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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)

2014

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Abbreviations and acronyms

3GCREC	Third-generation cephalosporin-resistant *Escherichia coli*
3GCRKP	Third-generation cephalosporin-resistant *Klebsiella pneumoniae*
AmpC	Ampicillinase C
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
CPE	Carbapenemase-producing *Enterobacteriaceae*
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
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

Austria

Federal Ministry of Health

Medical University Vienna

Elisabethinen Hospital, Linz

www.elisabethinen.or.at

Belgium

Scientific Institute of Public Health

www.wiv-isp.be/Nsih

Bulgaria

Alexander University Hospital, Sofia

National Center of Infectious and Parasitic Diseases

Croatia

Reference Center for Antimicrobial Resistance Surveillance, Ministry of Health

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

Cyprus

Microbiology Department, 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) and Bacterial Infections Unit

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, Msida

Netherlands

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Romania
National Institute of Public Health

Slovakia
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Public Health Authority of Slovakia
Regional Public Health Authority Banska Bystrica

Slovenia
National Institute of Public Health
www.nijz.si
Medical faculty, 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 29 EU/EEA countries in 2015 (data referring to 2014), and on trend analyses of data reported by the participating countries for the period 2011-2014.

The antimicrobial resistance situation in Europe displays large variations depending on the bacterium, antimicrobial group and geographical region. For several antimicrobial group-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 by countries in the south and east of Europe. These differences are most likely related to differences in antimicrobial use, infection control and healthcare utilisation practices in the countries.

For gram-negative bacteria, the situation is especially worrying with high and, in many cases, increasing resistance percentages reported from many parts of Europe. Over the last four years (2011-2014), resistance to third-generation cephalosporins in *Klebsiella pneumoniae* and *Escherichia coli* increased significantly at EU/EEA level as well as in many of the individual Members States. A large proportion of the isolates resistant to third-generation cephalosporins produced an extended-spectrum beta-lactamase (ESBL). Third-generation cephalosporin resistance was often seen in combination with fluoroquinolone and aminoglycoside resistance. The EU/EEA trend for this type of combined resistance increased significantly between 2011 and 2014 for both *E. coli* and *K. pneumoniae*. Increasing trends were observed in more than a third of the individual countries, both in countries with high and low levels of resistance. The observed increase in combined resistance to multiple antimicrobial groups, as well as the high proportion of ESBL-producing isolates, is especially worrying, as this leaves few treatment alternatives for patients with infections caused by these pathogens. Besides its impact on treatment outcome of individual patients, frequent resistance in gram-negative bacteria may lead to an increased use of carbapenems, thus further favouring the emergence and spread of carbapenem-resistant bacteria.

While the EU/EEA population-weighted mean for carbapenem resistance in 2014 was 7.3 % for *K. pneumoniae*, carbapenem resistance remained very low in *E. coli* (0.1 %). Large inter-country variations were noted for *K. pneumoniae* for which resistance percentages ranged between zero and 62.3 %. With a few exceptions, countries reporting the highest levels of combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides also reported the highest percentages of carbapenem resistance. The four-year trend for carbapenem resistance appeared fairly stable in *E. coli*, with few changes observed in national data between 2011 and 2014 and no significant increase of the EU/EEA population-weighted mean during the same period. A more dynamic pattern was observed for *K. pneumoniae*, with a significantly increasing four-year trend for both the EU/EEA population-weighted mean as well as for seven individual Member States, including countries with both high and low resistance levels. Carbapenem resistance and resistance to multiple antimicrobial groups were also common in *Pseudomonas aeruginosa* and *Acinetobacter* species. For *P. aeruginosa*, the EU/EEA population-weighted mean percentage for carbapenem resistance increased significantly between 2011 and 2014. For *Acinetobacter* spp., no trend analysis was possible as data have only been available since 2012. However, this was the bacterium for which the highest carbapenem resistance levels were reported, with more than a third of the reporting countries reporting resistance percentages above 50 % in 2014.

Treatment alternatives for patients infected with bacteria resistant to both carbapenems and other key antimicrobial groups are often limited to combination therapy and to older antimicrobial agents such as polymyxins, e.g. colistin. Although data on polymyxin susceptibility as part of EARS-Net surveillance are not complete, the fact that some countries, especially countries with already high percentages of carbapenem resistance, report large numbers of isolates with polymyxin resistance is an indication of the further loss of effective antimicrobial treatment options for gram-negative bacterial infections.

The increase in carbapenem resistance in *K. pneumoniae* observed in the EARS-Net surveillance data is most likely the result of an increase in isolates producing a carbapenemase, as previously reported from the ECDC-funded European Survey on Carbapenemase-Producing Enterobacteriaceae (EuSCAPE). The continuous spread of carbapenemase-producing Enterobacteriaceae (CPE), mostly *K. pneumoniae*, presents a serious threat to healthcare and patient safety in European hospitals, to which many European countries have reacted by intensifying their containment efforts. However, results from EuSCAPE have highlighted that gaps still remain and many countries are still lacking national guidance for CPE prevention and control.

Resistance trends in gram-positive bacteria showed a more diverse pattern across Europe. For meticillin-resistant *Staphylococcus aureus* (MRSA), the EU/EEA population-weighted mean percentage has continued to decrease over the last four years, from 18.6 % in 2011 to 17.4 % in 2014. The decline in recent years has, however, been less pronounced than for the period 2009-2012.

For *Streptococcus pneumoniae*, resistance percentages were generally stable during the period 2011-2014, but with large inter-country variations. Macrolide non-susceptibility in *S. pneumoniae* was, for most countries, higher than penicillin-non-susceptibility.

The significantly increasing four-year trend of the population-weighted EU/EEA mean percentage for vancomycin resistance in *E. faecium* observed last year continued in 2014. The future development of vancomycin-resistant *E. faecium* in Europe requires close attention, as the number of countries reporting significantly increasing trends has increased in recent years. In 2014, more than a third of the reporting countries saw an increasing trend in vancomycin-resistant enterococci, the highest number since 2004.

Antimicrobial resistance is a serious threat to public health in Europe. 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 increase in antimicrobial resistance to a number of key antimicrobial groups in invasive bacterial isolates reported to EARS-Net is therefore of great concern. Prudent antimicrobial use and comprehensive infection prevention and control strategies targeting all healthcare sectors are the cornerstones of effective interventions aiming to prevent selection and transmission of bacteria resistant to antimicrobial agents.

1 Introduction

Antimicrobial resistance

Antimicrobial resistance (AMR) is a microorganism's ability to resist the action of one or more antimicrobial agents. The consequences can be severe, as prompt treatment with effective antimicrobial agents is one of the single most effective interventions to reduce the risk of a poor outcome from serious infections. Effective antimicrobial agents ensuring the prevention and treatment of bacterial complications are also crucial for many medical interventions such as major surgery, transplants and aggressive treatment of cancer.

Increasing levels of resistance to key antimicrobial groups are reported from many parts of the world, including Europe. AMR is a serious threat to public health and patient safety in Europe, leading to mounting healthcare costs, patient treatment failure, and deaths. Analyses from the European Centre for Disease Prevention and Control (ECDC) in 2009 estimated that infections caused by a subset of resistant bacteria are responsible for about 25 000 deaths in Europe annually. In addition to these avoidable deaths, healthcare costs and productivity losses have been estimated to be at least EUR 1.5 billion [1]. With the increase in AMR noted since these estimates were produced, the numbers are most likely to be considerably higher today.

Development of AMR is a natural phenomenon caused by mutations in bacterial genes, and many of the genetic elements coding for AMR can also spread between bacteria. A bacterium can acquire several different resistance mechanisms and hence be resistant to several antimicrobial agents, which is especially problematic as it may severely limit the available treatment alternatives for the infection. For a detailed description of resistance mechanisms, please refer to the resistance mechanism section for each bacterium in Chapter 3.

The major drivers behind the occurrence and spread of AMR are the use of antimicrobial agents and the transmission of antimicrobial-resistant microorganisms between humans, between animals, and between humans, animals and the environment. While antimicrobial use exerts ecological pressure on bacteria and contributes to emergence and selection of AMR, poor infection prevention and control practices and inadequate sanitary conditions favour the further spread of these bacteria.

AMR calls for concerted efforts at Member State level as well as close international cooperation. 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 required the most, together with appropriate use of antimicrobial agents, infection prevention and control, and development of new effective antimicrobial agents or alternatives for treatment [3]. AMR is listed as a special health issue in Annex 1 of Commission Decision 2000/96/EC on the communicable diseases to be covered by the Community network under Decision No 1082/2013/EU of the European Parliament and of the Council on serious cross-border threats to health [4].

EARS-Net

The European Antimicrobial Resistance Surveillance Network (EARS-Net) is the main EU surveillance system for AMR, and data reported from the network serve as important indicators on the occurrence and spread of AMR in European countries. All 28 EU Member States and two of the remaining three EEA countries (Iceland and Norway) participate in EARS-Net. The vast majority of the countries regularly report data for all bacteria and antimicrobial groups under surveillance. The number of participating laboratories has continuously increased since the initiation of the network, indicating a strengthening of national AMR surveillance systems in Europe. The widespread and continuing implementation of EUCAST breakpoints for antibacterial susceptibility testing in Europe, and the high proportion of laboratories that participate in the annual EARS-Net EQA exercise, contribute to improved data quality and an increasing ability in the Member States to report comparable AMR data.

EARS-Net is the continuation of the European Antimicrobial Resistance Surveillance System (EARSS), which was coordinated by the Dutch National Institute for Public Health and the Environment (RIVM). Established in 1998, EARSS successfully created an international network for AMR surveillance and demonstrated how international AMR data could inform decisions and raise awareness among stakeholders and policy makers. By 1 January 2010, the 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 by the network from EU/EEA Member States 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 viii). Scientific guidance and support to the network is provided by the EARS-Net

Coordination Committee. This group is composed of individual experts selected from among the nominated disease-specific contact points and experts from other organisations that are involved in AMR surveillance. 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 also 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 and ESCMID.

The objectives of EARS-Net are:

- to collect comparable, representative and accurate AMR data;
- to analyse temporal and spatial trends of AMR in Europe;
- to provide timely AMR data 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 by offering an annual external quality assessment (EQA).

EARS-Net is the largest publicly funded system for AMR surveillance in Europe, so data from EARS-Net play an important role in raising awareness at the political level, among public health officials, in the scientific community and among 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[I] and more detailed analyses are presented in annual reports and scientific publications.

Harmonisation of European breakpoints and methods through EUCAST

The European Committee on Antimicrobial Susceptibility Testing (EUCAST) was established to harmonise clinical antimicrobial breakpoints and to define breakpoints for new agents in Europe. Prior to these efforts, there were at least seven breakpoint systems (from France, Germany, Norway, Sweden, the Netherlands, the UK and the system developed by Clinical and Laboratory Standards Institute (CLSI, formerly NCCLS) in the USA) and at least four different disk diffusion antimicrobial susceptibility test methods (from France, Sweden, the UK and the USA) in use in Europe. The susceptibility test results from these systems varied greatly for some agent-organism combinations (e.g. cefotaxime with Enterobacteriaceae, piperacillin-tazobactam with Enterobacteriaceae and *Pseudomonas aeruginosa*) while not varying at all or very little for others (e.g. meticillin susceptibility of *Staphylococcus aureus*, oxacillin screening for penicillin non-susceptibility in *Streptococcus pneumoniae*). As the antimicrobial susceptibility test results reported to EARSS and later to EARS-Net were based on results obtained from everyday testing of pathogens isolated from blood cultures in the national laboratories, it became obvious that discrepant results depended on the breakpoints used and these breakpoints therefore had to be harmonised.

The harmonisation process started in 2002 and was largely completed by 2008 for the more commonly used agents. This resulted in common breakpoints for France, Germany, Norway, Sweden, the Netherlands and the UK, but not for the many European countries using the United States-based CLSI system. Furthermore, there was no sign that laboratories in countries following CLSI breakpoints would adopt any of the European systems. In several countries it was noted that the absence of a EUCAST disk diffusion method was a significant barrier to adoption of EUCAST breakpoints. Starting in 2009, EUCAST therefore developed a standardised disk diffusion method and supported its introduction in all European countries. The method was based on the Kirby-Bauer approach with Mueller-Hinton agar and an inoculum standardised to a 0.5 McFarland standard. Since 2012, a method calibrated to EUCAST minimum inhibitory concentration (MIC) breakpoints and MICs determined with the ISO standard broth microdilution method has been available on the EUCAST website[II]. The method is updated annually with recommendations for new agents, additional bacterial species and other modifications in line with revised MIC breakpoints.

An increasing number of laboratories in Europe and beyond (countries currently including Australia, Brazil, Morocco, New Zealand and South Africa) are adopting EUCAST breakpoints and methods. EUCAST breakpoints are now implemented in semi-automated susceptibility testing equipment and the transition to EUCAST is therefore simple for laboratories using these devices. Each method has limitations and these are listed on the EUCAST website. The change to EUCAST breakpoints requires more effort for laboratories using other disk diffusion methods, but is often facilitated either directly by EUCAST, through workshops at ECCMID or ESCMID postgraduate courses, or by educational activities through the National Antimicrobial Susceptibility Testing Committees (NACs).

Data from the EARS-Net EQA from 2009-2012, from the United Kingdom National External Quality Assessment Scheme (UKNEQAS) from 2009-2013 and data collected by EUCAST through a questionnaire in the first quarter of 2013 were analysed to investigate implementation of EUCAST guidelines in Europe. A rapid change towards using EUCAST breakpoints was observed over time. By the end of the study period, EUCAST breakpoints had

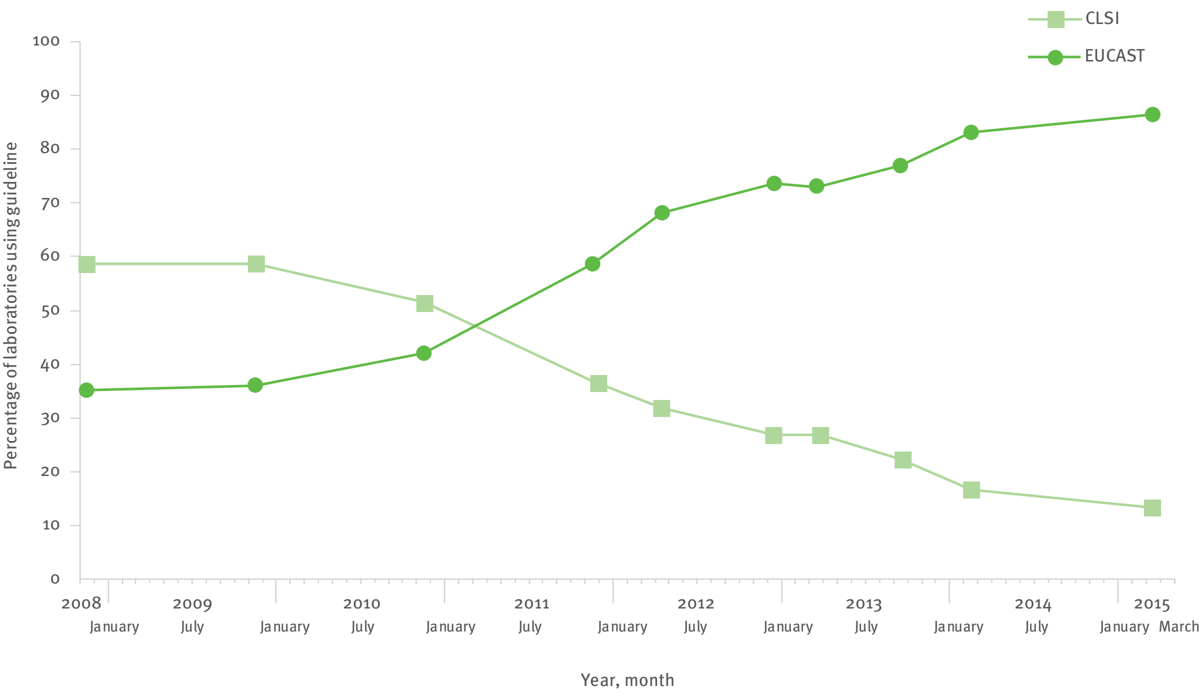
I EARS-Net interactive database. Available at http://ecdc.europa.eu/en/activities/surveillance/EARS-Net/database/Pages/database.aspx

II The European Committee on Antimicrobial Susceptibility Testing (EUCAST) website: http://www.eucast.org been implemented by 61.2 % of laboratories participating in EARS-Net and 73.2 % of laboratories participating in UKNEQAS. Responses to the EUCAST questionnaire indicated that EUCAST breakpoints were used by over 50 % of laboratories in 18 countries, by 10 to 50 % of laboratories in eight countries and by less than 10 % in seven countries. The EUCAST disk diffusion method was used by more than 50 % of laboratories in 12 countries, by 10 to 50 % of laboratories in 10 countries and by less than 10 % in 11 countries.

The EUCAST disk diffusion test has replaced national disk diffusion tests in Sweden, Germany and France and will soon do so in the UK, leaving only two widely used disk diffusion methods, the CLSI and EUCAST. The movement of laboratories from CLSI to EUCAST breakpoints is clearly illustrated in the graph from UKNEQAS (Figure 1), which shows that almost 90 % of laboratories taking part in UKNEQAS have now adopted EUCAST guidelines.

Standardisation of breakpoint guidelines and methods are essential to ensure consistent clinical reporting of antimicrobial susceptibility test results and comparable data in antimicrobial resistance surveillance. A continued Europe-wide implementation of EUCAST guidelines is a major factor in meeting these requirements.

Figure 1.1. Use of antimicrobial susceptibility testing guidelines in Europe, November 2008 – April 2015



Source. Data based on 630 – 750 laboratories per year participating in the UK National External Quality Assessment Scheme (UKNEQAS). Courtesy of Christine Walton and Derek Brown, UKNEQAS.

2 EARS-Net data collection and analysis

A total of 29 countries, including all EU Member States except Poland, and two of the three remaining EEA countries (Iceland and Norway) reported AMR data for 2014 to EARS-Net before August 2015. 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 in EARS-Net. 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 to describe the mechanisms of resistance and recommended methods of detection for key EARS-Net bacterium–antimicrobial group combinations [6].

Routine antimicrobial susceptibility test (AST) results are collected from clinical laboratories by the national network 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/specimens/antimicrobial agents under AMR surveillance and creates one record per patient, bacterium, antimicrobial agent 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. Data presented by EARS-Net might diverge slightly from the data presented by the Member States themselves, as analysis algorithms and population coverage might differ.

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 interpreted as either resistant (R) or intermediate (I) in susceptibility with the same local clinical breakpoint 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. In 2014, approximately 80% of the participating laboratories used EUCAST clinical breakpoints (see Annex 1 for more information).

As a general rule, data were expressed as a resistance percentage, i.e. the percentage of R isolates out of all isolates with 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. Only countries reporting data for the last four years were included in the EU/EEA mean. Country weightings 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 weighting 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 on-line 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 including only laboratories which consistently reported for the full four-year period in order to exclude selection bias when assessing the significance of the trends.

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. Please note that this restriction might in some cases result in a considerably lower number of isolates compared to the non-restricted analysis.

For an overview of the number of reporting laboratories, 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 from the denominator. For more information on national blood culture frequencies, see Annex 2.

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 CLSI to EUCAST clinical guidelines (see Chapter 1 and Annex 1 for further information). As a result, the interpretation of AST results may vary, at least for resistance mechanisms resulting in 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 EQA to assess the reliability of the laboratory test results. For more information on the EARS-Net EQA and laboratory performance, see Annex 1.

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 the most frequent cause 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 agents 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, the new anti-MRSA cephalosporins (ceftaroline and ceftobiprole), 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, *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 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 2014 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 and combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides both increased significantly between 2011 and 2014.
- Carbapenem resistance in *E. coli* remained rare in Europe.
- The highest resistance percentages were generally reported from southern and south-eastern Europe.

Aminopenicillins

For 2014, 28 countries reported 73 624 *E. coli* isolates with AST information for aminopenicillins (amoxicillin or ampicillin). The number of isolates reported per country ranged from 151 to 10 325 (Table 3.2).

Aminopenicillin resistance was very common, with national resistance percentages ranging from 34.7 % (Finland) to 73.0 % (Bulgaria) in 2014. Trends for the period 2011-2014 were calculated for the 27 countries reporting data for at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for three countries (Bulgaria, Lithuania and Luxembourg). For Bulgaria, 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, Denmark, Finland, Hungary and the Netherlands). These trends remained significant when considering only data from laboratories reporting consistently for all four years (Table 3.2).

The EU/EEA population-weighted mean percentage for aminopenicillin resistance was 57.1 % in 2014. No significant trend was noted between 2011 and 2014 (Table 3.2).

Fluoroquinolones

For 2014, 29 countries reported 82 815 *E. coli* isolates with AST information for fluoroquinolones (ciprofloxacin, levofloxacin, moxifloxacin, norfloxacin or ofloxacin). The number of isolates reported per country ranged from 141 to 10 307 (Table 3.3).

The national percentages of resistant isolates ranged from 7.8 % (Iceland) to 46.4 % (Cyprus) in 2014. A majority of the countries reporting resistance percentages of 25 % or higher were located in southern and south-eastern Europe (Figure 3.1 and Table 3.3).

Trends for the period 2011-2014 were calculated for the 29 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for six countries (Belgium, Greece, Italy, Norway, Portugal and Sweden). For Greece, Portugal 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 four countries (Austria, Denmark, Germany and the Netherlands). For Germany and the Netherlands, these trends did not remain significant when considering only data from laboratories reporting consistently for all four years (Table 3.3).

The EU/EEA population-weighted mean percentage for fluoroquinolone resistance was 22.4 % in 2014. No significant trend was noted between 2011 and 2014 (Table 3.3).

Third-generation cephalosporins

For 2014, 29 countries reported 84 016 *E. coli* isolates with AST information for third-generation cephalosporins (cefotaxime, ceftriaxone or ceftazidime). The number of isolates reported per country ranged from 152 to 10 349 (Table 3.4).

The national percentages of resistant isolates ranged from 3.3 % (Iceland) to 40.4 % (Bulgaria) in 2014. The majority of countries reporting resistance percentages of 25 % or higher were located in southern and south-eastern Europe (Figure 3.2 and Table 3.4).

Trends for the period 2011-2014 were calculated for the 29 countries reporting data for at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for 12 countries (Belgium, Bulgaria, the Czech Republic, France, Germany, Greece, Ireland, Italy, Norway, Portugal, Slovenia and Sweden). For Greece and Italy, the trend was not significant when considering only data from laboratories reporting consistently for all four years. A significantly decreasing trend was reported for Denmark, but this trend was not significant when considering only data from laboratories reporting consistently for all four years (Table 3.4).

The trend for the EU/EEA population-weighted mean percentage increased significantly for the period 2011-2014, from 9.6 % in 2011 to 12.0 % in 2014 (Table 3.4).

Figure 3.1. ***Escherichia coli*****. Percentage (%) of invasive isolates with resistance to fluoroquinolones, by country, EU/EEA countries, 2014**

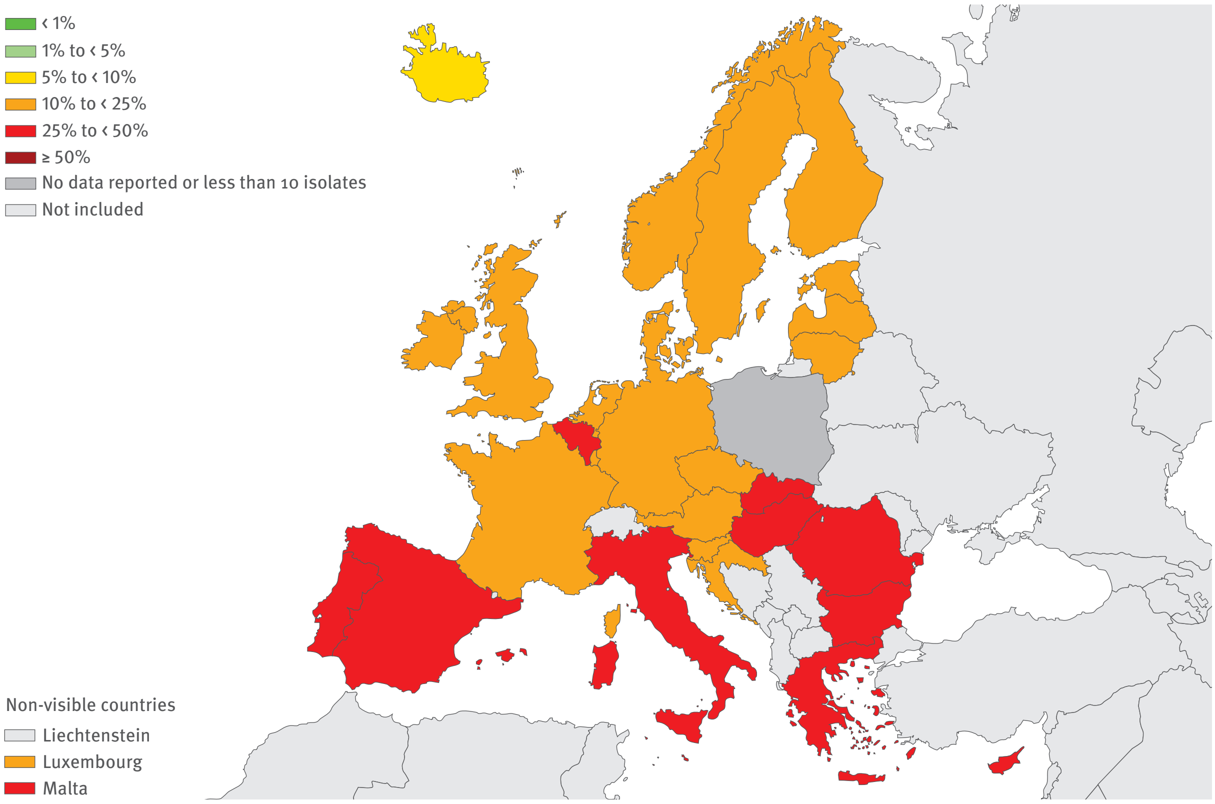


Figure 3.2. ***Escherichia coli*****. Percentage (%) of invasive isolates with resistance to third-generation cephalosporins, by country, EU/EEA countries, 2014**

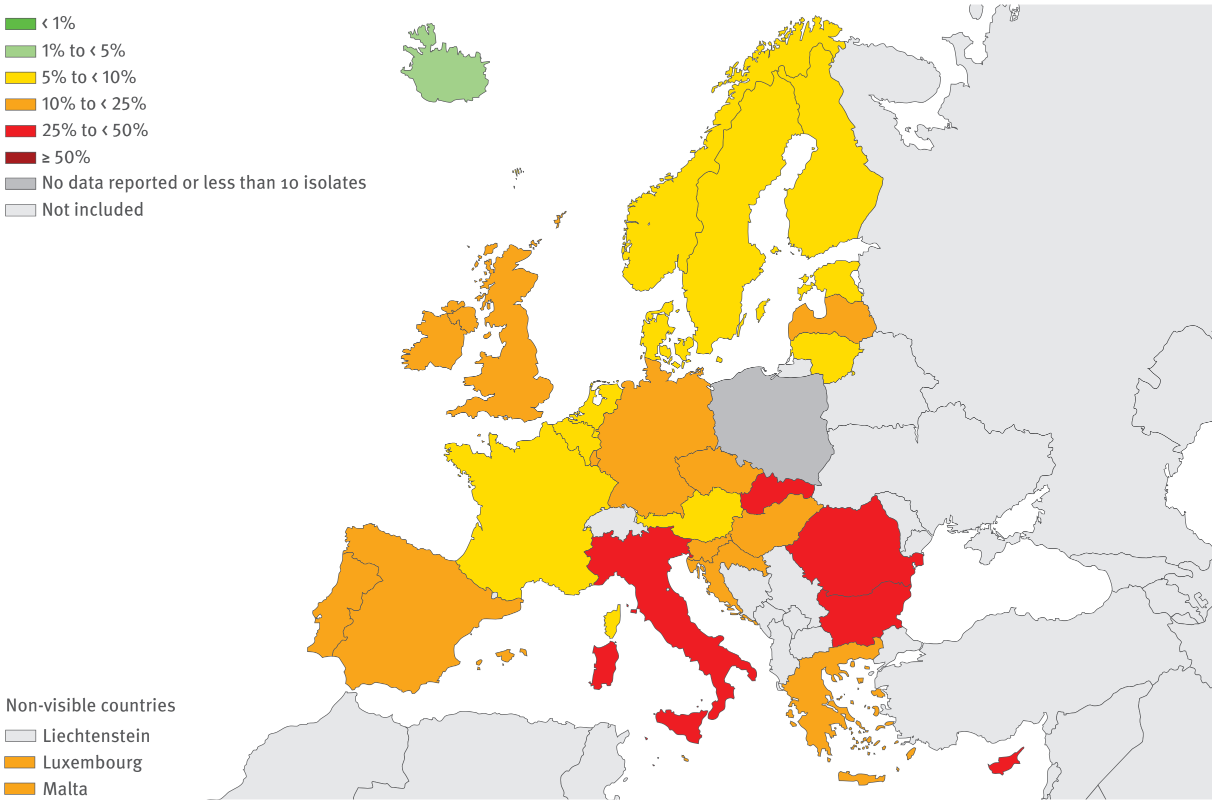


Table 3.1. *Escherichia coli*. Number of laboratories reporting isolates resistant to third-generation cephalosporins (3GCREC), numbers of 3GCREC isolates identified and percentage of isolates positive for extended-spectrum beta-lactamase (ESBL), as ascertained by the participating laboratories, EU/EEA countries, 2014

Country	Number of laboratories reporting 3GCREC included in analysis*/ total number of laboratories reporting 3GCREC	Number of 3GCREC included in analysis/total number of 3GCREC	% ESBL
Estonia	8/8	38/38	71.1
France	49/53	871/1029	78.5
Ireland	27/28	288/289	84.0
Denmark	2/10	82/309	84.1
Italy	4/38	40/1059	85.0
Slovakia	14/14	283/283	85.9
Spain	33/38	630/718	87.9
Netherlands	19/35	172/369	89.5
Germany	2/21	11/658	90.9
Czech Republic	44/44	416/416	91.6
Latvia	3/4	16/18	93.8
Norway	1/18	16/198	93.8
Finland	18/18	219/219	94.1
Slovenia	9/10	118/155	94.1
Austria	20/38	191/444	94.2
Portugal	39/52	667/825	94.2
Sweden	14/14	364/364	95.9
Croatia	14/14	117/117	96.6
Bulgaria	12/18	60/88	96.7
Romania	13/16	69/90	98.6
Lithuania	10/10	48/48	100
Luxembourg	5/5	44/44	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.

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.

Among *E. coli* isolates resistant to third-generation cephalosporins, large proportions were ascertained as ESBL-positive by the countries in 2014. On country level, the percentage of ESBL-positive isolates ranged between 71.1 % and 100 %, with a majority of the countries reporting percentages above 90 % (Table 3.1). Results might not be directly comparable between countries as there are national differences in the definition of ESBL, and some countries might report AmpC-positive isolates as ESBL. The presence of ESBLs may also be masked by carbapenemases such as MBLs (but not OXA-48-like enzymes) and/or severe permeability defects [6].

Aminoglycosides

For 2014, 29 countries reported 83 344 *E. coli* isolates with AST information for aminoglycosides (amikacin, gentamicin or tobramycin). The number of isolates reported per country ranged from 152 to 10 347 (Table 3.5).

The national percentages of resistant isolates ranged from 4.6 % (Finland) to 28.2 % (Bulgaria) in 2014 (Table 3.5 and Figure 3.3). The resistance estimates for the aminoglycoside group were mainly based on gentamicin or tobramycin AST results. Amikacin results were only used when no information was available for the other agents in the aminoglycoside group.

Trends for the period 2011-2014 were calculated for the 29 countries reporting data for at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for seven countries (Bulgaria, Croatia, Czech Republic, Ireland, Norway, Slovakia and Sweden). For Bulgaria, 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 (Belgium, Malta and the Netherlands). These decreasing trends remained significant when considering only data from laboratories reporting consistently for all four years (Table 3.5).

The EU/EEA population-weighted mean for aminoglycoside resistance was 9.8 % in 2014. No significant trend was noted between 2011 and 2014 (Table 3.5).

Susceptibility data for amikacin were less frequently reported than for gentamicin and/or tobramycin and generally showed lower resistance percentages. A total of 42 581 isolates had susceptibility data for both amikacin and gentamicin and/or tobramycin (51 % of the isolates included in the all aminoglycosides analysis). Among isolates with resistance to either gentamicin or tobramycin, 7.8 % of the isolates were also resistant to amikacin.

Carbapenems

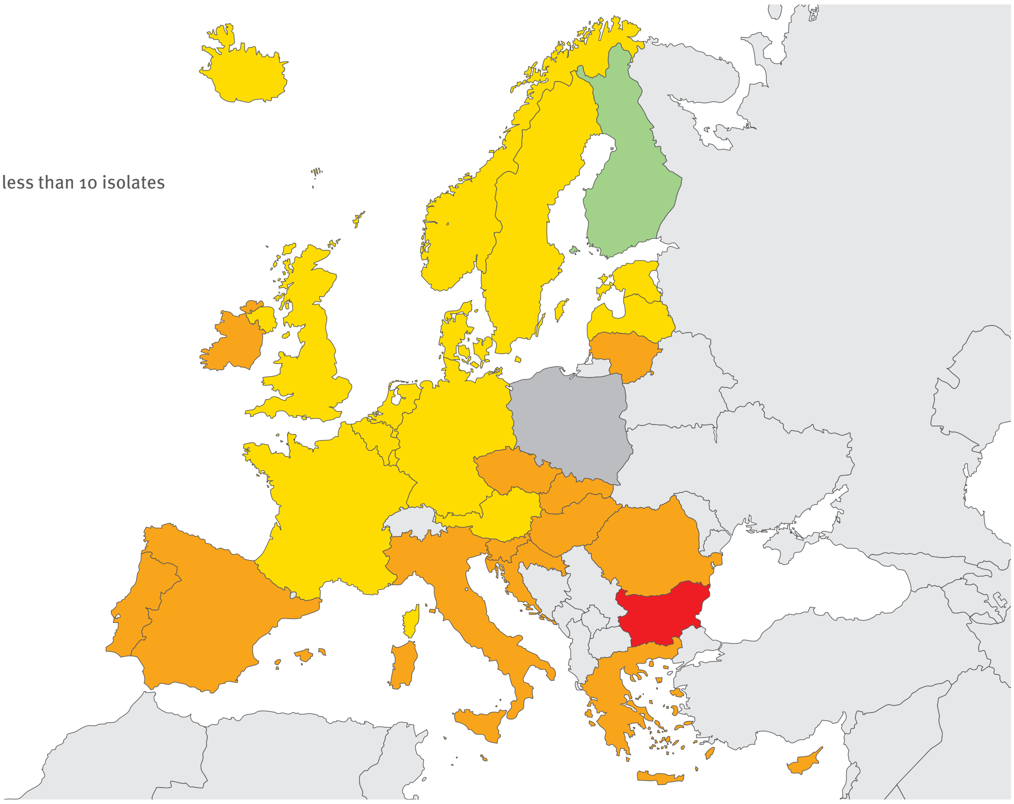
For 2014, 29 countries reported 80 806 isolates with AST information for carbapenems (meropenem, imipenem or ertapenem). The number of isolates reported per country ranged from 140 to 9 693 (Table 3.6).

The national percentages of resistant isolates ranged from zero (Croatia, Cyprus, the Czech Republic, Estonia, Finland, Hungary, Iceland, Latvia, Lithuania, Malta, the Netherlands, Norway, Slovakia, Slovenia and Sweden) to 1.2 % (Greece) in 2014 (Table 3.6 and Figure 3.4). Resistance estimates for the carbapenem group are mainly based on imipenem and meropenem or AST results. Susceptibility data for ertapenem were only considered when results for meropenem or imipenem were not available.

Trends for the period 2011-2014 were calculated for the 28 countries reporting at least 20 isolates per year during the full four-year period. A significantly increasing trend was observed for Spain, a trend that remained significant when considering only data from laboratories reporting consistently for all four years. It should be noted that CLSI clinical breakpoints were used in Spain during the full four-year period; when data were reanalysed by EUCAST clinical breakpoints, no statistically significant increasing trend was observed. A significantly decreasing trend was not observed for any country (Table 3.6).

Figure 3.3. ***Escherichia coli*. Percentage (%) of invasive isolates with resistance to aminoglycosides, by country, EU/EEA countries, 2014**

- < 1%
- 1% to < 5%
- 5% to < 10%
- 10% to < 25%
- 25% to < 50%
- ≥ 50%
- No data reported or less than 10 isolates
- Not included

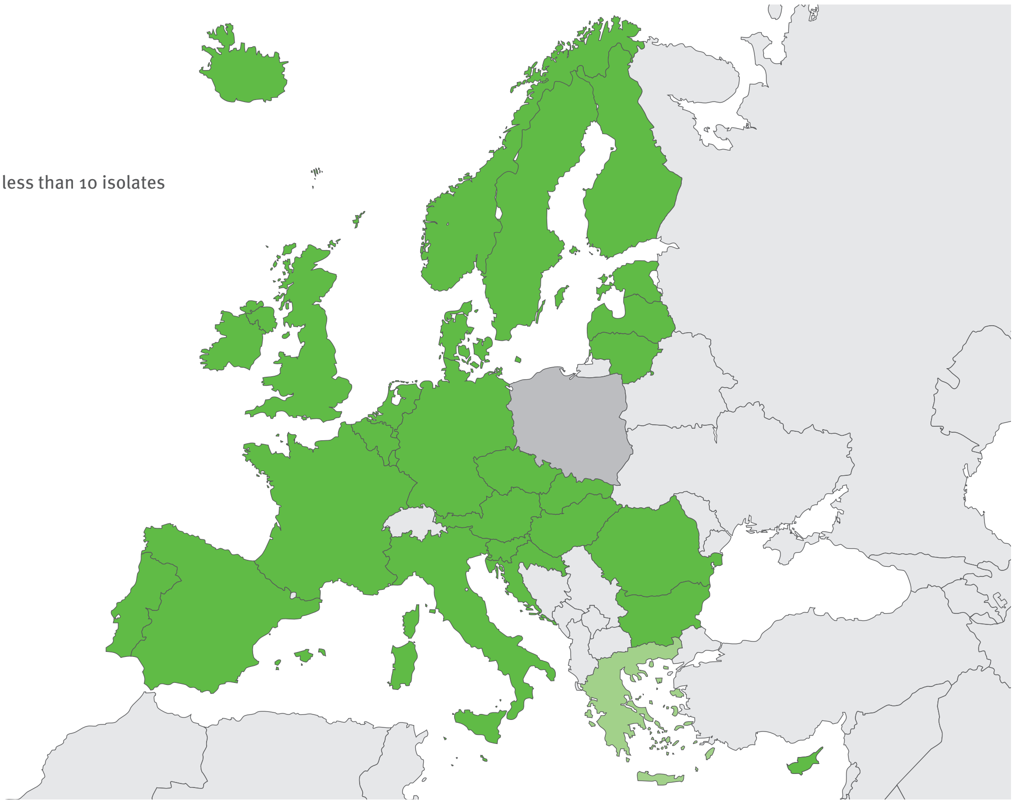


Non-visible countries

- Liechtenstein
- Luxembourg
- Malta

Figure 3.4. ***Escherichia coli*. Percentage (%) of invasive isolates with resistance to carbapenems, by country, EU/EEA countries, 2014**

- < 1%
- 1% to < 5%
- 5% to < 10%
- 10% to < 25%
- 25% to < 50%
- ≥ 50%
- No data reported or less than 10 isolates
- Not included



Non-visible countries

- Liechtenstein
- Luxembourg
- Malta

The EU/EEA population-weighted mean percentage for carbapenem resistance was 0.1% in 2014, and remained lower than 0.5% in most countries. No significant trend for the EU/EEA population-weighted mean percentage was noted between 2011 and 2014 (Table 3.6).

Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides

For 2014, 29 countries reported 80 129 isolates with sufficient AST information to determine combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides. The number of isolates reported per country ranged from 141 to 10 305 (Table 3.7).

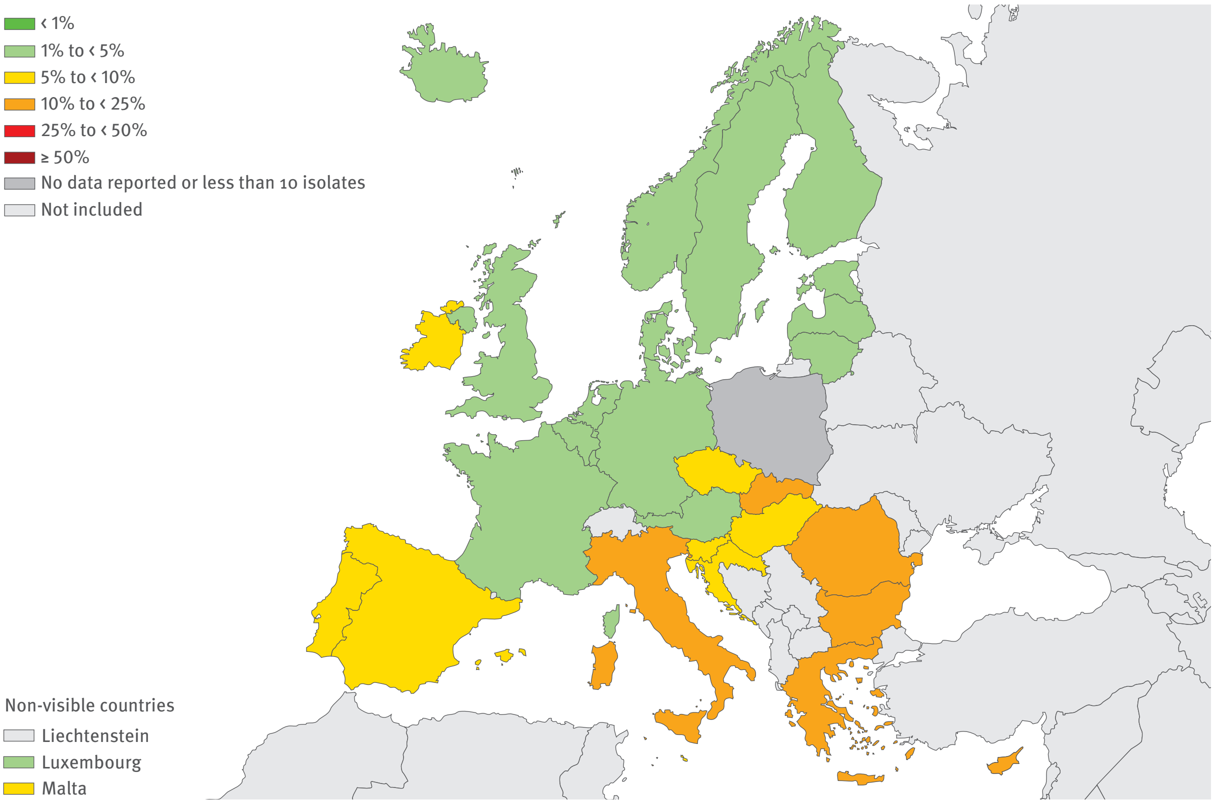
The national percentages of resistant isolates ranged from 1.4% (Iceland) to 19.7% (Bulgaria) in 2014 (Table 3.7 and Figure 3.4). Trends for the period 2011-2014 were calculated for the 29 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for 12 countries (Belgium, Bulgaria, Croatia, the Czech Republic, France, Ireland, Italy, Norway, Slovakia, Slovenia, Sweden and the United Kingdom). For Bulgaria, Italy, Norway and Sweden, the trends were not significant when considering only data from laboratories reporting consistently for all four years. Significantly decreasing trends were observed for two countries (Denmark and Latvia). These trends remained significant when considering only data from laboratories reporting consistently for all four years.

The trend for the EU/EEA population-weighted mean percentage increased significantly for the period 2011-2014, from 3.8% in 2011 to 4.8% in 2014 (Table 3.7).

Other resistance combinations and resistance to other antimicrobial groups

Of the 52 788 isolates (62.7% of all *E. coli* isolates) tested for all antimicrobial groups under regular EARS-Net surveillance (aminopenicillins, fluoroquinolones, third-generation cephalosporins, aminoglycosides and carbapenems), 41.4% were fully susceptible to all tested antimicrobial groups in 2014. Among the resistant isolates, single resistance to one antimicrobial group (mainly aminopenicillins) was the most common resistance phenotype (34.1%). For isolates with resistance to two antimicrobial groups (12.4%), combined aminopenicillin and fluoroquinolone resistance was most common, and for those with resistance to three antimicrobial groups (7.3%), combined aminopenicillin, fluoroquinolone and third-generation cephalosporin resistance accounted for the majority. Resistance to four antimicrobial groups was less frequent (4.7%); the vast majority of these isolates was resistant to

Figure 3.5. *Escherichia coli*. Percentage (%) of invasive isolates with combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides, by country, EU/EEA countries, 2014



aminopenicillins, third-generation cephalosporins, fluoroquinolones and aminoglycosides. As carbapenem resistance remained uncommon in *E. coli*, resistance combinations including this antimicrobial group were rare. A total of 19 isolates with resistance to all antimicrobial groups under regular EARS-Net surveillance was reported (Table 3.8).

Sixteen countries reported AST data for polymyxins for a total of 12 245 isolates (14.3 % of all reported *E. coli* isolates) in 2014. Only five countries reported polymyxin AST data for more than half of the reported *E. coli* isolates. Only a small proportion (0.6 %) of the isolates was resistant to polymyxins. Among carbapenem-resistant isolates also tested for resistance to polymyxins (17 out of 50 isolates), 4.4 % were polymyxin resistant, whereas only 0.5 % of carbapenem-susceptible isolates were polymyxin resistant. No *E. coli* isolate resistant to all five of the other antimicrobial groups under regular EARS-Net surveillance and also tested for resistance to polymyxins (6 out of 19 isolates) was polymyxin resistant. However, the small number of tested isolates, the rare occurrence of both carbapenem and colistin resistance in *E. coli* and differences in the use of laboratory methodology used to determine susceptibility mean that these findings should be interpreted with caution and may not be representative for Europe as whole.

3.1.4 Discussion and conclusions

In line with the results from previous years, antimicrobial resistance was very common in *E. coli*. A majority of the isolates were resistant to at least one of the antimicrobial groups under regular surveillance. The highest EU/EEA population-weighted mean resistance percentages in 2014 were reported for aminopenicillins (57.1 %) (Table 3.2) and fluoroquinolones (22.4 %) (Table 3.3). The trends of the EU/EEA population-weighted mean for both aminopenicillin and fluoroquinolone resistance have, however, remained stable between 2011 and 2014 with very little variation between years. Increasing aminopenicillin and fluoroquinolone resistance trends were mainly observed in countries with high resistance percentages, whereas countries with decreasing trends mostly reported lower resistance levels.

A large proportion of the third-generation cephalosporin-resistant isolates produced ESBLs, and combined resistance to other key antimicrobial groups such as fluoroquinolones and aminoglycosides was common. Increases in third-generation cephalosporin resistance and combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides were observed for the EU/EEA population-weighted mean as well as in more than a third of the individual countries. In contrast to aminopenicillin and fluoroquinolone resistance, increasing trends were reported from countries with both low and high resistance percentages.

Carbapenem resistance in *E. coli* remained very rare in Europe with resistance percentages of <0.1 % reported by the majority of countries. However, carbapenem resistance requires close monitoring as carbapenemase-producing Enterobacteriaceae (CPE) are becoming more widespread in Europe [8]. An increase in combined resistance and the high frequency of ESBL-producing isolates may lead to an increased use of carbapenems, thus favouring further dissemination of CPE.

The increasing frequency of resistance in *E. coli* to key antimicrobial agents as well as combined resistance to several antimicrobial groups are of serious concern and reflect a continuous loss of effectiveness in treating patients with serious *E. coli* infections. *E. coli* is among the most common causes of blood stream infection 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. Comprehensive infection control measures and prudent antimicrobial use are fundamental to prevent selection and transmission of antimicrobial-resistant *E. coli*.

Table 3.2. *Escherichia coli*. Total number of invasive isolates tested (N) and percentage with resistance to aminopenicillins (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2011-2014

Country	2011			2012			2013			2014				Trend 2011-2014	Comment**
	N	%R	(95%CI)	N	%R	(95%CI)	N	%R	(95%CI)	N	%R	(95%CI)			
Finland	2 264	37.3	(35–39)	2 090	39.7	(38–42)	2 124	37.3	(35–39)	2 365	34.7	(33–37)			‹
Norway	2 617	39.1	(37–41)	2 995	43.2	(41–45)	3 016	43.0	(41–45)	3 404	41.8	(40–43)			
Iceland	129	48.1	(39–57)	131	44.3	(36–53)	121	46.3	(37–56)	151	43.0	(35–51)			
Denmark	3 638	47.9	(46–50)	3 708	45.2	(44–47)	3 965	46.3	(45–48)	4 490	44.9	(43–46)			‹
Netherlands	4 425	48.5	(47–50)	4 697	49.0	(48–50)	4 656	47.5	(46–49)	6 458	46.0	(45–47)			‹
Estonia	–	–	(–)	216	48.1	(41–55)	235	46.4	(40–53)	261	47.1	(41–53)		N/A	
Latvia	130	54.6	(46–63)	153	54.2	(46–62)	135	51.9	(43–61)	182	48.4	(41–56)			
Austria	3 148	50.3	(49–52)	3 625	50.6	(49–52)	4 379	51.3	(50–53)	4 742	50.4	(49–52)			
Germany	3 638	52.3	(51–54)	4 162	49.6	(48–51)	5 220	52.9	(52–54)	5 543	51.7	(50–53)			
Slovenia	1 002	53.9	(51–57)	1 168	50.4	(48–53)	1 224	51.5	(49–54)	1 216	52.6	(50–55)			
Malta	219	53.0	(46–60)	207	54.6	(48–62)	248	54.8	(48–61)	279	53.4	(47–59)			
Croatia	975	55.3	(52–58)	904	51.4	(48–55)	1 036	53.7	(51–57)	1 077	54.0	(51–57)			
Czech Republic	2 683	60.7	(59–63)	2 811	56.8	(55–59)	2 954	54.9	(53–57)	2 978	54.4	(53–56)			‹
Greece	1 297	54.5	(52–57)	1 270	55.0	(52–58)	1 149	56.4	(53–59)	1 057	55.7	(53–59)			
France	8 784	55.1	(54–56)	9 599	55.2	(54–56)	10 146	55.1	(54–56)	10 325	55.9	(55–57)			
EU/EEA (population-weighted mean)*		**57.6**	**(56–59)**		**57.2**	**(56–59)**		**57.5**	**(56–59)**		**57.1**	**(56–58)**			
Lithuania	383	47.8	(43–53)	461	52.5	(48–57)	432	54.2	(49–59)	590	57.8	(54–62)			›
Belgium	3 507	58.7	(57–60)	3 898	56.3	(55–58)	4 350	56.8	(55–58)	2 876	58.9	(57–61)			
Portugal	1 963	56.5	(54–59)	2 152	59.4	(57–62)	2 677	59.4	(58–61)	4 899	58.9	(57–60)			
Hungary	991	64.7	(62–68)	1 328	63.9	(61–67)	1 411	60.9	(58–64)	1 603	59.1	(57–61)			‹
Luxembourg	353	52.1	(47–57)	335	50.7	(45–56)	299	54.5	(49–60)	371	59.6	(54–65)			›
United Kingdom	5 074	62.8	(61–64)	5 846	62.7	(61–64)	6 648	63.1	(62–64)	6 637	62.7	(62–64)			
Slovakia	610	68.4	(65–72)	596	64.9	(61–69)	786	61.5	(58–65)	866	64.5	(61–68)			
Spain	5 592	65.6	(64–67)	5 672	65.4	(64–67)	5 720	65.1	(64–66)	5 817	64.9	(64–66)			
Italy	1 530	67.1	(65–69)	2 123	67.5	(66–70)	2 356	65.7	(64–68)	2 178	65.4	(63–67)			
Romania	24	70.8	(49–87)	185	58.9	(51–66)	279	67.4	(62–73)	253	68.0	(62–74)			
Ireland	2 118	69.5	(68–72)	2 329	67.4	(65–69)	2 465	69.4	(68–71)	2 694	68.7	(67–70)			
Cyprus	134	77.6	(70–84)	176	70.5	(63–77)	162	77.2	(70–83)	153	71.2	(63–78)			
Bulgaria	152	60.5	(52–68)	207	71.0	(64–77)	160	74.4	(67–81)	159	73.0	(65–80)			›~
Poland	934	62.0	(59–65)	736	63.3	(60–67)	277	65.3	(59–71)	–	–	(–)		N/A	
Sweden	352	34.7	(32–38)	230	28.3	(23–34)	452	34.1	(30–39)	–	–	(–)		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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates 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 with resistance to fluoroquinolones (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2011-2014**

Country	2011			2012			2013			2014				Trend 2011-2014	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Iceland	121	14.0	(8–22)	134	9.7	(5–16)	116	14.7	(9–22)	141	7.8	(4–14)			
Finland	3020	11.0	(10–12)	3162	11.7	(11–13)	3594	13.3	(12–14)	3987	11.0	(10–12)			
Norway	2505	9.0	(8–10)	2843	11.3	(10–13)	2975	10.9	(10–12)	3415	11.0	(10–12)			›
Sweden	5101	10.1	(9–11)	5537	11.1	(10–12)	7356	11.6	(11–12)	5142	11.3	(10–12)			›~
Denmark	3583	14.1	(13–15)	3923	14.1	(13–15)	3963	12.4	(11–14)	4489	12.3	(11–13)			‹
Estonia	312	9.9	(7–14)	304	14.1	(10–19)	338	11.8	(9–16)	407	12.3	(9–16)			
Lithuania	381	12.9	(10–17)	456	14.7	(12–18)	431	16.0	(13–20)	592	12.8	(10–16)			
Netherlands	4427	14.3	(13–15)	4697	15.5	(14–17)	4730	14.1	(13–15)	6444	13.3	(12–14)			‹~
United Kingdom	5564	17.5	(17–19)	6241	16.6	(16–18)	6998	16.3	(15–17)	6919	16.8	(16–18)			
France	8694	17.9	(17–19)	9470	17.8	(17–19)	10069	16.7	(16–17)	10307	17.6	(17–18)			
Latvia	131	16.8	(11–24)	152	14.5	(9–21)	134	18.7	(12–26)	181	17.7	(12–24)			
Austria	3162	22.3	(21–24)	3610	20.6	(19–22)	4279	22.0	(21–23)	4642	19.8	(19–21)			‹
Croatia	952	20.3	(18–23)	892	17.0	(15–20)	1026	20.2	(18–23)	1072	20.1	(18–23)			
Germany	3636	23.7	(22–25)	4188	21.1	(20–22)	5254	22.1	(21–23)	6163	20.6	(20–22)			‹~
Czech Republic	2682	23.5	(22–25)	2809	21.0	(19–23)	2953	20.8	(19–22)	2976	21.6	(20–23)			
EU/EEA (population-weighted mean)*		**22.4**	**(21–24)**		**22.2**	**(21–24)**		**22.4**	**(21–24)**		**22.4**	**(21–24)**			
Slovenia	1002	20.7	(18–23)	1168	21.4	(19–24)	1224	19.9	(18–22)	1216	23.3	(21–26)			
Ireland	2153	22.9	(21–25)	2380	24.3	(23–26)	2478	24.2	(22–26)	2703	24.5	(23–26)			
Luxembourg	353	24.1	(20–29)	334	24.0	(19–29)	295	27.8	(23–33)	368	24.7	(20–29)			
Belgium	3549	21.5	(20–23)	3515	22.2	(21–24)	4113	23.0	(22–24)	2599	26.7	(25–28)			›
Hungary	1213	31.2	(29–34)	1393	28.9	(27–31)	1432	30.3	(28–33)	1614	28.4	(26–31)			
Malta	219	32.0	(26–39)	216	31.9	(26–39)	248	29.8	(24–36)	279	29.0	(24–35)			
Romania	50	28.0	(16–42)	186	29.0	(23–36)	300	31.0	(26–37)	307	31.3	(26–37)			
Portugal	1917	27.2	(25–29)	2158	30.3	(28–32)	2685	31.6	(30–33)	5027	32.4	(31–34)			›~
Greece	1433	26.6	(24–29)	1372	29.1	(27–32)	1240	30.9	(28–34)	1105	32.8	(30–36)			›~
Spain	5597	34.5	(33–36)	5654	33.9	(33–35)	5926	34.9	(34–36)	5818	34.0	(33–35)			
Bulgaria	179	30.2	(24–37)	223	34.1	(28–41)	187	37.4	(30–45)	215	38.6	(32–45)			
Slovakia	739	41.8	(38–45)	695	41.3	(38–45)	808	40.3	(37–44)	887	43.0	(40–46)			
Italy	1899	40.5	(38–43)	2920	42.1	(40–44)	3928	42.2	(41–44)	3647	43.9	(42–46)			›
Cyprus	137	47.4	(39–56)	176	42.0	(35–50)	162	51.9	(44–60)	153	46.4	(38–55)			
Poland	1141	27.3	(25–30)	1033	29.3	(27–32)	1035	27.3	(25–30)	–	–	(–)	N/A	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 EU/EEA population-weighted mean excludes countries not reporting data for all four years

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates 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 with resistance to third-generation cephalosporins (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2011-2014**

Country	2011			2012			2013			2014			Trend 2011-2014	Comment**
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		
Iceland	130	6.2	(3–12)	138	5.1	(2–10)	121	5.0	(2–10)	152	3.3	(1–8)		
Finland	3020	5.0	(4–6)	3162	6.2	(5–7)	3689	7.1	(6–8)	4009	5.5	(5–6)		
Sweden	5102	3.6	(3–4)	5537	4.5	(4–5)	7532	5.2	(5–6)	6546	5.6	(5–6)		›
Netherlands	4408	5.7	(5–6)	4702	6.0	(5–7)	4740	5.8	(5–7)	6497	5.7	(5–6)		
Norway	2523	3.6	(3–4)	3019	4.9	(4–6)	3077	5.5	(5–6)	3421	5.8	(5–7)		›
Denmark	2532	8.5	(7–10)	2519	7.9	(7–9)	2451	8.1	(7–9)	4410	7.0	(6–8)		‹~
Lithuania	385	7.0	(5–10)	462	4.8	(3–7)	432	7.6	(5–11)	594	8.1	(6–11)		
Estonia	90	12.2	(6–21)	305	7.9	(5–11)	340	7.4	(5–11)	410	9.3	(7–12)		
Austria	3160	9.1	(8–10)	3710	8.7	(8–10)	4376	9.8	(9–11)	4739	9.4	(9–10)		
Belgium	3985	6.0	(5–7)	4097	6.9	(6–8)	4051	8.0	(7–9)	2802	9.7	(9–11)		›
France	8479	8.2	(8–9)	9563	10.0	(9–11)	10154	9.5	(9–10)	10349	9.9	(9–11)		›
United Kingdom	5182	9.6	(9–10)	5663	13.1	(12–14)	6586	14.7	(14–16)	6219	10.3	(10–11)		
Germany	3642	8.0	(7–9)	4186	8.8	(8–10)	5249	10.7	(10–12)	6246	10.5	(10–11)		›
Ireland	2166	9.0	(8–10)	2288	9.2	(8–10)	2480	10.6	(9–12)	2691	10.7	(10–12)		›
Croatia	983	9.6	(8–12)	906	7.5	(6–9)	1040	8.8	(7–11)	1079	10.8	(9–13)		
Malta	219	12.8	(9–18)	216	13.9	(10–19)	248	8.9	(6–13)	279	10.8	(7–15)		
Latvia	132	15.9	(10–23)	154	13.0	(8–19)	136	14.0	(9–21)	165	10.9	(7–17)		
Luxembourg	353	8.2	(6–12)	334	11.4	(8–15)	301	10.6	(7–15)	368	12.0	(9–16)		
EU/EEA (population-weighted mean)*		**9.6**	**(9–11)**		**11.9**	**(11–13)**		**12.7**	**(12–14)**		**12.0**	**(11–13)**		**›**
Spain	5600	12.0	(11–13)	5672	13.5	(13–14)	5932	13.3	(12–14)	5821	12.3	(12–13)		
Slovenia	1002	8.8	(7–11)	1168	9.5	(8–11)	1224	8.7	(7–10)	1216	12.7	(11–15)		›
Czech Republic	2684	11.4	(10–13)	2812	11.5	(10–13)	2954	13.1	(12–14)	2978	14.0	(13–15)		›
Hungary	1224	15.1	(13–17)	1411	17.4	(15–20)	1437	18.9	(17–21)	1619	16.4	(15–18)		
Portugal	1901	11.3	(10–13)	2154	13.5	(12–15)	2678	14.9	(14–16)	5024	16.4	(15–17)		›
Greece	1435	14.9	(13–17)	1393	16.2	(14–18)	1255	17.2	(15–19)	1122	21.0	(19–24)		›~
Italy	1870	19.8	(18–22)	2997	26.3	(25–28)	3990	26.2	(25–28)	3694	28.7	(27–30)		›~
Cyprus	138	36.2	(28–45)	176	31.8	(25–39)	162	38.9	(31–47)	153	28.8	(22–37)		
Romania	95	21.1	(13–31)	191	25.1	(19–32)	298	22.8	(18–28)	306	29.4	(24–35)		
Slovakia	740	30.9	(28–34)	693	30.7	(27–34)	807	29.7	(27–33)	889	31.8	(29–35)		
Bulgaria	179	22.9	(17–30)	223	38.1	(32–45)	187	39.6	(33–47)	218	40.4	(34–47)		›
Poland	938	11.7	(10–14)	1037	12.9	(11–15)	1036	10.9	(9–13)	–	–	(–)	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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates 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 with resistance to aminoglycosides (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2011-2014**

Country	2011			2012			2013			2014				Trend 2011-2014	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Finland	3020	5.2	(4–6)	2993	6.1	(5–7)	3530	6.5	(6–7)	3817	4.6	(4–5)			
Iceland	129	6.2	(3–12)	138	3.6	(1–8)	121	4.1	(1–9)	152	5.3	(2–10)			
Norway	2470	4.1	(3–5)	3023	5.8	(5–7)	3079	6.4	(6–7)	3419	6.0	(5–7)			›
Sweden	4832	4.8	(4–5)	5537	5.8	(4–6)	7101	6.0	(5–7)	5606	6.1	(5–7)			›
Netherlands	4431	7.8	(7–9)	4708	7.2	(6–8)	4743	6.2	(6–7)	6488	6.3	(6–7)			‹
Germany	3645	7.6	(7–9)	4190	7.1	(6–8)	5253	7.0	(6–8)	6244	6.9	(6–8)			
Estonia	314	4.8	(3–8)	306	7.5	(5–11)	341	7.6	(5–11)	412	7.0	(5–10)			
Austria	3144	7.4	(7–8)	3713	6.5	(6–7)	4369	7.3	(7–8)	4734	7.2	(6–8)			
Denmark	3638	6.4	(6–7)	3687	7.3	(6–8)	3887	6.5	(6–7)	4493	7.3	(7–8)			
France	8742	7.9	(7–8)	5750	8.2	(7–9)	10156	7.8	(7–8)	10347	7.8	(7–8)			
Belgium	3831	9.3	(8–10)	3689	5.9	(5–7)	4093	6.1	(5–7)	2320	7.9	(7–9)			‹
Luxembourg	354	8.2	(6–12)	334	6.3	(4–9)	308	6.8	(4–10)	368	8.2	(6–11)			
Latvia	132	11.4	(7–18)	154	11.7	(7–18)	136	6.6	(3–12)	181	8.8	(5–14)			
United Kingdom	5661	8.2	(7–9)	6390	8.6	(8–9)	7167	9.2	(9–10)	7273	9.0	(8–10)			
EU/EEA (population-weighted mean)*		**9.6**	**(9–11)**		**10.4**	**(10–11)**		**9.9**	**(9–11)**		**9.8**	**(9–11)**			
Malta	219	15.5	(11–21)	216	13.9	(10–19)	248	9.7	(6–14)	279	10.4	(7–15)			‹
Czech Republic	2674	8.8	(8–10)	2812	8.4	(7–10)	2957	9.1	(8–10)	2979	10.7	(10–12)			›
Lithuania	382	9.7	(7–13)	461	9.5	(7–13)	430	11.2	(8–15)	590	10.7	(8–13)			
Croatia	979	7.6	(6–9)	905	7.1	(5–9)	1028	7.9	(6–10)	1078	11.0	(9–13)			›
Slovenia	1002	9.8	(8–12)	1168	8.6	(7–10)	1224	9.7	(8–12)	1216	11.6	(10–14)			
Ireland	2158	10.2	(9–12)	2378	11.1	(10–12)	2482	11.4	(10–13)	2705	12.4	(11–14)			›
Hungary	1226	14.8	(13–17)	1409	17.2	(15–19)	1431	17.1	(15–19)	1610	14.8	(13–17)			
Spain	5603	14.8	(14–16)	5675	15.6	(15–17)	5930	15.4	(14–16)	5822	15.1	(14–16)			
Greece	1434	16.8	(15–19)	1372	17.9	(16–20)	1240	17.0	(15–19)	1113	15.9	(14–18)			
Portugal	1962	16.1	(14–18)	2155	16.3	(15–18)	2685	15.8	(14–17)	4993	16.3	(15–17)			
Romania	50	18.0	(9–31)	185	24.3	(18–31)	298	14.8	(11–19)	303	17.2	(13–22)			
Cyprus	138	23.9	(17–32)	176	21.0	(15–28)	162	24.7	(18–32)	153	17.6	(12–25)			
Italy	1985	18.3	(17–20)	3093	21.4	(20–23)	4002	18.5	(17–20)	3544	19.3	(18–21)			
Slovakia	740	17.8	(15–21)	694	21.2	(18–24)	808	24.3	(21–27)	889	22.8	(20–26)			›
Bulgaria	179	17.3	(12–24)	223	26.5	(21–33)	187	32.1	(25–39)	216	28.2	(22–35)			›~
Poland	1171	8.4	(7–10)	1046	11.9	(10–14)	1070	11.0	(9–13)	–	–	(–)		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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates 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 with resistance to carbapenems (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2011-2014

Country	2011			2012			2013			2014				Trend 2011-2014	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Croatia	983	0.0	(0–0)	900	0.0	(0–0)	1038	0.0	(0–0)	1079	0.0	(0–0)			
Cyprus	138	0.7	(0–4)	176	<0.1	(0–2)	162	0.0	(0–2)	153	0.0	(0–2)			
Czech Republic	1675	0.0	(0–0)	1729	0.1	(0–0)	1733	0.0	(0–0)	1702	0.0	(0–0)			
Estonia	233	<0.1	(0–2)	252	<0.1	(0–1)	283	0.0	(0–1)	254	0.0	(0–1)			
Finland	3020	0.0	(0–0)	3161	0.0	(0–0)	3690	0.0	(0–0)	4013	0.0	(0–0)			
Hungary	1151	0.1	(0–0)	1307	0.0	(0–0)	1355	0.1	(0–1)	1517	0.0	(0–0)			
Iceland	129	0.0	(0–3)	138	0.0	(0–3)	121	0.0	(0–3)	140	0.0	(0–31)			
Latvia	131	<0.1	(0–3)	153	<0.1	(0–2)	135	0.0	(0–3)	182	0.0	(0–2)			
Lithuania	1	<0.1	(0–98)	450	<0.1	(0–1)	431	0.0	(0–1)	593	0.0	(0–1)		N/A	
Malta	219	<0.1	(0–2)	216	<0.1	(0–2)	248	0.0	(0–1)	279	0.0	(0–1)			
Netherlands	4405	0.0	(0–0)	4701	0.0	(0–0)	4726	<0.1	(0–0)	6475	0.0	(0–0)			
Norway	2588	0.0	(0–0)	3023	0.0	(0–0)	3079	0.1	(0–0)	3420	0.0	(0–0)			
Slovakia	705	<0.1	(0–1)	659	0.9	(0–2)	588	0.0	(0–1)	820	0.0	(0–0)			
Slovenia	1002	0.0	(0–0)	1168	0.0	(0–0)	1224	0.1	(0–0)	1216	0.0	(0–0)			
Sweden	5092	0.0	(0–0)	5529	<0.1	(0–1)	7347	<0.1	(0–0)	6298	0.0	(0–0)			
Austria	2712	0.0	(0–0)	3340	0.1	(0–0)	4257	<0.1	(0–0)	4600	<0.1	(0–0)			
Belgium	3989	0.0	(0–0)	4119	0.0	(0–0)	4246	<0.1	(0–0)	2614	<0.1	(0–0)			
Denmark	2265	0.0	(0–0)	2865	0.0	(0–0)	2832	<0.1	(0–0)	3946	<0.1	(0–0)			
France	8503	0.0	(0–0)	9091	0.0	(0–0)	9585	0.1	(0–0)	9693	<0.1	(0–0)			
Ireland	2149	0.0	(0–0)	2369	0.0	(0–0)	2476	<0.1	(0–0)	2697	<0.1	(0–0)			
Portugal	1755	0.0	(0–0)	2041	0.1	(0–0)	2668	0.1	(0–0)	4998	<0.1	(0–0)			
Germany	3593	0.0	(0–0)	4184	0.0	(0–0)	5247	0.1	(0–0)	6247	0.1	(0–0)			
Spain	5593	<0.1	(0–0)	5670	0.1	(0–0)	5921	0.7	(1–1)	5817	0.1	(0–0)			>
United Kingdom	4640	0.1	(0–0)	5182	0.2	(0–0)	6251	<0.1	(0–0)	6365	0.1	(0–0)			
EU/EEA population-weighted mean)*		**<0.1**	**(0.0–0.2)**		**0.1**	**(0.0–0.2)**		**0.2**	**(0.1–0.4)**		**0.1**	**(0.0–0.2)**			
Italy	1854	0.2	(0–0)	3021	0.3	(0–1)	3989	0.6	(0–1)	3696	0.2	(0–0)			
Luxembourg	351	<0.1	(0–1)	333	<0.1	(0–1)	295	0.0	(0–1)	368	0.3	(0–2)			
Bulgaria	145	<0.1	(0–3)	191	2.6	(1–6)	176	2.8	(1–7)	197	0.5	(0–3)			
Romania	47	<0.1	(0–8)	182	0.0	(0–2)	299	0.0	(0–1)	305	0.7	(0–2)			
Greece	1127	0.9	(0–2)	1396	1.4	(1–2)	1256	1.4	(1–2)	1122	1.2	(1–2)			
Poland	1064	0.1	(0–1)	970	0.0	(0–0)	938	0.0	(0–0)	–	–	(–)		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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.
**The symbols > and < indicate significant increasing and decreasing trends, respectively.

Table 3.7. ***Escherichia coli*****. Total number of isolates tested (N) and percentage with combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2011-2014**

Country	2011			2012			2013			2014				Trend 2011-2014	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Iceland	120	0.8	(0–5)	134	1.5	(0–5)	116	0.9	(0–5)	141	1.4	(0–5)			
Denmark	2529	3.0	(2–4)	2285	2.6	(2–3)	2377	2.2	(2–3)	4406	1.9	(1–2)			‹
Norway	2259	1.2	(1–2)	2835	1.9	(1–3)	2971	2.5	(2–3)	3413	2.0	(2–2)			›~
Sweden	3915	1.4	(1–2)	5532	1.8	(1–2)	7094	2.0	(2–2)	4203	2.0	(2–2)			›~
Netherlands	4400	2.2	(2–3)	4675	1.8	(1–2)	4722	1.9	(2–2)	6427	2.1	(2–3)			
Finland	3020	2.5	(2–3)	2993	3.1	(3–4)	3433	3.2	(3–4)	3787	2.2	(2–3)			
Latvia	131	9.2	(5–15)	152	6.6	(3–12)	134	4.5	(2–9)	163	2.5	(1–6)			‹
Lithuania	378	2.4	(1–4)	455	1.3	(0–3)	429	2.1	(1–4)	588	2.6	(1–4)			
Austria	3121	2.6	(2–3)	3579	2.5	(2–3)	4260	3.2	(3–4)	4617	2.7	(2–3)			
Germany	3631	3.6	(3–4)	4179	3.2	(3–4)	5241	2.7	(2–3)	6158	3.0	(3–3)			
Estonia	89	1.1	(0–6)	303	1.7	(1–4)	335	3.3	(2–6)	405	3.5	(2–6)			
France	8428	2.6	(2–3)	5655	3.3	(3–4)	10068	3.2	(3–4)	10305	3.5	(3–4)			›
Belgium	3331	1.4	(1–2)	3330	1.8	(1–2)	3748	2.3	(2–3)	2227	3.7	(3–5)			›
Luxembourg	353	2.8	(1–5)	334	2.7	(1–5)	287	2.1	(1–4)	368	4.1	(2–7)			
United Kingdom	5005	3.6	(3–4)	5577	4.2	(4–5)	6536	4.4	(4–5)	6190	4.4	(4–5)			›
EU/EEA (population-weighted mean)*		**3.8**	**(3–4)**		**4.9**	**(4–6)**		**4.6**	**(4–5)**		**4.8**	**(4–6)**			**›**
Ireland	2148	3.6	(3–4)	2283	4.0	(3–5)	2478	4.9	(4–6)	2689	5.0	(4–6)			›
Spain	5594	4.9	(4–6)	5651	5.9	(5–7)	5922	5.8	(5–6)	5816	5.3	(5–6)			
Croatia	947	2.6	(2–4)	889	2.8	(2–4)	1015	3.5	(2–5)	1070	6.0	(5–8)			›
Czech Republic	2667	3.7	(3–4)	2809	4.5	(4–5)	2953	4.9	(4–6)	2976	6.4	(6–7)			›
Malta	219	9.6	(6–14)	216	8.3	(5–13)	248	5.2	(3–9)	279	6.8	(4–10)			
Slovenia	1002	4.1	(3–6)	1168	5.1	(4–7)	1224	4.8	(4–6)	1216	7.2	(6–9)			›
Hungary	1209	8.3	(7–10)	1387	10.5	(9–12)	1422	11.0	(9–13)	1599	8.3	(7–10)			
Portugal	1891	7.5	(6–9)	2152	9.2	(8–11)	2677	8.5	(7–10)	4990	8.6	(8–9)			
Greece	1431	10.8	(9–13)	1368	10.7	(9–12)	1235	10.4	(9–12)	1104	10.9	(9–13)			
Cyprus	137	18.2	(12–26)	176	14.8	(10–21)	162	20.4	(14–27)	153	13.1	(8–19)			
Italy	1745	10.3	(9–12)	2686	14.4	(13–16)	3884	12.2	(11–13)	3441	13.8	(13–15)			›~
Romania	50	10.0	(3–22)	179	15.6	(11–22)	292	9.2	(6–13)	298	14.4	(11–19)			
Slovakia	739	12.9	(11–15)	692	13.6	(11–16)	807	17.2	(15–20)	887	17.1	(15–20)			›
Bulgaria	179	10.1	(6–15)	223	16.1	(12–22)	187	19.8	(14–26)	213	19.7	(15–26)			›~
Poland	902	4.0	(3–5)	1011	5.8	(4–7)	999	5.2	(4–7)	–	–	(–)		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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates 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=52 788), EU/EEA countries, 2014**

Resistance pattern	Number of isolates	% of total**
Fully susceptible	**21857**	**41.4**
Single resistance (to indicated antimicrobial group)		
Total	**18 044**	**34.1**
Aminopenicillins	16 707	31.6
Fluoroquinolones	1 210	2.3
Aminoglycosides	121	0.2
Carbapenems	6	<0.1
Resistance to two antimicrobial groups		
Total	**6 508**	**12.4**
Aminopenicillins + fluoroquinolones	4 427	8.4
Aminopenicillins + third-generation cephalosporins	1 209	2.3
Aminopenicillins + aminoglycosides	783	1.5
Fluoroquinolones + aminoglycosides	87	0.2
Aminopenicillins + carbapenems	2	<0.1
Resistance to three antimicrobial groups		
Total	**3 853**	**7.3**
Aminopenicillins + fluoroquinolones + third-generation cephalosporins	1 897	3.6
Aminopenicillins + fluoroquinolones + aminoglycosides	1 718	3.3
Aminopenicillins + third-generation cephalosporins + aminoglycosides	231	0.4
Aminopenicillins + third-generation cephalosporins + carbapenems	3	<0.1
Aminopenicillins + fluoroquinolones + carbapenems	3	<0.1
Aminopenicillins + aminoglycosides + carbapenems	1	<0.1
Resistance to four antimicrobial groups		
Total	**2 514**	**4.7**
Aminopenicillins + fluoroquinolones + third-generation cephalosporins + aminoglycosides	2 498	4.7
Aminopenicillins + fluoroquinolones + third-generation cephalosporins + carbapenems	9	<0.1
Aminopenicillins + fluoroquinolones + aminoglycosides + carbapenems	4	<0.1
Aminopenicillins + third-generation cephalosporins + aminoglycosides + carbapenems	3	<0.1
Resistance to five antimicrobial groups		
Aminopenicillins + fluoroquinolones + third-generation cephalosporins + aminoglycosides + carbapenems	**19**	**<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, but may also be found on skin, in the oropharynx and upper airways in hospitalised individuals. *K. pneumoniae* includes three different phylogenetic groups (KpI, KpII and KpIII). More recently, the *K. pneumoniae* KpII and KpIII phylogroups have been assigned to two new species: *Klebsiella quasipneumoniae* and *Klebsiella variicola*, respectively. However, commercial identification systems do not distinguish among the three species, which continue to be reported as *K. pneumoniae* (*sensu lato*).

The majority of infections caused by *K. pneumoniae* are healthcare-associated, and can spread rapidly between colonised or infected patients and via the hands of hospital personnel, leading to nosocomial outbreaks. Infections include urinary tract infections, lower respiratory tract infections and bloodstream infections. Some strains can cause severe invasive infections (often liver abscesses with bacteraemia and metastatic infections) also occurring in otherwise healthy subjects.

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*, however, *K. pneumoniae* has a chromosomally encoded class A 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 *K. pneumoniae* strains have been observed in the United States, Greece, Italy, Israel, China and a number of countries in South America, and similar strains are now spreading in several European countries, while *K. pneumoniae* strains producing the VIM metallo-carbapenemase are common 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 isolates with reduced carbapenem susceptibility for carbapenemase production. 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 phenotype highly resistant to beta-lactams. 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 2014 were resistant to at least one antimicrobial group under surveillance, and combined resistance to multiple antimicrobial groups was common. The most common resistance phenotype was combined resistance to three key antimicrobial groups: fluoroquinolones, third-generation cephalosporins and aminoglycosides.
- 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 2011 and 2014.
- There were large inter-country differences in the percentage of carbapenem-resistant *K. pneumoniae*. The three countries with the highest carbapenem resistance (Greece, Italy and Romania) also contributed the vast majority of the isolates with combined carbapenem and polymyxin resistance.
- 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.

Fluoroquinolones

For 2014, 29 countries reported 19 536 isolates with AST information for fluoroquinolones (ciprofloxacin, levofloxacin, moxifloxacin, norfloxacin or ofloxacin). The number of isolates reported per country ranged from 28 to 2 175 (Table 3.10.).

The national percentages of resistant isolates ranged from 3.6% (Iceland) to 70.8% (Slovakia) (Table 3.10 and Figure 3.6) in 2014. Trends for the period 2011-2014 were calculated for the 27 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for nine countries (Belgium, Finland, France, Ireland, Italy, Malta, Norway, Spain and the United Kingdom). For Belgium, Finland and Italy, the trends were not significant when considering only data from laboratories reporting

Table 3.9. *Klebsiella pneumoniae*. Number of laboratories reporting isolates resistant to third-generation cephalosporins (3GCRKP), numbers of 3GCRKP isolates identified and percentage of isolates positive for extended-spectrum beta-lactamase (ESBL), as ascertained by the participating laboratories, EU/EEA countries, 2014

Country	Number of laboratories reporting 3GCRKP included in analysis*/ total number of laboratories reporting 3GCRKP	Number of 3GCRKP included in analysis/total number of 3GCRKP	%ESBL
Italy	8/41	79/745	57.0
France	48/51	528/648	71.6
Denmark	3/10	27/70	74.1
Austria	21/31	60/82	76.7
Slovakia	14/14	342/342	81.0
Ireland	17/17	41/41	85.4
Estonia	8/8	28/28	85.7
Romania	9/16	98/189	85.7
Sweden	12/12	45/45	88.9
Netherlands	15/22	29/50	89.7
Spain	27/32	180/228	91.1
Luxembourg	3/3	23/23	91.3
Czech Republic	41/43	680/732	94.4
Portugal	37/51	446/700	95.1
Croatia	14/14	160/160	99.4
Bulgaria	7/15	32/113	100
Finland	9/9	14/14	100
Lithuania	12/12	81/81	100
Latvia	4/5	51/55	100
Slovenia	9/9	62/62	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.

consistently for all four years. Significantly decreasing trends were observed for six countries (Austria, the Czech Republic, Denmark, Greece, Hungary and Lithuania). For Lithuania, 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 24.5 % in 2011 to 27.4 % in 2014 (Table 3.10).

Third-generation cephalosporins

For 2014, 29 countries reported 19 724 isolates with AST information for third-generation cephalosporins (cefotaxime, ceftriaxone or ceftazidime). The number of isolates reported per country ranged from 28 to 2 192 (Table 3.11).

The national percentages of resistant isolates ranged from zero (Iceland) to 74.8 % (Bulgaria) in 2014 (Table 3.11 and Figure 3.7). Trends for the period 2011-2014 were calculated for the 28 countries reporting data for at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for 11 countries (the Czech Republic, France, Ireland, Italy, Malta, Norway, Portugal, Romania, Spain, Sweden and the United Kingdom). For Italy, Portugal and Romania, the trends were not significant when considering only data from laboratories reporting consistently for all four years. Significantly decreasing trends were observed for five countries (Austria, Denmark, Greece, Hungary and Lithuania). For Denmark, 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 23.6 % in 2011 to 28.0 % in 2014 (Table 3.11).

Extended-spectrum beta-lactamase (ESBL)

Twenty 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 2014, 15 of 20 countries reported between 85 % and 100 % ESBL-positive isolates (Table 3.9). Data might not be comparable as there are national differences in the definition of ESBL, and some countries might report AmpC-positive isolates as ESBL. The presence of ESBLs may also be masked by carbapenemases such as MBLs or KPCs (but not OXA-48-like enzymes) and/or severe permeability defects [6].

Aminoglycosides

For 2014, 29 countries reported 19 520 isolates with AST information for aminoglycosides (amikacin, gentamicin or tobramycin). The number of isolates reported per country ranged from 28 to 2 191 (Table 3.12).

The percentages of resistant isolates in the reporting countries ranged from 2.3 % (Finland) to 68.2 % (Slovakia) in 2014. (Table 3.12 and Figure 3.8). The resistance estimate for the aminoglycoside group is mainly based on gentamicin or tobramycin AST results; amikacin results were only used when no information was available for the other agents in the aminoglycoside group.

Trends for the period 2011-2014 were calculated for the 27 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for eight countries (the Czech Republic, Finland, France, Ireland, Italy, Malta, Norway and Spain). For Finland, Norway and Italy, the trends were not significant when considering only data from laboratories reporting consistently for all four years. Significantly decreasing trends were observed for four countries (Greece, Hungary, Lithuania and the Netherlands). For Lithuania, the trend was not significant when considering only data from laboratories reporting consistently for all four years (Table 3.12).

The EU/EEA population-weighted mean showed a significantly increasing trend from 20.1 % in 2011 to 23.1 % in 2014 (Table 3.12).

Susceptibility data for amikacin were less frequently reported than for gentamicin and/or tobramycin and generally showed lower resistance percentages. A total of 12 299 isolates had susceptibility data for both

Figure 3.6. ***Klebsiella pneumoniae*. Percentage (%) of invasive isolates with resistance to fluoroquinolones, by country, EU/EEA countries, 2014**

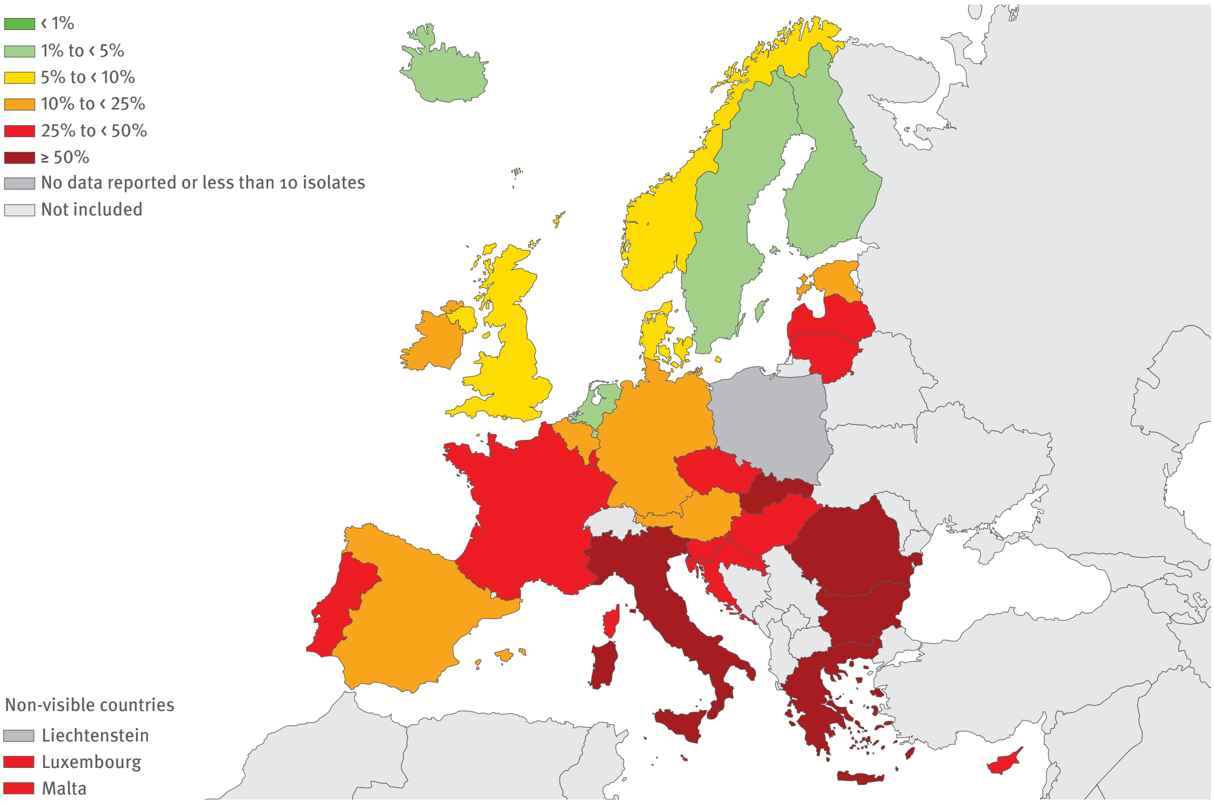
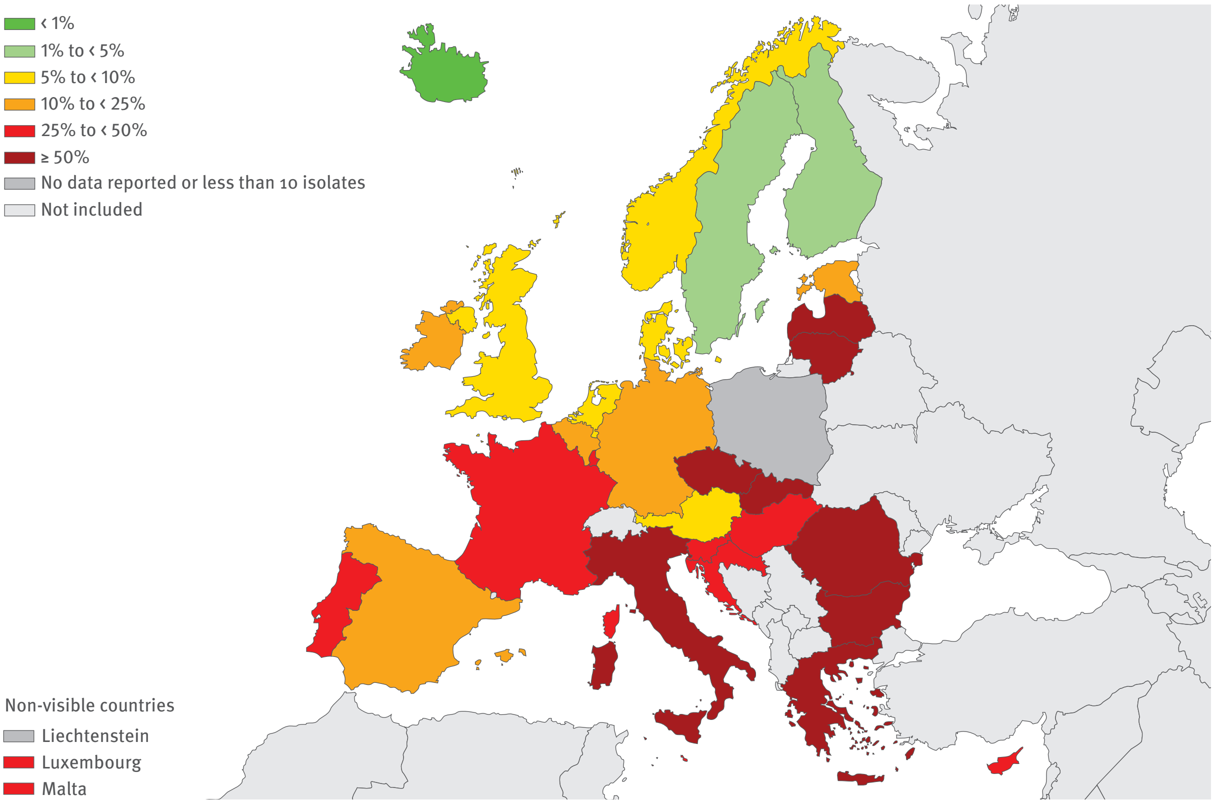


Figure 3.7. ***Klebsiella pneumoniae*. Percentage (%) of invasive isolates with resistance to third-generation cephalosporins, by country, EU/EEA countries, 2014**



amikacin and gentamicin and/or tobramycin (63 % of the isolates included in the all aminoglycosides analysis). Among isolates with resistance to either gentamicin or tobramycin, 22.5 % of the isolates were also resistant to amikacin.

Carbapenems

For 2014, 29 countries reported 19 164 isolates with AST information for carbapenems (meropenem, imipenem or ertapenem). The number of isolates reported per country ranged from 25 to 2 103 (Table 3.13).

The national percentages of resistant isolates in the reporting countries ranged from zero (Estonia, Finland, Iceland, Norway and Sweden) to 62.3 % (Greece) in 2014 (Table 3.13 and Figure 3.9). Resistance estimates for the carbapenem group are mainly based on imipenem and meropenem AST results. Susceptibility data for ertapenem were only considered when results for meropenem or imipenem were not available.

Trends for the period 2011-2014 were calculated for the 26 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for seven countries (Bulgaria, Croatia, France, Germany, Italy, Portugal and Spain). 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 Cyprus and Greece (Table 3.13).

The EU/EEA population-weighted mean showed a significantly increasing trend from 6.0 % in 2011 to 7.3 % in 2014 (Table 3.13).

Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides

For 2014, 29 countries reported 18 861 isolates with AST information for fluoroquinolones, third-generation cephalosporins and aminoglycosides. The number of isolates reported per country ranged from 28 to 2 175 (Table 3.14).

The national percentages of resistant isolates in the reporting countries ranged from zero (Iceland) to 63.3 % (Slovakia) (Table 3.14 and Figure 3.10). Trends for the period 2011-2014 were calculated for the 27 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for six countries (France, Ireland, Italy, Malta, Norway and the United Kingdom). 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 (Greece, Hungary, Lithuania and the Netherlands).

The EU/EEA population-weighted mean showed a significantly increasing trend, from 16.7 % in 2011 to 19.6 % in 2014 (Table 3.14).

Other resistance combinations and resistance to other antimicrobial groups

Of the 18 180 isolates (90.7 % of total) tested for all antimicrobial groups under regular EARS-Net surveillance (fluoroquinolones, third-generation cephalosporins, aminoglycosides and carbapenems) in 2014, 65.0 % were fully susceptible to all tested antimicrobial groups. Among the resistant isolates, 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 group or two antimicrobial groups together. Overall, 5.7 % of all *K. pneumoniae* isolates were resistant to all groups under regular EARS-Net surveillance (Table 3.15). More than 80 % of these isolates were reported from Greece and Italy.

Nineteen countries reported AST data for polymyxins for a total of 4 958 isolates (24.7 % of all reported *K. pneumoniae* isolates in 2014). Only five countries reported polymyxin AST data for more than half of *K. pneumoniae* isolates. Overall, 8.2 % *K. pneumoniae* isolates were resistant to polymyxins. The highest percentages of polymyxin resistance were reported from Romania (25.8 %), Greece (19.9 %) and Italy (15.4 %). These three countries reported AST data on polymyxins for 81 %, 48 % and 57 % of their *K. pneumoniae* isolates, respectively. Among carbapenem-resistant isolates also tested for resistance to polymyxins (999 out of 1 345 isolates), 29.0 % were polymyxin resistant, whereas only 3.0 % of carbapenem-susceptible isolates also tested for resistance to polymyxins (3 896 out of 17 794 isolates), were polymyxin resistant. Of the isolates with resistance to both carbapenems and polymyxins, 47.5 % also had complete AST data for fluoroquinolones, third-generation cephalosporins and aminoglycosides. Among these, 5.2 % were resistant to all five antimicrobial groups. These isolates were almost exclusively reported from Greece, Italy and Romania. 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 may not be representative for Europe as a whole.

3.2.4 Discussion and conclusion

Antimicrobial resistance in *K. pneumoniae* is a public health concern of increasing importance in Europe. The EU/EEA population-weighted mean percentage for resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides as well as for combined resistance to all three of these antimicrobial groups all increased significantly during the period 2011-2014 (Tables 3.10, 3.11, 3.12 and 3.14). This is a continuation of the worrying trends in antimicrobial resistance in *K. pneumoniae* described in previous reports. Increasing resistance trends were noted for individual countries with both low and high resistance percentages.

Figure 3.8. ***Klebsiella pneumoniae*****. Percentage (%) of invasive isolates with resistance to aminoglycosides, by country, EU/EEA countries, 2014**

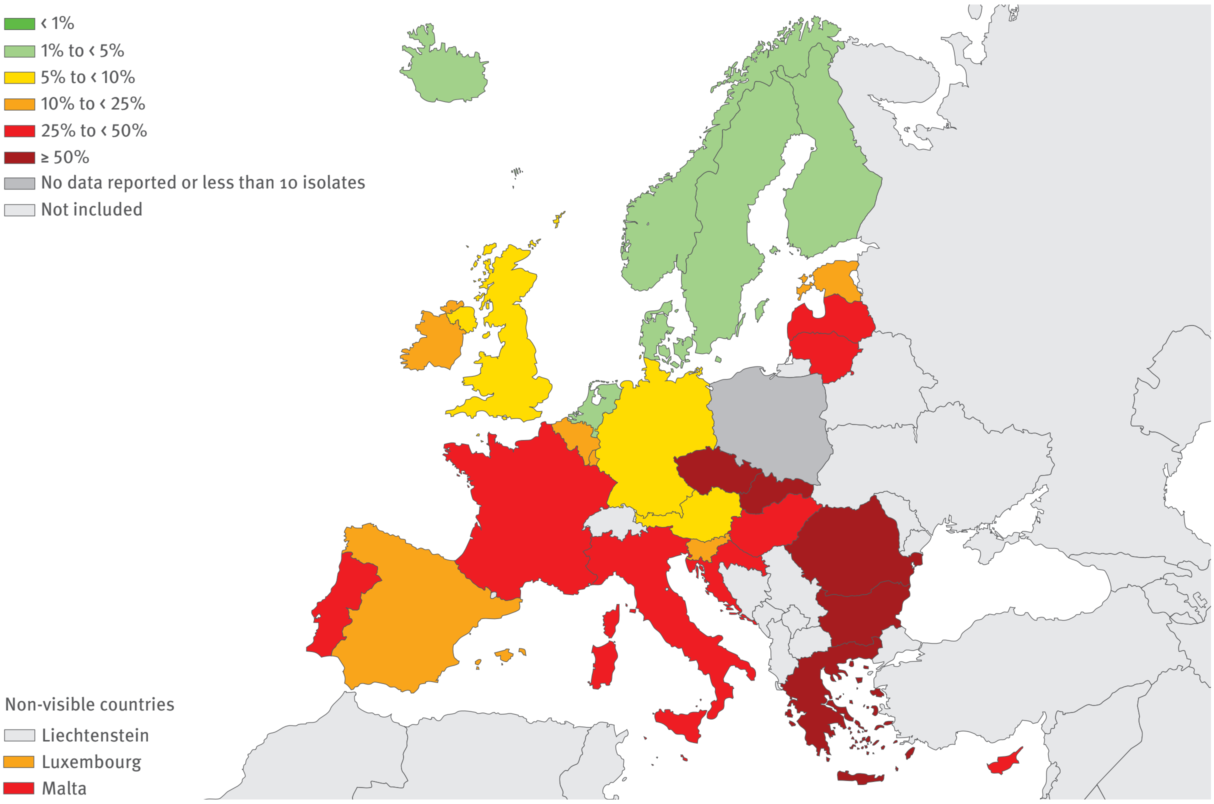
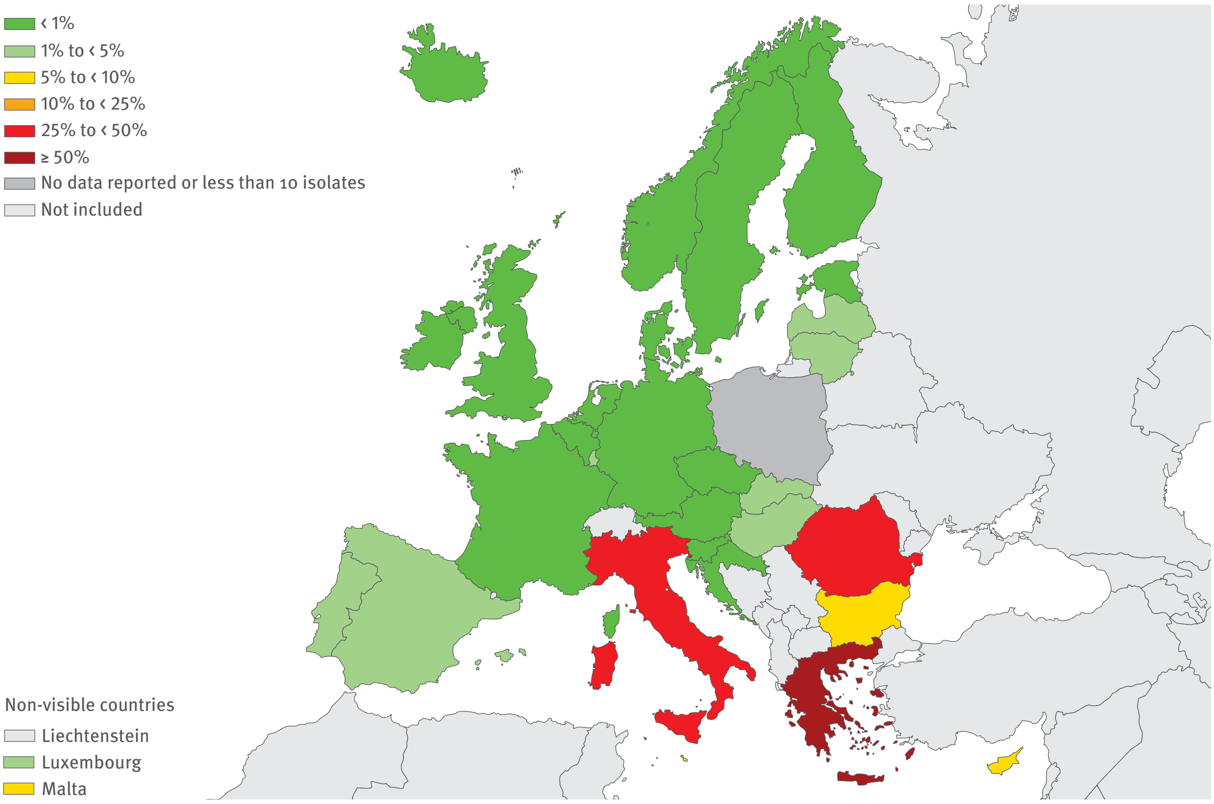


Figure 3.9. ***Klebsiella pneumoniae*****. Percentage (%) of invasive isolates with resistance to carbapenems, by country, EU/EEA countries, 2014**



The percentage of third-generation cephalosporin-resistant isolates with ESBL production was high (Table 3.9). As for *E. coli*, the increase 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 bacteria.

The significantly increasing trend of the EU/EEA population-weighted mean percentage for carbapenem resistance noted between 2009 and 2013 continued in 2014. With only a few exceptions, the countries reporting the highest carbapenem resistance percentages were those that also reported the highest levels of combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides. Three countries (Greece, Italy and Romania) reported carbapenem resistance percentages considerably higher than any other country (62.3 %, 32.9 % and 31.5 %, respectively). These countries also reported the highest percentages of polymyxin-resistant *K. pneumoniae*, indicating an especially worrisome situation.

Very few therapeutic options are left for patients infected with multidrug-resistant *K. pneumoniae* with additional resistance to carbapenems, and mortality is therefore high. Emergence of resistance to polymyxins, especially in countries with already high percentages of multidrug and carbapenem resistance, is another step towards pandrug resistance, i.e. resistance to all available antimicrobial agents, of *K. pneumoniae* infections.

Information on carbapenemase production is very limited in the EARS-Net data, but recent information from the European Survey on Carbapenemase-Producing Enterobacteriaceae (EuSCAPE) project indicates that CPE continue to spread in Europe, with an especially problematic situation for *K. pneumoniae*. Although most countries only reported single hospital outbreaks in EuSCAPE, the epidemiological situation had deteriorated in many countries between 2010 and 2014 [8]. ECDC issued two risk assessments targeting CPE during 2011 [9,10] emphasising the need for implementation of infection control measures such as active patient screening and additional hygiene precautions when caring for CPE-positive patients. These were complemented in 2014 with an ECDC systematic review of the effectiveness of infection control measures to prevent the transmission of CPE through the cross-border transfer of patients [11]. Although many European countries recently upgraded their level of CPE management, gaps still remain and many countries still lack national guidance for CPE infection prevention and control [8].

Figure 3.10. *Klebsiella pneumoniae*. Percentage (%) of invasive isolates with combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides, by country, EU/EEA countries, 2014

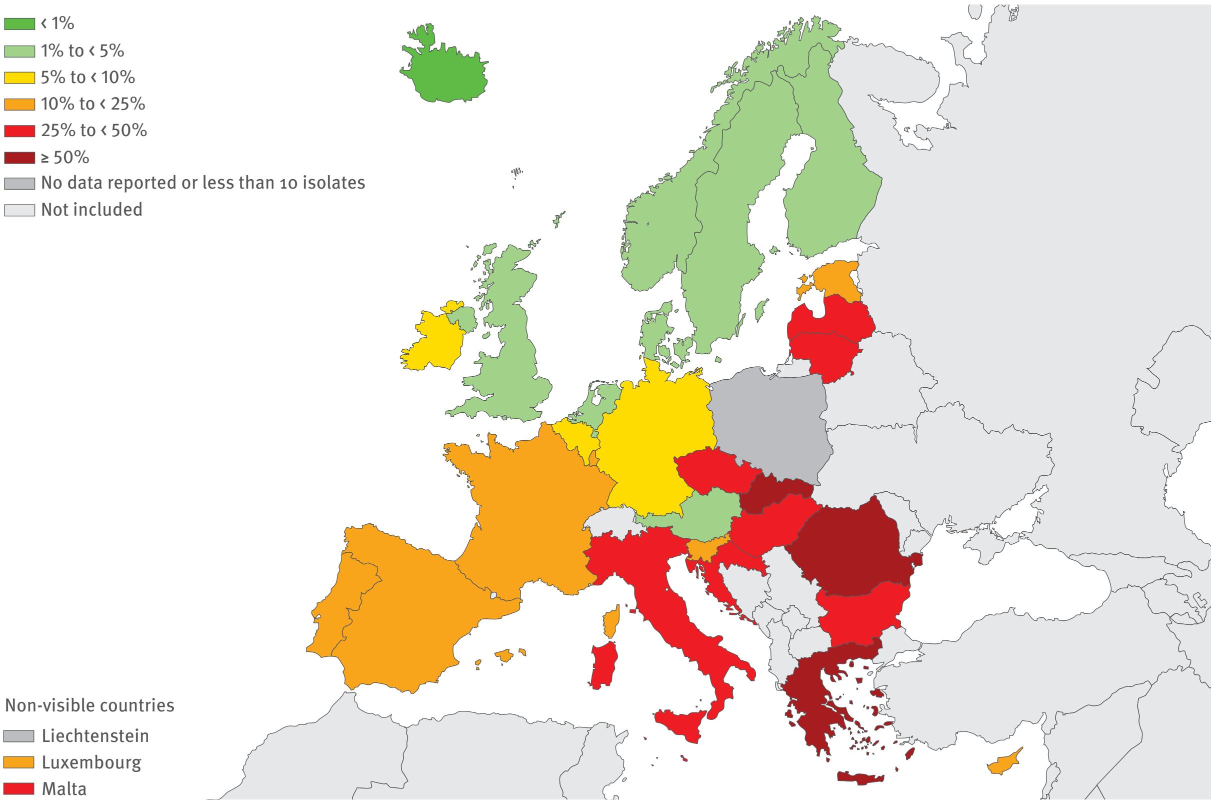


Table 3.10. *Klebsiella pneumoniae*. Total number of invasive isolates tested (N) and percentage with resistance to fluoroquinolones (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2011-2014

Country	2011			2012			2013			2014			Trend 2011-2014	Comment**
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		
Iceland	24	4.2	(0–21)	14	7.1	(0–34)	28	0.0	(0–12)	28	3.6	(0–18)	N/A	
Sweden	943	3.8	(2–5)	977	3.7	(3–5)	1270	3.9	(3–5)	763	4.1	(3–6)		
Finland	404	2.7	(1–5)	536	2.1	(1–4)	533	2.4	(1–4)	581	4.6	(3–7)		›~
Netherlands	728	7.3	(6–9)	670	5.4	(4–7)	638	6.1	(4–8)	886	4.7	(3–6)		
Norway	427	3.5	(2–6)	596	4.0	(3–6)	616	4.9	(3–7)	746	6.2	(5–8)		›
Denmark	888	11.6	(10–14)	941	8.8	(7–11)	874	8.9	(7–11)	943	6.9	(5–9)		‹
United Kingdom	985	4.6	(3–6)	1036	7.4	(6–9)	1155	8.7	(7–10)	1129	7.7	(6–9)		›
Austria	797	16.6	(14–19)	829	15.4	(13–18)	925	15.8	(13–18)	971	10.4	(9–12)		‹
Germany	519	14.1	(11–17)	663	13.7	(11–17)	745	14.8	(12–18)	980	12.7	(11–15)		
Ireland	303	8.9	(6–13)	338	7.4	(5–11)	316	14.6	(11–19)	355	13.5	(10–18)		›
Belgium	663	14.9	(12–18)	532	17.3	(14–21)	639	22.2	(19–26)	506	18.2	(15–22)		›~
Spain	1145	17.0	(15–19)	1150	16.5	(14–19)	1241	21.8	(20–24)	1266	18.6	(17–21)		›
Estonia	91	22.0	(14–32)	87	17.2	(10–27)	90	26.7	(18–37)	133	21.8	(15–30)		
Cyprus	83	36.1	(26–47)	65	21.5	(12–33)	68	23.5	(14–35)	80	26.3	(17–37)		
EU/EEA (population-weighted mean)*		**24.5**	**(22–28)**		**24.1**	**(22–28)**		**28.2**	**(26–31)**		**27.4**	**(26–30)**		**›**
France	1683	28.0	(26–30)	1691	24.4	(22–27)	1916	29.4	(27–32)	2175	31.0	(29–33)		›
Luxembourg	48	33.3	(20–48)	50	32.0	(20–47)	53	22.6	(12–36)	66	31.8	(21–44)		
Slovenia	232	35.3	(29-42)	254	33.1	(27-39)	245	32.7	(27-39)	233	32.6	(27-39)		
Malta	52	13.5	(6–26)	57	26.3	(16–40)	69	27.5	(17–40)	101	33.7	(25–44)		›
Hungary	420	51.0	(46–56)	485	41.6	(37–46)	555	37.7	(34–42)	641	34.9	(31–39)		‹
Portugal	617	36.3	(33–40)	777	35.8	(32–39)	911	35.7	(33–39)	1712	36.5	(34–39)		
Croatia	292	42.5	(37–48)	331	42.9	(38–48)	373	43.2	(38–48)	330	44.8	(39–50)		
Latvia	63	38.1	(26–51)	78	46.2	(35–58)	88	43.2	(33–54)	116	44.8	(36–54)		
Lithuania	137	54.7	(46–63)	184	55.4	(48–63)	144	45.1	(37–54)	154	45.5	(37–54)		‹~
Czech Republic	1287	52.8	(50–56)	1399	50.4	(48–53)	1291	47.7	(45–50)	1382	48.0	(45–51)		‹
Bulgaria	121	51.2	(42–60)	127	47.2	(38–56)	138	45.7	(37–54)	151	50.3	(42–59)		
Italy	597	45.7	(42–50)	835	49.9	(46–53)	1428	54.4	(52–57)	1295	55.7	(53–58)		›~
Romania	10	30.0	(7–65)	100	50.0	(40–60)	213	51.6	(45–59)	257	66.5	(60–72)	N/A	
Greece	1635	72.2	(70–74)	1428	69.7	(67–72)	1172	67.6	(65–70)	1063	67.6	(65–70)		‹
Slovakia	465	70.8	(66-75)	376	66.8	(62-72)	489	66.9	(63-71)	493	70.8	(67-75)		
Poland	369	57.7	(53–63)	359	60.2	(55–65)	374	70.1	(65–75)	–	–	(–)	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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates 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 with resistance to third-generation cephalosporins (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2011-2014

Country	2011			2012			2013			2014				Trend 2011-2014	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Iceland	26	7.7	(1–25)	14	21.4	(5–51)	30	0.0	(0–12)	28	0.0	(0–12)		N/A	
Finland	404	2.5	(1–5)	536	1.7	(1–3)	546	2.2	(1–4)	582	2.4	(1–4)			
Sweden	943	2.3	(1–3)	977	2.9	(2–4)	1300	3.6	(3–5)	1000	4.5	(3–6)			›
Netherlands	720	8.1	(6–10)	683	6.7	(5–9)	644	7.5	(6–10)	911	5.5	(4–7)			
Norway	421	2.9	(1–5)	621	3.2	(2–5)	645	4.0	(3–6)	746	5.9	(4–8)			›
Denmark	637	11.1	(9–14)	621	10.5	(8–13)	529	11.5	(9–15)	925	7.6	(6–9)			‹~
Austria	795	13.3	(11–16)	859	11.8	(10–14)	941	10.7	(9–13)	996	8.2	(7–10)			‹
United Kingdom	935	5.3	(4–7)	931	11.8	(10–14)	1077	13.6	(12–16)	977	9.3	(8–11)			›
Ireland	304	7.6	(5–11)	326	9.5	(7–13)	316	19.3	(15–24)	354	11.6	(8–15)			›
Germany	519	12.5	(10–16)	664	13.0	(10–16)	746	16.1	(13–19)	1006	12.7	(11–15)			
Belgium	668	13.6	(11–16)	540	16.5	(13–20)	594	15.3	(13–18)	485	16.3	(13–20)			
Spain	1145	13.4	(11–15)	1153	16.7	(15–19)	1241	19.8	(18–22)	1265	18.0	(16–20)			›
Estonia	43	39.5	(25–56)	90	17.8	(11–27)	90	23.3	(15–33)	135	20.7	(14–29)			
Slovenia	232	30.2	(24–37)	254	28.3	(23–34)	245	29.0	(23–35)	233	26.6	(21–33)			
EU/EEA (population-weighted mean)*		**23.6**	**(22–26)**		**24.6**	**(22–27)**		**29.1**	**(26–31)**		**28.0**	**(25–30)**			**›**
France	1654	25.3	(23–28)	1711	22.6	(21–25)	1938	28.0	(26–30)	2192	29.6	(28–32)			›
Malta	52	13.5	(6–26)	57	26.3	(16–40)	69	27.5	(17–40)	101	29.7	(21–40)			›
Cyprus	83	41.0	(30–52)	65	23.1	(14–35)	68	30.9	(20–43)	80	32.5	(22–44)			
Luxembourg	48	35.4	(22–51)	50	34.0	(21–49)	53	34.0	(22–48)	66	34.8	(24–48)			
Hungary	431	53.1	(48–58)	500	43.0	(39–47)	557	37.3	(33–42)	644	35.6	(32–39)			‹
Portugal	616	35.4	(32–39)	781	38.7	(35–42)	911	37.0	(34–40)	1712	40.9	(39–43)			›~
Croatia	299	48.2	(42–54)	332	52.1	(47–58)	376	50.0	(45–55)	334	47.9	(42–53)			
Lithuania	137	60.6	(52–69)	186	64.0	(57–71)	145	44.1	(36–53)	154	52.6	(44–61)			‹
Czech Republic	1287	48.3	(45–51)	1399	51.2	(49–54)	1291	52.0	(49–55)	1383	52.9	(50–56)			›
Latvia	65	38.5	(27–51)	78	62.8	(51–74)	92	66.3	(56–76)	104	52.9	(43–63)			
Italy	627	45.9	(42–50)	852	47.9	(44–51)	1441	55.1	(52–58)	1319	56.5	(54–59)			›~
Slovakia	466	68.2	(64–72)	378	62.7	(58–68)	488	66.4	(62–71)	493	69.4	(65–73)			
Greece	1665	75.8	(74–78)	1459	70.9	(68–73)	1208	70.1	(67–73)	1092	72.5	(70–75)			‹
Romania	25	44.0	(24–65)	102	60.8	(51–70)	214	67.3	(61–74)	256	73.8	(68–79)			›~
Bulgaria	121	81.0	(73–88)	127	74.8	(66–82)	138	69.6	(61–77)	151	74.8	(67–82)			
Poland	278	59.7	(54–66)	362	60.5	(55–66)	376	65.2	(60–70)	–	–	(–)		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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates 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 3.12. *Klebsiella pneumoniae*. Total number of invasive isolates tested (N) and percentage with resistance to aminoglycosides (%R), including 95% confidence intervals (95% CI), EU/EEA countries, 2011-2014

Country	2011			2012			2013			2014			Trend 2011-2014	Comment**
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		
Finland	404	1.2	(0–3)	516	0.4	(0–1)	523	1.5	(1–3)	559	2.3	(1–4)		›~
Sweden	919	2.0	(1–3)	977	2.5	(2–4)	1235	2.9	(2–4)	860	3.3	(2–5)		
Iceland	26	0.0	(0–13)	16	0.0	(0–21)	30	0.0	(0–12)	28	3.6	(0–18)	N/A	
Netherlands	729	8.1	(6–10)	685	6.3	(5–8)	653	6.1	(4–8)	900	3.9	(3–5)		‹
Norway	426	2.8	(1–5)	622	2.4	(1–4)	644	2.3	(1–4)	744	4.8	(3–7)		›~
Denmark	908	5.8	(4–8)	902	6.0	(5–8)	864	4.4	(3–6)	943	4.9	(4–6)		
Austria	790	7.2	(6–9)	858	5.4	(4–7)	947	5.3	(4–7)	994	5.5	(4–7)		
United Kingdom	979	4.3	(3–6)	1059	6.1	(5–8)	1163	6.5	(5–8)	1173	5.7	(4–7)		
Germany	518	8.9	(7–12)	663	8.3	(6–11)	743	9.6	(8–12)	1006	7.1	(6–9)		
Belgium	608	8.1	(6–11)	503	10.7	(8–14)	600	9.8	(8–13)	375	10.1	(7–14)		
Ireland	304	7.6	(5–11)	338	9.2	(6–13)	317	17.4	(13–22)	355	12.1	(9–16)		›
Spain	1145	10.5	(9–12)	1153	14.1	(12–16)	1241	16.0	(14–18)	1266	13.9	(12–16)		›
Estonia	90	12.2	(6–21)	91	13.2	(7–22)	91	9.9	(5–18)	136	19.1	(13–27)		
Luxembourg	48	29.2	(17–44)	50	26.0	(15–40)	53	28.3	(17–42)	66	19.7	(11–31)		
Slovenia	232	22.0	(17–28)	254	20.5	(16–26)	245	20.0	(15–26)	233	20.2	(15–26)		
EU/EEA (population-weighted mean)*		**20.1**	**(18–24)**		**21.3**	**(19–24)**		**23.7**	**(21–25)**		**23.1**	**(21–25)**		›
France	1688	23.6	(22–26)	1119	23.6	(21–26)	1938	26.7	(25–29)	2191	27.8	(26–30)		›
Cyprus	83	27.7	(18–39)	65	18.5	(10–30)	68	25.0	(15–37)	80	28.8	(19–40)		
Malta	52	9.6	(3–21)	57	26.3	(16–40)	69	26.1	(16–38)	101	29.7	(21–40)		›
Portugal	619	31.5	(28–35)	780	31.8	(29–35)	912	30.3	(27–33)	1706	31.3	(29–34)		
Hungary	430	53.0	(48–58)	500	41.0	(37–45)	556	36.9	(33–41)	639	32.1	(28–36)		‹
Latvia	65	33.8	(23–47)	78	51.3	(40–63)	92	48.9	(38–60)	118	44.1	(35–54)		
Italy	661	34.6	(31–38)	868	42.4	(39–46)	1438	44.9	(42–47)	1211	48.6	(46–51)		›~
Lithuania	137	55.5	(47–64)	186	63.4	(56–70)	145	47.6	(39–56)	154	48.7	(41–57)		‹~
Croatia	300	44.0	(38–50)	332	46.1	(41–52)	376	50.5	(45–56)	334	49.1	(44–55)		
Czech Republic	1283	44.7	(42–48)	1399	54.4	(52–57)	1291	51.0	(48–54)	1383	50.7	(48–53)		›
Greece	1649	69.0	(67–71)	1432	62.9	(60–65)	1171	59.0	(56–62)	1069	61.1	(58–64)		‹
Bulgaria	120	71.7	(63–80)	127	54.3	(45–63)	138	56.5	(48–65)	151	63.6	(55–71)		
Romania	10	50.0	(19–81)	99	54.5	(44–65)	213	57.3	(50–64)	251	67.3	(61–73)	N/A	
Slovakia	466	66.3	(62–71)	378	63.0	(58–68)	489	64.0	(60–68)	494	68.2	(64–72)		
Poland	383	47.5	(42–53)	369	51.8	(47–57)	380	58.4	(53–63)	–	–	(–)	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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates 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 3.13. *Klebsiella pneumoniae*. Total number of invasive isolates tested (N) and percentage with resistance to carbapenems (%R), including 95% confidence intervals (95% CI), EU/EEA countries, 2011-2014

Country	2011			2012			2013			2014			Trend 2011-2014	Comment**
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		
Estonia	73	0.0	(0–5)	79	1.3	(0–7)	74	2.7	(0–9)	92	0.0	(0–4)		
Finland	404	0.0	(0–1)	536	0.0	(0–1)	546	0.0	(0–1)	583	0.0	(0–1)		
Iceland	24	0.0	(0–13)	16	0.0	(0–19)	30	0.0	(0–11)	25	0.0	(0–4)	N/A	
Norway	443	0.0	(0–1)	623	0.5	(0–1)	645	0.2	(0–1)	746	0.0	(0–0)		
Sweden	941	0.0	(0–0)	977	0.0	(0–0)	1269	0.0	(0–0)	978	0.0	(0–0)		
Czech Republic	1193	0.1	(0–0)	1307	0.3	(0–1)	1133	0.5	(0–1)	1148	0.1	(0–0)		
Denmark	589	0.0	(0–1)	680	0.3	(0–1)	645	0.2	(0–1)	830	0.2	(0–1)		
Netherlands	722	0.3	(0–1)	684	0.1	(0–1)	646	0.2	(0–1)	903	0.2	(0–1)		
Belgium	646	0.3	(0–1)	545	0.7	(0–2)	618	0.3	(0–1)	429	0.5	(0–2)		
France	1640	0.0	(0–0)	1627	0.5	(0–1)	1842	0.7	(0–1)	2103	0.5	(0–1)		›
Austria	610	0.2	(0–1)	738	0.8	(0–2)	910	1.2	(1–2)	971	0.6	(0–1)		
Ireland	302	0.3	(0–2)	338	0.0	(0–1)	317	0.3	(0–2)	353	0.6	(0–2)		
Germany	512	0.0	(0–1)	661	0.0	(0–1)	743	0.7	(0–2)	1006	0.7	(0–1)		›
United Kingdom	825	0.4	(0–1)	888	0.5	(0–1)	1051	0.5	(0–1)	1068	0.8	(0–2)		
Croatia	299	0.0	(0–1)	331	0.0	(0–1)	376	0.5	(0–2)	334	0.9	(0–3)		›
Slovenia	232	0.0	(0–2)	254	0.4	(0–2)	245	0.4	(0–2)	233	0.9	(0–3)		
Hungary	413	1.9	(1–4)	481	2.9	(2–5)	531	1.7	(1–3)	621	1.1	(0–2)		
Lithuania	19	0.0	(0–18)	185	0.0	(0–2)	144	0.0	(0–3)	154	1.3	(0–5)	N/A	
Luxembourg	48	0.0	(0–7)	48	0.0	(0–7)	53	1.9	(0–10)	66	1.5	(0–8)		
Latvia	65	0.0	(0–6)	77	0.0	(0–5)	92	0.0	(0–4)	118	1.7	(0–6)		
Portugal	580	0.3	(0–1)	749	0.7	(0–2)	904	1.8	(1–3)	1701	1.8	(1–3)		›
Spain	1144	0.3	(0–1)	1152	0.8	(0–1)	1241	1.6	(1–2)	1266	2.3	(2–3)		›
Slovakia	434	0.7	(0–2)	331	6.3	(4–10)	342	0.6	(0–2)	456	2.6	(1–5)		
Cyprus	83	15.7	(9–25)	65	9.2	(3–19)	68	5.9	(2–14)	80	5.0	(1–12)		‹
Bulgaria	116	0.0	(0–3)	108	1.9	(0–7)	129	0.0	(0–3)	139	7.2	(4–13)		›
EU/EEA (population-weighted mean)*		**6.0**	**(4–8)**		**6.4**	**(5–8)**		**8.4**	**(7–10)**		**7.3**	**(6–9)**		**›**
Malta	52	3.8	(0–13)	57	3.5	(0–12)	69	5.8	(2–14)	101	9.9	(5–17)		
Romania	10	0.0	(0–31)	102	13.7	(8–22)	215	20.5	(15–26)	257	31.5	(26–38)	N/A	
Italy	615	26.7	(23–38)	845	29.1	(26–32)	1453	34.3	(32–37)	1315	32.9	(30–36)		›~
Greece	1636	68.2	(66–70)	1460	60.5	(58–63)	1209	59.4	(57–62)	1088	62.3	(59–65)		‹
Poland	376	0.5	(0–2)	359	0.8	(0–2)	370	0.8	(0–2)	–	–	(–)	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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates 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 with combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2011-2014

Country	2011			2012			2013			2014				Trend 2011-2014	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Iceland	24	0.0	(0–14)	14	0.0	(0–23)	28	0.0	(0–12)	28	0.0	(0–12)		N/A	
Finland	404	1.2	(0–3)	516	0.2	(0–1)	510	0.4	(0–1)	556	1.4	(1–3)			
Sweden	890	0.9	(0–2)	977	1.4	(1–2)	1235	1.7	(1–3)	623	1.4	(1–3)			
Netherlands	720	4.3	(3–6)	667	2.7	(2–4)	631	2.2	(1–4)	867	2.0	(1–3)			‹
Denmark	633	4.9	(3–7)	577	3.1	(2–5)	519	3.5	(2–5)	925	3.1	(2–4)			
United Kingdom	914	2.1	(1–3)	913	2.3	(1–3)	1070	4.9	(4–6)	974	3.2	(2–4)			›
Austria	785	4.1	(3–6)	828	4.2	(3–6)	919	3.8	(3–5)	969	3.4	(2–5)			
Norway	374	0.8	(0–2)	593	1.5	(1–3)	616	1.8	(1–3)	744	3.9	(3–6)			›
Germany	518	6.9	(5–9)	663	6.2	(4–8)	742	6.9	(5–9)	979	5.3	(4–7)			
Ireland	303	3.3	(2–6)	326	3.4	(2–6)	316	7.9	(5–11)	354	7.3	(5–11)			›
Belgium	587	4.9	(3–7)	477	8.2	(6–11)	555	7.0	(5–9)	354	7.9	(5–11)			
Spain	1145	8.3	(7–10)	1150	8.9	(7–11)	1241	11.2	(9–13)	1265	10.0	(8–12)			
Estonia	42	19.0	(9–34)	86	10.5	(5–19)	89	9.0	(4–17)	132	11.4	(7–18)			
Cyprus	83	25.3	(16–36)	65	10.8	(4–21)	68	8.8	(3–18)	80	15.0	(8–25)			
Luxembourg	48	27.1	(15–42)	50	20.0	(10–34)	53	17.0	(8–30)	66	16.7	(9–28)			
Slovenia	232	19.8	(15–26)	254	17.3	(13–23)	245	15.9	(12–21)	233	18.9	(14–25)			
EU/EEA (population-weighted mean)*		**16.7**	**(15–20)**		**17.4**	**(15–20)**		**20.1**	**(18–24)**	**0**	**19.6**	**(18–24)**			**›**
Portugal	614	20.8	(18–24)	776	25.1	(22–28)	909	21.9	(19–25)	1705	23.0	(21–25)			
France	1647	19.5	(18–21)	1097	19.4	(17–22)	1916	22.9	(21–25)	2175	23.8	(22–26)			›
Malta	52	3.8	(0–13)	57	19.3	(10–32)	69	20.3	(12–32)	101	26.7	(18–36)			›
Hungary	417	46.0	(41–51)	485	37.5	(33–42)	551	32.1	(28–36)	636	28.9	(25–33)			‹
Croatia	292	30.5	(25–36)	331	30.8	(26–36)	373	29.8	(25–35)	330	30.9	(26–36)			
Lithuania	137	43.1	(35–52)	184	52.2	(45–60)	144	33.3	(26–42)	154	35.1	(28–43)			‹
Czech Republic	1283	36.0	(33–39)	1399	41.8	(39–44)	1291	38.3	(36–41)	1382	38.7	(36–41)			
Latvia	63	33.3	(22–46)	78	42.3	(31–54)	88	39.8	(29–51)	104	41.3	(32–51)			
Bulgaria	120	45.8	(37–55)	127	36.2	(28–45)	138	36.2	(28–45)	151	41.7	(34–50)			
Italy	566	32.9	(29–37)	758	40.2	(37–44)	1403	41.8	(39–44)	1170	44.0	(41–47)			›~
Romania	10	30.0	(7–65)	97	42.3	(32–53)	210	42.9	(36–50)	248	56.0	(50–62)		N/A	
Greece	1630	64.1	(62–66)	1427	59.9	(57–62)	1166	55.4	(52–58)	1063	56.8	(54–60)			‹
Slovakia	465	62.4	(58–67)	376	55.3	(50–60)	487	57.9	(53–62)	493	63.3	(59–68)			
Poland	259	37.1	(31–43)	353	48.4	(43–54)	366	52.5	(47–58)	–	–	(–)		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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates 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=18 180), EU/EEA countries, 2014

Resistance pattern	Number of isolates	% of total**
Fully susceptible	**11820**	**65.0**
Single resistance (to indicated antimicrobial group)		
Total (all single resistance)	**1 131**	**6.1**
Fluoroquinolones	532	2.9
Third-generation cephalosporins	460	2.5
Aminoglycosides	134	0.7
Carbapenems	5	<0.1
Resistance to two antimicrobial groups		
Total (all two-group combinations)	**1 256**	**6.8**
Third-generation cephalosporins + fluoroquinolones	498	2.7
Third-generation cephalosporins + aminoglycosides	463	2.5
Fluoroquinolones + aminoglycosides	258	1.4
Third-generation cephalosporins + carbapenems	33	0.2
Fluoroquinolones + carbapenems	3	0.0
Aminoglycosides + carbapenems	1	0.0
Resistance to three antimicrobial groups		
Total (all three-group combinations)	**2 929**	**16.1**
Third-generation cephalosporins + fluoroquinolones + aminoglycosides	2 766	15.2
Third-generation cephalosporins + fluoroquinolones + carbapenems	142	0.8
Third-generation cephalosporins + aminoglycosides + carbapenems	18	0.1
Fluoroquinolones + aminoglycosides + carbapenems	3	<0.1
Resistance to four antimicrobial groups		
Third-generation cephalosporins + fluoroquinolones + aminoglycosides + carbapenems	**1 044**	**5.7**

* Only data from isolates tested against all four 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-fermentative 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. *P. aeruginosa* may chronically colonise patients with cystic fibrosis, causing severe intermittent exacerbation of the condition.

Finally, *P. aeruginosa* is commonly found in burns units where 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 antibiotic molecules from penetrating its outer membrane or extruding them if they enter the cell. 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 national percentages ranging between 4.4 % and 58.5 % in 2014. The EU/EEA population-weighted mean percentage for carbapenem resistance increased significantly from 16.8 % in 2011 to 18.3 % in 2014.
- The decrease in fluoroquinolone and aminoglycoside resistance reported from several countries in recent years was also reflected in a significantly decreasing EU/EEA population-weighted mean percentage between 2011 and 2014.
- Combined resistance was common in *P. aeruginosa*: 14.9 % of the isolates were resistant to at least three antimicrobial groups and 5.5 % were resistant to all five antimicrobial groups under regular EARS-Net surveillance.

Piperacillin + tazobactam

For 2014, 29 countries reported 11 342 isolates with AST information for piperacillin + tazobactam. The number of isolates reported per country ranged from 3 to 1783 (Table 3.16).

For countries reporting 10 or more isolates in 2014, the national percentages of resistant isolates ranged from 4.4 % (Denmark) to 62.2 % (Romania) (Table 3.16 and Figure 3.11). Trends for the period 2011-2014 were calculated for the 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, Portugal and Slovenia). For Italy 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 Finland and France.

The EU/EEA population-weighted mean showed a significantly increasing trend, from 16.0 % in 2011 to 16.9 % in 2014 (Table 3.16).

As the EUCAST 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 may bias 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 hamper assessing the impact of this change.

Figure 3.11. ***Pseudomonas aeruginosa*. Percentage (%) of invasive isolates with resistance to piperacillin + tazobactam, by country, EU/EEA countries, 2014**

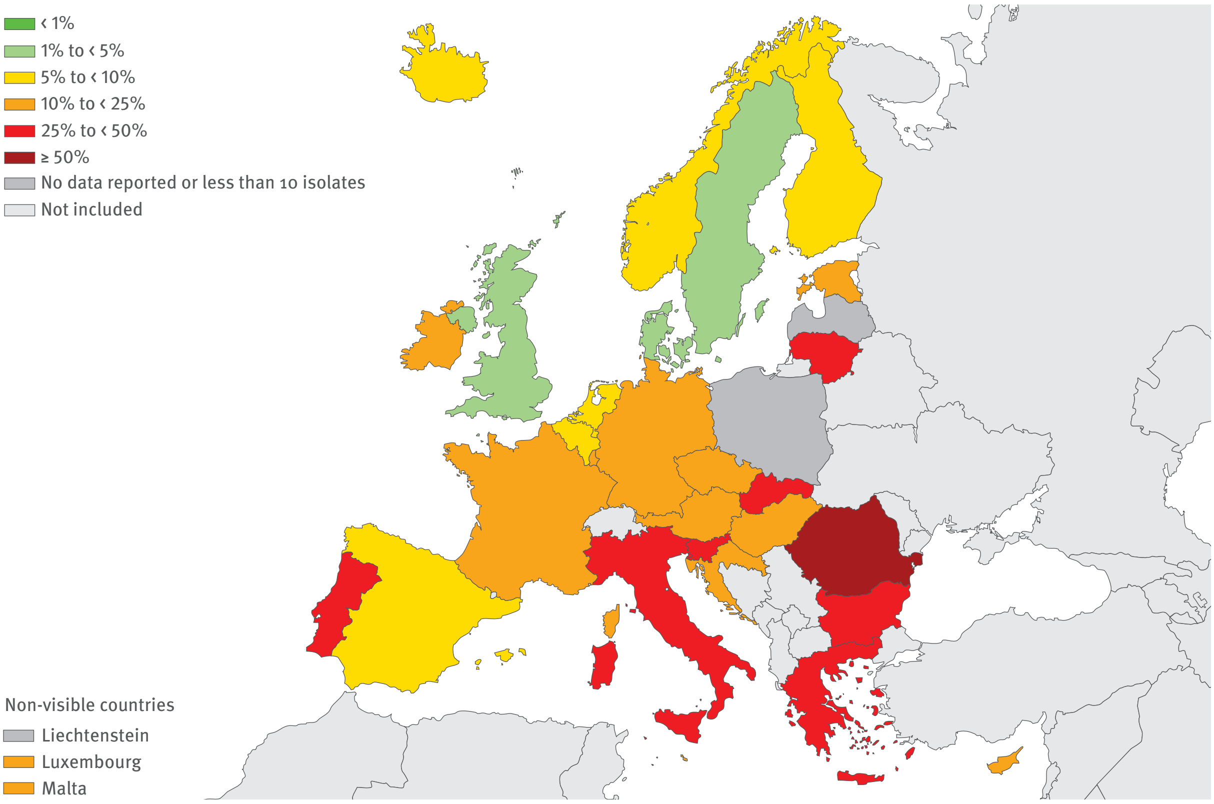
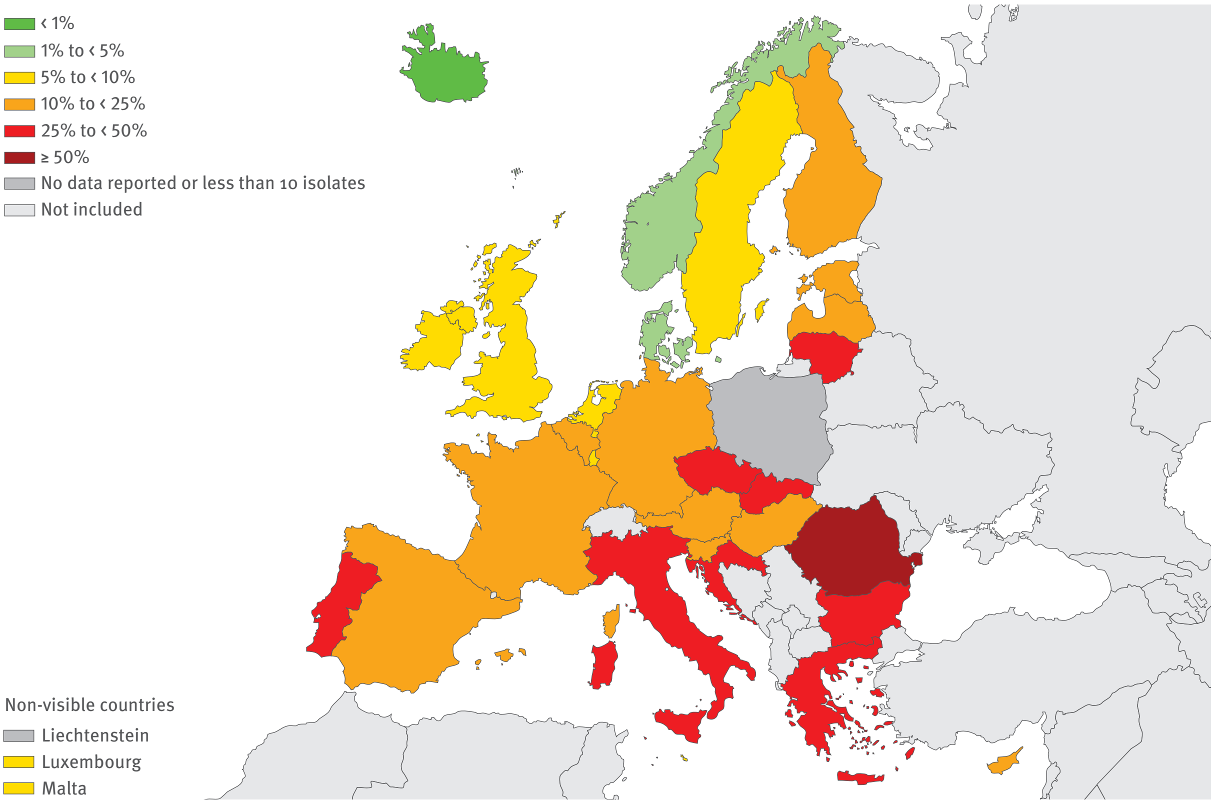


Figure 3.12. ***Pseudomonas aeruginosa*. Percentage (%) of invasive isolates with resistance to fluoroquinolones, by country, EU/EEA countries, 2014**



Fluoroquinolones

For 2014, 29 countries reported 11 447 isolates with AST information for fluoroquinolones (ciprofloxacin or levofloxacin). The number of isolates reported per country ranged from 11 to 1779 (Table 3.17).

For countries reporting 10 or more isolates in 2014, the percentages of resistant isolates ranged from zero (Iceland) to 55.4 % (Romania) (Table 3.17 and Figure 3.12). Trends for the period 2011-2014 were calculated for the 25 countries reporting at least 20 isolates per year during the full four-year period. A significantly increasing trend was not observed for any country. Significantly decreasing trends were observed for six countries (Austria, Belgium, Denmark, France, Germany and Slovakia). For Belgium and Germany, 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 decreasing trend from 22.1 % in 2011 to 19.4 % in 2014 (Table 3.17).

Ceftazidime

For 2014, 29 countries reported 11 407 isolates with AST information for ceftazidime. The number of isolates reported per country ranged from 3 to 1778 (Table 3.18).

For countries reporting 10 or more isolates in 2014, the percentages of resistant isolates in the reporting countries ranged from 2.4 % (Luxembourg) to 59.1 % (Romania) (Table 3.18 and Figure 3.13). Trends for the period 2011-2014 were calculated for the 25 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for five countries (Croatia, Hungary, Italy, Portugal and Slovenia). For Italy 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 France and Greece.

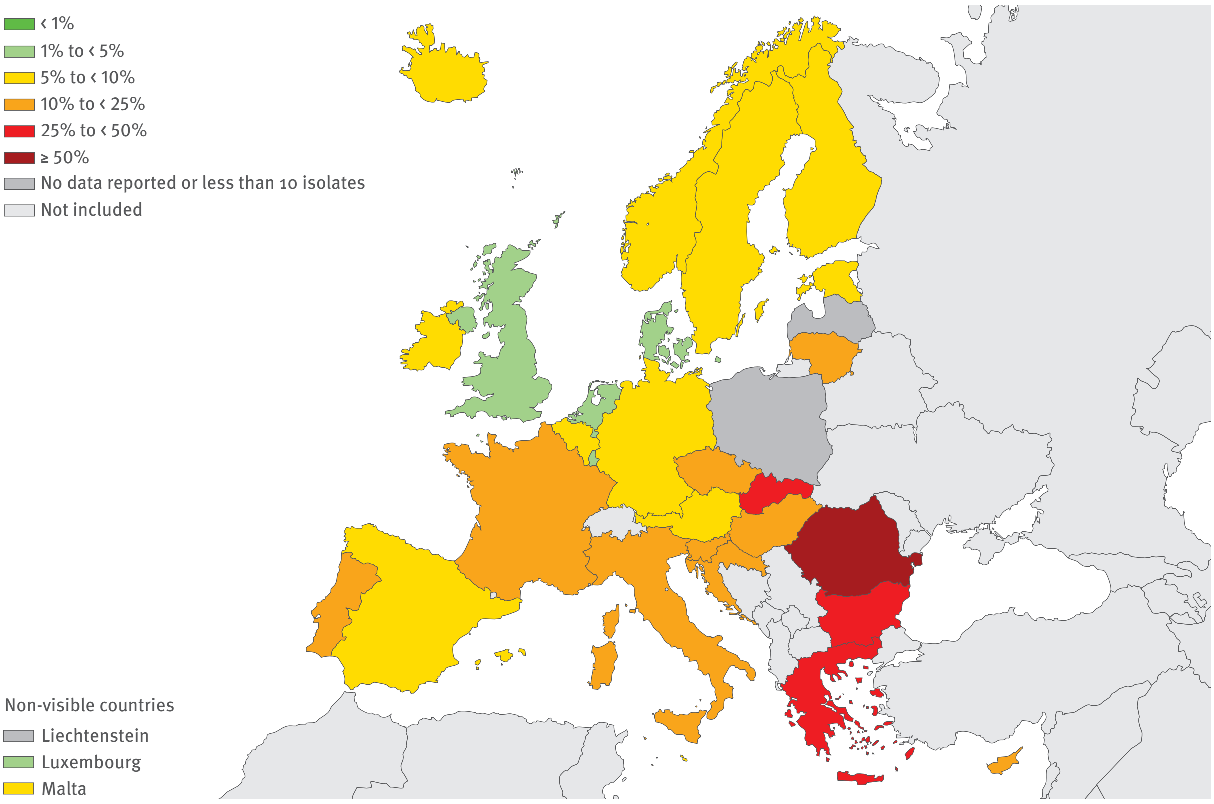
The EU/EEA population-weighted mean percentage for ceftazidime resistance was 13.1 % in 2014. No significant trend was noted between 2011 and 2014 (Table 3.18).

Aminoglycosides

For 2014, 29 countries reported 11 489 isolates with AST information for aminoglycosides (gentamicin, netilmicin or tobramycin). The number of isolates reported per country ranged from 11 to 1787 (Table 3.19).

The national percentages of resistant isolates ranged from zero (Iceland) to 63.4 % (Romania) (Table 3.19 and Figure 3.14). Trends for the period 2011-2014 were calculated for the 25 countries reporting at least 20 isolates per year during the full four-year period. A significantly increasing trend was not observed for any country. Significantly decreasing trends were observed for five countries (Austria, France, Germany, Malta and

Figure 3.13. ***Pseudomonas aeruginosa*. Percentage (%) of invasive isolates with resistance to ceftazidime, by country, EU/EEA countries, 2014**



Slovakia). These trends remained significant when considering only data from laboratories reporting consistently for all four years.

The EU/EEA population-weighted mean showed a significantly decreasing trend from 16.7% in 2011 to 14.8% in 2014 (Table 3.19).

Carbapenems

For 2014, 29 countries reported 11606 isolates with AST information for carbapenems (imipenem or meropenem). The number of isolates reported per country ranged from 11 to 1780 (Table 3.20).

The national percentages of resistant isolates ranged from 4.4% (the Netherlands) to 58.5% (Romania) (Table 3.20 and Figure 3.15). Trends for the period 2011-2014 were calculated for the 25 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for three countries (Germany, Hungary and Slovakia). A significantly decreasing trend was observed for Greece. All trends remained significant when considering only data from laboratories reporting consistently for all four years.

The EU/EEA population-weighted mean showed a significantly increasing trend for the period 2011-2014 from 16.8% in 2011 to 18.3% in 2014 (Table 3.20).

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

For 2014, 29 countries reported 11649 isolates with AST information for combined resistance. The number of isolates reported per country ranged from 11 to 1784 (Table 3.21).

The national percentages of resistant isolates ranged from zero (Estonia and Iceland) to 59.6% (Romania) (Table 3.21 and Figure 3.16). Trends for the period 2011-2014 were calculated for the 25 countries reporting at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for Hungary and Slovenia. Significantly decreasing trends were observed for Austria and France. All trends remained significant when considering only data from laboratories reporting consistently for all four years.

The EU/EEA population-weighted mean percentage for combined resistance was 13.3% in 2014. No significant trend could be noted between 2011 and 2014 (Table 3.21).

Other resistance combinations and resistance to other antimicrobial groups

Of all *P. aeruginosa* isolates tested for all antimicrobial groups under regular EARS-Net surveillance (piperacillin + tazobactam, fluoroquinolones, ceftazidime, aminoglycosides and carbapenems), 65.5% were susceptible to all tested antimicrobial groups. Resistance to all five antimicrobial groups was the most common resistance phenotype (5.5%), followed by single carbapenem resistance (4.6%) (Table 3.22).

Eighteen countries reported AST data for polymyxins for a total of 4807 isolates (41.7% of all reported *P. aeruginosa* isolates in 2014). Nine countries reported polymyxin AST data for more than half of their reported *P. aeruginosa* isolates. Overall, 2.0% of the *P. aeruginosa* isolates were resistant to polymyxins.

3.3.4 Discussion and conclusions

In 2014, high percentages of resistance in *P. aeruginosa* were reported, especially from eastern and south-eastern parts of Europe.

The decrease in fluoroquinolone resistance reported from several countries and at EU/EEA level in recent years continued in 2014. A similar reduction in national fluoroquinolone resistance levels has recently been reported from Canada [12] and from acute care hospitals in the United States [13]. 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.

Carbapenem resistance was common, with national percentages ranging between 4.4% and 58.5% in 2014. The EU/EEA population-weighted mean percentage for carbapenem resistance increased significantly from 16.8% in 2011 to 18.3% in 2014 (Table 3.20). The countries reporting high carbapenem resistance percentages in *P. aeruginosa* generally also report high percentage for *E. coli*, *K. pneumoniae* and *Acinetobacter* spp. (Tables 3.6, 3.13 and 3.25).

Combined resistance to multiple antimicrobial groups was common, with 14.9% of the isolates being resistant to at least three antimicrobial groups and 5.5% being resistant to all five groups under regular EARS-Net surveillance (Table 3.22). *P. aeruginosa* carries intrinsic resistance to a number of antimicrobial classes and any additional acquired resistance severely limits the therapeutic options for treating serious infections.

P. aeruginosa is recognised as a major cause of healthcare-associated infection. 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.

Figure 3.14. ***Pseudomonas aeruginosa*****. Percentage (%) of invasive isolates with resistance to aminoglycosides, by country, EU/EEA countries, 2014**

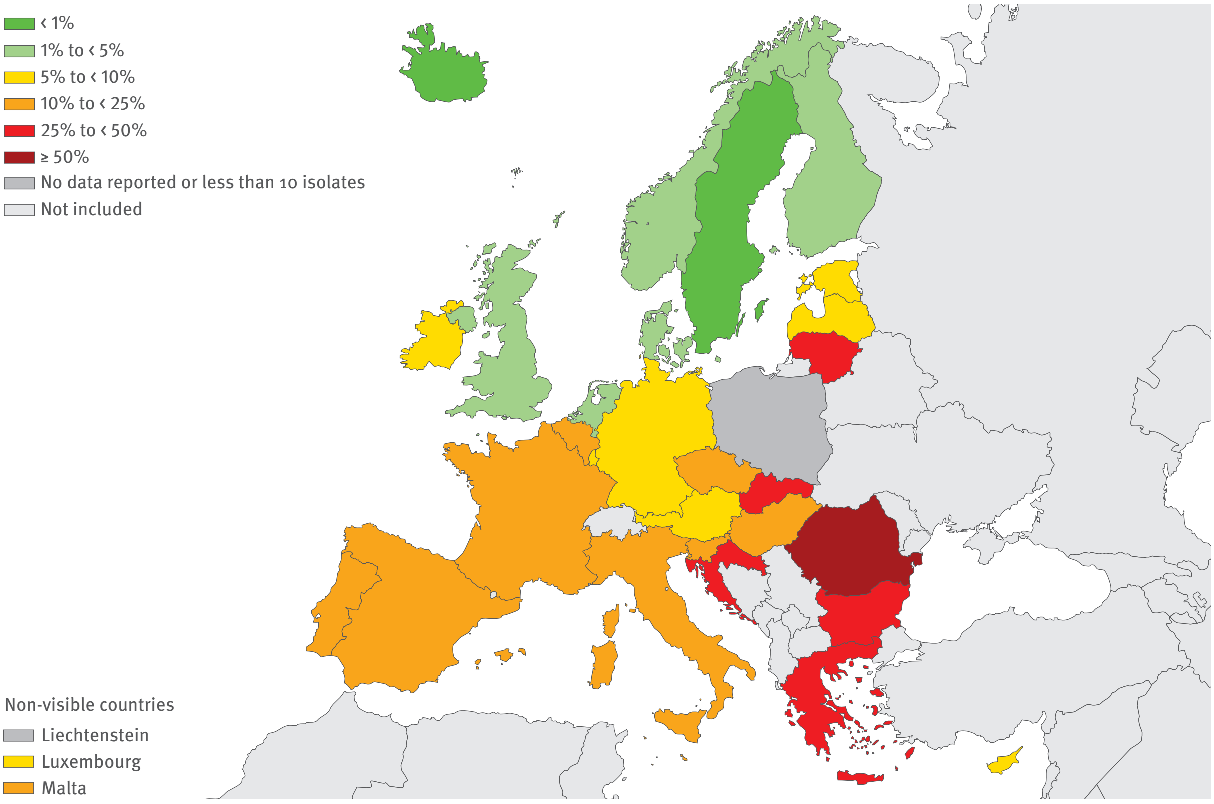


Figure 3.15. ***Pseudomonas aeruginosa*****. Percentage (%) of invasive isolates with resistance to carbapenems, by country, EU/EEA countries, 2014**

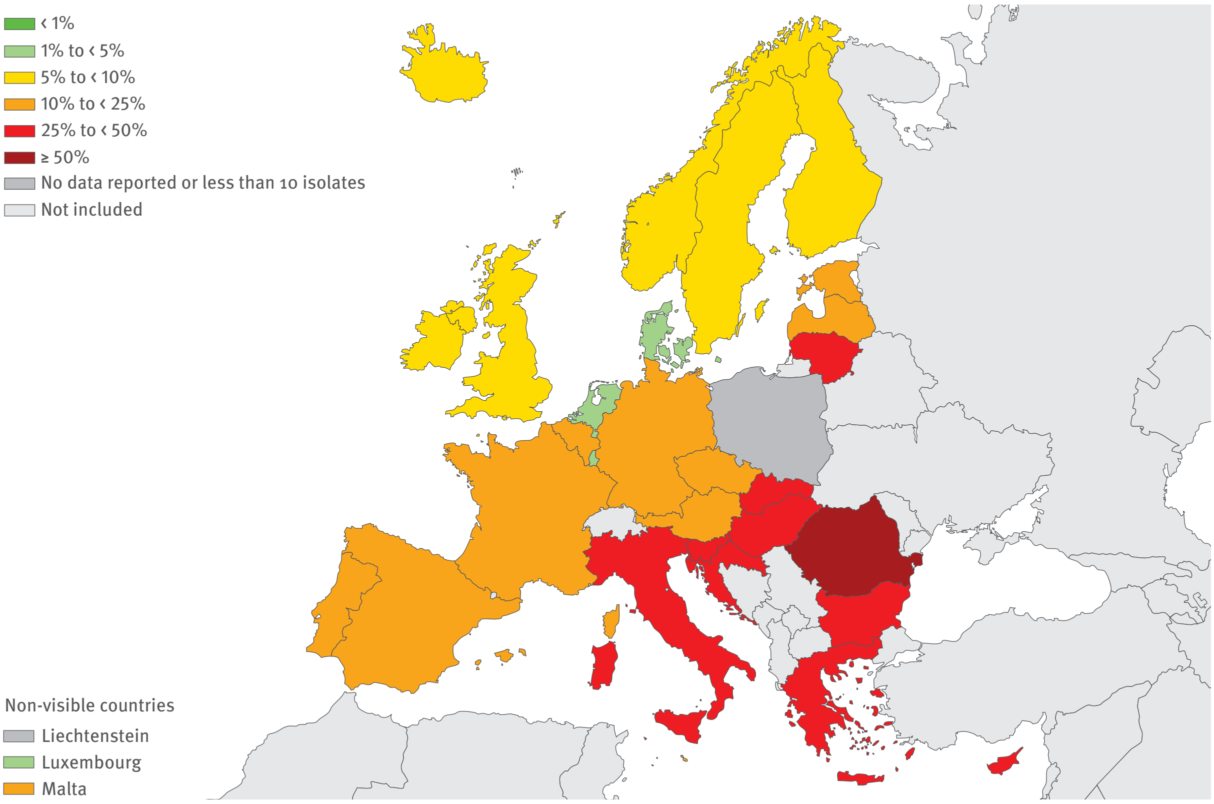


Figure 3.16. ***Pseudomonas aeruginosa.*** **Percentage (%) of invasive isolates with combined resistance (resistance to three or more antimicrobial groups among piperacillin + tazobactam, ceftazidime, fluoroquinolones, aminoglycosides and carbapenems), by country, EU/EEA countries, 2014**

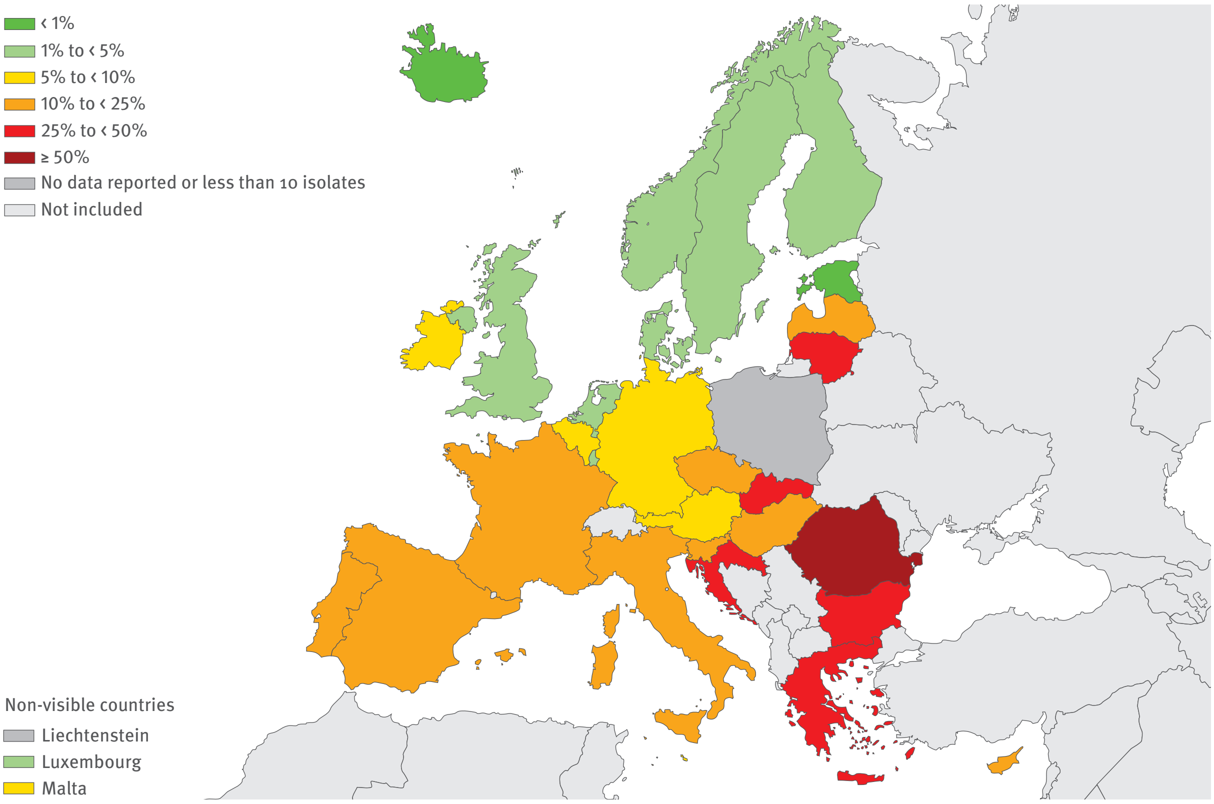


Table 3.16. *Pseudomonas aeruginosa*. Total number of invasive isolates tested (N) and percentage with resistance to piperacillin + tazobactam (%R), including 95% confidence intervals (95%CI), EU/EEA countries, 2011-2014

Country	2011			2012			2013			2014			Trend 2011-2014	Comment**
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		
Denmark	405	5.4	(3–8)	389	4.6	(3–7)	414	2.4	(1–4)	388	4.4	(3–7)		
Sweden	386	4.4	(3–7)	271	5.9	(3–9)	531	7.3	(5–10)	337	4.7	(3–8)		
United Kingdom	557	4.3	(3–6)	636	3.1	(2–5)	671	4.8	(3–7)	610	4.8	(3–7)		
Finland	211	15.6	(11–21)	314	7.6	(5–11)	326	8.6	(6–12)	306	6.9	(4–10)		‹
Spain	833	6.4	(5–8)	835	6.7	(5–9)	818	8.6	(7–11)	870	7.8	(6–10)		
Norway	142	4.9	(2–10)	198	7.1	(4–12)	198	9.1	(5–14)	254	7.9	(5–12)		
Netherlands	391	6.4	(4–9)	386	5.2	(3–8)	381	6.6	(4–10)	530	8.1	(6–11)		
Iceland	17	5.9	(0–29)	10	10.0	(0–45)	11	0.0	(0–28)	11	9.1	(0–41)	N/A	
Belgium	376	15.4	(12–19)	342	9.6	(7–13)	431	13.2	(10–17)	294	9.5	(6–13)		
Estonia	3	#	(#)	31	16.1	(5–34)	17	11.8	(1–36)	39	10.3	(3–24)	N/A	
Malta	42	23.8	(12–39)	31	9.7	(2–26)	24	20.8	(7–42)	38	10.5	(3–25)		
Luxembourg	32	15.6	(5–33)	31	16.1	(5–34)	34	11.8	(3–27)	37	10.8	(3–25)		
Ireland	172	2.9	(1–7)	216	16.2	(12–22)	202	11.4	(7–17)	178	11.2	(7–17)		
Austria	528	13.6	(11–17)	588	18.2	(15–22)	616	13.3	(11–16)	636	11.8	(9–15)		
Cyprus	51	19.6	(10–33)	50	10.0	(3–22)	47	8.5	(2–20)	42	16.7	(7–31)		
EU/EEA (population-weighted mean)*		**16.0**	**(13–19)**		**16.4**	**(14–19)**		**16.3**	**(14–19)**		**16.9**	**(14–21)**		›
France	1572	22.5	(20–25)	1627	19.9	(18–22)	1815	15.4	(14–17)	1783	17.0	(15–19)		‹
Germany	386	14.8	(11–19)	432	15.5	(12–19)	608	18.4	(15–22)	642	17.4	(15–21)		
Czech Republic	448	22.1	(18–26)	489	26.4	(23–31)	516	27.5	(24–32)	429	23.1	(19–27)		
Hungary	599	10.7	(8–13)	610	19.2	(16–23)	657	19.8	(17–23)	736	23.5	(20–27)		›
Croatia	224	23.2	(18–29)	194	21.6	(16–28)	233	23.6	(18–30)	216	24.5	(19–31)		
Slovenia	118	12.7	(7–20)	134	7.5	(4–13)	133	13.5	(8–21)	112	25.9	(18–35)		›
Portugal	522	19.0	(16–23)	586	19.8	(17–23)	87	24.1	(16–35)	1061	28.5	(26–31)		›~
Bulgaria	43	23.3	(12–39)	50	26.0	(15–40)	59	13.6	(6–25)	48	31.3	(19–46)		
Greece	923	31.1	(28–34)	849	34.3	(31–38)	863	29.9	(27–33)	666	31.4	(28–35)		
Italy	233	21.9	(17–28)	541	30.1	(26–34)	754	30.9	(28–34)	686	31.5	(28–35)		›~
Lithuania	30	13.3	(4–31)	28	10.7	(2–28)	35	8.6	(2–23)	31	32.3	(17–51)		
Slovakia	266	41.4	(35–48)	195	38.5	(32–46)	265	41.5	(36–48)	269	36.1	(30–42)		
Romania	7	#	(#)	44	50.0	(35–65)	80	55.0	(43–66)	90	62.2	(51–72)	N/A	
Latvia	11	9.1	(0–41)	17	17.6	(4–43)	24	20.8	(7–42)	3	#	(#)	N/A	
Poland	191	31.4	(25–39)	157	29.9	(23–38)	171	31.6	(25–39)	–	–	(–)	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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates 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 with resistance to fluoroquinolones (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2011-2014

Country	2011 N	2011 %R	2011 (95% CI)	2012 N	2012 %R	2012 (95% CI)	2013 N	2013 %R	2013 (95% CI)	2014 N	2014 %R	2014 (95% CI)	Trend 2011-2014	Comment**
Iceland	16	6.3	(0–30)	10	10.0	(0–45)	11	0.0	(0–28)	11	0.0	(0–28)	N/A	
Norway	147	5.4	(2–10)	209	5.7	(3–10)	205	8.8	(5–14)	257	3.1	(1–6)		
Denmark	403	6.9	(5–10)	389	4.1	(2–7)	408	3.2	(2–5)	388	3.6	(2–6)		<
Malta	42	19.0	(9–34)	31	0.0	(0–11)	25	8.0	(1–26)	38	5.3	(1–18)		
United Kingdom	585	6.2	(4–8)	664	4.8	(3–7)	711	5.8	(4–8)	629	5.4	(4–7)		
Netherlands	434	7.1	(5–10)	395	6.1	(4–9)	370	6.2	(4–9)	541	6.7	(5–9)		
Sweden	441	5.2	(3–8)	357	6.7	(4–10)	531	6.0	(4–8)	338	7.7	(5–11)		
Ireland	179	6.1	(3–11)	215	14.9	(10–20)	205	12.2	(8–17)	178	8.4	(5–14)		
Luxembourg	32	18.8	(7–36)	31	19.4	(7–37)	34	20.6	(9–38)	41	9.8	(3–23)		
Finland	233	15.5	(11–21)	327	8.0	(5–11)	316	11.4	(8–15)	289	10.0	(7–14)		
Estonia	16	6.3	(0–30)	32	15.6	(5–33)	20	25.0	(9–49)	39	10.3	(3–24)	N/A	
Austria	511	18.6	(15–22)	487	14.4	(11–18)	533	15.2	(12–19)	599	10.9	(8–14)		<
Belgium	397	21.2	(17–26)	329	18.2	(14–23)	486	16.9	(14–21)	309	12.6	(9–17)		<~
Germany	385	18.2	(14–22)	434	19.6	(16–24)	607	16.3	(13–19)	623	13.0	(10–16)		<~
Cyprus	51	13.7	(6–26)	52	15.4	(7–28)	47	10.6	(4–23)	42	16.7	(7–31)		
Latvia	12	25.0	(5–57)	18	22.2	(6–48)	25	24.0	(9–45)	18	16.7	(4–41)	N/A	
EU/EEA (population-weighted mean)*		**22.1**	**(19–26)**		**20.8**	**(18–24)**		**20.0**	**(17–23)**		**19.4**	**(16–22)**		<
France	1554	27.0	(25–29)	1723	22.2	(20–24)	1863	21.2	(19–23)	1779	20.6	(19–23)		<
Slovenia	118	9.3	(5–16)	134	14.9	(9–22)	133	11.3	(6–18)	112	22.3	(15–31)		
Hungary	599	20.4	(17–24)	618	22.3	(19–26)	667	23.4	(20–27)	743	24.6	(22–28)		
Spain	838	24.2	(21–27)	848	21.0	(18–24)	825	22.7	(20–26)	873	24.6	(22–28)		
Lithuania	30	16.7	(6–35)	28	10.7	(2–28)	37	10.8	(3–25)	31	25.8	(12–45)		
Portugal	516	25.6	(22–30)	587	25.6	(22–29)	735	23.9	(21–27)	1062	26.3	(24–29)		
Bulgaria	47	29.8	(17–45)	52	32.7	(20–47)	60	18.3	(10–30)	48	27.1	(15–42)		
Italy	318	26.1	(21–31)	675	31.4	(28–35)	773	28.7	(26–32)	739	28.3	(25–32)		
Croatia	225	35.1	(29–42)	194	23.7	(18–30)	240	21.7	(17–27)	230	30.0	(24–36)		
Czech Republic	448	33.9	(30–39)	489	30.9	(27–35)	516	33.7	(30–38)	447	32.7	(28–37)		
Greece	933	38.8	(36–42)	864	44.3	(41–48)	853	43.5	(40–47)	676	37.7	(34–41)		
Slovakia	266	58.6	(52–65)	199	56.3	(49–63)	286	53.1	(47–59)	275	45.5	(39–52)		<
Romania	9	#	(#)	45	53.3	(38–68)	84	45.2	(34–56)	92	55.4	(45–66)	N/A	
Poland	194	30.4	(24–37)	175	26.9	(20–34)	194	29.4	(23–36)	–	–	(–)	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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

**The symbols > and < indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates 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 with resistance to ceftazidime (% R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2011-2014**

Country	2011			2012			2013			2014				Trend 2011-2014	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Luxembourg	32	9.4	(2–25)	31	3.2	(0–17)	34	11.8	(3–27)	41	2.4	(0–13)			
Denmark	402	5.2	(3–8)	325	4.9	(3–8)	357	3.1	(2–5)	386	3.9	(2–6)			
United Kingdom	578	4.8	(3–7)	634	3.9	(3–6)	695	3.7	(2–5)	588	4.6	(3–7)			
Netherlands	434	4.6	(3–7)	398	2.8	(1–5)	371	3.8	(2–6)	534	4.9	(3–7)			
Norway	146	3.4	(1–8)	202	6.4	(3–11)	193	6.2	(3–11)	251	5.2	(3–9)			
Malta	42	11.9	(4–26)	31	6.5	(1–21)	25	8.0	(1–26)	38	5.3	(1–18)			
Sweden	475	5.1	(3–7)	357	6.2	(4–9)	531	6.8	(5–9)	433	5.5	(4–8)			
Finland	215	9.3	(6–14)	317	5.0	(3–8)	321	5.0	(3–8)	307	6.2	(4–9)			
Estonia	4	#	(#)	29	17.2	(6–36)	19	0.0	(0–18)	28	7.1	(1–24)		N/A	
Ireland	181	4.4	(2–9)	210	14.3	(10–20)	204	7.8	(5–12)	175	8.0	(4–13)			
Austria	498	10.6	(8–14)	572	14.0	(11–17)	608	9.5	(7–12)	631	8.7	(7–11)			
Belgium	417	8.9	(6–12)	326	8.3	(6–12)	459	9.4	(7–12)	316	8.9	(6–13)			
Iceland	17	5.9	(0–29)	10	10.0	(0–45)	11	0.0	(0–28)	11	9.1	(0–41)		N/A	
Spain	836	8.9	(7–11)	839	8.9	(7–11)	825	9.0	(7–11)	864	9.6	(8–12)			
Germany	386	9.1	(6–12)	437	9.6	(7–13)	607	10.0	(8–13)	638	9.9	(8–12)			
France	1466	16.0	(14–18)	1607	14.1	(12–16)	1868	11.5	(10–13)	1778	12.0	(11–14)			<
EU/EEA (population-weighted mean)*		**12.8**	**(10–16)**		**13.3**	**(11–16)**		**12.3**	**(10–15)**		**13.1**	**(10–16)**			
Lithuania	29	20.7	(8–40)	28	7.1	(1–24)	37	8.1	(2–22)	30	16.7	(6–35)			
Slovenia	118	7.6	(4–14)	134	6.7	(3–12)	133	13.5	(8–21)	112	20.5	(13–29)			>
Czech Republic	448	20.3	(17–24)	489	20.4	(17–24)	516	22.9	(19–27)	446	21.5	(18–26)			
Portugal	526	15.2	(12–19)	587	15.3	(13–19)	737	15.5	(13–18)	1061	22.0	(20–25)			>~
Cyprus	51	23.5	(13–37)	52	15.4	(7–28)	47	12.8	(5–26)	42	23.8	(12–39)			
Hungary	604	11.9	(9–15)	608	18.1	(15–21)	662	20.8	(18–24)	739	24.1	(21–27)			>
Croatia	215	17.7	(13–23)	189	11.6	(7–17)	239	18.8	(14–24)	227	24.2	(19–30)			>
Italy	303	16.2	(12–21)	603	25.5	(22–29)	722	23.7	(21–27)	683	24.9	(22–28)			>~
Greece	930	37.4	(34–41)	883	31.0	(28–34)	849	27.9	(25–31)	649	26.7	(23–30)			<
Slovakia	250	25.2	(20–31)	154	35.1	(28–43)	285	30.9	(26–37)	261	29.5	(24–35)			
Bulgaria	39	30.8	(17–48)	52	34.6	(22–49)	56	12.5	(5–24)	47	29.8	(17–45)			
Romania	9	#	(#)	39	51.3	(35–68)	64	43.8	(31–57)	88	59.1	(48–69)		N/A	
Latvia	11	9.1	(0–41)	18	22.2	(6–48)	25	24.0	(9–45)	3	#	(#)		N/A	
Poland	142	23.2	(17–31)	156	23.7	(17–31)	49	22.4	(12–37)	–	–	(–)		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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

**The symbols > and < indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates 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 with resistance to aminoglycosides (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2011-2014**

Country	2011			2012			2013			2014				Trend 2011-2014	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Iceland	17	0.0	(0–20)	10	0.0	(0–31)	11	0.0	(0–28)	11	0.0	(0–28)		N/A	
Sweden	331	1.5	(0–3)	357	1.7	(1–4)	519	2.9	(2–5)	313	0.6	(0–2)			
Norway	147	0.0	(0–2)	197	2.0	(1–5)	194	1.5	(0–4)	240	1.3	(0–4)			
United Kingdom	590	3.4	(2–5)	667	2.2	(1–4)	715	2.5	(1–4)	641	1.9	(1–3)			
Denmark	404	2.2	(1–4)	372	3.8	(2–6)	408	4.9	(3–7)	388	2.3	(1–4)			
Finland	269	4.8	(3–8)	326	2.5	(1–5)	326	3.1	(1–6)	305	2.3	(1–5)			
Netherlands	434	5.1	(3–8)	404	4.0	(2–6)	374	2.9	(1–5)	547	2.9	(2–5)			
Ireland	181	3.9	(2–8)	215	9.8	(6–15)	205	10.7	(7–16)	178	5.6	(3–10)			
Latvia	12	25.0	(5–57)	18	22.2	(6–48)	25	20.0	(7–41)	18	5.6	(0–27)		N/A	
Germany	386	11.7	(9–15)	436	10.6	(8–14)	609	7.6	(6–10)	643	5.9	(4–8)			‹
Austria	536	13.4	(11–17)	592	11.5	(9–14)	618	7.4	(6–10)	638	6.6	(5–9)			‹
Luxembourg	32	15.6	(5–33)	31	6.5	(1–21)	34	23.5	(11–41)	41	7.3	(2–20)			
Estonia	16	0.0	(0–21)	33	24.2	(11–42)	21	9.5	(1–30)	40	7.5	(2–20)		N/A	
Belgium	424	12.5	(10–16)	347	11.8	(9–16)	487	12.7	(10–16)	317	10.1	(7–14)			
Malta	42	33.3	(20–50)	31	6.5	(1–21)	25	0.0	(0–14)	38	13.2	(4–28)			‹
Cyprus	51	15.7	(7–29)	52	15.4	(7–28)	47	4.3	(1–15)	42	9.5	(4–22)			
EU/EEA (population-weighted mean)*		**16.7**	**(14–20)**		**18.4**	**(16–22)**		**15.8**	**(13–19)**		**14.8**	**(12–18)**			‹
Spain	839	18.7	(16–22)	853	16.5	(14–19)	825	14.9	(13–18)	873	16.8	(14–19)			
Slovenia	118	8.5	(4–15)	134	9.7	(5–16)	133	7.5	(4–13)	112	17.0	(11–25)			
Portugal	526	15.4	(12–19)	586	14.7	(12–18)	737	14.2	(12–17)	1064	17.6	(15–20)			
France	1599	21.3	(19–23)	1259	24.5	(22–27)	1869	15.5	(14–17)	1787	18.0	(16–20)			‹
Czech Republic	448	24.1	(20–28)	489	23.7	(20–28)	516	26.2	(22–30)	446	20.6	(17–25)			
Hungary	605	18.0	(15–21)	619	26.7	(23–30)	664	25.0	(22–28)	741	21.3	(18–24)			
Italy	335	17.6	(14–22)	701	30.2	(27–34)	783	27.2	(24–30)	709	24.4	(21–28)			
Lithuania	30	13.3	(4–31)	28	14.3	(4–33)	37	13.5	(5–29)	31	25.8	(12–45)			
Bulgaria	48	37.5	(24–53)	52	32.7	(20–47)	60	20.0	(11–32)	48	31.3	(19–46)			
Croatia	227	35.2	(29–42)	197	25.4	(19–32)	246	23.6	(18–29)	232	35.3	(29–42)			
Slovakia	267	52.8	(47–59)	199	41.7	(35–49)	286	38.8	(33–45)	276	37.0	(31–43)			‹
Greece	935	38.2	(35–41)	897	40.7	(37–44)	860	41.6	(38–45)	677	37.1	(33–41)			
Romania	10	60.0	(26–88)	45	51.1	(36–66)	86	51.2	(40–62)	93	63.4	(53–73)		N/A	
Poland	198	32.8	(26–40)	176	24.4	(18–31)	196	24.5	(19–31)	–	–	(–)		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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.
**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively.

Table 3.20. ***Pseudomonas aeruginosa*****. Total number of invasive isolates tested (N) and percentage with resistance to carbapenems (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2011-2014**

Country	2011			2012			2013			2014				Trend 2011-2014	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)			Comment**
Netherlands	431	3.5	(2–6)	397	3.3	(2–6)	375	3.5	(2–6)	543	4.4	(3–7)			
Denmark	403	5.5	(3–8)	355	3.7	(2–6)	410	2.9	(2–5)	386	4.7	(3–7)			
Luxembourg	32	15.6	(5–33)	31	6.5	(1–21)	34	17.6	(7–35)	42	4.8	(1–16)			
Norway	148	4.1	(2–9)	208	6.7	(4–11)	206	5.8	(3–10)	256	5.9	(3–9)			
United Kingdom	540	5.6	(4–8)	603	6.3	(4–9)	671	5.2	(4–7)	590	6.3	(4–9)			
Sweden	487	8.0	(6–11)	357	5.3	(3–8)	517	7.2	(5–10)	408	7.1	(5–10)			
Finland	269	10.8	(7–15)	327	6.1	(4–9)	326	10.4	(7–14)	307	7.2	(5–11)			
Ireland	180	6.1	(3–11)	213	11.3	(7–16)	204	9.3	(6–14)	177	8.5	(5–14)			
Iceland	17	5.9	(0–29)	10	10.0	(0–45)	11	9.1	(0–41)	11	9.1	(0–41)		N/A	
Belgium	459	10.7	(8–14)	391	9.7	(7–13)	518	11.0	(8–14)	344	10.2	(7–14)			
Austria	538	13.6	(11–17)	562	14.6	(12–18)	616	12.3	(10–15)	636	12.7	(10–16)			
Czech Republic	448	13.2	(10–17)	489	15.1	(12–19)	516	15.7	(13–19)	448	14.1	(11–18)			
Estonia	12	8.3	(0–38)	32	12.5	(4–29)	20	10.0	(1–32)	39	15.4	(6–31)		N/A	
Malta	42	23.8	(12–39)	31	3.2	(0–17)	25	16.0	(5–36)	38	15.8	(6–31)			
Latvia	12	8.3	(0–38)	18	11.1	(1–35)	25	28.0	(12–49)	18	16.7	(4–41)		N/A	
Germany	386	9.8	(7–13)	438	10.7	(8–14)	609	15.3	(13–18)	642	17.0	(14–20)			›
EU/EEA (population-weighted mean)*		**16.8**	**(14–20)**		**17.0**	**(14–20)**		**17.5**	**(14–20)**		**18.3**	**(15–21)**			›
Spain	839	16.3	(14–19)	853	16.4	(14–19)	825	17.6	(15–20)	872	18.5	(16–21)			
France	1622	20.0	(18–22)	1722	18.0	(16–20)	1862	17.2	(15–19)	1780	18.7	(17–21)			
Portugal	505	19.8	(16–24)	568	20.4	(17–24)	733	20.6	(18–24)	1064	22.5	(20–25)			
Italy	316	20.6	(16–25)	682	25.1	(22–29)	788	25.9	(23–29)	753	25.1	(22–28)			
Lithuania	30	20.0	(8–39)	28	17.9	(6–37)	37	18.9	(8–35)	31	29.0	(14–48)			
Bulgaria	48	29.2	(17–44)	51	31.4	(19–46)	59	13.6	(6–25)	48	29.2	(17–44)			
Slovenia	118	23.7	(16–32)	134	21.6	(15–30)	133	25.6	(18–34)	112	31.3	(23–41)			
Cyprus	51	43.1	(29–58)	52	19.2	(10–33)	47	19.1	(9–33)	42	33.3	(20–50)			
Hungary	604	21.2	(18–25)	619	27.5	(24–31)	668	30.2	(27–34)	744	33.5	(30–37)			›
Croatia	226	29.6	(24–36)	195	26.2	(20–33)	241	25.3	(20–31)	232	35.3	(29–42)			
Slovakia	249	30.5	(25–37)	179	40.8	(34–48)	214	58.9	(52–66)	250	38.4	(32–45)			›
Greece	900	54.0	(51–57)	907	47.7	(44–51)	877	49.3	(46–53)	699	42.9	(39–47)			‹
Romania	10	60.0	(26–88)	45	57.8	(42–72)	86	60.5	(49–71)	94	58.5	(48–69)		N/A	
Poland	184	24.5	(18–31)	171	22.8	(17–30)	189	32.3	(26–39)	–	–	(–)		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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively.

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, 2011-2014**

Country	2011			2012			2013			2014			Trend 2011-2014	Comment**
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		
Estonia	13	0.0	(0–25)	33	9.1	(2–24)	21	0.0	(0–16)	40	0.0	(0–9)	N/A	
Iceland	17	5.9	(0–29)	10	10.0	(0–45)	11	0.0	(0–28)	11	0.0	(0–28)	N/A	
Denmark	404	3.2	(2–5)	388	1.8	(1–4)	414	1.7	(1–3)	388	1.5	(1–3)		
Norway	148	1.4	(0–5)	209	3.3	(1–7)	205	3.4	(1–7)	257	1.6	(0–4)		
Sweden	476	2.1	(1–4)	357	2.8	(1–5)	531	4.1	(3–6)	436	1.6	(1–3)		
United Kingdom	587	2.6	(1–4)	666	1.7	(1–3)	711	2.4	(1–4)	627	1.6	(1–3)		
Netherlands	434	3.0	(2–5)	402	2.5	(1–5)	375	2.4	(1–5)	544	2.8	(2–5)		
Finland	233	7.7	(5–12)	327	4.6	(3–7)	326	4.6	(3–7)	306	3.9	(2–7)		
Luxembourg	32	15.6	(5–33)	31	6.5	(1–21)	34	5.9	(1–20)	41	4.9	(1–17)		
Ireland	181	3.3	(1–7)	215	10.2	(7–15)	205	7.3	(4–12)	178	5.6	(3–10)		
Austria	537	10.8	(8–14)	595	10.8	(8–14)	617	8.3	(6–11)	638	7.1	(5–9)		‹
Malta	42	23.8	(12–39)	31	0.0	(0–11)	25	8.0	(1–26)	38	7.9	(2–21)		
Belgium	424	10.8	(8–14)	346	8.7	(6–12)	487	11.3	(9–14)	317	8.2	(5–12)		
Germany	387	7.2	(5–10)	438	8.4	(6–11)	609	9.2	(7–12)	643	8.9	(7–11)		
Latvia	12	8.3	(0–38)	18	11.1	(1–35)	25	24.0	(9–45)	18	11.1	(1–35)	N/A	
Spain	839	12.6	(10–15)	853	10.8	(9–13)	825	12.2	(10–15)	873	12.4	(10–15)		
EU/EEA (population-weighted mean)*		**14.1**	**(12–17)**		**13.5**	**(11–16)**		**13.0**	**(11–16)**		**13.3**	**(11–16)**		
France	1621	19.0	(17–21)	1723	14.7	(13–17)	1869	12.6	(11–14)	1784	13.7	(12–15)		‹
Cyprus	51	19.6	(10–33)	52	17.3	(8–30)	47	4.3	(1–15)	42	16.7	(7–31)		
Slovenia	118	10.2	(5–17)	134	9.7	(5–16)	133	11.3	(6–18)	112	19.6	(13–28)		›
Czech Republic	448	21.2	(18–25)	489	21.7	(18–26)	516	23.3	(20–27)	446	20.2	(17–24)		
Portugal	525	16.2	(13–20)	587	18.1	(15–21)	737	11.9	(10–15)	1064	20.6	(18–23)		
Hungary	604	12.4	(10–15)	619	17.6	(15–21)	668	18.9	(16–22)	746	21.8	(19–25)		›
Italy	319	16.9	(13–22)	648	23.9	(21–27)	779	24.5	(22–28)	748	23.0	(20–26)		
Lithuania	30	10.0	(2–27)	28	14.3	(4–33)	37	8.1	(2–22)	31	25.8	(12–45)		
Bulgaria	48	25.0	(14–40)	52	34.6	(22–49)	60	8.3	(3–18)	48	29.2	(17–44)		
Croatia	227	26.9	(21–33)	197	20.3	(15–27)	245	18.4	(14–24)	232	31.5	(26–38)		
Greece	935	38.4	(35–42)	898	40.2	(37–43)	859	39.3	(36–43)	679	36.4	(33–40)		
Slovakia	267	40.1	(34–46)	199	39.2	(32–46)	285	36.1	(31–42)	268	37.3	(32–43)		
Romania	10	60.0	(26–88)	45	48.9	(34–64)	83	49.4	(38–61)	94	59.6	(49–70)	N/A	
Poland	195	26.2	(20–33)	176	21.6	(16–28)	189	14.3	(10–20)	–	–	(–)	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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.
**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively.

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 = 11 649), EU/EEA countries, 2014**

Resistance pattern	Number of isolates	% of total*
Fully susceptible (to tested antibiotics)	**7 630**	**65.5**
Single resistance (to indicated antimicrobial group)		
Total (all single resistance types)	**1462**	**12.6**
Carbapenems	532	4.6
Fluoroquinolones	435	3.7
[Piperacillin + tazobactam]	217	1.9
Aminoglycosides	199	1.7
Ceftazidime	79	0.7
Resistance to two antimicrobial groups		
Total (all two-group combinations)	**834**	**7.3**
[Piperacillin + tazobactam] + ceftazidime	292	2.5
Fluoroquinolones + aminoglycosides	185	1.6
Fluoroquinolones + carbapenems	126	1.1
[Piperacillin + tazobactam] + carbapenems	76	0.7
Aminoglycosides + carbapenems	50	0.4
[Piperacillin + tazobactam] + fluoroquinolones	43	0.4
Fluoroquinolones + ceftazidime	21	0.2
Ceftazidime + carbapenems	20	0.2
[Piperacillin + tazobactam] + aminoglycosides	13	0.1
Ceftazidime + amonoglycosides	8	0.1
Resistance to three antimicrobial groups		
Total (all three-group combinations)	**621**	**5.4**
Fluoroquinolones + aminoglycosides + carbapenems	186	1.6
[Piperacillin + tazobactam] + ceftazidime + carbapenems	114	1.0
[Piperacillin + tazobactam] + fluoroquinolones + cefatzidime	83	0.7
[Piperacillin + tazobactam] + fluoroquinolones + aminoglycosides	82	0.7
[Piperacillin + tazobactam] + fluoroquinolones + carbapenems	41	0.4
[Piperacillin + tazobactam] + ceftazidime + aminoglycosides	40	0.3
Fluoroquinolones + ceftazidime + aminoglycosides	27	0.2
Fluoroquinolones + ceftazidime + carbapenems	21	0.2
[Piperacillin + tazobactam] + aminoglycosides + carbapenems	18	0.2
Ceftazidime + amonoglycosides + carbapenems	9	0.1
Resistance to four antimicrobial groups		
Total (all four-group combinations)	**467**	**4.0**
[Piperacillin + tazobactam] + fluoroquinolones + aminoglycosides + carbapenems	141	1.2
[Piperacillin + tazobactam] + fluoroquinolones + cefatzidime + carbapenems	116	1.0
Fluoroquinolones + ceftazidime + aminoglycosides + carbapenems	93	0.8
[Piperacillin + tazobactam] + fluoroquinolones + cefatzidime + aminoglycosides	69	0.6
[Piperacillin + tazobactam] + ceftazidime + aminoglycosides + carbapenems	48	0.4
Resistance to five antimicrobial groups		
[Piperacillin + tazobactam] + fluoroquinolones + cefatzidime + aminoglycosides+ carbapenems	**635**	**5.5**

* Not adjusted for population differences in the reporting countries

3.4 *Acinetobacter* species

3.4.1 Clinical and epidemiological importance

The *Acinetobacter* genus consists of a large number of species, most being environmental species with low pathogenicity. The correct identification of *Acinetobacter* isolates to species level is challenging and 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 (consisting of the species *A. baumannii*, *A. pittii* and *A. nosocomialis*), which is by far the clinically most 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.

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 production, 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 disease, immune suppression, major trauma or burn injuries, invasive procedures, presence of indwelling catheters, mechanical ventilation, extended hospital stay and previous administration of antibiotics. The risks for acquiring a multidrug-resistant strain of the *A. baumannii* group are similar and include 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 which prevents 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 Antimicrobial susceptibility

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

Fluoroquinolones

For 2014, 28 countries reported 4 058 isolates with AST information for fluoroquinolones (ciprofloxacin or levofloxacin). The number of isolates reported per country ranged from 3 to 806 (Table 3.23).

The percentages of resistant isolates in countries which reported more than 10 isolates ranged from 2.9 % (Denmark) to 95.3 % (Greece) (Figure 3.17 and Table 3.23). Belgium, Iceland and Luxembourg reported fewer than 10 isolates and are therefore not included in Figure 3.17.

Aminoglycosides

For 2014, 28 countries reported 4 025 isolates with AST information for aminoglycosides (gentamicin, netilmicin or tobramycin). The number of isolates reported per country ranged from 3 to 801 (Table 3.24).

Figure 3.17. ***Acinetobacter*** **spp. Percentage (%) of invasive isolates with resistance to fluoroquinolones, by country, EU/EEA countries, 2014**

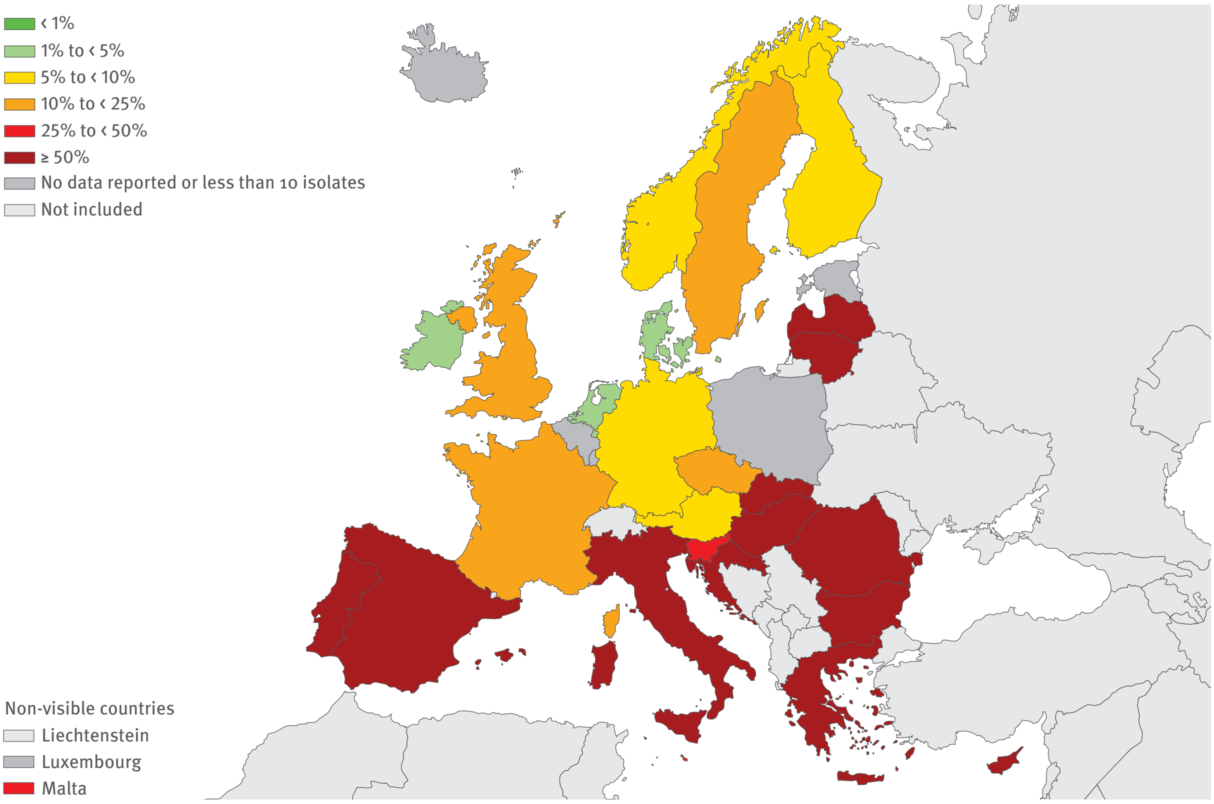
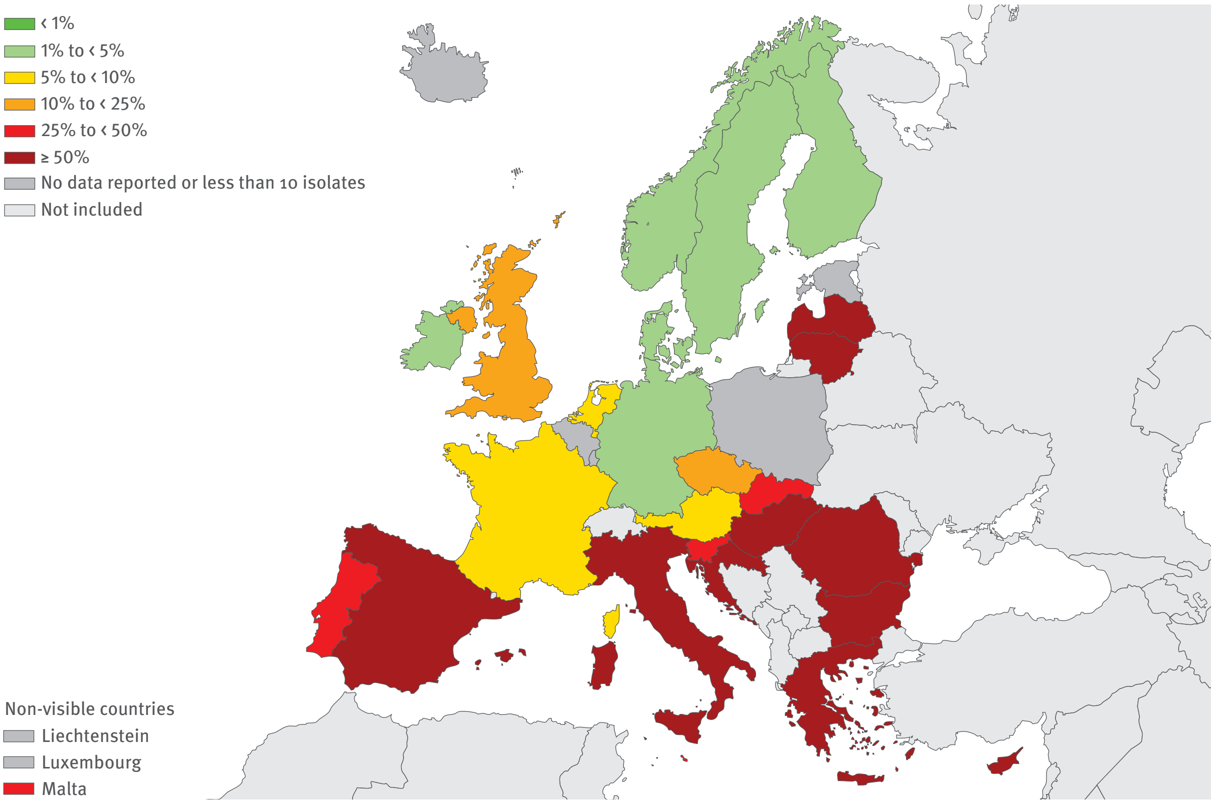


Figure 3.18. ***Acinetobacter*** **spp. Percentage (%) of invasive isolates with resistance to aminoglycosides, by country, EU/EEA countries, 2014**



The percentages of resistant isolates in countries which reported more than 10 isolates ranged from 1.7% (Denmark) to 89.1% (Italy) (Figure 3.18 and Table 3.24). Belgium, Iceland and Luxembourg reported fewer than 10 isolates and are therefore not included in Figure 3.18.

Carbapenems

For 2014, 28 countries reported 4 085 isolates with AST information for carbapenems (imipenem or meropenem). The number of isolates reported per country ranged from 3 to 841 (Table 3.25).

The percentages of resistant isolates in countries that reported more than 10 isolates ranged from zero (the Netherlands) to 93.2% (Greece) (Figure 3.19 and Table 3.25). Belgium, Iceland and Luxembourg reported fewer than 10 isolates and are therefore not included in Figure 3.19.

Combined resistance (fluoroquinolones, aminoglycosides and carbapenems)

For 2014, 28 countries reported 3 910 isolates with sufficient AST information to determine combined resistance to fluoroquinolones, aminoglycosides and carbapenems (93.8% of all isolates). The number of isolates reported per country ranged from 3 to 794 (Table 3.26).

The percentages of isolates with combined resistance in countries that reported more than 10 isolates ranged from zero (Finland, Denmark and the Netherlands) to 86.9% (Greece) (Figure 3.20 and Table 3.26). Belgium, Iceland and Luxembourg reported fewer than 10 isolates and are therefore not included in Figure 3.20.

Among the isolates tested for all three antimicrobial groups under surveillance, 38.6% were susceptible to all of them. Combined resistance to all three groups was the most common resistance phenotype (47.8%). Single resistance (4.3% of all isolates) and resistance to two antimicrobial groups (9.2%) were less commonly reported and most frequently included fluoroquinolone resistance alone or in combination with another antimicrobial group (Table 3.27).

Polymyxins

Twenty countries reported AST data for polymyxins for a total of 2 238 isolates (53.7% of all reported *Acinetobacter* spp. isolates in 2014). Overall, 4.0% of the isolates were resistant to polymyxins, of which a majority (80.1%) 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 may not be representative of Europe as a whole.

3.4.5 Discussion and conclusions

After a pilot period during 2012-2013, inclusion of *Acinetobacter* spp. in EARS-Net was evaluated as being feasible, and *Acinetobacter* spp. is now included in the routine EARS-Net protocol. Surveillance is 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 there are clear guidelines on susceptibility testing and interpretive criteria.

The number of countries reporting data on *Acinetobacter* spp. increased from 18 in 2012 to 28 in 2014 and the number of reported isolates 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* spp. infections as well as availability of routine national surveillance data for *Acinetobacter* spp.

Combined resistance to all three antimicrobial groups under regular EARS-Net surveillance (fluoroquinolones, aminoglycosides and carbapenems) was the most commonly reported resistance phenotype and accounted for almost half of the reported isolates (Table 3.27). However, a wide variation in antimicrobial resistance of *Acinetobacter* spp. in Europe can be noted, with especially high resistance percentages reported from the Baltic countries, southern and south-eastern Europe. Croatia, Cyprus, Greece, Latvia, Lithuania, Italy and Romania reported the highest resistance percentages in 2014 for fluoroquinolones (Table 3.23), aminoglycosides (Table 3.24) and carbapenems (Table 3.25), as well as combined resistance to all three groups (ranging from 61.5% to 95.3%) (Table 3.26). As data are not available for four years, trends have not been analysed. However, for the countries with the highest resistance percentages (Greece and Italy), resistance increased during the reporting period. Of further concern are the polymyxin-resistant isolates reported mainly from these two countries.

As for *E. coli* and *K. pneumoniae*, resistance to carbapenems is often associated with production of carbapenemases. Results from the EuSCAPE project show that carbapenemase-producing *Acinetobacter* spp. (carbapenem-resistant *Acinetobacter* spp. – CRA) might be more widely disseminated in Europe than CPE [14]. The high levels of carbapenem resistance in *Acinetobacter* spp. reported from many countries in EARS-Net support this assumption.

The presence of *Acinetobacter* spp. in the healthcare environment is a concern as the bacterium can persist in the environment for long periods and is notoriously difficult to eradicate once established. The high levels of antimicrobial resistance reported from several regions in Europe are of great concern, especially when resistance to the last-line treatment alternatives such as carbapenems is high and resistance to polymyxins is present.

Figure 3.19. ***Acinetobacter*** **spp. Percentage (%) of invasive isolates with resistance to carbapenems, by country, EU/EEA countries, 2014**

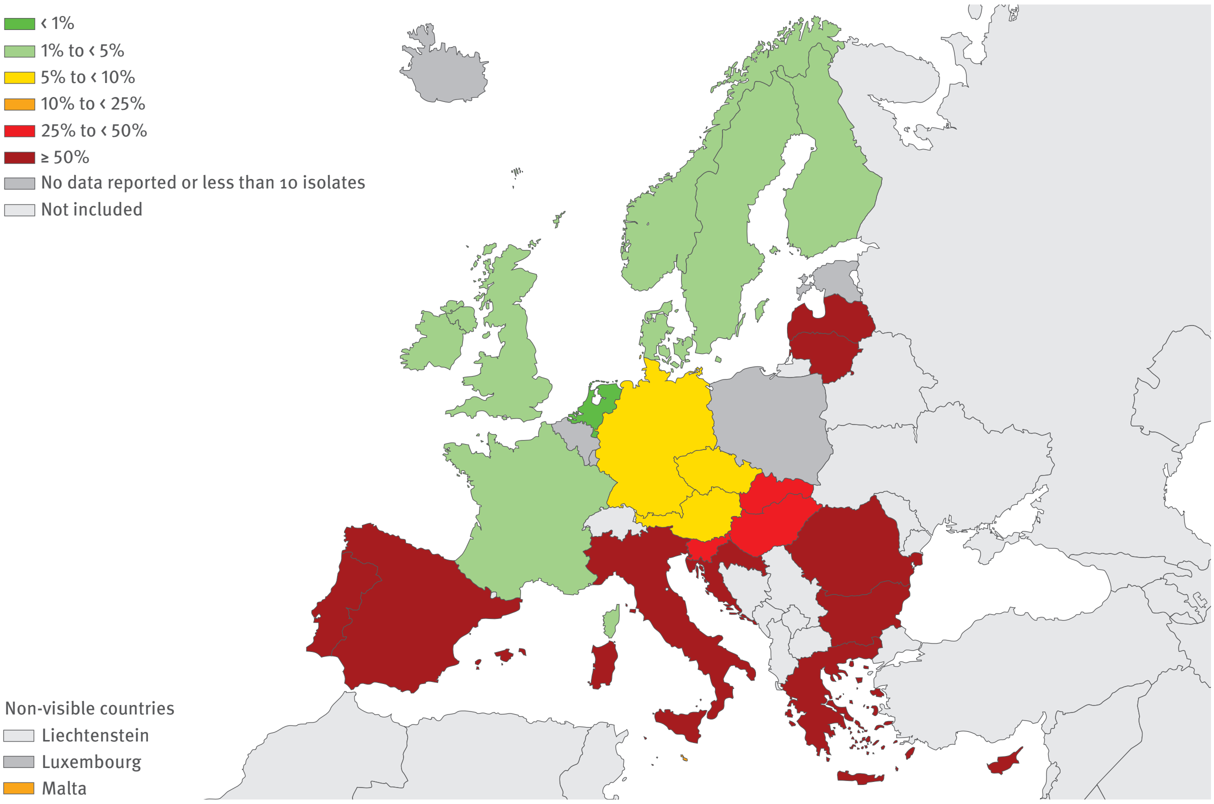


Figure 3.20. ***Acinetobacter*** **spp. Percentage (%) of invasive isolates with combined resistance to fluoroquinolones, aminoglycosides and carbapenems, by country, EU/EEA countries, 2014**

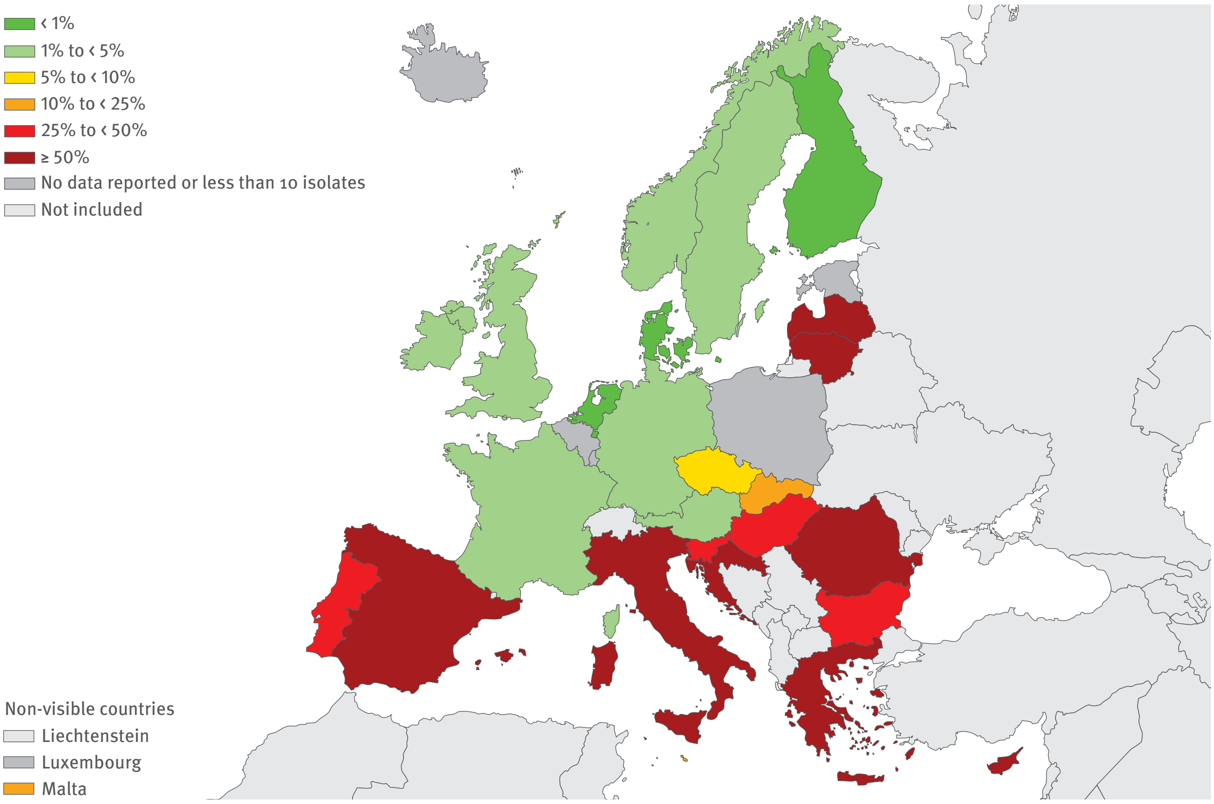


Table 3.23. ***Acinetobacter*** **spp. Total number of invasive isolates tested (N) and percentage with resistance to fluoroquinolones (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2012-2014**

Country	2012			2013			2014			
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	
Denmark	83	12.0	(6–21)	79	6.3	(2–14)	69	2.9	(0–10)	
Netherlands	10	0.0	(0–31)	69	2.9	(0–10)	72	4.2	(1–12)	
Ireland	–	–	(–)	88	1.1	(0–6)	86	4.7	(1–11)	
Austria	–	–	(–)	51	21.6	(11–35)	75	5.3	(1–13)	
Norway	25	0.0	(0–14)	36	0.0	(0–10)	34	5.9	(1–20)	
Germany	121	8.3	(4–15)	173	9.8	(6–15)	199	6.0	(3–10)	
Finland	–	–	(–)	36	2.8	(0–15)	31	6.5	(1–21)	
United Kingdom	105	2.9	(1–8)	165	3.6	(1–8)	123	11.4	(6–18)	
Sweden	–	–	(–)	74	5.4	(1–13)	52	11.5	(4–23)	
France	385	15.6	(12–20)	397	13.6	(10–17)	395	11.9	(9–16)	
Czech Republic	–	–	(–)	91	19.8	(12–29)	59	15.3	(7–27)	
Malta	6	#	(#)	7	#	(#)	10	30.0	(7–65)	
Slovenia	25	28.0	(12–49)	25	28.0	(12–49)	34	41.2	(25–59)	
Slovakia	–	–	(–)	188	58.5	(51–66)	170	51.8	(44–59)	
Portugal	168	77.4	(70–83)	225	68.9	(62–75)	264	52.7	(46–59)	
Hungary	405	78.0	(74–82)	472	73.5	(69–77)	441	66.4	(62–71)	
Spain	–	–	(–)	76	74.6	(67–83)	79	67.1	(56–77)	
Bulgaria	65	69.2	(57–80)	94	70.2	(60–79)	115	73.9	(65–82)	
Cyprus	23	56.5	(34–77)	33	60.6	(42–77)	58	77.6	(65–87)	
Romania	54	88.9	(77–96)	137	90.5	(84–95)	123	83.7	(76–90)	
Lithuania	–	–	(–)	–	–	(–)	66	84.8	(74–92)	
Latvia	–	–	(–)	–	–	(–)	52	88.5	(77–96)	
Croatia	–	–	(–)	112	92.9	(86–97)	164	92.1	(87–96)	
Italy	236	86	(81–90)	472	83.1	(79–86)	468	92.1	(89–94)	
Greece	1204	93.1	(92–94)	812	95.0	(93–96)	806	95.3	(94–97)	
Belgium	–	–	(–)	3	#	(#)	4	#	(#)	
Iceland	2	#	(#)	0	#	(#)	3	#	(#)	
Luxembourg	6	#	(#)	3	#	(#)	6	#	(#)	
Poland	209	78.0	(72–83)	188	81.4	(75–87)	–	–	(–)	

–: 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 with resistance to aminoglycosides (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2012-2014**

Country	2012			2013			2014			
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	
Denmark	77	10.4	(5–19)	75	1.3	(0–7)	60	1.7	(0–9)	
Ireland	–	–	(–)	88	1.1	(0–6)	89	2.2	(0–8)	
Sweden	–	–	(–)	74	8.1	(3–17)	36	2.8	(0–15)	
Norway	25	4.0	(0–20)	36	2.8	(0–15)	33	3.0	(0–16)	
Finland	–	–	(–)	36	0.0	(0–10)	31	3.2	(0–17)	
Germany	119	5.9	(2–12)	173	6.4	(3–11)	197	4.1	(2–8)	
Netherlands	59	1.7	(0–9)	67	4.5	(1–13)	73	5.5	(2–13)	
France	278	12.9	(9–17)	409	11.5	(9–15)	409	8.6	(6–12)	
Austria	–	–	(–)	51	9.8	(3–21)	79	8.9	(4–17)	
United Kingdom	108	2.8	(1–8)	163	2.5	(1–6)	129	10.1	(5–17)	
Czech Republic	–	–	(–)	91	16.5	(10–26)	59	10.2	(4–21)	
Malta	5	#	(#)	7	#	(#)	10	30.0	(7–65)	
Slovenia	25	20.0	(7–41)	25	20.0	(7–41)	34	38.2	(22–56)	
Slovakia	–	–	(–)	188	50.0	(43–57)	171	41.5	(34–49)	
Portugal	169	65.1	(57–72)	231	56.3	(50–63)	265	42.3	(36–48)	
Spain	–	–	(–)	77	68.4	(68–84)	80	60.0	(48–71)	
Hungary	407	68.8	(64–73)	475	69.5	(65–74)	444	63.5	(59–68)	
Bulgaria	65	58.5	(46–71)	91	58.2	(47–68)	99	63.6	(53–73)	
Cyprus	23	52.2	(31–73)	33	60.6	(42–77)	57	73.7	(60–84)	
Latvia	–	–	(–)	–	–	(–)	52	75.0	(61–86)	
Romania	54	57.4	(43–71)	137	80.3	(73–87)	122	77.9	(69–85)	
Lithuania	–	–	(–)	–	–	(–)	66	86.4	(76–94)	
Croatia	–	–	(–)	114	92.1	(86–96)	167	88.0	(82–93)	
Greece	1234	78.1	(76–80)	814	88.5	(86–91)	801	88.6	(86–91)	
Italy	234	83.3	(78–88)	468	82.9	(79–86)	449	89.1	(86–92)	
Belgium	–	–	(–)	3	#	(#)	4	#	(#)	
Iceland	2	#	(#)	0	#	(#)	3	#	(#)	
Luxembourg	6	#	(#)	3	#	(#)	6	#	(#)	
Poland	205	63.4	(56–70)	191	73.8	(67–80)	–	–	(–)	

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

Table 3.25. ***Acinetobacter*** **spp. Total number of invasive isolates tested (N) and percentage with resistance to carbapenems (%R), including 95 % confidence intervals (95 % CI), EU/EEA countries, 2012-2014**

Country	2012			2013			2014			
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	
Netherlands	67	6.0	(2–15)	65	1.5	(0–8)	74	0.0	(0–5)	
Ireland	–	–	(–)	85	2.4	(0–8)	79	1.3	(0–7)	
Denmark	64	9.4	(4–19)	61	1.6	(0–9)	62	1.6	(0–9)	
United Kingdom	80	2.5	(0–9)	149	2.0	(0–6)	120	1.7	(0–6)	
France	389	3.3	(2–6)	406	5.9	(4–9)	401	2.5	(1–5)	
Norway	25	0.0	(0–14)	36	0.0	(0–10)	34	2.9	(0–15)	
Finland	–	–	(–)	35	0.0	(0–10)	32	3.1	(0–16)	
Sweden	–	–	(–)	72	5.6	(2–14)	52	3.8	(0–13)	
Czech Republic	–	–	(–)	91	4.4	(1–11)	59	5.1	(1–14)	
Germany	121	6.6	(3–13)	173	9.2	(5–15)	201	5.5	(3–10)	
Austria	–	–	(–)	51	7.8	(2–19)	78	6.4	(2–14)	
Malta	6	#	(#)	7	#	(#)	10	10.0	(0–45)	
Slovenia	25	24.0	(9–45)	25	24.0	(9–45)	34	26.5	(13–44)	
Slovakia	–	–	(–)	142	45.8	(37–54)	161	32.9	(26–41)	
Hungary	418	48.1	(43–53)	481	50.1	(46–55)	443	44.5	(40–49)	
Portugal	168	79.2	(72–85)	229	69.0	(63–75)	262	53.1	(47–59)	
Bulgaria	58	60.3	(47–73)	89	59.6	(49–70)	110	59.1	(49–68)	
Spain	–	–	(–)	94	75.5	(66–82)	78	65.4	(54–76)	
Lithuania	–	–	(–)	–	–	(–)	66	69.7	(57–80)	
Cyprus	23	56.5	(34–77)	33	60.6	(42–77)	58	77.6	(65–87)	
Latvia	–	–	(–)	–	–	(–)	52	78.8	(65–89)	
Romania	54	81.5	(69–91)	137	85.4	(78–91)	123	81.3	(73–88)	
Croatia	–	–	(–)	114	89.5	(82–94)	166	87.3	(81–92)	
Italy	231	82.1	(77–86)	468	79.5	(76–83)	476	89.9	(87–92)	
Greece	1254	87.8	(86–90)	848	90.6	(88–92)	841	93.2	(91–95)	
Belgium	–	–	(–)	3	#	(#)	4	#	(#)	
Iceland	2	#	(#)	0	#	(#)	3	#	(#)	
Luxembourg	5	#	(#)	1	#	(#)	6	#	(#)	
Poland	209	38.3	(32–45)	189	49.7	(42–57)	–	–	(–)	

–: 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 with combined resistance to fluoroquinolones, aminoglycosides and carbapenems (%R), including 95 % confidence intervals (95 % CI), by country, EU/EEA countries, 2012-2014**

Country	2012			2013			2014			
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	
Denmark	58	8.6	(3–19)	57	1.8	(0–9)	49	0.0	(0–7)	
Finland	–	–	(–)	34	0.0	(0–10)	30	0.0	(0–12)	
Netherlands	10	0.0	(0–31)	64	1.6	(0–8)	69	0.0	(0–5)	
Ireland	–	–	(–)	84	0.0	(0–4)	79	1.3	(0–7)	
France	272	4.0	(2–7)	389	4.1	(2–7)	391	1.5	(1–3)	
United Kingdom	79	1.3	(0–7)	149	1.3	(0–5)	119	1.7	(0–6)	
Germany	119	4.2	(1–10)	172	5.2	(2–10)	188	2.1	(1–5)	
Austria	–	–	(–)	51	5.9	(1–16)	74	2.7	(0–9)	
Sweden	–	–	(–)	71	5.6	(2–14)	36	2.8	(0–15)	
Norway	25	0.0	(0–14)	36	0.0	(0–10)	33	3.0	(0–16)	
Czech Republic	–	–	(–)	91	4.4	(1–11)	59	5.1	(1–14)	
Malta	5	#	(#)	7	#	(#)	10	10.0	(0–45)	
Slovakia	–	–	(–)	142	31.7	(24–40)	161	24.8	(18–32)	
Slovenia	25	12.0	(3–31)	25	20.0	(7–41)	34	26.5	(13–44)	
Portugal	168	64.3	(57–72)	222	56.3	(50–63)	260	39.2	(33–45)	
Hungary	394	41.6	(37–47)	466	48.7	(44–53)	438	42.0	(37–47)	
Bulgaria	58	32.8	(21–46)	86	39.5	(29–51)	97	48.5	(38–59)	
Spain	–	–	(–)	70	70.0	(64–83)	78	56.4	(45–68)	
Latvia	–	–	(–)	–	–	(–)	52	61.5	(47–75)	
Lithuania	–	–	(–)	–	–	(–)	66	66.7	(54–78)	
Cyprus	23	47.8	(27–69)	33	60.6	(42–77)	57	73.7	(60–84)	
Romania	54	50.0	(36–64)	137	74.5	(66–82)	121	77.7	(69–85)	
Croatia	–	–	(–)	112	86.6	(79–92)	163	85.9	(80–91)	
Italy	217	77.4	(71–82)	453	79.0	(75–83)	439	86.8	(83–90)	
Greece	1203	74.5	(72–77)	810	85.2	(83–88)	794	86.9	(84–89)	
Belgium	–	–	(–)	3	#	(#)	4	#	(#)	
Iceland	2	#	(#)	0	#	(#)	3	#	(#)	
Luxembourg	5	#	(#)	1	#	(#)	6	#	(#)	
Poland	197	35.0	(28–42)	184	46.7	(39–54)	–	–	(–)	

–: 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 = 3 910), EU and EEA countries, 2014**

Resistance pattern	Number of isolates	% of total*
Fully susceptible	1511	38.6
Single resistance (to indicated antimicrobial group)		
Total (any single resistance)	**168**	**4.3**
Fluoroquinolones	98	2.5
Aminoglycosides	48	1.2
Carbapenems	22	0.6
Resistance to two antimicrobial groups		
Total (any two-group combinations)	**361**	**9.2**
Fluoroquinolones + aminoglycosides	201	5.1
Fluoroquinolones + carbapenems	149	3.8
Aminoglycosides + carbapenems	11	0.3
Resistance to three antimicrobial groups		
Fluoroquinolones + aminoglycosides + carbapenems	1870	47.8

Only data from isolates tested against all three 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.

Pneumococci carry a variety of virulence factors that facilitate adherence to, 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. Acquisition of mosaic PBP results in different degrees of resistance ranging from low-level clinical resistance, conventionally termed intermediate[1] (I), to full clinical resistance (R). However, in the absence of meningitis, infections with intermediate strains are often successfully treated with high doses of benzylpenicillin 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 agents in *S. pneumoniae*:

The acquisition of an erythromycin ribosomal methylation gene (commonly *erm*B) results in a post-transcriptional modification of the 23S subunit of rRNA, which blocks the binding of the macrolide to the ribosome. 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 agent 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) confers very high MICs and cannot be overcome by increasing dosages of the antimicrobial agents.

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 that 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 antimicrobial agents 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 frequency of dual beta-lactam/macrolide resistance, particularly among serotypes commonly found in children, means that in practice the use of agents from either group will result in increasing resistance to the other class, and frequent use of macrolides has been considered a major driver of increasing beta-lactam resistance.

Even though a small decrease in penicillin resistance had been detected in some countries before introducing PCVs, the widespread use of these vaccines may have influenced the decrease in AMR levels by eliminating infections with (and more importantly, paediatric carriage of) common 'classic' resistant serotypes (14, 6B, 19F and 23F), all of which are covered by the multivalent PCVs currently on the market.

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

3.5.3 Antimicrobial susceptibility

- Susceptibility of *S. pneumoniae* showed wide variations between European countries. Macrolide non-susceptibility was, for most countries, higher than 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 isolates from serogroups 1, 3 and 7 were susceptible to both penicillin and macrolides, but for serogroup 19, 52 % of the isolates had decreased susceptibility to penicillin and/or macrolides.

Penicillin

For 2014, 28 countries reported 10 456 isolates with AST information for penicillin. The number of isolates reported per country ranged from 8 to 1 288 (Table 3.28).

Among the countries reporting 10 isolates or more, the percentages of penicillin-non-susceptible isolates ranged from zero (Cyprus) to 46.7 % (Romania) in 2014. Trends for the period 2011-2014 were calculated for the 25 countries reporting data for at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for Italy and Sweden. For both countries, the trend was not significant when considering only data from laboratories reporting consistently for all four years. No country reported a significantly decreasing trend for the period 2011-2014 (Table 3.28).

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 was not calculated for *S. pneumoniae*.

Macrolides

For 2014, 28 countries reported 10 730 isolates with AST information for macrolides (azithromycin, clarithromycin or erythromycin). The number of isolates reported per country ranged from 8 to 1 287 (Table 3.29).

Among the countries reporting 10 isolates or more, the percentages of macrolide-non-susceptible isolates ranged from zero (Cyprus) to 48.0 % (Romania) in 2014 (Table 3.29, Figure 3.21). Trends for the period 2011-2014 were calculated for the 24 countries reporting data for at least 20 isolates per year during the full four-year period. Significantly increasing trends were observed for three countries (the Czech Republic, Norway and Slovakia). For all three countries, this trend was not significant when considering only data from laboratories reporting consistently for all four years. Significantly decreasing trends were observed for three countries (Belgium, Finland and Slovenia).

Non-susceptibility to penicillins and macrolides

For 2014, 28 countries reported 10 001 isolates with AST information for both penicillins and macrolides. The number of isolates reported per country ranged from 8 to 1 190 (Table 3.30).

Among the countries reporting 10 isolates or more, the percentages of isolates with non-susceptibility to both penicillin and macrolides ranged from zero (Cyprus) to 37.8 % (Romania) in 2014 (Table 3.30). Trends for the period 2011-2014 were calculated for the 24 countries reporting data for at least 20 isolates per year during the full four-year period. A significantly increasing trend was observed for Sweden, but it was not significant when considering only data from laboratories reporting consistently for all four years. Significantly decreasing trends were observed for Finland and Spain. For Spain, the trend was not significant when considering only data from laboratories reporting consistently for all four years.

Serogroups

Twelve countries reported *S. pneumoniae* serotype/group for 2014. Nine of them reported serotype/group for at least 30 isolates and were thus included for analysis.

In 2014, serogroups 1 and 19 were the most prevalent (accounting for 13.2 % and 12.8 % of isolates, respectively), followed by serogroup 7 (11.9 %) and serogroup 3 (8.6 %). These four serogroups have been dominant among EARS-Net isolates during recent years. Among the most commonly reported serogroups, dual non-susceptibility to penicillin and macrolides was mainly observed in serogroups 19, 14, and 6 (by order of decreasing percentage). Single non-susceptibility to penicillins was most common in serogroups 19, 14 and 9, and single non-susceptibility to macrolides was most common in serogroups 19, 1, 14 and 6 (Figure 3.22).

3.5.4 Discussion and conclusions

As in previous years, large inter-country variations can be noted in *S. pneumoniae* susceptibility to penicillins and macrolides.

Differences and changes in the clinical breakpoints used to determine 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. With a shift from CLSI to EUCAST guidelines, resistance percentages might increase due to the more restrictive breakpoints applied by EUCAST for non-meningitis cases. In addition, clinical breakpoints differ depending on site of infection. However, limited information on the use of guidelines and incomplete quantitative susceptibility data hamper an assessment of the impact of these differences on the data.

In parallel to EARS-Net, the invasive pneumococcal disease (IPD) enhanced surveillance network, also coordinated by ECDC, collects additional data on IPD cases from reference laboratories throughout Europe [15]. For most countries, antimicrobial susceptibility testing results reported to EARS-Net correspond with the data reported for the IPD enhanced surveillance. However, for a few countries, there seem to be differences in antimicrobial susceptibility testing results between the two systems. For some countries, this may be due to differences in data sources, or a low number of cases and large confidence intervals may not allow appropriate comparison.

Although the number of countries reporting data on serotype distribution to EARS-Net is increasing, data remain incomplete. Data reported for 2014 support previous observations that most penicillin-non-susceptible isolates belong to only a few serogroups.

Most EU/EEA Member States have implemented routine immunisation for children with the multivalent pneumococcal conjugate vaccines (PCV), and in some instances they also target adult high-risk groups, such as the elderly and the immunocompromised, with the polysaccharide vaccine [16]. Data from the IPD network have shown that the highest IPD notification rates were among children under one year of age and among adults 65 years and over, providing supporting scientific evidence for the recommendations for targeting these age groups for vaccination. Increased immunisation and better serotype coverage of the available PCVs are likely to impact the epidemiology of IPD in Europe, both in terms of changes in age-specific incidence and potential serotype replacement. Continued surveillance of IPD in Europe is therefore essential to monitor serotype replacement and the prevalence of antimicrobial-resistant strains in order to document any changes in the characteristics of the disease, guide treatment decisions, and inform future vaccine development. The IPD surveillance initiatives at ECDC are currently being harmonised to make the best use of the available data.

Figure 3.21. *Streptococcus pneumoniae*. Percentage (%) of invasive isolates non-susceptible to macrolides, by country, EU/EEA countries, 2014

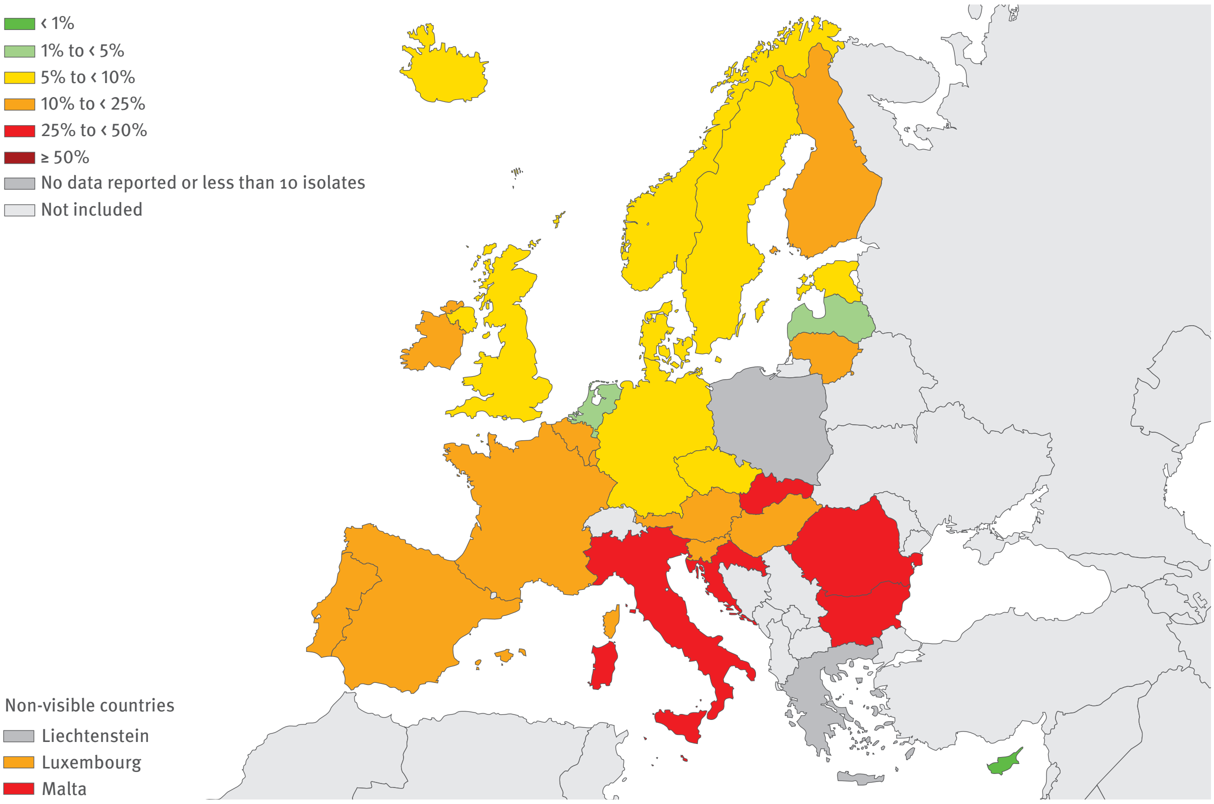
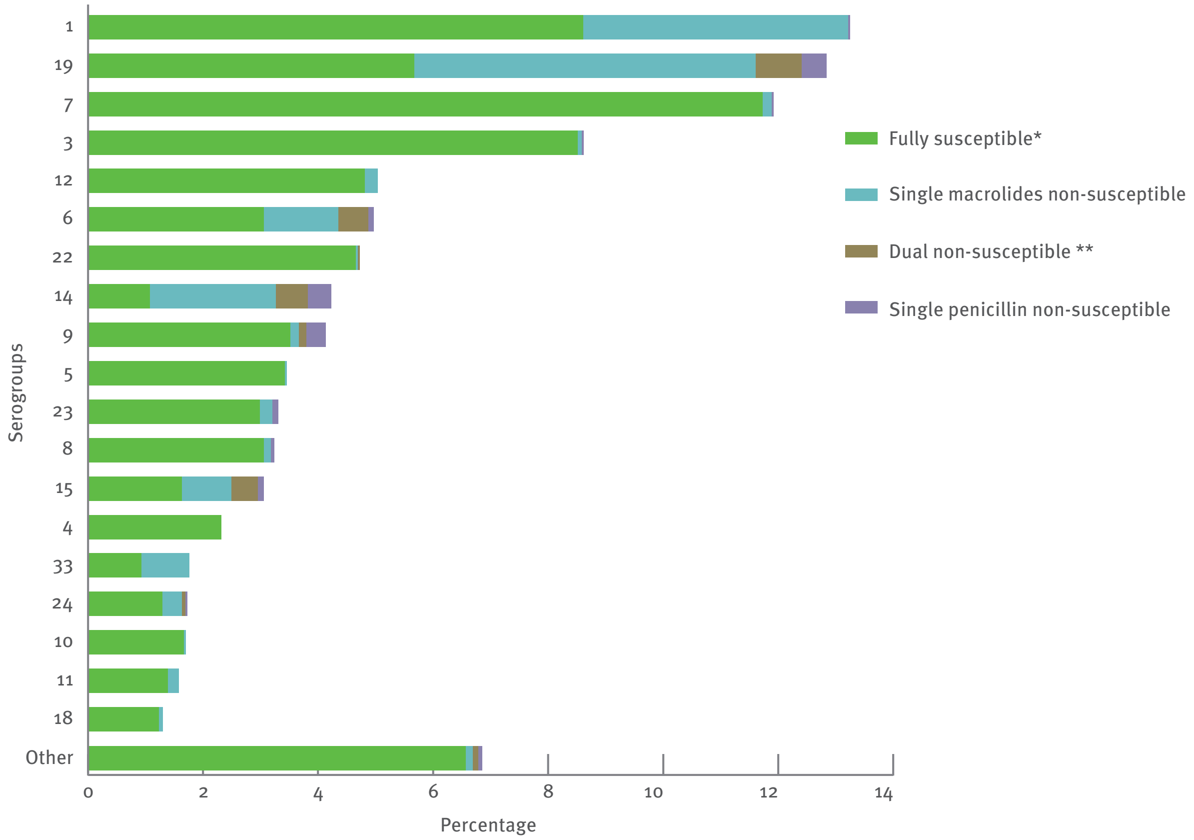


Figure 3.22. ***Streptococcus pneumoniae*. Distribution of serogroups and associated resistance profiles per serogroup, 2014**



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, 2011-2014**

Country	2011			2012			2013			2014				Trend 2011-2014	
	N	%IR	(95% CI)	N	%IR	(95% CI)	N	%IR	(95% CI)	N	%IR	(95% CI)			Comment*
Cyprus	12	25.0	(5–57)	8	#	(#)	15	40.0	(16–68)	12	0.0	(0–26)		N/A	
Belgium	1829	0.8	(0–1)	1658	1.5	(1–2)	1536	1.7	(1–2)	1110	1.3	(1–2)			
Netherlands	1067	1.1	(1–2)	1063	1.5	(1–2)	1032	1.1	(1–2)	1139	2.1	(1–3)			
Estonia	51	2.0	(0–10)	53	0.0	(0–7)	78	1.3	(0–7)	72	4.2	(1–12)			
Iceland	32	9.4	(2–25)	27	3.7	(0–19)	18	16.7	(4–41)	24	4.2	(0–21)		N/A	
Latvia	40	12.5	(4–27)	64	6.3	(2–15)	67	11.9	(5–22)	48	4.2	(1–14)			
Germany	347	1.7	(1–4)	310	5.2	(3–8)	471	7.0	(5–10)	499	4.4	(3–7)			
Norway	619	3.4	(2–5)	576	5.9	(4–8)	549	3.3	(2–5)	534	5.1	(3–7)			
United Kingdom	1324	5.4	(4–7)	1153	4.9	(4–6)	1207	4.9	(4–6)	1288	5.1	(4–6)			
Austria	405	3.0	(2–5)	291	5.2	(3–8)	385	2.1	(1–4)	361	3.0	(3–8)			
Denmark	896	4.8	(3–6)	867	5.1	(4–7)	789	6.6	(5–9)	709	5.6	(4–8)			
Czech Republic	316	3.8	(2–7)	274	2.9	(1–6)	333	2.1	(1–4)	274	5.8	(3–9)			
Luxembourg	50	8.0	(2–19)	31	3.2	(0–17)	43	16.3	(7–31)	32	6.3	(1–21)			
Sweden	1193	4.1	(3–5)	1030	5.0	(4–6)	696	6.8	(5–9)	696	7.9	(6–10)			›~
Slovenia	253	12.3	(9–17)	251	10.0	(7–14)	279	7.9	(5–12)	300	9.7	(7–14)			
Portugal	439	10.5	(8–14)	299	8.4	(5–12)	475	7.6	(5–10)	610	10.2	(8–13)			
Hungary	139	11.5	(7–18)	160	10.0	(6–16)	154	5.8	(3–11)	128	11.7	(7–19)			
Finland	634	12.9	(10–16)	553	17.0	(14–20)	597	14.1	(11–17)	593	12.5	(10–15)			
Italy	174	6.9	(4–12)	141	12.1	(7–19)	268	14.6	(11–19)	182	14.8	(10–21)			›~
Lithuania	48	18.8	(9–33)	37	16.2	(6–32)	59	23.7	(14–37)	67	16.4	(8–27)			
Ireland	324	19.4	(15–24)	319	19.1	(15–24)	310	20.3	(16–25)	328	17.7	(14–22)			
Slovakia	26	7.7	(1–25)	20	5.0	(0–25)	28	10.7	(2–28)	29	20.7	(8–40)			
France	1413	23.8	(22–26)	824	23.4	(21–26)	919	22.4	(20–25)	656	22.3	(19–26)			
Bulgaria	33	21.2	(9–39)	21	28.6	(11–52)	28	21.4	(8–41)	32	25.0	(11–43)			
Croatia	125	18.4	(12–26)	97	22.7	(15–32)	118	25.4	(18–34)	129	26.4	(19–35)			
Spain	736	30.2	(27–34)	604	27.0	(23–31)	569	27.6	(24–31)	551	27.9	(24–32)			
Romania	36	61.1	(43–77)	44	38.6	(24–55)	44	25.0	(13–40)	45	46.7	(32–62)			
Poland	165	18.2	(13–25)	121	23.2	(16–31)	167	32.3	(25–40)	–	–	(–)		N/A	
Malta	10	50.0	(19–81)	18	38.9	(17–64)	7	#	(#)	8	#	(#)		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. The symbol ~ indicates 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, 2011-2014**

Country	2011			2012			2013			2014			Trend 2011-2014	Comment*
	N	%IR	(95% CI)	N	%IR	(95% CI)	N	%IR	(95% CI)	N	%IR	(95% CI)		
Cyprus	12	25.0	(5–57)	7	#	(#)	15	26.7	(8–55)	12	0.0	(0–28)	N/A	
Latvia	46	0.0	(0–8)	64	4.7	(1–13)	66	1.5	(0–8)	48	4.1	(0–14)		
Netherlands	1200	4.5	(3–6)	1153	4.4	(3–6)	1155	4.8	(4–6)	1287	4.3	(3–6)		
Estonia	45	2.2	(0–12)	52	5.8	(1–16)	59	3.4	(0–12)	54	5.6	(1–15)		
Denmark	896	5.1	(4–7)	867	6.0	(5–8)	789	4.8	(3–7)	709	6.6	(5–9)		
Sweden	1143	5.3	(4–7)	947	4.9	(4–6)	1164	6.5	(5–8)	788	6.7	(5–9)		
Germany	353	7.9	(5–11)	324	7.4	(5–11)	477	10.7	(8–14)	499	7.1	(5–10)		
United Kingdom	1263	5.9	(5–7)	1114	6.8	(5–8)	935	7.5	(6–9)	1260	7.1	(6–9)		
Norway	570	4.2	(3–6)	533	5.3	(4–8)	499	4.4	(3–7)	492	7.5	(5–10)		›~
Czech Republic	316	3.5	(2–6)	274	7.7	(5–11)	333	8.7	(6–12)	274	7.7	(5–11)		›~
Iceland	32	21.9	(9–40)	27	7.4	(1–24)	18	16.7	(4–41)	24	8.7	(1–28)	N/A	
Austria	373	11.5	(8–15)	319	17.9	(14–23)	421	10.2	(7–14)	400	10.5	(8–14)		
Ireland	310	18.4	(14–23)	307	16.9	(13–22)	305	18.0	(14–23)	328	13.9	(10–18)		
Luxembourg	52	15.4	(7–28)	38	15.8	(6–31)	48	25.0	(14–40)	32	14.3	(5–30)		
Finland	638	24.5	(21–28)	586	22.0	(19–26)	650	18.6	(16–22)	636	14.5	(12–17)		‹
Hungary	129	14.7	(9–22)	147	19.7	(14–27)	139	14.4	(9–21)	128	14.6	(9–22)		
Portugal	417	14.9	(12–19)	308	18.5	(14–23)	496	20.6	(17–24)	658	16.0	(13–19)		
Belgium	1829	26.0	(24–28)	1662	25.4	(23–28)	1574	22.9	(21–25)	1108	17.9	(16–20)		‹
Slovenia	251	24.3	(19–30)	250	21.2	(16–27)	279	10.4	(7–15)	300	19.3	(15–24)		‹
Spain	746	24.8	(22–28)	579	26.4	(23–30)	560	25.7	(22–30)	544	20.0	(17–24)		
Lithuania	41	26.8	(14–43)	35	25.7	(12–43)	56	25.0	(14–38)	67	22.6	(13–35)		
France	1413	26.0	(24–28)	824	28.9	(26–32)	919	29.8	(27–33)	656	23.0	(20–26)		
Bulgaria	30	13.3	(4–31)	20	20.0	(6–44)	27	18.5	(6–38)	30	26.7	(12–46)		
Croatia	123	23.6	(16–32)	77	10.4	(5–19)	116	32.8	(24–42)	116	27.6	(21–36)		
Italy	266	27.4	(22–33)	243	34.2	(28–40)	394	24.6	(20–29)	182	28.6	(23–35)		
Malta	8	#	(#)	18	50.0	(26–74)	9	#	(#)	8	37.5	(9–76)	N/A	
Slovakia	25	12.0	(3–31)	22	27.3	(11–50)	29	17.2	(6–36)	29	41.4	(24–61)		›~
Romania	18	44.4	(22–69)	43	39.5	(25–56)	42	38.1	(24–54)	50	48.0	(34–63)	N/A	
Poland	135	26.7	(19–35)	110	27.3	(19–37)	142	31.7	(24–40)	–	–	(–)	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. The symbol ~ indicates 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, 2011-2014

Country	2011			2012			2013			2014				Trend 2011-2014	
	N	%IR	(95% CI)	N	%IR	(95% CI)	N	%IR	(95% CI)	N	%IR	(95% CI)			Comment*
Cyprus	12	16.7	(2–48)	7	#	(#)	15	26.7	(8–55)	11	0.0	(0–28)		N/A	
Belgium	1829	0.6	(0–1)	1614	1.2	(1–2)	1534	0.9	(0–2)	1069	0.7	(0–1)			
Netherlands	978	0.3	(0–1)	972	0.8	(0–2)	921	0.4	(0–1)	1025	1.2	(1–2)			
Germany	343	0.0	(0–1)	308	1.3	(0–3)	463	2.6	(1–4)	491	1.4	(1–3)			
Estonia	42	0.0	(0–8)	34	0.0	(0–10)	59	0.0	(0–6)	54	1.9	(0–10)			
Norway	567	1.4	(1–3)	533	3.2	(2–5)	497	1.4	(1–3)	490	2.2	(1–4)			
United Kingdom	1126	3.6	(3–5)	627	2.2	(1–4)	867	3.1	(2–4)	1190	2.9	(2–4)			
Austria	355	2.3	(1–4)	262	4.2	(2–7)	380	1.6	(1–3)	351	3.1	(2–6)			
Czech Republic	316	1.9	(1–4)	274	1.8	(1–4)	333	1.2	(0–3)	274	3.3	(2–6)			
Denmark	896	3.0	(2–4)	867	3.5	(2–5)	789	4.2	(3–6)	709	3.9	(3–6)			
Sweden	1143	2.4	(2–4)	947	3.0	(2–4)	694	3.2	(2–5)	693	4.2	(3–6)			>~
Iceland	32	9.4	(2–25)	26	3.8	(0–20)	18	16.7	(4–41)	23	4.3	(0–22)		N/A	
Latvia	38	0.0	(0–9)	64	1.6	(0–8)	66	0.0	(0–5)	46	4.3	(1–15)			
Slovenia	251	6.0	(3–10)	250	4.8	(3–8)	279	2.9	(1–6)	300	4.7	(3–8)			
Portugal	402	5.2	(3–8)	278	6.5	(4–10)	467	4.3	(3–7)	601	5.8	(4–8)			
Luxembourg	50	6.0	(1–17)	30	3.3	(0–17)	43	11.6	(4–25)	32	6.3	(1–21)			
Finland	610	9.0	(7–12)	532	10.7	(8–14)	579	7.6	(6–10)	570	6.5	(5–9)			<
Hungary	129	8.5	(4–15)	147	7.5	(4–13)	139	3.6	(1–8)	123	7.3	(3–13)			
Bulgaria	30	13.3	(4–31)	20	20.0	(6–44)	26	7.7	(1–25)	30	10.0	(2–27)			
Croatia	123	11.4	(6–18)	77	9.1	(4–18)	116	15.5	(9–23)	116	10.3	(5–17)			
Italy	162	4.3	(2–9)	116	10.3	(5–17)	248	8.1	(5–12)	163	11.0	(7–17)			
Ireland	310	13.5	(10–18)	307	12.4	(9–17)	305	13.1	(10–17)	317	11.4	(8–15)			
Spain	720	16.9	(14–20)	551	15.1	(12–18)	556	16.0	(13–19)	526	12.2	(9–15)			<~
France	1413	18.8	(17–21)	824	17.2	(15–20)	919	18.9	(16–22)	656	15.9	(13–19)			
Lithuania	41	17.1	(7–32)	35	14.3	(5–30)	56	14.3	(6–26)	62	16.1	(8–28)			
Slovakia	25	4.0	(0–20)	20	5.0	(0–25)	28	7.1	(1–24)	26	19.2	(7–39)			
Malta	7	#	(#)	18	38.9	(17–64)	7	#	(#)	8	37.5	(9–76)		N/A	
Romania	18	44.4	(22–69)	43	32.6	(19–49)	42	21.4	(10–37)	45	37.8	(24–53)		N/A	
Poland	134	14.9	(9–22)	110	16.4	(10–25)	139	24.5	(18–32)	–	–	(–)		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. The symbol ~ indicates 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 opportunistic microorganism 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. Most 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. A high incidence of MRSA thus adds to the overall clinical and economic burden in hospitals, causing prolonged hospital stay and higher mortality, mainly due to delayed initiation of appropriate therapy and less effective alternative treatment regimens.

3.6.2 Resistance mechanisms

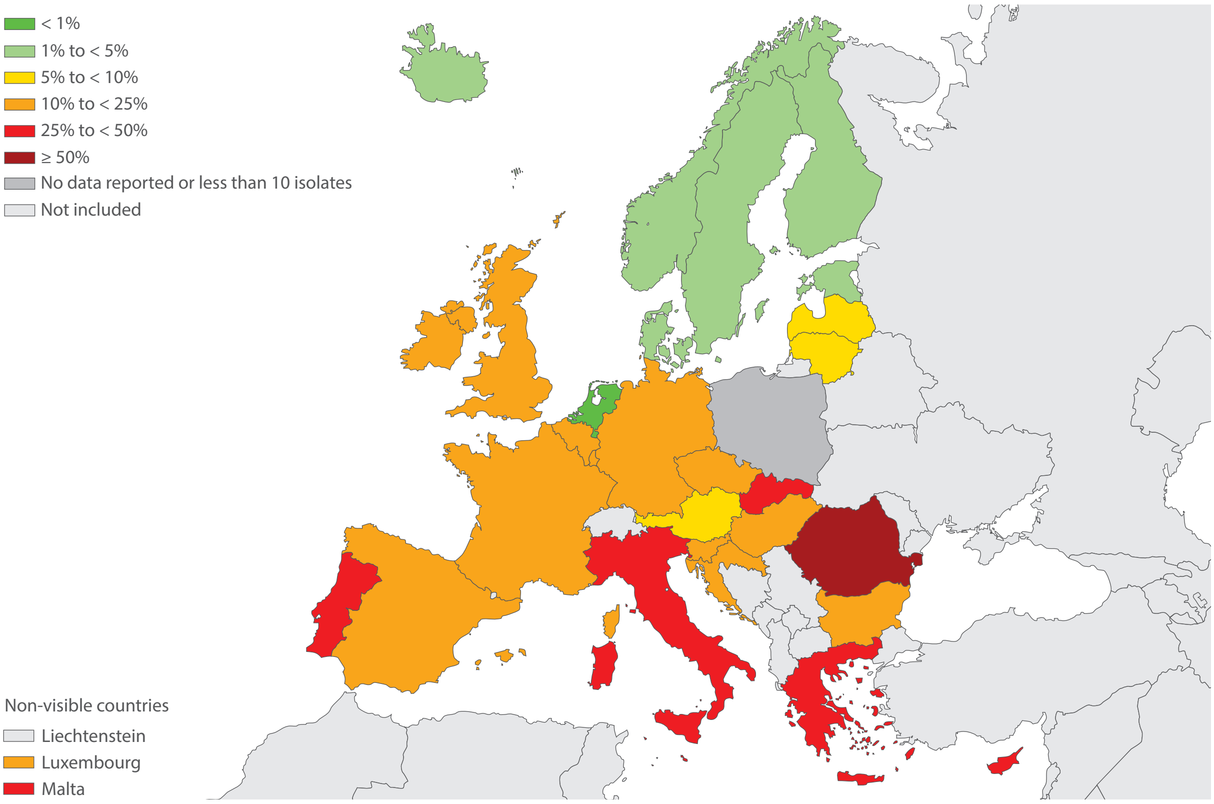
S. aureus acquires resistance to meticillin and all other beta-lactam agents through expression of the exogenous *mecA* gene. It codes for a variant penicillin-binding protein PBP2' (PBP2a) with low affinity for beta-lactams, thus preventing the inhibition by beta-lactams of cell wall synthesis. In some *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.

3.6.3 Antimicrobial susceptibility

- Wide inter-country variations in the occurrence of MRSA were evident across Europe, with percentages ranging from 0.9% to 56.0%. MRSA percentages were generally lower in northern Europe and higher in the southern and south-eastern parts.
- The EU/EEA population-weighted mean MRSA percentage continued to decrease significantly from 18.6% in 2011 to 17.4% in 2014.

Figure 3.23. ***Staphylococcus aureus*. Percentage (%) of invasive isolates with resistance to meticillin (MRSA), by country, EU/EEA countries, 2014**



Beta-lactams

For 2014, 29 countries reported 40414 isolates with AST or molecular information sufficient to discern MRSA. The number of isolates reported per country ranged from 61 to 5484 (Table 3.31).

The national percentages of isolates reported as MRSA ranged from 0.9% (Netherlands) to 56.0% (Romania) in 2014 (Table 3.31 and Figure 3.23). Trends for the period 2011-2014 were calculated for the 29 countries reporting at least 20 isolates per year during the four years. Significantly increasing trends were observed for Denmark and Slovenia. Significantly decreasing trends were observed for eight countries (Belgium, France, Germany, Ireland, Italy, Luxembourg, Portugal and the United Kingdom). For Belgium the trend was not significant when considering only data from laboratories reporting consistently for all four years.

The EU/EEA population-weighted mean percentage for MRSA decreased significantly from 18.6% in 2011 to 17.4% in 2014 (Table 3.31).

3.6.4 Discussion and conclusions

The decline in MRSA has been less pronounced in recent years compared with that observed for the period 2009 to 2012, but the decreasing MRSA trend continued in eight out of 29 countries, including countries with both low and high national MRSA percentages.

Despite this positive development, MRSA remains a public health priority in Europe, as seven out of 29 countries reported MRSA percentages above 25% (Table 3.31). To continue reducing the spread of MRSA in Europe, comprehensive MRSA strategies targeting all healthcare sectors (acute care, long-term care and ambulatory care) remain essential. Despite MRSA still being a major cause of healthcare-associated infections, community-associated MRSA is increasingly being reported from many parts of the world, including Europe. In addition, the proportion of community-onset infections caused by MRSA clones, that are usually associated with healthcare-associated infections, has increased, indicating transfer of healthcare-associated MRSA clones into the community [17].

Table 3.31. ***Staphylococcus aureus*. Total number of invasive isolates tested (N) and percentage with resistance to meticillin (MRSA) including 95% confidence intervals (95% CI), EU/EEA countries, 2011-2014**

Country	2011			2012			2013			2014			Trend 2011-2014	Comment**
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		
Netherlands	1801	1.4	(1–2)	1944	1.3	(1–2)	2062	1.2	(1–2)	2524	0.9	(1–1)		
Norway	1223	0.3	(0–1)	1430	1.3	(1–2)	1473	0.7	(0–1)	1544	1.0	(1–2)		
Sweden	3751	1.0	(1–1)	3262	0.7	(0–1)	4099	1.0	(1–1)	2745	1.0	(1–1)		
Denmark	1452	1.2	(1–2)	1431	1.3	(1–2)	1685	1.7	(1–2)	1874	2.5	(2–3)		›
Finland	1319	3.2	(2–4)	1409	2.1	(1–3)	1555	1.7	(1–3)	1831	2.6	(2–3)		
Estonia	116	1.7	(0–6)	104	7.7	(3–15)	170	3.5	(1–8)	223	3.1	(1–6)		
Iceland	71	2.8	(0–10)	58	1.7	(0–9)	69	0.0	(0–5)	61	3.3	(0–11)		
Austria	1966	7.4	(6–9)	2164	7.7	(7–9)	2534	9.2	(8–10)	2651	7.8	(7–9)		
Lithuania	278	5.4	(3–9)	323	10.2	(7–14)	267	9.7	(6–14)	383	7.8	(5–11)		
Latvia	192	9.9	(6–15)	211	9.0	(6–14)	172	7.0	(4–12)	220	8.2	(5–13)		
United Kingdom	3408	13.6	(13–15)	2679	14.0	(13–15)	2117	13.7	(12–15)	2395	11.3	(11–13)		‹
Germany	2388	16.2	(15–18)	2563	15.4	(14–17)	3070	12.7	(12–14)	3146	11.8	(11–13)		‹
Luxembourg	127	20.5	(14–29)	131	15.3	(10–23)	135	8.9	(5–15)	125	12.0	(7–19)		‹
Czech Republic	1555	14.5	(13–16)	1611	13.0	(11–15)	1707	13.2	(12–15)	1695	13.0	(11–15)		
Slovenia	464	7.1	(5–10)	445	10.3	(8–14)	465	9.0	(7–12)	495	13.1	(10–16)		›
Belgium	1744	17.4	(16–19)	1568	16.6	(15–19)	1612	16.9	(15–19)	988	13.4	(11–16)		‹~
France	4716	20.1	(19–21)	5228	19.2	(18–20)	5431	17.0	(16–18)	5484	17.4	(16–18)		‹
EU/EEA (population-weighted mean)*		**18.6**	**(17–20)**		**18.6**	**(17–20)**		**18.1**	**(17–20)**		**17.4**	**(16–19)**		**‹**
Ireland	1057	23.7	(21–26)	1038	22.6	(20–25)	1069	19.9	(18–22)	1075	19.4	(17–22)		‹
Bulgaria	214	22.4	(17–29)	227	19.8	(15–26)	214	19.2	(14–25)	216	20.8	(16–27)		
Croatia	415	27.7	(23–32)	403	21.3	(17–26)	520	24.0	(20–28)	484	21.3	(18–25)		
Spain	1950	22.5	(21–24)	1899	24.2	(22–26)	1777	22.6	(21–25)	1920	22.1	(20–24)		
Hungary	1156	26.2	(24–29)	1143	24.8	(22–27)	1200	24.0	(22–27)	1279	23.1	(21–25)		
Slovakia	566	26.1	(23–30)	474	21.7	(18–26)	552	27.0	(23–31)	640	28.0	(25–32)		
Italy	1261	38.2	(33–38)	1636	35.2	(33–38)	2394	35.8	(34–38)	2133	33.6	(32–36)		‹
Cyprus	113	41.6	(32–51)	165	35.2	(28–43)	157	32.5	(25–40)	136	36.0	(28–45)		
Greece	784	39.2	(36–43)	876	41.0	(38–44)	757	40.3	(37–44)	556	37.1	(35–42)		
Malta	130	49.2	(40–58)	102	47.1	(37–57)	114	51.8	(42–61)	82	42.7	(32–54)		
Portugal	1307	54.6	(52–57)	1455	53.8	(51–56)	2390	46.8	(45–49)	3193	47.4	(46–49)		‹
Romania	109	49.5	(40–59)	229	53.3	(47–60)	383	64.5	(59–69)	316	56.0	(50–62)		
Poland	860	24.3	(21–27)	781	25.5	(22–29)	743	16.0	(13–19)	–	–	(–)	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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates 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. Enterococci are regarded as harmless commensals. However, they can cause invasive diseases when the commensal relationship with the host is disrupted. Enterococci can cause a variety of infections, including endocarditis, bloodstream infections, and urinary tract infections, and are associated with peritonitis and intra-abdominal abscesses.

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 clonal complex (CC) 17 in *E. faecium*, and by CC2 and CC9 in *E. faecalis*. The latter CCs 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 penicillin-resistant *E. faecium*.

3.7.2 Resistance mechanisms

Enterococci are intrinsically resistant to a broad range of antimicrobial agents 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 or mutation.

Beta-lactam antimicrobials

By nature, enterococci have low susceptibility to many beta-lactam agents as a consequence of their low-affinity penicillin-binding proteins (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 aminopenicillins 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 due to the wide dissemination of ampicillin-resistant strains belonging to 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, several different aminoglycoside-modifying enzymes have been identified, targeting various amino and hydroxyl groups on aminoglycoside molecules. 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 where it was attributed to the widespread use of vancomycin in 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 in 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 an important cause of healthcare-associated infections in Europe and a major infection control challenge.
- The EU/EEA population-weighted mean percentage of 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 2014, 26 countries reported 9 560 isolates with information on high-level aminoglycoside resistance. The number of isolates reported per country ranged from 12 to 1741 (Table 3.32).

The national percentages of resistant isolates in the reporting countries ranged from 8.3% (Iceland) to 76.5% (Romania) in 2014. (Table 3.32 and Figure 3.24). Trends for the period 2011-2014 were calculated for the 23 countries reporting at least 20 isolates per year during all four years. A significantly increasing trend was observed for Austria and Belgium. For both countries, this trend was not significant when considering only data from laboratories reporting consistently for all four years. Significantly decreasing trends were observed for four countries (Czech Republic, France, Germany and Greece). For Germany, the trend was not significant

Figure 3.24. ***Enterococcus faecalis*****. Percentage (%) of invasive isolates with high-level resistance to aminoglycosides, by country, EU/EEA countries, 2014**

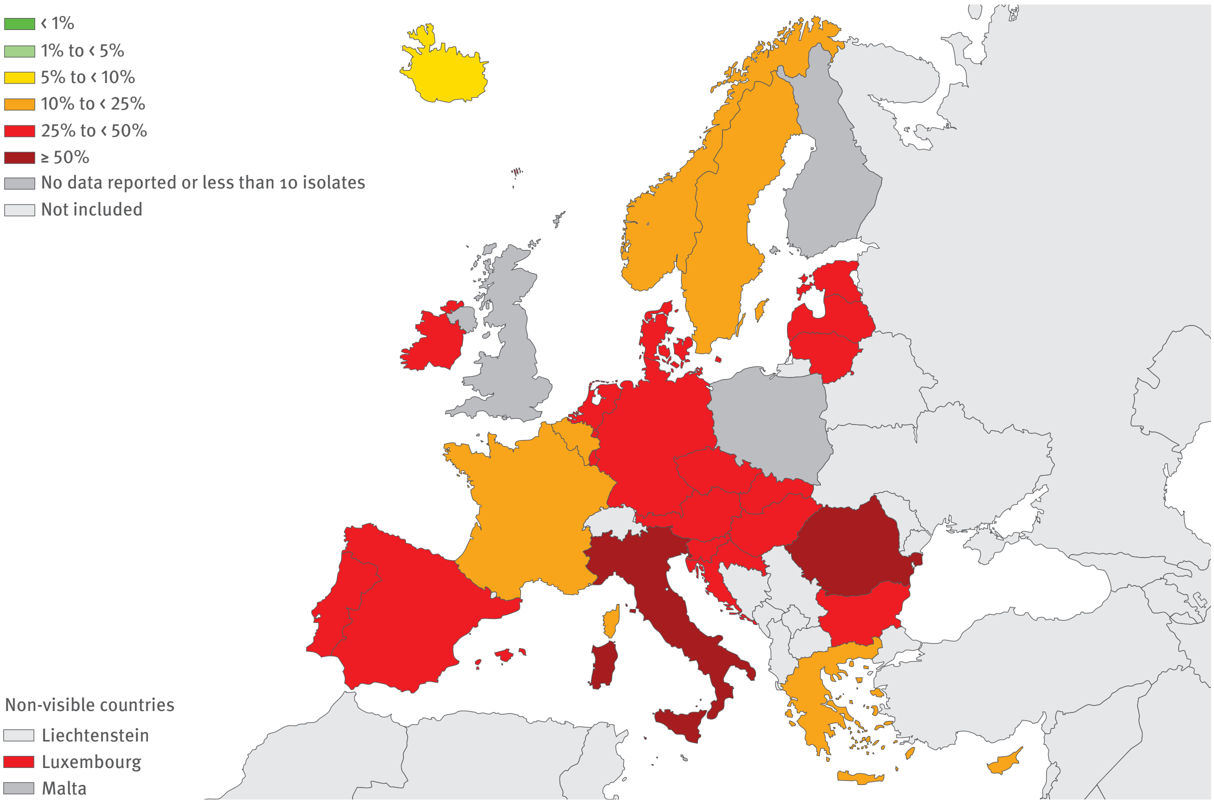
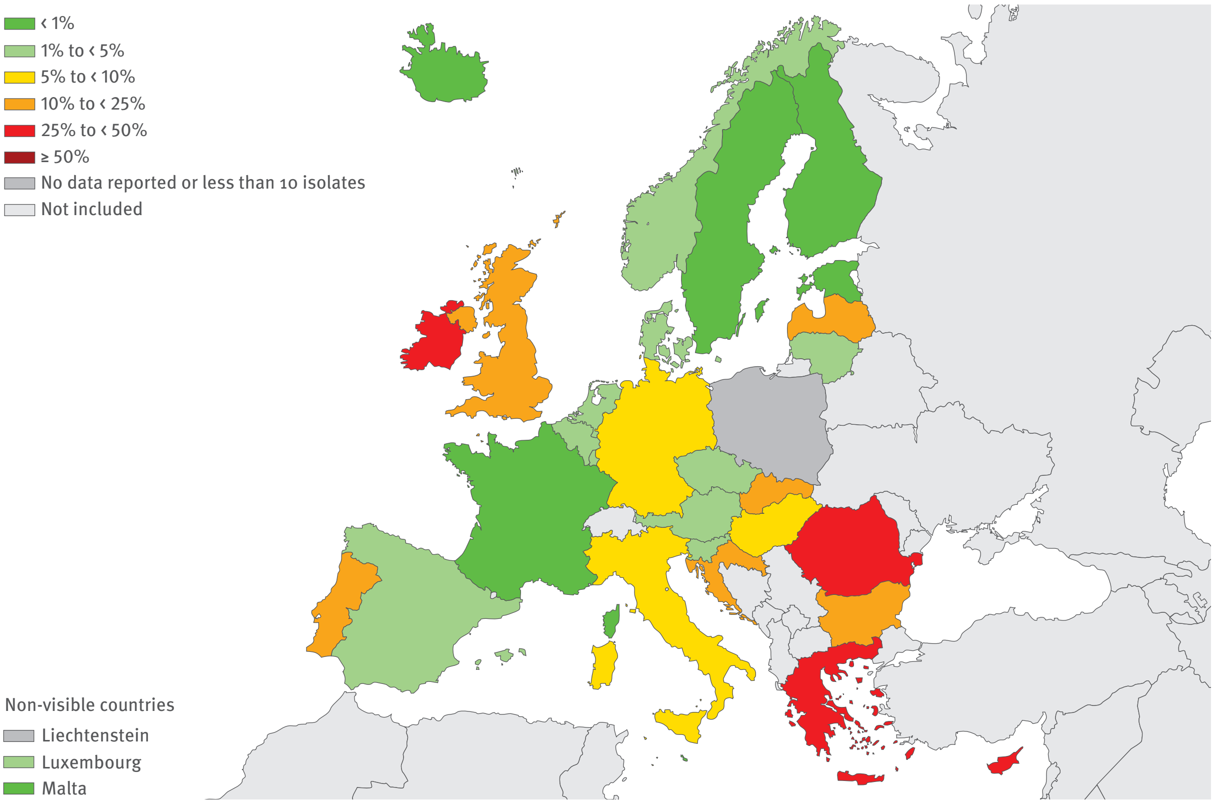


Figure 3.25. ***Enterococcus faecium*****. Percentage (%) of invasive isolates with resistance to vancomycin, by country, EU/EEA countries, 2014**



when considering only data from laboratories reporting consistently for all four years.

The EU/EEA population-weighted mean percentage for high-level aminoglycoside resistance was 28.8% in 2014 (Table 3.32).

Vancomycin

Vancomycin resistance in *E. faecalis* remains low in most countries. For more information, please refer to the EARS-Net interactive database and the Country Summary sheets[i].

3.7.3.2 *Enterococcus faecium*

Vancomycin

For 2014, 29 countries reported 8142 isolates with AST information for vancomycin. The number of isolates reported per country ranged from 11 to 882 (Table 3.33).

The national percentages of resistant isolates ranged from zero (Estonia, Finland, Iceland and Malta) to 45.1% (Ireland) in 2014 (Table 3.33 and Figure 3.25). Trends for the period 2011-2014 were calculated for 24 countries reporting at least 20 isolates per year during all four years. Significantly increasing trends were observed for eight countries (Bulgaria, Croatia, Denmark, Hungary, Ireland, Italy, Slovakia and United Kingdom). Significantly decreasing trends were observed for three countries (Belgium, France and Germany). For Belgium and Germany the trend was not significant when considering only data from laboratories reporting consistently for all four years.

The EU/EEA population-weighted mean percentage for vancomycin resistance increased significantly from 6.2% in 2011 to 7.9% in 2014.

High-level aminoglycoside resistance

With few exceptions, national percentages for high-level aminoglycoside resistance in *E. faecium* were higher than for *E. faecalis*. For more information, please refer to the EARS-Net interactive database and the Country Summary sheets[i].

3.7.4 Discussion and conclusions

The change from the stable situation in vancomycin-resistant *E. faecium* in previous years to an increasing number of countries reporting significantly increasing trends may indicate a changing epidemiology for this pathogen in Europe. More than a third of the countries included in the analysis reported a significantly increasing trend for the period 2011-2014, which was the highest proportion since sufficient data for four-year trend analyses became available in 2004. The EU/EEA population-weighted mean percentage for vancomycin resistance in *E. faecium* also showed a significantly increasing trend for the period 2011-2014.

High levels of antimicrobial-resistant enterococci remain a major infection control challenge and an important cause of healthcare-associated infections in Europe. Enterococci have intrinsic resistance to several antimicrobial classes and the ability to acquire additional resistance which severely limits the number of treatment options. Besides the fact that infections caused by resistant strains are difficult to treat, enterococci are highly tenacious and easily disseminate in healthcare settings.

[i] EARS-Net interactive database. Available at http://ecdc.europa.eu/en/healthtopics/antimicrobial_resistance/database/Pages/database.aspx

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, 2011-2014**

Country	2011			2012			2013			2014				Trend 2011-2014	
	N	%R	(95%CI)	N	%R	(95%CI)	N	%R	(95%CI)	N	%R	(95%CI)			Comment**
Iceland	19	0.0	(0–18)	17	11.8	(1–36)	15	33.3	(12–62)	12	8.3	(0–38)		N/A	
France	955	20.0	(18–23)	1528	16.7	(15–19)	1639	14.7	(13–17)	1741	13.7	(12–15)			‹
Sweden	890	19.3	(17–22)	792	14.8	(12–17)	605	16.4	(14–20)	723	15.8	(13–19)			
Cyprus	54	18.5	(9–31)	77	10.4	(5–19)	67	26.9	(17–39)	80	17.5	(10–28)			
Greece	653	37.4	(34–41)	667	28.3	(25–32)	548	23.5	(20–27)	407	20.1	(18–25)			‹
Norway	115	21.7	(15–30)	123	30.1	(22–39)	168	26.8	(20–34)	270	20.7	(16–26)			
Belgium	335	18.2	(14–23)	395	24.6	(20–29)	398	27.6	(23–32)	170	22.9	(17–30)			›~
Netherlands	363	33.3	(28–38)	287	30.7	(25–36)	279	26.9	(22–32)	403	28.8	(24–33)			
EU/EEA (population-weighted mean)*		**33.9**	**(30–38)**		**29.1**	**(26–33)**		**30.8**	**(27–35)**		**28.8**	**(26–33)**			
Lithuania	48	43.8	(29–59)	59	50.8	(37–64)	44	54.5	(39–70)	65	29.2	(19–42)			
Denmark	45	31.1	(18–47)	112	27.7	(20–37)	48	27.1	(15–42)	60	30.0	(19–43)			
Luxembourg	27	44.4	(25–65)	45	22.2	(11–37)	36	27.8	(14–45)	39	30.8	(17–48)			
Ireland	244	29.9	(24–36)	279	32.6	(27–38)	277	32.1	(27–38)	290	31.4	(26–37)			
Portugal	403	29.8	(25–35)	347	42.9	(38–48)	545	37.2	(33–41)	607	32.6	(29–36)			
Croatia	139	34.5	(27–43)	152	37.5	(30–46)	167	34.7	(28–42)	149	32.9	(25–41)			
Germany	578	41.0	(37–45)	680	35.6	(32–39)	807	39.3	(36–43)	903	33.6	(30–37)			‹~
Slovenia	125	36.0	(28–45)	129	34.9	(27–44)	146	32.2	(25–40)	119	36.1	(28–45)			
Estonia	6	#	(#)	19	42.1	(20–67)	10	20.0	(3–56)	19	36.8	(16–62)		N/A	
Austria	327	30.9	(26–36)	425	29.2	(25–34)	503	31.4	(27–36)	421	37.1	(32–42)			›~
Czech Republic	556	46.2	(42–50)	581	41.7	(38–46)	603	40.0	(36–44)	525	38.7	(34–43)			‹
Spain	917	39.3	(36–43)	878	38.3	(35–42)	899	42.6	(39–46)	970	38.9	(36–42)			
Bulgaria	62	30.6	(20–44)	78	38.5	(28–50)	102	47.1	(37–57)	105	40.0	(31–50)			
Slovakia	189	49.7	(42–57)	179	50.3	(43–58)	209	57.4	(50–64)	261	41.0	(35–47)			
Latvia	34	26.5	(13–44)	55	29.1	(18–43)	54	61.1	(47–74)	13	46.2	(19–75)		N/A	
Hungary	461	48.6	(44–53)	452	56.2	(51–61)	602	51.7	(48–56)	659	49.8	(46–54)			
Italy	330	50.0	(44–56)	301	50.8	(45–57)	584	46.2	(42–50)	515	55.3	(51–60)			
Romania	–	–	(-)	51	56.9	(42–71)	80	58.8	(47–70)	34	76.5	(59–89)		N/A	
Poland	190	48.4	(41–56)	122	45.9	(37–55)	184	45.1	(38–53)	–	–	(-)		N/A	
United Kingdom	75	16.0	(9–26)	135	29.6	(22–38)	136	30.9	(23–39)	–	–	(-)		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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

**The symbols › and ‹ indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates 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 with resistance to vancomycin, including 95 % confidence intervals (95 % CI), EU/EEA countries, 2011-2014**

Country	2011			2012			2013			2014			Trend 2011-2014	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		Comment**
Estonia	4	#	(#)	40	0.0	(0–9)	40	0.0	(0–9)	48	0.0	(0–7)	N/A	
Finland	212	0.9	(0–3)	274	0.7	(0–3)	302	0.3	(0–2)	368	0.0	(0–1)		
Iceland	13	0.0	(0–25)	12	0.0	(0–26)	17	5.9	(0–29)	11	0.0	(0–28)	N/A	
Malta	14	0.0	(0–23)	6	#	(#)	10	0.0	(0–31)	11	0.0	(0–28)	N/A	
Sweden	461	0.0	(0–1)	404	0.0	(0–1)	575	0.0	(0–1)	452	0.4	(0–2)		
France	569	1.4	(1–3)	614	0.8	(0–2)	733	0.1	(0–1)	737	0.5	(0–1)		‹
Netherlands	481	1.0	(0–2)	484	0.0	(0–1)	439	0.5	(0–2)	532	1.1	(0–2)		
Slovenia	83	0.0	(0–4)	95	0.0	(0–4)	102	1.0	(0–5)	115	1.7	(0–6)		
Norway	165	1.8	(0–5)	168	0.6	(0–3)	211	2.4	(1–5)	227	1.8	(0–4)		
Spain	542	1.5	(1–3)	537	1.5	(1–3)	553	0.9	(0–2)	546	2.4	(1–4)		
Belgium	215	7.0	(4–11)	212	1.4	(0–4)	235	1.7	(0–4)	195	3.1	(1–7)		‹~
Luxembourg	24	4.2	(0–21)	20	0.0	(0–17)	19	5.3	(0–26)	31	3.2	(0–17)		
Austria	354	4.5	(3–7)	376	3.2	(2–6)	437	5.9	(4–9)	480	4.4	(3–7)		
Czech Republic	211	7.6	(4–12)	262	11.5	(8–16)	268	9.0	(6–13)	250	4.4	(2–8)		
Denmark	615	1.3	(1–3)	593	2.0	(1–4)	644	3.4	(2–5)	715	4.5	(3–6)		›
Lithuania	26	7.7	(1–25)	36	5.6	(1–19)	25	0.0	(0–14)	44	4.5	(1–15)		
EU/EEA population-weighted mean)*		**6.2**	**(4–9)**		**8.1**	**(6–11)**		**8.9**	**(7–12)**		**7.9**	**(6–11)**		**›**
Hungary	120	0.8	(0–5)	142	3.5	(1–8)	210	7.1	(4–12)	224	8.5	(5–13)		›
Italy	236	4.2	(2–8)	435	6.0	(4–9)	565	4.4	(4–9)	472	8.5	(6–11)		›
Germany	535	11.4	(9–14)	647	16.2	(13–19)	826	14.5	(12–17)	882	9.1	(7–11)		‹~
Slovakia	103	3.9	(1–10)	82	4.9	(1–12)	132	7.6	(4–13)	129	10.1	(5–17)		›
Croatia	57	1.8	(0–9)	60	0.0	(0–6)	74	6.8	(2–15)	67	10.4	(4–20)		›
Bulgaria	39	0.0	(0–9)	42	0.0	(0–8)	44	2.3	(0–12)	60	13.3	(6–25)		›
Latvia	22	9.1	(1–29)	18	5.6	(0–27)	25	12.0	(3–31)	15	13.3	(2–40)	N/A	
Portugal	208	20.2	(15–26)	257	23.3	(18–29)	350	22.0	(18–27)	363	20.1	(16–25)		
United Kingdom	302	8.9	(6–13)	362	13.3	(10–17)	442	23.3	(19–28)	423	21.3	(17–25)		›
Romania	12	0.0	(0–26)	34	2.9	(0–15)	54	11.1	(4–23)	56	25.0	(14–38)		
Greece	424	23.1	(19–27)	418	17.2	(14–21)	345	21.2	(17–26)	264	26.9	(23–29)		
Cyprus	17	0.0	(0–20)	29	10.3	(2–27)	30	23.3	(10–42)	35	40.0	(24–58)	N/A	
Ireland	347	34.9	(30–40)	386	44.0	(39–49)	398	42.7	(38–48)	390	45.1	(40–50)		›
Poland	202	8.4	(5–13)	157	8.3	(4–14)	173	12.7	(8–19)	–	–	(–)	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 EU/EEA population-weighted mean excludes countries not reporting data for all four years.

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

References

1 European Centre for Disease Prevention and Control. The bacterial challenge: time to react. Stockholm: ECDC; 2009. Available from: http://www.ecdc.europa.eu/en/publications/Publications/0909_TER_The_Bacterial_Challenge_Time_to_React.pdf

2 Council of the European Union. Council Conclusions on Antimicrobial Resistance (AMR). Available from: http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/lsa/101035.pdf

3 European Commission. Directorate-General for Health & Consumers. Communication from the commission to the European Parliament and the Council. Action plan against the rising threats from Antimicrobial Resistance. Brussels, 2011. Available from: http://ec.europa.eu/dgs/health_consumer/docs/communication_amr_2011_748_en.pdf

4 Decision No 1082/2013/EU of the European Parliament and of the Council of 22 October 2013 on serious cross-border threats to health and repealing Decision No 2119/98/EC. OJ L 293, 22.19.2013, p. 1. Available from: http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32013D1082&rid=1

5 European Centre for Disease Prevention and Control. EARS-Net Reporting Protocol. July 2015. Stockholm: ECDC; 2015. Available from: http://ecdc.europa.eu/en/activities/surveillance/EARS-Net/Documents/2015-EARS-Net-reporting-protocol.pdf

6 European Committee on Antimicrobial Susceptibility Testing. EUCAST guidelines for detection of resistance mechanisms and specific resistances of clinical and/or epidemiological importance. Version 1.0, December 2013. Available from: http://www.eucast.org/fileadmin/src/media/PDFs/EUCAST_files/Resistance_mechanisms/EUCAST_detection_of_resistance_mechanisms_v1.0_20131211.pdf

7 Eurostat [Internet]. Luxembourg: European Commission. c1995–2015. [Accessed 10 August 2015]. Available from: http://ec.europa.eu/eurostat/data/database.

8 Albiger B, Glasner C, Struelens MJ, Grundmann H, Monnet DL, and the European Survey on Carbapenemase-Producing Enterobacteriaceae (EuSCAPE) working group. EUROROUNDUPS. Carbapenemase-producing Enterobacteriaceae in Europe: assessment by national experts from 38 countries. Euro Surveill. In press 2015.

9 European Centre for Disease Prevention and Control. Risk assessment on the spread of carbapenemase-producing Enterobacteriaceae (CPE) through patient transfer between health-care facilities, with special emphasis on cross-border transfer. Stockholm: ECDC; 2011. Available from: http://ecdc.europa.eu/en/publications/Publications/110913_Risk_assessment_resistant_CPE.pdf

10 European Centre for Disease Prevention and Control. Updated risk assessment on the spread of NDM and its variant within Europe. Stockholm: ECDC; 2011. Available from: http://ecdc.europa.eu/en/publications/Publications/1111_TER_Risk-assessment-NDM.pdf

11 European Centre for Disease Prevention and Control. Systematic review of the effectiveness of infection control measures to prevent the transmission of carbapenemase-producing Enterobacteriaceae through cross-border transfer of patients. Stockholm: ECDC; 2014. Available from: http://ecdc.europa.eu/en/publications/Publications/CPE-systematic-review-effectiveness-infection-control-measures-to-prevent-transmission-2014.pdf

12 Lagacé-Wiens PR1, Adam HJ, Low DE, Blondeau JM, Baxter MR, Denisuik AJ, et al; Canadian Antimicrobial Resistance Alliance. Trends in antibiotic resistance over time among pathogens from Canadian hospitals: results of the CANWARD study 2007-11. J Antimicrob Chemother. 2013 May;68 Suppl 1:i23-9.

13 Pakyz AL, Lee JA, Ababneh MA, Harpe SE, Oinonen MJ, Polk RE. Fluoroquinolone use and fluoroquinolone-resistant Pseudomonas aeruginosa is declining in US academic medical centre hospitals. J Antimic rob Chemother. 2012 Jun;67(6):1562-4.

14 European Centre for Disease Prevention and Control. Carbapenemase-producing bacteria in Europe: interim results from the European Survey on carbapenemase-producing Enterobacteriaceae (EuSCAPE) project. Stockholm: ECDC; 2013 Available from: http://www.ecdc.europa.eu/en/publications/Publications/antimicrobial-resistance-carbapenemase-producing-bacteria-europe.pdf

15 European Centre for Disease Prevention and Control. Surveillance of invasive bacterial diseases in Europe, 2012. Stockholm: ECDC; 2015. Available from: http://ecdc.europa.eu/en/publications/Publications/Surveillance%20of%20IBD%20in%20Europe%202012.pdf

16 European Centre for Disease Prevention and Control. Vaccine Scheduler [Website]. Available from: http://vaccine-schedule.ecdc.europa.eu/Pages/Scheduler.aspx

17 Grundmann H, Schouls LM, Aanensen DM, Pluister GN, Tami A, Chlebowicz M, et al. The dynamic changes of dominant clones of *Staphylococcus aureus* causing bloodstream infections in the European region: results of a second structured survey. Euro Surveill. 2014 Dec 11;19(49).

Annexes

Annex 1. External quality assessment 2014

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

The purpose of the EARS-Net EQA was to determine the accuracy of quantitative antimicrobial susceptibility test (AST) results reported by individual laboratories and thereby estimate the overall comparability of routinely collected test results between laboratories and countries across Europe. The 2014 panel included an *Escherichia coli, Klebsiella pneumoniae*, *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Enterococcus faecium* and an *Acinetobacter baumannii* complex as agreed with ECDC. A panel of six lyophilised isolates were prepared and found fully compliant in quality control testing in house, and confirmed by two expert reference laboratories. The strains were characterised and tested by two reference laboratories: Specialist Antimicrobial Chemotherapy Unit, Cardiff (UK) and EUCAST Reference and Development 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

EQA panels were dispatched to 905 participants in 30 countries. Participants were asked to report the identification of each organism and clinical susceptibility characterisation – susceptible, intermediate and resistant (S, I, R) – according to the guidelines used. The return rate was similar that for to previous years; 837 (92 %) laboratories returned reports. Figure A1.1 shows the proportion 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.

Figure A1.1. Number of participating laboratories returning EQA reports 2014, by country

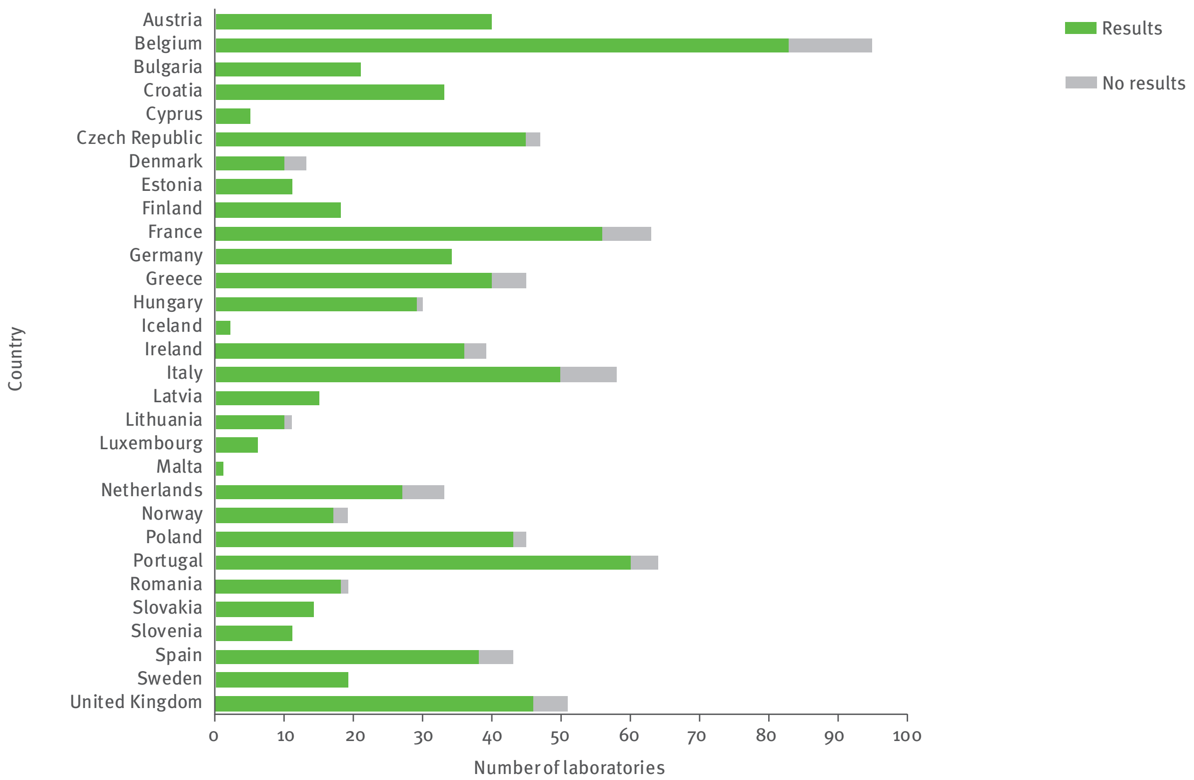
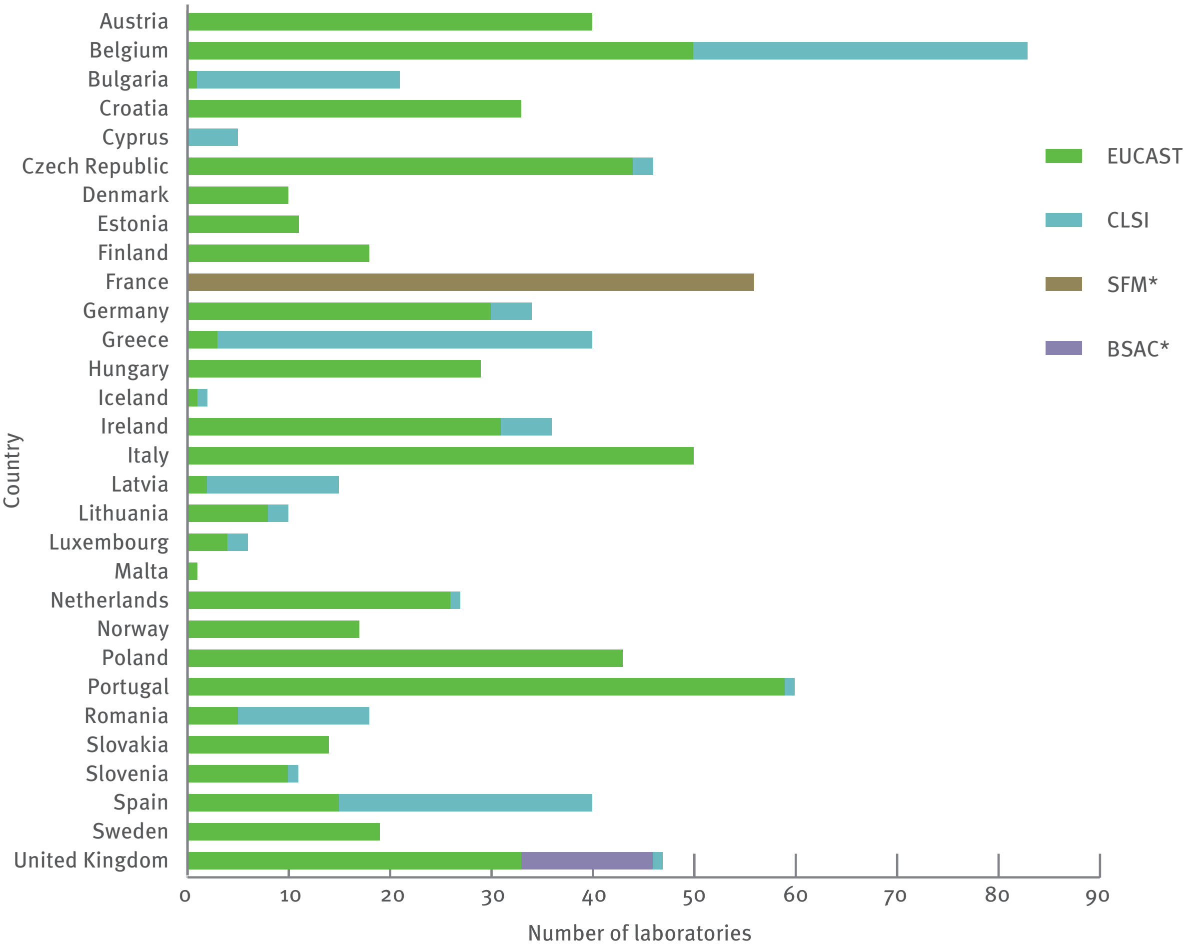


Figure A1.2. Clinical guidelines reported to be used by laboratories: number of laboratories per country, 2014



* National guidelines harmonised with EUCAST: BSAC: British Society for Antimicrobial Chemotherapy; SFM: Société Française de Microbiologie.

Table A1.1. ***Escherichia coli*** **(2 486). Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories (Ref 1 and Ref 2) and the overall concordance of the participating laboratories**

Antibiotic agent	MIC (mg/L)		Result	
	Ref 1	Ref 2	EUCAST/CLSI	Overall concordance (%)
Amikacin	16		I/S	95.9
Amoxicillin	≥128		R	99.2
Amoxicillin-clavulanic acid	≥128(64)*		R	90.5
Ampicillin	≥128		R	99.9
Cefotaxime	≥128		R	99.9
Ceftazidime	32	64	R	99.0
Ceftriaxone	≥128		R	99.5
Ciprofloxacin	≥128		R	99.9
Doripenem	–		S**	99.3
Ertapenem	0.12	0.25	S	99.1
Gentamicin	≥128		R	99.4
Imipenem	0.12	0.25	S	98.9
Levofloxacin	–		R**	98.6
Meropenem	0.03		S	99.3
Ofloxacin	–		R**	97.6
Piperacillin-tazobactam***	32	64	R/I	57.3
Tobramycin	≥128		R	99.7
ESBL	–		Positive	99.3

* Amoxicillin-clavulanic acid: fixed 2 mg/L (ratio)
** The assigned result was based on participant consensus
*** Fixed 4 mg/L tazobactam

Use of methods and clinical guidelines

For the determination of AST results, laboratories used automated methods (52 %), disk diffusion tests (41 %), MIC (6 %), gradient strip or a combination of methods (1 %). For species identification, 56 % used an automated instrument and 44 % used conventional methods. Increased use of conventional methods was associated with identification of the *S. pneumoniae*.

Some 20 % of laboratories applied CLSI guidelines, this represented a significant reduction from the previous year when the proportion was 36 %. Use of EUCAST guidelines was reported by 72 % of laboratories. France (SFM) and the UK (BSAC) used national guidelines; however, both have been implementing EUCAST breakpoints in their national MIC breakpoint recommendations as harmonised breakpoints have been agreed, and have adjusted the interpretation of their disk diffusion methods accordingly. Therefore, a combined total of 80 % of laboratories used EUCAST breakpoints. Figure A1.2 shows the (inter)national guidelines used by laboratories in different countries.

Antimicrobial susceptibility results

Specimen 2486 – *Escherichia coli*

This organism was an *Escherichia coli* which produces a CTX-M-15 ESBL conferring reduced susceptibility to beta-lactam agents included in reference testing other than carbapenems. Almost all (99.3 % of 818) participants reported that the organism was ESBL-positive and there were no significant problems in testing beta-lactam agents other than beta-lactamase inhibitor combinations (Table A1.1).

The organism was resistant to amoxicillin-clavulanic acid by both EUCAST and CLSI breakpoints. Overall, 90.5 % of participants reported amoxicillin-clavulanic-acid-resistant, 8.1 % intermediate and 1.4 % susceptible. CLSI guidelines include an intermediate category (S ≤8, I 16, R ≥32 mg/L) while EUCAST guidelines (S ≤8, R >8 mg/L) have no intermediate category, and this was reflected in more frequent intermediate reports by participants using CLSI guidelines (Table A1.2).

The organism was resistant to piperacillin-tazobactam (MIC 32–64 mg/L) by EUCAST breakpoints (S ≤8 mg/L, R >16 mg/L) and intermediate by CLSI breakpoints (S ≤16 mg/L, R ≥128 mg/L). There were high discrepancy rates in reporting susceptibility by participants, with 29.1 % reporting resistant, 28.2 % intermediate and 42.7 % susceptible. The difference in guidelines was reflected in reports by participants, who were more likely to report susceptible with CLSI guidelines (Table A1.3). The isolate was low-level resistant to piperacillin-tazobactam but irrespective of the differences in breakpoint guidelines the reported results of susceptible were unexpectedly common.

Participants following EUCAST or EUCAST-related guidelines were less likely to report piperacillin-tazobactam-susceptible if they used disk diffusion methods than if they used automated methods (Table A1.4). Participants using CLSI guidelines were more likely to report susceptible with disk diffusion methods but the difference in reporting between those using disk diffusion or automated methods was small.

The organism was clearly resistant to gentamicin and tobramycin and there were no problems in detecting resistance, but it was borderline in susceptibility to amikacin (MIC 16 mg/L). The isolate was intermediate to amikacin by EUCAST breakpoints (S ≤8, R >16 mg/L) and susceptible by CLSI breakpoints (S ≤16, I 32, R ≥64 mg/L). There were high discrepancy rates in reporting susceptibility by participants, with 4.1 % reporting resistant, 34.2 % intermediate and 61.7 % susceptible. The difference in guidelines was reflected in reports by participants, who were more likely to report susceptible with CLSI guidelines than with EUCAST guidelines (Table A1.5).

Participants following EUCAST or EUCAST-related guidelines were less likely to report the intended amikacin intermediate result if they used disk diffusion methods than if they used automated methods. Among those using CLSI guidelines, there was much less difference in reporting between those using disk diffusion or automated methods (Table A1.6).

Specimen 2487 – *Klebsiella pneumoniae*

This organism was a *Klebsiella pneumoniae* which produces a VIM carbapenemase and was clearly resistant to carbapenems and all other beta-lactam agents tested. Reports that the organism was an ESBL-producer were not uncommon and 32.8 % of participants reported the presence of an ESBL. Synergy between third-generation cephalosporins and clavulanic acid was not seen in reference tests, although detection of an ESBL in the presence of a carbapenemase is often difficult. It may be that some participants used an extended definition of an ESBL when giving results for the ESBL test, although this is not possible to read out of the reported data.

Aminoglycoside susceptibility was typical for an organism producing AAC(6')I in that the organism was susceptible to gentamicin (MIC 1 mg/L), borderline to amikacin (MIC 16 mg/L; intermediate by EUCAST breakpoints and susceptible by CLSI breakpoints); and resistant to tobramycin (MIC 16 mg/L). For amikacin, reporting was variable, with 13.3 % of 746 participants reporting susceptible, 60.2 % intermediate and 26.5 % resistant. Among participants using EUCAST or EUCAST-related guidelines, reports of intermediate were common and reports of susceptible uncommon (Table A1.8). In line with differences in breakpoints between EUCAST and CLSI, among participants using CLSI guidelines, reports of susceptible were more common and reports of intermediate less common than with EUCAST guidelines

Table A1.2. ***Escherichia coli*** **(2486). Reported amoxicillin-clavulanic acid susceptibility results and clinical breakpoint guidelines used**

Antibiotic agent	EUCAST and EUCAST-related guidelines				CLSI guidelines			
	N	% S	% I	% R	N	% S	% I	% R
Amoxicillin-clavulanic acid	623	1.1	2.7	96.2	166	2.4	27.1	70.5

Table A1.3. ***Escherichia coli*** **(2486). Reported piperacillin-tazobactam susceptibility results and clinical breakpoint guidelines used**

Antibiotic agent	EUCAST and EUCAST-related guidelines				CLSI guidelines			
	N	% S	% I	% R	N	% S	% I	% R
Piperacillin-tazobactam	646	38.9	28.5	32.6	163	59.5	28.2	12.3

Table A1.4. ***Escherichia coli*** **(2486). Reported piperacillin-tazobactam susceptibility results, clinical breakpoint guidelines and method used**

Breakpoint guidelines	Disk diffusion methods				Automated methods			
	N	% S	% I	% R	N	% S	% I	% R
EUCAST and EUCAST-related	274	27.4	38.3	34.3	322	48.1	20.2	31.7
CLSI	55	63.6	29.1	7.3	98	58.2	26.5	15.3

Table A1.5. ***Escherichia coli*** **(2486). Reported amikacin susceptibility results and clinical breakpoint guidelines used**

Antibiotic agent	EUCAST and EUCAST-related guidelines				CLSI guidelines			
	N	% S	% I	% R	N	% S	% I	% R
Amikacin	579	56.8	38.7	4.5	153	80.4	17.0	2.6

Table A1.6. ***Escherichia coli*** **(2486). Reported amikacin susceptibility results, clinical breakpoint guidelines and method used**

Breakpoint guidelines	Disk diffusion methods				Automated methods			
	N	% S	% I	% R	N	% S	% I	% R
EUCAST and EUCAST-related	242	80.6	16.9	2.5	282	34.0	61.4	4.6
CLSI	56	83.9	10.7	5.4	91	78.0	19.8	2.2

Table A1.7. ***Klebsiella pneumoniae*** **(2 487). Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories (Ref 1 and Ref 2) and the overall concordance of the participating laboratories**

Antibiotic agent	MIC (mg/L)		Result	
	Ref 1	Ref 2	EUCAST/CLSI	Overall concordance (%)
Amikacin	16		I/S	73.5
Amoxicillin	≥128		R	100
Amoxicillin-clavulanic acid	≥ 128(64)*		R	98.6
Ampicillin	≥ 128		R	100
Cefotaxime	≥ 128		R	98.8
Ceftazidime	≥ 128		R	98.9
Ceftriaxone	≥ 128		R	99.2
Ciprofloxacin	≥ 128		R	100
Doripenem	–		R**	98.6
Ertapenem	≥ 128		R	99.0
Gentamicin	1		S	97.3
Imipenem	64		R	98.5
Levofloxacin	–		R**	100
Meropenem	≥ 128		R	99.0
Ofloxacin	–		R**	100
Piperacillin-tazobactam	≥ 128		R	98.8
Tobramycin	16		R	97.0
ESBL	–		Negative	67.2

* Amoxicillin-clavulanic acid: fixed 2 mg/L (ratio)
** The assigned result was based on participant consensus

(Table A1.8), although despite the susceptible interpretation of reference MICs according to CLSI guidelines, 66.7 % of CLSI users reported either intermediate or resistant.

Participants following EUCAST or EUCAST-related guidelines were less likely to report the intended amikacin intermediate result if they used disk diffusion methods than if they used automated methods (Table A1.9). This difference in reporting between participants using disk diffusion or automated methods was also seen among those using CLSI guidelines, but there was less difference than with EUCAST or EUCAST-related guidelines (Table A1.9).

EUCAST expert rules note that acquired AAC(6')I may not confer phenotypic resistance to amikacin despite modification of amikacin, and that such organisms should be reported intermediate even if they appear susceptible. This rule is under review by EUCAST and may be removed from the next version, but, in line with the current expert rule, some participants may have edited susceptible test results to intermediate.

Specimen 2488 – *Staphylococcus aureus*

This organism was a *Staphylococcus aureus* with low-level resistance to vancomycin and teicoplanin (VISA). Detection of reduced susceptibility to glycopeptide agents in *S. aureus* is difficult and this was reflected in the failure of many participants to detect reduced susceptibility (Table A1.10).

Of 819 participants reporting vancomycin susceptibility, only 42.1 % reported resistant and 9.8 % intermediate, while 48.1 % incorrectly reported susceptible. Reduced susceptibility to teicoplanin was more readily detected, and of 720 participants reporting teicoplanin susceptibility, 75.0 % reported resistant, 9.7 % intermediate and 15.3 % susceptible.

Isolates of *S. aureus* with vancomycin MICs of 4–8 mg/L were originally termed 'vancomycin intermediate *S. aureus*' (VISA) because the level of resistance is low and is distinguishable from the high-level resistance displayed by *S. aureus* carrying the *vanA* gene (MICs >8 mg/L). While CLSI have maintained this distinction, EUCAST does not have an intermediate category because VISA strains are clinically resistant. A lower proportion of participants incorrectly reported susceptible among the participants following EUCAST or EUCAST-related guidelines than among those following CLSI guidelines. In line with the difference in reporting guidelines, most non-susceptible reports with CLSI guidelines were in the intermediate category while with EUCAST guidelines most were in the resistant category (Table A1.11).

MICs of teicoplanin for VISA are usually higher than vancomycin MICs, and reduced susceptibility to glycopeptides may be more readily detected with teicoplanin than with vancomycin. While EUCAST breakpoints for teicoplanin are set to report all VISA isolates as teicoplanin resistant (S ≤2 mg/L, R >2 mg/L), CLSI breakpoints are significantly higher (S ≤8 mg/L, R ≥32 mg/L) and VISA isolates are borderline susceptible–intermediate. In line with the differences in breakpoints, participants following EUCAST or EUCAST-related guidelines mostly reported teicoplanin-resistant while participants following CLSI guidelines were most likely to report susceptible or intermediate (Table A1.11).

Reduced susceptibility to glycopeptides in *S. aureus* cannot be reliably detected by disk diffusion methods and EUCAST and CLSI both state that disk diffusion should not be used. In total, 319 participants reported disk diffusion as their method for vancomycin and 79 participants reported disk diffusion zone diameters. However, most of the 319 also reported an MIC value and clearly set up an MIC test instead of or as well as disk diffusion. Of 16 participants apparently using only a disk diffusion method, presumably with historical outdated breakpoints, 14 (87.5 %) reported the isolate vancomycin-susceptible. Of 370 reporting use of a MIC method or giving a MIC result other than with an automated system, 41.4 % reported the isolate vancomycin-susceptible. Of 430 reporting use of an automated method, 50.5 % reported the isolate vancomycin-susceptible. While MIC methods were most reliable in detecting reduced susceptibility to vancomycin and disk diffusion clearly unreliable, none of the methods performed well and overall there are serious concerns regarding the ability of participants to detect vancomycin resistance in VISA isolates.

Specimen 2489 – *Streptococcus pneumoniae*

This organism was a *Streptococcus pneumoniae* with reduced susceptibility to penicillin (MIC 0.25–0.5 mg/L). 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 and route of administration. Patients with pneumonia caused by strains with intermediate susceptibility (MIC 0.12–2 mg/L) are, depending on the parenteral dosage, treatable with benzylpenicillin, ampicillin or amoxicillin. Hence, such strains may be reported susceptible if from pneumonia. Patients with meningitis caused by strains with penicillin MIC >0.0 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. In this distribution, data were collected on results of the oxacillin screen test, penicillin reporting without a site of infection, and the interpretation that would be reported if the isolate was from a case of pneumonia and if the isolate was from a case of meningitis. Irrespective of recommendations by EUCAST and CLSI, reporting practices vary considerably and, as noted previously for distributions of *S. pneumoniae* with intermediate susceptibility to penicillin, this is reflected in the variability of responses.

Of 487 participants reporting a result for oxacillin (screening test for penicillin resistance), 86.9 % reported resistant, 4.5 % intermediate and 8.6 % susceptible. There were no significant differences in reporting oxacillin susceptibility between those following EUCAST or EUCAST-related guidelines and those following CLSI guidelines (Table A1.13). There were no problems in detecting reduced susceptibility to oxacillin in reference tests by EUCAST and CLSI methods (zone diameters around 12 mm). EUCAST and CLSI guidelines do not include an intermediate category for oxacillin as the oxacillin screening test is not considered to distinguish reliably between isolates with different degrees of reduced susceptibility; so reports of intermediate are inappropriate. As the oxacillin disk susceptibility test is a screening test that requires MIC determination to distinguish degrees of reduced susceptibility to benzylpenicillin reliably, it may be more appropriate to report non-susceptible isolates as 'non-susceptible' rather than resistant.

It is unclear how different participants interpreted the result for penicillin without a site of infection. Overall, 70.4 % reported the isolate as being of intermediate susceptibility to penicillin, with 7.2 % reporting resistant and 22.4 % susceptible. The differences relate partly to guidelines followed as reports of intermediate were more common among participants using EUCAST and EUCAST-related guidelines than among those using CLSI guidelines (Table A1.13), but may also partly relate to national or local differences in reporting practices.

If the isolate was from a case of pneumonia, 57.1 % of participants would report penicillin-susceptible, 40.4 % intermediate and only 2.5 % resistant. The differences in reporting for pneumonia again may partly relate to differences in reporting practices. Some participants may apply the guidelines for isolates other than meningitis without allowing for the high doses used to treat pneumonia. Some may report susceptible because higher doses are always used to treat pneumonia and variation in dosing listed by EUCAST would not affect reporting if the MIC is 0.25–0.5 mg/L. Some may report intermediate because susceptibility is dose-dependent and clinicians are left to interpret based on the dose they use. The CLSI guidelines do not distinguish different options among sites of infection other than meningitis and participants following CLSI guidelines were more likely to report susceptible than those using EUCAST or EUCAST-related guidelines (Table A1.13).

If the isolate was from a case of meningitis, 94.1 % of 781 participants would report resistant, 2.2 % intermediate and 3.7 % susceptible. Both EUCAST and CLSI guidelines indicate that if the isolate is from a case of meningitis, it should be reported resistant to penicillin, and there were no significant differences in reporting susceptibility between those following EUCAST or EUCAST-related guidelines and those following CLSI guidelines (Table A1.13).

The organism was susceptible to fluoroquinolones. Of 628 participants reporting susceptibility to levofloxacin, 98.7 % reported susceptible, and of 472 reporting susceptibility to moxifloxacin, 98.9 % reported susceptible. However, of 289 participants using the norfloxacin screening disk method, which is included in EUCAST guidelines, only 88.2 % reported susceptible and 11.8 % reported resistant.

Specimen 2490 – *Enterococcus faecium*

This organism was an *Enterococcus faecium* with high-level resistance to gentamicin (Table A1.14).

There were more discrepancies than seen previously for enterococci with high-level resistance to gentamicin, with 9.1 % of participants incorrectly reporting that the isolate was negative in tests for high-level resistance. High-level resistance to gentamicin can be unstable, although this was not seen in reference tests. In disk diffusion tests, unstable resistance may be seen as a zone of inhibition with isolated colonies within the zone. No comments describing this phenomenon were made by participants and failure to detect high-level resistance was only marginally more common among participants using disk diffusion (10.8 % of 315) than among those using automated methods (7.8 % of 399). The 157 participants following CLSI guidelines were less likely to detect high-level gentamicin resistance (82.8 % positive) than the 620 following EUCAST or EUCAST-related guidelines (92.9 % positive).

Table A1.8. *Klebsiella pneumoniae* (2487). Reported amikacin susceptibility results and clinical breakpoint guidelines used

	EUCAST and EUCAST-related guidelines				CLSI guidelines			
Antibiotic agent	N	% S	% I	% R	N	% S	% I	% R
Amikacin	590	8.0	62.3	28.8	156	33.3	48.7	18.0

Table A1.9. *Klebsiella pneumoniae* (2487). Reported amikacin susceptibility results, clinical breakpoint guidelines and method used

Breakpoint guidelines	Disk diffusion methods				Automated methods			
	N	% S	% I	% R	N	% S	% I	% R
EUCAST and EUCAST-related	246	13.4	53.7	32.9	289	3.5	73.7	22.8
CLSI	56	23.2	44.6	32.2	94	38.3	51.1	10.6

Specimen 2491 – *Acinetobacter baumannii* complex

This organism was an *Acinetobacter baumannii* complex isolate with a GES-12 carbapenemase and there were no significant problems detecting resistance to carbapenems. The organism was also resistant to gentamicin (MIC 32–64 mg/L), tobramycin (MIC 32 mg/L) and amikacin (MIC ≥128 mg/L) by both EUCAST and CLSI guidelines (Table A1.15).

With EUCAST guidelines, there is no intermediate category to gentamicin or tobramycin (S ≤4, R >4 mg/L for both agents) but CLSI include an intermediate category (S ≤4, R ≥16 mg/L for both agents). The difference in breakpoints was reflected in more frequent intermediate reports by participants using CLSI guidelines with gentamicin and tobramycin. For amikacin, an intermediate category is included for both EUCAST (S ≤8, R >16 mg/L) and CLSI (S ≤16, R ≥64 mg/L), but CLSI breakpoints are higher and these differences were again reflected in reporting by participants, with fewer reports of resistance with CLSI breakpoints (Table A1.16).

For gentamicin, tobramycin and amikacin with all guidelines, reports of resistant were less common among participants using automated methods than among those using disk diffusion methods (Table A1.17).

Table A1.10. ***Staphylococcus aureus*** **(2 488). Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories (Ref 1 and Ref 2) and the overall concordance of the participating laboratories**

Antibiotic agent	MIC (mg/L)		Result	
	Ref 1	Ref 2	EUCAST/CLSI	Overall concordance (%)
Cefoxitin	≥ 128		R	99.6
Ciprofloxacin	16		R	99.0
Clindamycin	≥ 128		R	99.7
Erythromycin	≥ 128		R	99.9
Fusidic acid	0.12	0.06	S/–	98.9
Gentamicin	128	256	R	99.6
Oxacillin	≥ 128		R	100
Penicillin	64		R	99.9
Rifampicin	≥ 128		R	99.6
Teicoplanin	8	16	R(S/I)	75.0
Tetracycline	64		R	98.0
Vancomycin	4		R/I	51.9

Table A1.11. ***Staphylococcus aureus*** **(2488). Reported vancomycin and teicoplanin susceptibility results and clinical breakpoint guidelines used**

Antibiotic agent	EUCAST and EUCAST-related guidelines				CLSI guidelines			
	N	%S	%I	%R	N	%S	%I	%R
Vancomycin	655	45.8	2.4	51.8	164	57.3	39.0	3.7
Teicoplanin	573	7.2	1.0	91.8	147	47.0	43.5	9.5

Table A1.12. ***Streptococcus pneumoniae*** **(2489). Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories (Ref 1 and Ref 2) and the overall concordance of the participating laboratories**

Antibiotic agent	MIC (mg/L)		Result	
	Ref 1	Ref 2	EUCAST/CLSI	Overall concordance (%)
Cefotaxime				
meningitis				99.7
pneumonia	0.12	0.06	S	98.7
non-meningitis				99.3
Ceftriaxone				
meningitis				99.2
pneumonia	0.12	0.25	S	99.8
non-meningitis				97.4
Clindamycin	–		R*	96.1
Erythromycin	≥ 128		R	98.5
Levofloxacin	1		S	98.7
Moxifloxacin	0.12		S	98.9
Norfloxacin	Screening test		S*	88.2
Oxacillin	Screening test		R	86.9
Penicillin				
meningitis			R	94.1
pneumonia	0.25	0.5	S/–	51.4
non-meningitis			–/S	86.5

* The assigned result was based on participant consensus

Table A1.13. ***Streptococcus pneumoniae*** **(2489). Reported oxacillin and penicillin susceptibility results and clinical breakpoint guidelines used**

Antibiotic agent	EUCAST and EUCAST-related guidelines				CLSI guidelines			
	N	% S	% I	% R	N	% S	% I	% R
Oxacillin	403	8.9	5.0	86.1	84	7.1	2.4	90.5
Penicillin	563	17.4	75.5	7.1	116	46.5	45.7	7.8
Penicillin (pneumonia)	627	49.9	47.2	2.9	156	86.5	13.5	0.0
Penicillin (meningitis)	625	3.7	2.4	93.9	156	3.8	1.3	94.9

Table A1.14. ***Enterococcus faecium*** **(2 490). Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories (Ref 1 and Ref 2) and the overall concordance of the participating laboratories**

Antibiotic agent	MIC		Result	
	Ref 1	Ref 2	EUCAST/CLSI	Overall concordance (%)
Amoxicillin	32		R	94.2
Ampicillin	32	64	R	98.9
HLR gentamicin	>512		Positive (deteced)	90.9
Teicoplanin	1		S	99.7
Vancomycin	1		S	99.4

Table A1.15. ***Acinetobacter baumannii*** **complex (2 491). Minimum inhibitory concentration (MIC) and intended results reported by the reference laboratories (Ref 1 and Ref 2) and the overall concordance of the participating laboratories**

Antibiotic agent	MIC		Result	
	Ref 1	Ref 2	EUCAST/CLSI	Overall concordance (%)
Amikacin	≥ 128		R	88.3
Ciprofloxacin	64	≥ 128	R	99.9
Colistin	0.5	1	S	98.3
Doripenem	–	–	R*	98.8
Gentamicin	32	64	R	85.9
Imipenem	32	64	R	99.7
Meropenem	54	≥ 128	R	99.9
Tobramycin	32		R	85.6

* The assigned result was based on participant consensus

Table A1.16. ***Acinetobacter baumannii*** **complex (2491). Reported gentamicin, tobramycin and amikacin susceptibility results and clinical guidelines used**

Antibiotic agent	EUCAST and EUCAST-related guidelines				CLSI guidelines			
	N	% S	% I	% R	N	% S	% I	% R
Gentamicin	640	5.6	0.5	93.9	162	8.0	37.7	54.3
Tobramycin	544	6.4	0.3	93.3	131	16.0	29.8	54.2
Amikacin	549	0.5	9.1	90.4	146	8.9	10.3	80.8

Table A1.17. ***Acinetobacter baumannii*** **complex (2491). Reported gentamicin, tobramycin and amikacin susceptibility results and methods used**

Antibiotic agent	All disk diffusion methods				All automated methods			
	N	% S	% I	% R	N	% S	% I	% R
Gentamicin	313	2.9	4.8	92.3	420	8.3	11.0	80.7
Tobramycin	267	3.7	3.0	93.3	352	12.2	9.4	78.4
Amikacin	301	1.3	3.0	95.7	333	3.6	16.2	80.2

Annex 2. EARS-Net laboratory/hospital denominator data 2014

Laboratory and hospital denominator data have been collected and presented in this Annex to aid the correct interpretation of the EARS-Net data on antimicrobial resistance.

Methods

Questionnaires were sent to the EARS-Net nominated contact points in March 2015. The contact points distributed the questionnaires to the participating laboratories and hospitals in their country. Information was collected on the total number of blood culture sets processed in the laboratories, and the number of hospital beds for each participating hospital, the type of hospital, the bed occupancy and the number of admissions. The national data managers received the completed questionnaires, compiled them and produced the final format suitable for uploading to The European Surveillance System (TESSy). Laboratories were defined as reporting denominator data if they provided the number of blood culture sets performed for one or more hospitals. Hospitals were defined as reporting denominator data if they provided the number of beds.

Organisation of healthcare systems and affiliation between laboratories and hospitals differs considerably between countries, which might influence data comparability. For countries submitting denominator data for a small percentage of hospitals or laboratories contributing data to EARS-Net, the reported figures might not be representative for the overall country profile.

Participation

Nineteen of the 29 countries reporting AMR data for 2014 also returned hospital denominator data referring to the same year, while for three countries, hospital denominator data referring to 2013 were available and included in the analysis. Eighteen countries could provide sufficient laboratory denominator data to calculate the number of blood culture sets per 1000 patient days for 2014 and two for 2013.

Population coverage

Data on population coverage for AMR data at country level are not reported because of their inherent limitations. Some laboratories and hospitals that report AST data do not provide denominator data. This would introduce bias into the calculation of country population coverage since only those laboratories and hospitals that report denominator data can be included. Secondly, laboratories and hospitals cluster in big cities and, for this reason, some of the catchment areas overlap. This could lead to double counts, which would artificially increase the estimated coverage.

Hospital denominator information

The total number of hospital beds for hospitals reporting both AMR and denominator data ranged from 1331 in Cyprus to 87975 in France, reflecting the size of the country as well as the rate of participation in EARS-Net and the rate of response to the questionnaires.

The percentage of ICU beds over total hospital beds shows wide variation by country, ranging from 2% in Hungary, to 13% in the Czech Republic. The overall median length of stay in hospital was 5.9 days with the lowest median in the United Kingdom (3.8 days) and the highest in Malta (12.2 days). The length of stay in Malta is influenced by the inclusion of a long-term care facility. The annual occupancy rate was 85% or higher in four of the 21 countries providing data for this variable (Table A2.1).

Hospital characteristics

Both the size of a hospital and the level of specialisation may influence the occurrence of antimicrobial resistance in the hospital. As can be seen from Table A2.2 and Figure A2.1, the distribution of size and specialisation level of hospitals varied considerably between the reporting countries. This does not necessarily reflect different distributions of the origin of EARS-Net blood cultures per country, as not all hospitals contribute evenly to the EARS-Net database. On the other hand, this diversity can indicate differences in case-mix, which may confound comparison of AMR results between countries.

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

Laboratory denominator information

In 2014/2013 (latest available data), a median of 30 blood culture sets per 1000 patient days were processed in the EARS-Net laboratories responding to the questionnaire. The highest rate was reported by Sweden (66.2 cultures per 1000 patient days) and the lowest by Bulgaria (6.6 cultures per 1000 patient days) (Table A2.3). For the majority of the reporting countries, there are only minor changes in the number of blood culture sets per 1 000 patient days when comparing 2014/2013 (latest available data) data with 2012/2011 (latest available data).

Table A2.1. Hospital denominator data for 2013 or 2014 (using the latest available data)

Country	Number of hospitals reporting		Total number of beds	Percentage of ICU beds (%)	Annual occupancy rate (%)	Median length of stay (days)	IQR length of stay (days)
	Denominator data	AMR data					
Austria	136	155	54586	6	65	4.3	3.7–5.3
Bulgaria*	19	20	8862	7	74	5.4	4.9–6.0
Cyprus	5	6	1331	8	78	5.2	4.9–6.1
Czech Republic	61	69	29409	13	77	6.4	5.8–7.4
Estonia	13	13	5174	6	75	6.5	5.9–7.5
Finland*	14	18	9795	4	–	–	(–)
France	146	168	87975	8	79	5.6	5.1–6.0
Germany	44	242	15237	7	80	6.1	5.5–7.2
Hungary	71	72	55901	2	73	7.9	6.9–10.2
Ireland	53	57	11829	–	90	4.7	3.9–6.5
Italy	40	48	24321	4	80	6.9	6.1–8.1
Latvia	17	19	5735	4	71	5.9	5.4–7.0
Lithuania*	22	34	11944	4	69	7.0	6.2–9.4
Malta	3	3	1487	4	89	12.2**	3.3–73.9
Norway	16	51	10737	–	85	3.9	3.8–4.2
Portugal	69	85	20073	5	74	6.8	2.1–7.9
Romania	16	16	6305	–	70	6.0	5.9–6.3
Slovakia	26	26	13509	8	69	6.6	5.5–7.2
Slovenia	16	16	7447	5	71	5.3	4.6–6.0
Spain	39	43	23689	5	75	–	(–)
Sweden	33	46	10322	5	95	–	(–)
United Kingdom	37	106	26523	6	79	3.8	2.6–4.6

-: No information available
* Data from 2013
** Includes data from a long-term care facility

Table A2.2. Hospital characteristics for 2013 or 2014 (using the latest available data)

Country	Number of hospitals reporting		Percentage of hospitals by level of care				
	Denominator data	AMR data	Tertiary level	Secondary level	Primary level	Other	Unknown
Austria	136	155	9	26	40	25	0
Bulgaria*	19	20	63	32	5	0	0
Cyprus	5	6	20	20	40	20	0
Czech Republic	61	69	33	30	21	2	15
Estonia	13	13	44	44	12	0	0
Finland*	14	18	64	36	0	0	0
France	146	168	34	65	0	0	0
Germany	44	242	23	36	32	9	0
Hungary	71	72	46	25	13	15	0
Ireland	53	57	17	51	15	17	0
Italy	40	48	58	35	5	0	2
Latvia	17	19	41	47	0	12	0
Lithuania*	22	34	45	23	23	9	0
Malta	3	3	33	33	0	33	0
Norway	16	51	56	25	19	0	0
Portugal	69	85	41	13	23	16	7
Romania	16	16	11	44	0	44	0
Slovakia	26	26	58	15	8	19	0
Slovenia	16	16	13	44	25	19	0
Spain	39	43	59	23	18	0	0
Sweden	33	46	15	45	39	0	0
United Kingdom	37	106	41	32	8	5	14

* Data from 2013

Discussion and conclusions

In summary, the situation for most countries as assessed from denominator data reported to EARS-Net in 2014/2013 appears stable and similar to 2012. This indicates that based on EARS-Net data, the comparison of resistance percentages over time remains valid.

The ascertainment of blood-stream infections is strongly linked to the blood culture rate. Therefore, the wide range in blood culture rates observed in the countries providing denominator data has implications for inter-country comparisons of both the incidence of infections, which could be underestimated in some countries, and of the percentage of resistance. In particular, the percentage of resistance could be overestimated if blood cultures are not systematically performed before starting empiric therapy and if blood cultures are more likely to be performed in patients not responding to initial empiric treatment.

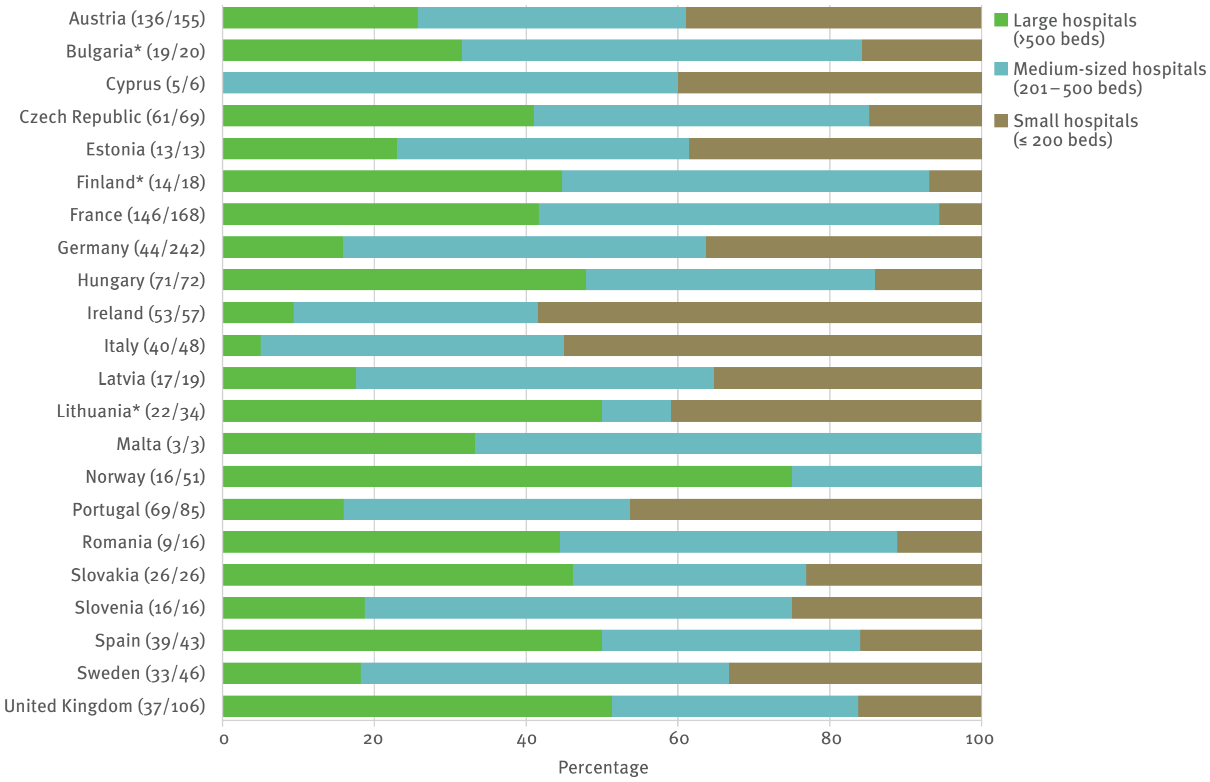
For future improvement of the denominator data collection and analysis, a further increase in the number of countries reporting denominator data, as well as an increased number of hospitals and laboratories participating within countries, would be desirable. Furthermore, an improved estimation of the coverage of the EARS-Net surveillance, e.g. by using national estimations based on knowledge of the country-specific situation, would also be desirable.

Table A2.3. Laboratory denominator information for 2014 or 2013 (using the latest available data)

Country	Number of laboratories reporting		Number of hospitals	Total number of blood culture sets	Number of blood culture sets per 1000 patient days
	Denominator data	AMR data			
Austria	37	39	136	207792	16.0
Bulgaria*	19	20	19	15881	6.6
Cyprus	5	5	5	14604	38.7
Czech Republic	37	47	49	121392	16.8
Estonia	11	11	13	23965	16.7
France	146	168	146	896902	35.1
Germany	10	21	44	72224	16.3
Hungary	28	30	57	124673	9.8
Ireland	37	40	52	204933	53.5
Italy	35		40	280875	41.9
Latvia	14	14	17	11314	7.6
Lithuania*	11	11	22	21038	7.0
Malta	1	1	3	10170	21.0
Norway	16	19	16	184109	55.4
Portugal	47	57	62	308579	58.5
Romania	9	16	9	39992	24.9
Slovakia	14	14	26	66283	19.4
Slovenia	10	10	16	66646	34.8
Sweden	15	16	33	299070	66.2
United Kingdom	9	61	11	127706	44.5

* Data from 2013

Figure A2.1. Percentage of small, medium and large hospitals per country, based on number of beds, for all hospitals reporting both antimicrobial resistance data and denominator data in 2014 or 2013 (using latest available data)



* Data from 2013

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 2003–2014. 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 2003–2014

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.

Austria

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter* spp	
	Labs	Isolates	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	426	38	2543	38	4390	38	1113	38	947	38	618	18	51
2014	39	410	39	2662	39	4757	39	1140	39	996	39	638	21	79

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	1	1	<1	<1	2	<1	3	2	2	1	<1	2
Penicillin RI	9	5	5	5	5	5	5	4	3	5	2	5
Macrolides RI	13	13	15	13	13	12	14	11	12	18	10	11
Staphylococcus aureus												
Oxacillin/meticillin R	15	14	14	9	11	8	6	7	7	8	9	8
Escherichia coli												
Aminopenicilins R	41	46	49	53	53	50	49	51	50	51	51	50
Aminoglycosides R	5	6	6	8	8	7	6	6	7	6	7	7
Fluoroquinolones R	14	17	19	22	26	23	20	21	22	21	22	20
Third-generation cephalosporins R	2	3	4	7	9	7	8	7	9	9	10	9
Carbapenems R	<1	<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	2
HL gentamicin R	33	23	29	29	30	21	31	32	31	29	31	37
Vancomycin R	<1	<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	94
HL gentamicin R	22	22	30	21	28	19	31	42	49	38	45	49
Vancomycin R	<1	<1	1	<1	2	2	4	4	5	3	6	4
Klebsiella pneumoniae												
Aminoglycosides R	–	–	3	5	5	6	4	6	7	5	5	6
Fluoroquinolones R	–	–	11	8	13	12	8	18	17	15	16	10
Third-generation cephalosporins R	–	–	6	6	8	8	8	13	13	12	11	8
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	1	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	13	8	6	8	6	9	14	18	13	12
Ceftazidime R	–	–	7	9	5	6	6	8	11	14	10	9
Carbapenems R	–	–	10	15	12	11	9	14	14	15	12	13
Aminoglycosides R	–	–	6	10	8	8	8	11	13	11	7	7
Fluoroquinolones R	–	–	14	15	15	12	13	16	19	14	15	11
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	–	22	5
Aminoglycosides R	–	–	–	–	–	–	–	–	–	–	10	9
Carbapenems R	–	–	–	–	–	–	–	–	–	–	8	6

Belgium

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	2	3
2014	96	1181	27	1034	27	2895	25	558	26	506	27	357	3	4

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	<1	<1	3	4	3	<1	<1	<1	<1	<1	<1	<1
Penicillin RI	12	9	12	10	9	8	<1	<1	<1	2	2	1
Macrolides RI	34	33	31	31	25	24	23	25	26	25	23	18
Staphylococcus aureus												
Oxacillin/meticillin R	30	33	31	22	23	21	21	21	17	17	17	13
Escherichia coli												
Aminopenicilins R	50	50	53	54	57	55	56	57	59	56	57	59
Aminoglycosides R	5	5	4	6	5	4	7	6	9	6	6	8
Fluoroquinolones R	12	15	17	19	19	17	20	22	22	22	23	27
Third-generation cephalosporins R	3	3	4	3	4	4	6	5	6	7	8	10
Carbapenems R	–	–	–	–	–	–	–	<1	<1	<1	<1	<1
Enterococcus faecalis												
Aminopenicilins RI	1	2	<1	<1	<1	3	1	2	2	2	3	<1
HL gentamicin R	17	22	26	30	26	30	23	18	18	25	28	23
Vancomycin R	1	<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	85
HL gentamicin R	<1	11	22	19	23	17	32	30	33	39	29	30
Vancomycin R	<1	5	14	4	<1	5	4	3	7	1	2	3
Klebsiella pneumoniae												
Aminoglycosides R	–	–	–	–	–	–	10	2	8	11	10	10
Fluoroquinolones R	–	–	–	–	–	–	13	13	15	17	22	18
Third-generation cephalosporins R	–	–	–	–	–	–	15	13	14	16	15	16
Carbapenems R	–	–	–	–	–	–	1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	–	–	–	–	7	12	15	10	13	10
Ceftazidime R	–	–	–	–	–	–	6	7	9	8	9	9
Carbapenems R	–	–	–	–	–	–	9	5	11	10	11	10
Aminoglycosides R	–	–	–	–	–	–	12	11	13	12	13	10
Fluoroquinolones R	–	–	–	–	–	–	16	12	21	18	17	13
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	–	#	#
Aminoglycosides R	–	–	–	–	–	–	–	–	–	–	#	#
Carbapenems R	–	–	–	–	–	–	–	–	–	–	#	#

Less than 10 isolates reported, data not displayed.

Bulgaria

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	11	65
2013	14	29	20	214	17	187	19	154	17	138	13	60	13	94
2014	12	32	20	216	20	218	19	182	17	151	12	48	15	115

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	9	22	30	7	9	21	22	18	21	29	21	25
Penicillin RI	14	22	33	7	16	21	37	18	21	29	21	25
Macrolides RI	11	17	8	15	17	4	27	25	13	20	19	27
Staphylococcus aureus												
Oxacillin/meticillin R	31	23	29	28	13	25	16	19	22	20	19	21
Escherichia coli												
Aminopenicilins R	54	64	69	64	70	65	66	72	61	71	74	73
Aminoglycosides R	22	20	24	28	20	31	18	16	17	26	32	28
Fluoroquinolones R	19	24	29	26	35	32	28	33	30	34	37	39
Third-generation cephalosporins R	18	22	28	29	23	29	19	25	23	38	40	40
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	3	3	<1
Enterococcus faecalis												
Aminopenicilins RI	7	15	8	31	13	8	16	5	6	12	2	3
HL gentamicin R	36	33	24	53	29	44	36	41	31	38	47	40
Vancomycin R	<1	2	<1	2	<1	<1	<1	<1	<1	<1	3	<1
Enterococcus faecium												
Aminopenicilins RI	60	59	96	97	100	93	96	100	84	95	88	97
HL gentamicin R	60	62	56	79	75	84	65	71	79	71	77	78
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2	13
Klebsiella pneumoniae												
Aminoglycosides R	–	–	53	60	59	59	65	69	72	54	57	64
Fluoroquinolones R	–	–	26	24	41	52	48	52	51	47	46	50
Third-generation cephalosporins R	–	–	50	60	55	73	69	76	81	75	70	75
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	2	<1	7
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	50	33	14	48	33	15	23	26	14	31
Ceftazidime R	–	–	45	13	21	55	23	19	31	35	13	30
Carbapenems R	–	–	38	14	7	17	24	31	29	31	14	29
Aminoglycosides R	–	–	53	42	29	48	31	21	38	33	20	31
Fluoroquinolones R	–	–	47	17	14	36	33	21	30	33	18	27
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	69	70	74
Aminoglycosides R	–	–	–	–	–	–	–	–	–	59	58	64
Carbapenems R	–	–	–	–	–	–	–	–	–	60	60	59

Croatia

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	13	114
2014	14	129	16	485	18	1080	16	220	16	334	16	232	15	167

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	–	–	–	–	–	–	–	23	<1	1	3	<1
Penicillin RI	–	–	–	–	–	–	–	23	18	23	26	26
Macrolides RI	–	–	–	–	–	–	–	29	24	10	33	28
Staphylococcus aureus												
Oxacillin/meticillin R	–	–	–	–	–	–	–	26	28	21	24	21
Escherichia coli												
Aminopenicilins R	–	–	–	–	–	–	–	53	55	51	54	54
Aminoglycosides R	–	–	–	–	–	–	–	7	8	7	8	11
Fluoroquinolones R	–	–	–	–	–	–	–	17	20	17	20	20
Third-generation cephalosporins R	–	–	–	–	–	–	–	9	10	8	9	11
Carbapenems R	–	–	–	–	–	–	–	<1	<1	<1	<1	<1
Enterococcus faecalis												
Aminopenicilins RI	–	–	–	–	–	–	–	5	1	5	10	7
HL gentamicin R	–	–	–	–	–	–	–	30	35	38	35	33
Vancomycin R	–	–	–	–	–	–	–	<1	1	<1	<1	<1
Enterococcus faecium												
Aminopenicilins RI	–	–	–	–	–	–	–	82	98	98	89	94
HL gentamicin R	–	–	–	–	–	–	–	60	63	60	56	63
Vancomycin R	–	–	–	–	–	–	–	10	2	<1	7	10
Klebsiella pneumoniae												
Aminoglycosides R	–	–	–	–	–	–	–	49	44	46	51	49
Fluoroquinolones R	–	–	–	–	–	–	–	47	42	43	43	45
Third-generation cephalosporins R	–	–	–	–	–	–	–	56	48	52	50	48
Carbapenems R	–	–	–	–	–	–	–	2	<1	<1	<1	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	–	–	–	–	–	16	23	22	24	25
Ceftazidime R	–	–	–	–	–	–	–	11	18	12	19	24
Carbapenems R	–	–	–	–	–	–	–	29	30	26	25	35
Aminoglycosides R	–	–	–	–	–	–	–	26	35	25	24	35
Fluoroquinolones R	–	–	–	–	–	–	–	26	35	24	22	30
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	–	93	92
Aminoglycosides R	–	–	–	–	–	–	–	–	–	–	92	88
Carbapenems R	–	–	–	–	–	–	–	–	–	–	90	97

Cyprus

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter* spp	
	Labs	Isolates	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	5	23
2013	4	15	5	160	5	162	5	97	5	68	5	47	5	33
2014	4	12	5	138	5	153	5	115	5	80	5	42	5	58

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	<1	<1	<1	31	7	21	18	33	25	25	40	<1
Penicillin RI	<1	14	19	38	33	43	36	42	25	25	40	<1
Macrolides RI	33	<1	13	31	27	29	36	55	25	14	27	<1
Staphylococcus aureus												
Oxacillin/meticillin R	64	49	56	34	48	46	33	32	42	35	32	36
Escherichia coli												
Aminopenicilins R	63	61	72	62	72	58	66	62	78	70	77	71
Aminoglycosides R	11	11	13	10	11	10	10	16	24	21	25	18
Fluoroquinolones R	32	22	29	35	39	45	43	43	47	42	52	46
Third-generation cephalosporins R	11	9	16	16	18	19	14	20	36	32	39	29
Carbapenems R	<1	<1	<1	<1	2	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis												
Aminopenicilins RI	<1	3	3	5	2	16	32	6	2	1	<1	<1
HL gentamicin R	43	77	71	44	61	65	66	24	19	10	27	18
Vancomycin R	<1	3	<1	<1	<1	1	<1	<1	4	<1	<1	<1
Enterococcus faecium												
Aminopenicilins RI	100	100	80	43	92	60	80	78	82	76	90	83
HL gentamicin R	–	33	<1	14	33	10	13	<1	6	<1	3	11
Vancomycin R	<1	33	40	14	25	20	13	<1	<1	10	23	40
Klebsiella pneumoniae												
Aminoglycosides R	–	–	11	12	13	21	19	19	28	18	25	29
Fluoroquinolones R	–	–	22	12	23	23	43	39	36	22	24	26
Third-generation cephalosporins R	–	–	33	27	31	35	42	34	41	23	31	33
Carbapenems R	–	–	<1	<1	3	10	17	16	16	9	6	5
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	13	27	31	23	18	19	20	10	9	17
Ceftazidime R	–	–	38	24	15	9	18	17	24	15	13	24
Carbapenems R	–	–	13	11	19	19	8	29	43	19	19	33
Aminoglycosides R	–	–	13	11	25	21	5	10	16	15	4	10
Fluoroquinolones R	–	–	13	27	23	38	13	17	14	15	11	17
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	57	61	78
Aminoglycosides R	–	–	–	–	–	–	–	–	–	52	61	78
Carbapenems R	–	–	–	–	–	–	–	–	–	57	61	78

Czech Republic

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	19	91
2014	45	274	44	1695	45	2981	42	775	44	1383	40	448	18	59

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	<1	2	<1	<1	<1	<1	<1	<1	<1	<1	2	3
Penicillin RI	2	6	4	2	4	3	4	5	4	3	2	6
Macrolides RI	2	4	2	3	5	3	5	6	3	8	9	8
Staphylococcus aureus												
Oxacillin/meticillin R	6	9	13	12	13	14	15	13	15	13	13	13
Escherichia coli												
Aminopenicilins R	45	47	50	56	56	60	61	59	61	57	55	54
Aminoglycosides R	5	5	6	8	7	9	9	8	9	8	9	11
Fluoroquinolones R	13	16	20	23	24	26	23	23	23	21	21	22
Third-generation cephalosporins R	1	2	2	5	7	10	10	10	11	11	13	14
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis												
Aminopenicilins RI	4	<1	<1	2	3	2	<1	8	4	2	1	<1
HL gentamicin R	44	43	45	43	49	49	47	48	46	42	40	39
Vancomycin R	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	4	<1
Enterococcus faecium												
Aminopenicilins RI	80	81	92	90	91	94	98	98	97	98	96	96
HL gentamicin R	48	43	69	74	79	75	65	54	61	69	63	68
Vancomycin R	3	3	14	4	6	8	6	5	8	11	9	4
Klebsiella pneumoniae												
Aminoglycosides R	–	–	36	38	43	42	47	47	45	54	51	51
Fluoroquinolones R	–	–	38	47	48	52	54	55	53	50	48	48
Third-generation cephalosporins R	–	–	32	35	46	48	52	48	48	51	52	53
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	21	29	30	27	28	28	22	26	28	23
Ceftazidime R	–	–	40	30	33	44	29	28	20	20	23	22
Carbapenems R	–	–	31	33	36	29	29	16	13	15	16	14
Aminoglycosides R	–	–	27	29	32	43	33	33	24	24	26	21
Fluoroquinolones R	–	–	45	47	43	46	41	41	34	31	34	33
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	–	20	15
Aminoglycosides R	–	–	–	–	–	–	–	–	–	–	17	10
Carbapenems R	–	–	–	–	–	–	–	–	–	–	4	5

Denmark

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter* spp	
	Labs	Isolates	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	10	83
2013	12	789	12	1685	11	3967	11	1224	11	875	11	414	11	79
2014	11	709	11	1874	10	4496	10	1308	10	943	10	388	10	72

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Penicillin RI	3	3	4	4	3	3	4	4	5	5	7	6
Macrolides RI	5	5	6	6	6	7	4	4	5	6	5	7
Staphylococcus aureus												
Oxacillin/meticillin R	<1	1	2	2	<1	2	2	1	1	1	2	2
Escherichia coli												
Aminopenicilins R	–	–	40	42	43	43	43	46	48	45	46	45
Aminoglycosides R	–	–	2	3	4	4	4	6	6	7	7	7
Fluoroquinolones R	–	–	5	7	9	10	13	14	14	14	12	12
Third-generation cephalosporins R	–	–	1	2	3	4	6	8	8	8	8	7
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis												
Aminopenicilins RI	–	–	–	<1	2	2	1	<1	<1	1	1	<1
HL gentamicin R	–	–	–	–	–	37	33	36	31	28	27	30
Vancomycin R	–	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecium												
Aminopenicilins RI	–	–	–	87	88	88	88	93	93	94	93	94
HL gentamicin R	–	–	–	–	–	61	52	74	73	62	72	66
Vancomycin R	–	–	–	<1	<1	<1	2	2	1	2	3	4
Klebsiella pneumoniae												
Aminoglycosides R	–	–	–	2	6	7	7	6	6	6	4	5
Fluoroquinolones R	–	–	–	6	13	16	16	11	12	9	9	7
Third-generation cephalosporins R	–	–	–	4	10	9	11	11	11	10	12	8
Carbapenems R	–	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	–	–	3	2	2	4	5	5	2	4
Ceftazidime R	–	–	–	–	2	3	4	3	5	5	3	4
Carbapenems R	–	–	–	–	2	1	3	3	5	4	3	5
Aminoglycosides R	–	–	–	–	1	1	<1	1	2	4	5	2
Fluoroquinolones R	–	–	–	–	6	3	5	6	7	4	3	4
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	12	6	3
Aminoglycosides R	–	–	–	–	–	–	–	–	–	10	1	2
Carbapenems R	–	–	–	–	–	–	–	–	–	9	2	2

Estonia

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	–	–
2014	10	72	11	226	11	412	9	81	10	136	7	40	–	–

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	<1	<1	<1	<1	<1	<1	<1	2	2	<1	<1	3
Penicillin RI	<1	<1	2	2	<1	5	1	2	2	<1	1	4
Macrolides RI	10	6	<1	3	2	4	2	4	2	6	3	6
Staphylococcus aureus												
Oxacillin/meticillin R	4	5	2	3	9	4	3	<1	2	8	4	3
Escherichia coli												
Aminopenicilins R	42	55	45	52	50	47	38	37	–	48	46	47
Aminoglycosides R	3	2	4	2	6	5	4	6	5	8	8	7
Fluoroquinolones R	5	6	5	7	7	7	8	8	10	14	12	12
Third-generation cephalosporins R	1	4	1	<1	1	5	2	6	12	8	7	9
Carbapenems R	<1	<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	17
HL gentamicin R	22	32	50	35	23	27	43	27	<1	42	20	37
Vancomycin R	<1	<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	73
HL gentamicin R	50	79	74	78	89	75	79	67	25	63	44	59
Vancomycin R	<1	<1	<1	<1	<1	3	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae												
Aminoglycosides R	–	–	8	9	2	15	15	26	12	13	10	19
Fluoroquinolones R	–	–	<1	5	2	7	19	25	22	17	27	22
Third-generation cephalosporins R	–	–	8	9	3	12	17	17	40	18	23	21
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	1	3	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	27	12	9	18	13	25	<1	16	12	10
Ceftazidime R	–	–	18	7	7	13	7	11	<1	17	<1	7
Carbapenems R	–	–	38	29	18	30	17	21	8	13	10	15
Aminoglycosides R	–	–	26	7	6	17	9	20	<1	24	10	8
Fluoroquinolones R	–	–	14	10	9	18	19	20	6	16	25	10
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	–	–	–
Aminoglycosides R	–	–	–	–	–	–	–	–	–	–	–	–
Carbapenems R	–	–	–	–	–	–	–	–	–	–	–	–

Finland

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter* spp	
	Labs	Isolates	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	11	37
2014	19	659	19	1831	19	4013	19	844	19	583	19	307	14	32

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	2	<1	<1	2	1	<1	2	1	<1	<1	<1	<1
Penicillin RI	10	8	7	12	13	11	13	14	13	17	14	12
Macrolides RI	20	20	20	24	25	24	28	28	24	22	19	14
Staphylococcus aureus												
Oxacillin/meticillin R	1	3	3	3	2	3	2	2	3	2	2	3
Escherichia coli												
Aminopenicilins R	33	33	35	36	34	35	36	34	37	40	37	35
Aminoglycosides R	1	2	2	2	3	4	3	4	5	6	6	5
Fluoroquinolones R	5	7	7	8	8	9	9	9	11	12	13	11
Third-generation cephalosporins R	1	2	2	2	2	2	3	4	5	6	7	5
Carbapenems R	<1	<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	<1
HL gentamicin R	39	39	27	25	22	13	–	–	–	–	–	–
Vancomycin R	<1	<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	84
HL gentamicin R	4	12	1	16	19	15	–	–	–	–	–	–
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae												
Aminoglycosides R	–	–	3	1	<1	1	1	4	1	<1	2	2
Fluoroquinolones R	–	–	3	4	<1	2	3	2	3	2	3	5
Third-generation cephalosporins R	–	–	2	<1	1	2	1	4	2	2	2	2
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	8	8	7	8	7	7	16	8	9	7
Ceftazidime R	–	–	5	3	5	5	5	3	9	5	5	6
Carbapenems R	–	–	15	8	9	6	8	10	11	6	10	7
Aminoglycosides R	–	–	10	8	8	6	4	4	5	2	3	2
Fluoroquinolones R	–	–	16	17	11	15	11	11	15	8	11	10
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	–	3	7
Aminoglycosides R	–	–	–	–	–	–	–	–	–	–	0	3
Carbapenems R	–	–	–	–	–	–	–	–	–	–	0	3

France

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	44	391
2013	229	919	54	5439	54	10157	53	2538	54	1938	54	1884	51	413
2014	150	656	53	5498	53	10350	53	2693	53	2196	53	1789	49	409

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	–	–	5	4	4	7	6	<1	<1	<1	<1	<1
Penicillin RI	43	39	36	32	34	30	27	28	24	23	22	22
Macrolides RI	48	45	41	36	37	31	27	30	26	29	30	23
Staphylococcus aureus												
Oxacillin/meticillin R	29	29	27	27	26	24	23	22	20	19	17	17
Escherichia coli												
Aminopenicilins R	50	47	50	53	54	54	55	55	55	55	55	56
Aminoglycosides R	5	4	5	6	6	7	8	7	8	8	8	8
Fluoroquinolones R	9	8	11	14	15	16	19	18	18	18	17	18
Third-generation cephalosporins R	<1	<1	1	2	2	4	7	7	8	10	10	10
Carbapenems R	<1	<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	<1
HL gentamicin R	16	17	15	16	15	18	18	18	20	17	15	14
Vancomycin R	<1	<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	77
HL gentamicin R	23	21	24	30	30	30	38	41	43	42	42	42
Vancomycin R	<1	5	3	3	1	<1	<1	1	1	<1	<1	<1
Klebsiella pneumoniae												
Aminoglycosides R	–	–	5	7	11	17	20	18	24	24	27	28
Fluoroquinolones R	–	–	7	9	14	21	24	22	28	24	29	31
Third-generation cephalosporins R	–	–	4	6	10	15	19	18	25	23	28	30
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	15	11	11	14	21	20	23	20	15	17
Ceftazidime R	–	–	9	6	7	8	17	13	16	14	12	12
Carbapenems R	–	–	14	12	14	14	17	18	20	18	17	19
Aminoglycosides R	–	–	22	17	19	16	22	18	21	24	16	18
Fluoroquinolones R	–	–	27	23	24	22	25	23	27	22	21	21
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	16	14	12
Aminoglycosides R	–	–	–	–	–	–	–	–	–	13	12	9
Carbapenems R	–	–	–	–	–	–	–	–	–	3	6	3

Germany

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter* spp	
	Labs	Isolates	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	11	121
2013	20	488	22	3071	22	5259	22	1841	21	746	21	609	13	181
2014	21	502	21	3417	21	6251	21	2035	20	1008	20	643	17	208

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	<1	<1	<1	1	<1	<1	<1	<1	<1	1	2	1
Penicillin RI	1	1	4	5	3	5	2	4	2	5	7	4
Macrolides RI	11	13	17	12	8	10	8	9	8	7	11	7
Staphylococcus aureus												
Oxacillin/meticillin R	18	20	21	20	16	19	18	21	16	15	13	12
Escherichia coli												
Aminopenicilins R	47	55	54	60	55	55	56	54	52	50	53	52
Aminoglycosides R	5	4	6	10	6	7	8	9	8	7	7	7
Fluoroquinolones R	14	24	23	29	30	23	23	25	24	21	22	21
Third-generation cephalosporins R	<1	2	2	4	8	5	8	8	8	9	11	11
Carbapenems R	<1	<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	<1
HL gentamicin R	47	42	34	29	67	39	40	47	41	36	39	34
Vancomycin R	<1	<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	92
HL gentamicin R	47	61	52	38	73	35	45	45	42	32	27	24
Vancomycin R	3	11	10	8	15	6	6	8	11	16	15	9
Klebsiella pneumoniae												
Aminoglycosides R	–	–	10	12	6	10	10	10	9	8	10	7
Fluoroquinolones R	–	–	6	12	9	15	15	15	14	14	15	13
Third-generation cephalosporins R	–	–	7	14	6	11	13	13	13	13	16	13
Carbapenems R	–	–	2	<1	2	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	<1	18	17	17	9	13	16	15	16	18	17
Ceftazidime R	–	<1	11	12	17	8	11	8	9	10	10	10
Carbapenems R	–	<1	25	17	22	11	11	13	10	11	15	17
Aminoglycosides R	–	<1	12	18	10	10	8	10	12	11	8	6
Fluoroquinolones R	–	<1	23	28	28	22	17	18	18	20	16	13
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	8	10	6
Aminoglycosides R	–	–	–	–	–	–	–	–	–	6	6	4
Carbapenems R	–	–	–	–	–	–	–	–	–	7	9	6

Greece

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter* spp	
	Labs	Isolates	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	37	1254
2013	–	–	32	776	31	1258	31	930	30	1212	30	886	29	849
2014	–	–	27	575	26	1123	26	725	27	1093	26	700	26	844

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	–	–	–	–	–	–	–	–	–	–	–	–
Penicillin RI	–	–	–	–	–	–	–	–	–	–	–	–
Macrolides RI	–	–	–	–	–	–	–	–	–	–	–	–
Staphylococcus aureus												
Oxacillin/meticillin R	45	44	42	43	48	41	40	39	39	41	40	37
Escherichia coli												
Aminopenicilins R	44	46	46	46	48	50	51	52	55	55	56	56
Aminoglycosides R	6	6	7	7	9	15	14	16	17	18	17	16
Fluoroquinolones R	12	12	12	14	19	22	23	24	27	29	31	33
Third-generation cephalosporins R	6	6	7	6	8	10	10	14	15	16	17	21
Carbapenems R	<1	<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	4
HL gentamicin R	52	59	54	57	65	52	61	43	37	28	24	20
Vancomycin R	7	4	4	5	7	7	6	3	6	7	7	2
Enterococcus faecium												
Aminopenicilins RI	89	84	85	88	91	85	86	93	93	94	89	91
HL gentamicin R	40	52	34	35	44	52	63	53	43	35	28	15
Vancomycin R	18	20	37	42	37	28	27	23	23	17	21	27
Klebsiella pneumoniae												
Aminoglycosides R	–	–	60	54	54	55	60	62	69	63	59	61
Fluoroquinolones R	–	–	54	50	55	64	66	71	72	70	68	68
Third-generation cephalosporins R	–	–	61	58	62	66	69	75	76	71	70	73
Carbapenems R	–	–	28	33	42	37	44	49	68	60	59	62
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	30	39	38	34	33	39	31	34	30	31
Ceftazidime R	–	–	27	34	40	37	34	40	37	31	28	27
Carbapenems R	–	–	39	48	47	49	44	43	54	48	49	43
Aminoglycosides R	–	–	41	48	50	48	42	43	38	41	42	37
Fluoroquinolones R	–	–	39	45	50	48	45	46	39	44	43	38
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	93	95	95
Aminoglycosides R	–	–	–	–	–	–	–	–	–	78	89	89
Carbapenems R	–	–	–	–	–	–	–	–	–	89	91	93

Hungary

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	27	418
2013	26	154	26	1201	30	1440	29	813	28	559	30	670	28	482
2014	25	129	26	1279	30	1622	28	883	28	644	29	746	27	446

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non–susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	3	<1	4	1	5	8	3	6	6	3	2	2
Penicillin RI	24	16	21	18	23	27	12	15	12	10	6	12
Macrolides RI	25	25	32	19	36	32	19	24	15	20	14	15
Staphylococcus aureus												
Oxacillin/meticillin R	15	17	20	25	23	23	29	30	26	25	24	23
Escherichia coli												
Aminopenicilins R	49	55	51	53	54	59	60	65	65	64	61	59
Aminoglycosides R	8	10	9	12	11	13	16	21	15	17	17	15
Fluoroquinolones R	15	19	22	27	26	26	30	37	31	29	30	28
Third–generation cephalosporins R	<1	3	4	5	5	9	13	19	15	17	19	16
Carbapenems R	<1	<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	2
HL gentamicin R	87	57	43	47	48	53	51	51	49	56	52	50
Vancomycin R	<1	<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	98
HL gentamicin R	96	80	64	67	53	62	70	62	45	51	58	61
Vancomycin R	<1	<1	<1	<1	<1	3	1	2	<1	4	7	8
Klebsiella pneumoniae												
Aminoglycosides R	–	–	26	20	29	36	40	48	53	41	37	32
Fluoroquinolones R	–	–	21	13	22	33	33	43	51	42	38	35
Third–generation cephalosporins R	–	–	28	20	25	35	38	46	53	43	37	36
Carbapenems R	–	–	<1	<1	<1	<1	<1	5	2	3	2	1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	10	9	11	13	19	14	11	19	20	24
Ceftazidime R	–	–	10	8	9	11	12	11	12	18	21	24
Carbapenems R	–	–	18	16	19	26	27	25	21	27	30	33
Aminoglycosides R	–	–	32	23	26	26	29	29	18	27	25	21
Fluoroquinolones R	–	–	28	21	24	26	27	27	20	22	23	25
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	78	74	66
Aminoglycosides R	–	–	–	–	–	–	–	–	–	69	70	65
Carbapenems R	–	–	–	–	–	–	–	–	–	48	50	45

Iceland

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter* spp	
	Labs	Isolates	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	1	2
2013	2	18	2	69	2	121	1	32	2	30	1	11	0	0
2014	1	24	2	61	2	152	1	23	1	28	1	11	1	3

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	<1	2	<1	<1	2	<1	<1	3	6	4	6	<1
Penicillin RI	9	17	8	6	7	9	<1	5	9	4	17	4
Macrolides RI	20	8	17	10	17	22	9	11	22	7	17	9
Staphylococcus aureus												
Oxacillin/meticillin R	<1	<1	<1	<1	<1	2	<1	2	3	2	<1	3
Escherichia coli												
Aminopenicilins R	42	43	38	45	46	44	50	46	48	44	46	43
Aminoglycosides R	2	<1	<1	7	6	7	7	3	6	4	4	5
Fluoroquinolones R	6	2	3	12	17	6	7	11	14	10	15	8
Third-generation cephalosporins R	1	<1	<1	<1	2	<1	2	4	6	5	5	3
Carbapenems R	<1	<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	<1
HL gentamicin R	<1	5	<1	3	13	30	15	13	<1	12	33	8
Vancomycin R	<1	<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	91
HL gentamicin R	<1	13	<1	14	14	43	36	13	15	9	35	55
Vancomycin R	<1	<1	<1	<1	<1	<1	8	6	<1	<1	6	<1
Klebsiella pneumoniae												
Aminoglycosides R	–	–	<1	<1	<1	4	<1	<1	<1	<1	<1	4
Fluoroquinolones R	–	–	<1	<1	<1	8	<1	<1	4	7	<1	4
Third-generation cephalosporins R	–	–	<1	<1	<1	4	<1	4	8	21	<1	<1
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	8	<1	<1	<1	13	8	6	10	<1	9
Ceftazidime R	–	–	8	<1	<1	<1	6	8	6	10	<1	9
Carbapenems R	–	–	8	<1	<1	<1	<1	<1	6	10	9	9
Aminoglycosides R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fluoroquinolones R	–	–	<1	<1	<1	<1	13	17	6	10	<1	<1
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	#	#	#
Aminoglycosides R	–	–	–	–	–	–	–	–	–	#	#	#
Carbapenems R	–	–	–	–	–	–	–	–	–	#	#	#

Less than 10 isolates reported, data not displayed.

Ireland

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter* spp	
	Labs	Isolates	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	22	89
2014	34	328	37	1075	39	2705	34	698	34	355	31	178	24	89

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	3	3	3	3	6	6	6	5	6	5	2	5
Penicillin RI	12	10	11	16	17	23	20	18	19	19	20	18
Macrolides RI	12	14	12	16	17	17	17	16	18	17	18	14
Staphylococcus aureus												
Oxacillin/meticillin R	42	41	42	42	38	33	27	24	24	23	20	19
Escherichia coli												
Aminopenicilins R	61	65	67	69	65	67	66	67	70	67	69	69
Aminoglycosides R	4	5	7	7	10	9	9	10	10	11	11	12
Fluoroquinolones R	10	12	17	21	21	23	22	23	23	24	24	25
Third-generation cephalosporins R	2	2	4	4	5	6	6	8	9	9	11	11
Carbapenems R	<1	<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	1
HL gentamicin R	32	42	42	43	38	31	34	29	30	33	32	31
Vancomycin R	<1	1	3	3	3	3	<1	<1	4	3	2	2
Enterococcus faecium												
Aminopenicilins RI	91	96	93	94	93	95	93	96	96	93	93	95
HL gentamicin R	54	56	52	44	36	27	38	39	36	39	38	44
Vancomycin R	19	22	31	36	33	35	38	39	35	44	43	45
Klebsiella pneumoniae												
Aminoglycosides R	–	–	5	9	10	9	11	7	8	9	17	12
Fluoroquinolones R	–	–	3	16	17	11	11	8	9	7	15	14
Third-generation cephalosporins R	–	–	7	9	8	11	11	8	8	10	19	12
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	7	7	6	5	4	8	3	16	11	11
Ceftazidime R	–	–	10	6	5	4	6	6	4	14	8	8
Carbapenems R	–	–	11	9	9	6	8	6	6	11	9	8
Aminoglycosides R	–	–	7	9	9	6	7	5	4	10	11	6
Fluoroquinolones R	–	–	14	17	18	16	9	11	6	15	12	8
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	–	1	5
Aminoglycosides R	–	–	–	–	–	–	–	–	–	–	1	2
Carbapenems R	–	–	–	–	–	–	–	–	–	–	2	1

Italy

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	27	249
2013	43	436	52	2540	43	4097	50	1386	48	1486	42	796	38	480
2014	42	283	46	2269	38	3802	47	1420	45	1352	37	760	31	485

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	5	5	5	<1	4	3	3	5	6	6	9	4
Penicillin RI	13	14	9	7	15	10	6	9	7	12	15	15
Macrolides RI	37	29	31	33	31	26	21	29	27	34	25	29
Staphylococcus aureus												
Oxacillin/meticillin R	39	40	37	38	34	34	37	37	38	35	36	34
Escherichia coli												
Aminopenicilins R	52	53	55	56	58	62	63	64	67	68	66	65
Aminoglycosides R	10	9	11	8	14	14	13	15	18	21	18	19
Fluoroquinolones R	25	28	28	27	32	38	36	39	41	42	42	44
Third-generation cephalosporins R	6	5	8	7	11	16	17	21	20	26	26	29
Carbapenems R	–	–	–	–	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis												
Aminopenicilins RI	4	4	4	4	4	13	20	13	11	4	4	10
HL gentamicin R	39	36	38	38	39	47	49	50	50	51	46	55
Vancomycin R	2	2	3	3	2	2	3	2	3	1	1	<1
Enterococcus faecium												
Aminopenicilins RI	80	78	77	86	73	64	60	70	83	87	82	83
HL gentamicin R	44	39	36	48	53	49	52	59	54	62	59	57
Vancomycin R	24	21	19	18	11	6	4	4	4	6	4	8
Klebsiella pneumoniae												
Aminoglycosides R	–	–	8	26	25	28	19	29	35	42	45	49
Fluoroquinolones R	–	–	11	23	27	28	20	39	46	50	54	56
Third-generation cephalosporins R	–	–	20	33	35	39	37	47	46	48	55	56
Carbapenems R	–	–	–	1	1	2	1	15	27	29	34	33
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	–	23	20	20	24	21	22	30	31	31
Ceftazidime R	–	–	–	20	25	24	16	18	16	26	24	25
Carbapenems R	–	–	–	21	27	33	31	22	21	25	26	25
Aminoglycosides R	–	–	–	32	29	30	29	23	18	30	27	24
Fluoroquinolones R	–	–	–	36	35	36	42	31	26	31	29	28
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	86	83	92
Aminoglycosides R	–	–	–	–	–	–	–	–	–	83	83	89
Carbapenems R	–	–	–	–	–	–	–	–	–	82	80	90

Latvia

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2004–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2004	4	17	7	87	–	–	–	–	–	–	–	–	–	–
2005	5	36	7	127	–	–	–	–	–	–	–	–	–	–
2006	7	37	11	172	10	62	10	56	6	28	9	16	–	–
2007	6	31	12	169	9	76	8	57	7	27	6	16	–	–
2008	3	18	12	164	10	90	9	51	11	40	6	11	–	–
2009	7	30	12	188	9	86	8	48	10	44	7	18	–	–
2010	4	38	10	155	8	98	8	61	8	64	6	21	–	–
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	–	–
2014	7	51	13	222	10	182	10	79	12	118	6	18	6	52

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	–	<1	<1	<1	<1	6	<1	5	10	6	12	4
Penicillin RI	–	<1	<1	<1	<1	6	<1	5	13	6	12	4
Macrolides RI	–	7	3	3	<1	<1	3	5	<1	5	2	4
Staphylococcus aureus												
Oxacillin/meticillin R	–	26	20	19	8	12	9	14	10	9	7	8
Escherichia coli												
Aminopenicilins R	–	–	–	44	43	48	43	50	55	54	52	48
Aminoglycosides R	–	–	–	5	14	10	13	11	11	12	7	9
Fluoroquinolones R	–	–	–	10	17	14	24	14	17	14	19	18
Third-generation cephalosporins R	–	–	–	6	14	11	12	12	16	13	14	11
Carbapenems R	–	–	–	<1	<1	<1	2	<1	<1	<1	<1	<1
Enterococcus faecalis												
Aminopenicilins RI	–	–	–	9	30	5	12	5	18	7	9	9
HL gentamicin R	–	–	–	50	–	27	38	47	26	29	61	46
Vancomycin R	–	–	–	<1	<1	<1	<1	<1	<1	<1	7	<1
Enterococcus faecium												
Aminopenicilins RI	–	–	–	94	77	90	82	100	96	89	96	97
HL gentamicin R	–	–	–	73	<1	78	79	83	42	28	25	47
Vancomycin R	–	–	–	<1	<1	7	18	13	9	6	12	13
Klebsiella pneumoniae												
Aminoglycosides R	–	–	–	25	22	52	43	55	34	51	49	44
Fluoroquinolones R	–	–	–	26	27	45	34	52	38	46	43	45
Third-generation cephalosporins R	–	–	–	36	44	58	55	55	38	63	66	53
Carbapenems R	–	–	–	<1	<1	3	<1	<1	<1	<1	<1	2
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	–	17	31	30	17	19	9	18	21	67
Ceftazidime R	–	–	–	29	13	36	17	10	9	22	24	67
Carbapenems R	–	–	–	13	6	40	7	14	8	11	28	17
Aminoglycosides R	–	–	–	47	31	45	22	29	25	22	20	6
Fluoroquinolones R	–	–	–	33	13	45	12	19	25	22	24	17
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	–	–	89
Aminoglycosides R	–	–	–	–	–	–	–	–	–	–	–	75
Carbapenems R	–	–	–	–	–	–	–	–	–	–	–	79

Lithuania

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter* spp	
	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates	Labs	Isolates
2006	9	35	13	167	11	171	8	30	8	35	7	14	–	–
2007	10	67	12	240	13	235	10	56	10	41	7	21	–	–
2008	11	48	12	278	12	304	10	67	11	54	7	21	–	–
2009	10	46	13	258	13	297	11	57	12	68	8	21	–	–
2010	9	40	11	257	10	333	10	59	9	81	8	31	–	–
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	–	–
2014	10	67	13	383	13	594	12	122	12	154	9	31	11	66

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	–	–	–	<1	1	<1	7	8	2	14	10	3
Penicillin RI	–	–	–	16	4	2	9	13	19	16	24	16
Macrolides RI	–	–	–	<1	9	6	7	<1	27	26	25	23
Staphylococcus aureus												
Oxacillin/meticillin R	–	–	–	13	10	11	11	14	5	10	10	8
Escherichia coli												
Aminopenicilins R	–	–	–	55	50	54	58	56	48	52	54	58
Aminoglycosides R	–	–	–	15	12	12	15	15	10	10	11	11
Fluoroquinolones R	–	–	–	12	9	14	15	14	13	15	16	13
Third-generation cephalosporins R	–	–	–	5	7	6	8	9	7	5	8	8
Carbapenems R	–	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis												
Aminopenicilins RI	–	–	–	5	3	5	3	13	10	5	28	4
HL gentamicin R	–	–	–	50	41	33	48	41	44	51	55	29
Vancomycin R	–	–	–	<1	<1	<1	<1	<1	<1	2	<1	<1
Enterococcus faecium												
Aminopenicilins RI	–	–	–	75	100	88	95	88	96	86	96	100
HL gentamicin R	–	–	–	75	81	78	64	87	88	78	70	86
Vancomycin R	–	–	–	<1	<1	<1	11	8	8	6	<1	5
Klebsiella pneumoniae												
Aminoglycosides R	–	–	–	26	37	41	56	52	55	63	48	49
Fluoroquinolones R	–	–	–	3	8	23	37	36	55	55	45	45
Third-generation cephalosporins R	–	–	–	23	27	36	57	51	61	64	44	53
Carbapenems R	–	–	–	<1	<1	<1	<1	<1	<1	<1	<1	1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	–	21	5	14	20	6	13	11	9	32
Ceftazidime R	–	–	–	31	<1	10	14	10	21	7	8	17
Carbapenems R	–	–	–	21	30	24	19	27	20	18	19	29
Aminoglycosides R	–	–	–	29	33	38	19	13	13	14	14	26
Fluoroquinolones R	–	–	–	46	38	35	33	16	17	11	11	26
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	–	–	85
Aminoglycosides R	–	–	–	–	–	–	–	–	–	–	–	86
Carbapenems R	–	–	–	–	–	–	–	–	–	–	–	70

Luxembourg

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	2	6
2013	5	49	5	135	8	322	5	61	4	53	5	34	2	3
2014	5	35	5	125	5	371	5	77	4	66	5	42	3	6

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	<1	6	7	5	3	5	11	4	2	3	7	3
Penicillin RI	15	11	12	5	6	11	19	12	8	3	16	6
Macrolides RI	28	33	24	26	24	14	16	18	15	16	25	14
Staphylococcus aureus												
Oxacillin/meticillin R	21	16	13	19	20	9	13	17	20	15	9	12
Escherichia coli												
Aminopenicilins R	49	49	49	46	49	56	57	63	52	51	55	60
Aminoglycosides R	4	4	7	6	5	8	9	6	8	6	7	8
Fluoroquinolones R	12	18	19	20	21	22	26	26	24	24	28	25
Third-generation cephalosporins R	<1	<1	3	2	4	6	8	9	8	11	11	12
Carbapenems R	<1	<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	7
HL gentamicin R	32	18	24	32	44	17	28	46	44	22	28	31
Vancomycin R	<1	<1	<1	<1	<1	3	10	4	4	<1	7	7
Enterococcus faecium												
Aminopenicilins RI	100	50	36	75	67	76	93	77	71	80	100	81
HL gentamicin R	<1	<1	23	30	10	21	29	19	40	44	31	14
Vancomycin R	<1	<1	<1	<1	<1	5	36	32	4	<1	5	3
Klebsiella pneumoniae												
Aminoglycosides R	–	–	–	<1	4	13	18	5	29	26	28	20
Fluoroquinolones R	–	–	–	6	12	12	21	7	33	32	23	32
Third-generation cephalosporins R	–	–	–	10	2	19	25	5	35	34	34	35
Carbapenems R	–	–	–	<1	<1	<1	<1	<1	<1	<1	2	2
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	<1	9	15	3	14	6	16	16	12	11
Ceftazidime R	–	–	<1	10	11	3	14	<1	9	3	12	2
Carbapenems R	–	–	<1	7	20	25	15	9	16	6	18	5
Aminoglycosides R	–	–	<1	4	22	6	9	9	16	6	24	7
Fluoroquinolones R	–	–	<1	10	36	15	11	22	19	19	21	10
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	0	33	0
Aminoglycosides R	–	–	–	–	–	–	–	–	–	0	0	0
Carbapenems R	–	–	–	–	–	–	–	–	–	0	0	0

Malta

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	1	6
2013	1	9	1	116	1	248	1	41	1	69	1	25	1	7
2014	1	8	1	83	1	279	1	41	1	101	1	38	1	10

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	<1	<1	8	3	<1	24	<1	11	10	<1	<1	25
Penicillin RI	<1	<1	15	7	<1	47	14	22	50	39	43	38
Macrolides RI	38	25	46	45	8	35	13	18	13	50	33	38
Staphylococcus aureus												
Oxacillin/meticillin R	43	56	56	67	52	56	59	48	49	47	52	43
Escherichia coli												
Aminopenicilins R	39	48	51	56	54	52	54	44	53	55	55	53
Aminoglycosides R	18	20	7	15	20	22	21	22	16	14	10	10
Fluoroquinolones R	24	36	31	32	35	34	30	34	32	32	30	29
Third-generation cephalosporins R	2	4	1	4	13	21	15	16	13	14	9	11
Carbapenems R	<1	<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	<1
HL gentamicin R	29	44	32	–	–	–	–	–	–	–	–	–
Vancomycin R	<1	<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	91
HL gentamicin R	50	<1	<1	–	–	–	–	–	–	–	–	–
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae												
Aminoglycosides R	–	–	17	6	<1	<1	<1	12	10	26	26	30
Fluoroquinolones R	–	–	11	6	11	8	3	16	13	26	28	34
Third-generation cephalosporins R	–	–	6	6	7	<1	<1	12	13	26	28	30
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	4	4	6	10
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	22	47	11	45	36	36	24	10	21	11
Ceftazidime R	–	–	11	30	3	33	29	14	12	6	8	5
Carbapenems R	–	–	18	20	11	30	21	24	24	3	16	16
Aminoglycosides R	–	–	16	8	8	23	21	31	33	6	<1	13
Fluoroquinolones R	–	–	44	24	11	19	22	24	19	<1	8	5
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	#	#	#
Aminoglycosides R	–	–	–	–	–	–	–	–	–	#	#	#
Carbapenems R	–	–	–	–	–	–	–	–	–	#	#	#

Less than 10 isolates reported, data not displayed.

Netherlands

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	18	70
2013	27	1269	25	2088	27	4758	26	1019	25	663	25	381	22	70
2014	35	1406	35	2580	35	6514	35	1256	35	926	35	555	26	75

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Penicillin RI	1	2	1	1	2	2	1	2	1	2	1	2
Macrolides RI	5	8	11	8	7	7	5	6	5	4	5	4
Staphylococcus aureus												
Oxacillin/meticillin R	1	1	<1	<1	2	<1	<1	1	1	1	1	<1
Escherichia coli												
Aminopenicilins R	45	43	48	47	49	48	45	48	49	49	48	46
Aminoglycosides R	3	3	4	3	5	6	4	7	8	7	6	6
Fluoroquinolones R	7	7	10	11	13	14	11	14	14	15	14	13
Third-generation cephalosporins R	1	1	2	3	4	5	4	5	6	6	6	6
Carbapenems R	<1	<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	<1
HL gentamicin R	29	37	38	28	38	34	31	34	33	31	27	29
Vancomycin R	1	<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	87
HL gentamicin R	20	20	40	50	62	53	76	65	66	63	73	66
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	1
Klebsiella pneumoniae												
Aminoglycosides R	–	–	5	4	5	7	3	7	8	6	6	4
Fluoroquinolones R	–	–	6	4	4	7	4	7	7	5	6	5
Third-generation cephalosporins R	–	–	4	4	7	8	6	7	8	7	7	5
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	4	2	2	6	3	4	6	5	7	8
Ceftazidime R	–	–	5	5	4	6	4	3	5	3	4	5
Carbapenems R	–	–	5	2	2	6	3	3	3	3	3	4
Aminoglycosides R	–	–	7	5	3	4	2	3	5	4	3	3
Fluoroquinolones R	–	–	9	9	5	8	7	4	7	6	6	7
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	<1	3	4
Aminoglycosides R	–	–	–	–	–	–	–	–	–	2	5	5
Carbapenems R	–	–	–	–	–	–	–	–	–	6	2	<1

Norway

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	10	25
2013	18	551	18	1473	18	3080	18	710	17	645	18	206	12	36
2014	19	536	19	1546	19	3422	19	764	18	746	19	257	13	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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	1
Penicillin RI	<1	2	2	2	2	2	2	4	3	6	3	5
Macrolides RI	8	8	14	12	10	7	6	4	4	5	4	8
Staphylococcus aureus												
Oxacillin/meticillin R	<1	<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	42
Aminoglycosides R	<1	<1	2	2	3	3	3	4	4	6	6	6
Fluoroquinolones R	2	4	5	5	7	7	9	9	9	11	11	11
Third-generation cephalosporins R	<1	<1	<1	1	2	3	2	4	4	5	6	6
Carbapenems R	<1	<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	<1
HL gentamicin R	38	27	32	33	34	29	36	34	22	30	27	21
Vancomycin R	<1	<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	85
HL gentamicin R	14	25	44	45	52	54	38	57	43	37	47	40
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	1	2	<1	2	2
Klebsiella pneumoniae												
Aminoglycosides R	<1	2	3	<1	<1	1	3	2	3	2	2	5
Fluoroquinolones R	<1	<1	1	7	5	4	6	7	4	4	5	6
Third-generation cephalosporins R	<1	<1	2	2	2	2	3	2	3	3	4	6
Carbapenems R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	<1	13	3	3	2	6	4	3	5	7	9	8
Ceftazidime R	<1	<1	3	5	3	4	5	2	3	6	6	5
Carbapenems R	<1	4	3	9	9	7	5	1	4	7	6	6
Aminoglycosides R	<1	4	<1	1	2	<1	<1	<1	<1	2	2	1
Fluoroquinolones R	4	5	4	9	7	3	2	4	5	6	9	3
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	0	0	6
Aminoglycosides R	–	–	–	–	–	–	–	–	–	4	3	3
Carbapenems R	–	–	–	–	–	–	–	–	–	0	0	3

Poland

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	35	214
2013	38	170	38	750	38	1072	37	460	35	383	30	198	33	192
2014	–	–	–	–	–	–	–	–	–	–	–	–	–	–

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
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 + tazobactam R	–	–	50	43	36	32	30	29	31	30	24	–
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	–
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	78	81	–
Aminoglycosides R	–	–	–	–	–	–	–	–	–	63	74	–
Carbapenems R	–	–	–	–	–	–	–	–	–	38	50	–

Portugal

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	15	169
2013	37	504	44	2450	34	2687	41	963	32	913	40	737	34	234
2014	50	668	53	3241	56	5027	51	1157	53	1714	51	1064	40	266

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	<1	<1	<1	<1	<1	<1	18	15	8	5	4	5
Penicillin RI	20	27	17	17	16	18	18	15	10	8	8	10
Macrolides RI	–	20	19	21	23	22	22	22	15	19	21	16
Staphylococcus aureus												
Oxacillin/meticillin R	45	46	47	48	48	53	49	53	55	54	47	47
Escherichia coli												
Aminopenicilins R	53	58	58	59	59	58	58	56	57	59	59	59
Aminoglycosides R	9	13	12	12	12	14	11	12	16	16	16	16
Fluoroquinolones R	26	27	29	28	30	29	28	27	27	30	32	32
Third-generation cephalosporins R	7	8	12	10	10	10	9	10	11	14	15	16
Carbapenems R	–	–	–	–	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis												
Aminopenicilins RI	4	5	<1	2	4	4	7	17	24	12	8	2
HL gentamicin R	34	29	38	41	41	43	34	39	30	43	37	33
Vancomycin R	3	6	5	5	4	4	4	2	4	3	3	1
Enterococcus faecium												
Aminopenicilins RI	88	83	92	76	93	86	91	91	81	94	90	88
HL gentamicin R	55	66	68	53	49	28	49	53	38	58	36	35
Vancomycin R	47	42	34	26	29	24	23	23	20	23	22	20
Klebsiella pneumoniae												
Aminoglycosides R	–	–	<1	13	11	19	20	27	32	32	30	31
Fluoroquinolones R	–	–	<1	20	18	22	28	31	36	36	36	37
Third-generation cephalosporins R	–	–	–	21	17	26	28	28	35	39	37	41
Carbapenems R	–	–	–	–	<1	<1	<1	1	<1	<1	2	2
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	–	15	14	17	17	18	19	20	24	28
Ceftazidime R	–	–	–	19	16	16	13	12	15	15	15	22
Carbapenems R	–	–	–	21	15	18	16	16	20	20	21	22
Aminoglycosides R	–	–	–	17	16	11	12	14	15	15	14	18
Fluoroquinolones R	–	–	–	21	19	23	21	20	26	26	24	26
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	77	69	53
Aminoglycosides R	–	–	–	–	–	–	–	–	–	65	56	42
Carbapenems R	–	–	–	–	–	–	–	–	–	79	69	53

Romania

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter* spp	
	Labs	Isolates	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	4	54
2013	8	44	15	384	14	302	14	135	16	221	15	94	16	138
2014	12	50	15	399	16	309	15	158	16	258	15	94	16	124

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	21	11	22	10	22	54	24	31	61	39	25	16
Penicillin RI	33	11	39	28	33	69	29	31	61	39	25	47
Macrolides RI	29	<1	31	25	19	27	33	36	44	40	38	48
Staphylococcus aureus												
Oxacillin/meticillin R	46	71	60	54	26	33	34	39	50	53	64	56
Escherichia coli												
Aminopenicilins R	70	79	78	85	76	55	60	83	71	59	67	68
Aminoglycosides R	21	33	14	41	35	24	11	12	18	24	15	17
Fluoroquinolones R	14	21	9	41	27	27	18	24	28	29	31	31
Third-generation cephalosporins R	19	23	17	41	27	24	14	21	21	25	23	29
Carbapenems R	<1	3	<1	3	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis												
Aminopenicilins RI	<1	29	<1	<1	25	10	13	<1	11	2	6	10
HL gentamicin R	25	<1	50	15	50	22	42	–	–	57	59	76
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	4
Enterococcus faecium												
Aminopenicilins RI	86	100	100	100	100	100	100	80	90	94	91	95
HL gentamicin R	63	100	70	80	67	50	71	–	–	85	86	84
Vancomycin R	<1	<1	<1	<1	<1	<1	<1	<1	<1	3	11	25
Klebsiella pneumoniae												
Aminoglycosides R	–	–	100	91	80	60	32	71	50	55	57	67
Fluoroquinolones R	–	–	33	34	23	20	11	29	30	50	52	67
Third-generation cephalosporins R	–	–	100	94	80	50	65	71	44	61	67	74
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	14	20	32
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	61	33	25	25	31	63	57	50	55	62
Ceftazidime R	–	–	52	<1	<1	13	30	60	56	51	44	59
Carbapenems R	–	–	61	<1	<1	13	46	70	60	58	60	59
Aminoglycosides R	–	–	65	33	25	38	38	50	60	51	51	63
Fluoroquinolones R	–	–	64	33	25	25	31	56	67	53	45	55
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	89	91	84
Aminoglycosides R	–	–	–	–	–	–	–	–	–	57	80	78
Carbapenems R	–	–	–	–	–	–	–	–	–	82	85	81

Slovakia

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter* spp	
	Labs	Isolates	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	14	188
2014	9	32	14	640	14	889	13	411	14	494	14	276	14	171

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	4	24	<1	–	–	–	–	–	4	5	4	10
Penicillin RI	11	29	<1	–	–	–	–	–	8	5	11	21
Macrolides RI	<1	33	40	–	–	–	–	–	12	27	17	41
Staphylococcus aureus												
Oxacillin/meticillin R	8	14	16	–	–	–	–	–	26	22	27	28
Escherichia coli												
Aminopenicilins R	54	62	59	–	–	–	–	–	68	65	61	65
Aminoglycosides R	6	11	7	–	–	–	–	–	18	21	24	23
Fluoroquinolones R	20	24	14	–	–	–	–	–	42	41	40	43
Third-generation cephalosporins R	<1	7	8	–	–	–	–	–	31	31	30	32
Carbapenems R	<1	<1	<1	–	–	–	–	–	<1	<1	<1	<1
Enterococcus faecalis												
Aminopenicilins RI	<1	7	7	–	–	–	–	–	2	2	1	2
HL gentamicin R	35	37	40	–	–	–	–	–	50	50	57	41
Vancomycin R	<1	<1	<1	–	–	–	–	–	<1	<1	<1	<1
Enterococcus faecium												
Aminopenicilins RI	92	91	100	–	–	–	–	–	96	95	97	95
HL gentamicin R	60	45	33	–	–	–	–	–	79	86	63	69
Vancomycin R	<1	9	<1	–	–	–	–	–	4	5	8	10
Klebsiella pneumoniae												
Aminoglycosides R	–	–	–	–	–	–	–	–	66	63	64	68
Fluoroquinolones R	–	–	–	–	–	–	–	–	71	67	67	71
Third-generation cephalosporins R	–	–	–	–	–	–	–	–	68	63	66	69
Carbapenems R	–	–	–	–	–	–	–	–	<1	6	<1	3
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	–	–	–	–	–	–	41	38	42	36
Ceftazidime R	–	–	–	–	–	–	–	–	25	35	31	30
Carbapenems R	–	–	–	–	–	–	–	–	31	41	59	38
Aminoglycosides R	–	–	–	–	–	–	–	–	53	42	39	37
Fluoroquinolones R	–	–	–	–	–	–	–	–	59	56	53	45
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	–	59	52
Aminoglycosides R	–	–	–	–	–	–	–	–	–	–	50	42
Carbapenems R	–	–	–	–	–	–	–	–	–	–	46	33

Slovenia

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	3	25
2013	10	279	10	465	10	1224	10	248	10	245	10	133	5	25
2014	10	300	10	495	10	1216	10	235	10	233	9	112	8	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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	2	2	2	5	4	3	1	<1	<1	1	<1	1
Penicillin RI	15	25	11	19	17	15	15	16	12	10	8	10
Macrolides RI	9	11	11	13	17	16	17	17	24	21	10	19
Staphylococcus aureus												
Oxacillin/meticillin R	13	12	10	7	8	7	10	12	7	10	9	13
Escherichia coli												
Aminopenicilins R	41	40	42	44	49	49	53	48	54	50	51	53
Aminoglycosides R	2	5	4	7	7	7	10	9	10	9	10	12
Fluoroquinolones R	11	12	12	15	17	17	18	19	21	21	20	23
Third-generation cephalosporins R	<1	1	2	2	4	4	5	7	9	10	9	13
Carbapenems R	<1	<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	3
HL gentamicin R	49	37	46	40	50	40	43	43	36	35	32	36
Vancomycin R	<1	<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	97
HL gentamicin R	82	56	47	54	63	57	56	66	66	63	60	58
Vancomycin R	<1	<1	<1	6	5	13	4	2	<1	<1	1	2
Klebsiella pneumoniae												
Aminoglycosides R	–	–	17	19	24	23	28	23	22	20	20	20
Fluoroquinolones R	–	–	14	21	26	25	27	25	35	33	33	33
Third-generation cephalosporins R	–	–	19	24	28	26	31	22	30	28	29	27
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	21	18	13	21	16	15	13	7	14	26
Ceftazidime R	–	–	11	8	7	14	8	5	8	7	14	21
Carbapenems R	–	–	13	6	19	16	15	19	24	22	26	31
Aminoglycosides R	–	–	21	15	10	13	12	8	8	10	8	17
Fluoroquinolones R	–	–	29	21	17	24	13	9	9	15	11	22
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	28	28	41
Aminoglycosides R	–	–	–	–	–	–	–	–	–	20	20	38
Carbapenems R	–	–	–	–	–	–	–	–	–	24	24	27

Spain

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	20	100
2014	39	583	39	1943	39	5824	39	1552	39	1266	39	874	23	83

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	7	9	9	8	8	7	8	10	10	8	8	7
Penicillin RI	32	29	25	27	22	23	22	30	30	27	28	28
Macrolides RI	27	27	23	22	18	22	19	27	25	26	26	20
Staphylococcus aureus												
Oxacillin/meticillin R	24	26	27	25	25	27	26	25	22	24	23	22
Escherichia coli												
Aminopenicilins R	58	60	62	64	62	63	65	65	66	65	65	65
Aminoglycosides R	7	7	10	9	10	11	13	14	15	16	15	15
Fluoroquinolones R	21	25	28	28	30	33	31	33	34	34	35	34
Third-generation cephalosporins R	4	7	8	7	7	9	11	12	12	14	13	12
Carbapenems R	<1	<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	1
HL gentamicin R	36	36	36	36	42	41	43	41	39	38	43	39
Vancomycin R	<1	<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	83
HL gentamicin R	11	17	16	21	40	35	38	27	23	26	36	35
Vancomycin R	3	2	3	3	2	1	3	1	1	1	<1	2
Klebsiella pneumoniae												
Aminoglycosides R	–	–	4	7	9	9	9	9	10	14	16	14
Fluoroquinolones R	–	–	11	8	17	15	16	14	17	17	22	19
Third-generation cephalosporins R	–	–	7	9	10	12	11	10	13	17	20	18
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	2	2
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	4	9	8	8	8	6	6	7	9	8
Ceftazidime R	–	–	6	7	10	11	8	7	9	9	9	10
Carbapenems R	–	–	17	12	15	13	16	18	16	16	18	18
Aminoglycosides R	–	–	4	11	15	18	20	18	19	17	15	17
Fluoroquinolones R	–	–	14	19	25	23	25	25	24	21	23	25
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	–	75	67
Aminoglycosides R	–	–	–	–	–	–	–	–	–	–	69	60
Carbapenems R	–	–	–	–	–	–	–	–	–	–	76	65

Sweden

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter* spp	
	Labs	Isolates	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	1016	18	3045	17	5273	18	1254	17	972	17	416	–	–
2012	18	1030	18	3263	17	5542	18	1211	17	977	17	357	–	–
2013	18	1166	18	4124	18	7538	18	1697	18	1300	18	533	9	75
2014	16	792	16	3501	16	6549	16	1358	16	1000	16	438	10	52

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	<1	<1	<1	<1	<1	<1	2	2	4	5	7	8
Penicillin RI	5	3	4	2	3	2	3	4	4	5	7	8
Macrolides RI	5	5	6	5	5	6	4	4	5	5	7	7
Staphylococcus aureus												
Oxacillin/meticillin R	<1	<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	6
Fluoroquinolones R	7	8	6	8	10	10	8	11	9	11	12	11
Third-generation cephalosporins R	<1	<1	1	2	2	2	3	3	4	4	5	6
Carbapenems R	–	–	<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	17	16	19	20	16	20	19	15	19	15	16	16
Vancomycin R	<1	<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	82
HL gentamicin R	11	7	4	12	14	25	24	22	32	20	33	22
Vancomycin R	2	1	<1	<1	<1	2	<1	<1	<1	<1	<1	<1
Klebsiella pneumoniae												
Aminoglycosides R	–	–	1	<1	1	1	<1	1	2	2	3	3
Fluoroquinolones R	–	–	5	5	6	7	2	5	2	4	4	4
Third-generation cephalosporins R	–	–	1	1	1	2	2	2	2	3	4	5
Carbapenems R	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	9	<1	2	1	2	1	4	6	7	5
Ceftazidime R	–	–	5	6	4	5	7	3	5	6	7	6
Carbapenems R	–	–	18	5	7	4	8	4	8	5	7	7
Aminoglycosides R	–	–	<1	<1	<1	<1	<1	<1	2	2	3	<1
Fluoroquinolones R	–	–	6	5	6	5	7	6	5	7	6	8
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	–	5	12
Aminoglycosides R	–	–	–	–	–	–	–	–	–	–	8	3
Carbapenems R	–	–	–	–	–	–	–	–	–	–	6	4

United Kingdom

General information on EARS-Net participating laboratories

Table 1: Annual number of reporting laboratories* and number of reported isolates, 2003–2014

Year	*S. pneumoniae*		*S. aureus*		*E. coli*		Enterococci		*K. pneumoniae*		*P. aeruginosa*		*Acinetobacter spp*	
	Labs	Isolates	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	24	109
2013	54	1301	56	2875	31	6481	30	957	31	1143	31	702	27	165
2014	56	1418	56	3551	31	7322	29	921	29	1179	29	649	27	129

* 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 2014

Table 2: Annual percentage (%) of antimicrobial non-susceptible and resistant isolates, 2003–2014

Microorganism by antimicrobial group	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Streptococcus pneumoniae												
Penicillin R	1	<1	2	<1	2	1	1	<1	<1	<1	<1	<1
Penicillin RI	5	3	4	3	4	5	3	3	5	5	5	5
Macrolides RI	13	13	11	12	10	6	4	5	6	7	7	7
Staphylococcus aureus												
Oxacillin/meticillin R	44	44	44	42	36	31	28	22	14	14	14	11
Escherichia coli												
Aminopenicilins R	55	53	56	57	55	61	62	62	63	63	63	63
Aminoglycosides R	4	6	8	7	7	7	7	8	8	9	9	9
Fluoroquinolones R	11	14	17	20	18	15	18	17	18	17	16	17
Third-generation cephalosporins R	3	3	6	8	9	7	9	9	10	13	15	10
Carbapenems R	–	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Enterococcus faecalis												
Aminopenicilins RI	–	–	2	3	4	2	2	6	4	4	2	3
HL gentamicin R	–	–	47	52	31	42	38	39	16	30	31	–
Vancomycin R	–	–	2	1	2	4	2	1	2	1	<1	3
Enterococcus faecium												
Aminopenicilins RI	–	–	84	78	82	83	91	84	90	93	92	93
HL gentamicin R	–	–	53	18	35	7	38	31	56	54	55	–
Vancomycin R	–	–	33	18	21	28	13	10	9	13	23	21
Klebsiella pneumoniae												
Aminoglycosides R	–	–	6	8	9	6	5	5	4	6	7	6
Fluoroquinolones R	–	–	12	13	12	7	6	7	5	7	9	8
Third-generation cephalosporins R	–	–	12	11	13	7	7	10	5	12	14	9
Carbapenems R	–	–	<1	<1	<1	1	<1	<1	<1	<1	<1	<1
Pseudomonas aeruginosa												
Piperacillin + tazobactam R	–	–	2	1	5	2	3	4	4	3	5	5
Ceftazidime R	–	–	3	3	7	4	5	5	5	4	4	5
Carbapenems R	–	–	9	6	10	6	8	6	6	6	5	6
Aminoglycosides R	–	–	4	4	5	3	1	2	3	2	3	2
Fluoroquinolones R	–	–	8	8	9	8	7	7	6	5	6	5
Acinetobacter spp												
Fluoroquinolones R	–	–	–	–	–	–	–	–	–	3	4	11
Aminoglycosides R	–	–	–	–	–	–	–	–	–	3	3	10
Carbapenems R	–	–	–	–	–	–	–	–	–	3	2	2

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