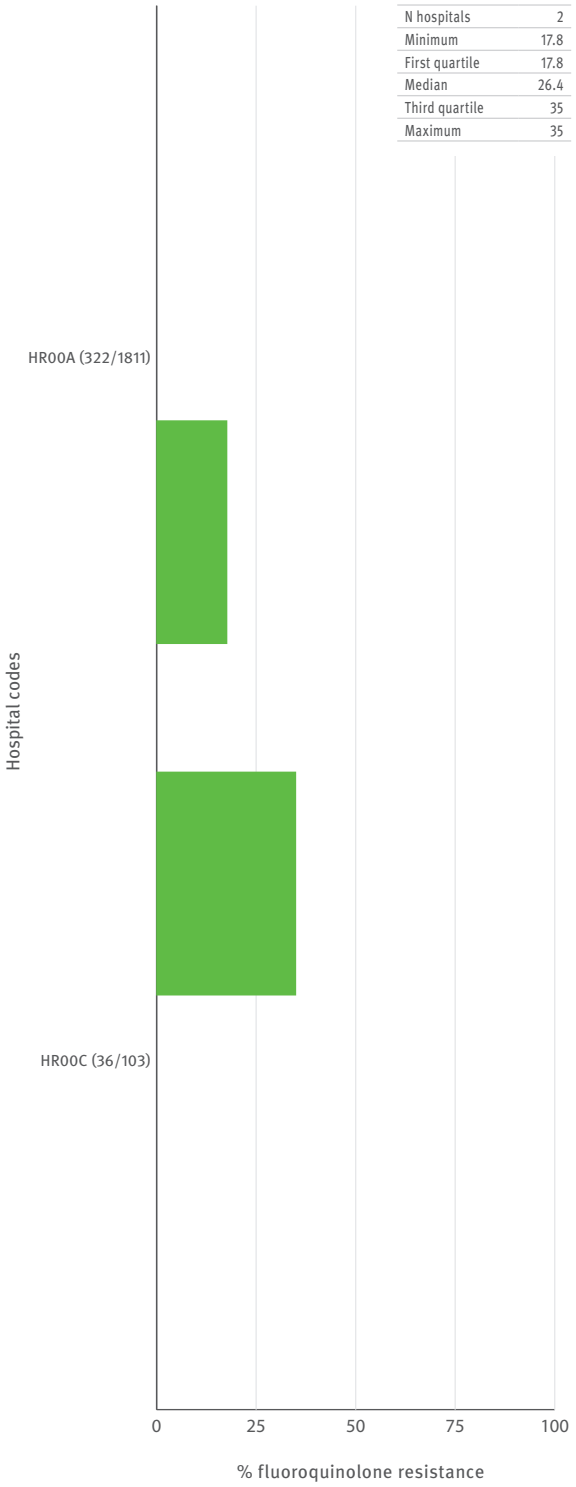
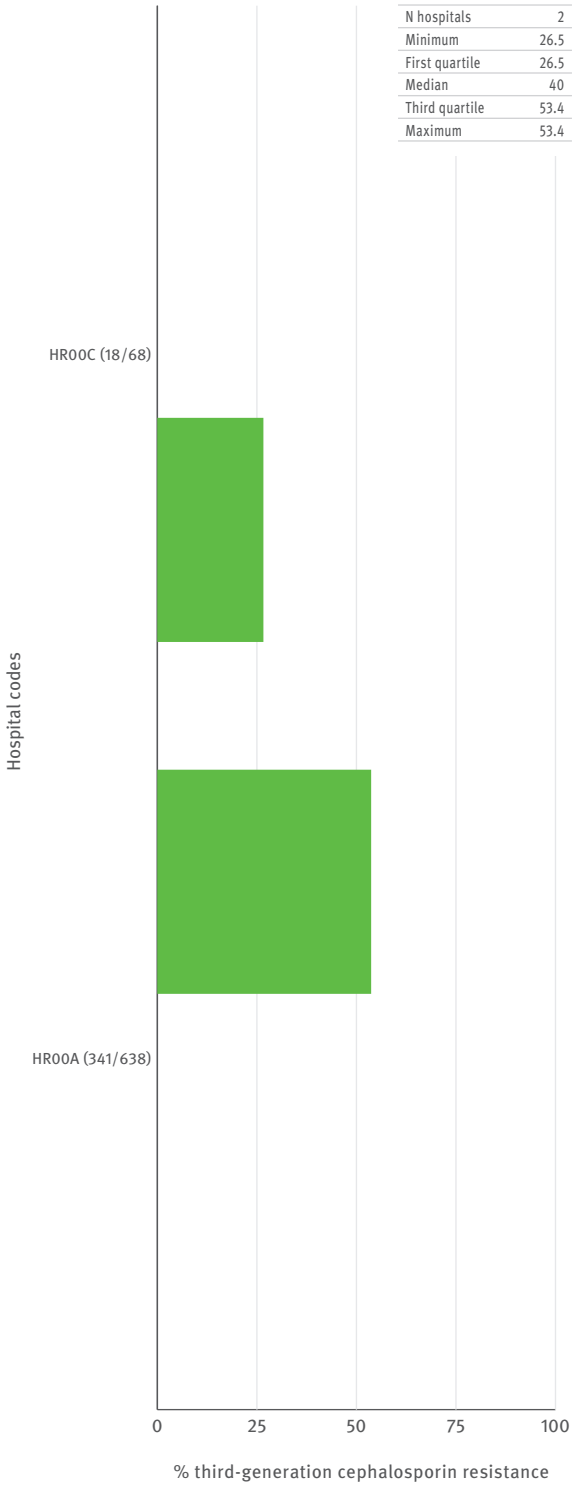


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Cyprus

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	2	12	4	113	5	138	4	71	4	83	4	51
2012	3	8	5	165	5	176	5	106	5	65	5	52
2013	4	15	5	160	5	162	5	97	5	68	5	47

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	<1	<1	<1	31	7	21	18	33	25	25	40
Penicillin RI	<1	14	19	38	33	43	36	42	25	25	40
Macrolides RI	33	<1	13	31	27	29	36	55	25	14	27
Staphylococcus aureus											
Oxacillin/meticillin R	64	49	56	34	48	46	33	32	42	35	32
Escherichia coli											
Aminopenicilins R	63	61	72	62	72	58	66	62	78	70	77
Aminoglycosides R	11	11	13	10	11	10	10	16	24	21	25
Fluoroquinolones R	32	22	29	35	39	45	43	43	47	42	52
Third-generation cephalosporins R	11	9	16	16	18	19	14	20	36	32	39
Carbapenems R	<1	<1	<1	<1	2	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	<1	3	3	5	2	16	32	6	2	1	<1
HL gentamicin R	43	77	71	44	61	65	66	24	19	10	27
Vancomycin R	<1	3	<1	<1	<1	1	<1	<1	4	<1	<1
Enterococcus faecium											
Aminopenicilins RI	100	100	80	43	92	60	80	78	82	76	90
HL gentamicin R	–	33	<1	14	33	10	13	<1	6	<1	3
Vancomycin R	<1	33	40	14	25	20	13	<1	<1	10	23
Klebsiella pneumoniae											
Aminoglycosides R	–	–	11	12	13	21	19	19	28	18	25
Fluoroquinolones R	–	–	22	12	23	23	43	39	36	22	24
Third-generation cephalosporins R	–	–	33	27	31	35	42	34	41	23	31
Carbapenems R	–	–	<1	<1	3	10	17	16	16	9	6
Pseudomonas aeruginosa											
Piperacillin R	–	–	13	27	31	23	18	19	20	10	9
Ceftazidime R	–	–	38	24	15	9	18	17	24	15	13
Carbapenems R	–	–	13	11	19	19	8	29	43	19	19
Aminoglycosides R	–	–	13	11	25	21	5	10	16	15	4
Fluoroquinolones R	–	–	13	27	23	38	13	17	14	15	11

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	91	33	100	34	99	47	100	0	100	17	99	27	99	19
CSF	9	50	–	–	1	50	–	–	–	–	1	100	1	0
Gender														
Male	57	38	58	36	47	52	56	0	53	19	57	29	65	19
Female	43	30	40	31	53	42	42	0	44	12	43	25	33	18
Unknown	–	–	2	33	1	50	2	0	3	50	–	–	2	50
Age (years)														
0–4	9	50	7	36	4	20	5	0	8	0	8	20	7	14
5–19	–	–	1	25	1	33	–	–	–	–	1	0	2	50
20–64	35	38	26	43	22	54	24	0	22	23	32	35	27	19
65 and over	39	44	44	29	49	49	48	0	49	7	42	23	51	18
Unknown	17	0	21	32	24	41	23	0	20	42	17	26	13	23
Hospital department														
ICU	4	100	23	46	10	57	35	0	22	0	29	36	45	22
Internal med.	65	33	52	28	65	47	44	0	51	20	42	20	25	16
Surgery	–	–	7	50	8	65	11	0	7	25	13	41	12	25
Other	9	0	8	28	10	26	3	0	8	20	9	17	12	8
Unknown	22	40	10	29	7	43	6	0	12	29	7	22	5	20

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Cyprus

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

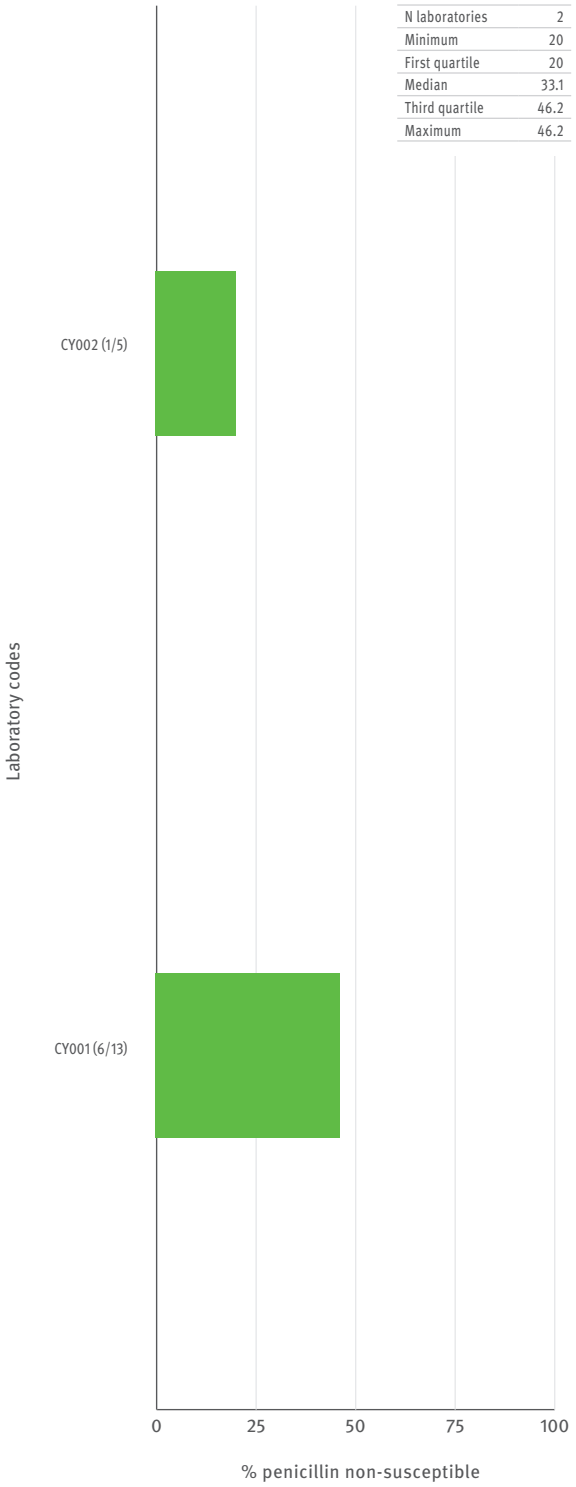


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

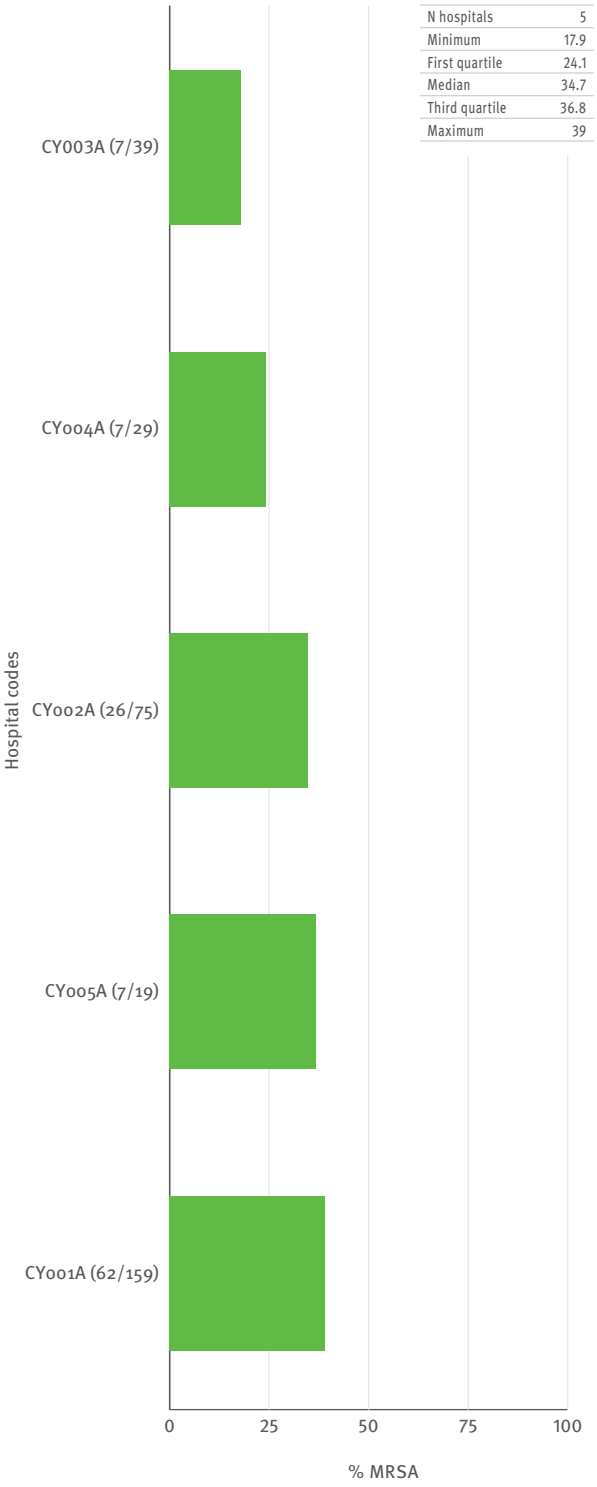


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

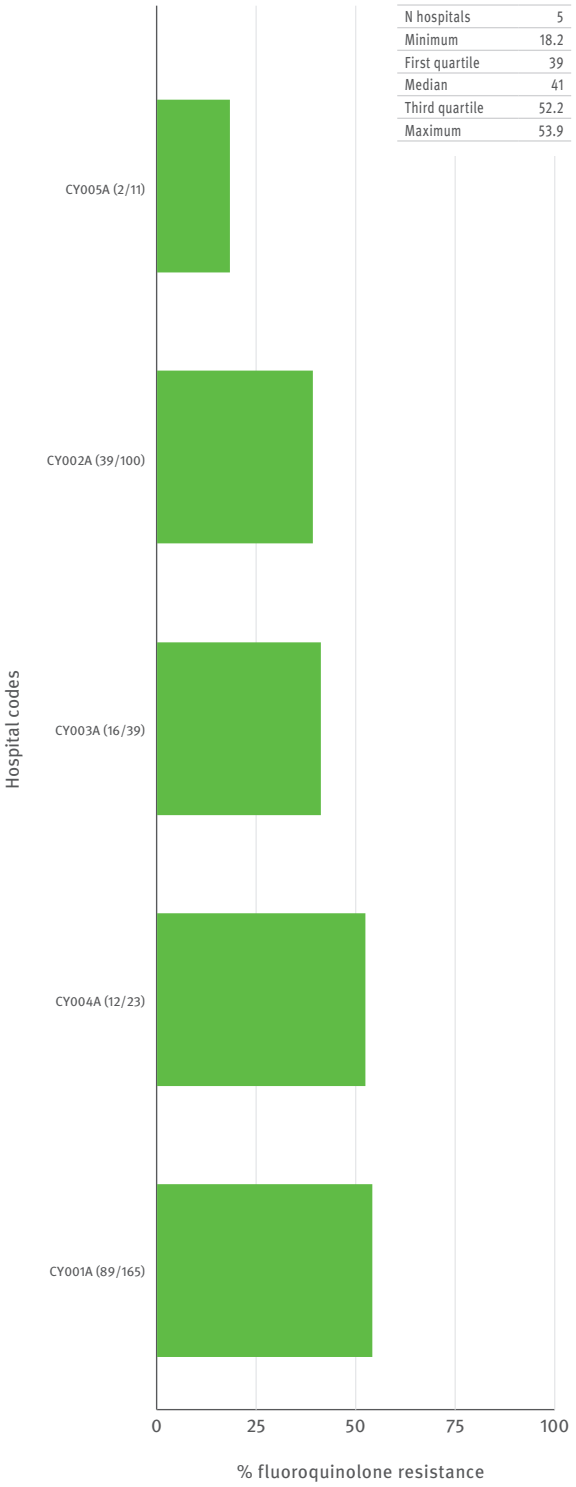
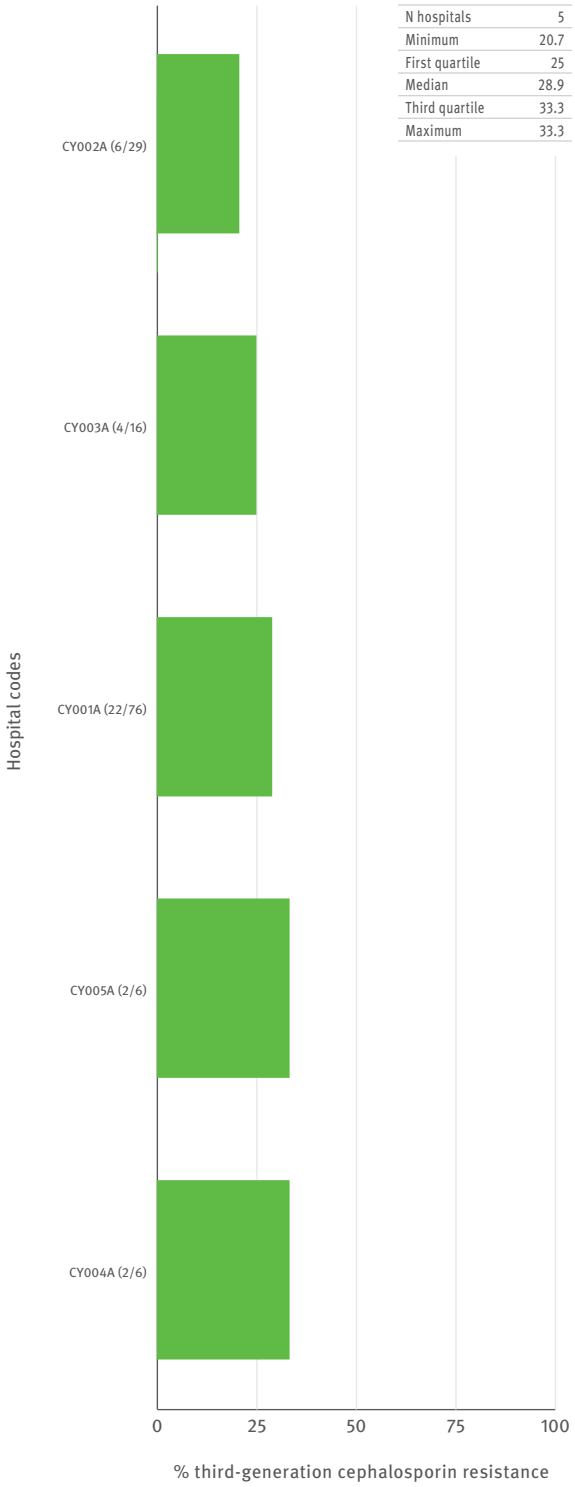


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Czech Republic

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	42	316	46	1555	45	2696	44	767	44	1287	42	448
2012	39	274	47	1611	44	2812	42	843	46	1399	44	489
2013	44	333	47	1707	46	2962	43	875	45	1291	43	516

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	<1	2	<1	<1	<1	<1	<1	<1	<1	<1	2
Penicillin RI	2	6	4	2	4	3	4	5	4	3	2
Macrolides RI	2	4	2	3	5	3	5	6	3	8	9
Staphylococcus aureus											
Oxacillin/meticillin R	6	9	13	12	13	14	15	13	15	13	13
Escherichia coli											
Aminopenicilins R	45	47	50	56	56	60	61	59	61	57	55
Aminoglycosides R	5	5	6	8	7	9	9	8	9	8	9
Fluoroquinolones R	13	16	20	23	24	26	23	23	23	21	21
Third-generation cephalosporins R	1	2	2	5	7	10	10	10	11	11	13
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	4	<1	<1	2	3	2	<1	8	4	2	1
HL gentamicin R	44	43	45	43	49	49	47	48	46	42	40
Vancomycin R	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	4
Enterococcus faecium											
Aminopenicilins RI	80	81	92	90	91	94	98	98	97	98	96
HL gentamicin R	48	43	69	74	79	75	65	54	61	69	63
Vancomycin R	3	3	14	4	6	8	6	5	8	11	9
Klebsiella pneumoniae											
Aminoglycosides R	–	–	36	38	43	42	47	47	45	54	51
Fluoroquinolones R	–	–	38	47	48	52	54	55	53	50	48
Third-generation cephalosporins R	–	–	32	35	46	48	52	48	48	51	52
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	21	29	30	27	28	28	22	26	28
Ceftazidime R	–	–	40	30	33	44	29	28	20	20	23
Carbapenems R	–	–	31	33	36	29	29	16	13	15	16
Aminoglycosides R	–	–	27	29	32	43	33	33	24	24	26
Fluoroquinolones R	–	–	45	47	43	46	41	41	34	31	34

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	85	3	100	13	100	21	100	3	100	10	100	52	99	15
CSF	15	2	–	–	0	7	–	–	–	–	0	60	1	25
Gender														
Male	62	4	62	13	42	26	66	3	58	8	62	53	66	15
Female	38	0	38	14	58	17	34	2	42	13	38	49	34	15
Age (years)														
0–4	5	3	4	0	2	6	4	0	1	0	2	36	2	6
5–19	4	0	2	2	1	19	1	7	1	0	1	60	2	6
20–64	46	2	40	10	28	19	36	1	48	11	37	56	37	18
65 and over	45	3	54	17	69	22	59	3	50	9	60	49	60	15
Hospital department														
ICU	28	2	27	16	20	25	41	3	43	6	41	59	45	17
Internal med.	28	5	41	13	49	18	29	3	20	10	31	42	23	10
Surgery	0	0	5	12	4	21	6	1	6	3	5	46	5	19
Other	40	2	25	10	27	22	25	2	30	18	23	53	26	17
Unknown	5	0	0	15	0	0	–	–	0	0	0	75	1	0

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Czech Republic

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

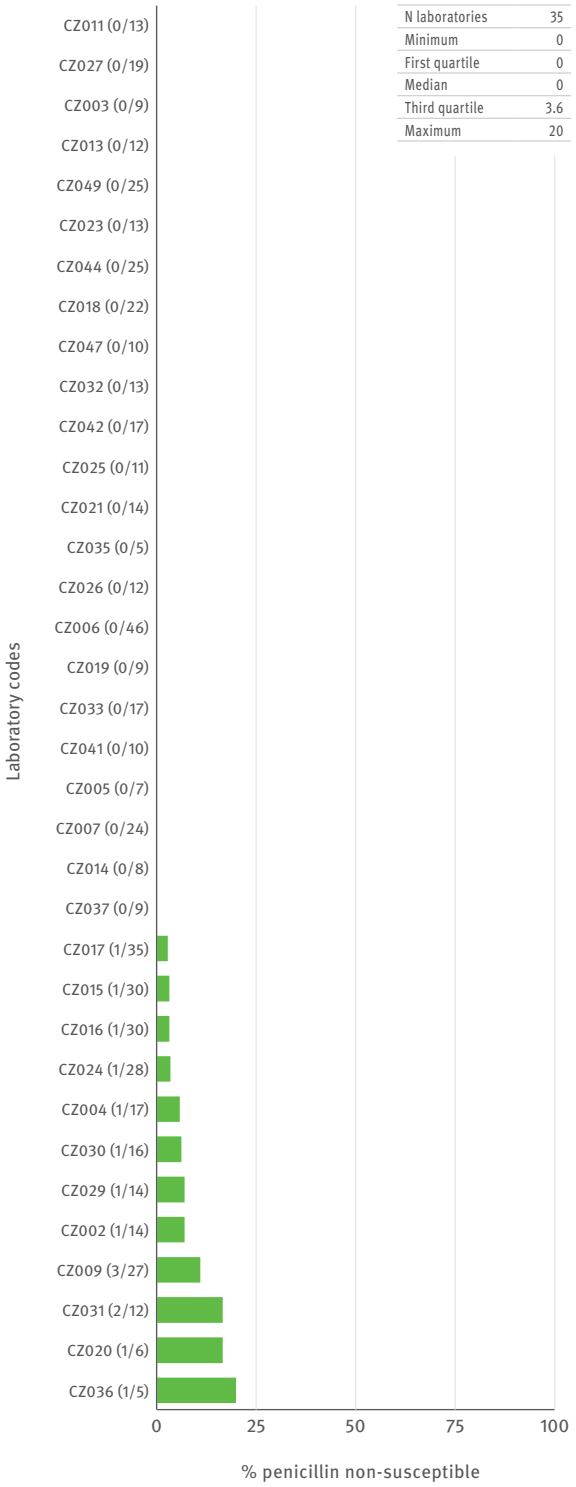


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

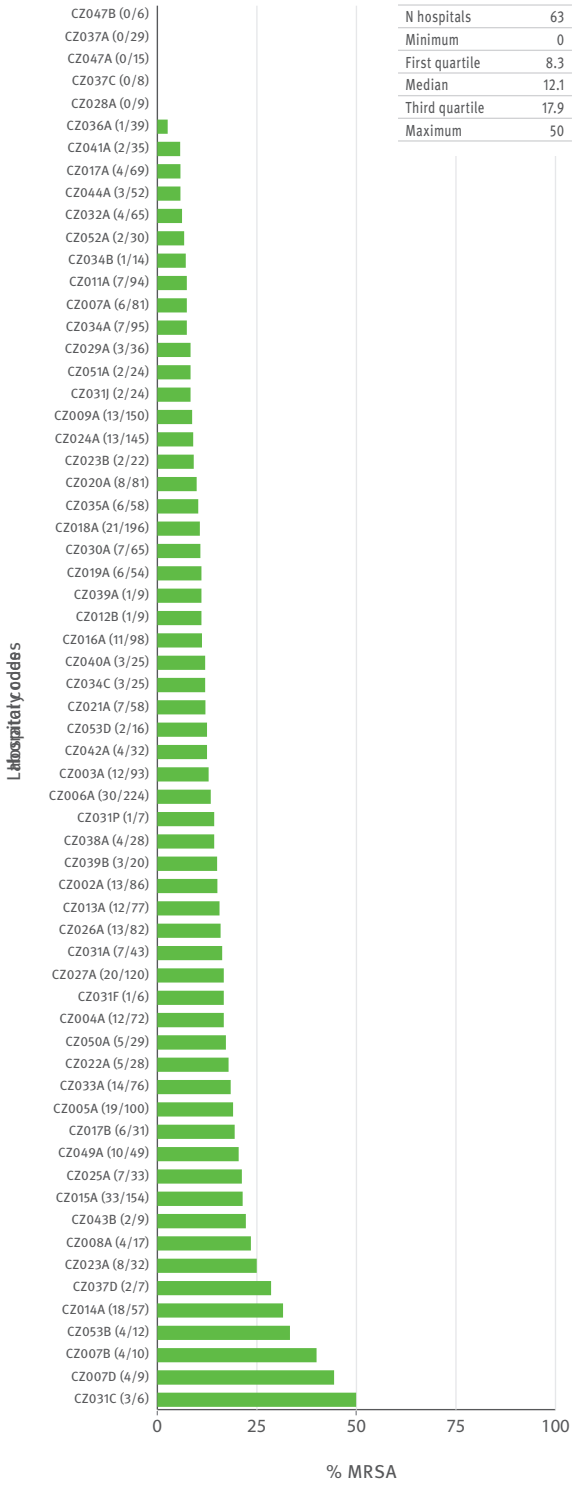
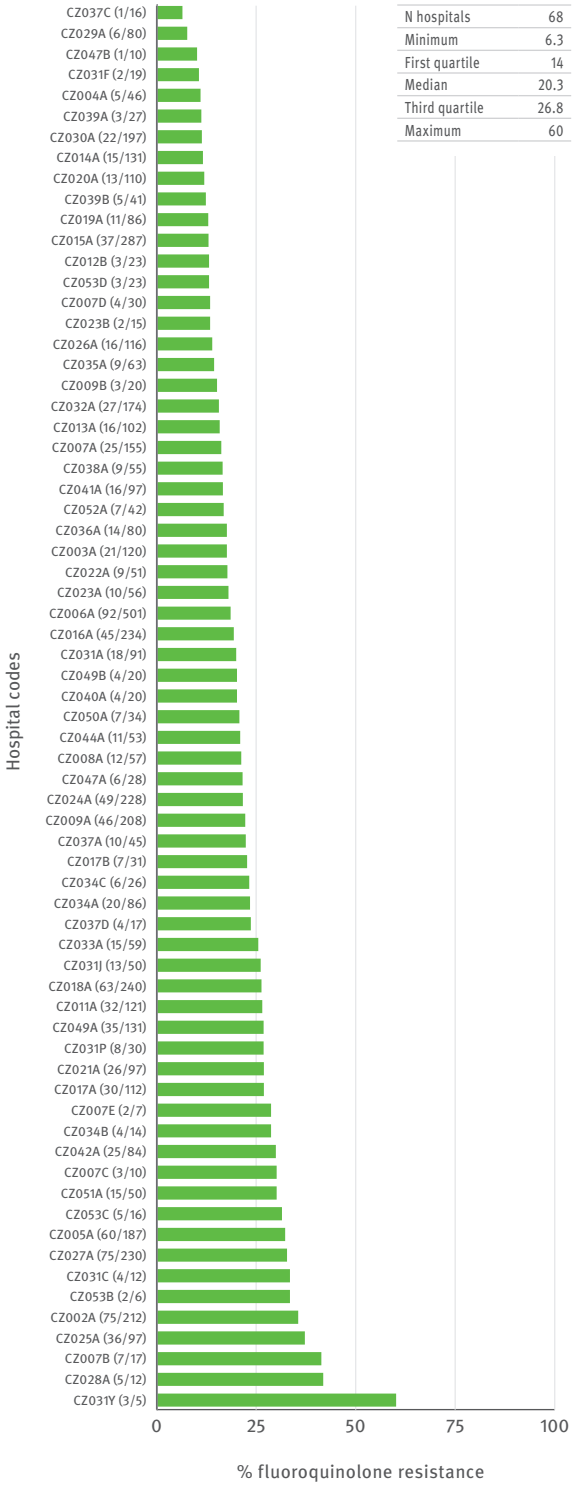
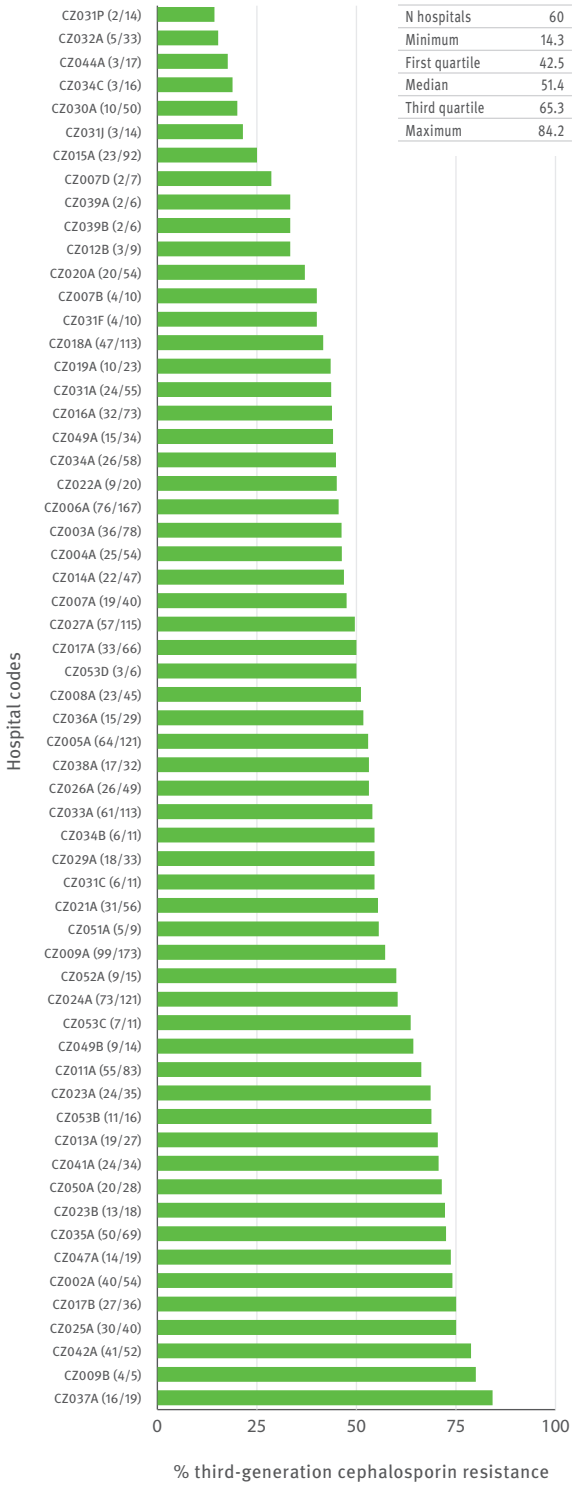


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)



N hospitals	68
Minimum	6.3
First quartile	14
Median	20.3
Third quartile	26.8
Maximum	60

Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



N hospitals	60
Minimum	14.3
First quartile	42.5
Median	51.4
Third quartile	65.3
Maximum	84.2

Denmark

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	13	896	13	1452	12	3642	12	1197	12	910	12	407
2012	13	867	13	1431	12	3925	12	1248	12	948	12	390
2013	12	789	12	1685	11	3967	11	1224	11	875	11	414

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Penicillin RI	3	3	4	4	3	3	4	4	5	5	7
Macrolides RI	5	5	6	6	6	7	4	4	5	6	5
Staphylococcus aureus											
Oxacillin/meticillin R	<1	1	2	2	<1	2	2	1	1	1	2
Escherichia coli											
Aminopenicilins R	–	–	40	42	43	43	43	46	48	45	46
Aminoglycosides R	–	–	2	3	4	4	4	6	6	7	7
Fluoroquinolones R	–	–	5	7	9	10	13	14	14	14	12
Third-generation cephalosporins R	–	–	1	2	3	4	6	8	8	8	8
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	–	–	–	<1	2	2	1	<1	<1	1	1
HL gentamicin R	–	–	–	–	–	37	33	36	31	28	27
Vancomycin R	–	–	–	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	–	–	–	87	88	88	88	93	93	94	93
HL gentamicin R	–	–	–	–	–	61	52	74	73	62	72
Vancomycin R	–	–	–	<1	<1	<1	2	2	1	2	3
Klebsiella pneumoniae											
Aminoglycosides R	–	–	–	2	6	7	7	6	6	6	4
Fluoroquinolones R	–	–	–	6	13	16	16	11	12	9	9
Third-generation cephalosporins R	–	–	–	4	10	9	11	11	11	10	12
Carbapenems R	–	–	–	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	–	–	3	2	2	4	5	5	2
Ceftazidime R	–	–	–	–	2	3	4	3	5	5	3
Carbapenems R	–	–	–	–	2	1	3	3	5	4	3
Aminoglycosides R	–	–	–	–	1	1	<1	1	2	4	5
Fluoroquinolones R	–	–	–	–	6	3	5	6	7	4	3

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E– faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	94	6	100	2	100	13	100	0	100	3	100	11	98	3
CSF	6	8	–	–	<1	4	–	–	–	–	<1	40	2	8
Gender														
Male	50	5	63	2	50	16	70	0	63	3	62	12	67	4
Female	50	6	37	1	50	11	30	0	37	3	38	9	33	2
Unknown	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Age (years)														
0–4	4	11	3	2	1	4	2	0	1	0	1	67	1	0
5–19	2	3	2	1	1	15	1	0	1	0	1	11	1	0
20–64	38	4	34	2	26	16	25	0	35	3	30	12	28	7
65 and over	56	7	60	1	72	13	72	0	63	2	68	10	69	2
Hospital department														
ICU	–	–	–	–	4	17	5	0	26	3	4	10	6	0
Internal med.	–	–	–	–	31	12	35	0	22	3	36	11	31	3
Surgery	–	–	–	–	12	14	18	0	24	4	17	10	14	7
Other	–	–	–	–	45	13	31	0	19	1	38	12	40	3
Unknown	100	6	100	2	8	16	10	0	10	1	5	8	9	1

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Denmark

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

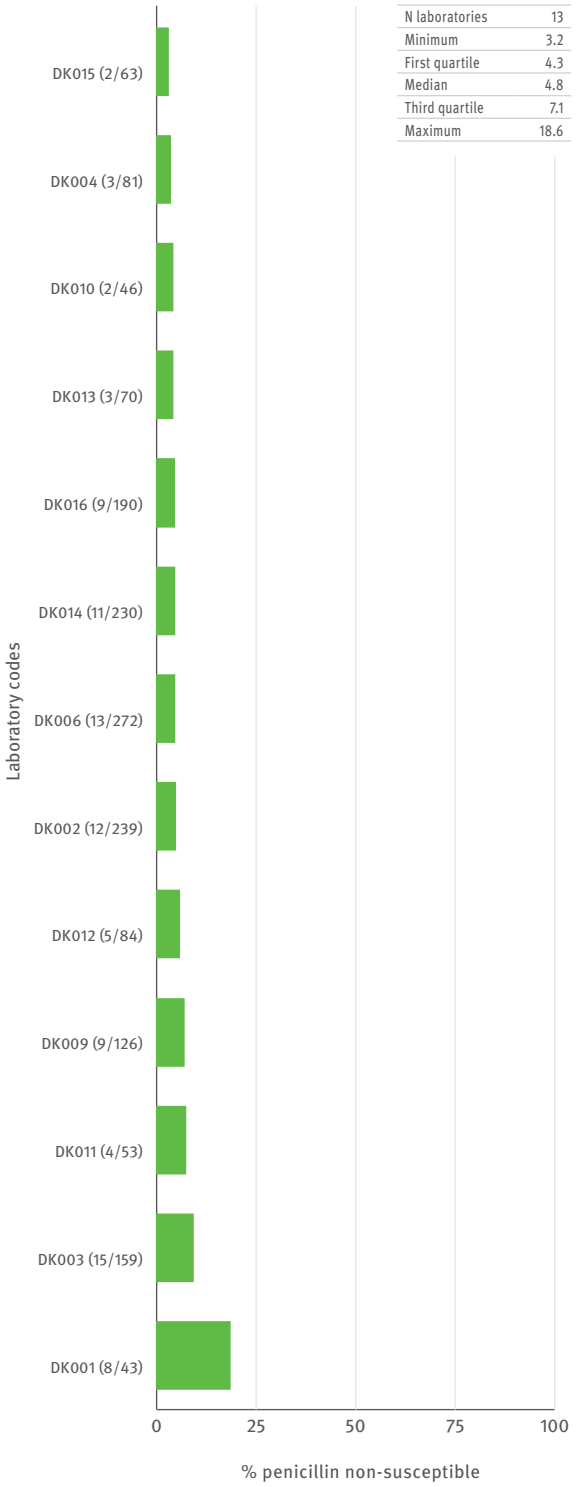


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

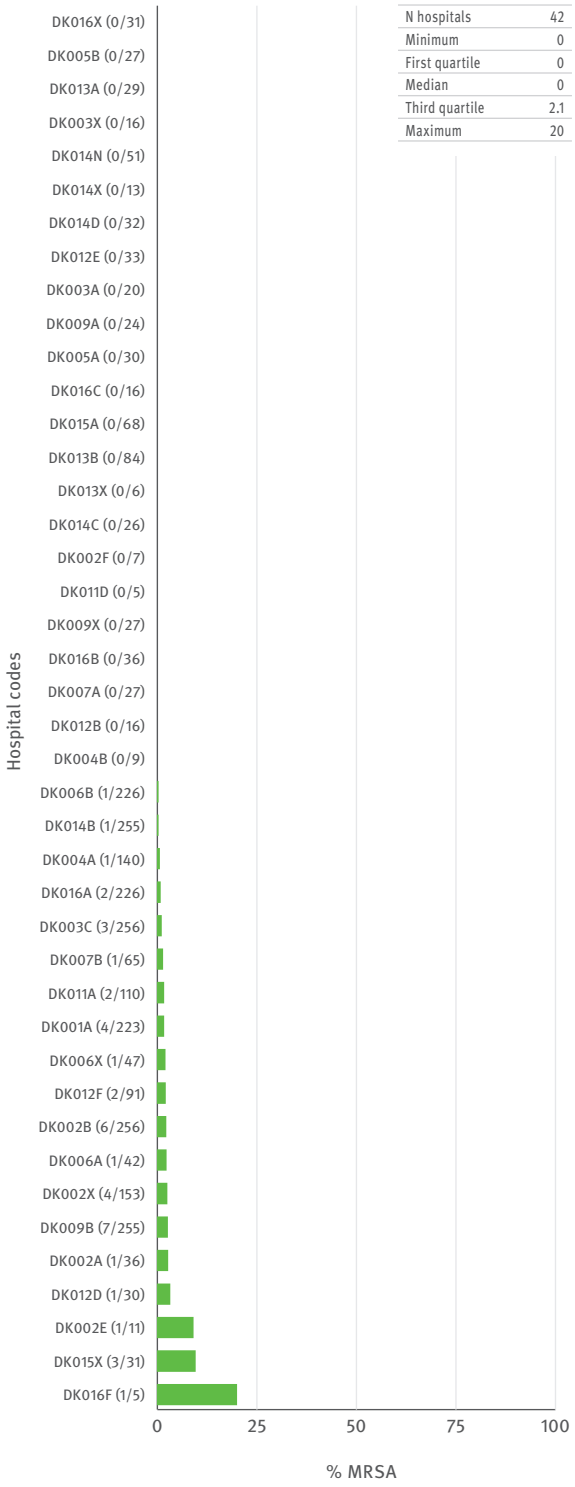


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

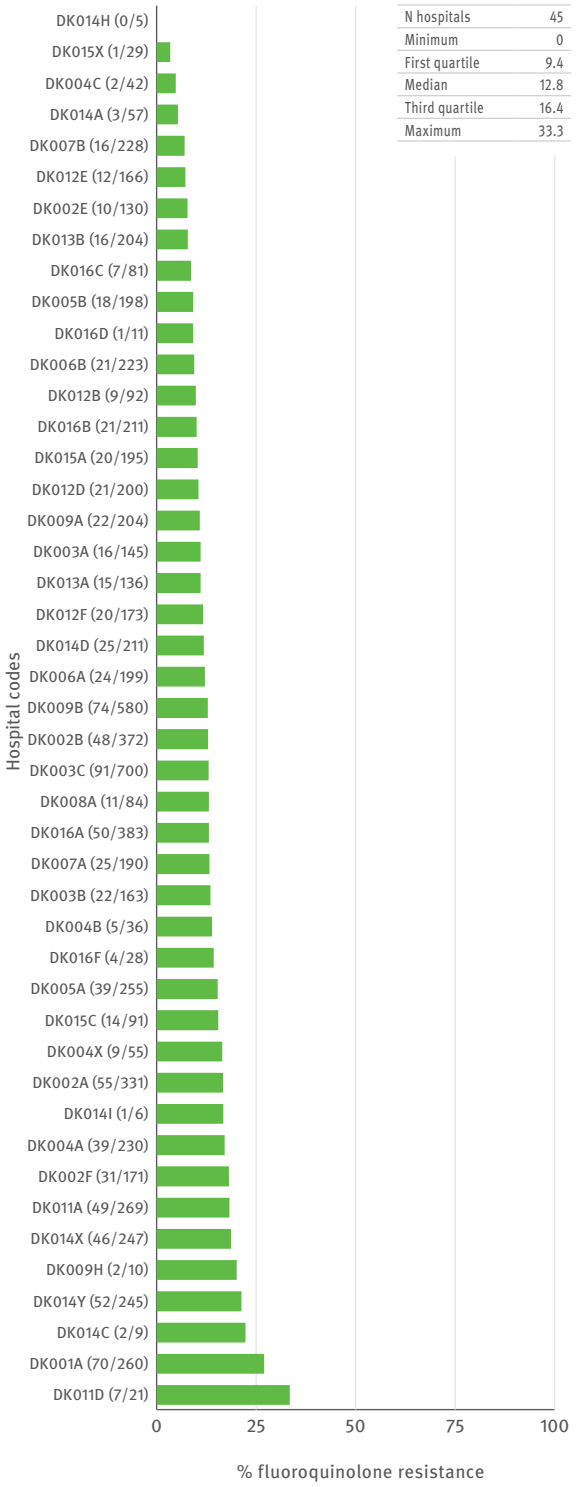
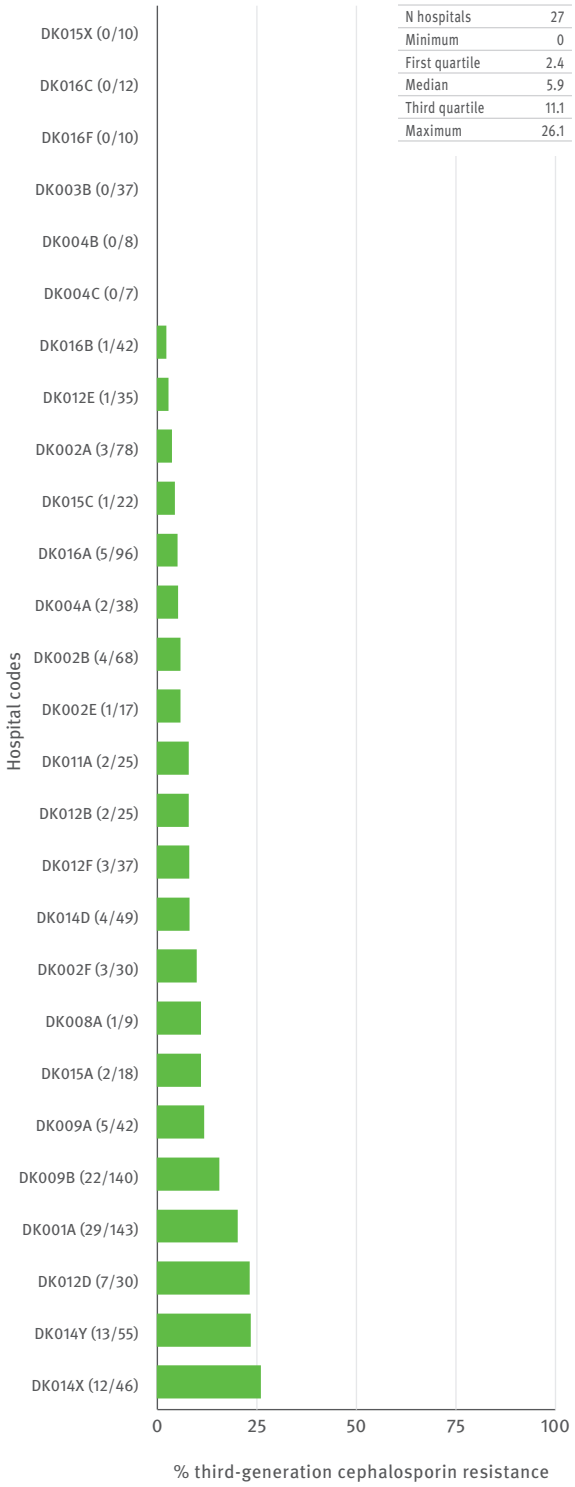


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Estonia

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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	43
2011	9	54	11	121	11	315	3	10	6	91	6	17
2012	9	71	10	163	11	306	8	76	9	91	7	33
2013	10	79	11	171	11	342	9	77	11	91	8	21

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	<1	<1	<1	<1	<1	<1	<1	2	2	<1	<1
Penicillin RI	<1	<1	2	2	<1	5	1	2	2	<1	1
Macrolides RI	10	6	<1	3	2	4	2	4	2	6	3
Staphylococcus aureus											
Oxacillin/meticillin R	4	5	2	3	9	4	3	<1	2	8	4
Escherichia coli											
Aminopenicilins R	42	55	45	52	50	47	38	37	–	48	46
Aminoglycosides R	3	2	4	2	6	5	4	6	5	8	8
Fluoroquinolones R	5	6	5	7	7	7	8	8	10	14	12
Third-generation cephalosporins R	1	4	1	<1	1	5	2	6	12	8	7
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	4	14	14	9	<1	9	9	14	–	14	24
HL gentamicin R	22	32	50	35	23	27	43	27	<1	42	20
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	75	79	83	84	94	85	90	90	–	89	74
HL gentamicin R	50	79	74	78	89	75	79	67	25	63	44
Vancomycin R	<1	<1	<1	<1	<1	3	<1	<1	<1	<1	<1
Klebsiella pneumoniae											
Aminoglycosides R	–	–	8	9	2	15	15	26	12	13	10
Fluoroquinolones R	–	–	<1	5	2	7	19	25	22	17	27
Third-generation cephalosporins R	–	–	8	9	3	12	17	17	40	18	23
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	1	3
Pseudomonas aeruginosa											
Piperacillin R	–	–	27	12	9	18	13	25	<1	16	12
Ceftazidime R	–	–	18	7	7	13	7	11	<1	17	<1
Carbapenems R	–	–	38	29	18	30	17	21	8	13	10
Aminoglycosides R	–	–	26	7	6	17	9	20	<1	24	10
Fluoroquinolones R	–	–	14	10	9	18	19	20	6	16	25

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	98	1	100	5	100	13	100	0	100	0	100	21	100	12
CSF	2	0	–	–	–	–	–	–	–	–	–	–	–	–
Gender														
Male	60	1	58	4	36	15	67	0	51	0	61	16	44	22
Female	40	0	42	6	64	12	33	0	49	0	39	27	56	3
Unknown	–	–	0	0	–	–	–	–	–	–	–	–	–	–
Age (years)														
0–4	6	0	9	4	3	14	16	0	13	0	7	0	4	0
5–19	3	0	3	0	1	25	1	0	–	–	2	33	–	–
20–64	44	2	46	2	34	12	32	0	31	0	41	26	42	9
65 and over	47	0	43	9	62	13	51	0	56	0	51	19	54	14
Hospital department														
ICU	26	3	16	0	14	12	16	0	34	0	25	22	40	14
Internal med.	28	0	36	6	45	10	29	0	25	0	35	19	21	9
Surgery	–	–	8	4	4	13	11	0	9	0	5	33	2	0
Other	46	0	39	6	38	17	44	0	31	0	35	19	37	11
Unknown	–	–	–	–	0	0	–	–	1	0	–	–	–	–

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Estonia

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

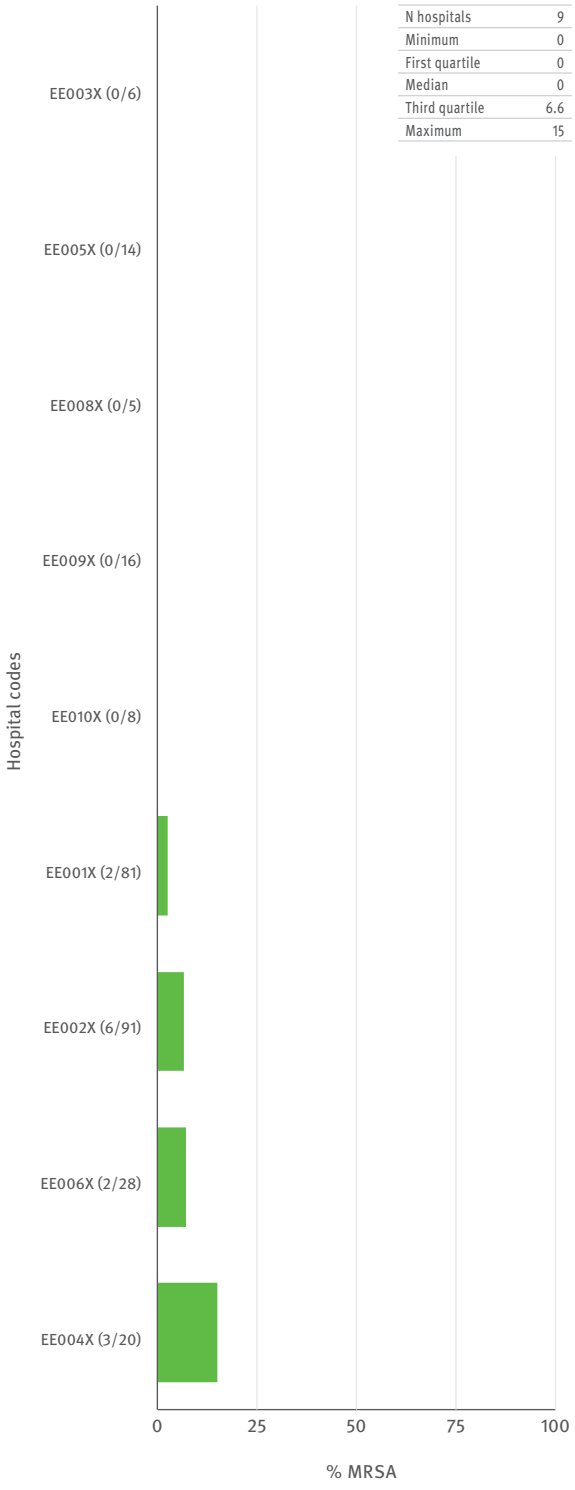
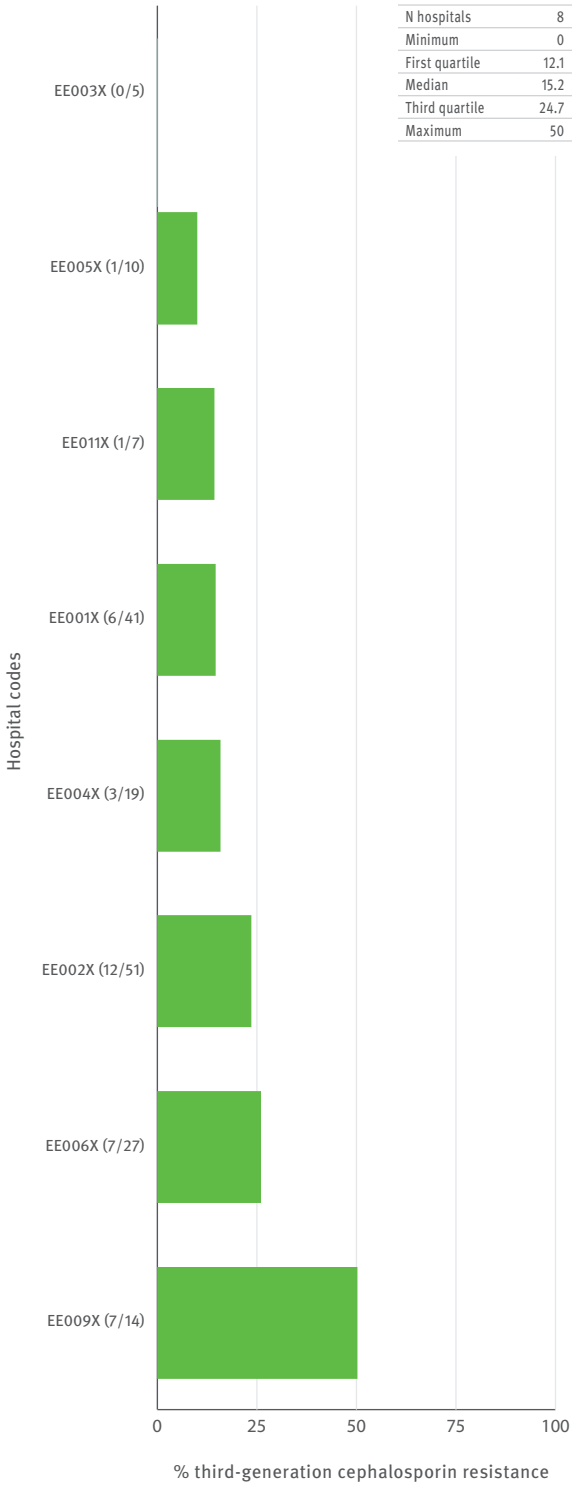


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Finland

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	17	662	18	1319	17	3021	16	479	17	404	16	269
2012	16	607	17	1409	17	3162	17	651	17	536	17	327
2013	18	675	18	1580	18	3721	18	698	18	550	18	327

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	2	<1	<1	2	1	<1	2	1	<1	<1	<1
Penicillin RI	10	8	7	12	13	11	13	14	13	17	14
Macrolides RI	20	20	20	24	25	24	28	28	24	22	19
Staphylococcus aureus											
Oxacillin/meticillin R	1	3	3	3	2	3	2	2	3	2	2
Escherichia coli											
Aminopenicilins R	33	33	35	36	34	35	36	34	37	40	37
Aminoglycosides R	1	2	2	2	3	4	3	4	5	6	6
Fluoroquinolones R	5	7	7	8	8	9	9	9	11	12	13
Third-generation cephalosporins R	1	2	2	2	2	2	3	4	5	6	7
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	<1	<1	<1	<1	2	<1	<1	<1	<1	<1	<1
HL gentamicin R	39	39	27	25	22	13	–	–	–	–	–
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	79	69	78	80	87	87	87	82	88	85	79
HL gentamicin R	4	12	1	16	19	15	–	–	–	–	–
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae											
Aminoglycosides R	–	–	3	1	<1	1	1	4	1	<1	2
Fluoroquinolones R	–	–	3	4	<1	2	3	2	3	2	3
Third-generation cephalosporins R	–	–	2	<1	1	2	1	4	2	2	2
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	8	8	7	8	7	7	16	8	9
Ceftazidime R	–	–	5	3	5	5	5	3	9	5	5
Carbapenems R	–	–	15	8	9	6	8	10	11	6	10
Aminoglycosides R	–	–	10	8	8	6	4	4	5	2	3
Fluoroquinolones R	–	–	16	17	11	15	11	11	15	8	11

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	96	15	100	2	100	13	100	0	100	1	100	2	98	8
CSF	4	17	0	0	0	17	–	–	–	–	0	0	2	20
Gender														
Male	55	15	62	2	38	16	67	0	58	1	56	2	61	8
Female	45	16	38	2	62	10	33	0	42	0	44	2	39	8
Age (years)														
0–4	5	16	3	3	1	0	5	0	1	0	1	0	0	0
5–19	3	10	3	2	1	14	1	0	1	0	0	0	1	13
20–64	48	17	39	1	25	12	23	0	32	1	28	3	25	9
65 and over	44	14	55	2	73	13	72	0	66	1	71	1	74	8
Hospital department														
ICU	1	0	1	3	1	12	2	0	5	0	1	0	2	19
Internal med.	8	13	9	2	6	15	7	0	8	0	6	0	6	10
Surgery	1	25	3	1	2	22	5	0	5	3	3	0	4	9
Other	51	13	49	2	52	12	45	0	42	0	47	3	45	9
Unknown	40	19	38	2	40	12	41	0	39	0	43	2	43	7

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Finland

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

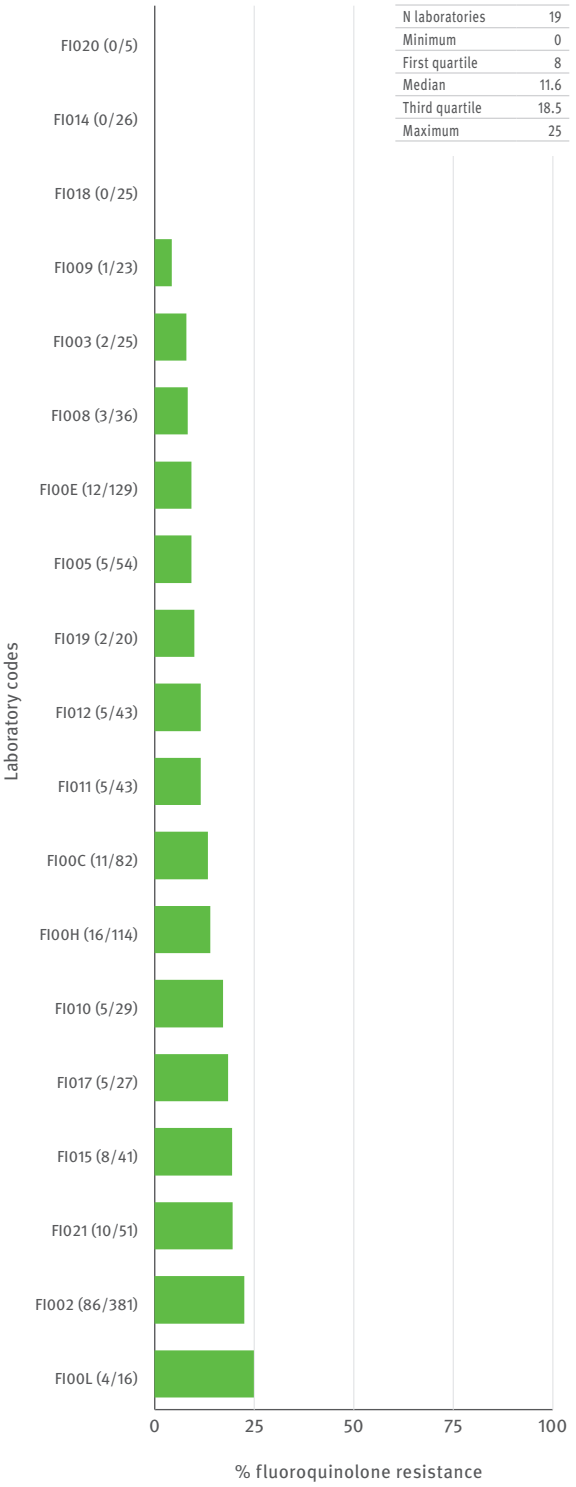


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

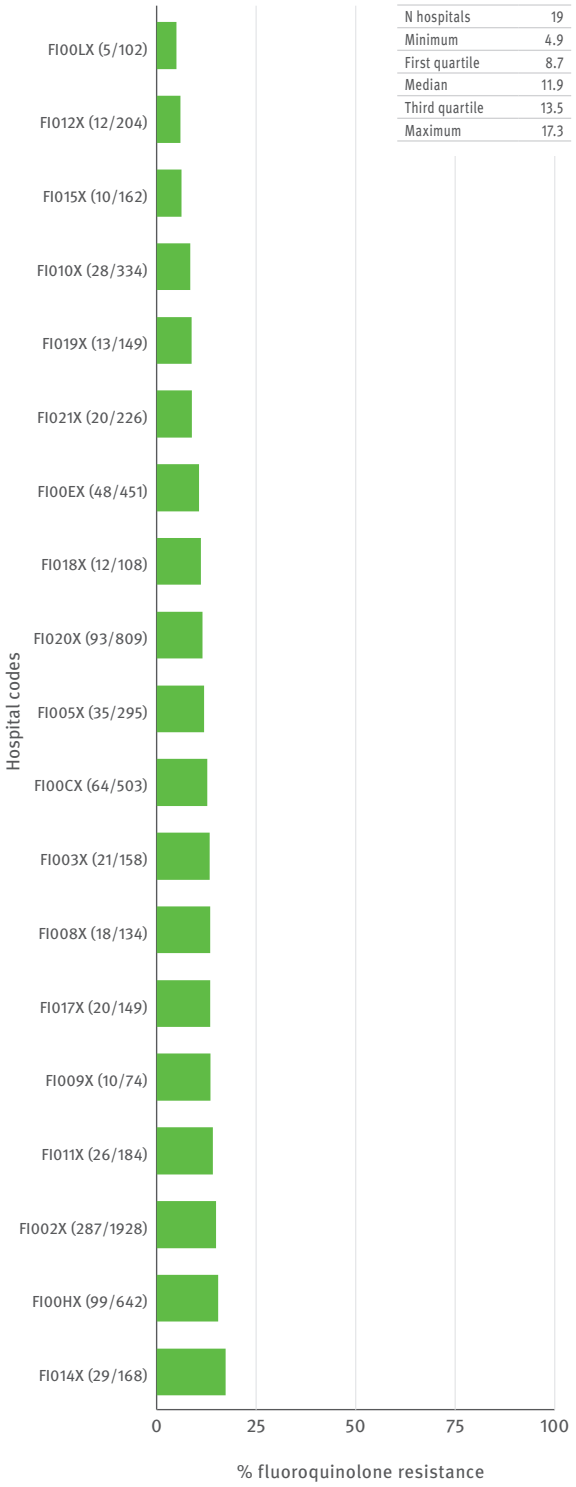


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)

France

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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	403	1389	21	1710	21	2266	20	468	–	–	–	–
2004	403	515	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
2011	255	1413	52	4740	52	8790	46	2163	52	1691	52	1634
2012	160	824	55	5242	55	9610	52	2263	55	1712	54	1731
2013	229	919	54	5439	54	10157	53	2538	54	1938	54	1884

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	–	–	5	4	4	7	6	<1	<1	<1	<1
Penicillin RI	43	39	36	32	34	30	27	28	24	23	22
Macrolides RI	48	45	41	36	37	31	27	30	26	29	30
Staphylococcus aureus											
Oxacillin/meticillin R	29	29	27	27	26	24	23	22	20	19	17
Escherichia coli											
Aminopenicilins R	50	47	50	53	54	54	55	55	55	55	55
Aminoglycosides R	5	4	5	6	6	7	8	7	8	8	8
Fluoroquinolones R	9	8	11	14	15	16	19	18	18	18	17
Third-generation cephalosporins R	<1	<1	1	2	2	4	7	7	8	10	10
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	3	1	<1	1	1	<1	1	<1	<1	<1	<1
HL gentamicin R	16	17	15	16	15	18	18	18	20	17	15
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	30	56	64	69	67	68	63	78	81	80	79
HL gentamicin R	23	21	24	30	30	30	38	41	43	42	42
Vancomycin R	<1	5	3	3	1	<1	<1	1	1	<1	<1
Klebsiella pneumoniae											
Aminoglycosides R	–	–	5	7	11	17	20	18	24	24	27
Fluoroquinolones R	–	–	7	9	14	21	24	22	28	24	29
Third-generation cephalosporins R	–	–	4	6	10	15	19	18	25	23	28
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	15	11	11	14	21	20	23	20	15
Ceftazidime R	–	–	9	6	7	8	17	13	16	14	12
Carbapenems R	–	–	14	12	14	14	17	18	20	18	17
Aminoglycosides R	–	–	22	17	19	16	22	18	21	24	16
Fluoroquinolones R	–	–	27	23	24	22	25	23	27	22	21

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	69	22	100	18	100	17	100	0	100	0	100	25	100	18
CSF	31	23	0	0	0	0	0	0	0	0	0	0	0	0
Gender														
Male	55	23	63	18	48	19	66	0	64	1	60	27	63	18
Female	45	23	35	19	50	15	32	0	35	0	38	23	36	17
Unknown	0	0	1	13	2	15	2	0	1	0	2	26	2	23
Age (years)														
0–4	18	23	4	8	3	8	4	0	1	0	2	19	2	15
5–19	7	15	3	5	1	16	1	0	<1	20	1	21	2	9
20–64	37	21	38	12	32	18	36	0	43	1	44	27	44	22
65 and over	38	26	54	23	64	17	59	0	55	0	52	24	51	14
Unknown	<1	20	1	51	<1	24	0	0	0	0	1	59	<1	35
Hospital department														
ICU	–	–	13	17	8	22	20	0	28	1	18	45	26	31
Internal med.	–	–	33	20	25	18	27	0	27	0	27	22	23	14
Surgery	–	–	13	17	9	18	13	0	12	1	11	27	9	15
Other	–	–	39	17	56	16	37	0	30	0	42	20	39	12
Unknown	100	23	3	23	3	22	3	0	4	0	3	23	3	15

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

France

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

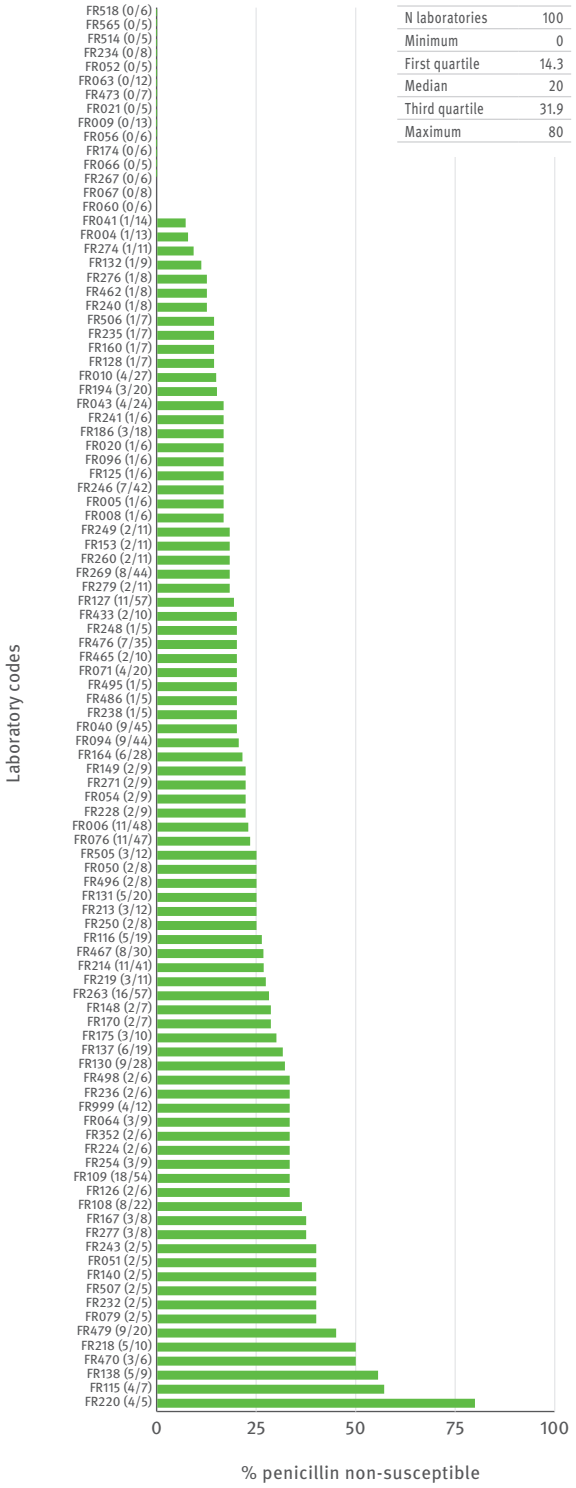


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

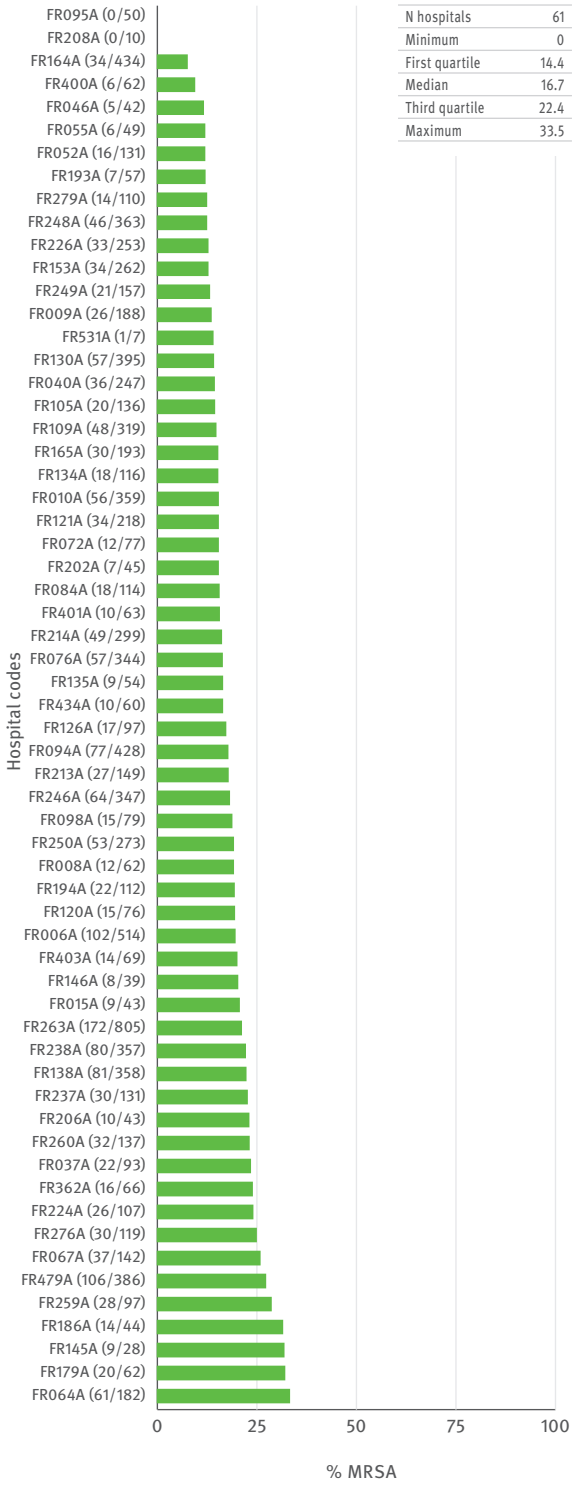


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

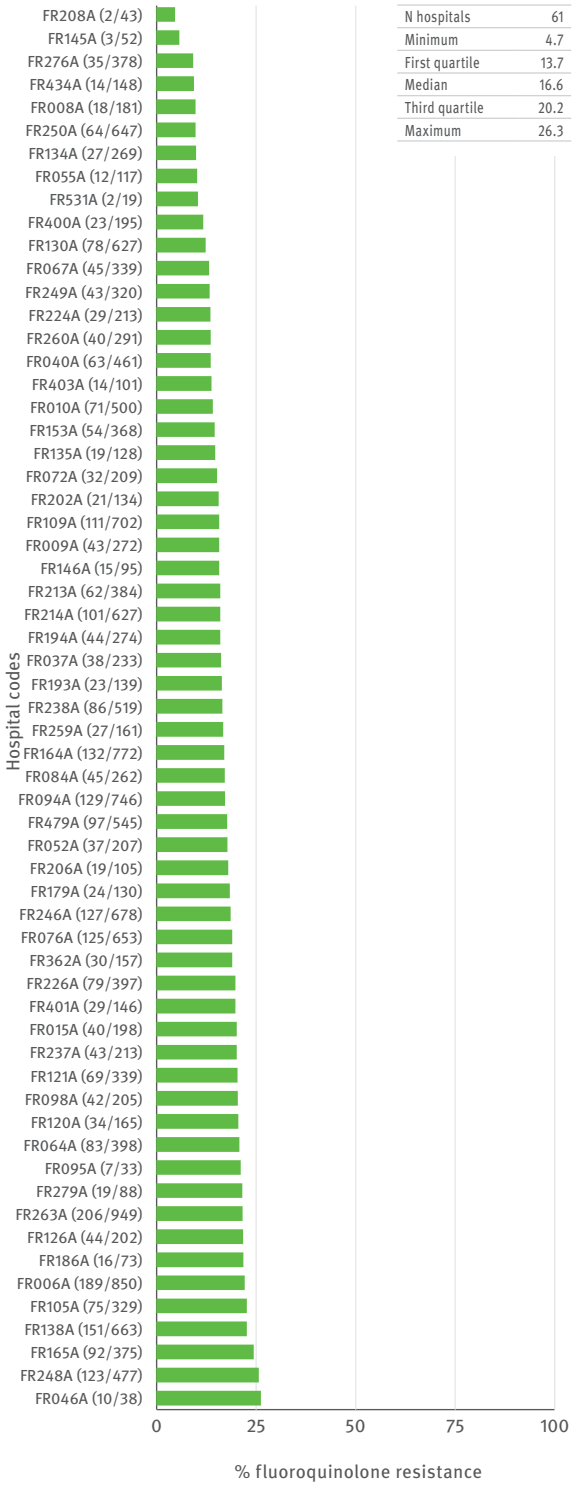
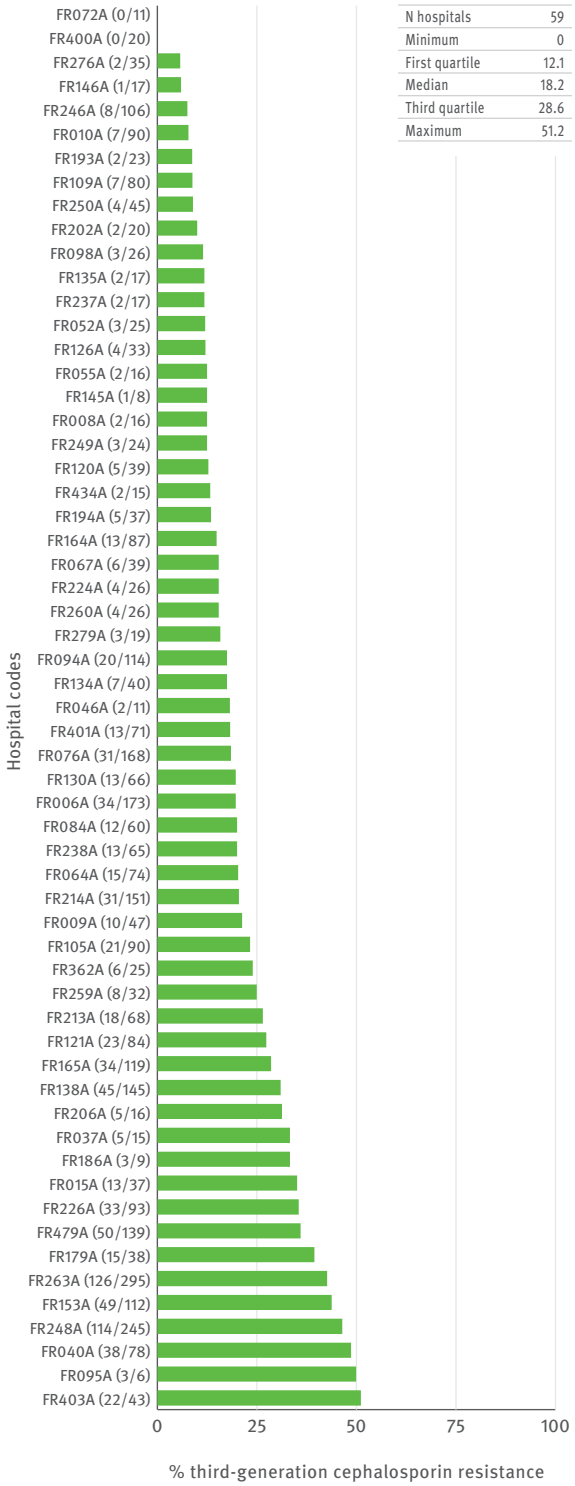


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Germany

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	18	359	19	2388	19	3650	17	1231	17	519	17	389
2012	20	326	21	2563	21	4194	21	1499	20	664	20	438
2013	20	488	22	3071	22	5259	22	1841	21	746	21	609

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	<1	<1	<1	1	<1	<1	<1	<1	<1	1	2
Penicillin RI	1	1	4	5	3	5	2	4	2	5	7
Macrolides RI	11	13	17	12	8	10	8	9	8	7	11
Staphylococcus aureus											
Oxacillin/meticillin R	18	20	21	20	16	19	18	21	16	15	13
Escherichia coli											
Aminopenicilins R	47	55	54	60	55	55	56	54	52	50	53
Aminoglycosides R	5	4	6	10	6	7	8	9	8	7	7
Fluoroquinolones R	14	24	23	29	30	23	23	25	24	21	22
Third-generation cephalosporins R	<1	2	2	4	8	5	8	8	8	9	11
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	7	7	3	3	7	<1	3	<1	<1	<1	<1
HL gentamicin R	47	42	34	29	67	39	40	47	41	36	39
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	78	93	96	94	95	95	94	94	96	93	93
HL gentamicin R	47	61	52	38	73	35	45	45	42	32	27
Vancomycin R	3	11	10	8	15	6	6	8	11	16	15
Klebsiella pneumoniae											
Aminoglycosides R	–	–	10	12	6	10	10	10	9	8	10
Fluoroquinolones R	–	–	6	12	9	15	15	15	14	14	15
Third-generation cephalosporins R	–	–	7	14	6	11	13	13	13	13	16
Carbapenems R	–	–	2	<1	2	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	<1	18	17	17	9	13	16	15	16	18
Ceftazidime R	–	<1	11	12	17	8	11	8	9	10	10
Carbapenems R	–	<1	25	17	22	11	11	13	10	11	15
Aminoglycosides R	–	<1	12	18	10	10	8	10	12	11	8
Fluoroquinolones R	–	<1	23	28	28	22	17	18	18	20	16

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

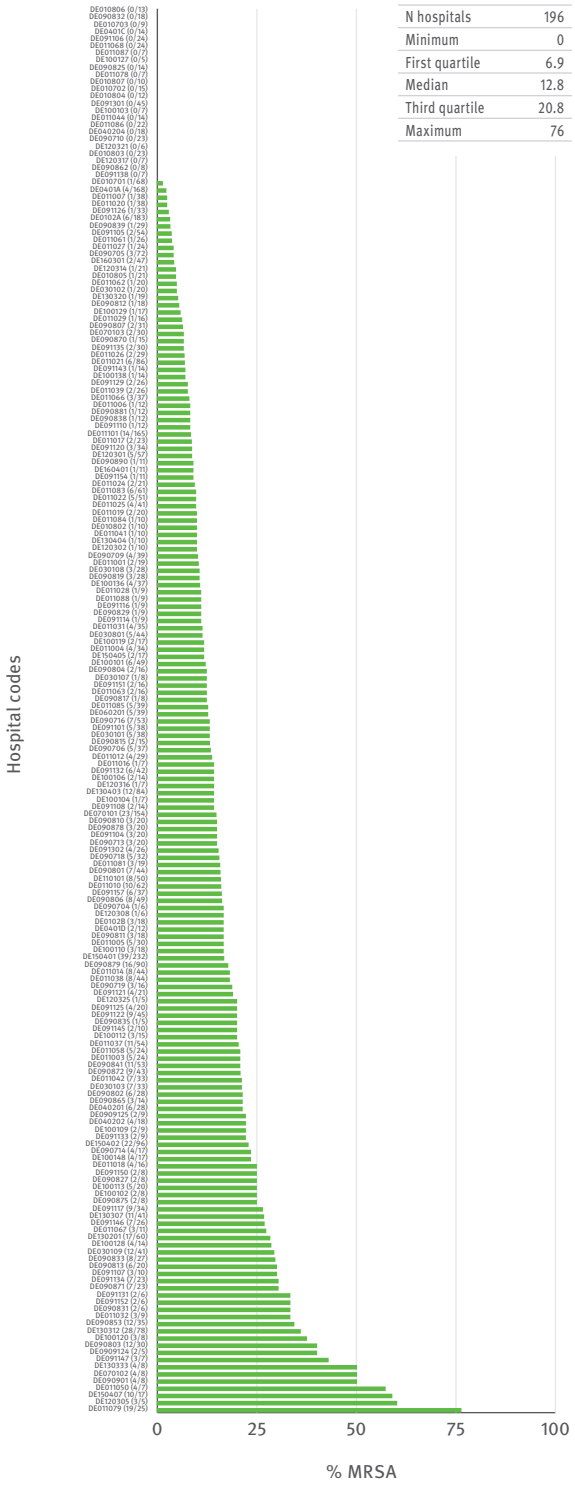
Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	92	5	100	14	100	22	100	0	100	15	99	14	98	13
CSF	8	17	–	–	0	33	–	–	–	–	1	36	2	37
Gender														
Male	49	7	54	14	38	25	57	0	53	17	54	16	61	12
Female	37	5	32	14	47	19	29	0	34	15	35	10	28	16
Unknown	15	6	14	13	15	23	14	0	13	11	11	19	11	14
Age (years)														
0–4	4	16	1	4	1	9	2	0	1	0	2	13	1	9
5–19	2	12	1	8	1	23	0	0	0	29	1	11	1	11
20–64	34	5	28	13	22	24	27	0	32	18	27	18	31	19
65 and over	59	6	69	15	76	21	71	0	67	14	70	13	67	11
Unknown	–	–	0	22	0	17	0	0	0	0	–	–	–	–
Hospital department														
ICU	21	6	21	16	13	24	26	1	41	16	18	21	23	16
Internal med.	55	5	46	13	53	18	38	1	31	16	44	9	37	13
Surgery	3	8	12	16	7	23	8	0	10	11	8	16	7	17
Other	20	10	21	12	24	28	26	0	17	14	28	18	31	11
Unknown	1	0	1	13	2	16	2	0	1	33	2	22	2	14

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Germany

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)



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

Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

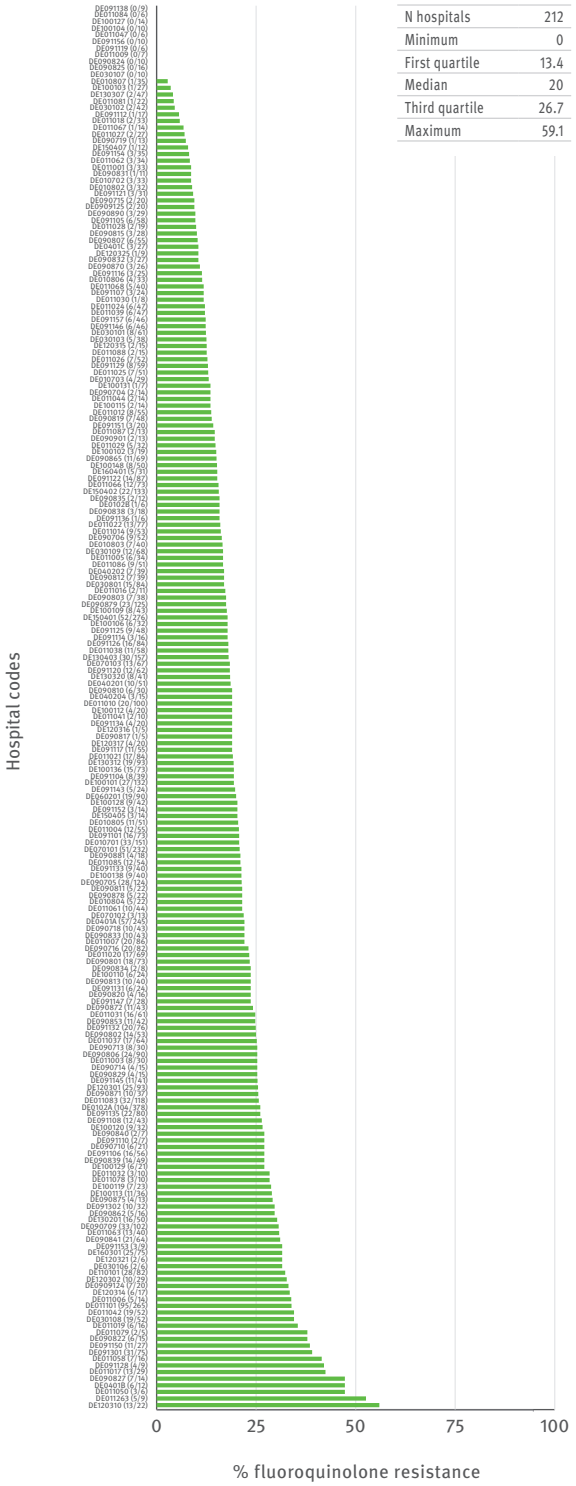
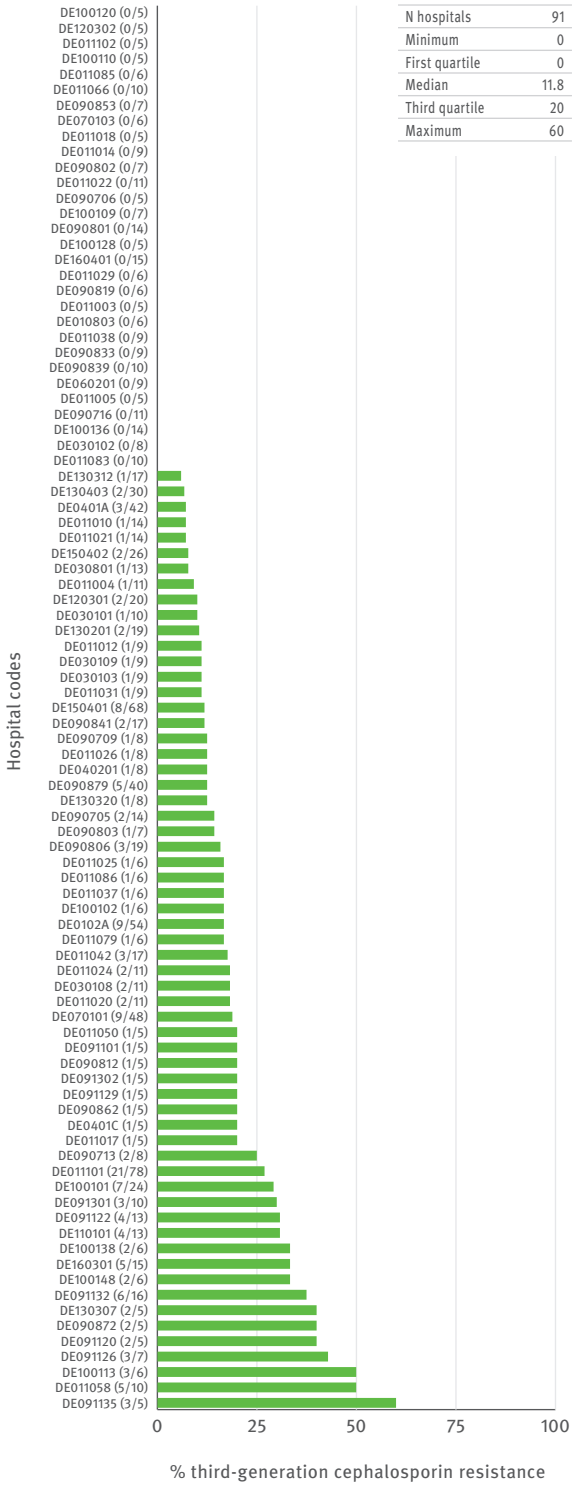


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Greece

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	–	–	39	826	37	1437	36	1122	38	1671	35	948
2012	–	–	38	877	37	1397	36	1121	37	1462	34	913
2013	–	–	32	776	31	1258	31	930	30	1212	30	886

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	–	–	–	–	–	–	–	–	–	–	–
Penicillin RI	–	–	–	–	–	–	–	–	–	–	–
Macrolides RI	–	–	–	–	–	–	–	–	–	–	–
Staphylococcus aureus											
Oxacillin/meticillin R	45	44	42	43	48	41	40	39	39	41	40
Escherichia coli											
Aminopenicilins R	44	46	46	46	48	50	51	52	55	55	56
Aminoglycosides R	6	6	7	7	9	15	14	16	17	18	17
Fluoroquinolones R	12	12	12	14	19	22	23	24	27	29	31
Third-generation cephalosporins R	6	6	7	6	8	10	10	14	15	16	17
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	1
Enterococcus faecalis											
Aminopenicilins RI	4	4	3	5	4	3	4	3	4	5	5
HL gentamicin R	52	59	54	57	65	52	61	43	37	28	24
Vancomycin R	7	4	4	5	7	7	6	3	6	7	7
Enterococcus faecium											
Aminopenicilins RI	89	84	85	88	91	85	86	93	93	94	89
HL gentamicin R	40	52	34	35	44	52	63	53	43	35	28
Vancomycin R	18	20	37	42	37	28	27	23	23	17	21
Klebsiella pneumoniae											
Aminoglycosides R	–	–	60	54	54	55	60	62	69	63	59
Fluoroquinolones R	–	–	54	50	55	64	66	71	72	70	68
Third-generation cephalosporins R	–	–	61	58	62	66	69	75	76	71	70
Carbapenems R	–	–	28	33	42	37	44	49	68	60	59
Pseudomonas aeruginosa											
Piperacillin R	–	–	30	39	38	34	33	39	31	34	30
Ceftazidime R	–	–	27	34	40	37	34	40	37	31	28
Carbapenems R	–	–	39	48	47	49	44	43	54	48	49
Aminoglycosides R	–	–	41	48	50	48	42	43	38	41	42
Fluoroquinolones R	–	–	39	45	50	48	45	46	39	44	43

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	–	–	100	41	100	30	100	7	100	19	98	70	98	48
CSF	–	–	–	–	<1	38	–	–	–	–	2	84	2	64
Gender														
Male	–	–	9	39	7	37	6	6	9	35	5	54	4	45
Female	–	–	4	52	8	25	5	7	4	34	3	60	3	23
Unknown	–	–	87	40	85	30	89	7	87	17	92	72	93	49
Age (years)														
0–4	–	–	4	26	5	22	6	9	4	11	4	70	4	55
5–19	–	–	1	20	0	0	–	–	<1	100	<1	25	<1	50
20–64	–	–	1	44	1	21	1	6	2	14	1	41	1	20
65 and over	–	–	2	50	3	32	2	8	2	53	1	60	1	35
Unknown	–	–	92	41	91	31	91	7	93	19	94	71	94	49
Hospital department														
ICU	–	–	12	54	4	32	31	13	30	19	42	89	45	59
Internal med.	–	–	70	38	77	29	50	5	50	20	38	54	39	39
Surgery	–	–	10	42	12	40	15	2	16	15	15	70	13	43
Other	–	–	3	25	3	6	1	0	1	29	2	21	1	19
Unknown	–	–	5	48	5	29	3	14	3	15	3	68	2	50

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Greece

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

No data reported

Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

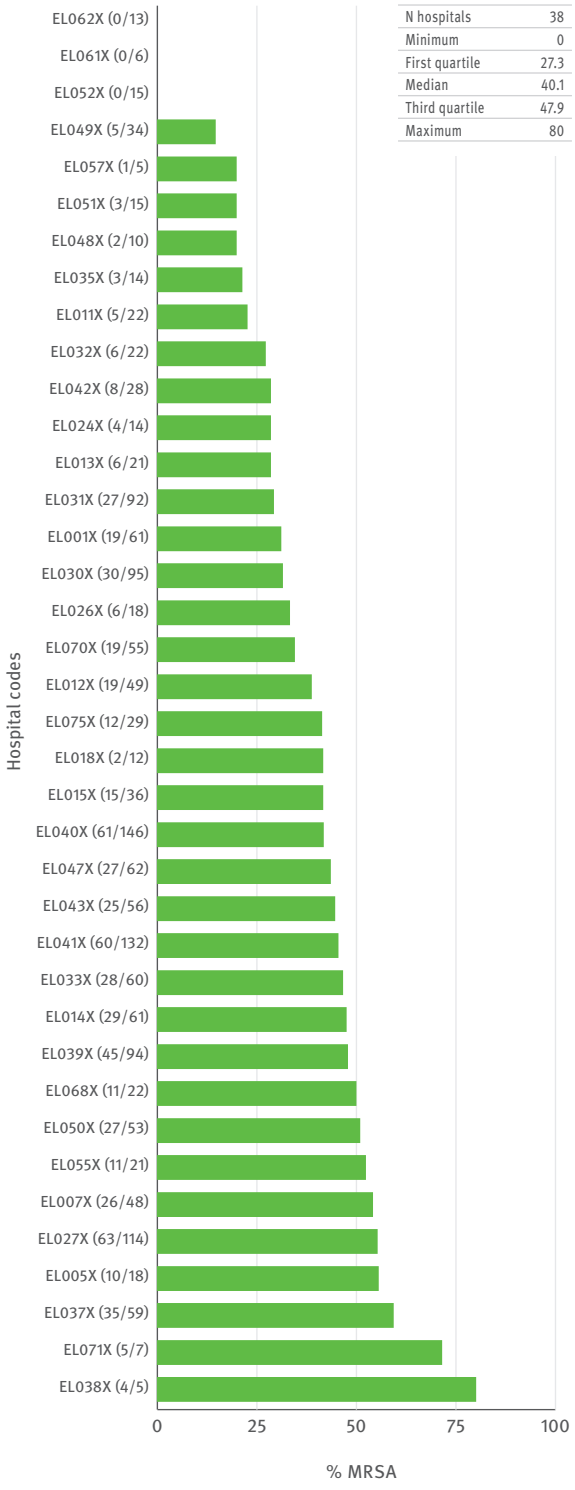


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

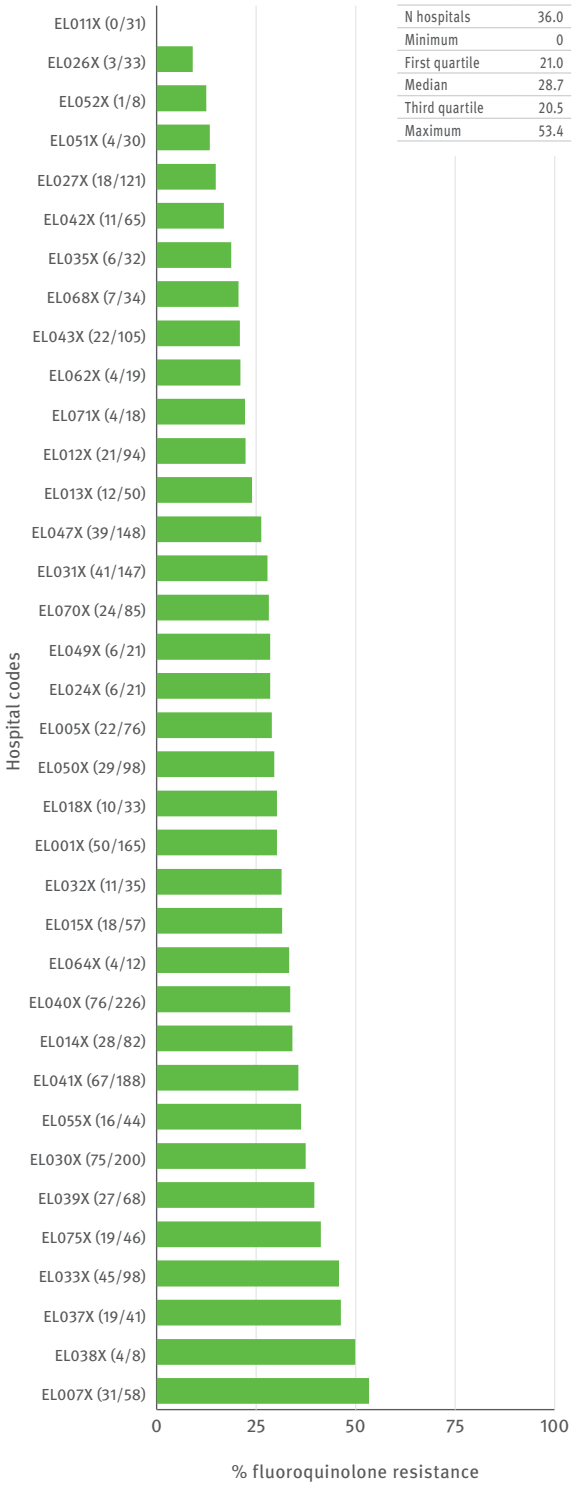
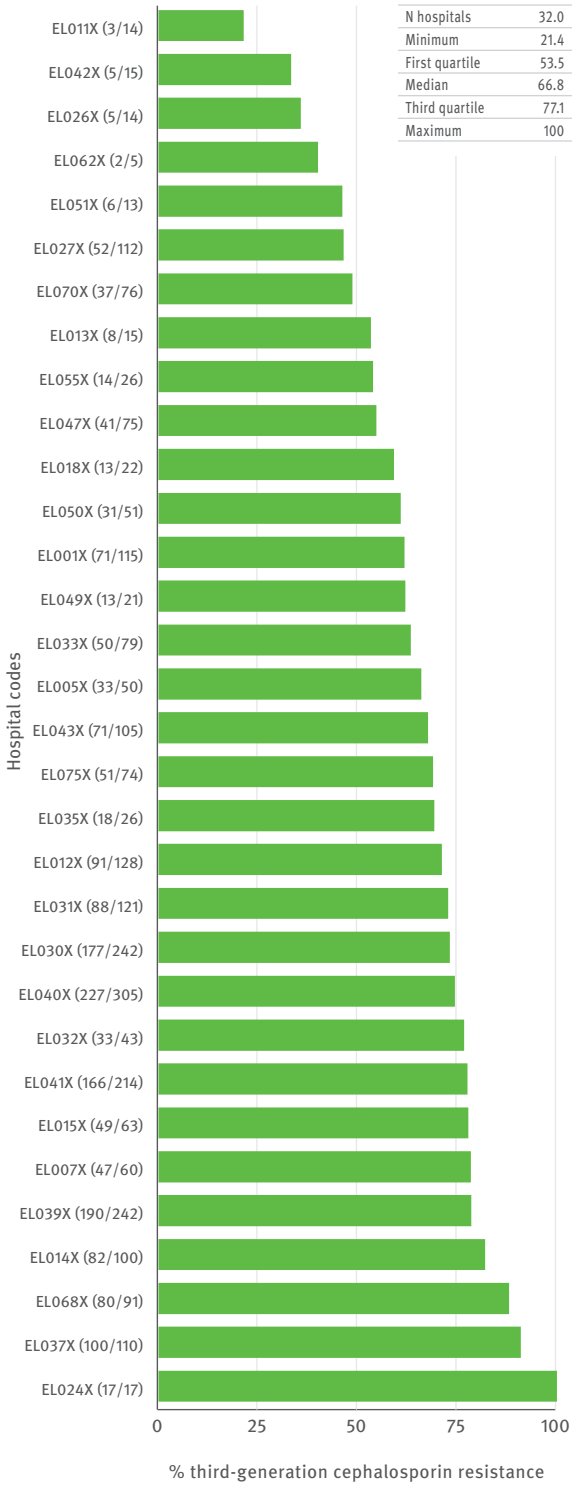


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Hungary

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	27	139	28	1156	30	1227	28	582	27	432	29	606
2012	26	160	28	1143	28	1415	28	594	27	500	29	619
2013	26	154	26	1201	30	1440	29	813	28	559	30	670

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Note: due to differences in the validation algorithms used by EARS-Net and Hungary, there are small discrepancies in the data presented by EARS-Net

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non–susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	3	<1	4	1	5	8	3	6	6	3	2
Penicillin RI	24	16	21	18	23	27	12	15	12	10	6
Macrolides RI	25	25	32	19	36	32	19	24	15	20	14
Staphylococcus aureus											
Oxacillin/meticillin R	15	17	20	25	23	23	29	30	26	25	24
Escherichia coli											
Aminopenicilins R	49	55	51	53	54	59	60	65	65	64	61
Aminoglycosides R	8	10	9	12	11	13	16	21	15	17	17
Fluoroquinolones R	15	19	22	27	26	26	30	37	31	29	30
Third–generation cephalosporins R	<1	3	4	5	5	9	13	19	15	17	19
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	<1	2	1	3	2	3	2	1	1	2	<1
HL gentamicin R	87	57	43	47	48	53	51	51	49	56	52
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	91	95	91	88	88	96	97	97	95	99	100
HL gentamicin R	96	80	64	67	53	62	70	62	45	51	58
Vancomycin R	<1	<1	<1	<1	<1	3	1	2	<1	4	7
Klebsiella pneumoniae											
Aminoglycosides R	–	–	26	20	29	36	40	48	53	41	37
Fluoroquinolones R	–	–	21	13	22	33	33	43	51	42	38
Third–generation cephalosporins R	–	–	28	20	25	35	38	46	53	43	37
Carbapenems R	–	–	<1	<1	<1	<1	<1	5	2	3	2
Pseudomonas aeruginosa											
Piperacillin R	–	–	10	9	11	13	19	14	11	19	20
Ceftazidime R	–	–	10	8	9	11	12	11	12	18	21
Carbapenems R	–	–	18	16	19	26	27	25	21	27	30
Aminoglycosides R	–	–	32	23	26	26	29	29	18	27	25
Fluoroquinolones R	–	–	28	21	24	26	27	27	20	22	23

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	74	8	100	24	99	30	100	0	100	6	98	40	96	29
CSF	26	8	–	–	1	18	–	–	–	–	2	33	4	34
Gender														
Male	59	8	58	24	45	31	58	0	52	4	58	42	58	31
Female	40	9	42	25	54	28	42	0	47	7	42	37	41	26
Unknown	1	0	1	25	0	36	1	0	1	0	1	67	1	25
Age (years)														
0–4	4	21	2	2	3	10	3	0	4	0	6	23	3	21
5–19	12	5	5	29	7	32	7	0	8	11	8	33	6	26
20–64	45	8	42	22	33	32	37	0	36	8	40	42	43	33
65 and over	39	7	51	27	57	29	53	0	52	4	47	42	48	26
Hospital department														
ICU	31	8	23	35	15	31	39	0	49	4	31	46	50	40
Internal med.	20	5	22	23	25	29	18	0	13	7	18	35	10	13
Surgery	0	0	10	29	6	36	10	0	7	8	9	48	10	26
Other	46	10	42	19	50	29	29	0	28	8	39	37	27	19
Unknown	3	0	3	16	4	32	3	0	3	0	3	29	3	0

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Hungary

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

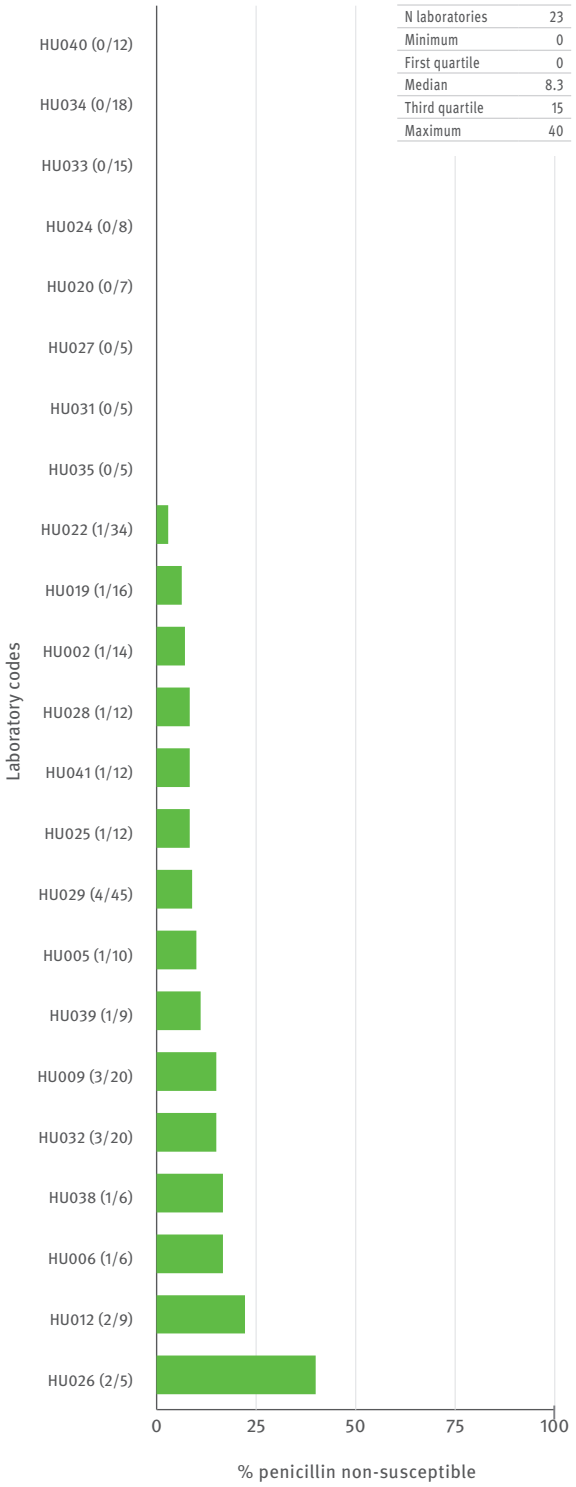


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

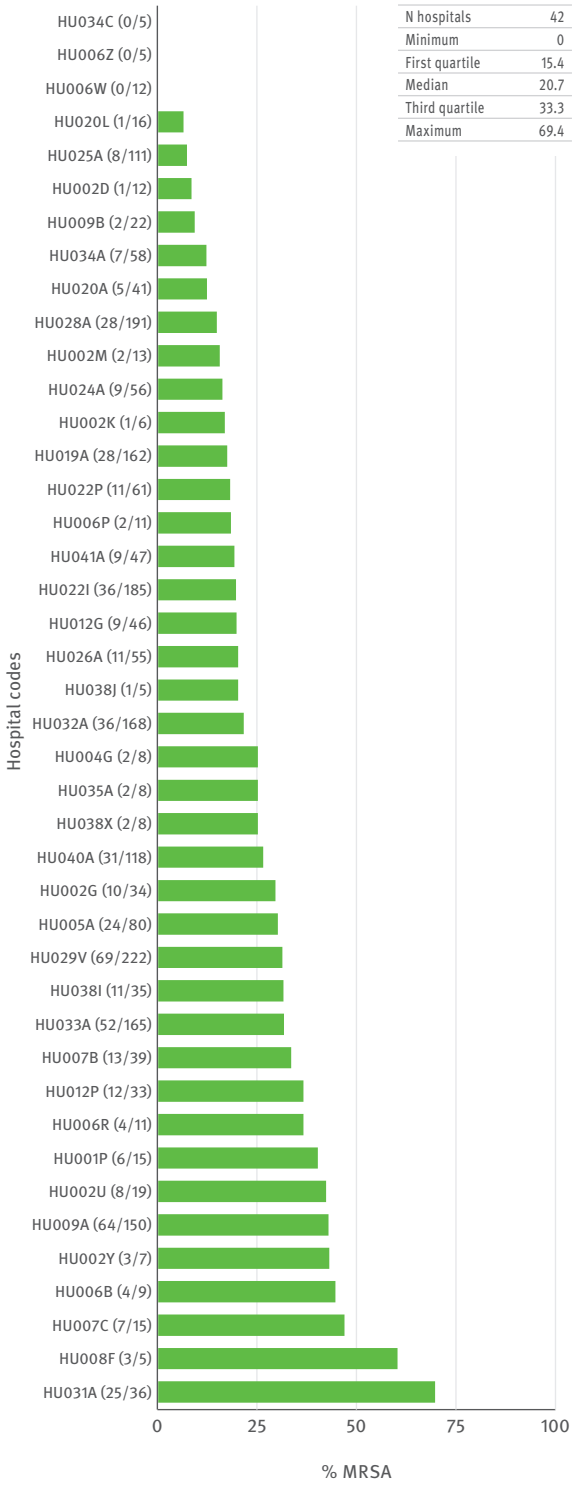


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

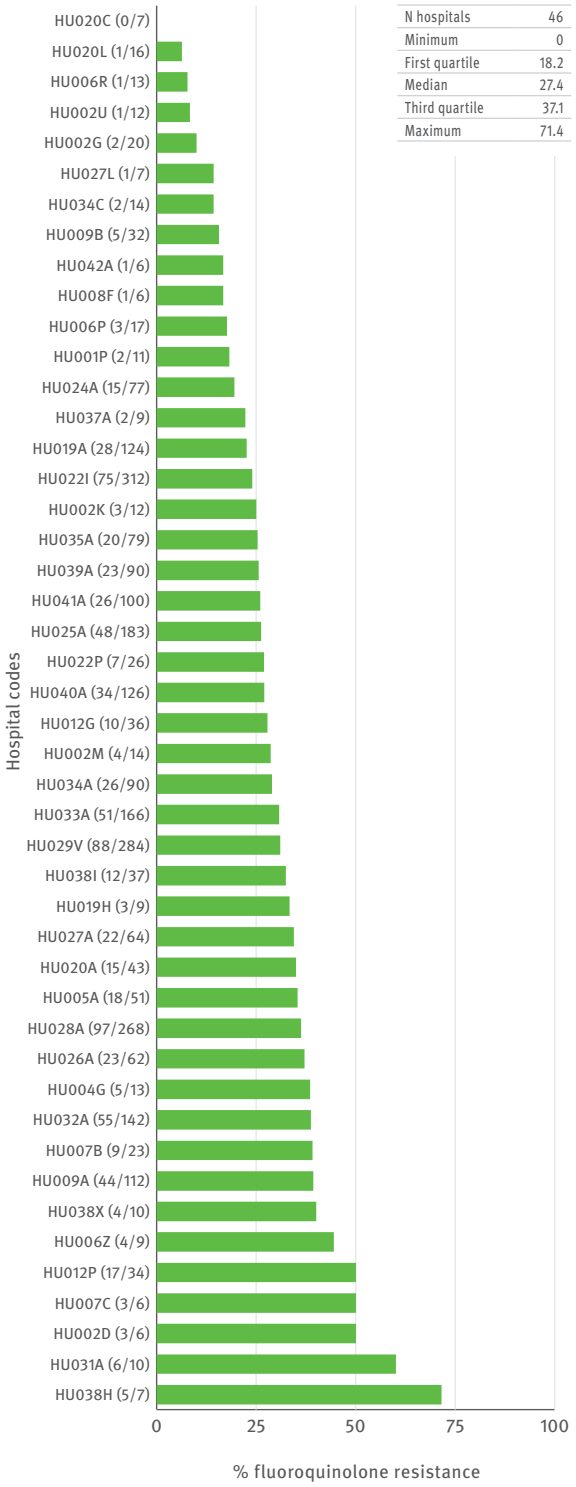
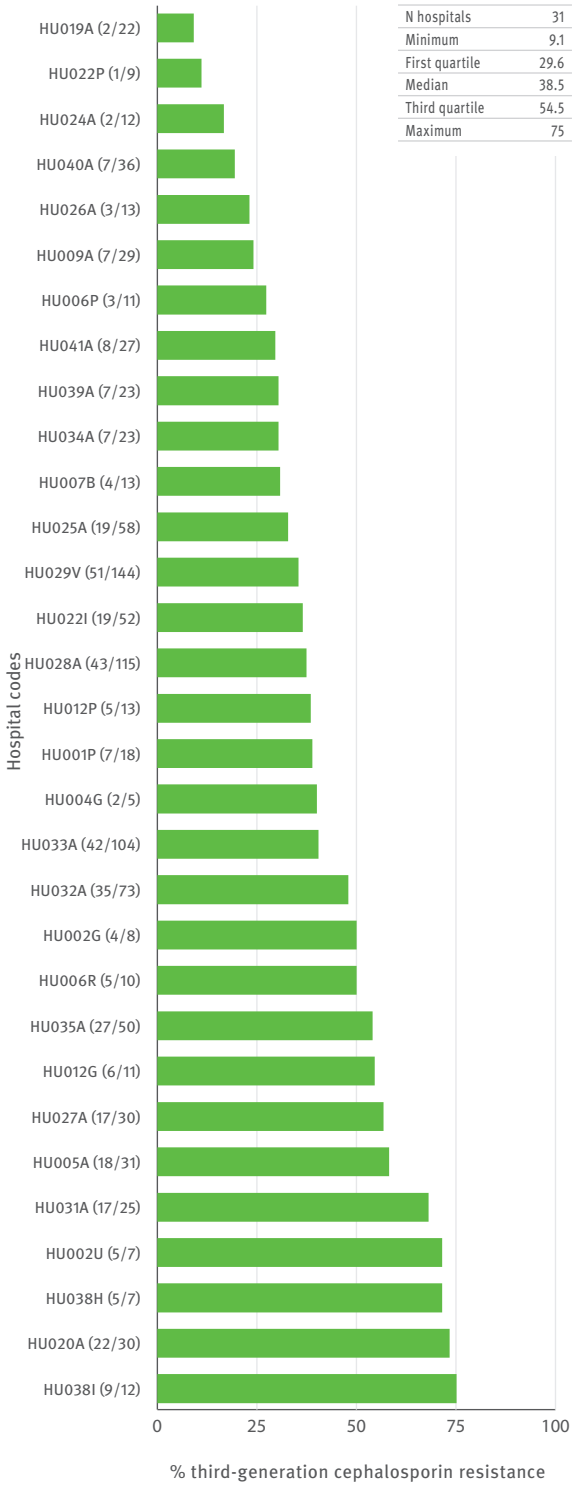


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Iceland

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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	36	2	59	2	111	2	51	2	27	2	16
2010	2	37	2	65	2	104	2	31	2	27	2	12
2011	2	32	2	71	2	130	2	32	2	26	2	17
2012	2	28	2	58	2	143	2	30	2	16	1	10
2013	2	18	2	69	2	121	1	32	2	30	1	11

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	<1	2	<1	<1	2	<1	<1	3	6	4	6
Penicillin RI	9	17	8	6	7	9	<1	5	9	4	17
Macrolides RI	20	8	17	10	17	22	9	11	22	7	17
Staphylococcus aureus											
Oxacillin/meticillin R	<1	<1	<1	<1	<1	2	<1	2	3	2	<1
Escherichia coli											
Aminopenicilins R	42	43	38	45	46	44	50	46	48	44	46
Aminoglycosides R	2	<1	<1	7	6	7	7	3	6	4	4
Fluoroquinolones R	6	2	3	12	17	6	7	11	14	10	15
Third-generation cephalosporins R	1	<1	<1	<1	2	<1	2	4	6	5	5
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	<1	<1	<1	7	<1	<1	<1	<1	<1	<1	<1
HL gentamicin R	<1	5	<1	3	13	30	15	13	<1	12	33
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	57	63	80	56	57	43	68	38	69	67	82
HL gentamicin R	<1	13	<1	14	14	43	36	13	15	9	35
Vancomycin R	<1	<1	<1	<1	<1	<1	8	6	<1	<1	6
Klebsiella pneumoniae											
Aminoglycosides R	–	–	<1	<1	<1	4	<1	<1	<1	<1	<1
Fluoroquinolones R	–	–	<1	<1	<1	8	<1	<1	4	7	<1
Third-generation cephalosporins R	–	–	<1	<1	<1	4	<1	4	8	21	<1
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	8	<1	<1	<1	13	8	6	10	<1
Ceftazidime R	–	–	8	<1	<1	<1	6	8	6	10	<1
Carbapenems R	–	–	8	<1	<1	<1	<1	<1	6	10	9
Aminoglycosides R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fluoroquinolones R	–	–	<1	<1	<1	<1	13	17	6	10	<1

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	87	5	100	1	100	12	100	0	100	3	100	7	100	10
CSF	13	33	–	–	–	–	–	–	–	–	–	–	–	–
Gender														
Male	38	0	68	1	45	15	58	0	62	6	48	14	67	7
Female	62	14	32	0	55	9	42	0	38	0	52	0	33	14
Age (years)														
0–4	2	0	3	0	4	0	–	–	–	–	–	–	–	–
5–19	–	–	8	0	2	0	–	–	–	–	–	–	5	0
20–64	60	15	39	2	36	10	33	0	31	11	41	6	38	13
65 and over	38	0	50	0	58	14	67	0	69	0	59	8	57	8
Hospital department														
ICU	2	0	1	0	2	20	6	0	17	0	5	0	29	0
Internal med.	9	25	17	0	11	19	21	0	7	0	16	14	10	0
Surgery	2	0	5	0	5	17	15	0	14	0	9	25	5	0
Other	78	9	75	1	78	11	58	0	59	6	61	4	52	18
Unknown	9	0	3	0	4	0	–	–	3	0	9	0	5	0

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Iceland

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

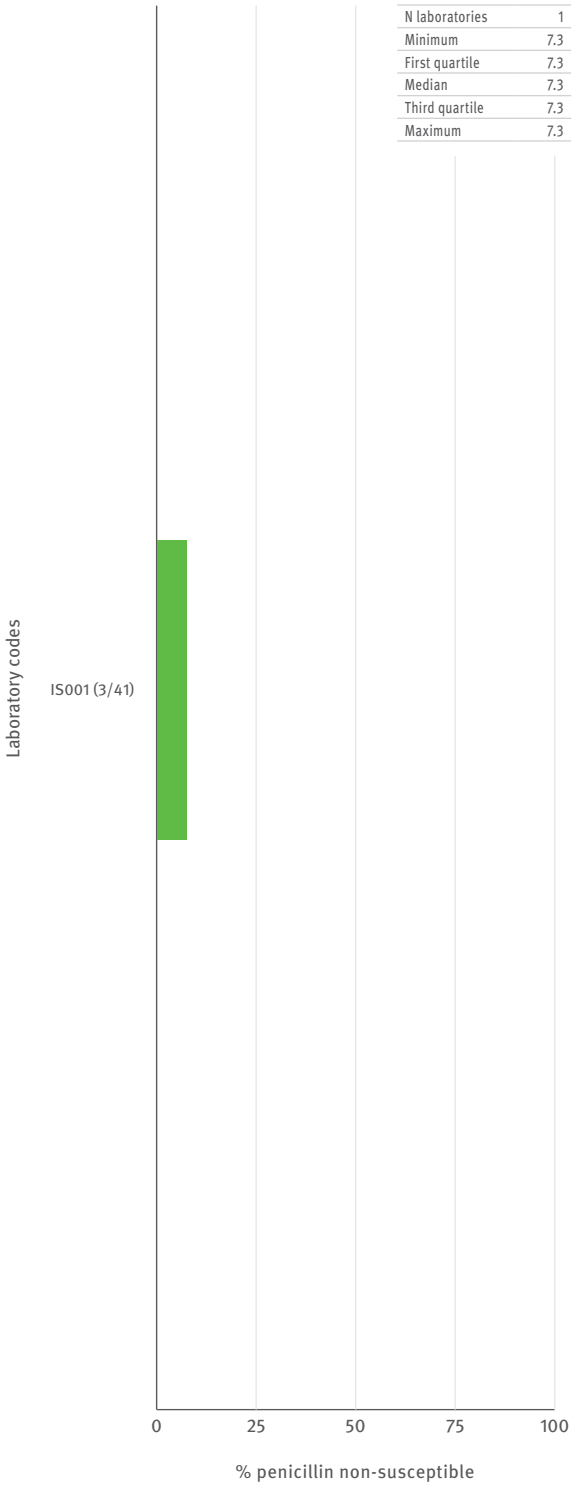


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

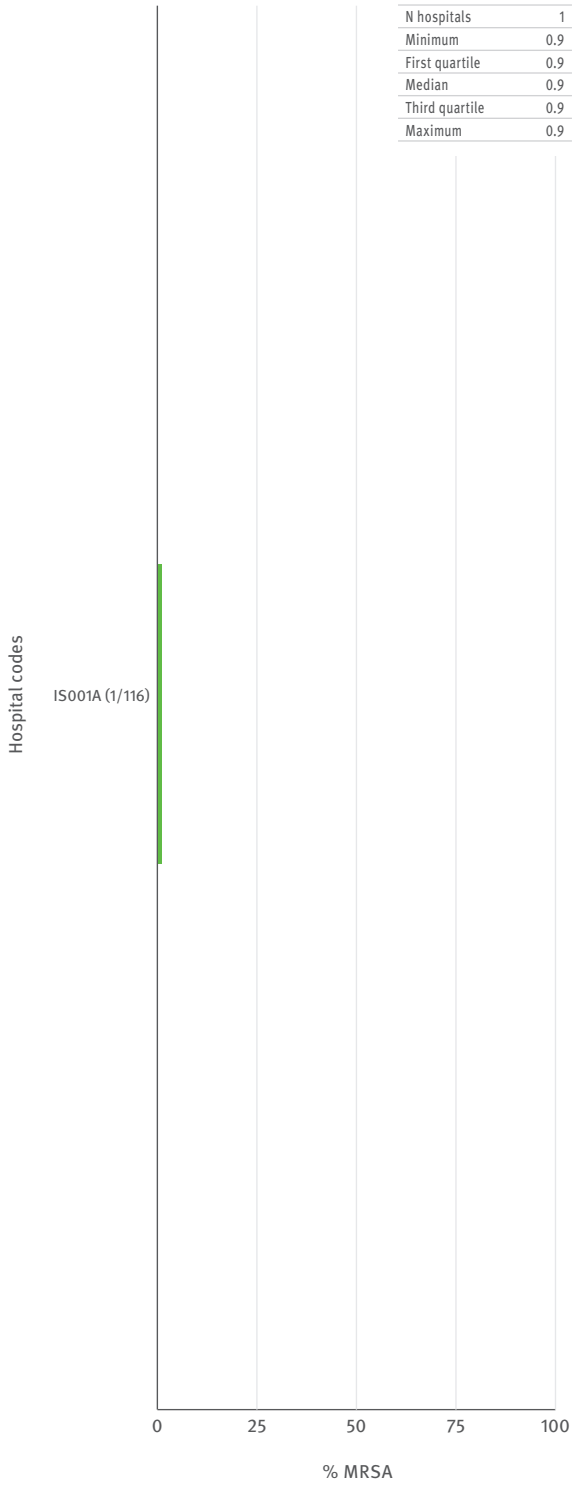


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

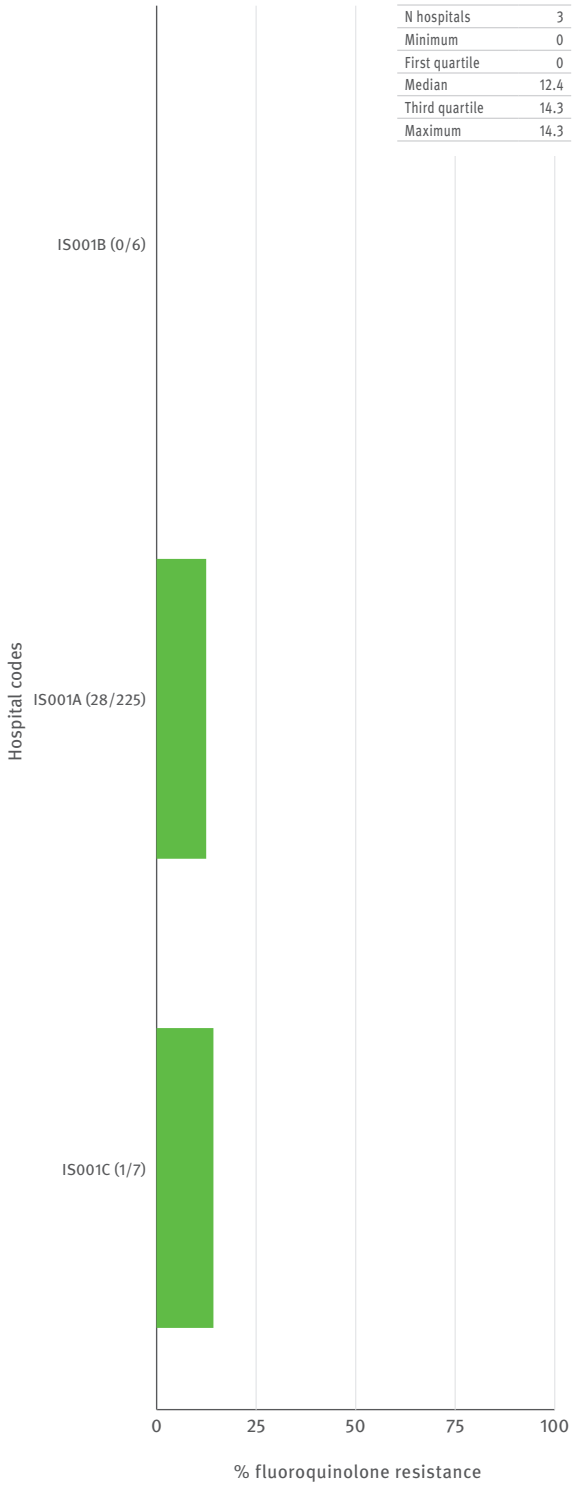
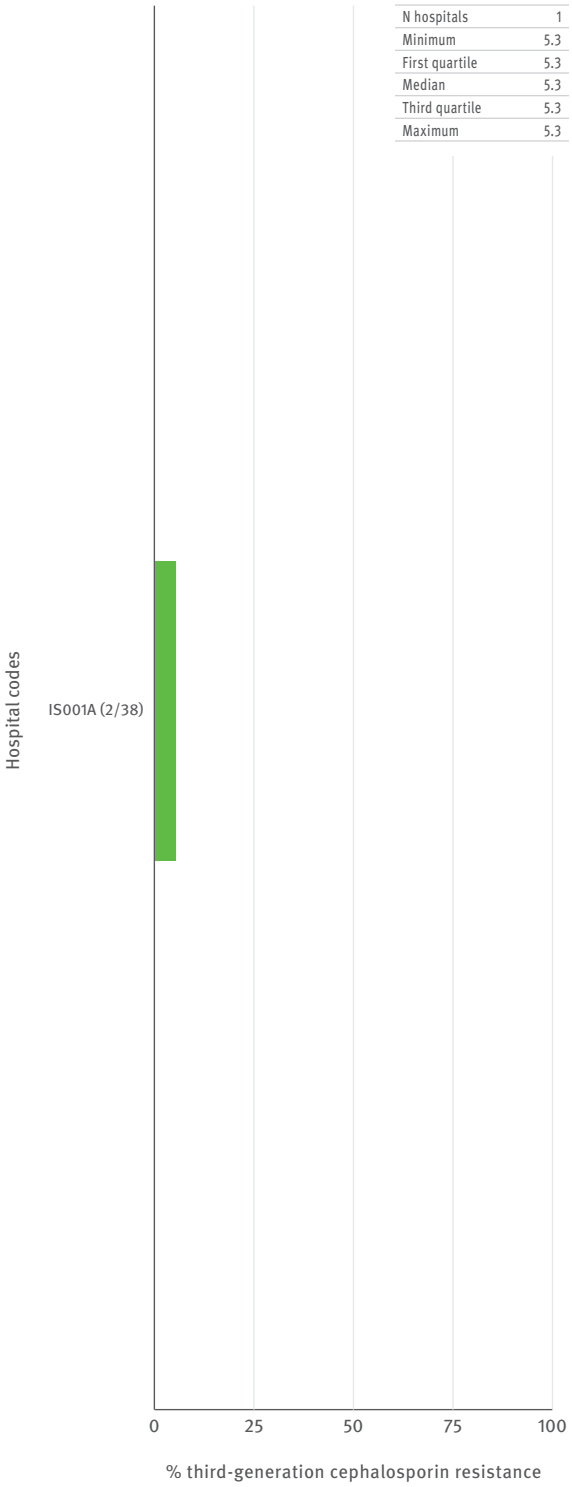


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Ireland

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	32	324	39	1057	38	2167	36	608	34	304	28	181
2012	30	319	40	1038	40	2386	37	677	32	338	34	216
2013	33	310	39	1069	40	2482	38	726	32	317	33	205

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	3	3	3	3	6	6	6	5	6	5	2
Penicillin RI	12	10	11	16	17	23	20	18	19	19	20
Macrolides RI	12	14	12	16	17	17	17	16	18	17	18
Staphylococcus aureus											
Oxacillin/meticillin R	42	41	42	42	38	33	27	24	24	23	20
Escherichia coli											
Aminopenicilins R	61	65	67	69	65	67	66	67	70	67	69
Aminoglycosides R	4	5	7	7	10	9	9	10	10	11	11
Fluoroquinolones R	10	12	17	21	21	23	22	23	23	24	24
Third-generation cephalosporins R	2	2	4	4	5	6	6	8	9	9	11
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	5	<1	4	5	2	<1	3	2	<1	4	3
HL gentamicin R	32	42	42	43	38	31	34	29	30	33	32
Vancomycin R	<1	1	3	3	3	3	<1	<1	4	3	2
Enterococcus faecium											
Aminopenicilins RI	91	96	93	94	93	95	93	96	96	93	93
HL gentamicin R	54	56	52	44	36	27	38	39	36	39	38
Vancomycin R	19	22	31	36	33	35	38	39	35	44	43
Klebsiella pneumoniae											
Aminoglycosides R	–	–	5	9	10	9	11	7	8	9	17
Fluoroquinolones R	–	–	3	16	17	11	11	8	9	7	15
Third-generation cephalosporins R	–	–	7	9	8	11	11	8	8	10	19
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	7	7	6	5	4	8	3	16	11
Ceftazidime R	–	–	10	6	5	4	6	6	4	14	8
Carbapenems R	–	–	11	9	9	6	8	6	6	11	9
Aminoglycosides R	–	–	7	9	9	6	7	5	4	10	11
Fluoroquinolones R	–	–	14	17	18	16	9	11	6	15	12

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2010 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	98	19	100	21	100	24	100	2	100	43	99	14	99	10
CSF	2	38	–	–	<1	25	–	–	–	–	1	0	1	0
Gender														
Male	53	21	65	23	48	29	67	2	59	42	59	16	61	9
Female	47	18	35	19	52	20	33	2	41	45	41	11	39	12
Unknown	–	–	–	–	<1	50	–	–	–	–	–	–	–	–
Age (years)														
0–4	10	20	6	5	3	9	6	0	1	0	2	25	3	18
5–19	3	19	4	12	1	8	1	0	1	29	1	17	2	22
20–64	35	18	40	15	29	21	35	3	37	52	41	14	31	16
65 and over	53	21	49	29	67	27	59	2	61	39	56	14	64	7
Unknown	<1	100	<1	50	0	0	–	–	–	–	–	–	0	0
Hospital department														
ICU	3	18	3	23	3	31	5	0	9	48	4	13	6	12
Internal med.	11	25	10	28	11	23	9	2	8	38	11	13	10	12
Surgery	1	43	3	37	3	24	5	0	5	26	4	11	2	0
Other	32	17	23	18	27	20	20	2	11	37	20	8	18	8
Unknown	52	20	62	21	56	26	61	3	67	46	62	17	63	11

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Ireland

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

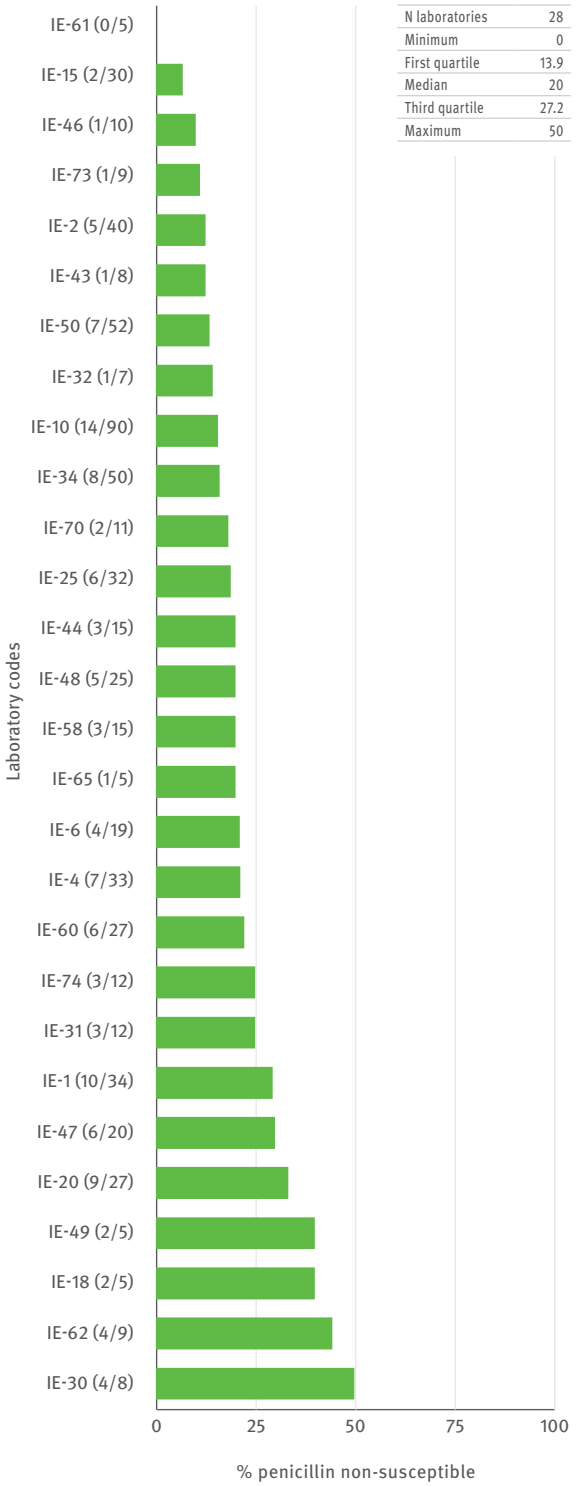


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

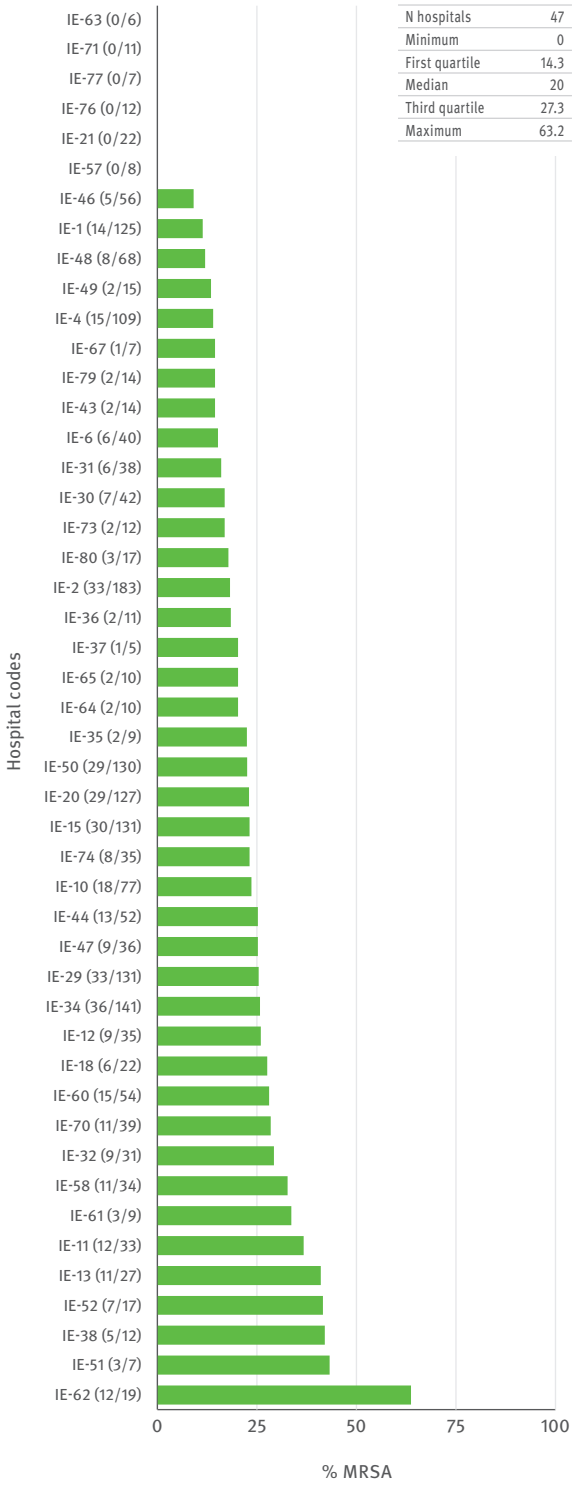


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

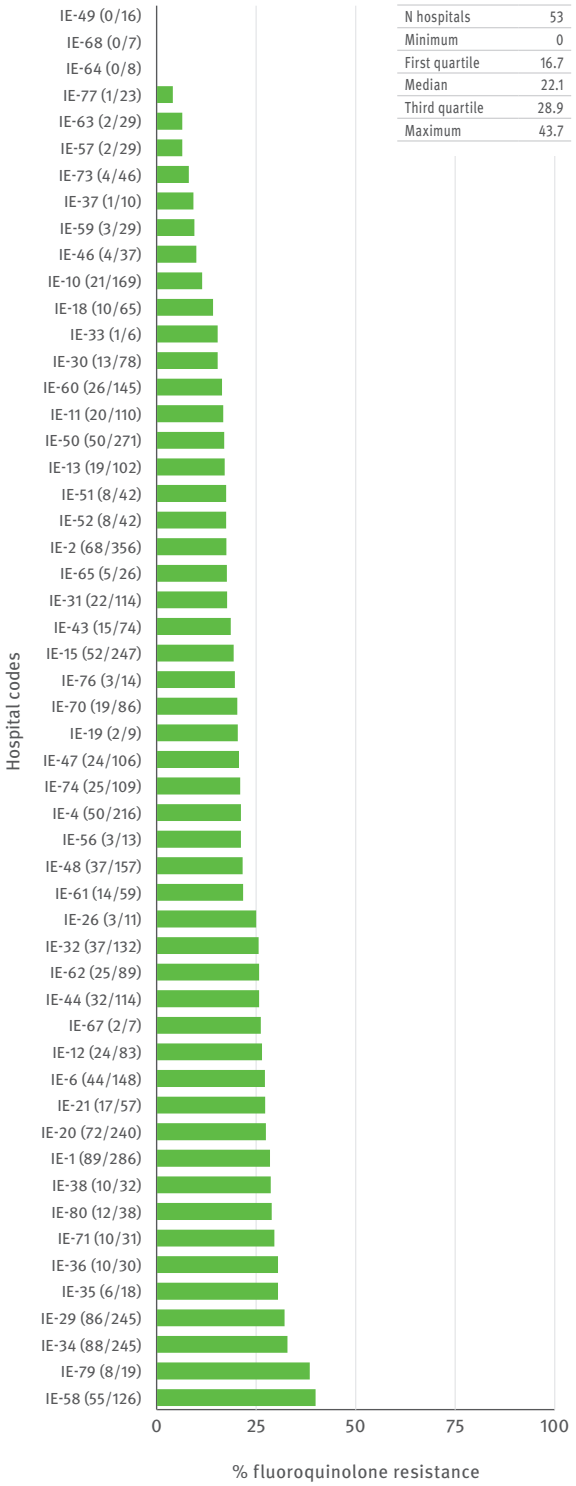


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)

Italy

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	29	294	31	1372	21	2098	31	841	30	688	21	355
2012	32	293	42	1772	42	3555	42	949	38	984	42	777
2013	43	436	52	2540	43	4097	50	1386	48	1486	42	796

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	5	5	5	<1	4	3	3	5	6	6	9
Penicillin RI	13	14	9	7	15	10	6	9	7	12	15
Macrolides RI	37	29	31	33	31	26	21	29	27	34	25
Staphylococcus aureus											
Oxacillin/meticillin R	39	40	37	38	34	34	37	37	38	35	36
Escherichia coli											
Aminopenicilins R	52	53	55	56	58	62	63	64	67	68	66
Aminoglycosides R	10	9	11	8	14	14	13	15	18	21	18
Fluoroquinolones R	25	28	28	27	32	38	36	39	41	42	42
Third-generation cephalosporins R	6	5	8	7	11	16	17	21	20	26	26
Carbapenems R	–	–	–	–	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	4	4	4	4	4	13	20	13	11	4	4
HL gentamicin R	39	36	38	38	39	47	49	50	50	51	46
Vancomycin R	2	2	3	3	2	2	3	2	3	1	1
Enterococcus faecium											
Aminopenicilins RI	80	78	77	86	73	64	60	70	83	87	82
HL gentamicin R	44	39	36	48	53	49	52	59	54	62	59
Vancomycin R	24	21	19	18	11	6	4	4	4	6	4
Klebsiella pneumoniae											
Aminoglycosides R	–	–	8	26	25	28	19	29	35	42	45
Fluoroquinolones R	–	–	11	23	27	28	20	39	46	50	54
Third-generation cephalosporins R	–	–	20	33	35	39	37	47	46	48	55
Carbapenems R	–	–	–	1	1	2	1	15	27	29	34
Pseudomonas aeruginosa											
Piperacillin R	–	–	–	23	20	20	24	21	22	30	31
Ceftazidime R	–	–	–	20	25	24	16	18	16	26	24
Carbapenems R	–	–	–	21	27	33	31	22	21	25	26
Aminoglycosides R	–	–	–	32	29	30	29	23	18	30	27
Fluoroquinolones R	–	–	–	36	35	36	42	31	26	31	29

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	86	12	100	36	100	42	100	1	100	5	99	52	98	25
CSF	14	24	–	–	<1	33	–	–	–	–	1	81	2	50
Gender														
Male	46	11	48	36	44	47	41	0	48	6	46	50	46	21
Female	36	9	33	37	42	34	22	1	30	3	29	43	27	22
Unknown	18	29	19	32	14	53	37	3	22	6	25	68	27	36
Age (years)														
0–4	2	43	1	25	1	11	1	0	1	0	1	24	1	21
5–19	2	20	1	23	<1	28	0	0	–	–	<1	83	<1	14
20–64	14	14	15	24	12	40	14	1	13	4	15	57	16	34
65 and over	35	12	29	38	33	41	37	2	24	4	30	51	28	21
Unknown	47	14	54	38	54	44	47	1	62	6	53	52	54	26
Hospital department														
ICU	9	11	11	42	6	38	20	2	19	8	21	67	20	36
Internal med.	33	7	39	37	38	41	33	0	32	4	30	46	26	19
Surgery	2	22	15	37	14	45	11	1	18	3	15	52	16	20
Other	55	18	36	32	42	43	36	2	31	5	35	49	38	26

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Italy

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

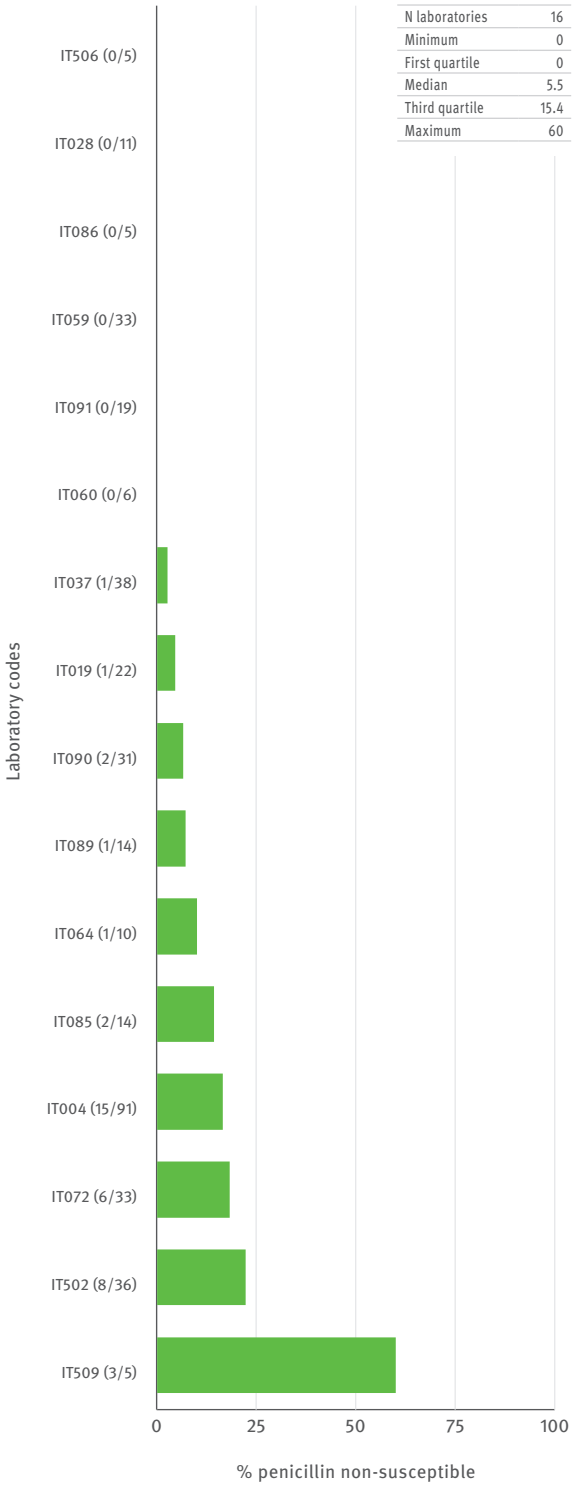


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

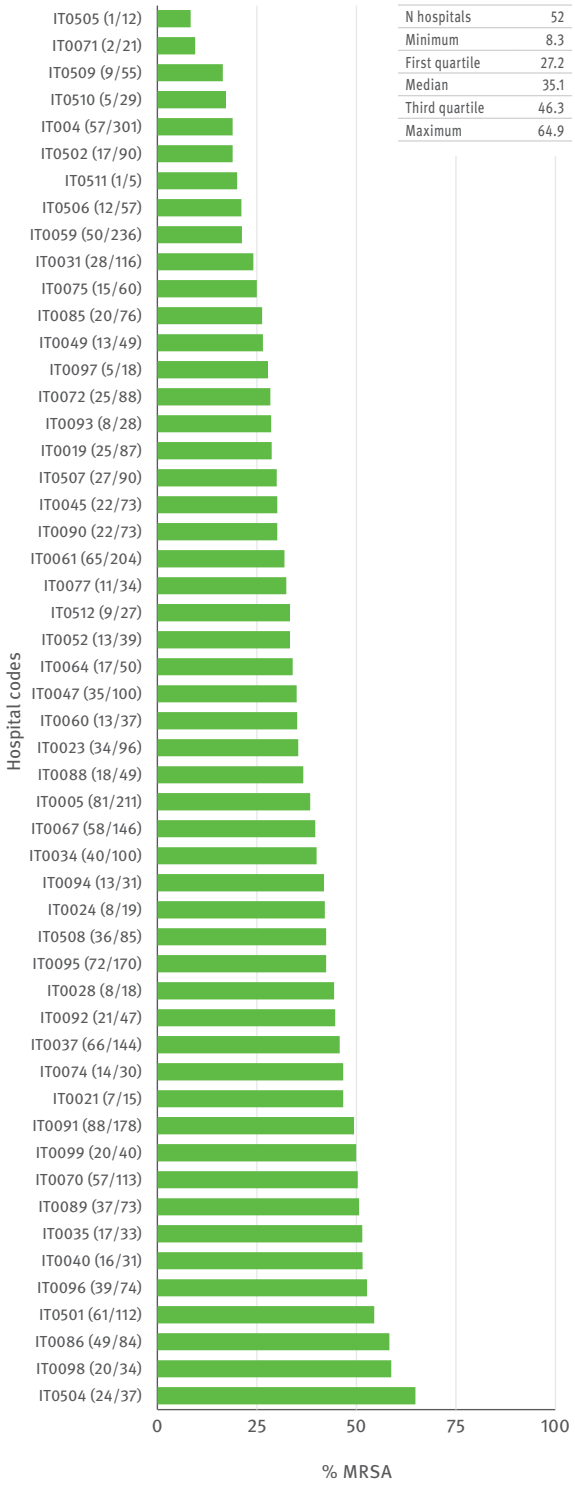


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

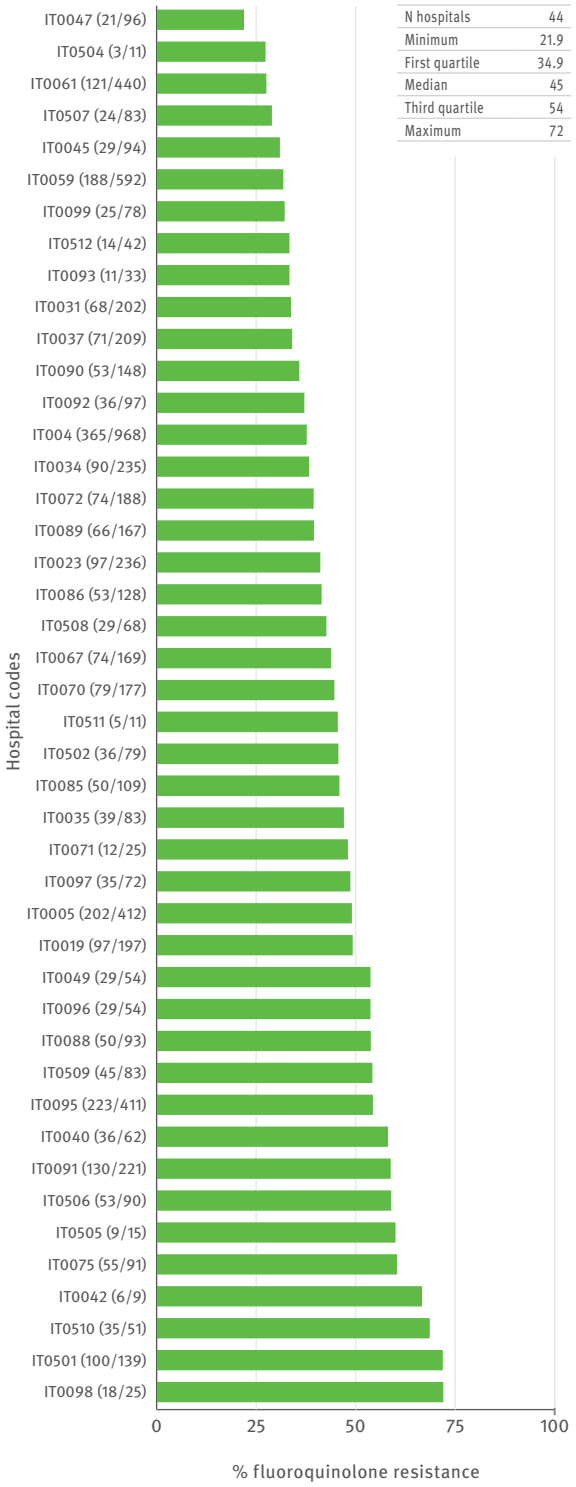
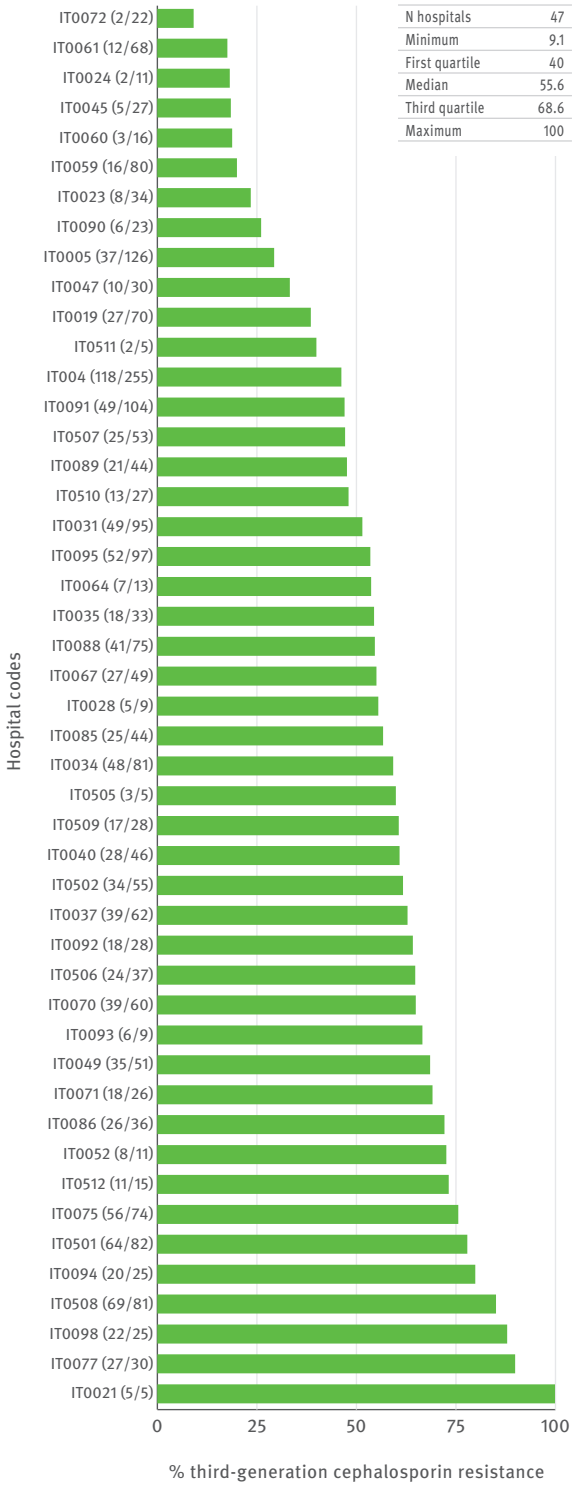


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Latvia

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2004–2013

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	–	–	–	–	–	–	–	–	–	–	–	–
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
2011	5	51	11	197	9	132	8	59	9	65	4	12
2012	7	64	11	211	10	154	7	73	8	78	6	18
2013	10	67	13	207	12	136	10	83	10	92	6	25

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	–	<1	<1	<1	<1	6	<1	5	10	6	12
Penicillin RI	–	<1	<1	<1	<1	6	<1	5	13	6	12
Macrolides RI	–	7	3	3	<1	<1	3	5	<1	5	2
Staphylococcus aureus											
Oxacillin/meticillin R	–	26	20	19	8	12	9	14	10	9	7
Escherichia coli											
Aminopenicilins R	–	–	–	44	43	48	43	50	55	54	52
Aminoglycosides R	–	–	–	5	14	10	13	11	11	12	7
Fluoroquinolones R	–	–	–	10	17	14	24	14	17	14	19
Third-generation cephalosporins R	–	–	–	6	14	11	12	12	16	13	14
Carbapenems R	–	–	–	<1	<1	<1	2	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	–	–	–	9	30	5	12	5	18	7	9
HL gentamicin R	–	–	–	50	–	27	38	47	26	29	61
Vancomycin R	–	–	–	<1	<1	<1	<1	<1	<1	<1	7
Enterococcus faecium											
Aminopenicilins RI	–	–	–	94	77	90	82	100	96	89	96
HL gentamicin R	–	–	–	73	<1	78	79	83	42	28	25
Vancomycin R	–	–	–	<1	<1	7	18	13	9	6	12
Klebsiella pneumoniae											
Aminoglycosides R	–	–	–	25	22	52	43	55	34	51	49
Fluoroquinolones R	–	–	–	26	27	45	34	52	38	46	43
Third-generation cephalosporins R	–	–	–	36	44	58	55	55	38	63	66
Carbapenems R	–	–	–	<1	<1	3	<1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	–	17	31	30	17	19	9	18	21
Ceftazidime R	–	–	–	29	13	36	17	10	9	22	24
Carbapenems R	–	–	–	13	6	40	7	14	8	11	28
Aminoglycosides R	–	–	–	47	31	45	22	29	25	22	20
Fluoroquinolones R	–	–	–	33	13	45	12	19	25	22	24

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	85	7	100	8	100	16	100	4	100	9	95	63	100	21
CSF	15	21	–	–	<1	100	–	–	–	–	5	100	–	–
Sex														
Male	68	10	57	10	40	26	59	2	42	6	66	63	60	23
Female	32	7	43	5	60	10	41	7	58	12	34	68	40	18
Unknown	–	–	–	–	0	0	–	–	–	–	–	–	–	–
Age (years)														
0 to 4 years	4	0	10	3	6	6	7	0	–	–	6	70	2	0
5 to 19 years	2	0	2	0	3	11	3	0	2	0	2	67	–	–
20 to 64 years	67	10	50	10	43	10	40	0	42	22	52	62	42	28
65 years or older	27	9	39	7	47	24	50	8	56	0	40	68	56	17
Hospital department														
ICU	56	5	26	12	30	25	40	7	51	5	45	58	51	27
Internal Med.	12	6	42	4	31	17	26	4	30	8	20	76	16	14
Surgery	1	0	9	17	6	17	15	0	7	33	6	82	12	0
Other	31	18	23	8	33	8	19	0	12	20	28	63	21	22
Unknown	–	–	0	0	–	–	–	–	–	–	1	100	–	–

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Latvia

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

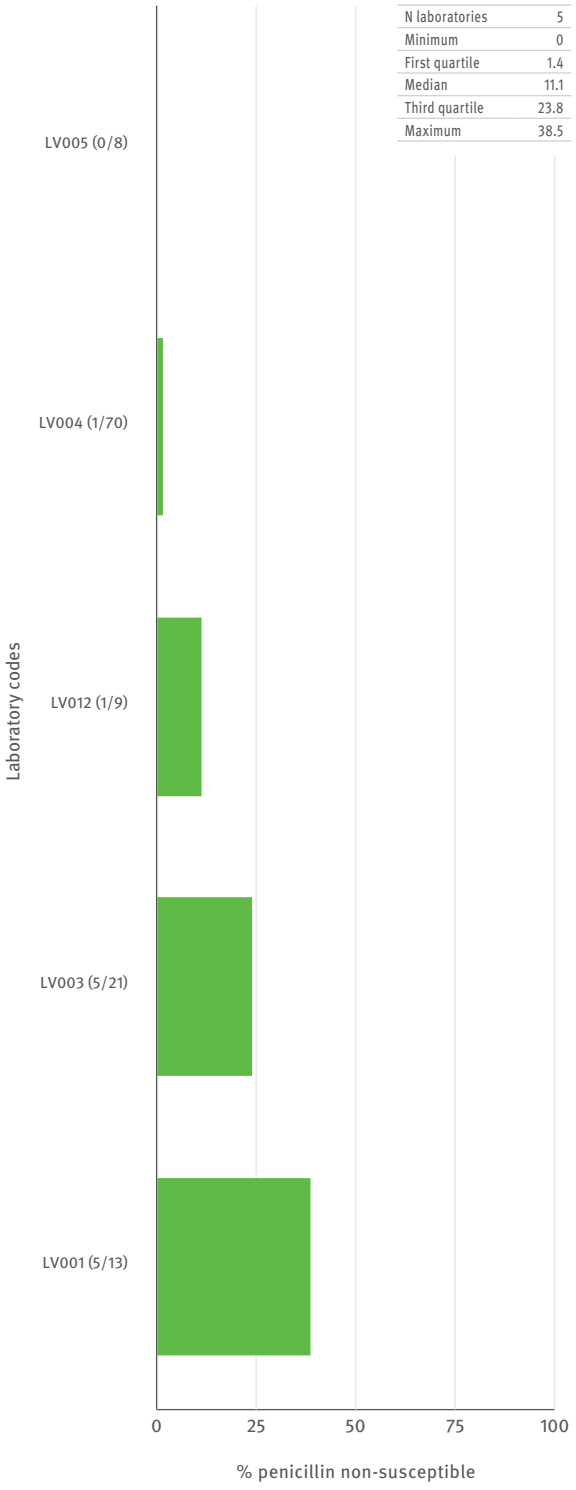


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

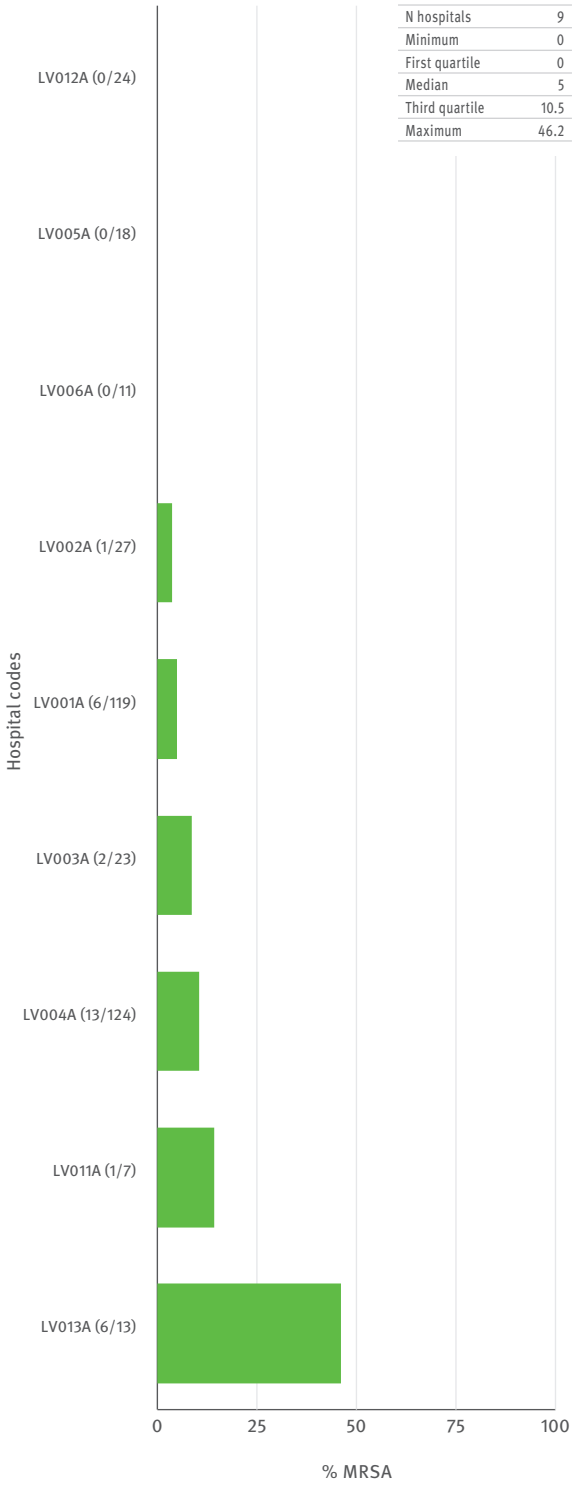


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

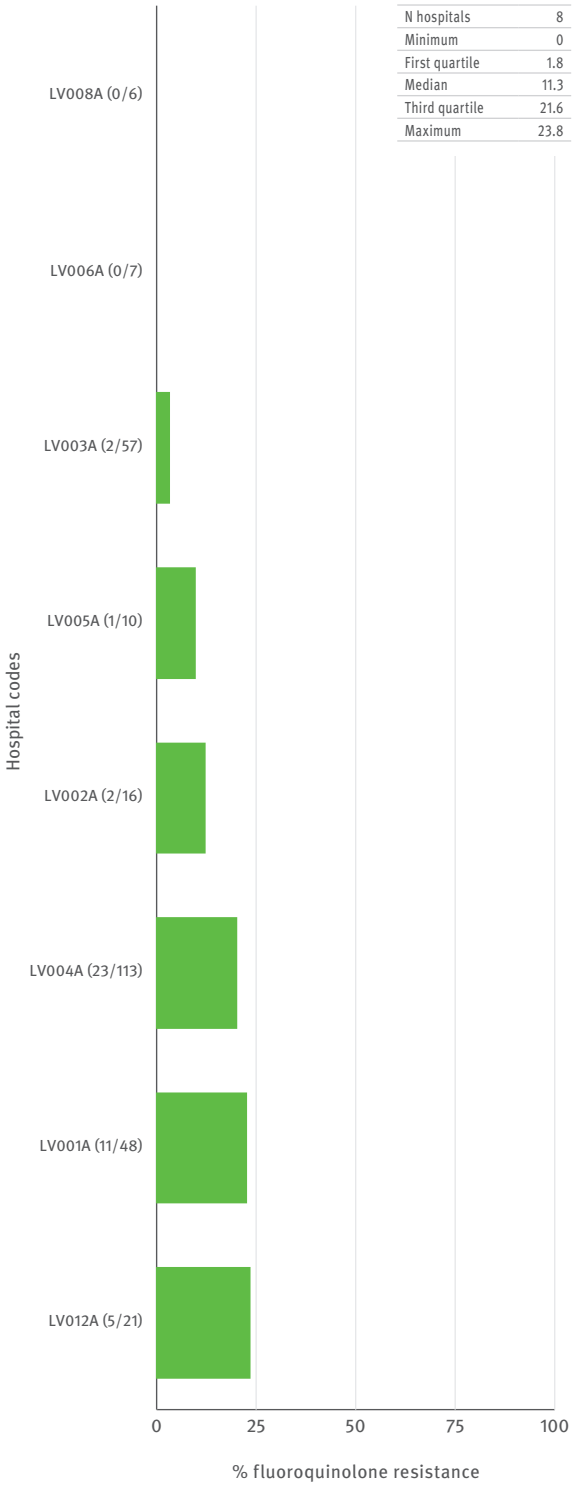
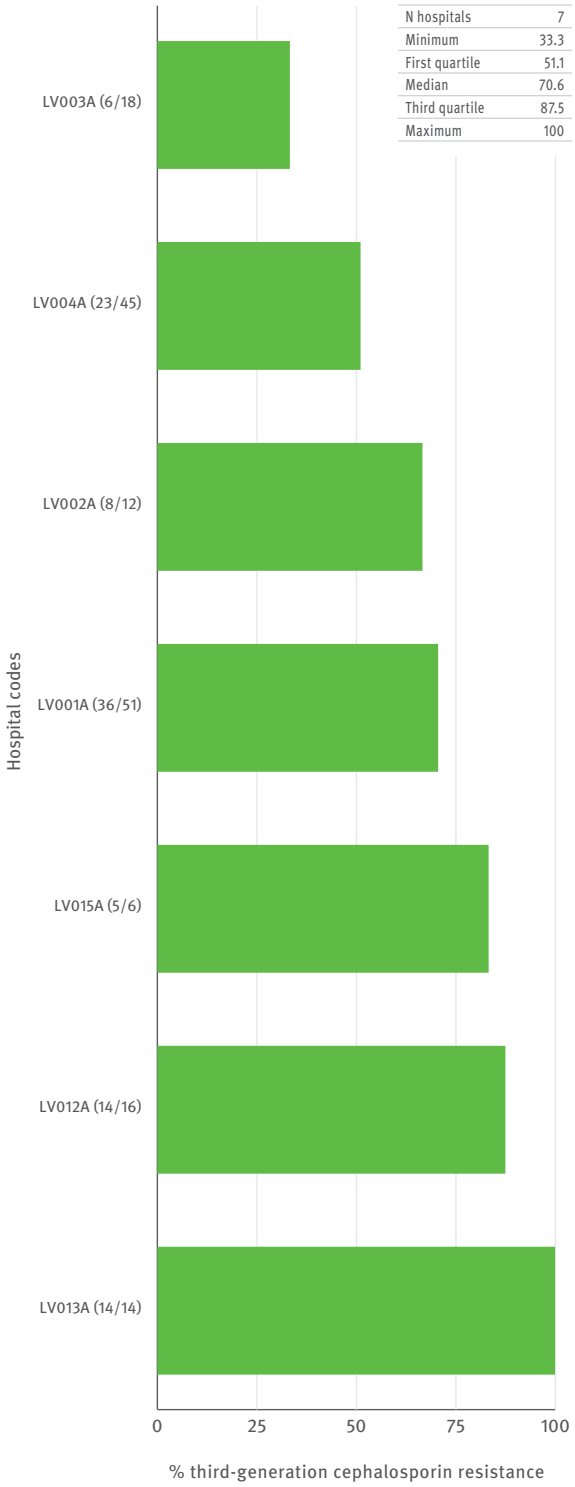


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Lithuania

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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	–	–	–	–	–	–	–	–	–	–	–	–
2004	–	–	–	–	–	–	–	–	–	–	–	–
2005	–	–	–	–	–	–	–	–	–	–	–	–
2006	9	35	13	167	11	171	8	30	8	35	7	14
2007	10	67	12	240	13	235	10	56	10	41	7	21
2008	11	48	12	278	12	304	10	67	11	54	7	21
2009	10	46	13	258	13	297	11	57	12	68	8	21
2010	9	40	11	257	10	333	10	59	9	81	8	31
2011	8	48	10	279	10	385	9	74	10	137	6	30
2012	9	37	11	323	11	462	11	96	11	186	9	28
2013	9	59	11	267	11	432	9	72	11	145	10	37

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	–	–	–	<1	1	<1	7	8	2	14	10
Penicillin RI	–	–	–	16	4	2	9	13	19	16	24
Macrolides RI	–	–	–	<1	9	6	7	<1	27	26	25
Staphylococcus aureus											
Oxacillin/meticillin R	–	–	–	13	10	11	11	14	5	10	10
Escherichia coli											
Aminopenicilins R	–	–	–	55	50	54	58	56	48	52	54
Aminoglycosides R	–	–	–	15	12	12	15	15	10	10	11
Fluoroquinolones R	–	–	–	12	9	14	15	14	13	15	16
Third-generation cephalosporins R	–	–	–	5	7	6	8	9	7	5	8
Carbapenems R	–	–	–	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	–	–	–	5	3	5	3	13	10	5	28
HL gentamicin R	–	–	–	50	41	33	48	41	44	51	55
Vancomycin R	–	–	–	<1	<1	<1	<1	<1	<1	2	<1
Enterococcus faecium											
Aminopenicilins RI	–	–	–	75	100	88	95	88	96	86	96
HL gentamicin R	–	–	–	75	81	78	64	87	88	78	70
Vancomycin R	–	–	–	<1	<1	<1	11	8	8	6	<1
Klebsiella pneumoniae											
Aminoglycosides R	–	–	–	26	37	41	56	52	55	63	48
Fluoroquinolones R	–	–	–	3	8	23	37	36	55	55	45
Third-generation cephalosporins R	–	–	–	23	27	36	57	51	61	64	44
Carbapenems R	–	–	–	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	–	21	5	14	20	6	13	11	9
Ceftazidime R	–	–	–	31	<1	10	14	10	21	7	8
Carbapenems R	–	–	–	21	30	24	19	27	20	18	19
Aminoglycosides R	–	–	–	29	33	38	19	13	13	14	14
Fluoroquinolones R	–	–	–	46	38	35	33	16	17	11	11

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	97	20	100	10	100	15	100	1	100	3	99	55	97	19
CSF	3	33	<1	100	0	0	–	–	–	–	1	100	3	0
Gender														
Male	64	21	58	12	33	23	69	1	52	3	61	59	63	17
Female	36	20	42	7	67	11	31	0	48	3	39	49	37	21
Age (years)														
0–4	14	46	4	19	2	0	4	0	–	–	3	73	–	–
5–19	5	20	3	0	1	40	–	–	–	–	1	75	2	0
20–64	51	14	50	7	38	14	37	0	43	8	41	52	38	24
65 and over	30	21	43	13	59	16	59	2	56	0	54	56	60	15
Unknown	–	–	–	–	–	–	–	–	2	0	–	–	–	–
Hospital department														
ICU	34	15	22	11	21	15	24	0	43	4	36	63	45	21
Internal med.	34	18	49	10	49	11	40	0	20	0	26	44	20	23
Surgery	–	–	11	11	7	18	13	0	15	0	14	53	9	0
Other	31	30	17	10	24	24	21	4	23	7	24	58	26	18
Unknown	–	–	1	0	–	–	1	0	–	–	–	–	–	–

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Lithuania

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

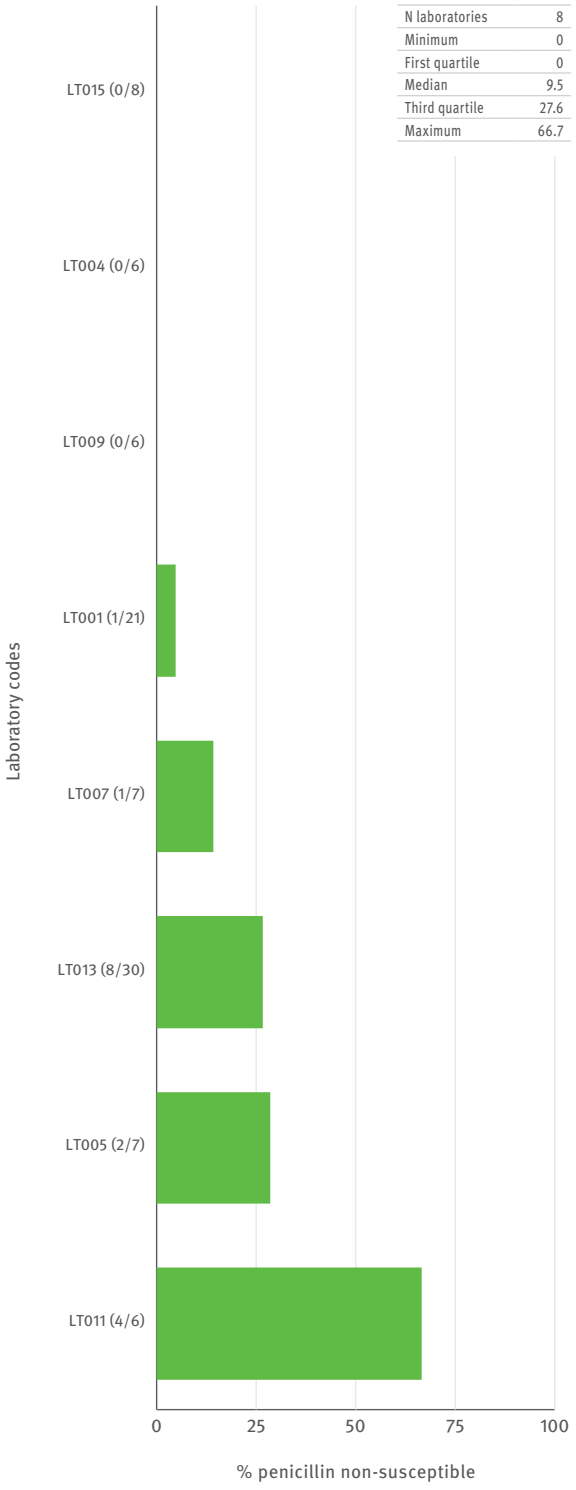


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

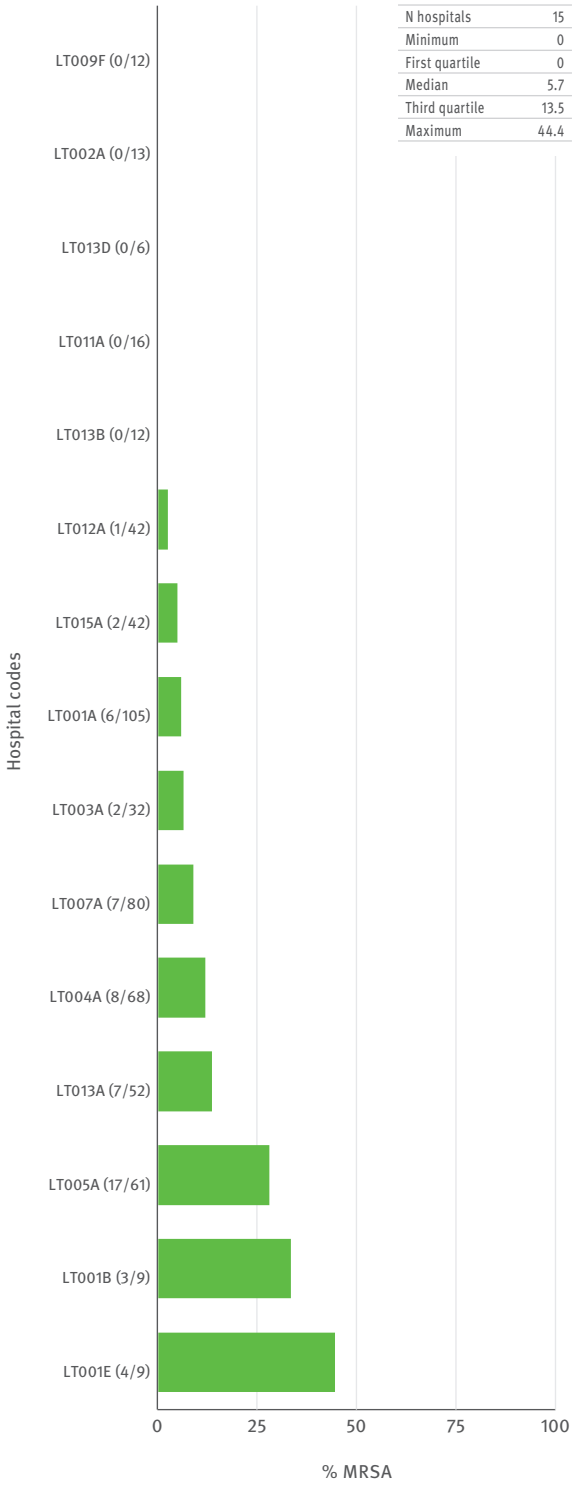


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

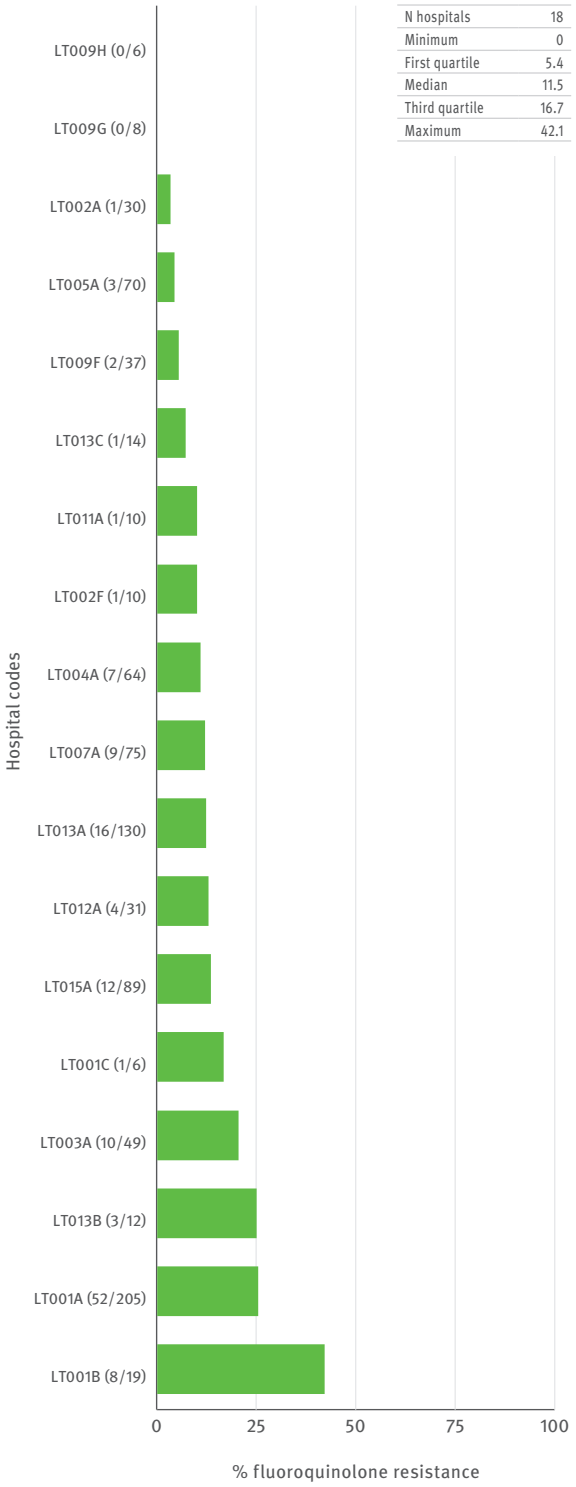


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)

Luxembourg

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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	302	5	54	3	28	6	35
2010	6	50	6	134	6	354	6	70	6	59	6	32
2011	5	52	5	127	5	354	5	76	4	48	5	32
2012	6	39	6	131	6	335	5	74	4	50	5	31
2013	5	49	5	135	8	322	5	61	4	53	5	34

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	<1	6	7	5	3	5	11	4	2	3	7
Penicillin RI	15	11	12	5	6	11	19	12	8	3	16
Macrolides RI	28	33	24	26	24	14	16	18	15	16	25
Staphylococcus aureus											
Oxacillin/meticillin R	21	16	13	19	20	9	13	17	20	15	9
Escherichia coli											
Aminopenicilins R	49	49	49	46	49	56	57	63	52	51	55
Aminoglycosides R	4	4	7	6	5	8	9	6	8	6	7
Fluoroquinolones R	12	18	19	20	21	22	26	26	24	24	28
Third-generation cephalosporins R	<1	<1	3	2	4	6	8	9	8	11	11
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	5	<1	<1	<1	<1	3	10	6	2	7	5
HL gentamicin R	32	18	24	32	44	17	28	46	44	22	28
Vancomycin R	<1	<1	<1	<1	<1	3	10	4	4	<1	7
Enterococcus faecium											
Aminopenicilins RI	100	50	36	75	67	76	93	77	71	80	100
HL gentamicin R	<1	<1	23	30	10	21	29	19	40	44	31
Vancomycin R	<1	<1	<1	<1	<1	5	36	32	4	<1	5
Klebsiella pneumoniae											
Aminoglycosides R	–	–	–	<1	4	13	18	5	29	26	28
Fluoroquinolones R	–	–	–	6	12	12	21	7	33	32	23
Third-generation cephalosporins R	–	–	–	10	2	19	25	5	35	34	34
Carbapenems R	–	–	–	<1	<1	<1	<1	<1	<1	<1	2
Pseudomonas aeruginosa											
Piperacillin R	–	–	<1	9	15	3	14	6	16	16	12
Ceftazidime R	–	–	<1	10	11	3	14	<1	9	3	12
Carbapenems R	–	–	<1	7	20	25	15	9	16	6	18
Aminoglycosides R	–	–	<1	4	22	6	9	9	16	6	24
Fluoroquinolones R	–	–	<1	10	36	15	11	22	19	19	21

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	95	10	100	12	100	26	100	3	100	3	99	34	98	13
CSF	5	25	0	0	0	0	–	–	–	–	1	0	2	0
Gender														
Male	53	13	63	11	49	30	75	4	67	0	54	32	54	11
Female	47	9	37	13	51	22	25	0	33	8	46	36	46	13
Age (years)														
0–4	9	14	3	11	2	0	–	–	–	–	1	100	2	0
5–19	7	0	1	0	0	0	–	–	–	–	1	100	3	0
20–64	27	10	35	11	27	21	29	0	23	0	33	29	28	17
65 and over	57	12	60	13	71	28	71	4	74	3	65	34	66	12
Unknown	–	–	<1	100	–	–	–	–	3	0	–	–	2	0
Hospital department														
ICU	12	11	13	12	7	35	20	0	28	0	13	31	18	17
Internal med.	1	0	14	8	10	23	13	0	5	0	11	36	12	0
Surgery	9	0	9	0	14	21	11	0	13	0	9	33	8	20
Other	57	14	43	11	41	25	29	0	33	8	43	32	38	8
Unknown	20	7	21	21	28	28	27	12	21	0	25	38	23	20

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Luxembourg

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

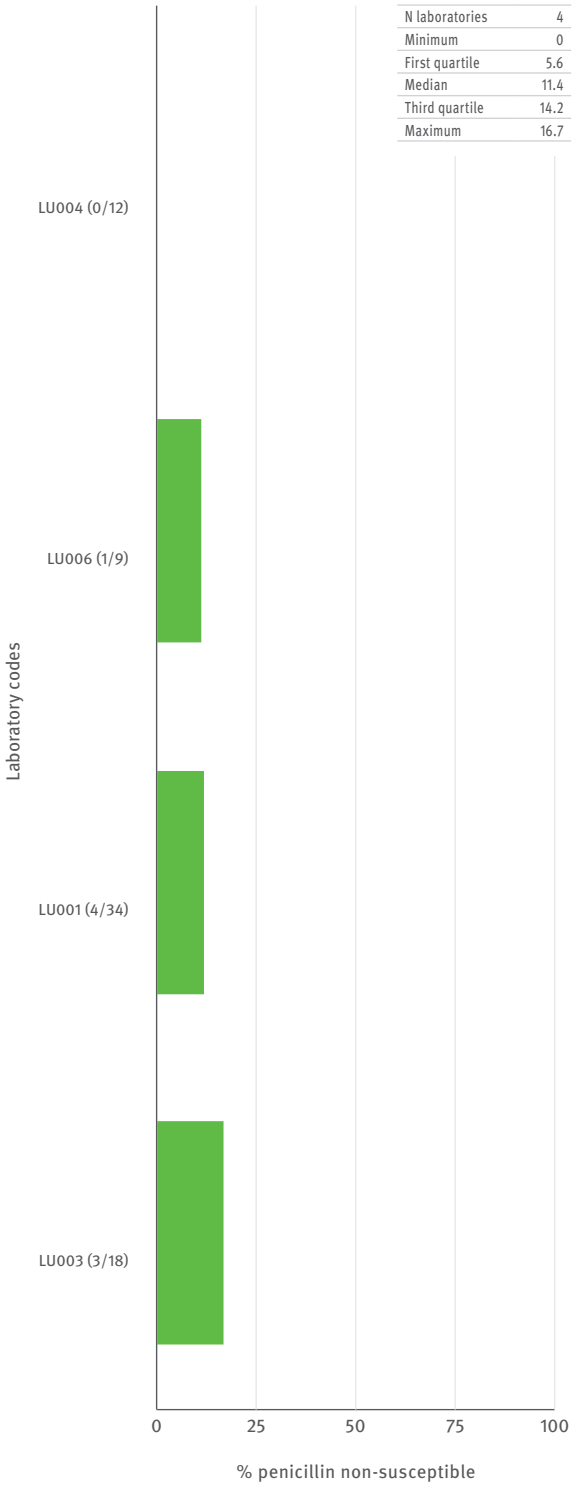


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

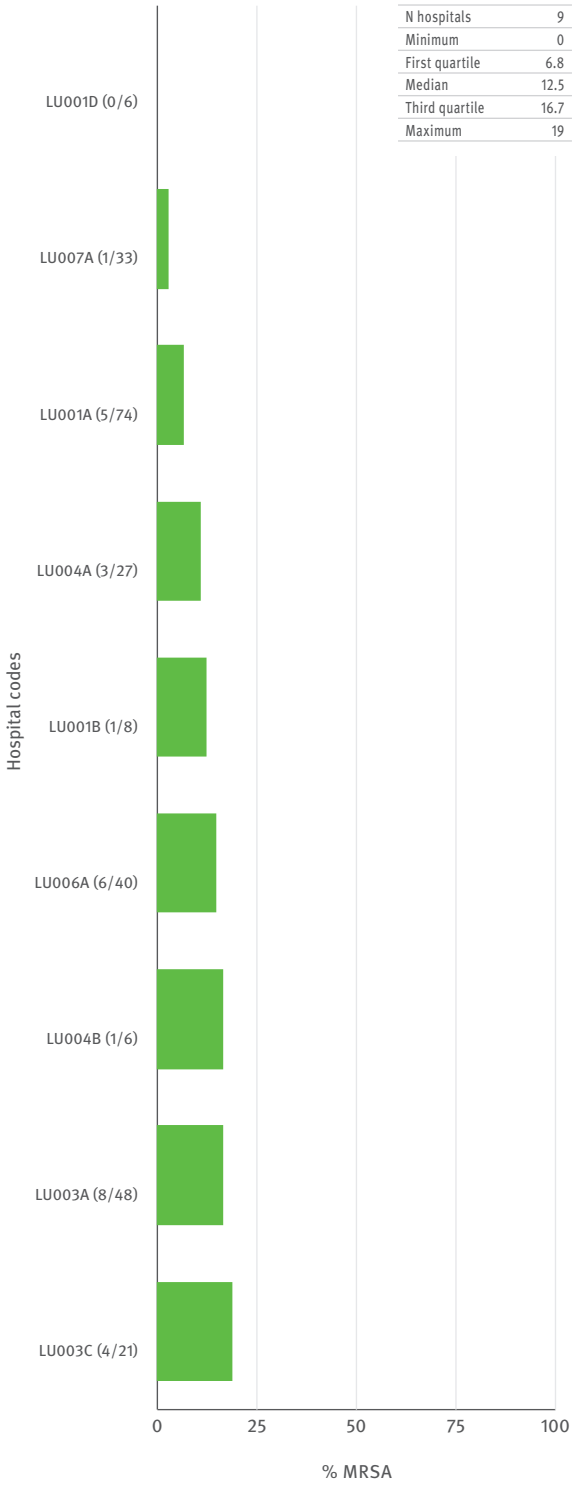


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

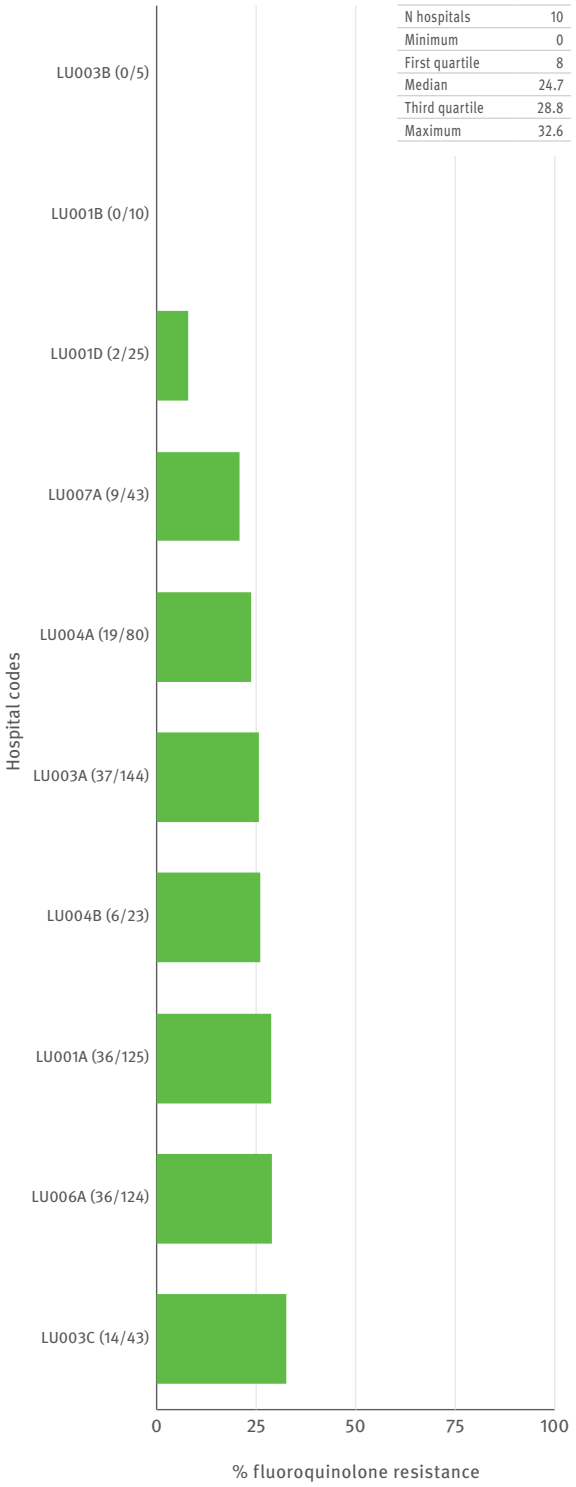
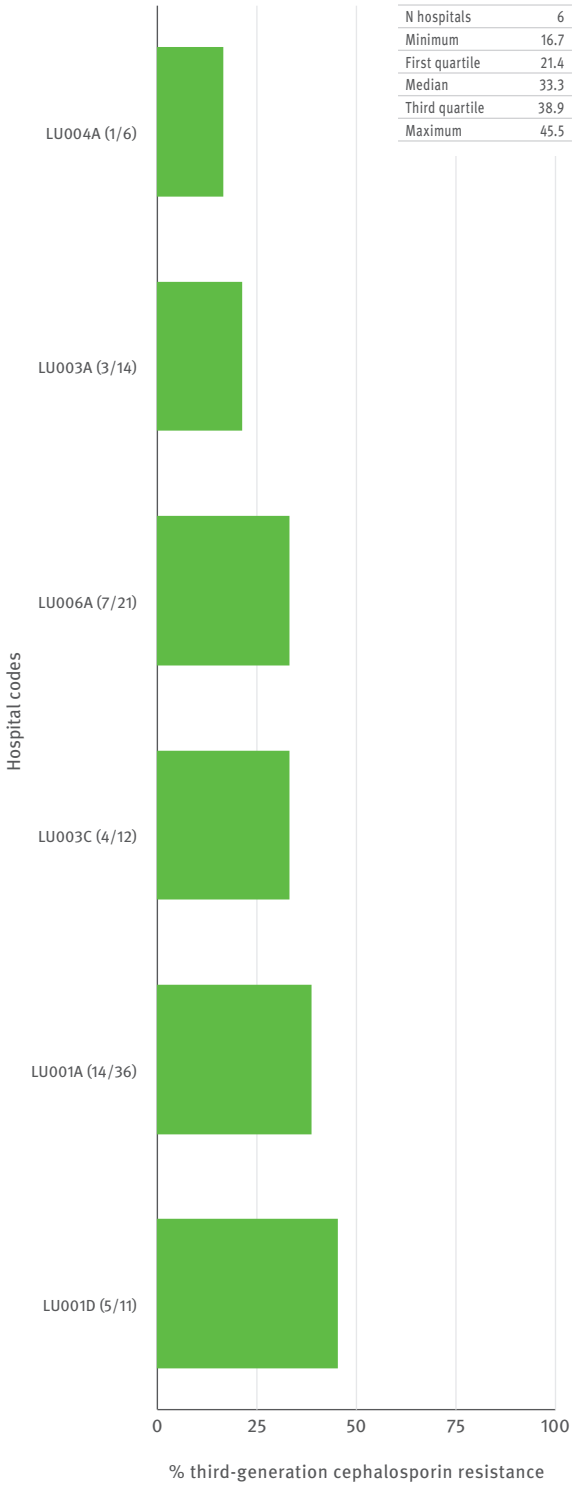


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Malta

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	1	11	1	130	1	219	1	53	1	52	1	42
2012	1	18	1	102	1	216	1	31	1	57	1	31
2013	1	9	1	116	1	248	1	41	1	69	1	25

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	<1	<1	8	3	<1	24	<1	11	10	<1	<1
Penicillin RI	<1	<1	15	7	<1	47	14	22	50	39	43
Macrolides RI	38	25	46	45	8	35	13	18	13	50	33
Staphylococcus aureus											
Oxacillin/meticillin R	43	56	56	67	52	56	59	48	49	47	52
Escherichia coli											
Aminopenicilins R	39	48	51	56	54	52	54	44	53	55	55
Aminoglycosides R	18	20	7	15	20	22	21	22	16	14	10
Fluoroquinolones R	24	36	31	32	35	34	30	34	32	32	30
Third-generation cephalosporins R	2	4	1	4	13	21	15	16	13	14	9
Carbapenems R	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	5	<1	3	2	3	<1	5	<1	<1	4	<1
HL gentamicin R	29	44	32	–	–	–	–	–	–	–	–
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	33	43	25	14	40	60	75	100	64	67	70
HL gentamicin R	50	<1	<1	–	–	–	–	–	–	–	–
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae											
Aminoglycosides R	–	–	17	6	<1	<1	<1	12	10	26	26
Fluoroquinolones R	–	–	11	6	11	8	3	16	13	26	28
Third-generation cephalosporins R	–	–	6	6	7	<1	<1	12	13	26	28
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	4	4	6
Pseudomonas aeruginosa											
Piperacillin R	–	–	22	47	11	45	36	36	24	10	21
Ceftazidime R	–	–	11	30	3	33	29	14	12	6	8
Carbapenems R	–	–	18	20	11	30	21	24	24	3	16
Aminoglycosides R	–	–	16	8	8	23	21	31	33	6	<1
Fluoroquinolones R	–	–	44	24	11	19	22	24	19	<1	8

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	100	40	100	50	100	31	100	0	100	0	98	27	98	9
CSF	–	–	–	–	0	0	–	–	–	–	2	0	2	0
Gender														
Male	60	40	64	50	46	38	64	0	69	0	56	31	68	8
Female	40	40	36	48	54	25	34	0	31	0	44	21	32	11
Unknown	–	–	–	–	–	–	2	0	–	–	–	–	–	–
Age (years)														
0–4	20	60	4	22	2	0	11	0	–	–	2	0	–	–
5–19	–	–	2	75	1	0	2	0	–	–	–	–	2	0
20–64	32	38	34	47	24	21	20	0	13	0	37	23	39	5
65 and over	48	33	60	52	73	35	68	0	88	0	60	30	59	12
Hospital department														
ICU	–	–	7	80	2	13	2	0	6	0	6	29	14	25
Internal med.	8	0	30	44	17	32	11	0	38	0	26	36	16	0
Surgery	4	0	12	62	9	51	16	0	13	0	11	43	16	33
Other	80	45	38	43	58	28	50	0	38	0	46	21	45	0
Unknown	8	50	13	54	14	31	21	0	6	0	11	14	9	0

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Malta

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

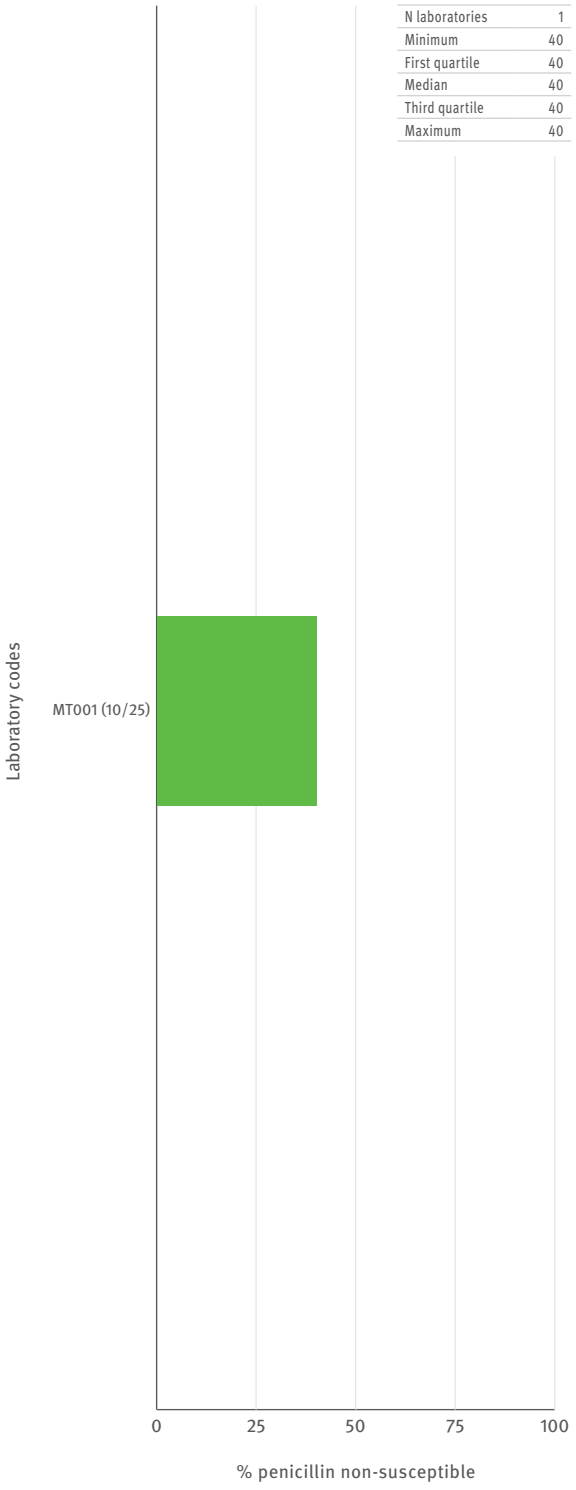


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

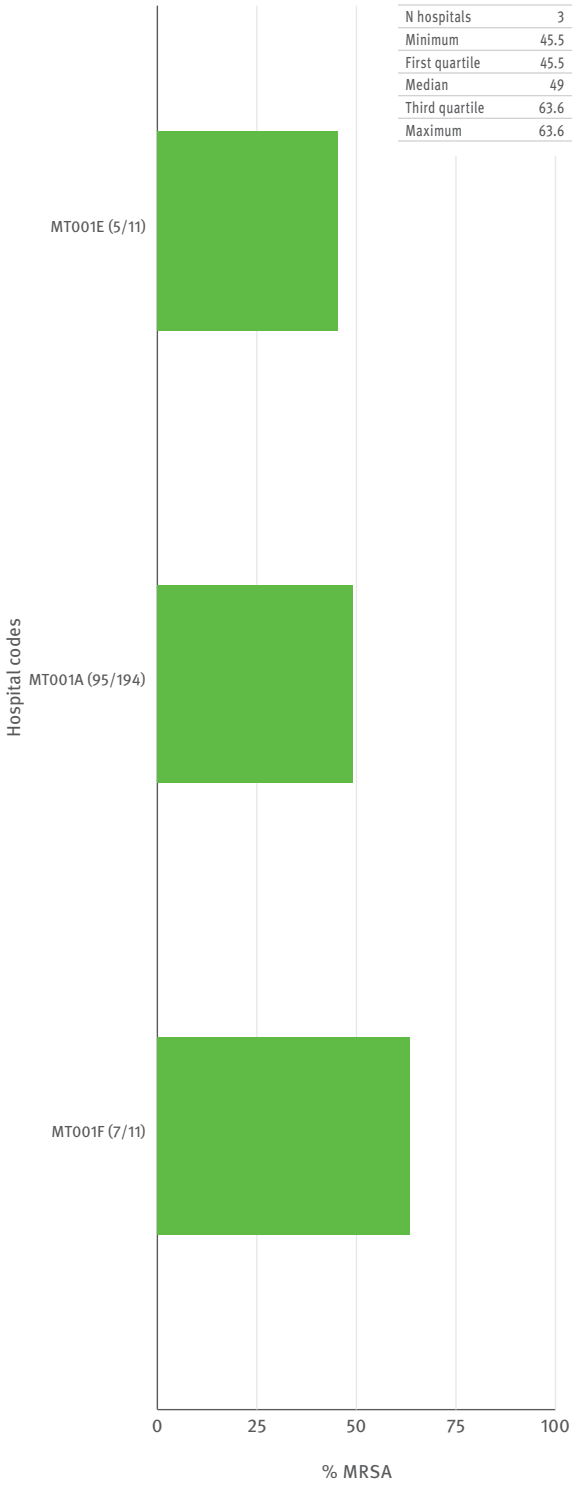


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

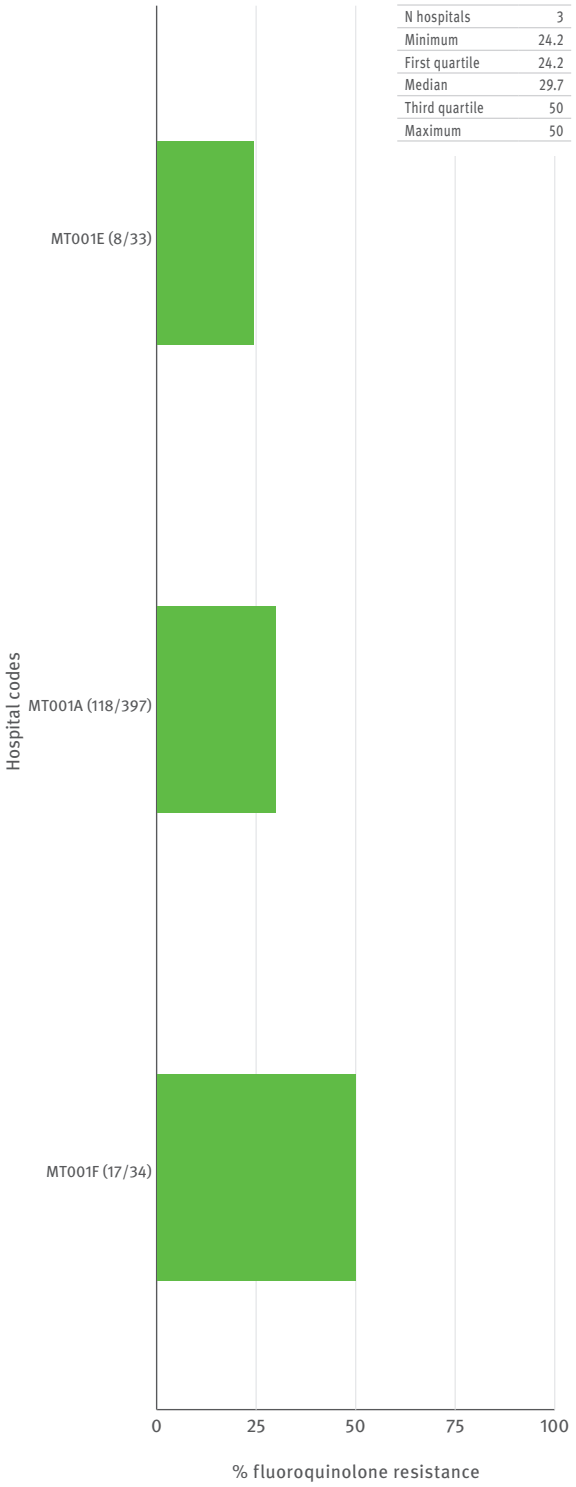
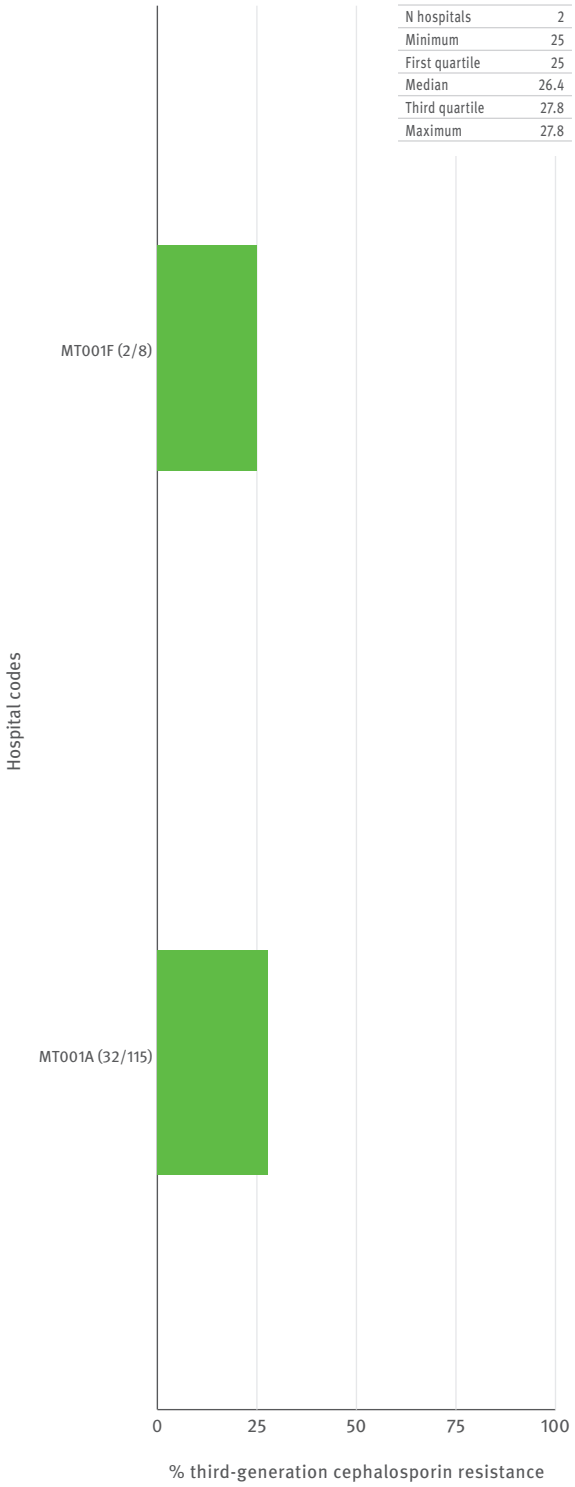


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Netherlands

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	25	1289	23	1815	23	4436	23	1108	23	729	23	434
2012	26	1246	25	1963	25	4738	24	1062	25	694	24	408
2013	27	1269	25	2088	27	4758	26	1019	25	663	25	381

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Penicillin RI	1	2	1	1	2	2	1	2	1	2	1
Macrolides RI	5	8	11	8	7	7	5	6	5	4	5
Staphylococcus aureus											
Oxacillin/meticillin R	1	1	<1	<1	2	<1	<1	1	1	1	1
Escherichia coli											
Aminopenicilins R	45	43	48	47	49	48	45	48	49	49	48
Aminoglycosides R	3	3	4	3	5	6	4	7	8	7	6
Fluoroquinolones R	7	7	10	11	13	14	11	14	14	15	14
Third-generation cephalosporins R	1	1	2	3	4	5	4	5	6	6	6
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	4	3	3	5	5	<1	2	3	1	1	<1
HL gentamicin R	29	37	38	28	38	34	31	34	33	31	27
Vancomycin R	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	30	42	61	73	83	86	89	89	91	91	90
HL gentamicin R	20	20	40	50	62	53	76	65	66	63	73
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1
Klebsiella pneumoniae											
Aminoglycosides R	–	–	5	4	5	7	3	7	8	6	6
Fluoroquinolones R	–	–	6	4	4	7	4	7	7	5	6
Third-generation cephalosporins R	–	–	4	4	7	8	6	7	8	7	7
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	4	2	2	6	3	4	6	5	7
Ceftazidime R	–	–	5	5	4	6	4	3	5	3	4
Carbapenems R	–	–	5	2	2	6	3	3	3	3	3
Aminoglycosides R	–	–	7	5	3	4	1	2	5	4	3
Fluoroquinolones R	–	–	9	9	5	8	7	4	7	6	6

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	95	1	100	1	100	15	100	0	100	0	100	7	99	3
CSF	5	0	–	–	0	0	–	–	–	–	0	0	1	0
Gender														
Male	52	1	62	1	51	17	70	0	60	0	59	8	67	3
Female	48	1	38	1	49	12	30	0	40	0	41	6	33	4
Unknown	–	–	–	–	0	0	–	–	–	–	–	–	–	–
Age (years)														
0–4	2	0	4	1	2	4	5	0	2	0	2	4	2	0
5–19	2	2	3	1	1	14	1	0	1	0	<1	50	1	14
20–64	41	2	32	2	26	15	25	0	39	0	27	10	28	4
65 and over	55	1	61	1	72	15	69	0	58	0	71	6	69	3
Unknown	–	–	–	–	0	0	0	0	–	–	–	–	–	–
Hospital department														
ICU	10	2	9	3	7	17	15	0	45	0	10	13	14	6
Internal med.	7	2	11	0	13	13	9	0	6	0	12	7	11	1
Surgery	3	2	8	1	6	15	8	0	9	0	6	12	9	1
Other	41	1	32	1	34	15	28	0	12	0	31	6	30	2
Unknown	40	1	40	1	40	15	41	0	28	0	40	6	37	5

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Netherlands

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

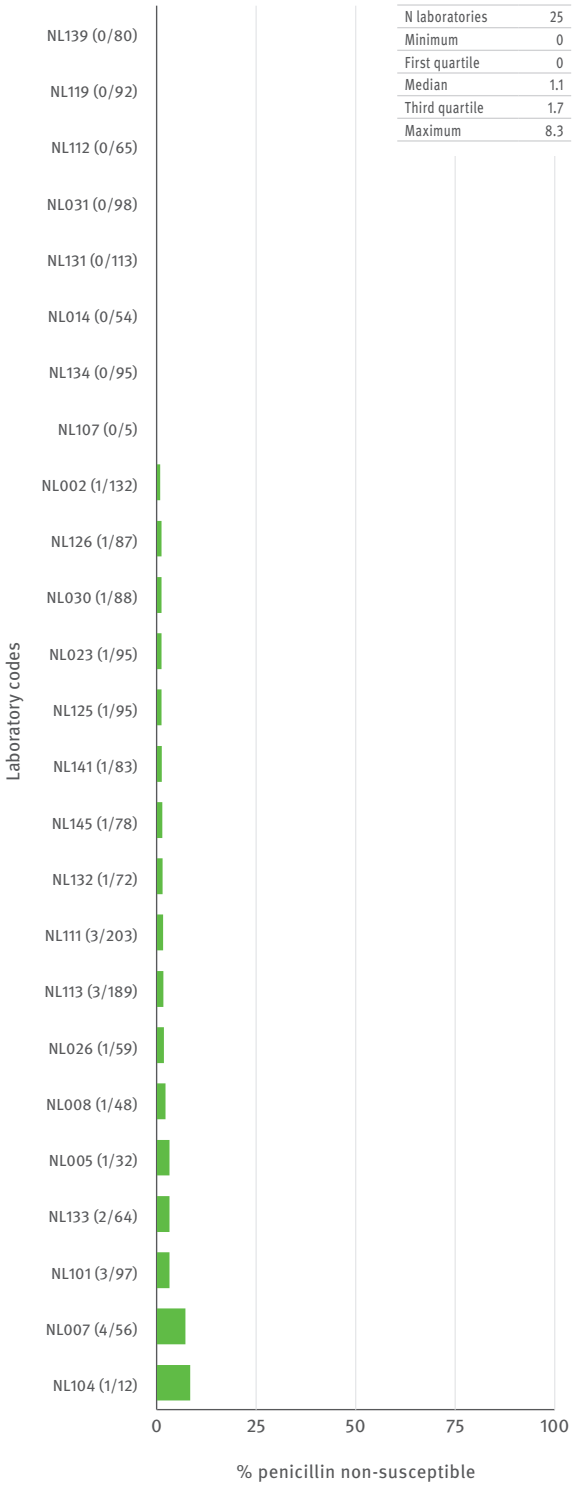


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

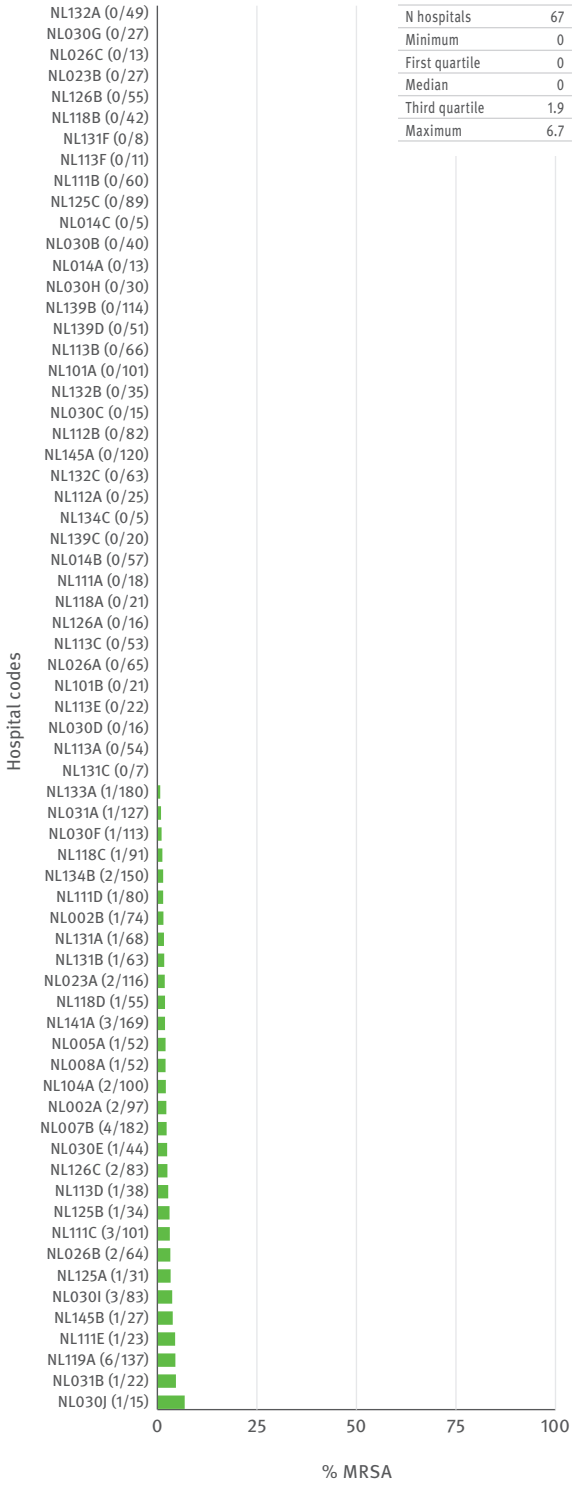


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

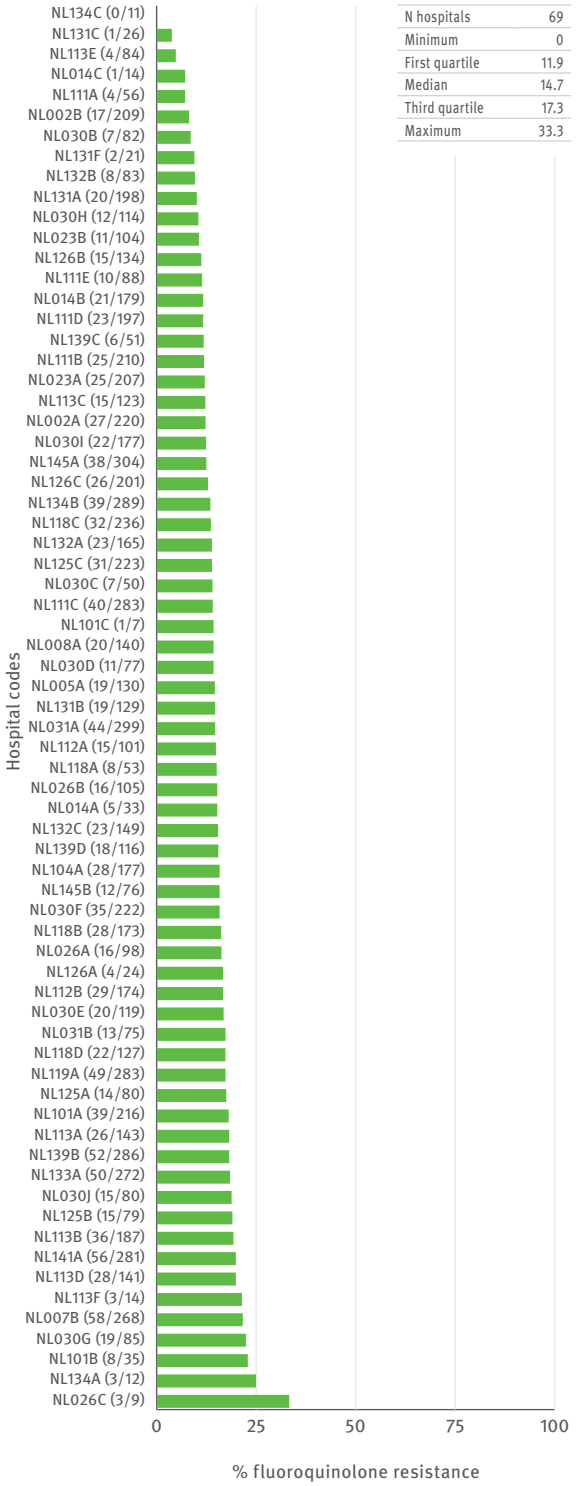
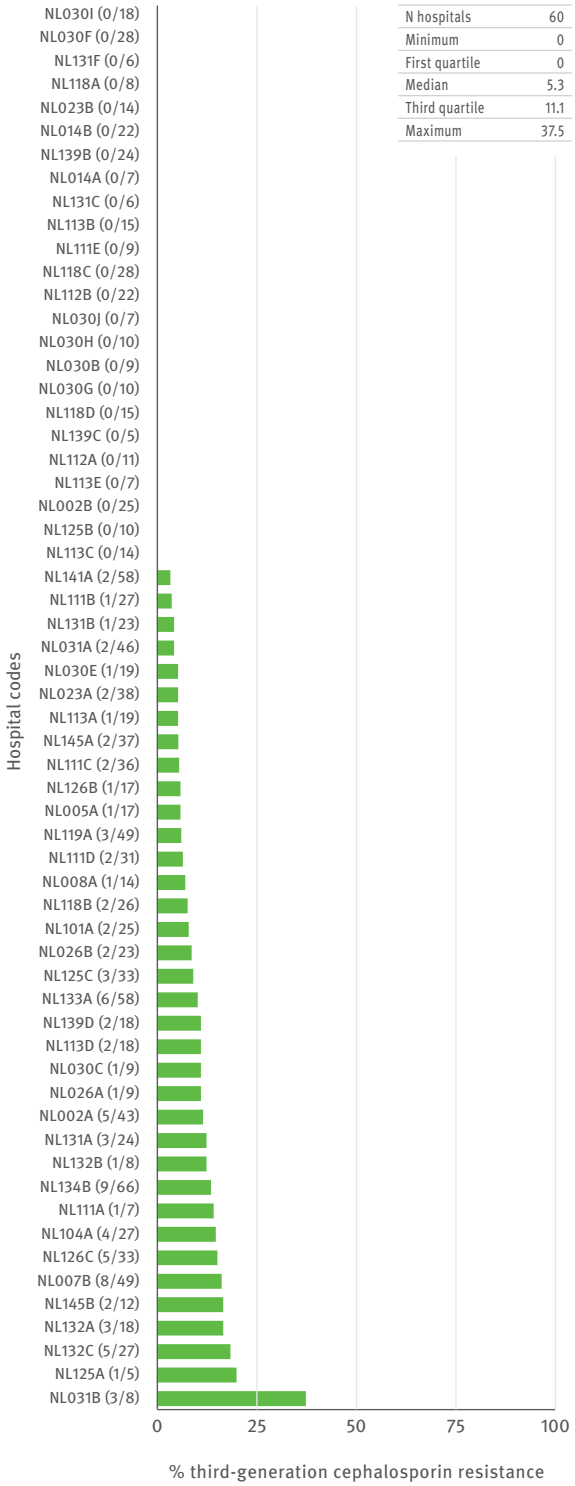


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Norway

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	17	622	17	1223	17	2620	17	588	17	450	17	148
2012	18	576	18	1430	18	3025	18	672	16	623	18	209
2013	18	551	18	1473	18	3080	18	710	17	645	18	206

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1
Penicillin RI	<1	2	2	2	2	2	2	4	3	6	3
Macrolides RI	8	8	14	12	10	7	6	4	4	5	4
Staphylococcus aureus											
Oxacillin/meticillin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1
Escherichia coli											
Aminopenicilins R	34	32	34	35	38	38	37	38	39	43	43
Aminoglycosides R	<1	<1	2	2	3	3	3	4	4	6	6
Fluoroquinolones R	2	4	5	5	7	7	9	9	9	11	11
Third-generation cephalosporins R	<1	<1	<1	1	2	3	2	4	4	5	6
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	4	<1	3	3	2	2	<1	<1	<1	1	<1
HL gentamicin R	38	27	32	33	34	29	36	34	22	30	27
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	43	80	72	75	81	78	76	85	75	83	88
HL gentamicin R	14	25	44	45	52	54	38	57	43	37	47
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	1	2	<1	2
Klebsiella pneumoniae											
Aminoglycosides R	<1	2	3	<1	<1	1	3	2	3	2	2
Fluoroquinolones R	<1	<1	1	7	5	4	6	7	4	4	5
Third-generation cephalosporins R	<1	<1	2	2	2	2	3	2	3	3	4
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	<1	13	3	3	2	6	4	3	5	7	9
Ceftazidime R	<1	<1	3	5	3	4	5	2	3	6	6
Carbapenems R	<1	4	3	9	9	7	5	1	4	7	6
Aminoglycosides R	<1	4	<1	1	2	<1	<1	<1	<1	2	2
Fluoroquinolones R	4	5	4	9	7	3	2	4	5	6	9

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	96	5	100	1	100	11	100	0	100	2	100	4	99	6
CSF	4	2	–	–	<1	20	–	–	–	–	<1	33	1	0
Gender														
Male	51	5	63	1	48	14	73	0	62	1	58	5	68	7
Female	49	5	37	1	52	8	27	0	38	2	42	2	32	5
Unknown	0	50	–	–	–	–	0	0	–	–	–	–	–	–
Age (years)														
0–4	4	9	4	4	2	7	2	5	1	0	1	17	2	30
5–19	2	12	3	1	1	15	1	0	1	0	1	11	1	0
20–64	44	4	35	1	26	12	24	0	32	3	26	4	25	10
65 and over	50	5	58	1	71	11	73	0	67	1	72	3	72	4
Hospital department														
ICU	6	3	7	1	5	11	8	0	15	2	5	6	10	14
Internal med.	28	4	30	0	28	10	26	0	20	3	26	4	25	4
Surgery	3	3	13	1	14	11	19	0	22	0	15	2	13	11
Other	62	5	50	1	52	12	46	0	42	2	53	4	51	5
Unknown	0	0	1	0	1	5	1	0	–	–	1	0	0	0

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Norway

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

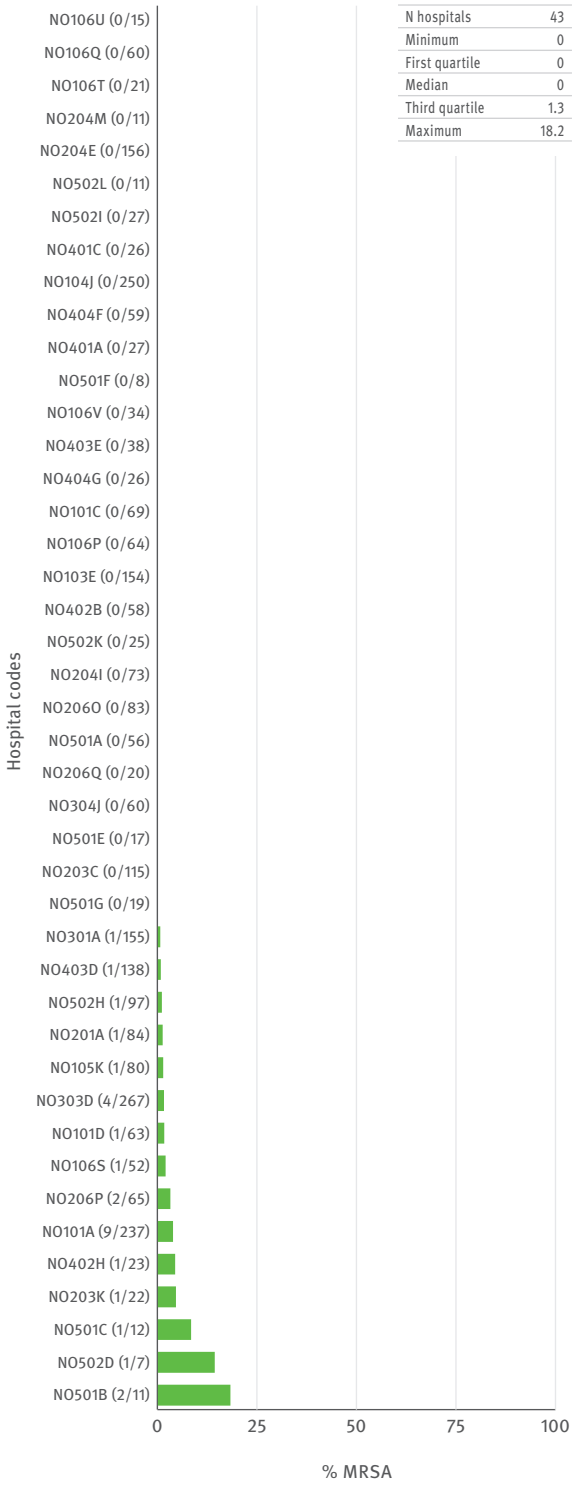


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

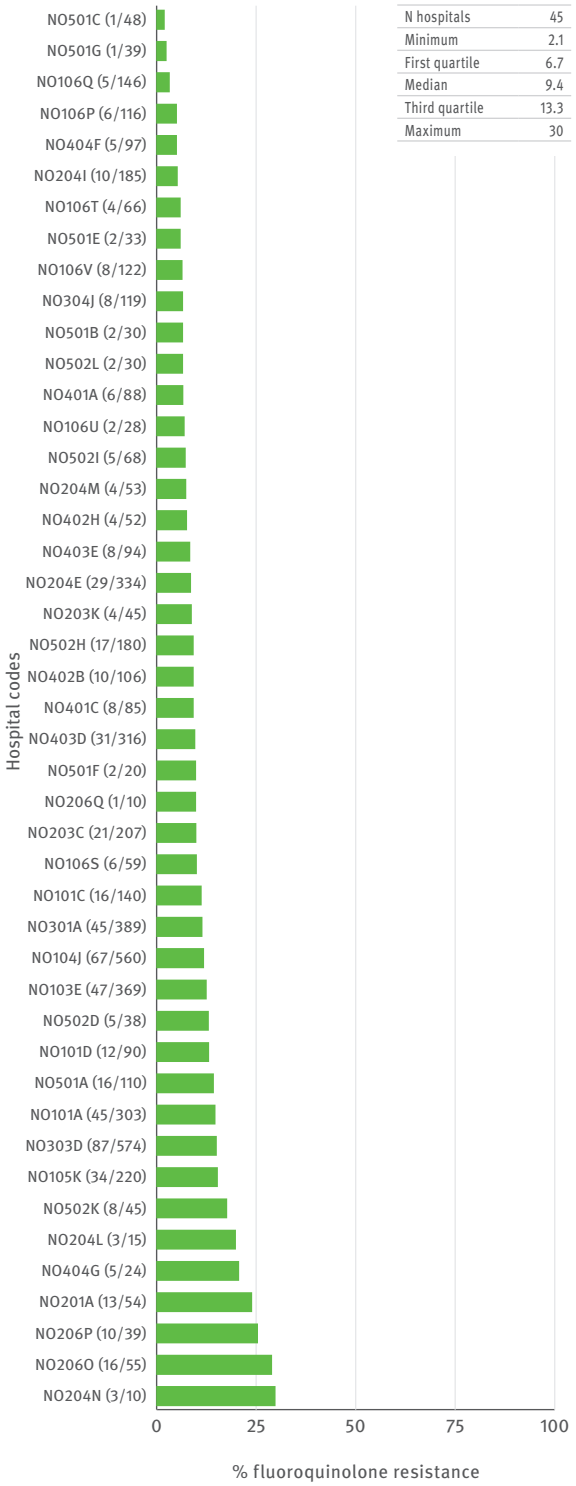


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)

Poland

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	41	166	45	868	45	1188	44	484	45	391	35	199
2012	30	121	41	782	41	1056	35	385	37	369	36	177
2013	38	170	38	750	38	1072	37	460	35	383	30	198

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	19	<1	17	<1	10	12	30	24	4	5	2
Penicillin RI	19	<1	33	<1	29	13	30	24	18	23	32
Macrolides RI	14	19	33	11	–	50	19	39	27	27	32
Staphylococcus aureus											
Oxacillin/meticillin R	19	19	24	20	15	12	20	13	24	25	16
Escherichia coli											
Aminopenicilins R	50	45	56	55	56	54	65	60	62	63	65
Aminoglycosides R	10	5	7	11	6	7	7	9	8	12	11
Fluoroquinolones R	7	9	20	20	13	20	23	26	27	29	27
Third-generation cephalosporins R	4	5	5	4	2	2	9	8	12	13	11
Carbapenems R	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	<1	2	9	2	4	6	<1	3	1	1	2
HL gentamicin R	48	33	48	50	46	29	39	36	48	46	45
Vancomycin R	<1	<1	<1	<1	2	<1	<1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	91	86	95	95	88	78	98	95	93	98	97
HL gentamicin R	55	100	62	85	84	67	75	65	70	66	70
Vancomycin R	<1	<1	5	<1	<1	<1	1	8	8	8	13
Klebsiella pneumoniae											
Aminoglycosides R	–	–	57	36	31	26	29	31	48	52	58
Fluoroquinolones R	–	–	34	29	3	32	32	33	58	60	70
Third-generation cephalosporins R	–	–	66	38	34	37	49	40	60	60	65
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	50	43	36	32	30	29	31	30	32
Ceftazidime R	–	–	31	42	21	27	21	22	23	24	22
Carbapenems R	–	–	27	30	18	14	25	25	24	23	32
Aminoglycosides R	–	–	54	46	40	27	28	30	33	24	24
Fluoroquinolones R	–	–	31	41	37	13	26	28	30	27	29

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	88	27	100	23	99	28	100	0	100	11	99	63	98	28
CSF	12	34	–	–	1	18	–	–	–	–	1	75	2	33
Gender														
Male	55	26	63	23	44	37	63	0	62	11	63	67	63	28
Female	44	30	37	22	56	22	37	0	38	10	37	57	36	27
Unknown	0	0	0	0	<1	14	–	–	1	0	0	0	<1	100
Age (years)														
0–4	11	50	5	21	4	11	5	0	3	0	4	56	4	15
5–19	5	31	2	17	1	26	1	0	2	14	3	39	3	36
20–64	47	22	48	24	38	30	41	0	50	18	44	65	50	29
65 and over	37	29	44	22	56	29	51	0	42	4	47	63	42	27
Unknown	1	0	1	11	1	19	2	0	3	0	1	75	2	29
Hospital department														
ICU	9	31	12	37	10	36	26	0	37	6	33	74	32	37
Internal med.	26	20	24	18	28	24	14	1	9	6	15	55	9	16
Surgery	2	60	8	33	5	34	11	0	8	4	8	63	9	32
Other	36	39	28	14	29	30	30	0	34	20	27	60	33	28
Unknown	27	17	28	26	27	27	19	0	12	8	17	53	18	14

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Poland

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

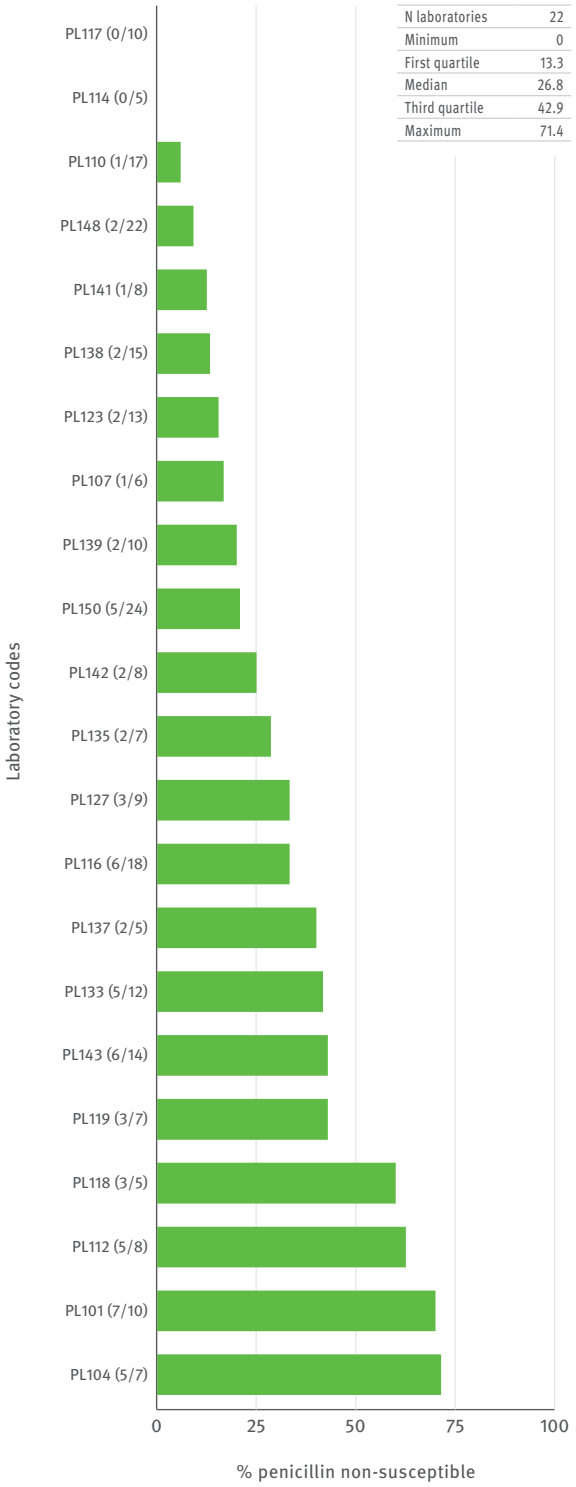


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

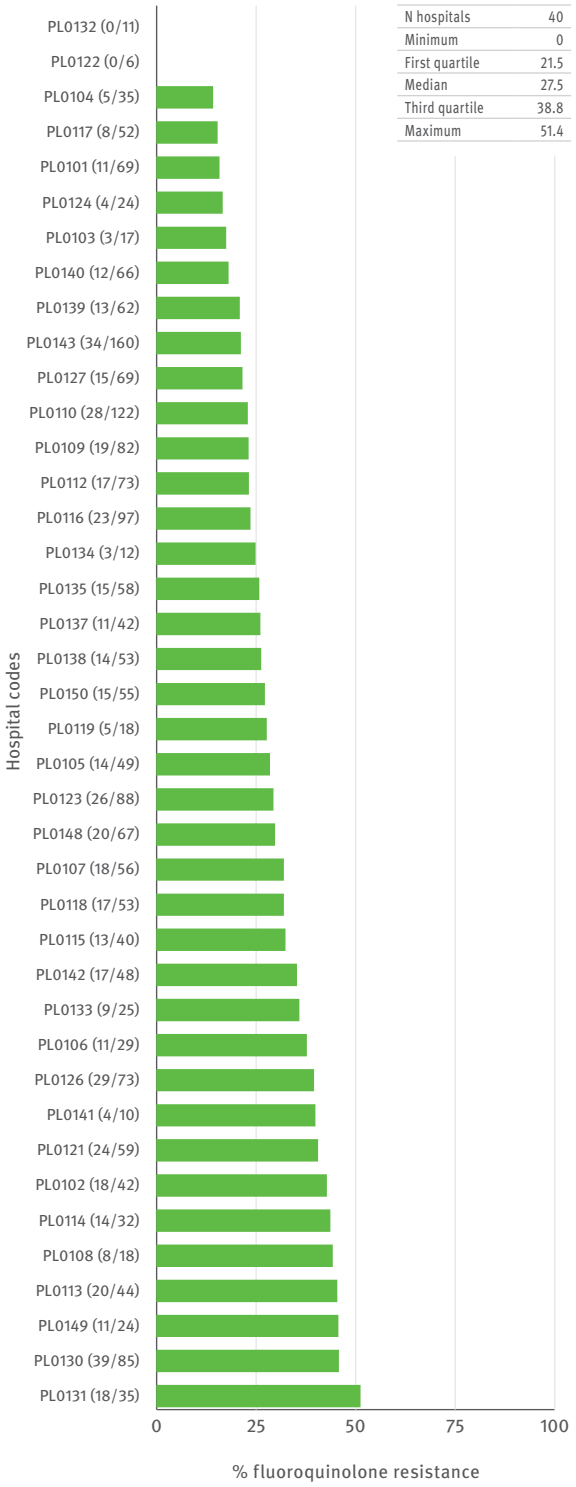
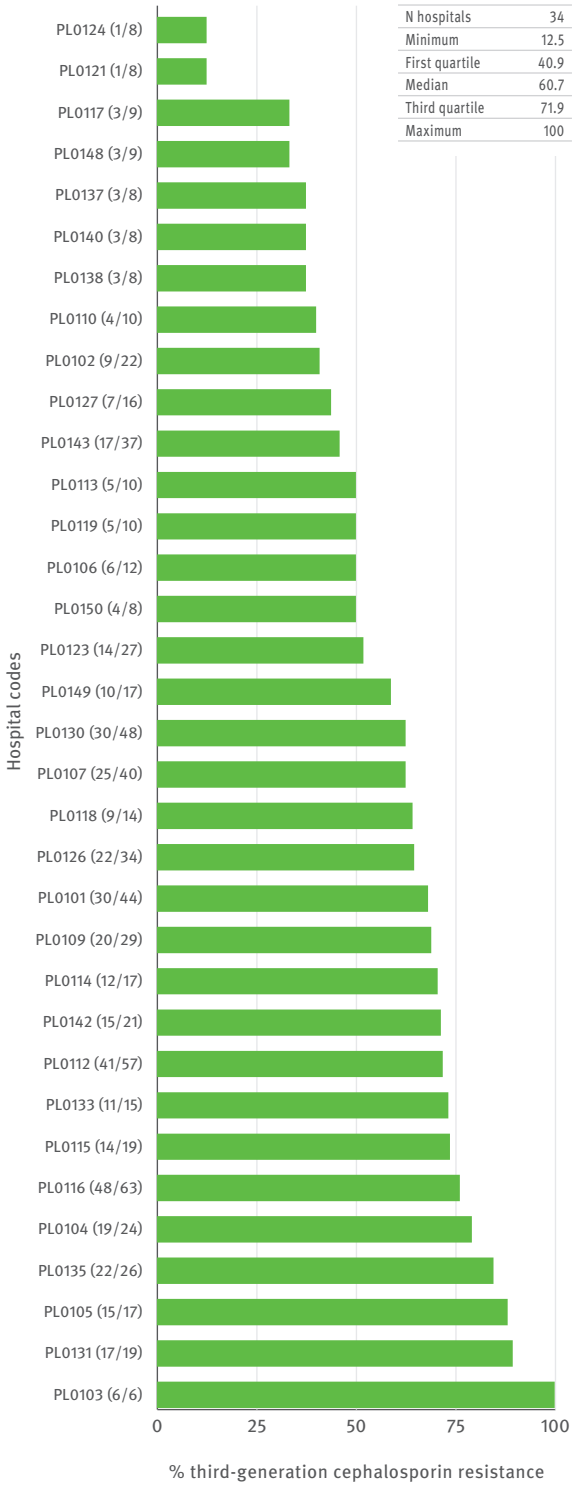


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Portugal

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	17	455	18	1507	18	1963	18	684	18	619	18	526
2012	16	330	18	1455	18	2158	18	687	19	781	18	588
2013	37	504	44	2429	34	2687	41	963	32	913	40	737

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	<1	<1	<1	<1	<1	<1	18	15	8	5	4
Penicillin RI	20	27	17	17	16	18	18	15	10	8	8
Macrolides RI	–	20	19	21	23	22	22	22	15	19	21
Staphylococcus aureus											
Oxacillin/meticillin R	45	46	47	48	48	53	49	53	55	54	47
Escherichia coli											
Aminopenicilins R	53	58	58	59	59	58	58	56	57	59	59
Aminoglycosides R	9	13	12	12	12	14	11	12	16	16	16
Fluoroquinolones R	26	27	29	28	30	29	28	27	27	30	32
Third-generation cephalosporins R	7	8	12	10	10	10	9	10	11	14	15
Carbapenems R	–	–	–	–	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	4	5	<1	2	4	4	7	17	24	12	8
HL gentamicin R	34	29	38	41	41	43	34	39	30	43	37
Vancomycin R	3	6	5	5	4	4	4	2	4	3	3
Enterococcus faecium											
Aminopenicilins RI	88	83	92	76	93	86	91	91	81	94	90
HL gentamicin R	55	66	68	53	49	28	49	53	38	58	36
Vancomycin R	47	42	34	26	29	24	23	23	20	23	22
Klebsiella pneumoniae											
Aminoglycosides R	–	–	<1	13	11	19	20	27	32	32	30
Fluoroquinolones R	–	–	<1	20	18	22	28	31	36	36	36
Third-generation cephalosporins R	–	–	–	21	17	26	28	28	35	39	37
Carbapenems R	–	–	–	–	<1	<1	<1	1	<1	<1	2
Pseudomonas aeruginosa											
Piperacillin R	–	–	–	15	14	17	17	18	19	20	24
Ceftazidime R	–	–	–	19	16	16	13	12	15	15	15
Carbapenems R	–	–	–	21	15	18	16	16	20	20	21
Aminoglycosides R	–	–	–	17	16	11	12	14	15	15	14
Fluoroquinolones R	–	–	–	21	19	23	21	20	26	26	24

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	97	8	100	49	100	31	100	3	100	23	99	38	99	20
CSF	3	19	–	–	0	0	–	–	–	–	1	42	1	50
Gender														
Male	60	10	63	49	44	37	61	3	58	20	59	40	64	22
Female	36	5	37	50	56	26	39	3	42	26	41	34	36	19
Unknown	4	0	–	–	–	–	<1	100	–	–	–	–	0	0
Age (years)														
0–4	7	5	4	31	2	10	5	0	1	0	5	33	2	36
5–19	2	11	2	9	1	22	2	0	1	13	1	38	2	25
20–64	36	9	30	37	29	27	26	3	38	25	37	40	36	23
65 and over	50	8	64	57	68	34	67	3	59	22	58	37	59	18
Unknown	4	3	1	43	0	0	<1	25	0	0	–	–	1	25
Hospital department														
ICU	4	4	11	56	4	34	17	2	21	23	11	35	13	23
Internal med.	17	9	21	58	16	34	15	1	13	17	17	38	17	14
Surgery	1	0	10	56	5	31	11	4	15	26	10	41	14	24
Other	75	8	57	44	73	30	57	3	51	23	62	38	56	21
Unknown	3	0	1	37	1	41	1	0	0	0	<1	17	0	0

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Portugal

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

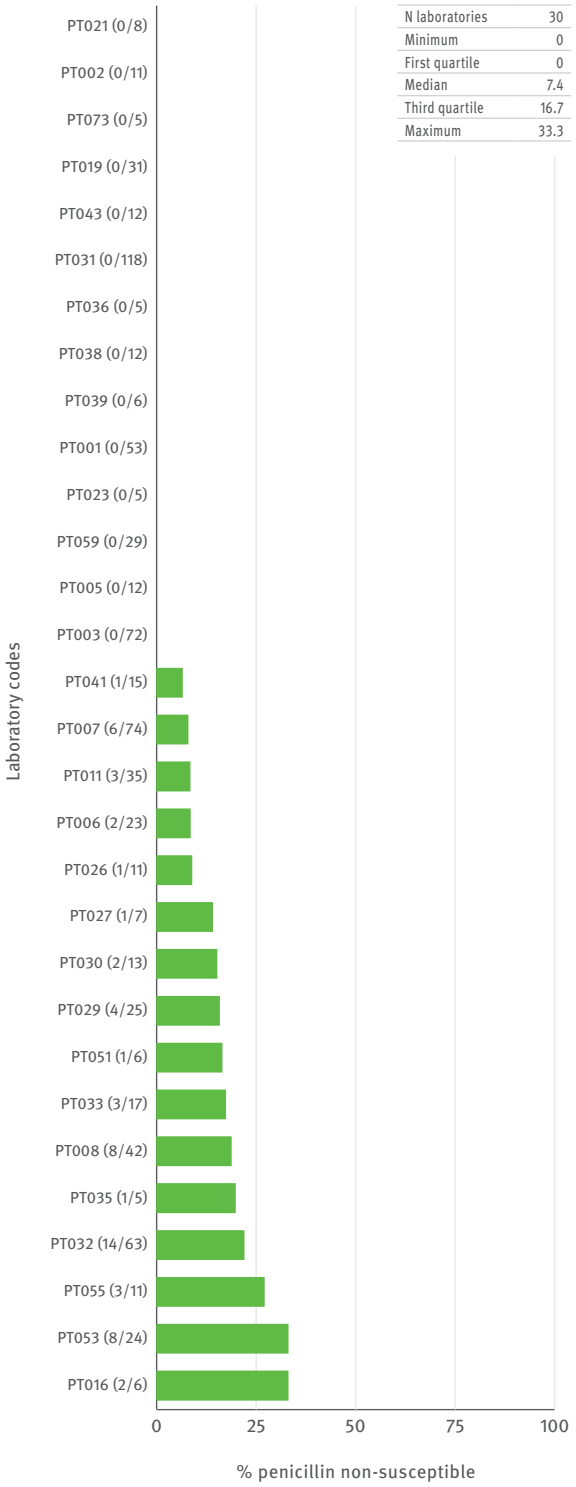


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

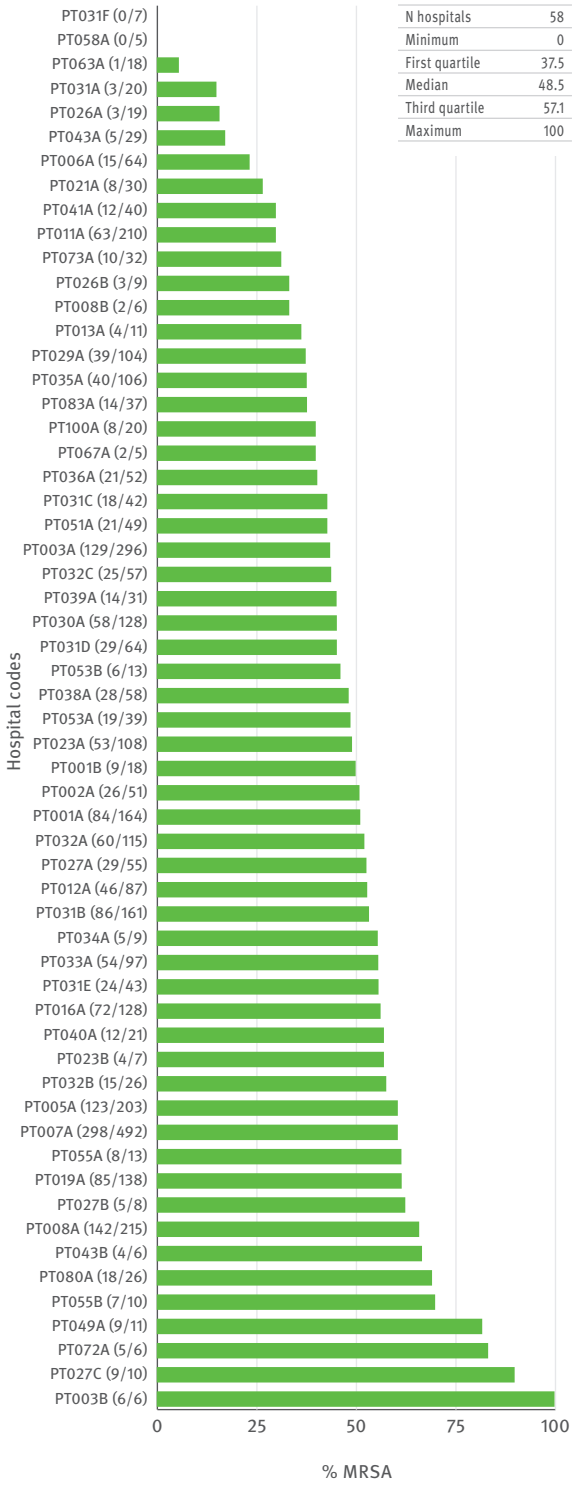


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

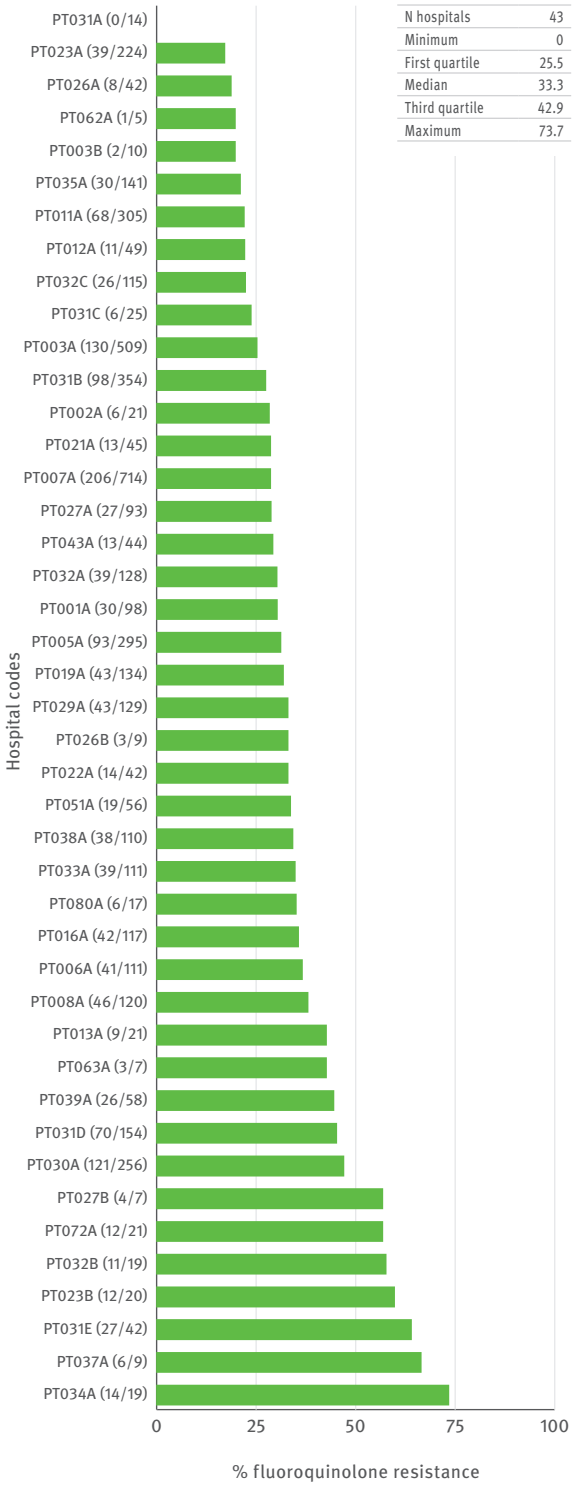
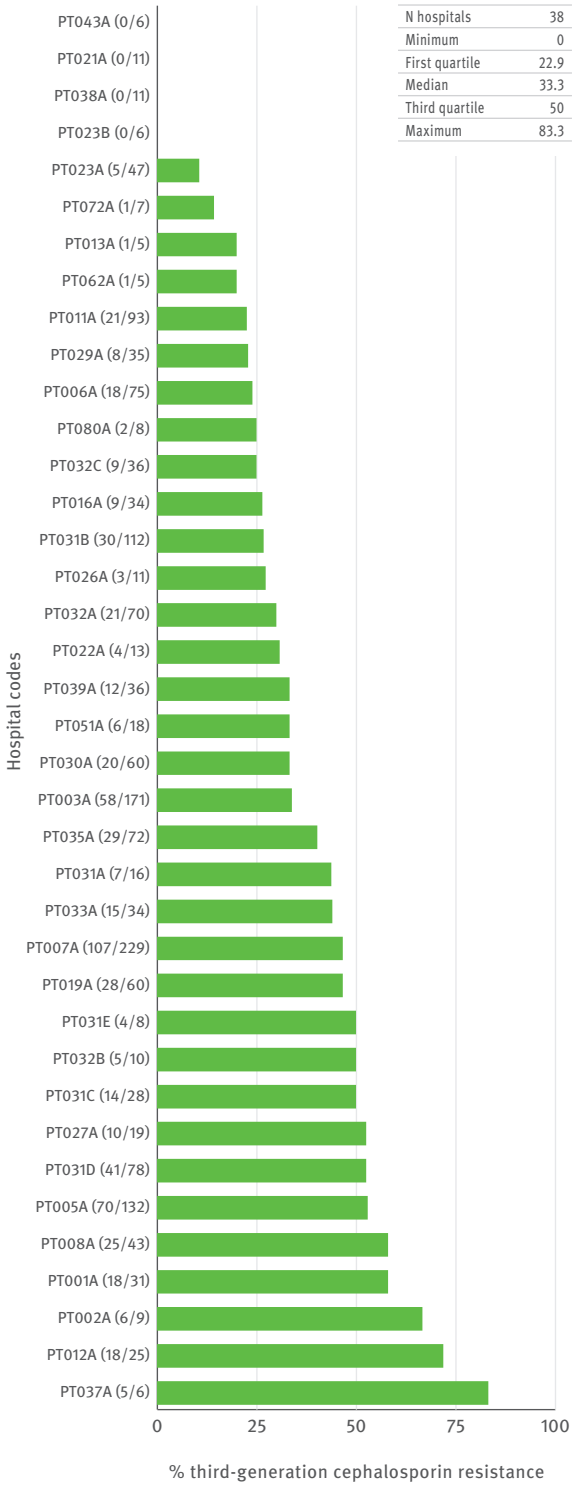


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Romania

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	3	36	5	109	3	95	3	31	4	25	4	10
2012	7	44	10	230	10	192	9	86	10	102	8	45
2013	8	44	15	384	14	302	14	135	16	221	15	94

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	21	11	22	10	22	54	24	31	61	39	25
Penicillin RI	33	11	39	28	33	69	29	31	61	39	25
Macrolides RI	29	<1	31	25	19	27	33	36	44	40	38
Staphylococcus aureus											
Oxacillin/meticillin R	46	71	60	54	26	33	34	39	50	53	64
Escherichia coli											
Aminopenicilins R	70	79	78	85	76	55	60	83	71	59	67
Aminoglycosides R	21	33	14	41	35	24	11	12	18	24	15
Fluoroquinolones R	14	21	9	41	27	27	18	24	28	29	31
Third-generation cephalosporins R	19	23	17	41	27	24	14	21	21	25	23
Carbapenems R	<1	3	<1	3	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	<1	29	<1	<1	25	10	13	<1	11	2	6
HL gentamicin R	25	<1	50	15	50	22	42	–	–	57	59
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Enterococcus faecium											
Aminopenicilins RI	86	100	100	100	100	100	100	80	90	94	91
HL gentamicin R	63	100	70	80	67	50	71	–	–	85	86
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	3	11
Klebsiella pneumoniae											
Aminoglycosides R	–	–	100	91	80	60	32	71	50	55	57
Fluoroquinolones R	–	–	33	34	23	20	11	29	30	50	52
Third-generation cephalosporins R	–	–	100	94	80	50	65	71	44	61	67
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	14	20
Pseudomonas aeruginosa											
Piperacillin R	–	–	61	33	25	25	31	63	57	50	55
Ceftazidime R	–	–	52	<1	<1	13	30	60	56	51	44
Carbapenems R	–	–	61	<1	<1	13	46	58	60	58	60
Aminoglycosides R	–	–	64	33	25	38	38	50	60	51	51
Fluoroquinolones R	–	–	64	33	25	25	31	56	67	53	45

Demographic characteristics

Table 3: Selected details on invasive isolates from the reporting period 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	49	14	100	60	100	30	100	1	100	8	98	66	92	60
CSF	51	49	–	–	0	0	–	–	–	–	2	40	8	60
Gender														
Male	57	30	59	60	47	33	49	0	64	9	61	66	57	59
Female	41	33	41	60	53	28	39	2	36	6	39	64	43	61
Unknown	2	50	<1	100	–	–	12	0	–	–	–	–	–	–
Age (years)														
0–4	9	75	5	81	3	6	6	0	14	0	14	79	11	79
5–19	6	60	2	33	1	0	2	0	2	0	1	100	2	33
20–64	55	23	53	55	46	32	47	0	38	3	47	60	56	59
65 and over	28	32	38	66	48	30	41	0	45	15	37	64	31	55
Unknown	2	0	1	75	1	67	4	20	1	0	1	100	1	100
Hospital department														
ICU	13	45	20	82	7	43	32	0	24	14	30	89	35	70
Internal med.	2	0	11	53	16	20	7	0	3	0	8	62	1	0
Surgery	–	–	7	68	2	38	3	0	2	0	7	87	7	67
Other	85	31	62	54	74	31	59	1	69	7	54	50	55	56
Unknown	–	–	–	–	1	67	–	–	1	0	–	–	2	0

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Romania

Figure 1: ***S. pneumoniae*****: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)**

Figure 2: ***S. aureus*****: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)**

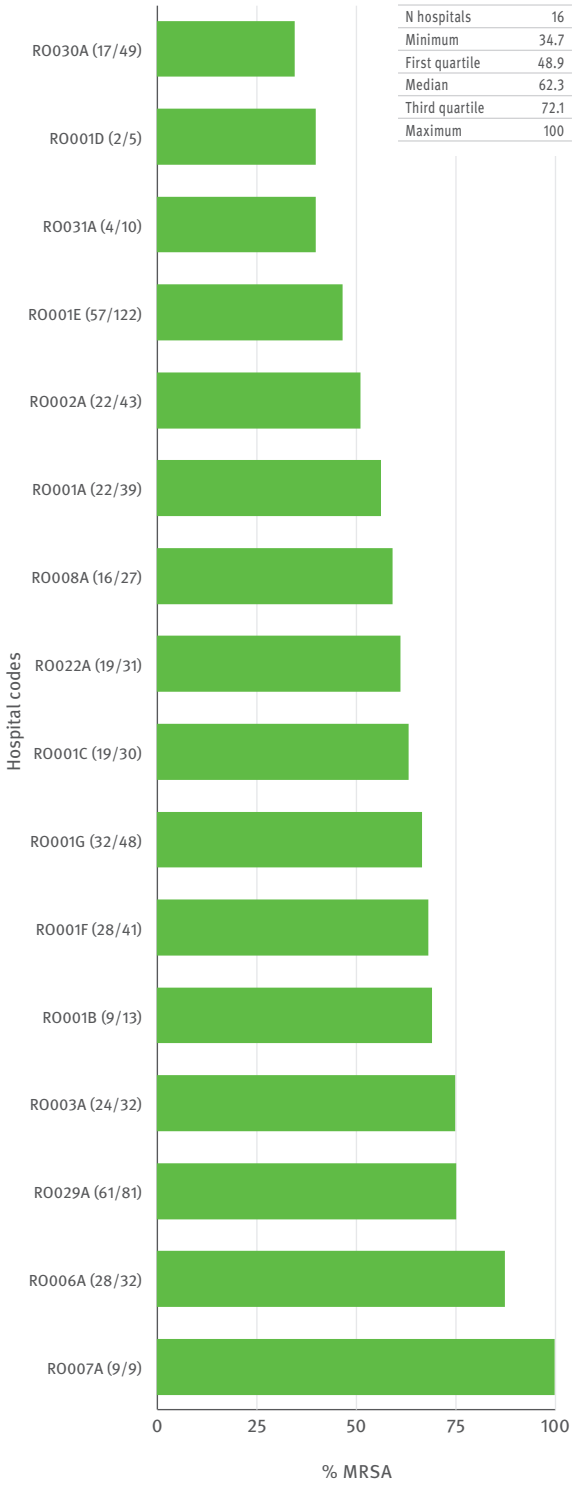
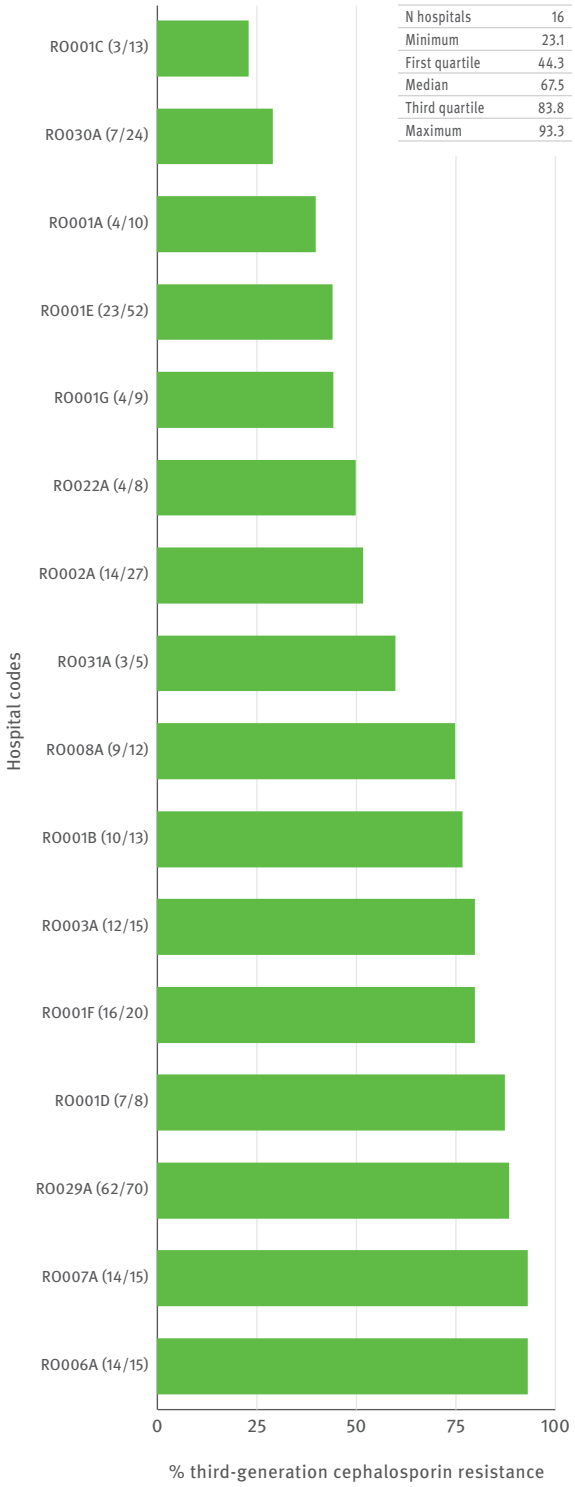


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Slovakia

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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	14	27	16	269	16	239	10	75	–	–	–	–
2004	9	17	15	289	15	310	12	82	–	–	–	–
2005	4	8	12	147	13	134	8	46	–	–	–	–
2006	–	–	–	–	–	–	–	–	–	–	–	–
2007	–	–	–	–	–	–	–	–	–	–	–	–
2008	–	–	–	–	–	–	–	–	–	–	–	–
2009	–	–	–	–	–	–	–	–	–	–	–	–
2010	–	–	–	–	–	–	–	–	–	–	–	–
2011	7	26	11	572	11	740	11	305	11	466	11	267
2012	10	22	14	478	14	696	14	274	14	378	14	199
2013	8	29	14	558	14	809	14	366	14	490	14	286

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	4	24	<1	–	–	–	–	–	4	5	4
Penicillin RI	11	29	<1	–	–	–	–	–	8	5	11
Macrolides RI	<1	33	40	–	–	–	–	–	12	27	17
Staphylococcus aureus											
Oxacillin/meticillin R	8	14	16	–	–	–	–	–	26	22	27
Escherichia coli											
Aminopenicilins R	54	62	59	–	–	–	–	–	68	65	61
Aminoglycosides R	6	11	7	–	–	–	–	–	18	21	24
Fluoroquinolones R	20	24	14	–	–	–	–	–	42	41	40
Third-generation cephalosporins R	<1	7	8	–	–	–	–	–	31	31	30
Carbapenems R	<1	<1	<1	–	–	–	–	–	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	<1	7	7	–	–	–	–	–	2	2	1
HL gentamicin R	35	37	40	–	–	–	–	–	50	50	57
Vancomycin R	<1	<1	<1	–	–	–	–	–	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	92	91	100	–	–	–	–	–	96	95	97
HL gentamicin R	60	45	33	–	–	–	–	–	79	86	63
Vancomycin R	<1	9	<1	–	–	–	–	–	4	5	8
Klebsiella pneumoniae											
Aminoglycosides R	–	–	–	–	–	–	–	–	66	63	64
Fluoroquinolones R	–	–	–	–	–	–	–	–	71	67	67
Third-generation cephalosporins R	–	–	–	–	–	–	–	–	68	63	66
Carbapenems R	–	–	–	–	–	–	–	–	<1	6	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	–	–	–	–	–	–	41	38	42
Ceftazidime R	–	–	–	–	–	–	–	–	25	35	31
Carbapenems R	–	–	–	–	–	–	–	–	31	41	59
Aminoglycosides R	–	–	–	–	–	–	–	–	53	42	39
Fluoroquinolones R	–	–	–	–	–	–	–	–	59	56	53

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	90	9	100	25	99	41	100	0	100	7	99	65	98	51
CSF	10	0	–	–	1	25	–	–	–	–	1	80	2	38
Gender														
Male	67	13	59	26	45	46	61	0	52	5	64	67	64	49
Female	33	0	41	23	55	36	39	1	48	9	36	61	36	53
Age (years)														
0–4	8	25	1	8	1	0	1	0	2	0	2	50	4	64
5–19	4	0	2	8	1	14	3	0	1	0	2	56	3	83
20–64	56	4	44	22	38	40	46	1	49	9	43	67	45	52
65 and over	31	13	52	28	60	43	51	0	47	5	53	64	48	46
Hospital department														
ICU	23	27	20	38	14	49	33	1	32	3	35	75	37	56
Internal med.	33	0	46	24	48	41	29	0	30	11	29	58	22	46
Surgery	4	0	8	22	9	37	14	0	12	8	10	68	12	39
Other	40	5	26	17	30	37	24	0	25	6	26	57	29	52
Unknown	–	–	0	0	<1	100	–	–	–	–	–	–	–	–

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Slovakia

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

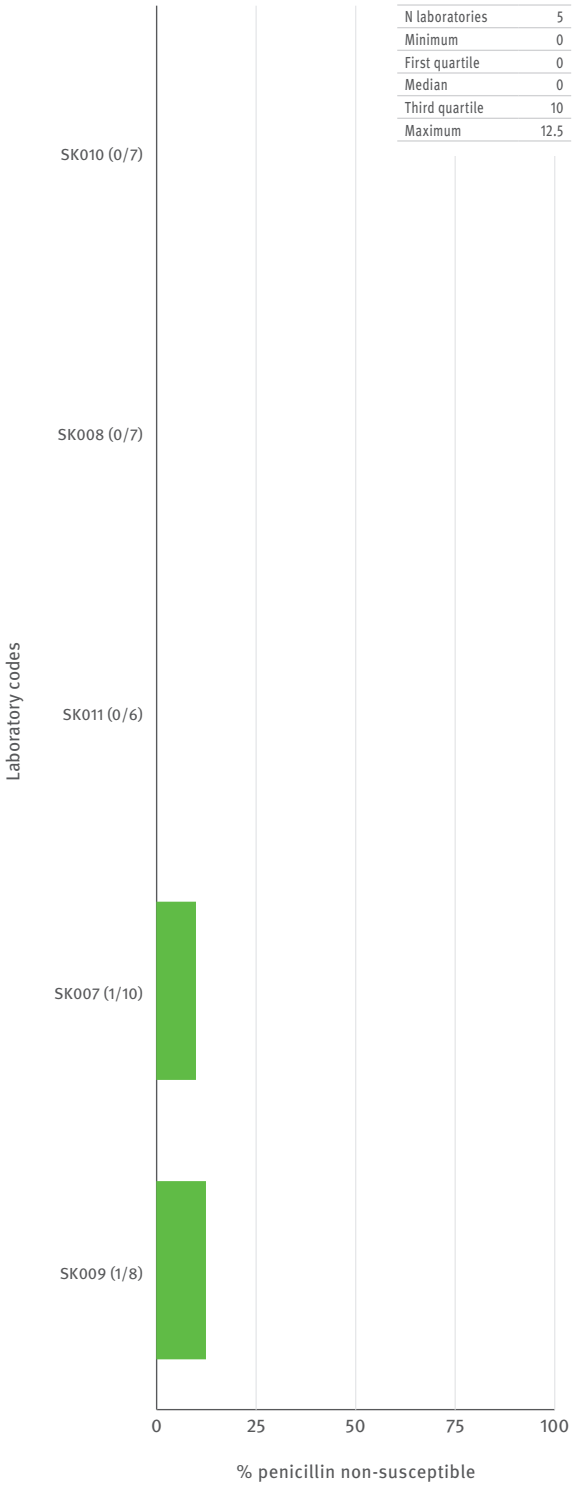


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

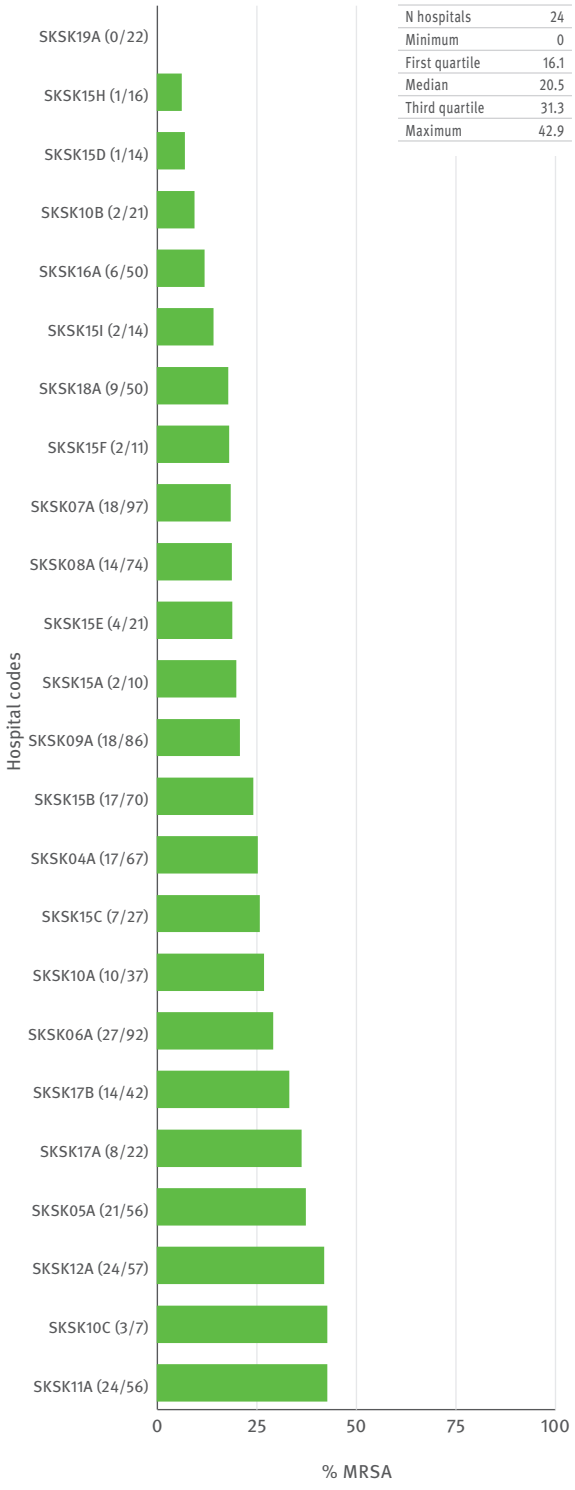


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

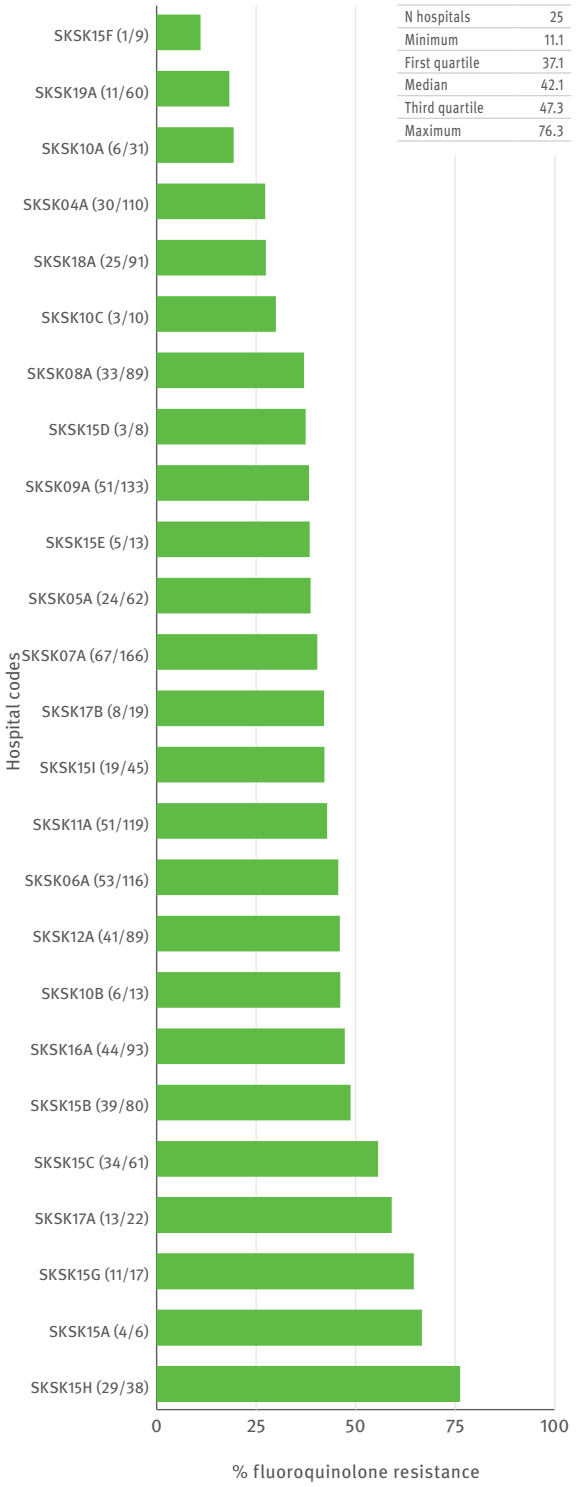
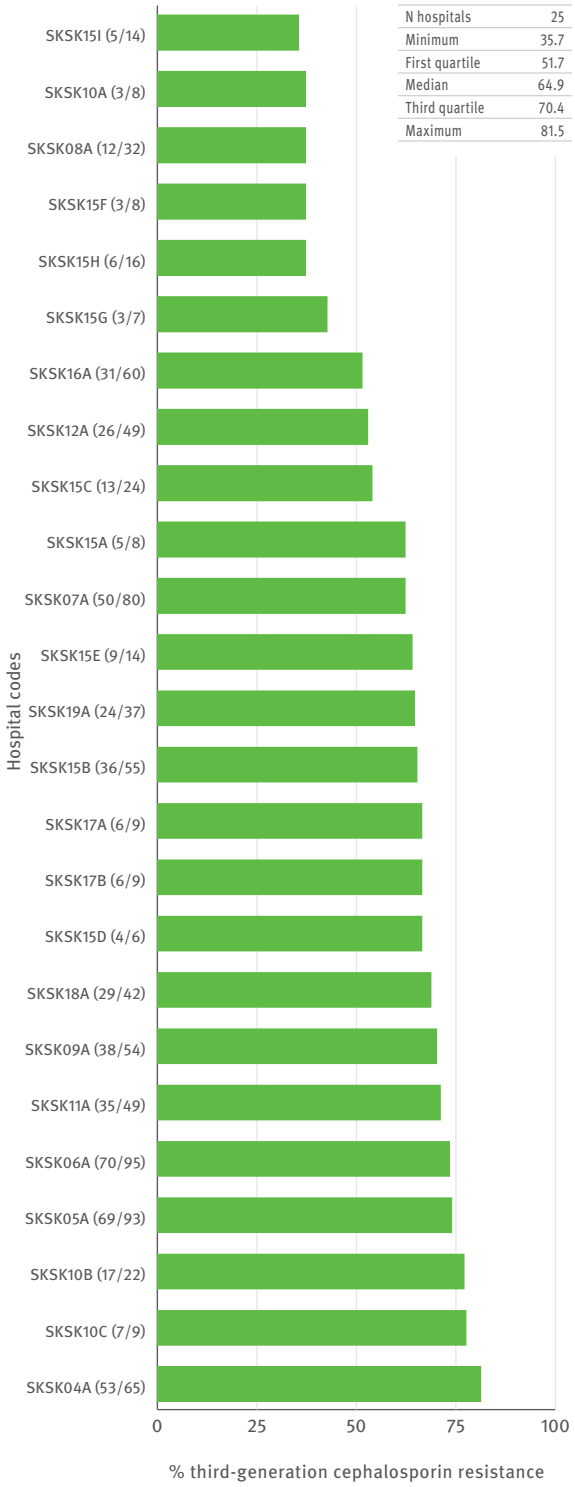


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Slovenia

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	10	253	10	464	10	1002	10	208	10	232	10	118
2012	10	251	10	445	10	1168	10	225	10	254	10	134
2013	10	279	10	465	10	1224	10	248	10	245	10	133

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	2	2	2	5	4	3	1	<1	<1	1	<1
Penicillin RI	15	25	11	19	17	15	15	16	12	10	8
Macrolides RI	9	11	11	13	17	16	17	17	24	21	10
Staphylococcus aureus											
Oxacillin/meticillin R	13	12	10	7	8	7	10	12	7	10	9
Escherichia coli											
Aminopenicilins R	41	40	42	44	49	49	53	48	54	50	51
Aminoglycosides R	2	5	4	7	7	7	10	9	10	9	10
Fluoroquinolones R	11	12	12	15	17	17	18	19	21	21	20
Third-generation cephalosporins R	<1	1	2	2	4	4	5	7	9	10	9
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	<1	<1	1	1	<1	<1	<1	2	<1	<1	<1
HL gentamicin R	49	37	46	40	50	40	43	43	36	35	32
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	83	76	93	86	92	96	94	95	90	93	90
HL gentamicin R	82	56	47	54	63	57	56	66	66	63	60
Vancomycin R	<1	<1	<1	6	5	13	4	2	<1	<1	1
Klebsiella pneumoniae											
Aminoglycosides R	–	–	17	19	24	23	28	23	22	20	20
Fluoroquinolones R	–	–	14	21	26	25	27	25	35	33	33
Third-generation cephalosporins R	–	–	19	24	28	26	31	22	30	28	29
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	21	18	13	21	16	15	13	7	14
Ceftazidime R	–	–	11	8	7	14	8	5	8	7	14
Carbapenems R	–	–	13	6	19	16	15	19	24	22	26
Aminoglycosides R	–	–	21	15	10	13	12	8	8	10	8
Fluoroquinolones R	–	–	29	21	17	24	13	9	9	15	11

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	95	8	100	10	100	21	100	0	100	1	98	29	97	23
CSF	5	21	–	–	<1	29	–	–	–	–	2	38	3	57
Gender														
Male	57	8	56	10	42	24	68	0	62	1	62	31	63	22
Female	43	10	44	10	58	18	32	0	38	0	38	25	37	27
Age (years)														
0–4	16	9	3	7	3	1	6	0	1	0	3	0	3	38
5–19	4	0	3	10	1	12	–	–	1	0	2	0	1	0
20–64	38	10	35	7	27	19	31	0	41	1	32	32	35	32
65 and over	43	8	59	11	69	22	63	0	57	0	64	29	61	18
Hospital department														
ICU	14	13	12	12	8	22	21	0	37	0	18	40	27	23
Internal med.	34	7	35	10	44	21	32	0	28	0	38	22	30	25
Surgery	1	33	11	14	6	23	14	0	13	0	10	42	13	38
Other	51	8	43	8	42	20	33	0	22	2	34	26	30	16

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Slovenia

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

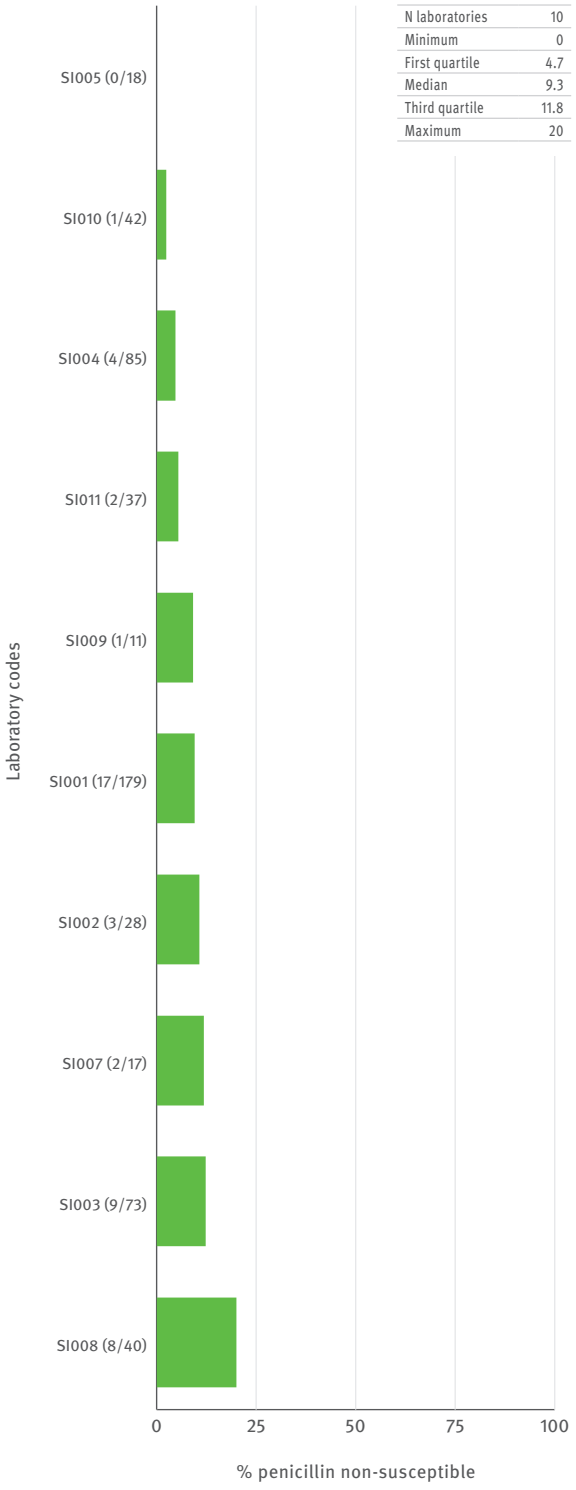


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

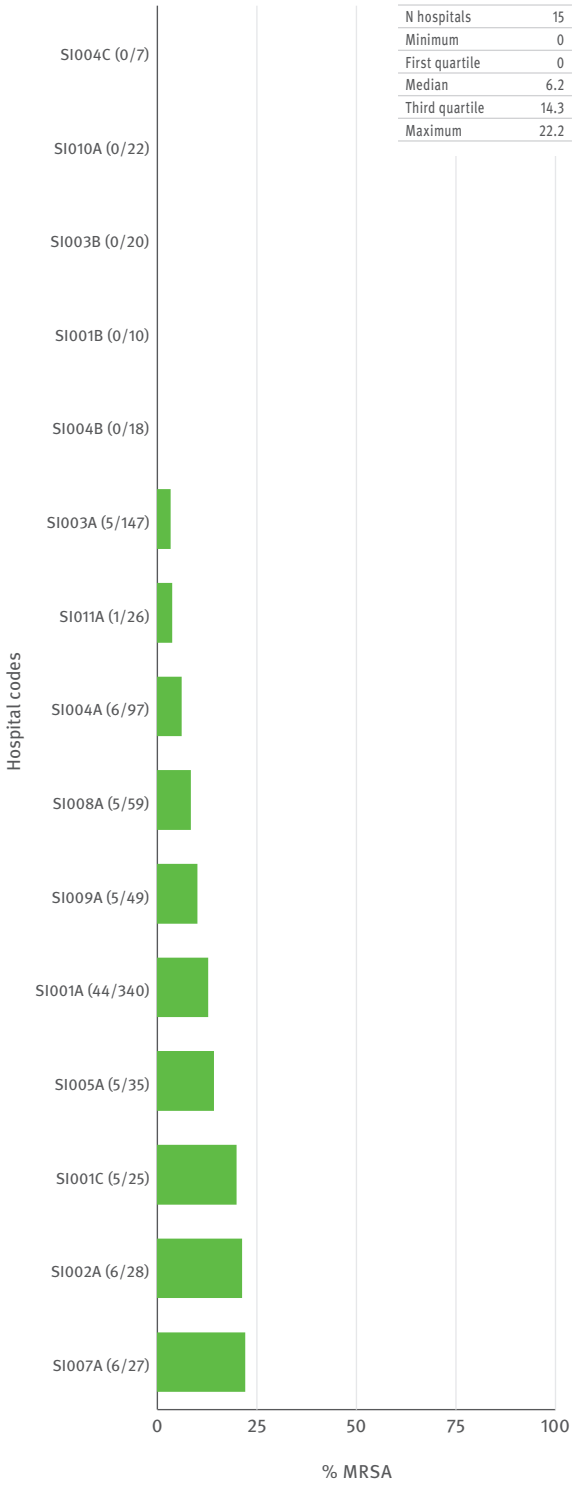


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

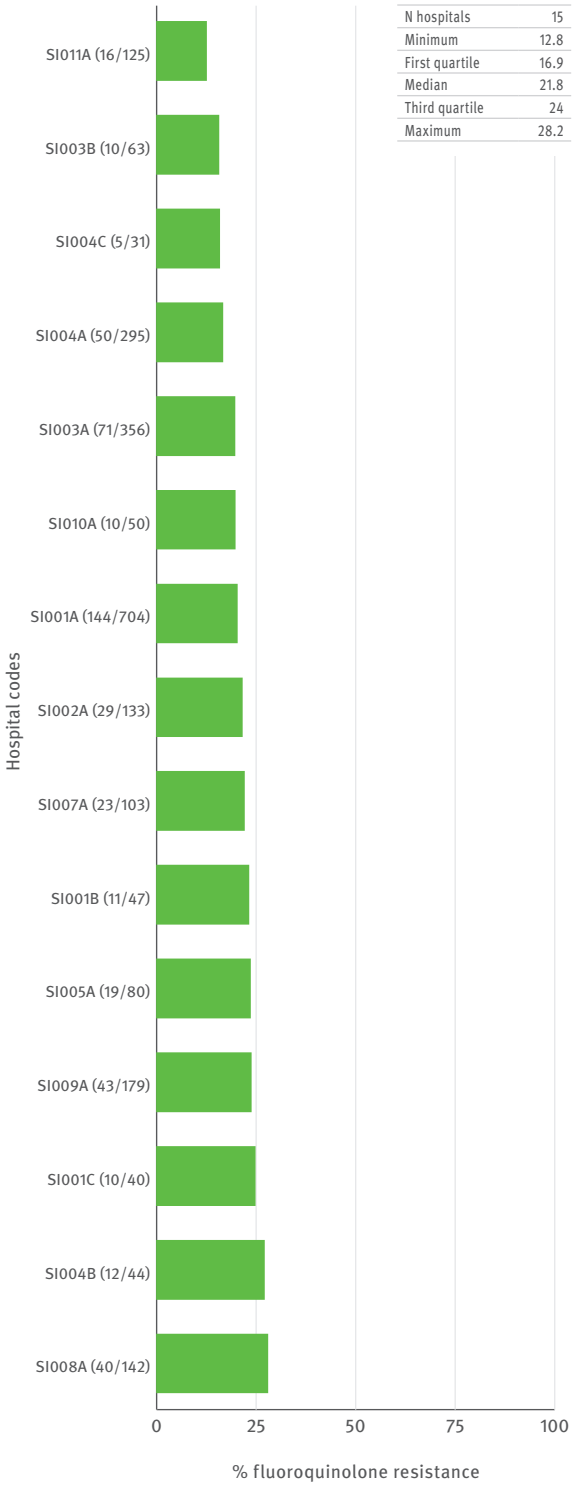
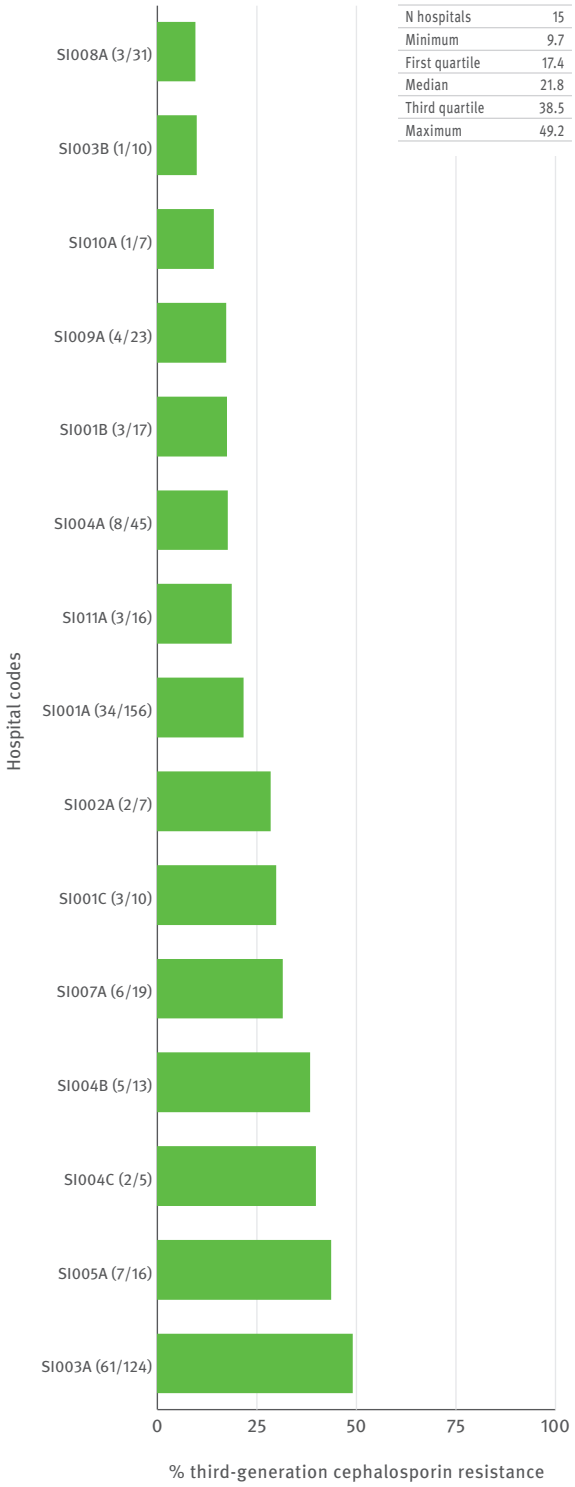


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Spain

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	40	763	40	1965	40	5605	39	1478	40	1145	40	839
2012	40	644	41	1904	40	5675	41	1508	40	1153	40	853
2013	38	596	39	1856	39	5933	39	1506	38	1241	39	825

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	7	9	9	8	8	7	8	30	10	27	30
Penicillin RI	32	29	25	27	22	23	22	30	30	27	28
Macrolides RI	27	27	23	22	18	22	19	27	25	26	26
Staphylococcus aureus											
Oxacillin/meticillin R	24	26	27	25	25	27	26	25	22	24	23
Escherichia coli											
Aminopenicilins R	58	60	62	64	62	63	65	65	66	65	65
Aminoglycosides R	7	7	10	9	10	11	13	14	15	16	15
Fluoroquinolones R	21	25	28	28	30	33	31	33	34	34	35
Third-generation cephalosporins R	4	7	8	7	7	9	11	12	12	14	13
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	1	2	<1	2	1	3	3	1	<1	2	4
HL gentamicin R	36	36	36	36	42	41	43	41	39	38	43
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	64	66	67	73	79	79	83	83	82	87	85
HL gentamicin R	11	17	16	21	40	35	38	27	23	26	36
Vancomycin R	3	2	3	3	2	1	3	1	1	1	<1
Klebsiella pneumoniae											
Aminoglycosides R	–	–	4	7	9	9	9	9	10	14	16
Fluoroquinolones R	–	–	11	8	17	15	16	14	17	17	22
Third-generation cephalosporins R	–	–	7	9	10	12	11	10	13	17	20
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	2
Pseudomonas aeruginosa											
Piperacillin R	–	–	4	9	8	8	8	6	6	7	9
Ceftazidime R	–	–	6	7	10	11	8	7	9	9	9
Carbapenems R	–	–	17	12	15	13	16	18	16	16	18
Aminoglycosides R	–	–	4	11	15	18	20	18	19	17	15
Fluoroquinolones R	–	–	14	19	25	23	25	25	24	21	23

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	93	28	100	23	100	34	100	0	100	1	99	18	99	17
CSF	7	35	–	–	<1	11	–	–	–	–	1	35	1	12
Gender														
Male	61	29	66	24	52	39	66	0	60	1	62	19	67	17
Female	39	28	34	23	48	30	34	0	39	1	38	16	33	18
Unknown	–	–	<1	30	<1	33	0	0	0	0	<1	29	0	0
Age (years)														
0–4	9	28	5	11	3	17	10	0	3	0	6	17	3	6
5–19	4	21	3	7	1	24	1	0	1	0	1	11	2	17
20–64	40	25	34	17	27	30	28	0	34	2	34	20	40	22
65 and over	47	32	58	29	68	37	61	0	63	1	59	17	56	14
Unknown	<1	25	<1	43	<1	19	<1	20	0	0	<1	50	0	0
Hospital department														
ICU	12	29	8	18	6	36	15	0	16	2	12	23	19	27
Internal med.	27	26	34	27	29	38	27	0	33	1	28	16	26	15
Surgery	1	38	8	29	7	32	10	0	10	0	11	19	10	14
Other	50	30	36	19	47	32	36	0	27	1	36	14	33	14
Unknown	10	26	13	25	12	37	13	0	14	2	13	31	11	14

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

Spain

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

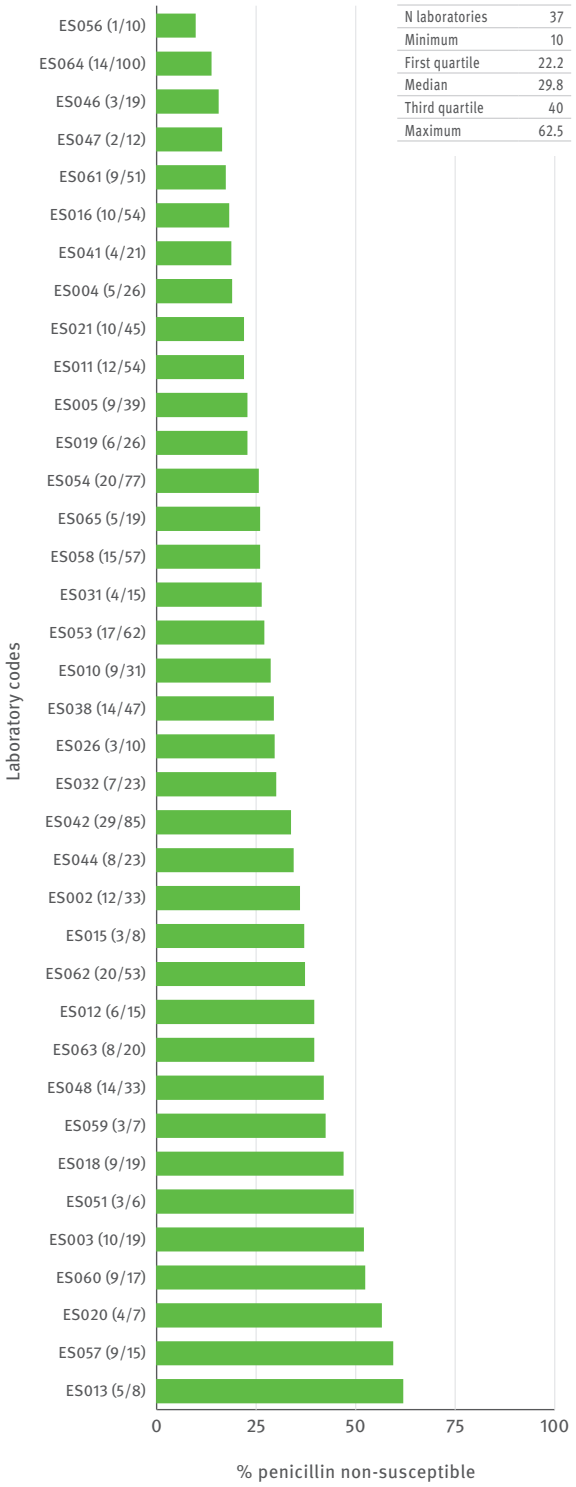


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

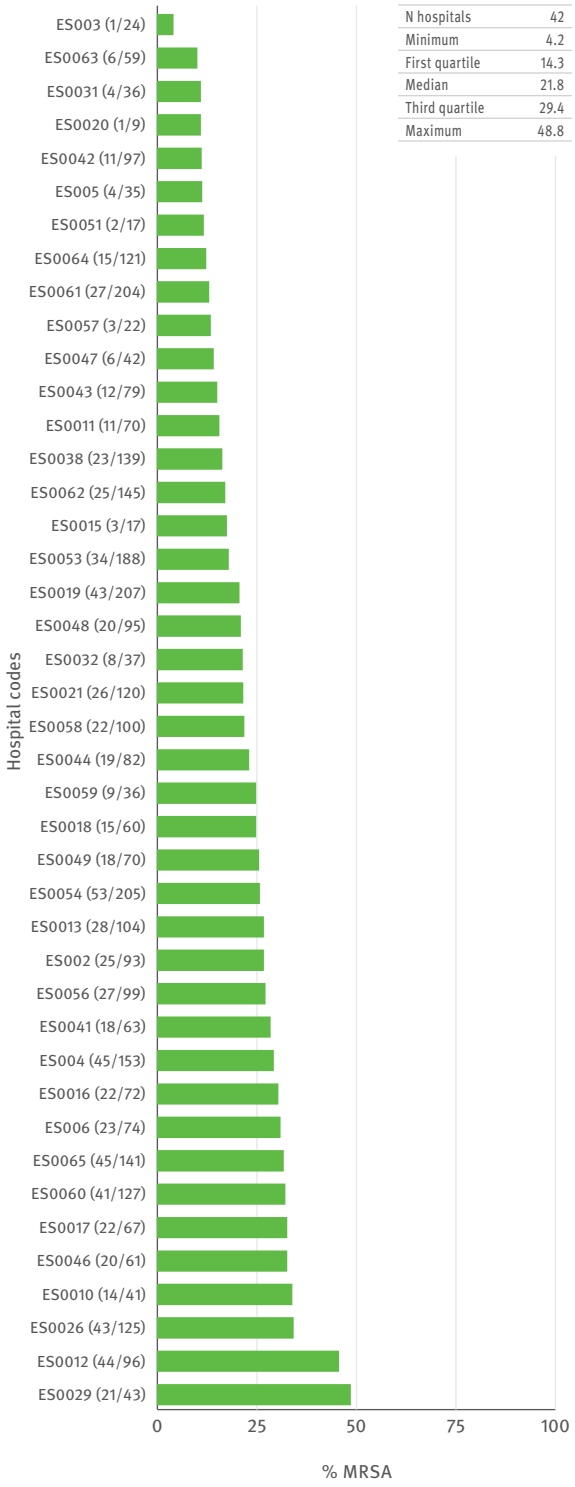


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

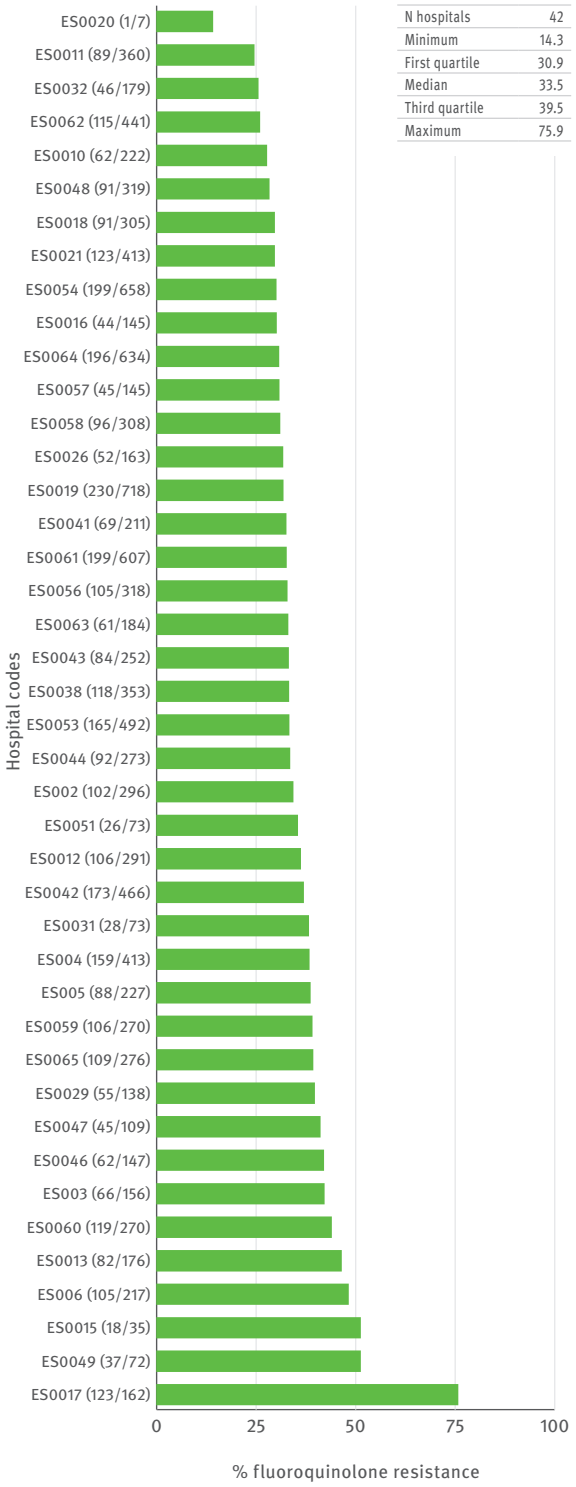
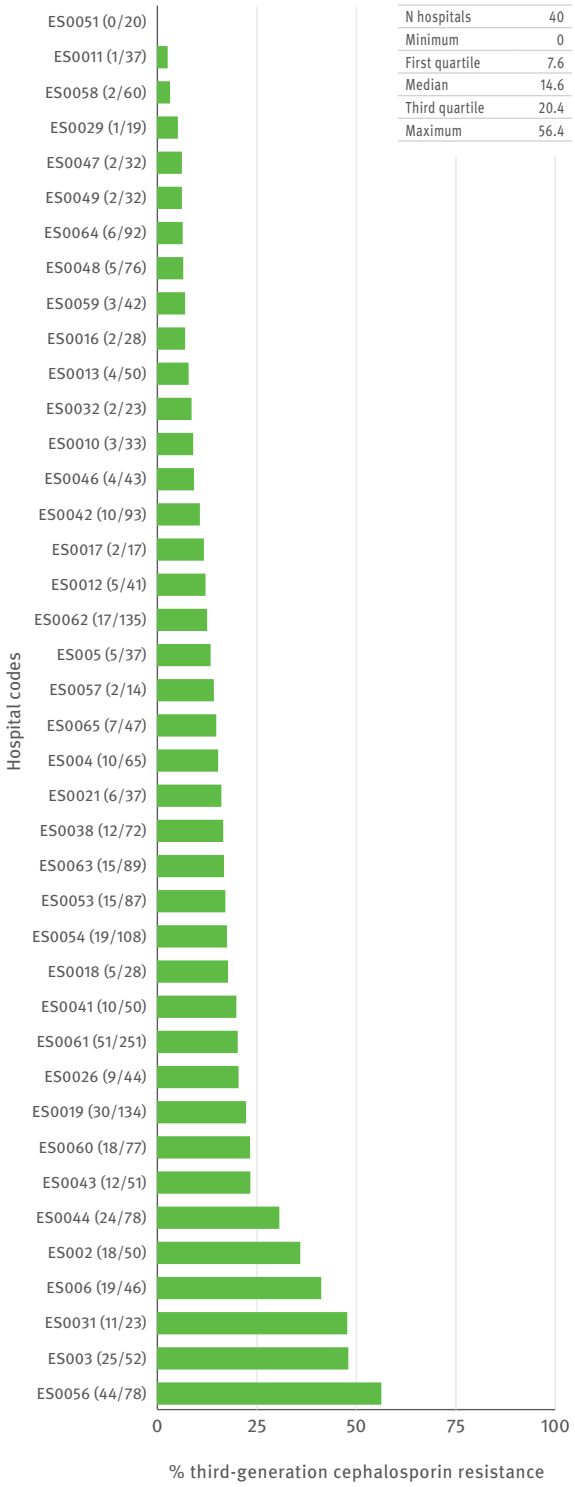


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



Sweden

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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	2867	18	4846	18	1038	18	878	18	377
2011	18	1195	18	3765	17	6325	18	1530	17	1164	17	509
2012	18	1030	18	3262	17	5541	18	1211	17	976	17	357
2013	18	1166	18	4124	18	7538	18	1697	18	1300	18	533

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	<1	<1	<1	<1	<1	<1	2	2	4	5	7
Penicillin RI	5	3	4	2	3	2	3	4	4	5	7
Macrolides RI	5	5	6	5	5	6	4	4	5	5	7
Staphylococcus aureus											
Oxacillin/meticillin R	<1	<1	1	<1	<1	<1	1	<1	<1	<1	1
Escherichia coli											
Aminopenicilins R	29	23	26	28	33	32	33	35	35	–	34
Aminoglycosides R	1	1	1	2	2	2	3	3	4	5	6
Fluoroquinolones R	7	8	6	8	10	10	8	11	9	11	12
Third-generation cephalosporins R	<1	<1	1	2	2	2	3	3	4	4	5
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	<1	<1	<1	<1	<1	<1	<1	2	<1	–	<1
HL gentamicin R	17	16	19	20	16	20	19	15	19	15	16
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium											
Aminopenicilins RI	77	78	74	76	79	82	76	82	88	–	80
HL gentamicin R	11	7	4	12	14	25	24	22	32	20	33
Vancomycin R	2	1	<1	<1	<1	2	<1	<1	<1	<1	<1
Klebsiella pneumoniae											
Aminoglycosides R	–	–	1	<1	1	1	<1	1	2	2	3
Fluoroquinolones R	–	–	5	5	6	7	2	5	2	4	4
Third-generation cephalosporins R	–	–	1	1	1	2	2	2	2	3	4
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	9	<1	2	1	2	1	4	6	7
Ceftazidime R	–	–	5	6	4	5	7	3	5	6	7
Carbapenems R	–	–	18	5	7	4	8	4	8	5	7
Aminoglycosides R	–	–	<1	<1	<1	<1	<1	<1	2	2	3
Fluoroquinolones R	–	–	6	5	6	5	7	6	5	7	6

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	99	6	100	1	100	11	100	0	100	0	100	3	100	6
CSF	1	0	–	–	0	0	–	–	–	–	0	0	–	–
Gender														
Male	50	6	62	1	47	16	71	0	63	0	59	4	65	7
Female	50	5	38	0	53	7	29	0	37	0	41	3	35	6
Age (years)														
0–4	2	11	3	3	1	4	4	0	1	0	1	4	1	30
5–19	2	0	2	1	1	10	1	0	1	0	1	17	2	27
20–64	36	5	30	1	24	14	22	0	29	0	24	5	26	10
65 and over	59	6	64	1	73	11	73	0	68	0	73	2	71	4
Unknown	1	5	1	0	1	14	1	0	0	0	1	0	1	17
Hospital department														
ICU	5	7	5	0	3	11	5	0	13	0	4	2	6	13
Internal med.	47	5	40	1	36	10	32	0	25	0	32	2	37	2
Surgery	5	1	17	0	21	12	24	0	26	0	24	3	16	6
Other	39	7	36	1	38	13	37	0	33	0	36	5	38	10
Unknown	4	5	3	0	3	10	3	0	3	0	3	3	3	13

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant Enterococcus; 3GCRKP: third-generation cephalosporin-resistant *K. pneumoniae*; CRPA: carbapenem-resistant *P. aeruginosa*.

Sweden

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)

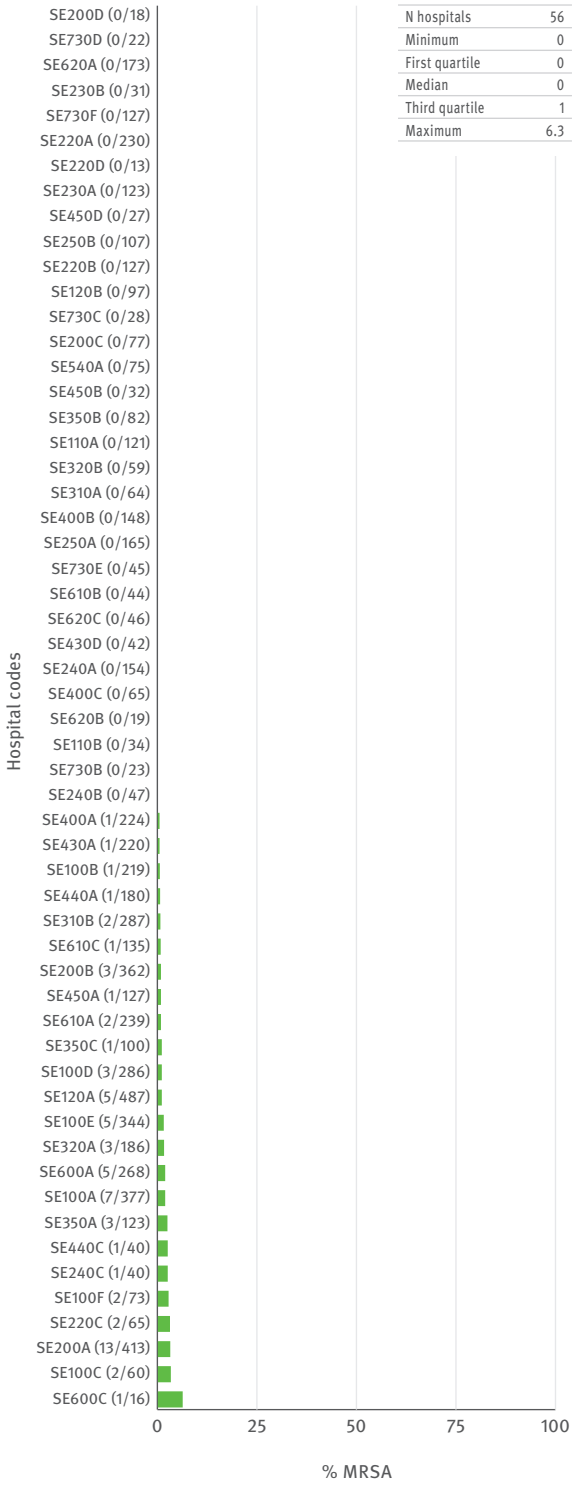


Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

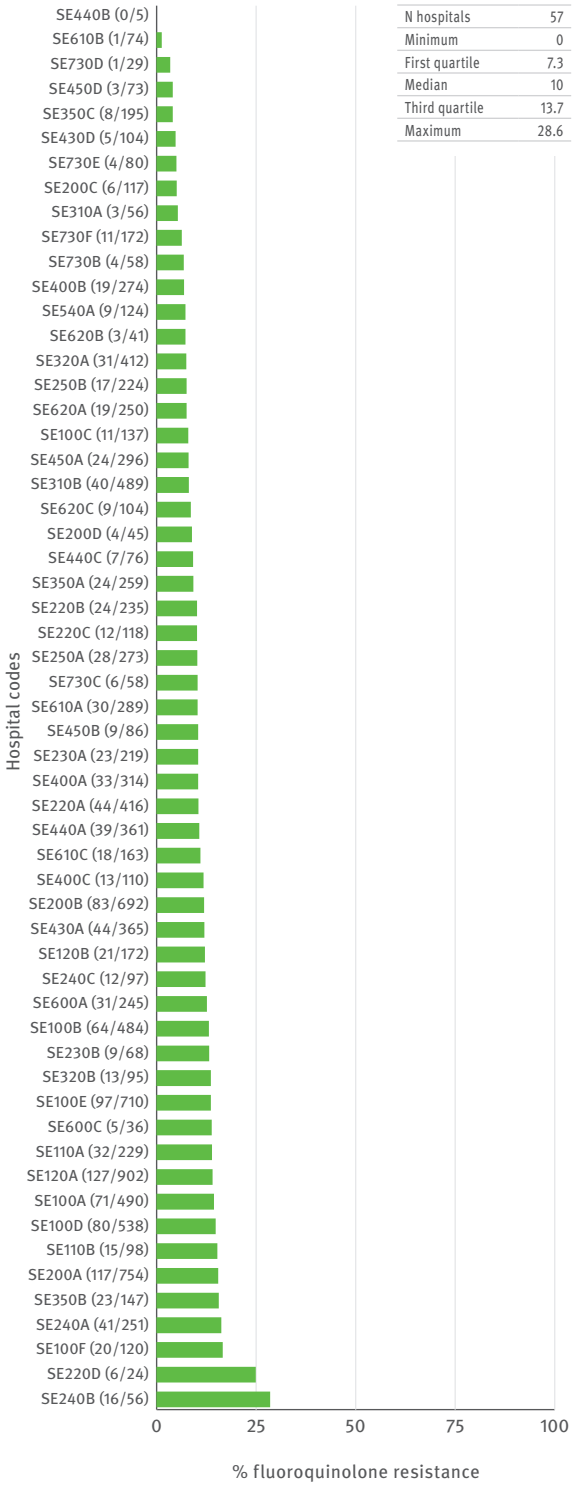


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)

United Kingdom

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2013

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
2011	53	1513	53	3430	29	5971	28	723	28	1007	28	599
2012	54	1295	55	2696	29	6527	27	877	28	1075	28	681
2013	54	1301	56	2875	31	6481	30	957	31	1143	31	702

* Number of laboratories reporting at least one isolate during the specific year. Please note that the total number of laboratories participating in EARS-Net might be higher.

Antibiotic resistance from 2003 to 2013

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2013

Microorganism by antimicrobial classes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Streptococcus pneumoniae											
Penicillin R	1	<1	2	<1	2	1	1	<1	<1	<1	<1
Penicillin RI	5	3	4	3	4	5	3	3	5	5	5
Macrolides RI	13	13	11	12	10	6	4	5	6	7	7
Staphylococcus aureus											
Oxacillin/meticillin R	44	44	44	42	36	31	28	22	14	13	14
Escherichia coli											
Aminopenicilins R	55	53	56	57	55	61	62	62	63	63	63
Aminoglycosides R	4	6	8	7	7	7	7	8	8	9	9
Fluoroquinolones R	11	14	17	20	18	15	18	17	18	17	16
Third-generation cephalosporins R	3	3	6	8	9	7	9	9	10	13	15
Carbapenems R	–	–	–	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis											
Aminopenicilins RI	–	–	2	3	4	2	2	6	4	4	2
HL gentamicin R	–	–	47	52	31	42	38	39	16	30	31
Vancomycin R	–	–	2	1	2	4	2	1	2	1	<1
Enterococcus faecium											
Aminopenicilins RI	–	–	84	78	82	83	91	84	90	93	92
HL gentamicin R	–	–	53	18	35	7	38	31	56	54	55
Vancomycin R	–	–	33	18	21	28	13	10	9	13	23
Klebsiella pneumoniae											
Aminoglycosides R	–	–	6	8	9	6	5	5	4	6	7
Fluoroquinolones R	–	–	12	13	12	7	6	7	5	7	9
Third-generation cephalosporins R	–	–	12	11	13	7	7	10	5	12	14
Carbapenems R	–	–	<1	<1	<1	1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa											
Piperacillin R	–	–	2	1	5	2	3	4	4	3	5
Ceftazidime R	–	–	3	3	7	4	5	5	5	4	4
Carbapenems R	–	–	9	6	10	6	8	6	6	6	5
Aminoglycosides R	–	–	4	4	5	3	1	2	3	2	3
Fluoroquinolones R	–	–	8	8	9	8	7	7	6	5	6

Demographic characteristics

Table 3: Selected details on invasive isolates reported for 2012 and 2013

Characteristic	*S. pneumoniae*		*S. aureus*		*E. coli*		*E. faecalis*		*E. faecium*		*K. pneumoniae*		*P. aeruginosa*	
	% total	% PNSP	% total	% MRSA	% total	% FREC	% total	% VRE	% total	% VRE	% total	% 3GCRKP	% total	% CRPA
Isolate source														
Blood	98	5	100	13	100	16	100	1	100	19	99	13	98	6
CSF	2	13	–	–	<1	8	–	–	–	–	1	6	2	19
Gender														
Male	49	4	61	14	48	19	68	1	59	18	59	15	65	6
Female	51	6	39	12	52	15	32	1	40	20	41	10	34	5
Unknown	0	0	<1	100	<1	7	0	0	<1	100	<1	40	<1	67
Age (years)														
0–4	1	0	<1	16	<1	14	0	0	0	0	<1	14	<1	100
5–19	4	12	5	5	2	8	8	1	3	15	3	12	3	5
20–64	3	7	3	5	1	13	1	10	2	31	1	32	2	33
65 and over	40	4	44	9	25	14	26	1	36	22	29	13	26	10
Unknown	52	5	48	18	72	17	65	0	58	17	67	12	69	3
Hospital department														
ICU	1	3	1	25	–	–	–	–	–	–	–	–	–	–
Internal med.	6	2	2	40	–	–	–	–	–	–	–	–	–	–
Surgery	1	6	<1	23	–	–	–	–	–	–	–	–	–	–
Other	58	5	79	13	47	17	49	1	45	13	46	12	47	6
Unknown	35	5	18	10	53	16	51	1	55	23	54	14	53	5

PNSP: penicillin-non-susceptible *S. pneumoniae*; MRSA: meticillin-resistant *S. aureus*; FREC: fluoroquinolone-resistant *E. coli*; VRE: vancomycin-resistant *E. faecalis* or *E. faecium*, 3GCRKP = third-generation cephalosporin-resistant *K. pneumoniae*; CRPA = carbapenem-resistant *P. aeruginosa*.

United Kingdom

Figure 1: *S. pneumoniae*: percentage (%) of invasive isolates with penicillin non-susceptibility by laboratory (2012–2013)

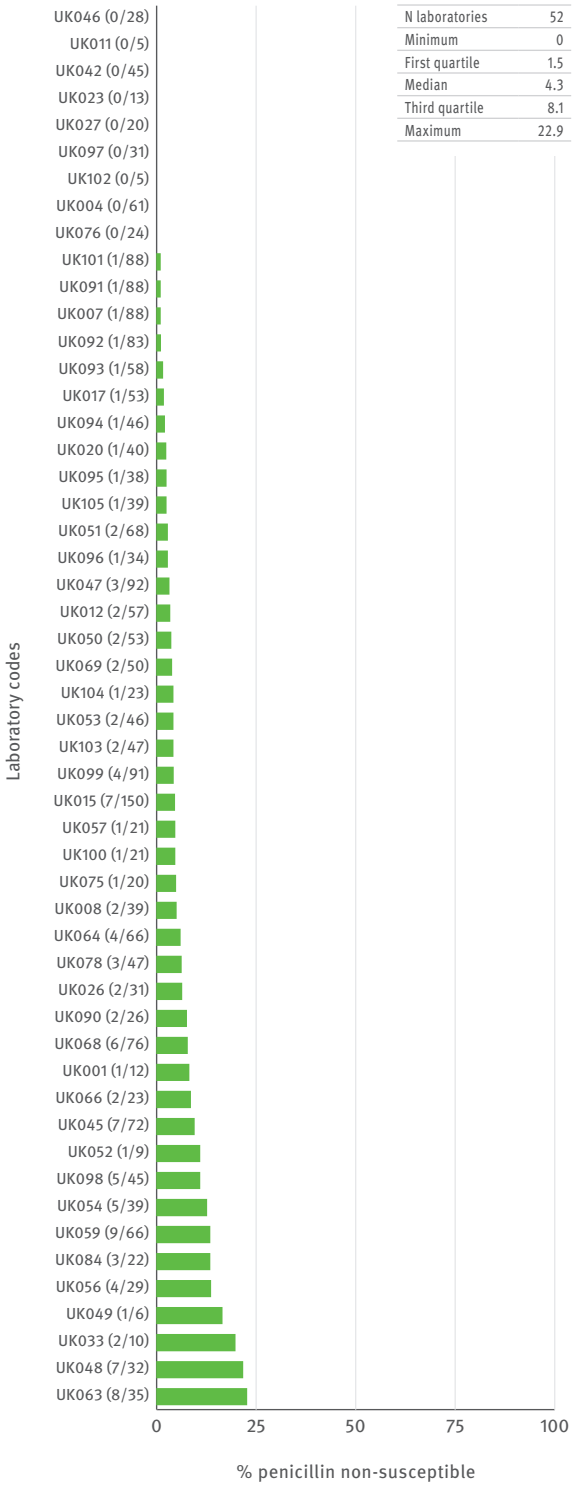
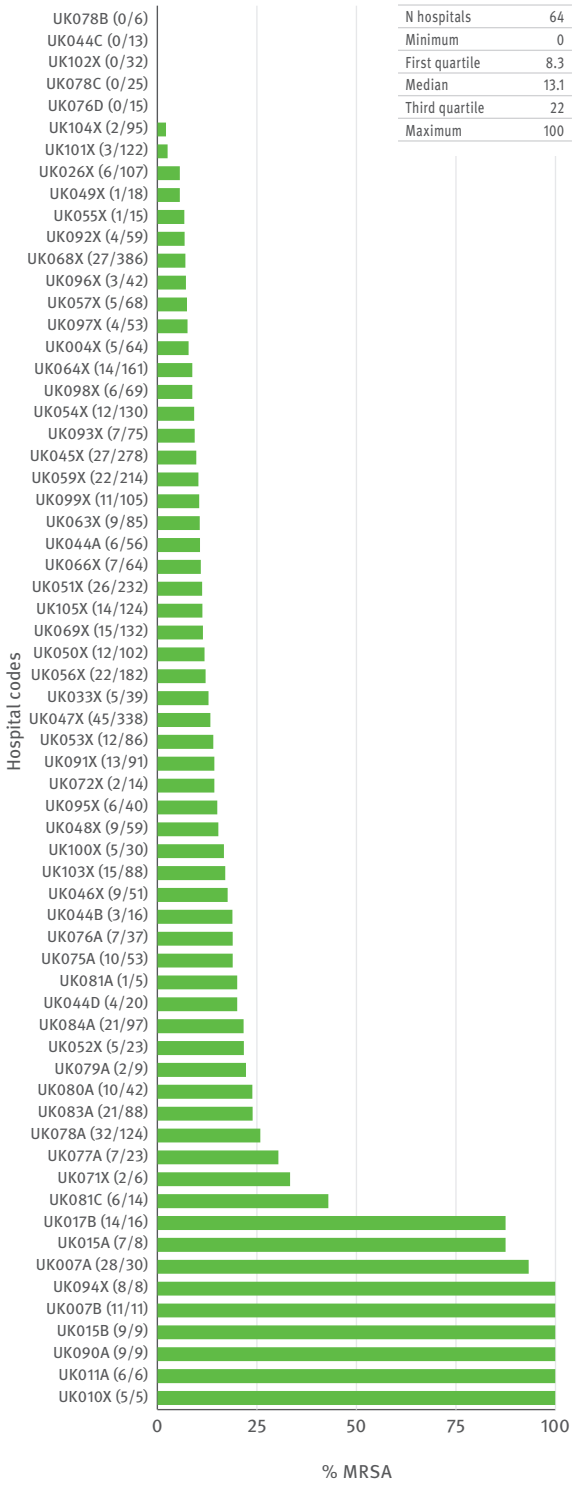


Figure 2: *S. aureus*: percentage (%) of invasive isolates with resistance to meticillin (MRSA) by hospital (2012–2013)



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

Figure 3: *E. coli*: percentage (%) of invasive isolates with resistance to fluoroquinolones by hospital (2012–2013)

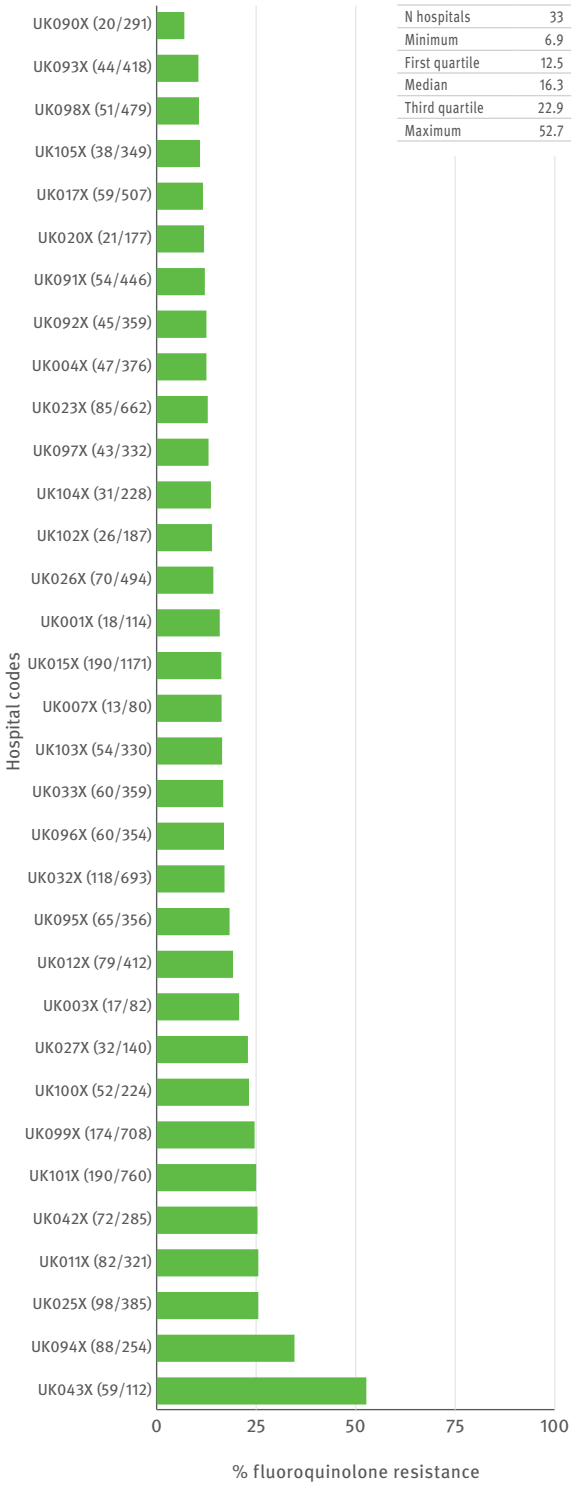
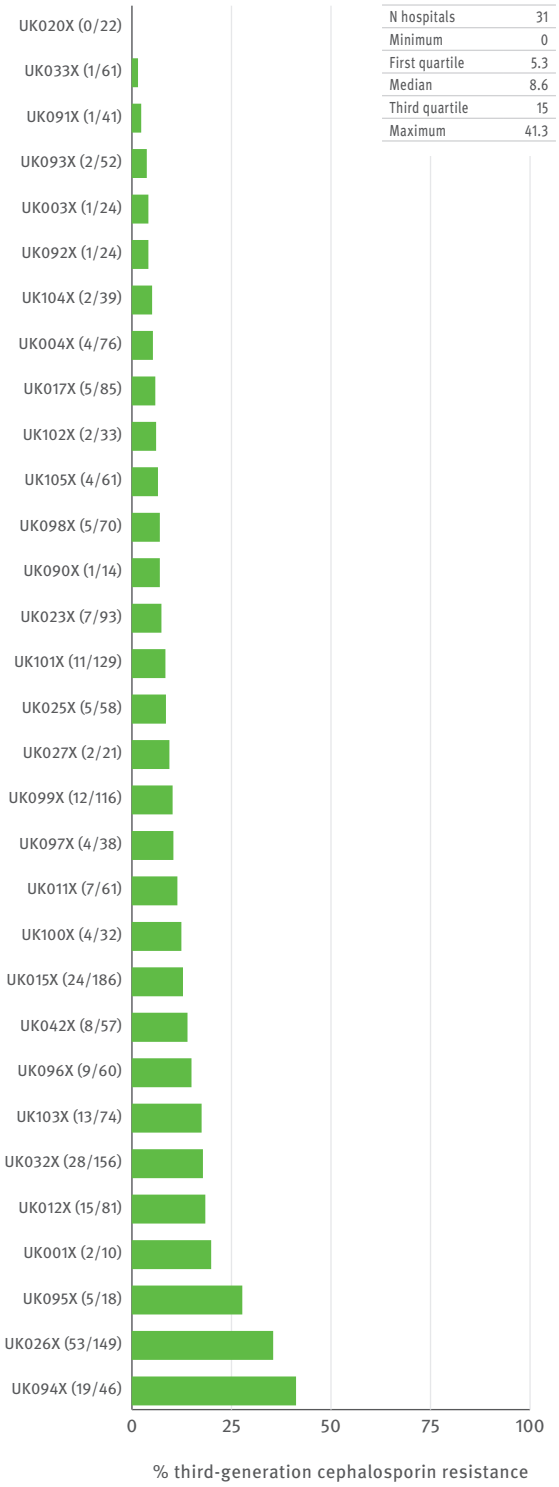


Figure 4: *K. pneumoniae*: percentage (%) of invasive isolates with resistance to third-generation cephalosporins by hospital (2012–2013)



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