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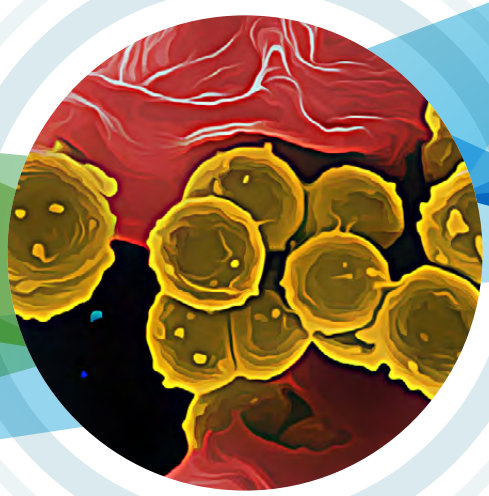

Antimicrobial resistance surveillance in Europe

2022

2020 data

Antimicrobial resistance surveillance in Europe

2022

2020 data

Abstract

Antimicrobial resistance (AMR) remains a major public health concern in the WHO European Region, with estimates from the European Union/European Economic Area (EU/EEA) alone showing that each year more than 670 000 infections are due to bacteria resistant to antibiotics and approximately 33 000 people die as a direct consequence.

This report is the first in a series published jointly by the European Centre for Disease Prevention and Control (ECDC) and the WHO Regional Office for Europe that includes AMR data from invasive isolates in Europe. The report shows that AMR is widespread in the WHO European Region, although the AMR situation varied widely depending on the bacterial species, antimicrobial group and geographical region. A north-to-south and west-to-east gradient was generally observed, with higher AMR percentages in the southern and eastern parts of Europe. Overall in the EU/EEA, AMR percentages for the bacterial species–antimicrobial group combinations under surveillance continue to be high, with carbapenem resistance in *Escherichia coli* and *Klebsiella pneumoniae* (*K. pneumoniae*) and vancomycin resistance in *Enterococcus faecium* showing a significant increase during 2016–2020. High percentages of resistance to third-generation cephalosporins and carbapenems in *K. pneumoniae* and high percentages of carbapenem-resistant *Acinetobacter* species and *Pseudomonas aeruginosa* in several countries in the European Region are of concern. Effectively tackling AMR in the WHO European Region requires greater efforts and investments.

Keywords

DRUG RESISTANCE, ANTIMICROBIAL RESISTANCE
ANTI-INFECTIVE AGENTS
INFECTION CONTROL
POPULATION SURVEILLANCE
DATA COLLECTION

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For the EU/EEA, the report and respective country profiles were sent for consultation and review to: ECDC national focal points for AMR; ECDC operational contact points for epidemiology (AMR); ECDC operational contact points for microbiology (AMR); ECDC operational contact points for The European Surveillance System (TESSy)/IT data manager (AMR); and the European Antimicrobial Resistance Surveillance Network (EARS-Net) Disease Network Coordination Committee.

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Foreword from the WHO Regional Director for Europe

Antimicrobial resistance (AMR) is threatening lives and livelihoods around the world. Despite significant progress, more than five years since the Global Action Plan on AMR was launched and over 10 years after the European Strategic Action Plan on Antibiotic Resistance was adopted, many of the goals and objectives in those plans still require our urgent attention and commitment. This is partly due to the disruptive effects of the COVID-19 pandemic on health systems and services in the WHO European Region. Scaling up efforts to tackle AMR as a region-wide priority is an integral part of WHO's European Programme of Work (2020–2025) *(1)*, as it is internationally through the implementation of WHO's Thirteenth General Programme of Work (2019–2023) *(2)*.

The European Centre for Disease Prevention and Control (ECDC) is a natural partner for the WHO Regional Office for Europe. Both organizations play a vital part in preventing and overcoming health threats in the European Region through their complementary mandates, and there are many good examples of how they have worked collaboratively since signing their 2010 declaration, "A shared vision for joint action".

AMR surveillance continues to be one of the cornerstones of a consolidated approach to the threat of AMR, and WHO has shown leadership in promoting and advancing surveillance in the Region, capitalizing on regional experience, best practices and networks of experts. The Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR) network was able to grow thanks to fruitful partnerships with the Netherlands National Institute for Public Health and the Environment and the European Society of Clinical Microbiology and Infectious Diseases, and close collaboration with ECDC and the sister European Antimicrobial Resistance Surveillance Network (EARS-Net), which has a long-standing tradition of carrying out AMR surveillance in European Union/European Economic Area (EU/EEA) countries.

In the spirit of establishing Europe as a best-practice region for surveillance, the advances made by the regional networks EARS-Net and CAESAR ultimately informed the establishment of the WHO Global AMR Surveillance System (GLASS) in 2015.

Ever since the CAESAR network was founded by the WHO Regional Office for Europe and partners in 2012, its goals have been to bridge the data gap for AMR and put AMR surveillance data for the whole Region on the map. Today, the CAESAR network includes 20 Member States, and AMR surveillance data are reported annually by 12 countries and one area, bringing the total number of European Member States reporting AMR surveillance data internationally to 42 out of 53. WHO will continue efforts to ensure that all Member States have the capacity to collect and share high-quality AMR surveillance data internationally for the benefit of the global community.

From those humble beginnings in 2012, this year marks an important step, in which AMR surveillance reporting in the European Region is in 100% alignment. This follows the example of other joint surveillance initiatives in the Region (such as for tuberculosis and HIV), for which joint reports with ECDC have been published. The joint AMR surveillance report has been the product of close and constant collaboration and exchange, and every effort has been made to standardize and align AMR surveillance in the Region.

This happens at an important point in time, when the Region has been hit hard by the COVID-19 pandemic. Our organizations must combine efforts to safeguard the advances made in the fight against AMR. Sharing national surveillance data is critically relevant and essential if AMR is to be kept firmly on the map and on the agenda of Member States.

Dr Hans Henri P. Kluge
WHO Regional Director for Europe

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2 All references accessed on 26 November 2021.

Foreword from the Director, European Centre for Disease Prevention and Control

Antimicrobial resistance (AMR) is a global challenge and a priority for the European Union (EU). Each year, there are over 670 000 infections due to antibiotic-resistant bacteria in the European Union/European Economic Area (EU/EEA), and approximately 33 000 people die as a direct consequence of these infections *(1)*. Efforts to prevent and control AMR are therefore vital for Europe.

Surveillance of AMR is an integral part of these efforts. Without surveillance, we would know little about the extent of AMR and where to focus our efforts. Surveillance enables us to monitor an ever-changing situation and act when necessary. Surveillance has its strengths, but also its limitations. While the results allow us to monitor trends, these need to be interpreted with caution; surveillance is not yet fully homogeneous across Europe and can vary over time and by country. Surveillance nevertheless provides fundamental information that can be used to address the challenges posed by AMR and help public health organizations and stakeholders in Europe and around the world to continue the fight against AMR – a fight we cannot afford to lose.

The continuous collection of AMR surveillance data requires significant effort. The European Centre for Disease Prevention and Control (ECDC) would like to take this opportunity to thank all those involved in AMR surveillance for their dedicated work, in particular those colleagues contributing to the European Antimicrobial Resistance Surveillance Network (EARS-Net).

ECDC and the WHO Regional Office for Europe have agreed to produce an annual joint report on AMR surveillance in Europe. For this purpose, both organizations have collaborated closely to align reporting of AMR surveillance data in the Region, including most EU/EEA countries and many other countries in the European Region, to the greatest extent possible. The resulting report is an essential element of ongoing surveillance efforts and, for the first time, provides an overview of the AMR situation in Europe and the information required for different actors across Europe to be able to take action against AMR.

ECDC is committed to ensuring that the prevention and control of AMR remains one of its top priorities, both by providing scientific evidence through surveillance, as in this report, and by supporting key public health actions. In recent years, ECDC has worked with the European Food Safety Authority and the European Medicines Agency to produce joint interagency reports on an integrated analysis of antimicrobial agent consumption and the occurrence of AMR in bacteria from humans and food-producing animals in the EU/EEA from a One Health perspective *(2)*. ECDC has also been working to implement genomic-based surveillance of multidrug-resistant bacteria of public health importance through the European Antimicrobial Resistance Genes Surveillance Network. The first phase of the surveillance involved carbapenemase-producing Enterobacterales. Finally, since 2008, ECDC has been coordinating the European Antibiotic Awareness Day initiative, marked each year on 18 November to raise awareness of the need for prudent use of antibiotics, and prevention and control of AMR in general *(3)*.

Everyone – including policy-makers, health professionals, patients and governmental and nongovernmental organizations – has a role to play in addressing the public health threat of AMR. We must all continue working together as partners and stakeholders. The information in this report provides a basis for planning action at all levels of society to respond to the challenge of AMR. On a wider scale, we need strong policy-making initiatives to prevent the spread of infectious diseases and the emergence of AMR, as well as the development and implementation of antimicrobial stewardship programmes and enhanced support for the development and availability of new antimicrobials. At individual level, we can all play a part in preserving the effectiveness of antibiotics by using them prudently and applying appropriate prevention and control measures to prevent the spread of infectious diseases, as well as the spread of AMR. By addressing the challenge of AMR together, we can win.

Dr Andrea Ammon
Director, European Centre for Disease Prevention and Control

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3. European Antibiotic Awareness Day. In: European Centre for Disease Prevention and Control [website]. Stockholm: European Centre for Disease Prevention and Control; 2021 (https://antibiotic.ecdc.europa.eu/en).

3 All references were accessed on 29 November 2021.

Abbreviations

AMR	antimicrobial resistance
AST	antimicrobial susceptibility testing
AWaRe	(WHO) Access, Watch, Reserve (classification system)
CAESAR	Central Asian and European Surveillance of Antimicrobial Resistance (network)
CCRE	carbapenem- and/or colistin-resistant Enterobacterales
CLSI	Clinical and Laboratory Standards Institute
CRE	carbapenem-resistant Enterobacterales
EARS-Net	European Antimicrobial Resistance Surveillance Network
EARSS	European Antimicrobial Resistance Surveillance System
ECDC	European Centre for Disease Prevention and Control
EQA	external quality assessment
ESAC-Net	European Surveillance of Antimicrobial Consumption Network
ESCMID	European Society of Clinical Microbiology and Infectious Diseases
EUCAST	European Committee on Antimicrobial Susceptibility Testing
EU/EEA	European Union/European Economic Area
EURGen-Net	European Antimicrobial Resistance Genes Surveillance Network
GAP-AMR	(WHO) Global Action Plan on Antimicrobial Resistance
GLASS	(WHO) Global Antimicrobial Resistance Surveillance System
HAI-Net	Healthcare-associated Infections Surveillance Network
I	susceptible, increased exposure
ICU	intensive care unit
IPC	infection prevention and control
LA-MRSA	livestock-associated methicillin-resistant *Staphylococcus aureus*
MIC	minimum inhibitory concentrations
MRSA	methicillin-resistant *Staphylococcus aureus*
NAP	national action plan
PCR	polymerase chain reaction (test)
PCVs	pneumococcal conjugated vaccines
R	resistant
RIVM	Netherlands National Institute for Public Health and the Environment
S	susceptible, standard dosing regimen
SARS-CoV-2	severe acute respiratory syndrome coronavirus 2

spp.	species
TESSy	The European Surveillance System
TrACSS	tripartite antimicrobial resistance country self-assessment survey

Bacterial species

A. baumannii	*Acinetobacter baumannii*
***Acinetobacter* spp.**	*Acinetobacter* species
E. coli	*Escherichia coli*
E. faecalis	*Enterococcus faecalis*
E. faecium	*Enterococcus faecium*
K. pneumoniae	*Klebsiella pneumoniae*
P. aeruginosa	*Pseudomonas aeruginosa*
S. aureus	*Staphylococcus aureus*
S. pneumoniae	*Streptococcus pneumoniae*

Executive summary

WHO European Region

The results presented in this report are based on antimicrobial resistance (AMR) data from invasive isolates reported to the Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR) network and the European Antimicrobial Resistance Surveillance Network (EARS-Net) in 2021 (data referring to 2020). Twelve countries and Kosovo[4] reported data to CAESAR, while 29 countries, including all from the European Union (EU) and two from the European Economic Area (EEA) (Iceland and Norway), reported data to EARS-Net. While the EARS-Net and CAESAR networks use comparable methods for data collection and analysis, the results presented in this report originate from distinct country/area surveillance systems. As these inherently are influenced by specific protocols and practices, caution is advised when comparing countries/areas in terms of AMR patterns.

Epidemiology

The AMR situation in bacterial species reported to the AMR surveillance networks in 2020 varied widely depending on the bacterial species, antimicrobial group and geographical region (see Fig. 1–10 in Chapter 3). Resistance to third-generation cephalosporins and carbapenems generally was higher in *Klebsiella pneumoniae* (*K. pneumoniae*) than *Escherichia coli* (*E. coli*). While carbapenem resistance remained rare in *E. coli* for most countries, 30% of countries reported resistance percentages of 25% or higher in *K. pneumoniae*. Carbapenem resistance was also common in *Pseudomonas aeruginosa* (*P. aeruginosa*) and *Acinetobacter* species (spp.), and at a higher percentage than in *K. pneumoniae*. As has been observed in previous regional reports, there is a north-to-south and west-to-east gradient of resistance, with higher rates observed in the southern and eastern parts of the Region. This was particularly evident for fluoroquinolone resistance in *E. coli*, third-generation cephalosporin and carbapenem resistance in *K. pneumoniae* and carbapenem resistance in *Acinetobacter* spp. Time trend analysis of resistance proportions by country was performed for EU/EEA countries. The results are summarized in the EU/EEA section.

Considering only the countries and areas that submitted data to CAESAR both in 2019 and 2020, the overall number of isolates reported was lower in 2020 than in 2019. This was a result of lower numbers of *E. coli*, *P. aeruginosa*, *Staphylococcus aureus* (*S. aureus*) and *Streptococcus pneumoniae* (*S. pneumoniae*) isolates being reported. Higher numbers were reported for *Acinetobacter* spp. and *Enterococcus faecium* (*E. faecium*). These overall tendencies were not always observed at country/area level, however all but one country reported higher numbers of *Acinetobacter* spp. isolates in 2020 than in 2019. In 2020, *E. coli* (38.4%), *S. aureus* (17.3%) and *K. pneumoniae* (14.9%) represented the majority (70.6%) of isolates.

Looking at bacterial species-specific results in 2020, resistance to fluoroquinolones in *E. coli* was generally lowest in northern and western parts of the WHO European Region and highest in southern and eastern parts (see Fig. 1 in Chapter 3). A resistance percentage below 10% was observed in one (3%) of 40 countries/areas reporting data on this microorganism. A resistance percentage of 25% or above was reported in 20 (50%) countries/areas. A resistance percentage of 50% or above was observed in three (8%) countries/areas. For third-generation cephalosporin resistance in *E. coli*, 10 (25%) of 40 countries/areas reported the lowest resistance percentages (5-<10%), whereas resistance percentages equal to or above 50% were observed in five (13%) (see Fig. 2 in Chapter 3). The recent emergence of carbapenem-resistant *E. coli* is of serious concern. Six (15%) of 40 countries/areas reported resistance percentages of 1% or above (see Fig. 3 in Chapter 3). Third-generation cephalosporin resistance in *K. pneumoniae* has become quite widespread in the WHO European Region. In 2020, percentages below 10% were observed in six (15%) of 41 countries/areas reporting data on this microorganism, while 18 (44%), particularly in the southern and eastern parts of the Region, reported resistance percentages of 50% or above (see Fig. 4 in Chapter 3).

Carbapenem resistance was more frequently reported in *K. pneumoniae* than in *E. coli*. In 2020, resistance percentages generally were low in the northern and western parts of the WHO European Region; 16 (39%) of 41 countries/areas reported resistance percentages below 1% (see Fig. 5 in Chapter 3). Twelve (30%) reported percentages equal to or above 25%, six of which (15% of 41 countries/areas) reported resistance percentages equal to or above 50%.

Large differences were observed in the percentages of carbapenem-resistant *P. aeruginosa* in the Region. In 2020, resistance percentages of below 5% were observed in four (10%) of 41 countries/areas reporting data on this microorganism, whereas six (15%) reported percentages equal to or above 50% (see Fig. 6 in Chapter 3). The percentages of carbapenem-resistant *Acinetobacter* spp. varied widely within the Region in 2020, from below 1% in three (8%) of 38 countries/areas reporting data on this microorganism to equal to or above 50% in 21 (55%), mostly in southern and eastern Europe (see Fig. 7 in Chapter 3). In 2020, nine (23%) of 40 countries/areas reporting

4 All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999).

data on *S. aureus* had the lowest methicillin-resistant *S. aureus* (MRSA) percentages (below 5%, see Fig. 8 in Chapter 3). MRSA percentages equal to or above 25% were found in 10 (25%) of 40 countries/areas. Large differences were observed across the Region in the percentage of penicillin non-wild-type *S. pneumoniae*. Three (9%) of 35 countries/areas reporting data on this microorganism had proportions below 5% in 2020, whereas percentages equal to or above 25% were found in nine (26%) (see Fig. 9 in Chapter 3). Resistance to vancomycin in *E. faecium* varied substantially among countries/areas in the Region. In 2020, resistance percentages of below 1% were reported by seven (18%) of 38 countries/areas reporting data on this microorganism, while percentages equal to or above 25% were found in 13 (34%), four of which (11% of 38) reported resistance percentages equal to or above 50% (see Fig. 10 in Chapter 3).

Discussion

These results from CAESAR and EARS-Net show clearly that AMR is widespread in the WHO European Region. While assessing the exact magnitude of AMR remains challenging in many settings, the presence of specific AMR patterns across clinical settings covered by the surveillance networks is apparent. High percentages of resistance to third-generation cephalosporins and carbapenems in *K. pneumoniae*, and high percentages of carbapenem-resistant *Acinetobacter* spp. in several countries/areas, are of concern. They suggest the dissemination of resistant clones in health-care settings and indicate the serious limitations in treatment options in many countries for patients with infections caused by these pathogens. While the west-to-east gradient in AMR percentages is evident for gram-negative bacteria (*E. coli*, *K. pneumoniae*, *Acinetobacter* spp.), it is less obvious for gram-positive bacteria (*S. aureus*, *S. pneumoniae*, *E. faecium*). As antimicrobial-resistant bacterial microorganisms cannot be contained within borders or regions, these results underline the need for concerted action to combat AMR throughout the WHO European Region.

The impact of the COVID-19 pandemic on AMR is apparent in many ways. Many countries providing AMR data to CAESAR reported fewer *E. coli* isolates in 2020 than in previous years. This may be related to decreased health-care activities in domains not linked directly to the COVID-19 response, including less engagement in AMR surveillance activities. In addition, many countries and areas in the WHO European Region reported lower numbers of *S. pneumoniae* isolates in 2020 than in previous years, which may be a result of the decreased circulation of respiratory pathogens in the community during lockdowns and the enforcement of measures to control the spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). On the other hand, typical health-care-associated pathogens such as *Acinetobacter* spp. and *E. faecium* were more frequently observed during 2020 than in previous years in many countries and areas.

Since the adoption of the European Strategic Action Plan on Antibiotic Resistance in 2011 *(1)* and the publication of the Global Action Plan on Antimicrobial Resistance (GAP-AMR) in 2015 *(2)*, most Member States of the WHO European Region have enhanced efforts to tackle AMR. Only 25 (50%) of the 50 countries/areas reported having developed a national action plan (NAP) on AMR in 2016, but the latest round of global monitoring showed that this had increased to 43 (86%) of the 50 countries/areas that responded in the Region (see Table 6 in Chapter 3). The challenge ahead is to ensure comprehensive implementation and adequate funding for NAPs. This shortcoming is more evident when looking at surveillance capacity in the WHO European Region: 20% of countries/areas still reported either having no capacity for generating AMR surveillance data or collecting AMR data only at local level and without a standardized approach.

Similarly, efforts to rationalize antimicrobial consumption in the Region remain heterogeneous. While 14 (48%) countries/areas reporting to the European Surveillance of Antimicrobial Consumption Network (ESAC-Net) met WHO's suggested national target of 60% of total antibacterial consumption each year being derived from WHO's Access category (as defined in the Access, Watch, Reserve (AwaRe)[5] classification list *(3)*), during the period 2014–2018, only one (7%) country reporting to the WHO Regional Office for Europe Antimicrobial Medicines Consumption Network achieved this target in each of these five years.

Public health implications

AMR is a looming threat to the health of millions of people worldwide. The COVID-19 pandemic has exposed the weaknesses in national health systems and the interconnectedness of countries and continents. Continuity of efforts to tackle AMR has been seriously challenged by repurposing health-care professionals to support the COVID-19 response across the European Region, and the effects of the pandemic on people and public health still need to be fully evaluated. This crisis is a powerful reminder that governments/authorities will need more coordinated action and collaboration than ever before to confront future health threats. Despite the global call for action that was renewed with the GAP-AMR in 2015 *(2)*, the European One Health Action Plan in 2017 *(4)* and the subsequent commitment by Member States to develop NAPs, several countries/areas are only just starting on their roadmap to implement effective interventions to tackle AMR. High-level commitment is still lacking and important programmes and interventions on infection prevention and control (IPC), antimicrobial stewardship and surveillance remain under-resourced. Despite important advances, this report highlights the persistent disparities in AMR prevalence across the WHO European Region and uncovers unexploited opportunities to counteract AMR. Greater efforts and investment

5 AWaRe classifies antibiotics into three stewardship groups – Access, Watch and Reserve – to emphasize the importance of their optimal uses and potential for AMR.

are required to increase the comparability, quantity and quality of AMR surveillance data.

EU/EEA countries

The EU and EEA results presented in this report are based on AMR data from invasive isolates reported to EARS-Net by 29 EU/EEA countries in 2021 (data referring to 2020) and on trend analyses of data reported by the participating countries for the period 2016 to 2020. The latest country-specific data can be retrieved from ECDC's Surveillance Atlas of Infectious Diseases *(5)*.

Epidemiology

The overall number of reported isolates at EU/EEA level increased in 2020 compared to 2019 for all bacterial species except *S. pneumoniae*. These increases were not always observed at country level. There was a large decrease in the overall number of *S. pneumoniae* isolates between 2019 and 2020, and similarly large decreases reported in all but one country.

The AMR situation reported by EU/EEA countries to EARS-Net for 2020 varied widely depending on the bacterial species, antimicrobial group and geographical region (see Table 7a, Fig. 1–10 and the country and area profiles in Chapter 3 and 4). Overall for the EU/EEA (excluding the United Kingdom), most of the bacterial species–antimicrobial combinations in this report showed either a significantly decreasing trend or no significant trend in the population-weighted mean AMR percentage during 2016–2020. The exceptions to this were carbapenem resistance in *E. coli* and *K. pneumoniae* and vancomycin resistance in *E. faecium*, for which there was a significant increase during this period (see Table 7b in Chapter 3).

In 2020, more than half of the *E. coli* isolates reported to EARS-Net and more than a third of the *K. pneumoniae* isolates were resistant to at least one antimicrobial group under surveillance, and combined resistance to several antimicrobial groups was a frequent occurrence. Among antimicrobial groups monitored for both species, AMR percentages generally were higher in *K. pneumoniae* than in *E. coli*. Carbapenem resistance remained rare in *E. coli*, but almost a quarter of EU/EEA countries reported carbapenem resistance percentages above 10% in *K. pneumoniae*. Carbapenem resistance was also common in *P. aeruginosa* and *Acinetobacter* spp. and at a higher percentage than in *K. pneumoniae*. For most gram-negative bacteria under surveillance, changes in the EU/EEA (excluding the United Kingdom) population-weighted mean AMR percentages between 2016 and 2020 were moderate and AMR remained at high levels, as previously reported.

For *S. aureus*, a decrease in the percentage of MRSA isolates was reported during 2016–2020 (see Table 7b in Chapter 3). MRSA nevertheless remains an important pathogen in the EU/EEA, with levels remaining high in several countries and combined resistance to another antimicrobial group common. A decreasing trend was also seen during 2016–2020 for the percentage of macrolide resistance in *S. pneumoniae* (see Table 7b in Chapter 3).

One development of particular concern was the increasing trend in the EU/EEA (excluding the United Kingdom) population-weighted mean percentage of vancomycin-resistant isolates of *E. faecium*, which increased from 11.6% in 2016 to 16.8% in 2020.

The reported AMR percentages for several bacterial species–antimicrobial group combinations varied widely among countries, with a north-to-south and west-to-east gradient evident. In general, the lowest AMR percentages were reported by countries in the north of Europe and the highest by countries in the south and east. There was no distinct geographical pattern for vancomycin-resistant *E. faecium*.

Discussion

WHO characterized COVID-19 as a new pandemic in March 2020 *(6)*. SARS-CoV-2 presented the world with a new and globally distributed infectious agent that affected public health across the planet, albeit with vaccines developed and recommended for authorization towards the end of 2020 *(7)*. Despite the pandemic, all EU/EEA countries that regularly report AMR data reported 2020 data in 2021.

The COVID-19 pandemic and the related public health interventions may have affected the reporting and analysis of results of 2020 AMR data in different ways and to varying degrees over time. Examples of this include changes in hospital admission patterns *(8)*, prescription of antimicrobials *(8)*, laboratory reporting capacity, or public health interventions *(8)*. Changes in public health interventions could, for example, explain the decrease in the number of *S. pneumoniae* isolates reported by EU/EEA countries for 2020.

The decreasing AMR trends in the EU/EEA (excluding the United Kingdom) during 2016–2020 for several bacterial species–antimicrobial group combinations under surveillance by EARS-Net had in most cases already been noted in the annual epidemiological report for 2019 *(9)*. Significantly increasing trends for carbapenem resistance in *E. coli* and *K. pneumoniae* and vancomycin resistance in *E. faecium* were observed for the period 2016–2020 (excluding the United Kingdom), similar to the previously reported trends for 2015–2019 when the United Kingdom was included *(9)*.

A large decrease in community antibiotic consumption in the EU/EEA was reported by ESAC-Net for 2020 *(10)*. Concomitant large changes in the AMR percentages were not observed at EU/EEA level in EARS-Net. For *E. coli*, there was a larger decrease in the percentages of resistance to aminopenicillins and third-generation cephalosporins in the EU/EEA in 2020 than for each year during the period 2016–2019. For a few other bacterial species–antimicrobial group combinations, there

were large increases in AMR percentages at EU/EEA level between 2019 and 2020, although an increasing trend during 2016–2020 (excluding the United Kingdom) was reported only for carbapenem resistance in *K. pneumoniae*.

Limitations to the quality of AMR data and interpretation of AMR percentages should be taken into consideration (see Annex 3). For example, there have been changes in the reporting of data to EARS-Net over time within countries and at EU/EEA level. This could have influenced the results, and this fact should be borne in mind when interpreting trends. The analysis for *P. aeruginosa* and aminoglycosides, for instance, changed: previously the analysis included netilmicin, gentamicin and tobramycin, but from 2020 onwards it includes only tobramycin. This hampers interpretation of the decrease in aminoglycoside resistance percentages observed for 2020. Other examples are changes to country surveillance systems, which may affect the interpretation of the AMR percentages over time (see country and area profiles in Chapter 4), and restriction on data generated using European Committee on Antimicrobial Susceptibility Testing (EUCAST) breakpoints and methodology, starting with data collected for 2019. The restriction to EUCAST breakpoints and methodology should, however, improve quality and comparability of data in the long term.

AMR percentages for the bacterial species–antimicrobial group combinations under surveillance continue to be high overall in the EU/EEA and the large variability in AMR percentages across EU/EEA countries remained in 2020. This highlights the opportunities for significant AMR reduction through interventions to improve IPC and antimicrobial stewardship practices.

For health-care settings, results from the ECDC point prevalence survey of health-care-associated infections and antimicrobial use in European acute care hospitals showed that the prevalence of patients receiving antibiotics was positively associated with AMR and, conversely, higher antibiotic stewardship activities and resources for IPC were associated with lower AMR percentages *(11)*. Another study showed that knowledge and perceived knowledge about antibiotics, antibiotic use and antibiotic resistance was high among health-care workers in EU/EEA countries, while highlighting areas where there was a need for educational interventions *(12)*. Prudent antimicrobial use and high standards of IPC in all health-care sectors remain the cornerstones of an effective response to AMR, and these studies highlight areas for improvement in health-care settings across the EU/EEA.

For the community, a recent study covering the period 2014–2018 reported on statistically significant decreasing trends in the total consumption of antibiotics for some EU/EEA countries *(13)*. The long-term effects on AMR of the large decrease in community antibiotic consumption observed in almost all EU/EEA countries in 2020 *(10)* remain to be seen. 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. Antimicrobial use exerts an ecological pressure on microorganisms and contributes to the emergence and selection of AMR, and poor IPC practices promote further spread of antimicrobial-resistant microorganisms. Prudent use of antimicrobials therefore is advisable, and relevant EU guidelines have been published by the European Commission *(14)*. Moreover, the importance of infection prevention in society as a whole through, for example, appropriate hand hygiene and vaccination should not be overlooked in the work against AMR.

AMR calls for concerted efforts at country level and close international cooperation. In 2017, the European Commission adopted a European One Health Action Plan against AMR to support the EU and its Member States in delivering innovative, effective and sustainable responses to AMR *(4)*. A majority of EU/EEA countries in a 2017 survey reported having implemented or initiated work towards establishing objectives and targets for the reduction of antibiotic use in humans, often through the development of a NAP on AMR. Only a few, however, had published these targets in 2017 *(15)* and had identified specific funding sources to implement their NAPs *(11)*. As of 2020, 25 out of 29 EU/EEA countries had reported having a NAP on AMR and three others were in the process of developing a NAP (see Table 6 in Chapter 3).

Public health implications

The high levels of AMR for several important bacterial species–antimicrobial group combinations reported to EARS-Net for 2020 show that AMR remains a serious challenge in the EU/EEA. Indeed, AMR is a considerable threat to public health, both in the EU/EEA *(4)* and worldwide *(2)*. Estimates based on data from EARS-Net show that each year, more than 670 000 infections occur in the EU/EEA due to bacteria resistant to antibiotics, and that approximately 33 000 people die as a direct consequence of these infections *(16)*. The related cost to the health-care systems of EU/EEA countries is estimated to be around €1.1 billion *(11)*.

Public health action to tackle AMR remains insufficient, despite the increased awareness of AMR as a threat to public health and the availability of evidence-based guidance for IPC, antimicrobial stewardship and adequate microbiological capacity. AMR will be an increasing concern unless governments respond more robustly to the threat. Further investment in public health interventions is needed urgently to tackle AMR. This would have a significant positive impact on population health and future health-care expenditure in the EU/EEA. It has been estimated that a mixed intervention package that included antibiotic stewardship programmes, enhanced hygiene, mass media campaigns and the use of rapid diagnostic tests would have the potential to prevent approximately 27 000 deaths each year in the EU/EEA. In addition to saving lives, such a public health package could pay for

itself within just one year and save around €1.4 billion per year in the EU/EEA *(11)*.

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Резюме

Европейский регион ВОЗ

Результаты, представленные в этом докладе, основаны на данных об устойчивости инвазивных изолятов к противомикробным препаратам (УПП), сообщенных в CAESAR (Сеть эпиднадзора за устойчивостью к противомикробным препаратам в Центральной Азии и Европе) и в EARS-Net (Европейская сеть эпиднадзора за устойчивостью к противомикробным препаратам) в 2021 г. (данные относятся к 2020 г.). Двенадцать стран и Косово[7] сообщили данные в CAESAR и 29 стран, включая все страны Европейского союза (ЕС) и две страны (Исландия и Норвегия), входящие в Европейскую экономическую зону (ЕЭЗ), сообщили данные в EARS-Net. Хотя сети EARS-Net и CAESAR используют совместимые методы сбора и анализа данных, результаты, представленные в этом докладе, основаны на данных, полученных из отличающихся друг от друга систем эпиднадзора стран/территорий. Несомненно, что на эти результаты влияют конкретные протоколы и практики, поэтому рекомендуется соблюдать осторожность при сравнении профилей УПП в странах/территориях.

Эпидемиология

Согласно сообщениям, предоставленным в сети эпиднадзора за УПП, ситуация с УПП у разных видов бактерий в 2020 г. широко варьировалась в зависимости от вида бактерий, группы противомикробных препаратов и географического региона (см. рис. 1–10 в Главе 3). Устойчивость к цефалоспоринам 3-го поколения и карбапенемам в целом была выше у *Klebsiella pneumoniae* (*K. pneumoniae*), чем у *Escherichia coli* (*E. coli*). Устойчивость *E. coli* к карбапенемам в большинстве стран оставалась редкостью, хотя о доле устойчивости *K. pneumoniae*, составлявшей 25% или выше, сообщили 30% стран. Также имела широкое распространение устойчивость к карбапенемам у *Pseudomonas aeruginosa* (*P. aeruginosa*) и *Acinetobacter* species (spp.), причем доли устойчивости были выше, чем у *K. pneumoniae*. Как отмечалось в предыдущих региональных докладах, наблюдается градиент устойчивости, направленный с севера на юг и с запада на восток; при этом более высокие показатели наблюдаются в южной и восточной частях Региона. Это было особенно очевидно в отношении устойчивости *E. coli* к фторхинолонам, устойчивости *K. pneumoniae* к цефалоспоринам 3-го поколения и карбапенемам и устойчивости *Acinetobacter* spp. к карбапенемам. Для стран ЕС/ЕЭЗ был проведен анализ изменения долей устойчивости во времени в разбивке по странам. Результаты обобщены в разделе «Страны ЕС/ЕЭЗ». Анализ данных, относящихся только к тем странам и территориям, которые предоставили их в CAESAR как в 2019 г., так и в 2020 г., показал, что общее количество сообщений об изолятах в 2020 г. было ниже, чем в 2019 г. Это стало результатом получения меньшего количества изолятов *E. coli*, *P. aeruginosa*, *Staphylococcus aureus* (*S. aureus*) и *Streptococcus pneumoniae* (*S. pneumoniae*). О большем числе изолятов сообщали в отношении *Acinetobacter* spp. и *Enterococcus faecium* (*E. faecium*). Эти общие тенденции не всегда наблюдались на уровне страны/территории, однако все страны, кроме одной, сообщили о большем числе изолятов *Acinetobacter* spp., полученных в 2020 г. по сравнению с 2019 г. В 2020 г. большинство изолятов (70,6%) составляли изоляты *E. coli* (38,4%), *S. aureus* (17,3%) и *K. pneumoniae* (14,9%).

Если рассматривать результаты, относящиеся к конкретным видам бактерий в 2020 г., то в целом устойчивость *E. coli* к фторхинолонам была самой низкой в северной и западной и самой высокой в южной и восточной частях Европейского региона ВОЗ (см. рис. 1 в Главе 3). Процент устойчивости ниже 10% наблюдался в одной (3%) из 40 стран/территорий, сообщивших данные об этом микроорганизме. Процент устойчивости 25% или выше был отмечен в 20 (50%) странах/территориях, а доля устойчивости 50% или выше – в трех (8%). Что касается устойчивости *E. coli* к цефалоспоринам 3-го поколения, то 10 (25%) из 40 стран/территорий сообщили о самом низком проценте устойчивости (5-<10%), тогда как в пяти (13%) наблюдались доли устойчивости, равные или превышающие 50% (см. рис. 2 в Главе 3). Недавнее появление устойчивой к карбапенемам кишечной палочки вызывает серьезную озабоченность: шесть (15%) из 40 стран/территорий сообщили, что доля устойчивости составила 1% или выше (см. рис. 3 в Главе 3). Устойчивость *K. pneumoniae* к цефалоспоринам 3-го поколения была достаточно широко распространена в Европейском регионе ВОЗ. В 2020 г. процентные показатели ниже 10% наблюдались в шести (15%) из 41 страны/территории, предоставившей данные об этом микроорганизме, в то время как 18 (44%) (особенно расположенные в южной и восточной частях Региона) сообщили о доле устойчивости 50% или выше (см. рис. 4 в Главе 4).

Устойчивость к карбапенемам чаще встречалась у *K. pneumoniae*, чем у *E. coli*. В 2020 г. процент устойчивости в северной и западной частях Европейского региона ВОЗ в целом был низким: 16 (39%) из 41 страны/территории сообщили о доле устойчивости ниже 1% (см. рис. 5 в Главе 3). О долях устойчивости,

7 Все упоминания Косово в настоящем документе следует понимать в контексте резолюции 1244 Совета Безопасности ООН (1999 г.).

равных или превышающих 25%, сообщили 12 (30%); при этом в шести из них (15% из 41 страны/территории) доли устойчивости были равны или превышали 50%. Значимые различия наблюдались в Регионе в долях устойчивых к карбапенемам изолятов *P. aeruginosa*. В 2020 г. доли устойчивости ниже 5% наблюдались в четырех (10%) из 41 страны/территории, предоставившей данные об этом микроорганизме, тогда как шесть (15%) сообщили о долях устойчивости, равных или превышающих 50% (см. рис. 6 в Главе 3). В 2020 г. процентная доля устойчивых к карбапенемам изолятов *Acinetobacter* spp. в Регионе широко варьировалась: от менее 1% в трех (8%) из 38 стран/территорий, предоставивших данные об этом микроорганизме, до 50% или более в 21 (55%) из них, расположенных в основном в южной и восточной частях Европы (см. рис. 7 в Главе 3). В 2020 г. в девяти (23%) из 40 стран/территорий, предоставивших данные о *S. aureus*, процент устойчивых к метициллину изолятов *этого микроорганизма* (MRSA) был самым низким (ниже 5%; см. рис. 8 в Главе 3). Доли MRSA, равные или превышающие 25%, были выявлены в 10 (25%) из 40 стран/территорий. В Регионе наблюдались большие различия в процентных долях устойчивости к пенициллину у *S. pneumoniae* недикого типа. В 2020 г. в трех (9%) из 35 стран/территорий, сообщивших данные об этом микроорганизме, доли устойчивых изолятов составляли менее 5%, тогда как в девяти (26%) были обнаружены доли устойчивости этого патогена, равные или превышающие 25% (см. рис. 9 в Главе 3). Устойчивость *E. faecium* к ванкомицину существенно различалась в странах/территориях Региона. В 2020 г. о долях устойчивости ниже 1% сообщили семь (18%) из 38 стран/территорий, предоставивших данные об этом микроорганизме, в то время как доли, равные или превышающие 25%, были обнаружены в 13 (34%), четыре из которых (11% из 38) сообщили о долях устойчивости, равных или превышающих 50% (см. рис. 10 в Главе 3).

Обсуждение

Результаты, полученные сетями CAESAR и EARS-Net, ясно показывают, что УПП широко распространена в Европейском регионе ВОЗ. Хотя оценка точных масштабов УПП остается сложной задачей во многих ситуациях, наличие определенных паттернов УПП в клинических учреждениях, охваченных сетями эпиднадзора, очевидно. Вызывает озабоченность высокий процент устойчивости *K. pneumoniae* к цефалоспоринам 3-го поколения и карбапенемам, а также значительные доли устойчивых к карбапенемам *Acinetobacter* spp. в ряде стран/территорий. Это может свидетельствовать о распространении устойчивых клонов в медицинских учреждениях и указывать на серьезные ограничения в вариантах лечения пациентов с инфекциями, вызванными этими патогенами, во многих странах. В то время как градиент процентных долей УПП с запада на восток явно просматривается для грамотрицательных бактерий (*E. coli*, *K. pneumoniae*, *Acinetobacter* spp.), он менее выражен в отношении грамположительных бактерий (*S. aureus*, *S. pneumoniae*, *E. faecium*). Поскольку распространение устойчивых к противомикробным препаратам бактерий невозможно сдерживать в пределах границ или регионов, полученные результаты подчеркивают необходимость согласованных действий по борьбе с УПП во всем Европейском регионе ВОЗ.

Влияние пандемии COVID-19 на УПП сказывается по многим направлениям. Из стран, предоставляющих данные об УПП в CAESAR, многие сообщили, что в 2020 г. исследовано меньше изолятов *E. coli*, чем в предыдущие годы. Это может быть связано с уменьшением активности в тех областях здравоохранения, которые не связаны напрямую с реагированием на пандемию COVID-19, включая менее активное участие в мероприятиях по надзору за УПП. Кроме того, многие страны и территории Европейского региона ВОЗ сообщили, что в 2020 г. по сравнению с предыдущими годами было выделено меньше изолятов *S. pneumoniae*, возможно, в результате снижения циркуляции респираторных патогенов в местных сообществах во время изоляции и применения мер по борьбе с распространением коронавируса тяжелого острого респираторного синдрома 2 (SARS-CoV-2). С другой стороны, во многих странах и территориях типичные возбудители инфекций, связанных с оказанием медицинской помощи, такие как *Acinetobacter* spp. и *E. faecium*, в 2020 г. выделяли чаще, чем в предыдущие годы.

После принятия в 2011 г. Европейского стратегического плана действий по проблеме устойчивости к антибиотикам *(1)* и публикации в 2015 г. Глобального плана действий по борьбе с устойчивостью к противомикробным препаратам *(2)* большинство государств-членов Европейского региона ВОЗ активизировали свои усилия по борьбе с УПП. В 2016 г. только 25 (50%) из 50 стран/территорий сообщили о разработке национального плана действий (НПД) по борьбе с УПП, тогда как по данным последнего раунда глобального мониторинга этот показатель увеличился до 43 (86%) из 50 ответивших стран/территорий Региона (см. таблицу 6 в Главе 3). Предстоящая задача состоит в том, как обеспечить полноценную реализацию и адекватное финансирование НПД. Сложность ее решения становится более очевидной при рассмотрении возможностей эпиднадзора в Европейском регионе ВОЗ: 20% стран/территорий по-прежнему сообщают о том, что они либо не имеют достаточного потенциала для сбора данных эпиднадзора за УПП, либо собирают данные об УПП только на местном уровне и не используют стандартизированный подход.

Точно так же усилия по оптимизации потребления противомикробных препаратов в Регионе остаются неравнозначными. Так, 14 (48%) стран/территорий, предоставивших отчеты в Европейскую сеть по надзору за потреблением противомикробных препаратов

(ESAC-Net), достигли в течение периода 2014–2018 гг. предложенного ВОЗ национального целевого показателя: 60% от общего ежегодного потребления антибактериальных препаратов должны составлять препараты из группы «доступа» [как определено в классификационном списке ВОЗ «доступ, наблюдение, резерв» (AwaRe)[8] *(3)*].В то же время только одна страна (7%), предоставляющая данные в Сеть ВОЗ по потреблению противомикробных препаратов, учрежденную Европейским региональным бюро ВОЗ, достигала этого целевого показателя в каждый год из этих пяти лет.

Последствия для общественного здравоохранения

УПП представляет собой надвигающуюся угрозу здоровью миллионов людей во всем мире. Пандемия COVID-19 выявила слабые места в национальных системах здравоохранения и взаимозависимость стран и континентов. Непрерывность усилий по борьбе с УПП была серьезно затруднена из-за перепрофилирования специалистов здравоохранения для поддержки мер в ответ на COVID-19 во всем Европейском регионе, а последствия пандемии для людей и общественного здравоохранения все еще нуждаются во всесторонней оценке. Этот кризис является грозным напоминанием о том, что правительствам/властным структурам как никогда прежде потребуются скоординированные действия и сотрудничество для противодействия будущим угрозам здоровью. Несмотря на глобальный призыв к действиям, который получил новый импульс с принятием ГПД-УПП в 2015 г. *(2)*, Европейского плана действий «Единое здоровье» в 2017 г. *(4)* и последующих обязательств государств-членов по разработке НПД, некоторые страны/территории только начинают составлять дорожную карту реализации эффективных мер по борьбе с УПП. По-прежнему отсутствует приверженность на высоком уровне, а важные программы и мероприятия по профилактике инфекций и инфекционному контролю (ПИИК), рациональному использованию противомикробных препаратов и эпиднадзору все также испытывают нехватку ресурсов. В этом докладе подчеркивается, что, несмотря на важные достижения, по-прежнему сохраняются различия в распространенности УПП в Европейском регионе ВОЗ; также в нем раскрываются неиспользованные возможности противодействия УПП. Необходимы серьезные усилия и инвестиции для повышения сопоставимости, количества и качества данных эпиднадзора за УПП.

Страны ЕС/ЕЭЗ

Результаты, относящиеся к странам ЕС и ЕЭЗ, которые рассматриваются в этом докладе, основаны на данных об УПП инвазивных изолятов, сообщенных в EARS-Net 29 странами ЕС/ЕЭЗ в 2021 г. (данные относятся к 2020 г.) а также на результатах анализа тенденций изменения данных, предоставленных странами-участницами за период 2016–2020 гг. Последние данные по странам можно найти в Атласе эпиднадзора за инфекционными болезнями ECDC *(5)*.

Эпидемиология

В 2020 г. в странах ЕС/ЕЭЗ общее количество зарегистрированных сообщений об изолятах всех видов бактерий, кроме *S. pneumoniae*, увеличилось по сравнению с 2019 г. Подобный рост не всегда наблюдался на страновом уровне. В период между 2019 и 2020 г. отмечено значительное снижение общего числа изолятов *S. pneumoniae*; при этом подобное значительное сокращение было зарегистрировано во всех странах, кроме одной.

Ситуация с УПП в 2020 г., о которой страны ЕС/ЕЭЗ сообщили в EARS-Net, сильно варьировалась в зависимости от вида бактерий, группы противомикробных препаратов и географического региона (см. таблицу 7a, рис. 1–10 и профили, относящиеся к стране или территории, в главах 3 и 4). В целом по ЕС/ЕЭЗ (данные Соединенного Королевства не включены) в 2016–2020 гг. для большинства комбинаций бактериальные виды–противомикробные препараты, рассматриваемых в этом докладе, выявлена либо выраженная тенденция к снижению, либо отсутствие значимой тенденции к изменению средневзвешенной по численности населения процентной доли УПП. Исключением являются процентные доли устойчивости к карбапенемам у *E. coli* и *K. pneumoniae* и устойчивости к ванкомицину у *E. faecium*, показатели которых в этот период значительно увеличились (см. таблицу 7b в Главе 3).

В 2020 г. более половины изолятов *E. coli* и более трети изолятов *K. pneumoniae*, сообщения о которых поступили в EARS-Net, были устойчивы по крайней мере к одной группе противомикробных препаратов, используемых при эпиднадзоре, а комбинированная устойчивость к нескольким группам противомикробных препаратов была частым явлением. Среди групп противомикробных препаратов, устойчивость к которым отслеживалась у обоих видов, процент УПП обычно был выше у *K. pneumoniae*, чем у *E. coli*. Устойчивость к карбапенемам оставалась редкостью у *E. coli*, но почти четверть стран ЕС/ЕЭЗ сообщила, что доля устойчивости *K. pneumoniae* к карбапенемам превышает 10%. Устойчивость *P. aeruginosa* и *Acinetobacter* spp. к карбапенемам также была обычным явлением, и процентная доля устойчивости была выше, чем у *K. pneumoniae*. Для большинства грамотрицательных бактерий, подлежащих эпиднадзору, изменения средневзвешенной по численности населения процентной доли УПП в странах ЕС/ЕЭЗ (данные Соединенного Королевства не включены) в период с

8 AWaRe классифицирует антибиотики на три группы рационального использования (доступ, наблюдение и резерв), чтобы подчеркнуть важность их оптимального использования и потенциал для сдерживания УПП.

2016 по 2020 г. были выражены умеренно и, как сообщалось ранее, показатели УПП оставались высокими.

У *S. aureus* в 2016–2020 гг. было зарегистрировано снижение процентной доли изолятов MRSA (см. таблицу 7b в Главе 3). Тем не менее устойчивые к метициллину стафилококки по-прежнему остаются важным для ЕС/ЕЭЗ патогеном; при этом в нескольких странах уровни MRSA остаются высокими и распространена сочетанная устойчивость к другим группам противомикробных препаратов. Кроме того, в течение 2016–2020 гг. наблюдалась тенденция к снижению доли устойчивости к макролидам у *S. pneumoniae*.

Одним из событий, вызывающих особую озабоченность, стала тенденция к увеличению средневзвешенной по численности населения ЕС/ЕЭЗ (данные Соединенного Королевства не включены) процентной доли устойчивых к ванкомицину изолятов *E. faecium*, которая выросла с 11,6% в 2016 г. до 16,8% в 2020 г.

Согласно сообщениям из разных стран, процентные доли УПП для некоторых комбинаций бактериальные виды–группы противомикробных препаратов широко варьируются, с явно выраженным градиентом с севера на юг и с запада на восток. В целом, самый низкий процент УПП был зарегистрирован в странах Северной Европы, а самый высокий – в странах южной и восточной частей Региона. Не выявлено четкого географического распределения устойчивых к ванкомицину изолятов *E. faecium*.

Обсуждение

В марте 2020 г. ВОЗ охарактеризовала COVID-19 как новую пандемию *(6)*. SARS-CoV-2 предстал перед миром как новый, распространяющийся глобально инфекционный агент, который повлиял на общественное здоровье по всей планете, хотя вакцины были разработаны и разрешены к использованию к концу 2020 г. *(7)*. В 2021 г., несмотря на пандемию, все страны ЕС/ЕЭЗ, регулярно предоставляющие сведения об УПП, сообщили данные за 2020 г.

С течением времени пандемия COVID-19 и связанные с ней меры общественного здравоохранения могли по-разному и в разной мере влиять на отчетность и результаты анализа данных об УПП 2020 г. Например, могли изменяться схемы госпитализации *(8)*, назначения противомикробных препаратов *(8)*, возможности лабораторной отчетности или проведения мероприятий общественного здравоохранения *(8)*. Изменения в мероприятиях общественного здравоохранения могут, в частности, объяснить уменьшение в 2020 г. количества изолятов *S. pneumoniae*, о которых сообщили страны ЕС/ЕЭЗ.

В ежегодном докладе об эпидемиологической ситуации за 2019 г. *(9)* в большинстве случаев уже были отмечены тенденции к снижению УПП в странах ЕС/ЕЭЗ (данные Соединенного Королевства не включены) за период 2016–2020 гг. для нескольких комбинаций бактериальные виды–группы противомикробных препаратов, подлежащих эпиднадзору в EARS-Net. В период 2016–2020 гг. (данные Соединенного Королевства не включены) наблюдались тенденции к значительному повышению долей устойчивости *E. coli* и *K. pneumoniae* к карбапенемам и *E. faecium* к ванкомицину, сходные с описанными ранее тенденциями 2015–2019 гг., когда данные Соединенного Королевства были включены *(9)*.

Сеть ESAC-Net сообщила, что в 2020 г. в ЕС/ЕЭЗ наблюдалось значительное сокращение потребления антибиотиков населением *(10)*. Сопутствующих значительных изменений процентных долей УПП на уровне ЕС/ЕЭЗ в сети EARS-Net не обнаружено. Что касается *E. coli*, то в 2020 г. в ЕС/ЕЭЗ выявлено более выраженное снижение процентных долей устойчивости этого патогена к аминопенициллинам и цефалоспоринам 3-го поколения, чем ежегодно в период 2016–2019 гг. Для ряда других комбинаций бактериальные виды–группы противомикробных препаратов наблюдалось значительное увеличение процентных долей УПП в странах ЕС/ЕЭЗ в период между 2019 и 2020 г., хотя в течение 2016–2020 гг. (данные Соединенного Королевства не включены) была отмечена только тенденция к увеличению долей устойчивости к карбапенемам у *K. pneumoniae*.

Следует учитывать ограничения, связанные с качеством данных по УПП и интерпретировать процентные доли УПП с осторожностью (см. приложение 3). Например, как на становом уровне, так и на уровне ЕС/ЕЭЗ, со временем происходили изменения в механизмах сообщения данных в EARS-Net. Это могло повлиять на результаты, и этот факт следует учитывать при интерпретации тенденций. Например, претерпел изменения анализ устойчивости *P. aeruginosa* к аминогликозидам: раньше в анализ были включены нетилмицин, гентамицин и тобрамицин, а с 2020 г. – только тобрамицин. Это затрудняет интерпретацию снижения процентной доли устойчивости к аминогликозидам, наблюдаемого в 2020 г. Другими примерами являются изменения в национальных системах эпиднадзора, которые могут повлиять на интерпретацию процентных долей УПП в разные периоды времени (см. профили для стран и территории в Главе 4), а также ограничения, связанные с переходом на использование пограничных значений и методологии EUCAST (Европейский комитет по тестированию чувствительности к противомикробным препаратам), начиная с данных, собранных за 2019 г. Однако в долгосрочной перспективе ограничения, связанные с использованием пограничных значений и методологии EUCAST должны способствовать улучшению качества и сопоставимости данных.

В целом в ЕС/ЕЭЗ процентные доли УПП для подлежащих эпиднадзору комбинаций бактериальные виды–группы противомикробных препаратов продолжают оставаться высокими, и в 2020 г. значительная вариабельность процентных долей УПП

в странах ЕС/ЕЭЗ сохранилась. Это указывает на возможности для значительного снижения УПП за счет мер по улучшению ПИИК и вмешательств по рациональному использованию противомикробных препаратов.

Что касается медицинских учреждений, то результаты проведенного ECDC одномоментного исследования распространенности инфекций, связанных с оказанием медицинской помощи, и использования противомикробных препаратов в европейских больницах неотложной помощи показали, что частота случаев, для лечения которых пациенты получали антибиотики, положительно коррелировала с УПП и, наоборот, более активное внедрение мероприятий по рациональному использованию антибиотиков и увеличение ресурсов для ПИИК ассоциировались с более низким процентом УПП *(11)*. В другом исследовании было показано, что среди медицинских работников в странах ЕС/ЕЭЗ уровень знаний и предполагаемых знаний об антибиотиках, применении антибиотиков и устойчивости к антибиотикам был высоким, но при этом были выявлены области, требующие проведения образовательных мероприятий *(12)*. Осмотрительное использование противомикробных препаратов и высокие стандарты ПИИК во всех секторах здравоохранения остаются ключевыми элементами эффективных мер реагирования на УПП, и эти исследования позволяют обозначить области, требующие улучшения в медицинских учреждениях стран ЕС/ЕЭЗ.

В проведенном недавно исследовании потребления антибиотиков населением в период 2014–2018 гг., сообщалось о статистически значимых тенденциях к снижению потребления в целом в некоторых странах ЕС/ЕЭЗ *(13)*. Долгосрочное влияние на УПП значительного снижения потребления антибиотиков населением, наблюдавшегося почти во всех странах ЕС/ЕЭЗ в 2020 г. *(10)*, еще предстоит проследить. Основными факторами возникновения и распространения УПП являются использование противомикробных препаратов и передача устойчивых к этим препаратам микроорганизмов между людьми, между животными, а также между людьми, животными и окружающей средой. Использование противомикробных препаратов оказывает экологическое давление на микроорганизмы и способствует появлению и отбору устойчивых штаммов, а неэффективная практика ПИИК ведет к дальнейшему распространению устойчивых к противомикробным препаратам микроорганизмов. В связи с этим Европейская комиссия опубликовала соответствующие руководящие принципы ЕС с рекомендациями по разумному использованию противомикробных препаратов *(14)*. Более того, в противодействии УПП не следует упускать из виду важность профилактики инфекций в обществе в целом посредством, например, соблюдения надлежащей гигиены рук и проведения вакцинации.

Борьба с УПП требует согласованных усилий на страновом уровне и тесного международного сотрудничества. В 2017 г. Европейская комиссия приняла Европейский план действий по борьбе с УПП «Единое здоровье», чтобы поддержать ЕС и его государства-члены в реализации инновационных, эффективных и устойчивых ответных мер в отношении УПП *(4)*. Большинство стран ЕС/ЕЭЗ в опросе 2017 г. сообщили, что реализовали или инициировали действия по установлению целей и задач с целью сокращения использования антибиотиков у людей, часто путем разработки НПД по борьбе с УПП. Однако лишь немногие из них опубликовали эти целевые показатели в 2017 г. *(15)* и определили конкретные источники финансирования для реализации своих НПД *(11)*. По состоянию на 2020 г. 25 из 29 стран ЕС/ЕЭЗ сообщили о наличии НПД по борьбе с УПП, а еще три страны находились в процессе разработки НПД (см. таблицу 6 в Главе 3).

Последствия для общественного здравоохранения

Поступившие в EARS-Net сообщения о выявлении в 2020 г. высоких уровней УПП для нескольких важных комбинаций бактериальные виды–группы противомикробных препаратов показывают, что УПП остается значительной проблемой в странах ЕС/ЕЭЗ. И несомненно, УПП представляет собой серьезную угрозу для здоровья населения как в ЕС/ЕЭЗ *(4)*, так и во всем мире *(2)*. Оценки, основанные на данных EARS-Net, показывают, что ежегодно в странах ЕС/ЕЭЗ регистрируется более 670 000 случаев инфекций, вызванных бактериями, устойчивыми к антибиотикам, и что около 33 000 человек умирают от этих инфекций *(16)*. Соответствующие затраты для систем здравоохранения стран ЕС/ЕЭЗ оцениваются примерно в 1,1 млрд евро *(11)*.

Действия общественного здравоохранения по борьбе с УПП остаются недостаточно эффективными, несмотря на возросшую осведомленность об УПП как об угрозе общественному здоровью и наличие научно-обоснованных рекомендаций по ПИИК, рациональному использованию противомикробных препаратов и созданию необходимого потенциала для микробиологических исследований. Озабоченность проблемой УПП будет расти, если правительства более решительно не отреагируют на угрозу УПП. Срочно необходимы дальнейшие инвестиции в мероприятия общественного здравоохранения по борьбе с УПП. Это окажет значительное положительное влияние на здоровье населения и будущие расходы на здравоохранение в ЕС/ЕЭЗ. Согласно подсчетам, потенциально использование комплексного пакета вмешательств, включающего программы рационального использования антибиотиков, усиленные гигиенические мероприятия, кампании в СМИ и применение быстрых диагностических тестов, может предотвратить в странах ЕС/ЕЭЗ около 27 000 смертей ежегодно. Помимо спасения жизней, такой пакет услуг общественного здравоохранения может окупиться в ЕС/ЕЭЗ всего за один год и позволит сэкономить около 1,4 млрд евро в год *(11)*.

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9 Все ссылки приводятся по состоянию на 10 января 2022 г.

1. Antimicrobial resistance – main facts

Antimicrobial resistance

Antimicrobial resistance (AMR) is the ability of a microorganism to resist the action of one or more antimicrobial agents. The consequences of AMR can be severe, and prompt treatment with effective antimicrobials is the most effective way of reducing the risk of poor outcome from serious infections. AMR is one of the biggest threats to public health today, both globally *(1)* and in the WHO European Region *(2,3)*, leading to mounting health-care costs, treatment failure and death *(4,5)*.

AMR can occur in different types of microorganisms, including fungi, parasites, viruses and bacteria. This report focuses on AMR in eight common bacterial pathogens of significant public health importance in Europe.

Acquired resistance in bacteria is caused by mutations in chromosomal genes or acquisition of exogenous resistance genes carried by mobile genetic elements that can spread horizontally between bacteria. Bacteria can acquire multiple resistance mechanisms and hence become resistant to several antimicrobial agents. This is particularly problematic as it may limit severely the available treatment alternatives for the infection.

The major drivers behind the occurrence and spread of AMR are the use of antimicrobial agents and 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 the emergence and selection of AMR, poor infection prevention and control (IPC) practices favour the further spread of these bacteria. Prudent antimicrobial use and high standards of IPC in all health-care settings are therefore the cornerstones of an effective response to AMR.

Surveillance of AMR in Europe

The problem of AMR calls for concerted efforts at local and national levels, and for close international cooperation. Surveillance data provide a basis for taking action to control AMR and the importance of data is highlighted in both the WHO European Strategic Action Plan on Antibiotic Resistance for the period 2011–2020 (document EUR/RC61/14, which was adopted by the WHO Regional Committee for Europe at its 61st session in resolution EUR/RC61/R6) *(2,3)* and the European One Health Action Plan against Antimicrobial Resistance *(6)*. Surveillance of AMR is listed as a special health issue in the European Commission Decision No. 1082/2013/EU of the European Parliament and of the Council of 22 October 2013 on serious cross-border threats to health *(7)* and the Commission Implementing Decision (EU) 2018/945 of 22 June 2018 on the communicable diseases and related special health issues to be covered by epidemiological surveillance *(8)*.

The main international AMR surveillance mechanisms in the WHO European Region are the European Antimicrobial Resistance Surveillance Network (EARS-Net) and the Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR) network. EARS-Net collects data from countries within the European Union and European Economic Area (EU/EEA), while CAESAR collects data from countries and areas within the WHO European Region that are not included in EARS-Net (primarily in eastern Europe and central Asia). Through close collaboration and by using compatible methodologies, the two surveillance networks complement one another, contributing to a pan-European overview of the AMR situation.

Facilitated through the WHO Regional Office for Europe and the WHO Collaborating Centre for AMR Epidemiology and Surveillance at the National Institute for Public Health and the Environment (RIVM) in the Netherlands, European data from EARS-Net and CAESAR are also reported to the WHO Global Antimicrobial Resistance Surveillance System (GLASS) *(9)* to support the WHO Global Action Plan on Antimicrobial Resistance *(1)*.

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2. Technical note

AMR surveillance networks in Europe

EARS-Net

EARS-Net is coordinated by the European Centre for Disease Prevention and Control (ECDC) with the aim of collecting, analysing and reporting data on AMR through a network of national surveillance systems across EU/EEA countries and, as defined in the EARS-Net protocol *(1)*, to enable action to address AMR. EARS-Net is the continuation of the European Antimicrobial Resistance Surveillance System (EARSS), which was coordinated by 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. The administration of EARSS was transferred from RIVM to ECDC on 1 January 2010 and the network was renamed EARS-Net.

EARS-Net is based on a network of representatives (ECDC national focal points for AMR, and operational contact points for epidemiology, for microbiology and for The European Surveillance System (TESSy) interaction) from EU/EEA countries that collect routine clinical antimicrobial susceptibility data from national AMR surveillance initiatives. Participating institutions are listed in Annex 1. Scientific guidance and support are provided by the EARS-Net Disease Network Coordination Committee, which is composed of experts elected from the nominated ECDC national focal points and operational contact points complemented by observers from organizations involved in AMR surveillance. EARS-Net activities are coordinated in close collaboration with two other 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) and the European Committee on Antimicrobial Susceptibility Testing (EUCAST), which is supported by ECDC and ESCMID.

In 2020, all EU Member States and two EEA countries (Iceland and Norway) participated in EARS-Net. The number of participating laboratories has increased continuously since the initiation of the network, indicating a strengthening of national AMR surveillance systems in the EU/EEA. The high proportion of laboratories that participate in the annual EARS-Net external quality assessment (EQA) exercise contributes to improved data quality and an increasing ability of EU/EEA countries to report comparable AMR data *(2)*. The EARS-Net EQA for 2020 was cancelled due to the COVID-19 pandemic.

CAESAR

The CAESAR network was founded in 2012 as a collaborative effort by the WHO Regional Office for Europe, the WHO Collaborating Centre for AMR Epidemiology and Surveillance at RIVM and ESCMID. These institutions participate directly in the activities of the network by having two or three of their experts in the CAESAR coordination group. The goal of the CAESAR network is to assist non-EU/EEA countries and areas in the WHO European Region in setting up or strengthening national AMR surveillance. The CAESAR manual *(3)* describes the objectives, methods and organization of the CAESAR network.

As of 2021, 20 countries are engaged in the CAESAR network – Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Georgia, Kazakhstan, Kyrgyzstan, Montenegro, North Macedonia, the Republic of Moldova, the Russian Federation, Serbia, Switzerland, Tajikistan, Turkey, Turkmenistan, the United Kingdom, Ukraine and Uzbekistan – and also Kosovo.[11] The number of countries and areas reporting data to CAESAR increased from five in 2013 to 13 in 2020.

The CAESAR network continuously strives to support the establishment of AMR surveillance networks and helps to improve the quality of laboratory test results, manage data, and analyse and report data from existing surveillance networks. The technical assistance provided is tailored to the development phase and the specific needs of each surveillance system. In countries and areas with officially established surveillance systems, emphasis is placed on harmonizing laboratory methods and streamlining data management. In those countries and areas where antimicrobial susceptibility testing is routinely performed in clinical settings but the data are not yet collected at aggregate level, emphasis is placed on setting up a surveillance network and standardizing data collection in parallel with the harmonization of laboratory methods. Finally, in countries and areas that underutilize bacteriological laboratory diagnostics, the focus is on building laboratory capacity and diagnostic stewardship through the implementation of proof-of-principle projects *(4)*.

Methodology

Antimicrobial susceptibility data

Every year, countries and areas report routine antimicrobial susceptibility testing (AST) results collected from one or more medical microbiology laboratories to EARS-Net and CAESAR, as applicable. Countries and areas can report data from sentinel laboratories if it is not possible to include data from all their relevant laboratories. AMR surveillance for both networks focuses on invasive isolates of eight key bacterial species (*Escherichia coli* (*E. coli*), *Klebsiella pneumoniae* (*K. pneumoniae*), *Pseudomonas aeruginosa* (*P. aeruginosa*), *Acinetobacter* species (spp.), *Streptococcus pneumoniae* (*S. pneumoniae*),

11 All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999).

Staphylococcus aureus (*S. aureus*), *Enterococcus faecalis* (*E. faecalis*) and *Enterococcus faecium* (*E. faecium*)). CAESAR also collects AST data from invasive isolates of *Salmonella* spp., while *Salmonella* spp. are covered separately in EU/EEA countries through the ECDC Food- and Waterborne Disease Network *(5)*. Other notifiable diseases caused by antimicrobial-resistant microorganisms, such as tuberculosis, are also monitored by the WHO Regional Office for Europe and ECDC but are not included in CAESAR and EARS-Net.

EARS-Net collects AMR data from EU/EEA countries through TESSy, a web-based platform for data submission and storage hosted by ECDC *(6)*. CAESAR collects data from non-EU/EEA countries and areas through various secure data-transfer channels. For detailed information on data collection, refer to the EARS-Net reporting protocol *(1)* and the CAESAR manual *(3)*.

Only data from invasive (blood and cerebrospinal fluid) isolates are included in EARS-Net and CAESAR. This restriction aims to reduce the impact of different sampling frames that to some extent hamper data interpretation. Any bacterial isolate of the species under surveillance found in a sample taken from a normally sterile body fluid may be considered a pathogen. Including routine, non-invasive isolates may produce incomparable results for surveillance purposes, as the processing of such samples is heavily influenced by clinical interpretation, which varies between countries and areas. Historically, EARS-Net accepted data on isolates from both specimen types for *E. coli*, *K. pneumoniae*, *P. aeruginosa*, *Acinetobacter* spp. and *S. pneumoniae*, while only isolates from blood were accepted for *S. aureus*, *E. faecalis* and *E. faecium*. To harmonize data collection between the networks, EARS-Net includes data from both specimen types for all bacterial species, starting with 2019 data.

Starting with the data collected for 2019, EARS-Net only accepts data generated using EUCAST breakpoints and methodology *(7)*. Before this, the use of EUCAST breakpoints was encouraged, but results based on other interpretive criteria used by reporting countries were also accepted for analysis. CAESAR encourages the use of EUCAST methodology and breakpoints, but accepts data based on other clinical breakpoint guidelines.

Correction and re-uploading of historical data by reporting countries and areas is possible. The latest published report therefore supersedes previous reports and reflects the most recent available data. This report is based on data reported to EARS-Net for the period 2016–2020 and retrieved from TESSy on 20 September 2021, as well as data reported to CAESAR for the period 2016–2020, as of 17 August 2021.

Data analysis

Before data analysis, data are de-duplicated to include only the first isolate per patient, year and bacterial species.

Susceptibility test categories

For the analysis, the qualitative susceptibility categories – S (susceptible, standard dosing regimen), I (susceptible, increased exposure) and R (resistant) – are used, as reported by the laboratory, since quantitative susceptibility information is missing for a large part of the data. For laboratories in the CAESAR network using an AST guideline other than EUCAST, the reported qualitative susceptibility categories (S/I/R) have been treated the same way as the susceptibility categories defined by EUCAST even though these have different microbiological or clinical implications. An isolate is considered resistant to an antimicrobial agent when tested and interpreted as R in accordance with the clinical breakpoint criteria used by the local laboratory. The term penicillin non-wild-type is used in this report for *S. pneumoniae*, referring to *S. pneumoniae* isolates reported by local laboratories as I or R to penicillin, assuming minimum inhibitory concentrations (MIC) to benzylpenicillin above those of wild-type isolates (› 0.06 mg/L). Laboratories not using EUCAST clinical breakpoints may have used different interpretive criteria for the susceptibility categories.

Percentages

Resistance/non-wild-type percentages are presented for a single antimicrobial agent and/or for a group of antimicrobial agents. The bacterial species–antimicrobial agent combinations presented in this report for 2020 are shown in Table 1. When combining results for antimicrobial agents representing an antimicrobial group, the outcome is based on the most resistant result. For example, if the susceptibility of a bacterial species to imipenem is I and susceptibility to meropenem is R, then the susceptibility to the group carbapenems, which comprises imipenem and meropenem, is set to R. Combined AMR is determined as R to at least one antimicrobial agent in each of the antimicrobial groups in the definition of combined AMR (with the exception of *S. pneumoniae*, for which combined AMR is calculated as combined penicillin non-wild-type and R to macrolides). Isolates with missing data on one or more of the required antimicrobial groups are excluded from the analysis of combined AMR. If fewer than 10 isolates are reported for a specific species–antimicrobial group combination in a country or area, the AMR percentage is not displayed in the maps or tables presented in this report.

Population-weighted EU/EEA mean percentage

A population-weighted EU/EEA mean percentage is calculated for each bacterial species–antimicrobial agent combination, based on data reported by EU/EEA countries. Country weightings are used to adjust for imbalances in reporting propensity and population coverage, as in most cases the total number of reported isolates by country does not reflect the population size.

The population-weighted EU/EEA mean percentage is determined by multiplying the AMR percentage for each

EU/EEA country with the corresponding national population weight based on the total EU/EEA population and summing up the results. Weights are rescaled if AMR percentages are not available for one or more countries. Annual population data are retrieved from the Eurostat online database *(8)*.

Trend analyses

For EARS-Net, the statistical significance of temporal trends in AMR percentages by country and for the population-weighted EU/EEA (excluding the United Kingdom) mean is calculated based on data from the last five years (2016–2020). Countries that did not report data for all years within the period under consideration or which reported fewer than 20 isolates for the specific bacterial species–antimicrobial agent/group combination in any year within the period are not included in the analysis. The statistical significance of trends is assessed by a chi-square test for trend, and a *P* value of < 0.05 is considered significant. An additional sensitivity analysis is performed when assessing the significance of the trends by including only laboratories that consistently reported data for the full five-year period, thereby minimizing bias due to changes in reporting laboratories over time (by expansion of the surveillance network, for instance). In some cases, this restriction results in a considerably lower number of isolates when compared with the analysis that includes all laboratories.

Trend analyses are not yet performed for CAESAR countries and areas.

Coverage and representativeness of population, hospitals and patients included in EARS-Net/ CAESAR

Data sources

For EARS-Net, data on coverage, blood-culture sets and representativeness from 2018 onwards are collected via TESSy *(1)*, while data for earlier years combine TESSy data with those collected through questionnaires distributed to the ECDC national focal points for AMR.

Table 1 Bacterial species–antimicrobial agent combinations for 2020 presented in this report

Bacterial species	Antimicrobial group/agent or specific resistance mechanism	Antimicrobial agent(s)
E. coli	Aminopenicillins	Ampicillin or amoxicillin
	Third-generation cephalosporins	Cefotaxime, ceftriaxone or ceftazidime
	Carbapenems	Imipenem or meropenem
	Fluoroquinolones	Ciprofloxacin, levofloxacin or ofloxacin
	Aminoglycosides	Gentamicin or tobramycin
K. pneumoniae	Third-generation cephalosporins	Cefotaxime, ceftriaxone or ceftazidime
	Carbapenems	Imipenem or meropenem
	Fluoroquinolones	Ciprofloxacin, levofloxacin or ofloxacin
	Aminoglycosides	Gentamicin or tobramycin
P. aeruginosa	Piperacillin-tazobactam	Piperacillin-tazobactam
	Ceftazidime	Ceftazidime
	Carbapenems	Imipenem or meropenem
	Fluoroquinolones	Ciprofloxacin or levofloxacin
	Aminoglycosides	Tobramycin
Acinetobacter spp.	Carbapenems	Imipenem or meropenem
	Fluoroquinolones	Ciprofloxacin or levofloxacin
	Aminoglycosides	Gentamicin or tobramycin
S. aureus	MRSA	Oxacillin or cefoxitin[a]
	Fluoroquinolones	Ciprofloxacin, levofloxacin or ofloxacin[b]
	Rifampicin	Rifampicin
S. pneumoniae	Penicillins	Penicillin or oxacillin[c]
	Third-generation cephalosporins	Cefotaxime or ceftriaxone
	Fluoroquinolones	Levofloxacin or moxifloxacin[d]
	Macrolides	Azithromycin, clarithromycin or erythromycin
E. faecalis	High-level aminoglycoside resistance	Gentamicin high-level resistance
E. faecium	Aminopenicillins	Ampicillin or amoxicillin
	High-level aminoglycoside resistance	Gentamicin high-level resistance
	Vancomycin	Vancomycin

MRSA: methicillin-resistant *Staphylococcus aureus*.

[a] For EARS-Net, MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. EARS-Net also includes data from molecular confirmation tests (detection of *mecA* gene by polymerase chain reaction (PCR) or a positive PBP2A-agglutionation test), which are given priority over phenotypic AST results. For CAESAR, MRSA is based on results for cefoxitin or, if not available, oxacillin.

[b] For EARS-Net, AST results for norfloxacin are also accepted if neither ciprofloxacin, levofloxacin nor ofloxacin results are available.

[c] Penicillin results are based on penicillin or, if not available, oxacillin.

[d] For EARS-Net, AST results for norfloxacin are also accepted if neither levofloxacin nor moxifloxacin results are available.

For CAESAR, an annual assessment of coverage and representativeness is based on information from WHO AMR focal points. They provide an estimate of the population coverage for the sites participating in the respective AMR surveillance network and the geographical and hospital representativeness of the total population. Data on hospital characteristics and numbers of requested blood-culture sets are collected using standardized questionnaires *(3)*.

Indicators of coverage and representativeness

Population coverage

Population coverage is expressed as the estimated percentage of the population in an entire country or area under surveillance by the laboratories contributing data to EARS-Net or CAESAR. For EU/EEA countries, population coverage refers to the proportion of the country's population covered by laboratories reporting to EARS-Net in the specific year. This value should be considered as an indication of the crude population coverage, as the exact proportion of the population under surveillance is often difficult to assess due to overlapping hospital catchment areas and patients seeking care in areas where they do not reside. For EARS-Net, the population coverage is calculated as the mean of the coverage for the following bacterial species: *E. coli*, *K. pneumoniae*, *P. aeruginosa*, *S. aureus*, *E. faecalis* and *E. faecium*. Due to outliers in some countries, *S. pneumoniae* and *Acinetobacter* spp. are not included in the calculation. For CAESAR, an estimate of the population coverage is based on the best estimates of the overall catchment population for the hospitals included in the country or area AMR surveillance network, as reported by the respective WHO AMR focal point.

Geographical representativeness

Geographical representativeness is a qualitative indicator referring to geographical coverage and the distribution of urban and regional areas. The categories are listed and described in Table 2.

Hospital representativeness

Hospital representativeness is a qualitative indicator referring to the representativeness of hospitals served by the EARS-Net/CAESAR participating laboratories, compared to the country/area distribution of hospital types. The categories are listed and described in Table 3.

Patient and isolate representativeness

Patient and isolate representativeness is a qualitative indicator referring to the representativeness of data reported by EARS-Net/CAESAR laboratories in relation to the patient mix in which infections with invasive microorganisms occur and what microorganisms cause these infections. The categories are listed and described in Table 4.

Blood-culture rate

Blood-culture rate refers to the number of blood-culture sets performed per 1000 patient days in hospitals served by EARS-Net/CAESAR laboratories. The definition of a blood-culture set and a patient day may differ between countries and areas and this may influence the estimate. For EARS-Net data, blood-culture rates are calculated as the mean of the blood-culture sets and the mean total number of patient days for hospitals served by laboratories that provided the number of blood-culture sets performed for the following bacterial

Table 2 Geographical representativeness, categories and definitions

Category	Description
High	All main geographical regions are covered, and the selection of urban and regional areas is considered to be representative of the country/area population
Medium	Most geographical regions are covered, and the selection of urban and regional areas is considered to be partly representative of the country/area population
Poor	Only one or a few geographical areas are covered and the selection of urban and regional areas is considered to be poorly representative of the country/area population
Unknown	Unknown or no data provided

Table 3 Hospital representativeness, categories and definitions

Category	Description
High	The hospital selection is representative of the country/area distribution of hospital types where blood samples are taken
Medium	The hospital selection is partly representative of the country/area distribution of hospital types where blood samples are taken
Poor	The hospital selection is poorly representative of the country/area distribution of hospital types where blood samples are taken
Unknown	Unknown or no data provided

Table 4 Patient and isolate representativeness, categories and definitions

Category	Description
High	The patient selection is representative of the patient mix for the hospitals included and of microorganisms causing invasive infections
Medium	The patient selection is partly representative of the patient mix for the hospitals included and of microorganisms causing invasive infections
Poor	The patient selection is poorly representative of the patient mix for the hospitals included and of microorganisms causing invasive infections
Unknown	Unknown or no data provided

species: *E. coli*, *K. pneumoniae*, *P. aeruginosa*, *S. aureus*, *E. faecalis* and *E. faecium*. Due to outliers in some countries, *S. pneumoniae* and *Acinetobacter* spp. are not included in the calculation. The blood-culture rates are presented as the number of blood-culture sets taken per 1000 patient days in hospitals providing AMR data to EARS-Net. For CAESAR, the number of blood-culture sets taken per 1000 patient days is calculated for hospitals individually and presented as the median, with the range included in parentheses.

Isolates from intensive care units

The proportion of isolates reported from intensive care units (ICUs) is calculated for each year and each bacterial species. Isolates with missing information on hospital department are excluded, and results are presented only for countries and areas from which data on the hospital department are available for 70% or more of isolates.

Progress indicators for AMR overall coordination and surveillance

Information on the status of the AMR overall coordination and surveillance presented in this report originates from the global tripartite AMR country self-assessment survey (TrACSS), coordinated by WHO, the Food and Agriculture Organization of the United Nations and the World Organisation for Animal Health *(9)*. The survey aims to provide a comparable and periodic assessment of country progress on AMR containment activities in line with the WHO Global Action Plan on AMR and is designed to be answered through self-assessment and consultation among all the relevant sectors involved. Each country is asked to submit one official response.

The progress indicators selected for this report refer to four main components of AMR activities: overall coordination on AMR; AMR surveillance; IPC; and antimicrobial stewardship (Annex 2). A description of the progress indicators is provided in Table 5. Except for indicators 5, 6 and 7, which are derived from the CAESAR and GLASS enrolment databases, all the other indicators are based on the results from the fifth round of TrACSS, launched on 23 March 2021 and concluded on 10 July 2021. For the purposes of presentation in this report, information on progress indicators 2, 4, 8 and 9 has been re-coded by the WHO Regional Office for Europe using a five-point scale (poor; fair; good; very good; excellent). The original questions and answers categories are reported in Annex 2 and are available through the publicly available TrACSS database *(10)*.

Table 5 Description of progress indicators of overall coordination on AMR and AMR surveillance

Area	Indicators	Description
Overall coordination on AMR	1. WHO AMR focal point appointed by the ministry of health/area agency	The ministry/agency appoints an AMR focal point to play a leading role in the formation of an intersectoral coordinating mechanism to contain AMR
	2. Multisectoral and One Health collaboration/ coordination	Based on the One Health approach, a multisectoral coordinating mechanism should be created to contain AMR at national/area level; this committee ideally should include representatives of relevant government/area sectors, local professional associations, authorities and leading scientific institutions
	3. AMR action plan developed	A national/area AMR action plan is the key document detailing the characteristics and objectives of the overall national/area strategy to combat AMR
AMR surveillance	4. National/area surveillance system for AMR in humans	Existence of a national/area surveillance system for identifying patterns and trends of AMR, generating evidence-based clinical guidelines and recognizing emerging pathogens
	5. Submits data to a regional network for AMR surveillance	Participation in a regional network for AMR surveillance (EARS-Net or CAESAR)
	6. Participates in a regional EQA scheme	Participation in a regional EQA scheme (EARS-Net or CAESAR)
	7. Enrolled in GLASS	Participation in GLASS for the monitoring of AMR on a global scale
IPC	8. IPC in human health care	Status of development and implementation of the main IPC measures at national/area level
Antimicrobial stewardship	9. Optimizing antimicrobial use in human health	Status of development and implementation of policies and guidelines for antimicrobial stewardship at national/area level

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3. Overview of antimicrobial resistance in Europe

WHO European Region

This chapter provides an overview of the status of the overall situation and progress related to AMR surveillance in the Region. The indicators chosen represent the main pillars of an AMR surveillance system. The information has mostly been obtained from TrACSS (see Chapter 2). The results are summarized in Table 6.

Progress on overall AMR coordination

Multisectoral and One Health collaboration/coordination

Overall, the results from the TrACCS survey show that when it comes to coordination between the human health sector and the other sectors relevant to AMR – the animal health, food production and environmental sectors – the situation in the WHO European Region is almost evenly split. One group of countries/areas (about 40% of respondents) reported having limited or non-existent mechanisms for intersectoral coordination, while the other group (about 50%) reported carrying out activities jointly, or even adopting an integrated approach to the implementation of the AMR action plan.

National/area AMR action plan

Among survey respondents, the vast majority (85%) of the countries/areas in the WHO European Region reported having developed an AMR national/area action plan. This result is encouraging on its own, but calls for a necessary distinction. Some of those who have developed an AMR action plan have also made provision for the required financial resources and have started implementing activities, with a defined monitoring and evaluation process in place. Others, however, after achieving the first milestone of developing the action plan have not been able to progress to the next stage of operationalizing the objectives. This is one of the main challenges for the years to come: supporting countries/areas in the Region to implement activities included in the AMR action plan and monitoring and evaluating the results generated.

Progress on surveillance networks and AMR laboratories

National/area surveillance system for AMR in humans

Results from the survey showed that about 70% of respondents have a national/area AMR surveillance system for common bacterial infections, with defined standards and coordination from a national/area reference laboratory and, in some cases, a link to the surveillance system for consumption of antimicrobial medicines. The remaining 30% of respondents reported having a surveillance system for AMR in humans but with limited scope, usually only at local level and lacking national/area coordination and quality management. This situation was reported mostly among CAESAR members, highlighting the fact that within this network, having a well functioning and geographically representative system of AMR surveillance that is able to generate reliable information on AMR remains a challenge. In coming years, renewed efforts and investment will need to be channelled into this objective.

Participation in the regional EQA scheme

All the members of EARS-Net and CAESAR regularly take part in the regional EQA scheme. This is a remarkable achievement that has built up over the years through constant support and guidance. The selection of strains used for the EQA exercise is standardized to make it compatible with the epidemiology of the AMR phenotypes of species under surveillance within EARS-Net and CAESAR. There are still some obstacles to making the EQA exercise sustainable, particularly within the CAESAR network, mainly related to logistics and national/area regulations that sometimes can restrict the ability to share laboratory sampling and testing panels internationally. A regional administrative agreement, paired with strong national/area leadership, is needed to remove these barriers and strengthen continued EQA activities.

Submitting AMR data to a regional surveillance network

While all the EARS-Net members currently are submitting data on AMR, only 14 (67%) of 21 members within the CAESAR network submit AMR to the regional surveillance network. This reflects the state of national/area surveillance systems. If the surveillance system for AMR is weak or does not have proper geographical coverage, it hampers the possibility of sharing reliable information on AMR. The vast majority of CAESAR members who submit their data to the regional network have a well established national/area surveillance network. Substantial improvements in AMR surveillance have been achieved within the CAESAR network through the implementation of laboratory training and the proof-of-principle AMR routine diagnostics surveillance project. Armenia and Georgia in particular have benefited from taking part in the project to initiate a functional, national, sentinel laboratory-based surveillance system for AMR. More recently, the proof-of-principle project has been implemented in Tajikistan and is also underway in Uzbekistan.

Enrolment in GLASS

Currently, only 29 of 53 members of the WHO European Region are also enrolled in GLASS. This does not prevent international collaboration in reporting and data sharing, but may reduce opportunities for countries and areas in the Region to receive global support in standardizing the collection, analysis and sharing of AMR data. The WHO Regional Office for Europe actively promotes participation in GLASS and will strive to increase enrolment in coming years.

Progress on IPC programmes and antimicrobial stewardship

IPC in human health care

Among the 49 respondents to TrACSS 2021, seven (14%) reported having no national/area IPC programme and six (12%) reported having IPC and water, sanitation and hygiene health standards that have not been implemented fully. IPC is the key to avoiding the mass spread of infectious diseases – as the COVID-19 pandemic has demonstrated dramatically – and is a central tool in curbing AMR. In coming years, increased efforts in the WHO European Region will be devoted to integrated surveillance that should include IPC as one of its foundational pillars.

Optimizing antimicrobial use in human health

Optimizing antimicrobial use refers to coordinated efforts of antimicrobial stewardship, which include proper diagnostics and appropriate use of antimicrobial drugs, improved patient outcomes, containment of AMR and reduced spread of resistant infections. It is a comprehensive indicator and the fact that most respondents to TrACSS 2021 reported the availability of guidelines for appropriate use of antimicrobials and implementation of antimicrobial stewardship practices in some health-care facilities is encouraging. At the same time, there is much still to be done. To exercise real antimicrobial stewardship based on evidence-informed local treatment guidelines, both national/area and local surveillance data are needed urgently. This can only be achieved with stronger national/area surveillance systems.

Table 6 Overall coordination and surveillance of AMR in the WHO European Region, 2020

Country/area	1. WHO AMR focal point appointed by the ministry of health/area agency	2. Multisectoral and One Health collaboration/coordination	3. AMR action plan developed	4. National surveillance system for AMR in humans	5. Submits data to a regional network for AMR surveillance	6. Participates in a regional EQA scheme	7. Enrolled in GLASS	8. IPC in human health care	9. Optimizing antimicrobial use in human health
Colour code	Yes No	Excellent Very good Good Fair Poor	Yes In progress No	Excellent Very good Good Fair Poor	Yes No	Yes No	Yes No	Excellent Very good Good Fair Poor	Excellent Very good Good Fair Poor
EU/EEA									
Austria	■	■	■	■	■	■	■	■	▣
Belgium	■	■	■	■	■	■	■	■	▣
Bulgaria	■	○	●	NA	■	■	▲	▲	NA
Croatia	■	▣	■	■	■	■	■	■	▣
Cyprus	■	○	■	▣	■	■	■	●	▲
Czechia	■	○	■	▣	■	■	■	●	▣
Denmark	■	■	■	■	■	■	■	▣	▣
Estonia	■	○	●	●	■	■	▲	▣	▣
Finland	■	▣	■	▣	■	■	■	■	▣
France	■	■	■	■	■	■	■	■	▣
Germany	■	■	■	▣	■	■	■	■	▣
Greece	■	■	■	▣	■	■	■	■	▣
Hungary	■	○	■	▣	■	■	▲	▣	▲
Iceland	■	■	■	■	■	■	▲	●	▣
Ireland	■	▣	■	●	■	■	■	■	▣
Italy	■	●	■	▣	■	■	■	○	●
Latvia	■	○	■	●	■	■	■	●	●
Lithuania	■	○	●	▣	■	■	■	●	●
Luxembourg	■	■	■	NA	■	■	■	▲	▣
Malta	■	●	■	■	■	■	■	■	■
Netherlands	■	■	■	■	■	■	■	■	■
Norway	NA	■	■	■	■	■	■	■	■
Poland	■	▲	▲	▣	■	■	■	▲	●
Portugal	■	▣	■	▣	■	■	▲	■	■
Romania	■	○	■	●	■	■	▲	○	○
Slovakia	■	●	■	▣	■	■	▲	▣	▣
Slovenia	■	●	■	▣	■	■	▲	▣	▣
Spain	■	▣	■	▣	■	■	▲	■	▣
Sweden	■	■	■	■	■	■	■	■	■

Table 6 contd

Country/area	1. WHO AMR focal point appointed by the ministry of health/area agency	2. Multisectoral and One Health collaboration/coordination	3. AMR action plan developed	4. National surveillance system for AMR in humans	5. Submits data to a regional network for AMR surveillance	6. Participates in a regional EQA scheme	7. Enrolled in GLASS	8. IPC in human health care	9. Optimizing antimicrobial use in human health
Colour code	Yes No	Excellent Very good Good Fair Poor	Yes In progress No	Excellent Very good Good Fair Poor	Yes No	Yes No	Yes No	Excellent Very good Good Fair Poor	Excellent Very good Good Fair Poor
Non-EU/EEA									
Albania									
Andorra	NA	NA	NA	NA				NA	NA
Armenia									
Azerbaijan									
Belarus									
Bosnia and Herzegovina	NA	NA	NA	NA				NA	NA
Georgia									
Israel									
Kazakhstan									
Kyrgyzstan									
Monaco	NA	NA	NA	NA				NA	NA
Montenegro									
North Macedonia									
Republic of Moldova									
Russian Federation									
San Marino									
Serbia									
Switzerland									
Tajikistan									
Turkey									
Turkmenistan									
Ukraine									
United Kingdom									
Uzbekistan									
Kosovo[1]	NA	NA	NA	NA				NA	NA

NA: not available.
[1] All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999).

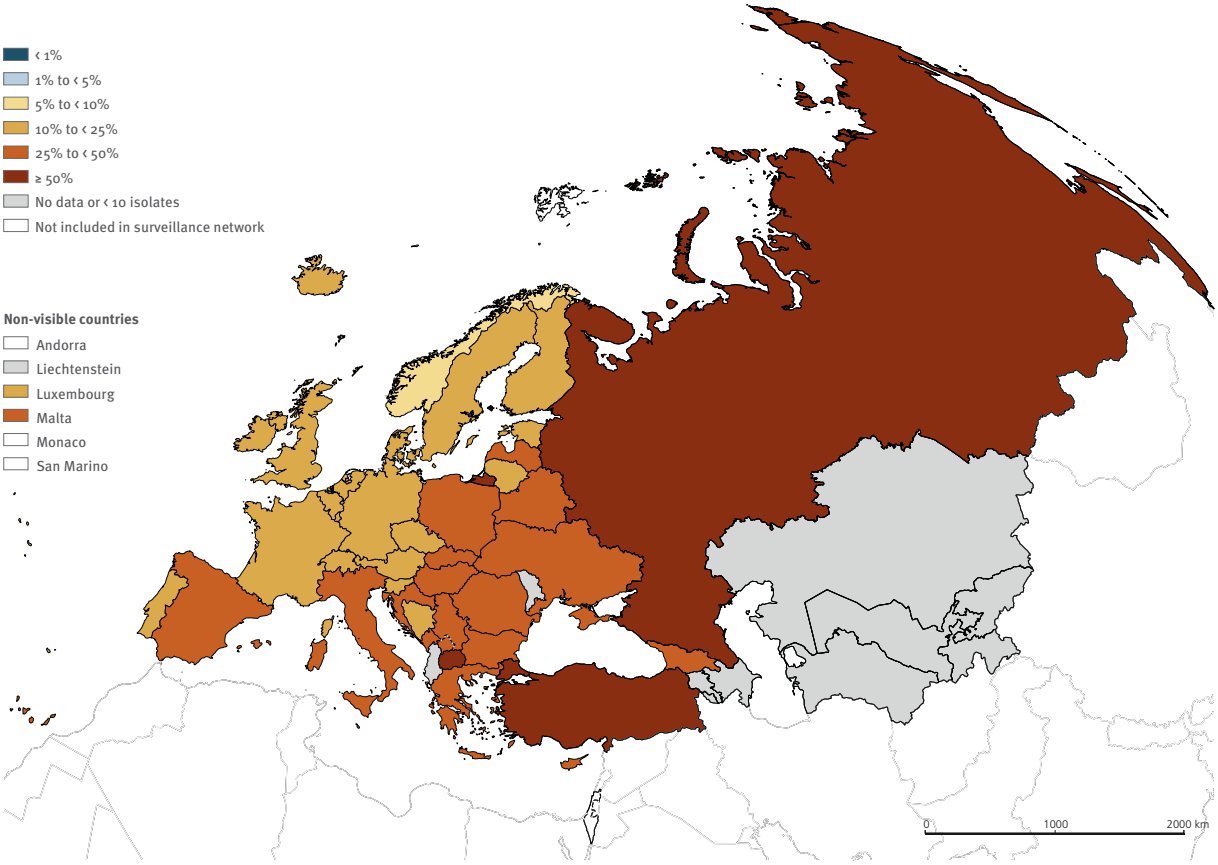
Bacterial species-specific results

Epidemiology

E. coli

E. coli is the most common cause of community-acquired bloodstream infections and urinary tract infections. In 2020, resistance to fluoroquinolones generally was lower in northern and western parts of the WHO European Region and higher in southern and eastern parts (Fig. 1). An AMR percentage below 10% was observed in one (3%) of 40 countries/areas (Norway) reporting data on this microorganism. Twenty countries/areas (50%) reported a percentage of 25% or above. AMR percentages of 50% or above were observed in three (8%) countries (North Macedonia, the Russian Federation and Turkey).

Fig. 1 *E. coli*: percentage of invasive isolates resistant to fluoroquinolones (ciprofloxacin/levofloxacin/ofloxacin), by country/area, WHO European Region, 2020

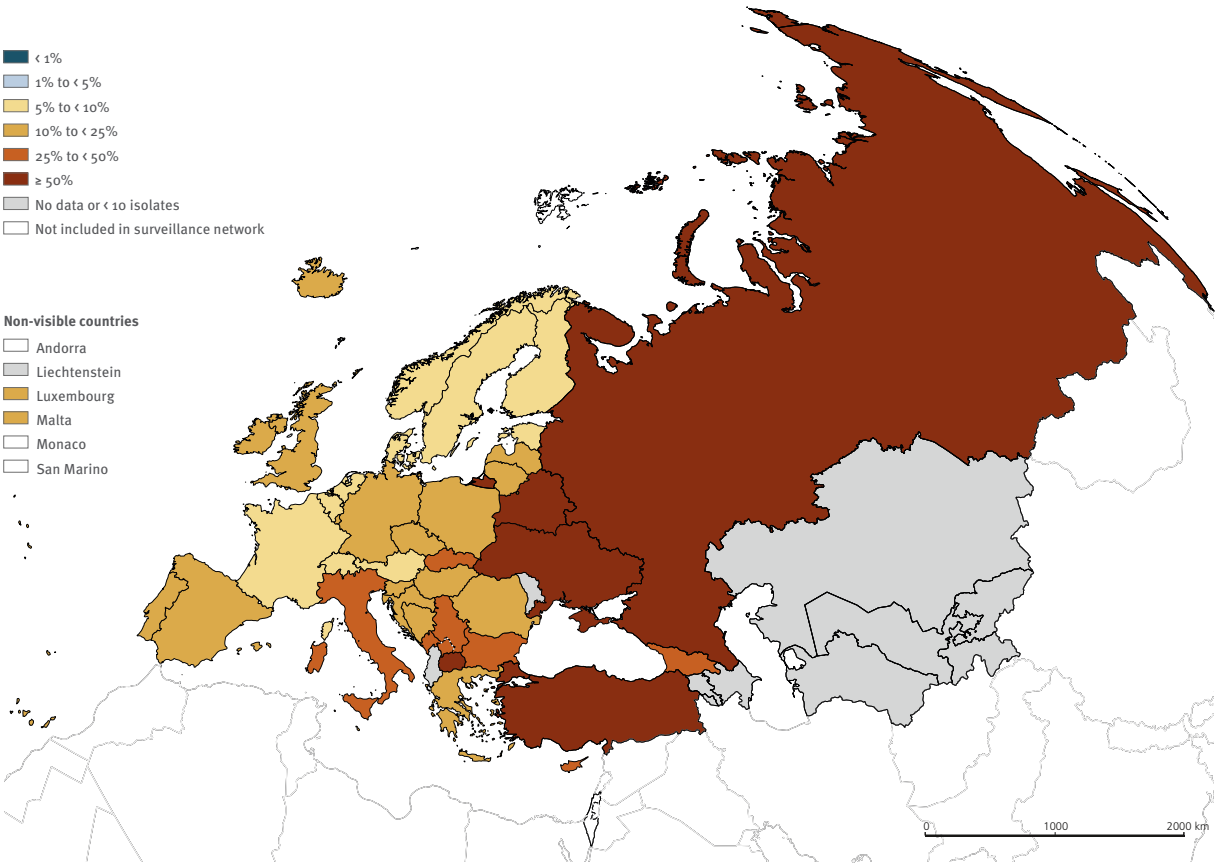


Note: data for Serbia and Kosovo (All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999)) were combined for this map. Data for the United Kingdom for 2020 do not include Scotland and Wales.

Data sources: 2020 data from the Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR, ©WHO 2021. All rights reserved.) and 2020 data from the European Antimicrobial Resistance Surveillance Network (EARS–Net, ©ECDC 2021).
Map production: ©WHO.

For third-generation cephalosporin resistance in *E. coli*, 10 (25%) of 40 countries/areas (Austria, Belgium, Denmark, Estonia, Finland, France, the Netherlands, Norway, Sweden and Switzerland) reported the lowest percentages in 2020 (5% to less than 10%), whereas AMR percentages equal to or above 50% were observed in five (13%) countries (Belarus, North Macedonia, the Russian Federation, Turkey and Ukraine) (Fig. 2).

Fig. 2 *E. coli*: percentage of invasive isolates resistant to third-generation cephalosporins (cefotaxime/ceftriaxone/ceftazidime), by country/area, WHO European Region, 2020

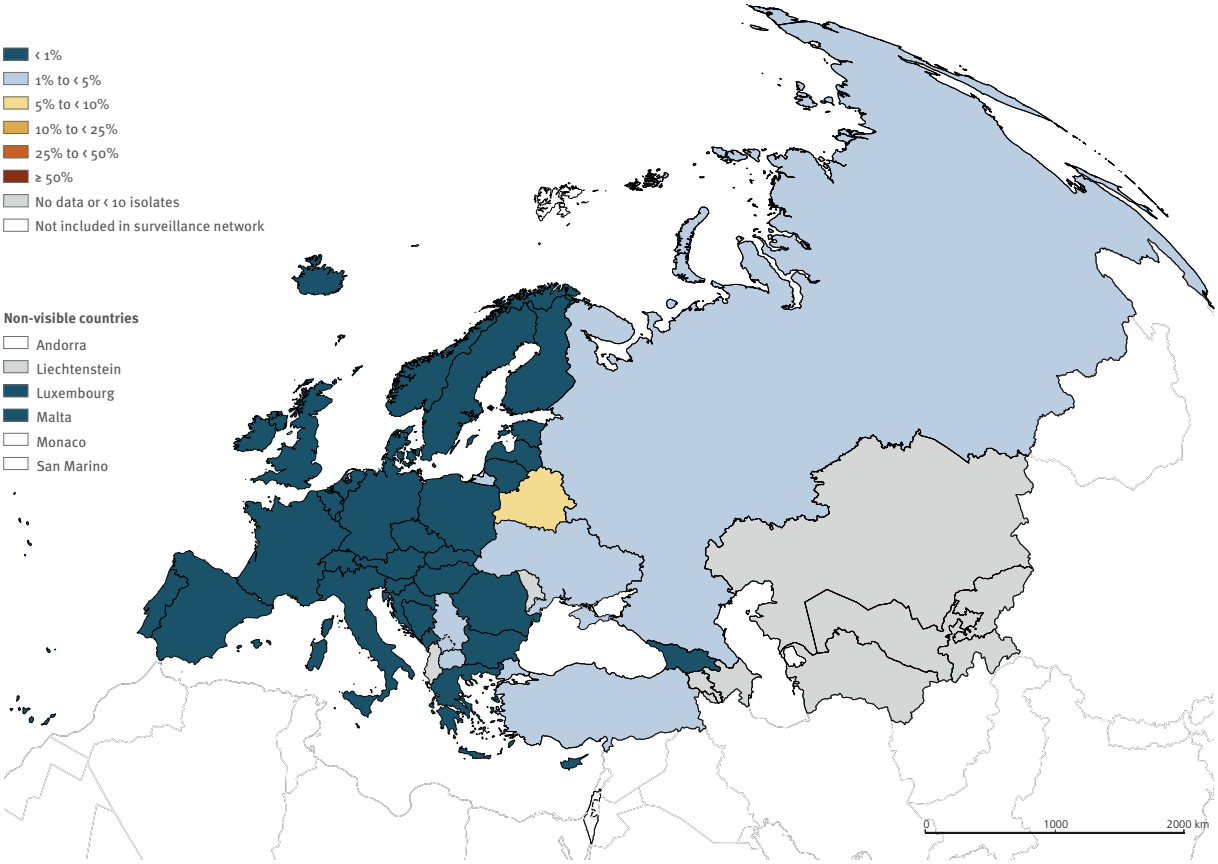


Note: data for Serbia and Kosovo (All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999)) were combined for this map. Data for the United Kingdom for 2020 do not include Scotland and Wales.

Data sources: 2020 data from the Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR, ©WHO 2021. All rights reserved.) and 2020 data from the European Antimicrobial Resistance Surveillance Network (EARS–Net, ©ECDC 2021).
Map production: ©WHO.

The recent emergence of carbapenem-resistant *E. coli* is of serious concern. Six (15%) of 40 countries/areas (Belarus, North Macedonia, the Russian Federation, Serbia, Turkey and Ukraine) reported percentages of 1% or above in 2020 (Fig. 3).

Fig. 3 *E. coli*: percentage of invasive isolates resistant to carbapenems (imipenem/meropenem), by country/area, WHO European Region, 2020



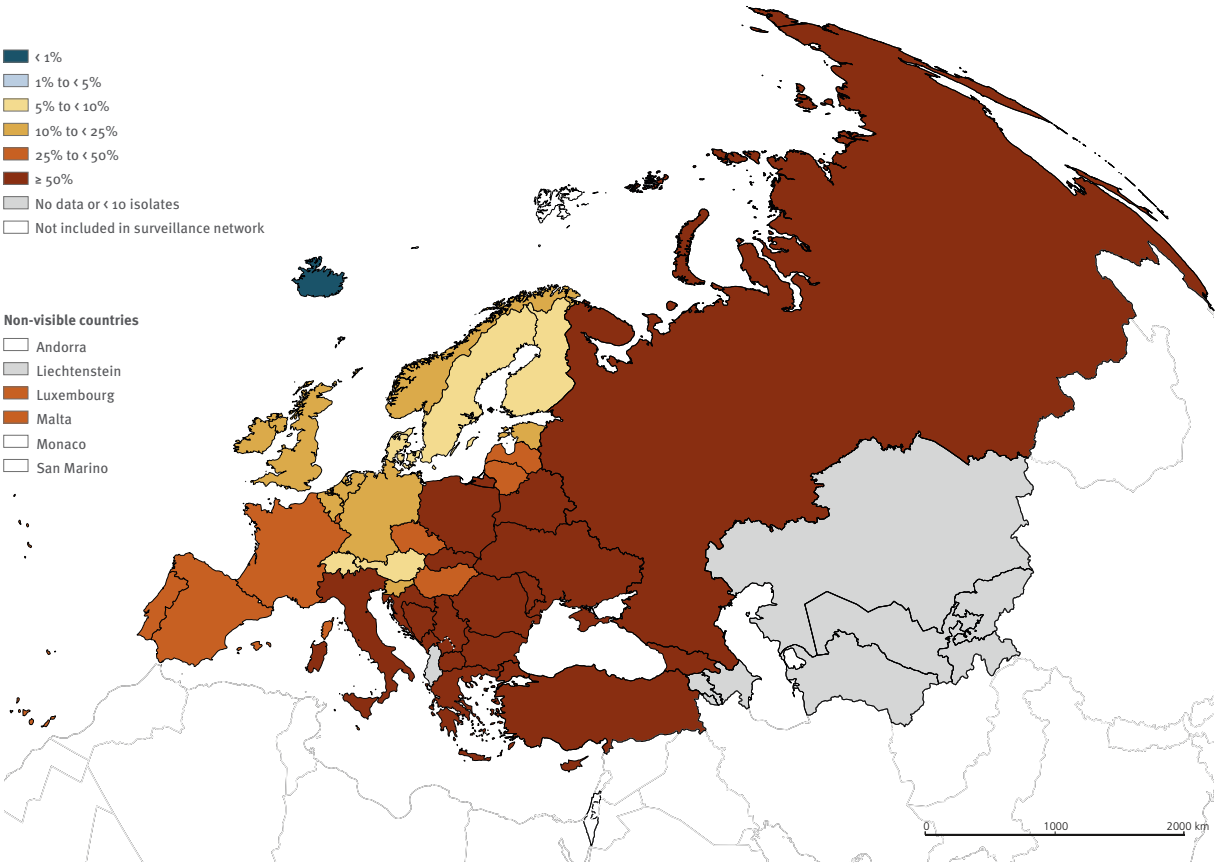
Note: data for Serbia and Kosovo (All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999)) were combined for this map. Data for the United Kingdom for 2020 do not include Scotland and Wales.

Data sources: 2020 data from the Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR, ©WHO 2021. All rights reserved.) and 2020 data from the European Antimicrobial Resistance Surveillance Network (EARS–Net, ©ECDC 2021).
Map production: ©WHO.

K. pneumoniae

Like *E. coli*, *K. pneumoniae* is a common cause of bloodstream and urinary and respiratory tract infections and is easily transmitted between patients, leading to nosocomial outbreaks. Third-generation cephalosporin resistance in *K. pneumoniae* has become quite widespread in the WHO European Region. In 2020, AMR percentages below 10% were observed in six (15%) of 41 countries/areas reporting data on this microorganism (Austria, Denmark, Finland, Iceland, Sweden and Switzerland), while 18 (44%), particularly in the southern and eastern parts of the Region, reported AMR percentages of 50% or above (Fig. 4).

Fig. 4 *K. pneumoniae*: percentage of invasive isolates resistant to third-generation cephalosporins (cefotaxime/ceftriaxone/ceftazidime), by country/area, WHO European Region, 2020

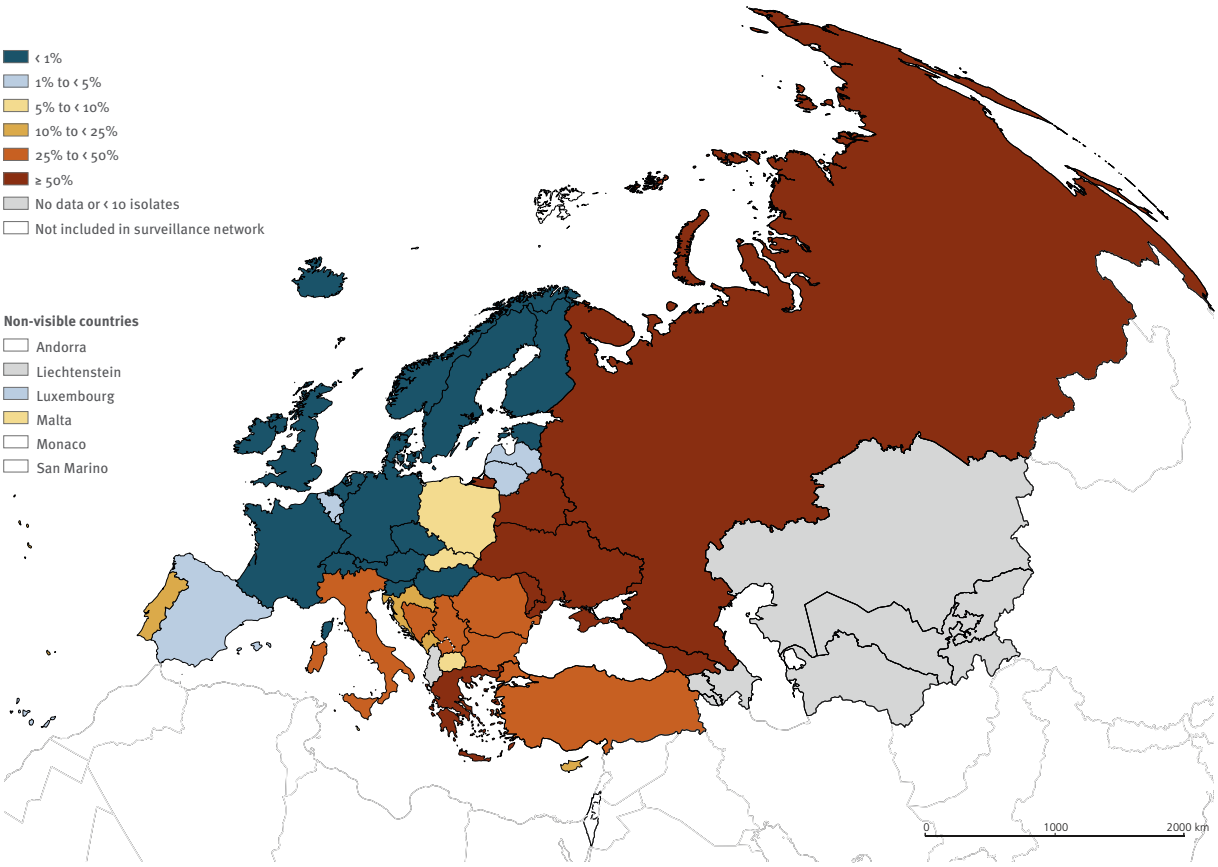


Note: data for Serbia and Kosovo (All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999)) were combined for this map. Data for the United Kingdom for 2020 do not include Scotland and Wales.

Data sources: 2020 data from the Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR, ©WHO 2021. All rights reserved.) and 2020 data from the European Antimicrobial Resistance Surveillance Network (EARS–Net, ©ECDC 2021).
Map production: ©WHO.

Carbapenem resistance was more frequently reported in *K. pneumoniae* than in *E. coli*. In 2020, percentages generally were low in the northern and western parts of the WHO European Region; 16 (39%) of 41 countries/areas reported AMR percentages below 1% (Fig. 5). Twelve (30%) countries reported percentages equal to or above 25%, six of which (15% of 41 countries/areas) reported AMR percentages equal to or above 50% (Belarus, Georgia, Greece, the Republic of Moldova, the Russian Federation and Ukraine) (Fig. 5).

Fig. 5 *K. pneumoniae*: percentage of invasive isolates resistant to carbapenems (imipenem/meropenem), by country/area, WHO European Region, 2020



Note: data for Serbia and Kosovo (All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999)) were combined for this map. Data for the United Kingdom for 2020 do not include Scotland and Wales.

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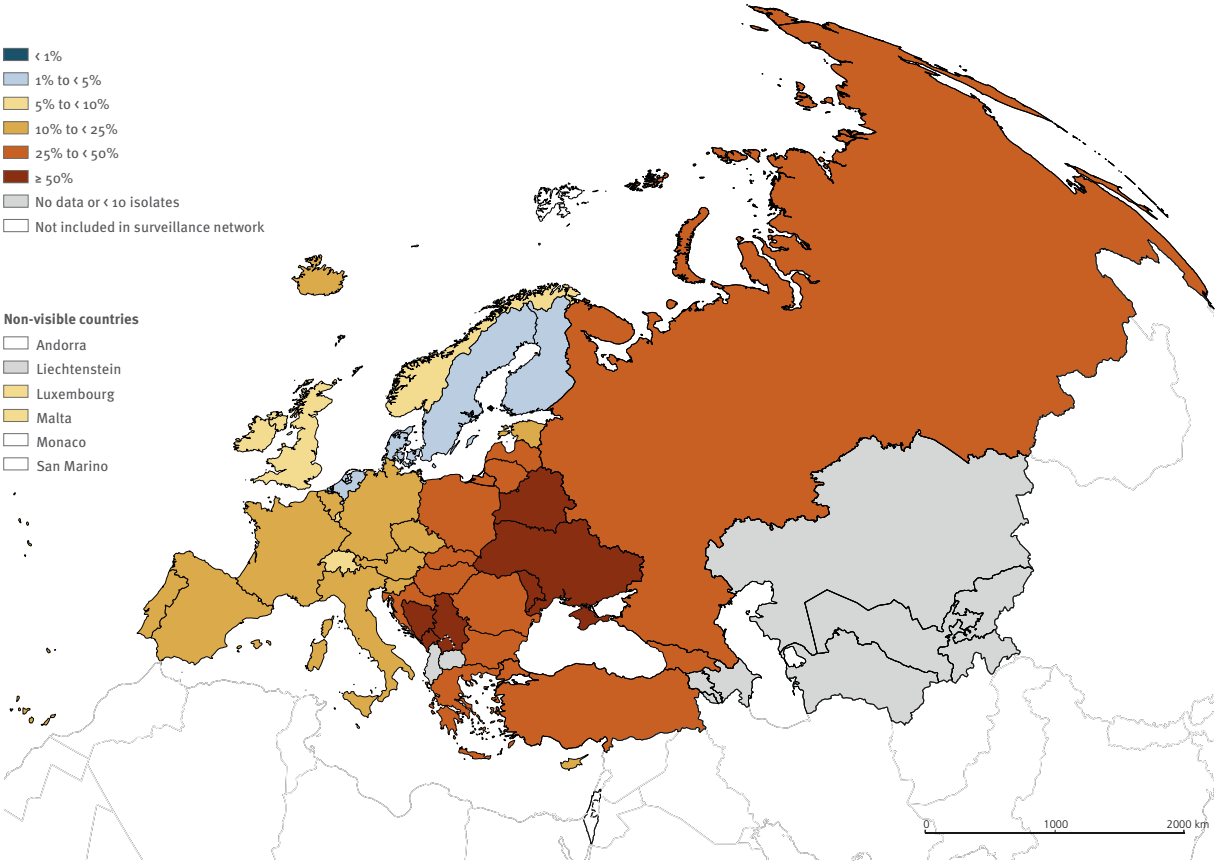
P. aeruginosa

P. aeruginosa is a common cause of infection (including hospital-acquired pneumonia, bloodstream and urinary tract infections) in hospitalized patients, especially those with compromised immune defences. It is intrinsically resistant to many antimicrobial agents and is challenging to control in health-care settings. Large differences are seen in the proportions of carbapenem-resistant *P. aeruginosa* within the WHO European Region (Fig. 6). In 2020, AMR percentages of below 5% were observed in four (10%) of 41 countries/areas reporting data on this microorganism (Denmark, Finland, the Netherlands and Sweden), whereas six (15%) countries reported percentages equal to or above 50% (Belarus, Bosnia and Herzegovina, Montenegro, the Republic of Moldova, Serbia and Ukraine).

Fig. 6 *P. aeruginosa*: percentage of invasive isolates with resistance to carbapenems (imipenem/meropenem), by country/area, WHO European Region, 2020



Note: data for Serbia and Kosovo (All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999)) were combined for this map. Data for the United Kingdom for 2020 do not include Scotland and Wales.

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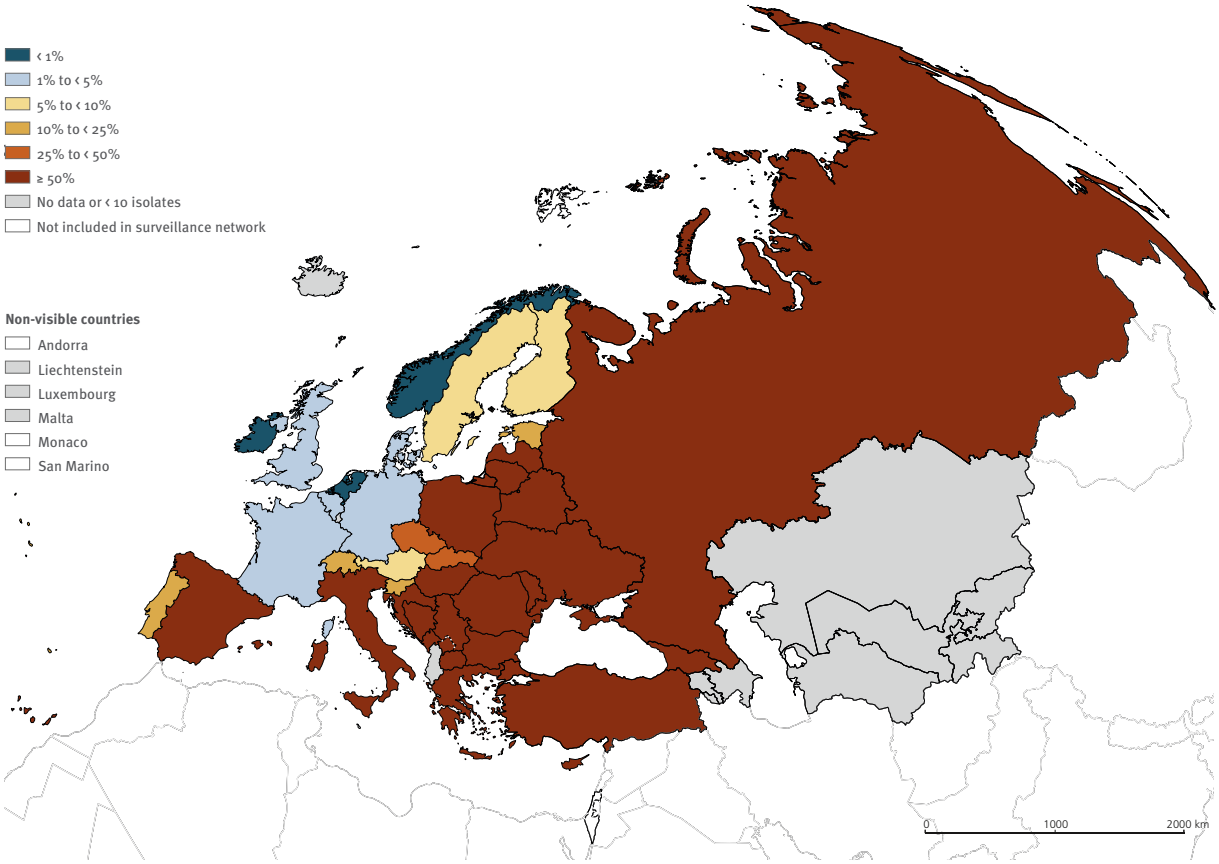
Acinetobacter spp.

Acinetobacter spp. mainly cause health-care-associated infections such as (ventilator-associated) pneumonia, (central line-associated) bloodstream infections and postoperative wound infections. *Acinetobacter* spp. can persist in the health-care environment and are difficult to eradicate once established. The percentages of carbapenem-resistant *Acinetobacter* spp. varied widely within the Region in 2020, from below 1% in three (8%) of 38 countries/areas reporting data on this microorganism (Ireland, the Netherlands and Norway) to percentages equal to or above 50% in 21 (55%) countries/areas, mostly in southern and eastern Europe (Fig. 7).

Fig. 7 *Acinetobacter* spp.: percentage of invasive isolates with resistance to carbapenems (imipenem/meropenem), by country/area, WHO European Region, 2020



Note: data for Serbia and Kosovo (All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999)) were combined for this map. Data for the United Kingdom for 2020 do not include Scotland and Wales.

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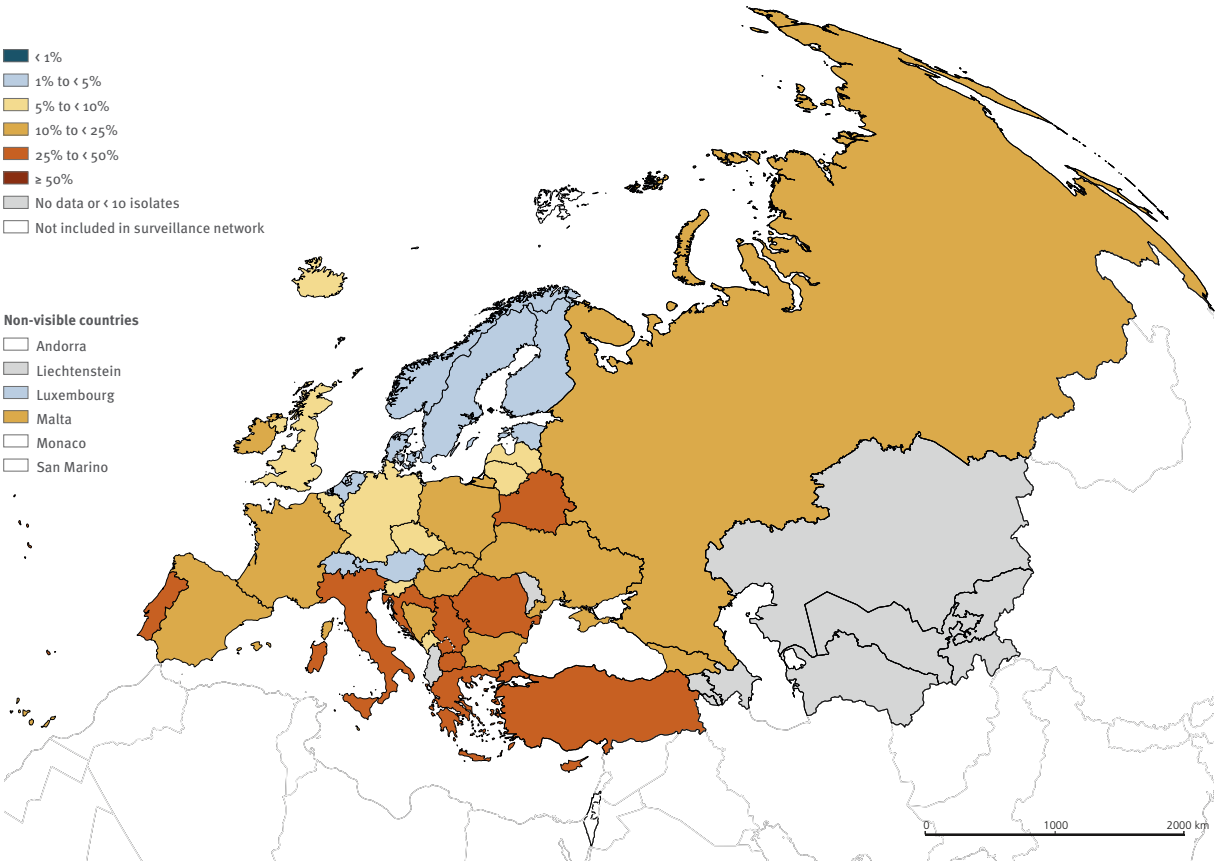
S. aureus

Methicillin-resistant *Staphylococcus aureus* (MRSA) is one of the most frequent causes of antibiotic-resistant health-care-associated infections worldwide. In addition, many parts of the world, including Europe, are reporting increasing levels of community-associated MRSA. *S. aureus* mainly causes infections of the skin, soft tissue and bone, and bloodstream infections. It is the most common cause of postoperative wound infections. In 2020, nine (23%) of 40 countries/areas reporting data on *S. aureus* had MRSA percentages below 5% (Austria, Denmark, Estonia, Finland, Luxembourg, the Netherlands, Norway, Sweden and Switzerland) (Fig. 8). MRSA percentages equal to or above 25% were found in 10 (25%) of 40 countries/areas (Belarus, Croatia, Cyprus, Greece, Italy, North Macedonia, Portugal, Romania, Serbia and Turkey).

Fig. 8 *S. aureus*: percentage of invasive isolates resistant to methicillin (MRSA),[a] by country/area, WHO European Region, 2020



Note: data for Serbia and Kosovo (All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999)) were combined for this map. Data for the United Kingdom for 2020 do not include Scotland and Wales.

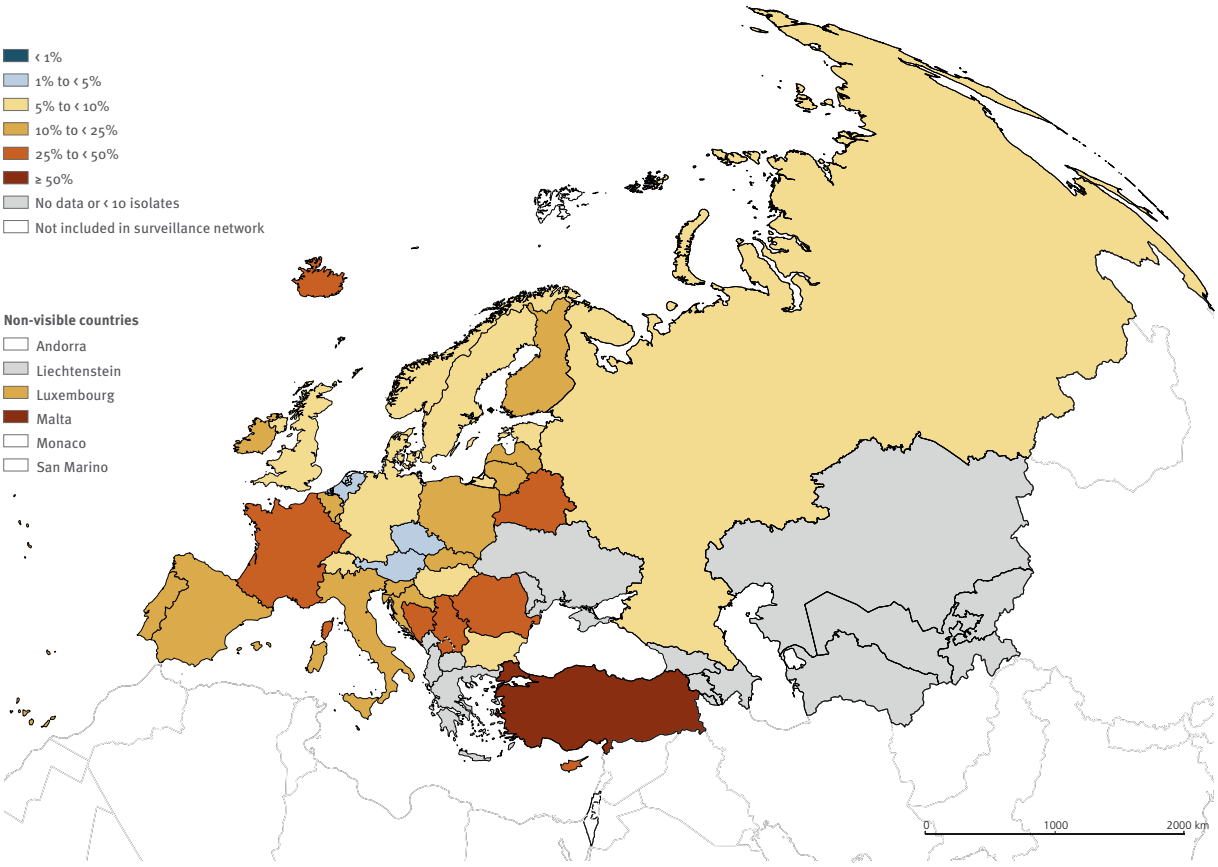
[a] For EARS-Net, MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. EARS-Net also includes data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test), which are given priority over phenotypic AST results. For CAESAR, MRSA is based on results for cefoxitin or, if not available, oxacillin.

Data sources: 2020 data from the Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR, ©WHO 2021. All rights reserved.) and 2020 data from the European Antimicrobial Resistance Surveillance Network (EARS–Net, ©ECDC 2021).
Map production: ©WHO.

S. pneumoniae

S. pneumoniae causes a wide range of infections, from mild, self-limiting conditions such as otitis media to more serious infections like community-acquired pneumonia and meningitis, with high mortality in vulnerable patient groups. Large differences were observed across the Region in the percentage of penicillin non-wild-type *S. pneumoniae*. Three (9%) of 35 countries/areas reporting data on this microorganism in 2020 had proportions below 5% (Austria, Czechia and the Netherlands), while percentages equal to or above 25% were found in nine (26%) countries (Belarus, Bosnia and Herzegovina, Cyprus, France, Iceland, Malta, Romania, Serbia and Turkey) (Fig. 9).

Fig. 9 *S. pneumoniae*: percentage of penicillin[a] non-wild-type[b] invasive isolates, by country/area, WHO European Region, 2020



Note: data for Serbia and Kosovo (All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999)) were combined for this map. Data for the United Kingdom for 2020 do not include Scotland and Wales.

[a] Penicillin results are based on penicillin or, if not available, oxacillin.

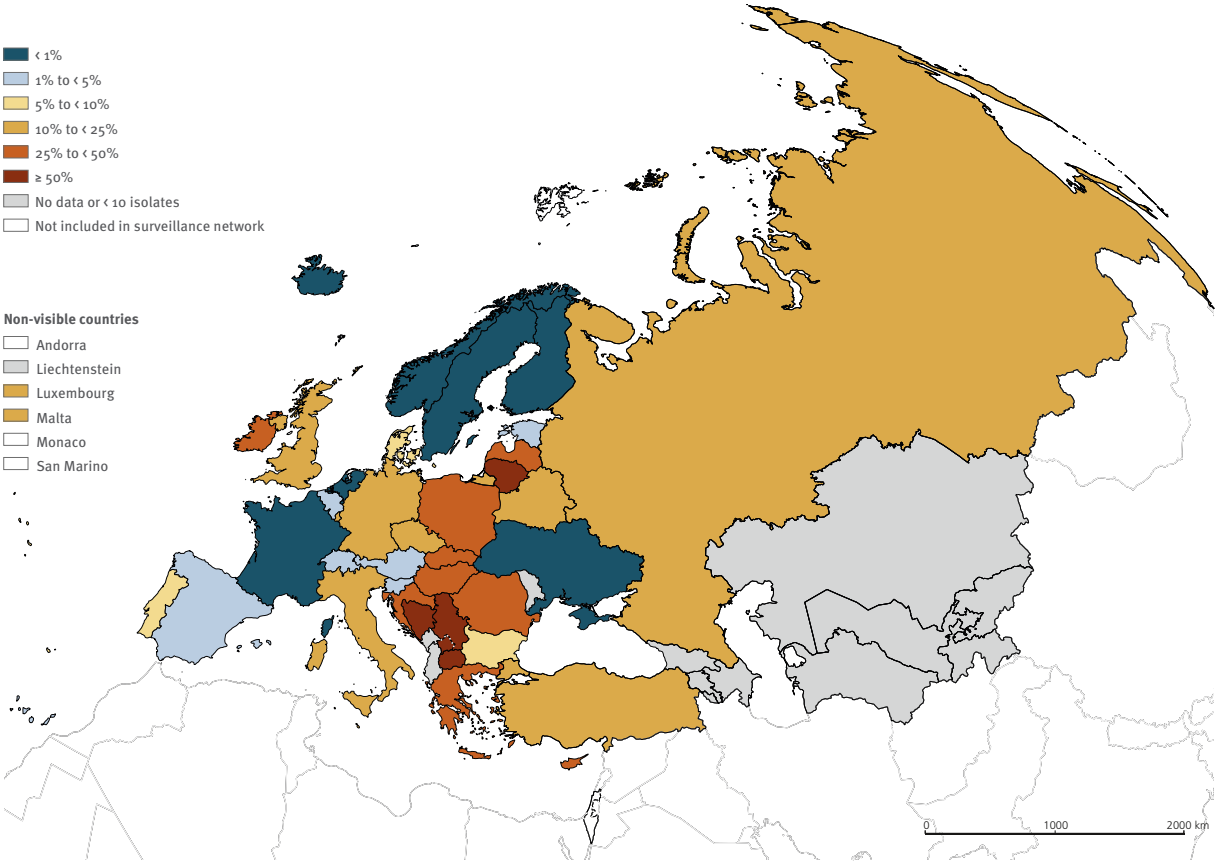
[b] For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by local laboratories as susceptible, increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (› 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints (this applies to only a few laboratories in CAESAR countries/areas in 2020) might define the cut-off values for the susceptibility categories differently.

Data sources: 2020 data from the Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR, ©WHO 2021. All rights reserved.) and 2020 data from the European Antimicrobial Resistance Surveillance Network (EARS–Net, ©ECDC 2021).
Map production: ©WHO.

E. faecium

E. faecium belongs to the normal bacterial microbiota of the human gastrointestinal tract. It is usually low-pathogenic but can, under certain circumstances, cause severe disease such as bloodstream infections, endocarditis and peritonitis. Resistance to vancomycin in *E. faecium* varied substantially among countries and areas in the Region. In 2020, percentages of below 1% were reported by seven (18%) of 38 countries/areas reporting data on this microorganism (Finland, France, Iceland, the Netherlands, Norway, Sweden and Ukraine) (Fig. 10). AMR percentages equal to or above 25% were found in 13 (34%), four of which (11% of 38 countries/areas) reported percentages equal to or above 50% (Bosnia and Herzegovina, Lithuania, North Macedonia and Serbia).

Fig. 10 *E. faecium*: percentage of invasive isolates resistant to vancomycin, by country/area, WHO European Region, 2020



Note: data for Serbia and Kosovo (All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999)) were combined for this map. Data for the United Kingdom for 2020 do not include Scotland and Wales.

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Map production: ©WHO.

Discussion

Despite the challenges faced as a result of the COVID-19 pandemic, 12 countries as well as Kosovo[13] reported data to CAESAR, while 29 countries, including all from the EU and two from the EEA (Iceland and Norway), reported data to EARS-Net.

The results from CAESAR and EARS-Net in this first AMR surveillance report jointly published by ECDC and the WHO Regional Office for Europe show clearly that AMR is widespread in the WHO European Region. While assessing the exact magnitude of AMR remains challenging in many settings, the presence of specific AMR patterns across clinical settings covered by the surveillance networks is apparent. High percentages of resistance to third-generation cephalosporins and carbapenems in *K. pneumoniae*, and high percentages of carbapenem-resistant *Acinetobacter* spp. in several countries, are of concern. They suggest the dissemination of resistant clones in health-care settings and indicate the serious limitations in treatment options in many countries/areas for patients with infections caused by these pathogens. While the west-to-east gradient in AMR percentages is evident for gram-negative bacteria (*E. coli*, *K. pneumoniae* and *Acinetobacter* spp.), it is less obvious for gram-positive bacteria (*S. aureus*, *S. pneumoniae* and *E. faecium*). As antimicrobial-resistant bacterial microorganisms cannot be contained within borders or regions, these results underline the need for concerted action to combat AMR throughout the WHO European Region.

While the EARS-Net and CAESAR networks use comparable methods for data collection and analysis, the results presented in this report originate from distinct country/area surveillance systems. As these inherently are influenced by specific protocols and practices, caution is advised when comparing countries/areas in terms of AMR patterns.

The impact of the COVID-19 pandemic on AMR is apparent in many ways. Many countries/areas providing AMR data to CAESAR reported fewer *E. coli* isolates in 2020 than in previous years. This may be related to decreased health-care activities in areas not linked directly to the COVID-19 response, including less engagement in AMR surveillance activities. In addition, many countries and areas in the WHO European Region reported lower numbers of *S. pneumoniae* isolates in 2020 than in previous years, which may be a result of the decreased circulation of respiratory pathogens in the community during lockdowns and the enforcement of measures to control the spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). On the other hand, typical health-care-associated pathogens such as *Acinetobacter* spp. and *E. faecium* were more frequently observed during 2020 than in previous years in many countries and areas.

Since the adoption of the European Strategic Action Plan on Antibiotic Resistance in 2011 *(1)* and the publication of the Global Action Plan on Antimicrobial Resistance (GAP-AMR) in 2015 *(2)*, most Member States of the WHO European Region have enhanced efforts to tackle AMR. Only 25 (50%) of the 50 countries/areas reported having developed a NAP on AMR in 2016, but the latest round of global monitoring showed that this had increased to 43 (86%) of the 50 countries/areas in the Region that responded *(3)*. The challenge ahead is how to ensure comprehensive implementation and adequate funding for the NAPs. This shortcoming is more evident when looking at surveillance capacity in the WHO European Region: 20% of countries/areas still reported either having no capacity for generating AMR surveillance data or are collecting AMR data only at local level and without a standardized approach.

Similarly, efforts to improve antimicrobial consumption in the Region remain heterogeneous. While 14 (48%) countries reporting to ESAC-Net met WHO's suggested national target of 60% of total antibacterial consumption each year being derived from WHO's Access category (as defined in the Access, Watch, Reserve (AWaRe)[14] classification list *(4)*) during the period 2014–2018, only one (7%) country reporting to the WHO Regional Office for Europe Antimicrobial Medicines Consumption Network achieved this target in each of these five years.

Public health implications

AMR is a looming threat to the health of millions of people worldwide. The COVID-19 pandemic has exposed the weaknesses in national health systems and the interconnectedness of countries and continents. Continuity of efforts to tackle AMR has been seriously challenged by repurposing health-care professionals to support the COVID-19 response across the European Region, and the effects of the pandemic on people and public health still need to be fully evaluated. This crisis is a powerful reminder that governments will need more coordinated action and collaboration than ever before to confront future health threats. Despite the global call for action that was renewed with the GAP-AMR in 2015 *(2)*, the European One Health Action Plan in 2017 *(5)* and the subsequent commitment by Member States to develop NAPs, several countries are only just starting on their roadmap to implement effective interventions to tackle AMR. High-level commitment is still lacking and important programmes and interventions on IPC, antimicrobial stewardship and surveillance remain under-resourced. Despite important advances, this report highlights the persistent disparities in AMR prevalence across the WHO European Region and uncovers unexploited opportunities to counteract AMR. Greater efforts and investment are required to increase the comparability, quantity and quality of AMR surveillance data.

13 All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999).

14 AWaRe classifies antibiotics into three stewardship groups – Access, Watch and Reserve – to emphasize the importance of their optimal uses and potential for AMR.

EU/EEA countries

Overall EU/EEA situation

Twenty-nine EU/EEA countries reported data for 2020 to EARS-Net. Twenty-eight reported data for all eight bacterial species under surveillance by EARS-Net (*E. coli*, *K. pneumoniae*, *P. aeruginosa*, *Acinetobacter* spp., *S. pneumoniae*, *S. aureus*, *E. faecalis* and *E. faecium*), while one (Greece) reported data for all bacterial species except *S. pneumoniae*. The most commonly reported bacterial species was *E. coli* (41.3%), followed by *S. aureus* (21.9%), *K. pneumoniae* (11.9%), *E. faecalis* (8.4%), *P. aeruginosa* (6.2%), *E. faecium* (5.5%), *S. pneumoniae* (2.6%) and *Acinetobacter* spp. (2.3%). The overall number of reported isolates at EU/EEA level increased in 2020 compared to 2019 for all bacterial species except *S. pneumoniae*. These increases were not always observed at country level. For *S. pneumoniae*, on the other hand, there was both a large decrease in the overall number of isolates between 2019 and 2020 (44.3%; from 15 608 in 2019 to 8689 in 2020) and similarly large decreases of 20% or more reported in all but one country.

Country-specific results on data availability and age group, sex and ICU patient percentages are available for each bacterial species in the country and area profiles (Chapter 4). Results by age group and sex for specific AMR phenotypes are available in ECDC's Surveillance Atlas of Infectious Diseases *(5)*.

The AMR situation reported by EU/EEA countries to EARS-Net for 2020 varied widely depending on the bacterial species, antimicrobial group and geographical region (Table 7a, Fig. 1–10 and country and area profiles). Overall for the EU/EEA (excluding the United Kingdom), most of the bacterial species–antimicrobial combinations in this report showed either a significantly decreasing trend or no significant trend in the population-weighted mean AMR percentage during 2016–2020. The exceptions to this were carbapenem resistance in *E. coli* and *K. pneumoniae* and vancomycin resistance in *E. faecium*, for which there was a significant increase during this period (Table 7b).

In 2020, more than half of the *E. coli* isolates reported to EARS-Net and more than a third of the *K. pneumoniae* isolates were resistant to at least one antimicrobial group under surveillance, and combined resistance to several antimicrobial groups was a frequent occurrence. Among antimicrobial groups monitored for both species, AMR percentages generally were higher in *K. pneumoniae* than in *E. coli*. Carbapenem resistance remained rare in *E. coli*, but almost a quarter of EU/EEA countries reported carbapenem resistance percentages above 10% in *K. pneumoniae*. Carbapenem resistance was also common in *P. aeruginosa* and *Acinetobacter* spp., and at a higher percentage than in *K. pneumoniae*. For most gram-negative bacteria under surveillance, changes in the EU/EEA (excluding the United Kingdom) population-weighted mean AMR percentages between 2016 and 2020 were moderate and AMR remained at high levels, as previously reported.

For *S. aureus*, a decrease in the percentage of MRSA isolates was reported during 2016–2020 (Table 7b). MRSA nevertheless remains an important pathogen in the EU/EEA, with levels remaining high in several countries and combined resistance to another antimicrobial group common. A decreasing trend was also seen during 2016–2020 for the percentage of macrolide resistance in *S. pneumoniae* (Table 7b).

One development of particular concern was the increasing trend in the EU/EEA (excluding the United Kingdom) population-weighted mean percentage of vancomycin-resistant isolates of *E. faecium*, which increased from 11.6% in 2016 to 16.8% in 2020.

The reported AMR percentages for several bacterial species–antimicrobial group combinations varied widely among countries, with a north-to-south and west-to-east gradient evident. In general, the lowest AMR percentages were reported by countries in the north of Europe and the highest by countries in the south and east. There was no distinct geographical pattern for vancomycin-resistant *E. faecium*.

Table 7a Total number of invasive isolates tested (N) and percentage of isolates with AMR phenotype (%) in EU/EEA, by bacterial species and antimicrobial group/agent, population-weighted EU/EEA mean, 2016–2020

Bacterial species	Antimicrobial group/agent	2016[a]		2017[a]		2018[a]		2019[a]		2020[b]		2020 EU/EEA country range[c]
		N	%	N	%	N	%	N	%	N	%	
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	108 239	59.0	125 866	58.7	133 700	57.5	130 603	57.1	105 827	54.6	34.1–67.5
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	123 944	14.9	140 584	14.9	152 720	15.1	157 918	15.1	137 465	14.9	5.8–41.4
	Carbapenem (imipenem/meropenem) resistance	122 437	0.1	140 438	0.1	151 457	0.1	156 871	0.3	134 032	0.2	0.0–0.8
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	125 161	25.2	141 562	25.7	154 698	25.3	161 718	23.8	137 785	23.8	10.0–48.2
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	124 480	11.6	141 788	11.4	154 266	11.1	161 432	10.8	134 683	10.9	5.5–34.2
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[d]	121 582	6.4	135 108	6.3	148 206	6.2	154 844	5.9	132 705	5.7	1.6–18.7
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	30 633	31.4	32 969	31.2	38 436	31.7	41 057	31.4	39 579	33.9	0.0–79.1
	Carbapenem (imipenem/meropenem) resistance	30 309	7.4	32 960	7.1	38 140	7.5	40 714	8.0	39 006	10.0	0.0–66.3
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	30 769	30.3	32 924	31.5	38 770	31.6	41 617	31.3	39 794	33.8	0.0–74.4
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	30 209	24.4	33 136	24.1	38 555	22.7	41 484	22.4	38 733	23.7	0.0–67.0
	Combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides[d]	29 589	20.6	31 613	20.5	37 402	19.5	40 270	19.4	38 094	21.0	0.0–58.3
P. aeruginosa	Piperacillin-tazobactam resistance	15 125	17.5	16 428	16.7	18 607	16.8	19 465	17.0	19 695	18.8	4.4–64.3
	Ceftazidime resistance	15 219	14.4	16 512	14.7	18 960	14.1	19 959	14.3	20 014	15.5	2.9–54.3
	Carbapenem (imipenem/meropenem) resistance	15 573	18.2	17 109	17.4	19 233	17.2	20 238	16.6	20 414	17.8	3.6–48.9
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	15 504	18.8	16 951	20.2	19 211	19.7	20 384	18.9	20 279	19.6	3.2–52.9
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[e]	15 525	14.0	16 979	13.2	19 186	11.8	20 344	11.5	12 840	9.4	0.0–37.1
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[e]	15 628	13.4	17 129	13.0	19 306	12.6	20 406	12.1	20 421	12.1	0.0–47.1
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	5 590	32.6	6 186	33.1	6 526	31.9	5 958	32.4	7 542	38.0	0.0–96.4
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	5 596	37.5	6 098	37.4	6 496	36.2	5 923	36.6	7 392	41.8	0.0–98.2
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	5 562	32.7	6 042	32.2	6 459	31.3	5 915	32.7	7 306	37.1	0.0–96.4
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[d]	5 418	28.3	5 872	28.2	6 294	28.3	5 682	29.4	7 140	34.1	0.0–95.1
S. aureus	MRSA[f]	57 730	17.7	66 279	16.8	72 882	16.4	74 718	15.7	72 314	16.7	1.4–49.1
S. pneumoniae	Penicillin non-wild-type[g]	15 666	13.1	17 212	12.9	18 676	12.9	18 235	12.2	8 032	15.6	3.9–56.3
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	16 027	16.6	17 613	15.7	19 217	15.2	18 940	14.5	8 362	16.9	3.5–43.8
	Combined penicillin non-wild-type and resistance to macrolides[g]	15 182	8.4	16 584	8.2	18 082	7.8	17 529	7.3	7 739	9.0	0.0–37.5
E. faecalis	High-level gentamicin resistance	12 910	31.8	13 930	29.7	15 343	27.1	13 596	26.8	14 279	29.0	4.1–51.6
E. faecium	Vancomycin resistance	12 511	12.3	14 213	14.9	15 992	17.3	16 549	18.2	18 151	16.8	0.0–56.6

[a] Number of EU/EEA countries: 30.
[b] Number of EU/EEA countries: 29.
[c] Lowest and highest national AMR percentage among reporting EU/EEA countries (n = 29).
[d] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[e] The aminoglycoside group includes only tobramycin from 2020 onwards.
[f] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutination test) are given priority over phenotypic AST results.
[g] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by local laboratories as susceptible, increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (› 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might have used different interpretive criteria for the susceptibility categories.

Table 7b Total number of invasive isolates tested (N) and percentages isolates with AMR phenotype (%) in EU/EEA (excluding the United Kingdom), by bacterial species and antimicrobial group/agent, population-weighted EU/EEA mean and trend (excluding the United Kingdom), 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA countryrange[a]	Trend 2016–2020[b]
		N	%	N	%	N	%	N	%	N	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	86 625	58.4	97 219	58.1	104 198	57.0	102 375	56.6	105 827	54.6	34.1–67.5	↓
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	102 098	15.7	112 659	15.6	124 043	15.7	131 325	15.6	137 465	14.9	5.8–41.4	↓
	Carbapenem (imipenem/meropenem) resistance	99 675	0.1	110 364	0.1	120 228	0.1	127 262	0.3	134 032	0.2	0.0–0.8	↑
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	102 278	26.4	111 377	26.9	123 358	26.4	132 015	24.7	137 785	23.8	10.0–48.2	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	101 314	11.8	111 049	11.6	122 147	11.2	130 984	10.8	134 683	10.9	5.5–34.2	↓
	Combined resistance to third-generation cephalosporins, fluoroquinolones, and aminoglycosides[c]	100 481	6.7	108 300	6.6	120 450	6.4	129 083	6.1	132 705	5.7	1.6–18.7	↓
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	26 719	34.7	27 996	34.1	33 255	34.4	36 190	34.1	39 579	33.9	0.0–79.1	–
	Carbapenem (imipenem/meropenem) resistance	26 241	8.4	27 686	8.1	32 548	8.5	35 439	9.0	39 006	10.0	0.0–66.3	↑
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	26 704	33.6	27 631	34.7	33 170	34.3	36 315	34.0	39 794	33.8	0.0–74.4	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	26 074	27.0	27 773	26.4	32 846	24.7	36 078	24.5	38 733	23.7	0.0–67.0	↓
	Combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides[c]	25 825	23.0	26 853	22.9	32 397	21.6	35 622	21.5	38 094	21.0	0.0–58.3	↓
P. aeruginosa	Piperacillin-tazobactam resistance	13 086	19.2	13 731	18.4	16 018	18.5	16 894	18.6	19 695	18.8	4.4–64.3	–
	Ceftazidime resistance	13 198	15.9	13 832	16.1	16 339	15.5	17 328	15.7	20 014	15.5	2.9–54.3	–
	Carbapenem (imipenem/meropenem) resistance	13 465	20.1	14 305	19.1	16 485	18.8	17 496	18.1	20 414	17.8	3.6–48.9	↓
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	13 385	20.6	14 149	22.0	16 472	21.2	17 635	20.5	20 279	19.6	3.2–52.9	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	13 385	15.6	14 148	14.5	16 405	12.9	17 552	12.6	12 840	9.4	0.0–37.1	↓
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	13 497	15.0	14 299	14.5	16 535	14.1	17 628	13.5	20 421	12.1	0.0–47.1	↓
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	5 006	37.1	5 404	37.6	5 812	36.3	5 240	36.9	7 542	38.0	0.0–96.4	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	5 007	42.3	5 305	41.9	5 776	41.1	5 216	41.0	7 392	41.8	0.0–98.2	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	4 964	37.0	5 252	36.3	5 733	35.2	5 194	36.8	7 306	37.1	0.0–96.4	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	4 860	32.3	5 126	32.1	5 618	32.4	5 012	33.6	7 140	34.1	0.0–95.1	↑[#]
S. aureus	MRSA[e]	51 013	19.3	57 396	18.3	63 837	17.7	65 604	17.1	72 314	16.7	1.4–49.1	↓
S. pneumoniae	Penicillin non-wild-type[f]	12 465	14.3	13 249	14.0	14 514	14.0	14 568	13.2	8 032	15.6	3.9–56.3	–
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	12 604	18.2	13 340	17.2	14 767	16.6	15 069	15.9	8 362	16.9	3.5–43.8	↓
	Combined penicillin non-wild-type and resistance to macrolides[f]	12 046	9.2	12 699	9.2	14 030	8.6	14 102	8.0	7 739	9.0	0.0–37.5	↓
E. faecalis	High-level gentamicin resistance	12 910	31.8	13 930	29.7	15 343	27.1	13 577	25.3	14 279	29.0	4.1–51.6	↓
E. faecium	Vancomycin resistance	10 708	11.6	12 011	13.3	13 377	16.2	14 121	17.7	18 151	16.8	0.0–56.6	↑

[a] Lowest and highest national AMR percentage among reporting EU/EEA countries (n = 29).
[b] ↑ and ↓ indicate statistically significant increasing and decreasing trends, respectively; [#] indicates a significant trend in the overall data, but not in data that only included laboratories reporting continuously for all five years; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by local laboratories as susceptible, increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (› 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might have used different interpretive criteria for the susceptibility categories.

Bacterial species-specific results

E. coli

Epidemiology

For 2020, 29 EU/EEA countries reported 138 793 isolates of *E. coli*. Of these, 105 827 (76%) isolates had AST results for aminopenicillins, 137 465 (99%) for third-generation cephalosporins, 137 785 (99%) for fluoroquinolones, 134 683 (97%) for aminoglycosides and 134 032 (97%) for carbapenems (Table 7a).

At EU/EEA level, more than half (54.0%) of the *E. coli* isolates reported to EARS-Net for 2020 were resistant to at least one of the antimicrobial groups under surveillance (aminopenicillins, fluoroquinolones, third-generation cephalosporins, aminoglycosides and carbapenems) (Table 8). In 2020, the highest EU/EEA population-weighted mean resistance percentage was reported for aminopenicillins (54.6%), followed by fluoroquinolones (23.8%), third-generation cephalosporins (14.9%) and aminoglycosides (10.9%). Resistance to carbapenems remained rare (0.2%) (Table 7a).

There was a significantly increasing trend between 2016 and 2020 in the EU/EEA (excluding the United Kingdom) population-weighted mean percentage for carbapenem resistance, while the EU/EEA (excluding the United Kingdom) trends for aminopenicillin resistance, third-generation cephalosporin resistance, fluoroquinolone resistance and aminoglycoside resistance decreased significantly during the same period. When restricting the analysis to include only laboratories that consistently reported data for all five years, all trends remained significant (Table 7b). Larger annual decreases in EU/EEA-level resistance percentages were seen in 2020 than in the period 2016–2019 for aminopenicillin (–2.0%) and third-generation cephalosporins (–0.7%) (Table 7b). The former was also reflected at country level by annual decreases in more than 80% of the countries reporting data on the species–antimicrobial group *(6)*.

Resistance to multiple antimicrobial groups was common. Among the resistant phenotypes, resistance to aminopenicillins, both as single resistance or in combination with other antimicrobial groups, was the most common at EU/EEA level (Table 8). In 2020, the percentage of combined resistance, measured as resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides, was 5.7% (EU/EEA (excluding the United Kingdom) population-weighted mean) and this showed a statistically significant decreasing trend during the period 2016–2020 (Table 7b).

Except for carbapenem resistance, large intercountry variations were noted for all antimicrobial groups under surveillance (Table 7a), with generally higher AMR percentages reported from southern and eastern Europe than from northern Europe (Fig. 1–3).

Table 8 *E. coli*: total number of invasive isolates tested (N = 98 567)[a] and AMR percentage (%) per phenotype, EU/EEA, 2020

AMR pattern[b]	Number of isolates	Percentage of total[c]
Fully susceptible (to included antimicrobial groups)	**45 338**	**46.0**
Single resistance (to indicated antimicrobial group)		
Total (all single resistance)	**32 535**	**33.0**
Aminopenicillins	29 512	29.9
Fluoroquinolones	2 547	2.6
Other antimicrobial groups	476	0.5
Resistance to two antimicrobial groups		
Total (all two-group combinations)	**10 026**	**10.2**
Aminopenicillins + fluoroquinolones	5 660	5.7
Aminopenicillins + third-generation cephalosporins	2 493	2.5
Aminopenicillins + aminoglycosides	1 710	1.7
Other antimicrobial group combinations	163	0.2
Resistance to three antimicrobial groups		
Total (all three-group combinations)	**6 742**	**6.8**
Aminopenicillins + third-generation cephalosporins + fluoroquinolones	4 417	4.5
Aminopenicillins + fluoroquinolones + aminoglycosides	1 830	1.9
Other antimicrobial group combinations	495	0.5
Resistance to four antimicrobial groups		
Total (all four-group combinations)	**3 902**	**4.0**
Aminopenicillins + third-generation cephalosporins + fluoroquinolones + aminoglycosides	3 873	3.9
Other antimicrobial group combinations	29	‹ 0.1
Resistance to five antimicrobial groups		
Aminopenicillins + third-generation cephalosporins + fluoroquinolones + aminoglycosides + carbapenems	24	‹ 0.1

[a] Only isolates with complete susceptibility information for aminopenicillins (amoxicillin or ampicillin), third-generation cephalosporins (cefotaxime, ceftriaxone or ceftazidime), carbapenems (imipenem or meropenem), fluoroquinolones (ciprofloxacin, levofloxacin or ofloxacin) and aminoglycosides (gentamicin or tobramycin) were included in the analysis. This represented 71% (98 567/138 793) of all reported *E. coli* isolates.
[b] Only AMR combinations › 1% of the total are specified.
[c] Not adjusted for population differences in the reporting countries.

Discussion

E. coli is a major cause of bloodstream infection in Europe, and prompt access to effective antimicrobial treatment is essential to reduce the health-related and economic burden caused by *E. coli* infection. Infections caused by antimicrobial-resistant *E. coli* proportionally contribute most to the burden of AMR in the EU/EEA, both in terms of the number of cases and the number of attributable deaths *(7)*. As resistant *E. coli* commonly occur in the community, interventions to reduce the burden of infection should not be restricted to hospital settings, but should also target primary and community care.

Time-series analyses of EU/EEA population-weighted means for third-generation cephalosporin resistance and fluoroquinolone resistance in *E. coli* reported to EARS-Net for the years 2002–2018 have shown that while AMR percentages increased substantially during the period, the increase was most prominent up until around 2012. After this, it was less pronounced *(8)*. A significantly declining EU/EEA (excluding the United Kingdom) trend was noted for the five-year period presented in this report (2016–2020). Percentages of AMR reported for 2020 nevertheless remain at a high level, highlighting the need for further efforts to improve antimicrobial stewardship and IPC.

Use of broad-spectrum antimicrobials is a known risk factor for the colonization and spread of antimicrobial-resistant Enterobacterales, including *E. coli*. Associations between national AMR percentages in *E. coli* and national antimicrobial consumption rates have been reported *(9)*. The latest data from ESAC-Net show a considerable decrease in antimicrobial consumption in 2020 *(10)*. A less uniform pattern is reflected for AMR percentages at EU/EEA level. The latest data from ESAC-Net also show that large intercountry variations in the use of broad-spectrum antimicrobials remain *(10)*, indicating a need for increased focus on antimicrobial stewardship and highlighting the potential for further reductions in antimicrobial consumption.

As high AMR levels have been reported in *E. coli* isolates from food-producing animals in Europe, including the rare occurrence of isolates with carbapenemase production *(11)*, ensuring cross-sectoral collaboration between the human, veterinary and food-production sectors is essential. This work is underpinned by the European One Health approach, which addresses AMR in both humans and animals. ECDC is working closely with the European Food Safety Authority and the European Medicines Agency to better understand the interrelationships between antimicrobial use and AMR in humans and animals across Europe, and produced the third joint interagency report on integrated analysis of antimicrobial agent consumption and occurrence of AMR in bacteria from humans and food-producing animals in 2021 *(9)*.

Although carbapenem-resistant isolates remained rare among the invasive *E. coli* isolates included in EARS-Net, there was a small but significant increase in the EU/EEA (excluding the United Kingdom) population-weighted mean between 2016 and 2020. A further increase in serious infections caused by carbapenem-resistant *E. coli* would have severe consequences on the burden of AMR in the EU/EEA. Carbapenem-resistant Enterobacterales (CRE) infections are associated with high mortality, primarily due to delays in the administration of effective treatment and the limited availability of treatment options. The 2019 update of ECDC's rapid risk assessment on CRE highlights the need for high standards in IPC, combined with adequate microbiological capacity to detect and prevent further spread *(12)*.

Carbapenem resistance is most often mediated by a range of carbapenemases, but there are carbapenemase-producing isolates that test susceptible to meropenem and/or imipenem, based on clinical breakpoints. One example is OXA-244-producing *E. coli* that might be classified only as extended spectrum beta lactamase-producing instead of carbapenemase-producing *E. coli*, unless specifically tested for OXA-48-like carbapenemases. A recent ECDC risk assessment on OXA-244-producing *E. coli (13)* indicated a pan-European problem, with a high risk of further spread of OXA-244-producing *E. coli* in the EU/EEA, given the rapid and simultaneous increase in multiple countries between 2016 and 2019. There is a risk that transmission of OXA-244-producing *E. coli* in the community may contribute to the loss of carbapenems as options for treatment of *E. coli* infections. This highlights the need for further investigation to determine the source and routes of transmission for these infections.

To address the need for enhanced CRE surveillance and complement the phenotypic-based surveillance data available from EARS-Net, a carbapenem- and/or colistin-resistant Enterobacterales (CCRE) periodically repeated survey has been incorporated into the European Antimicrobial Resistance Genes Surveillance Network (EURGen-Net) *(14)*. The survey results will provide information on the prevalence and distribution of carbapenemases and contribute to a better understanding of the epidemiology of CRE in Europe and risk factors associated with CRE infection and colonization. ECDC, to a limited extent, is also able to provide Member States with access to whole-genome sequencing services, primarily for investigating potential multicountry outbreaks. By way of example, these services were provided for a combined clonal and plasmid-mediated outbreak of carbapenemase-producing Enterobacterales in Lithuania in 2019–2020 *(15)*.

K. pneumoniae

Epidemiology

For 2020, 29 EU/EEA countries reported 40 075 isolates of *K. pneumoniae*. Of these, 39 579 (99%) isolates had AST results for third-generation cephalosporins, 39 794 (99%) for fluoroquinolones, 38 733 (97%) for

aminoglycosides and 39 006 (97%) for carbapenems (Table 7a).

At EU/EEA level, more than a third (38.0%) of the *K. pneumoniae* isolates reported to EARS-Net for 2020 were resistant to at least one of the antimicrobial groups under surveillance (fluoroquinolones, third-generation cephalosporins, aminoglycosides and carbapenems) (Table 9). In 2020, the highest EU/EEA population-weighted mean resistance percentage was reported for third-generation cephalosporins (33.9%), followed by fluoroquinolones (33.8%), aminoglycosides (23.7%) and carbapenems (10.0%) (Table 7a).

Between 2016 and 2020, there was a significantly increasing trend in the EU/EEA (excluding the United Kingdom) population-weighted mean percentage for carbapenem resistance, while the EU/EEA (excluding the United Kingdom) trend for aminoglycoside resistance decreased significantly during the same period. All noted EU/EEA (excluding the United Kingdom) trends remained significant when restricting the analysis to include only laboratories that consistently reported data (Table 7b). Notably, the annual change in resistance percentage at EU/EEA level indicated a quite large increase in 2020 (1%) for carbapenems compared with the period 2016–2019 (Table 7b).

Single resistance was less commonly reported than resistance to two or three antimicrobial groups, with the most common AMR phenotype being combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides (Table 9). The EU/EEA (excluding the United Kingdom) population-weighted mean for combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides was 21.0% in 2020 and showed a statistically significant decreasing trend during the period 2016–2020 (Table 7b).

Large intercountry variations were noted for all antimicrobial groups under surveillance (Table 7a), with generally higher AMR percentages reported from southern and eastern Europe than from northern Europe (Fig. 4 and 5). Several countries reported carbapenem resistance percentages above 10% for *K. pneumoniae*. The countries reporting the highest percentages of carbapenem resistance in *K. pneumoniae* were also among those reporting the highest AMR percentages for the other antimicrobial groups.

Discussion

The AMR situation in *K. pneumoniae* in the EU/EEA remains problematic. In addition, a significantly increasing trend in the EU/EEA (excluding the United Kingdom) population-weighted mean percentages for carbapenem resistance, as well as a larger increase in the EU/EEA (excluding the United Kingdom) population-weighted mean carbapenem resistance percentage was noted from 2019 to 2020 compared to the annual change in the previous years covered by this report. Carbapenem resistance was almost always combined with resistance to several other key antimicrobial groups, leading to a severely limited range of treatment options for serious infections caused by this type of bacteria. ECDC's study of the health burden of AMR found that even though the level of carbapenem-resistant *K. pneumoniae* was relatively low, the impact of AMR on the EU/EEA health

Table 9 ***K. pneumoniae*: total number of invasive isolates tested (N = 37 187)[a] and AMR percentage (%) per phenotype, EU/EEA, 2020**

AMR pattern[b]	Number of isolates	Percentage of total[c]
Fully susceptible (to included antimicrobial groups)	**23 069**	**62.0**
Single resistance (to indicated antimicrobial group)		
Total (all single resistance)	**2 839**	**7.6**
Fluoroquinolones	1 400	3.8
Third-generation cephalosporins	1 212	3.3
Other antimicrobial groups	227	0.6
Resistance to two antimicrobial groups		
Total (all two-group combinations)	**3 082**	**8.3**
Third-generation cephalosporins + fluoroquinolones	2 195	5.9
Third-generation cephalosporins + aminoglycosides	412	1.1
Other antimicrobial group combinations	475	1.3
Resistance to three antimicrobial groups		
Total (all three-group combinations)	**5 828**	**15.7**
Third-generation cephalosporins + fluoroquinolones + aminoglycosides	4 652	12.5
Third-generation cephalosporins + fluoroquinolones + carbapenems	1 101	3.0
Other antimicrobial group combinations	75	0.2
Resistance to four antimicrobial groups		
Third-generation cephalosporins + fluoroquinolones + aminoglycosides + carbapenems	2 369	6.4

[a] Only isolates with complete susceptibility information for third-generation cephalosporins (cefotaxime, ceftriaxone or ceftazidime), carbapenems (imipenem or meropenem), fluoroquinolones (ciprofloxacin, levofloxacin or ofloxacin) and aminoglycosides (gentamicin or tobramycin) were included in the analysis. This represented 93% (37 187/40 075) of all reported *K. pneumoniae* isolates.
[b] Only AMR combinations > 1% of the total are specified.
[c] Not adjusted for population differences in the reporting countries.

burden is heavy because of the high level of attributable mortality for these infections *(7)*. This underlines the need for continuous close monitoring and greater efforts to respond efficiently to this public health threat.

The highest percentages of carbapenem resistance were observed in south and south-eastern Europe, similar to the distribution of carbapenemase-producing Enterobacterales reflected by another European surveillance initiative, EURGen-Net *(16)*. Results from EURGen-Net also show that in several EU/EEA countries the situation deteriorated between 2010 and 2018 with regard to the epidemiological stage of the spread of carbapenemase-producing Enterobacterales *(16)*. Numerous reports on outbreaks with varying potential for, or recorded cross-border spread of, CRE demonstrate the transmission potential in EU/EEA health-care systems *(17–19)*. Outbreaks and clusters in EU/EEA countries also highlight the importance of detecting CRE early in settings with low incidence, due to their high transmissibility *(17–21)*.

CRE can be resistant to carbapenems as a result of various mechanisms, but most frequently through production of carbapenemase enzymes. It is not possible to assess the overall presence and spread of carbapenemase-producing Enterobacterales through the data available from EARS-Net, as some carbapenemases do not confer a fully carbapenem-resistant phenotype. One example is the OXA-48-like carbapenemase enzymes, which present a particular problem for laboratory detection because of their weak capacity to hydrolyse carbapenems *(17)*.

Although *K. pneumoniae* carbapenemase still plays an important role among the carbapenemases produced by *K. pneumoniae*, recent outbreaks of carbapenemase (NDM-1 and OXA-48)-producing and colistin-resistant *K. pneumoniae* have highlighted the concomitant increase in virulence, transmissibility and AMR among certain *K. pneumoniae* strains. These strains pose a considerably higher risk to human health than was previously the case with the broader *K. pneumoniae* population. A 2021 rapid risk assessment by ECDC raised the issue of emerging hypervirulent *K. pneumoniae* ST23 carrying carbapenemase genes *(22)*. The limited information available so far indicates that very few cases and clusters have been reported in the EU/EEA. Early detection of such strains and close cooperation between clinicians and public health services nevertheless are crucial to avoiding spread among the patient population in the EU/EEA.

There is a need for increased capacity in the EU/EEA to support outbreak investigations and surveillance with real-time whole genome sequencing to identify high-risk clones and implement enhanced control measures to avoid further spread *(20,21)*. One initiative to address this need is the CCRE surveys (part of EURGen-Net) that will provide updated and more detailed information on the distribution of carbapenemase-producing *K. pneumoniae* in Europe *(14)*.

As highlighted in the 2019 update of ECDC's rapid risk assessment on CRE, options for action include timely and appropriate diagnosis, high standards of IPC and antimicrobial stewardship *(12)*. Many EU/EEA countries have developed and implemented recommendations and guidance documents on multidrug-resistant Enterobacterales and/or CRE *(23)*, indicating a trend towards nationally coordinated responses to this public health threat. To support countries, ECDC published in 2017 a guidance document on how to prevent the entry and spread of CRE into health-care settings. The guidance outlines evidence-based best practices for the prevention of CRE, including measures for intervention that can be adopted or adapted to local needs, depending on the availability of financial and structural resources *(24)*.

Colistin is being used to treat CRE infections, but colistin resistance may develop during treatment. The transferable plasmid-mediated colistin-resistance genes that can transmit colistin resistance more easily between bacteria further increase the risk for spread of colistin resistance *(25)*. Colistin resistance poses a substantial public health risk to the EU/EEA because it further limits treatment options in patients with infections caused by multidrug-resistant gram-negative bacteria, including CRE. The distribution of colistin resistance is difficult to assess through EARS-Net, as colistin susceptibility testing generally is not part of the initial routine AST panel for Enterobacterales. Instead, this is performed at national level after referral of multidrug-resistant isolates to a reference laboratory. In addition, colistin susceptibility testing is methodologically challenging. A joint EUCAST and Clinical and Laboratory Standards Institute working group has issued recommendations confirming that broth microdilution is so far the only valid method for colistin susceptibility testing *(26)*. A survey among EARS-Net participating laboratories in 2017 showed that a majority of the local laboratories responding did not test for colistin susceptibility locally or used methods that are not recommended by EUCAST (ECDC, United Kingdom National External Quality Assessment Service, unpublished data, 2017). This has led to the conclusion that until local laboratory capacity has improved, data sources other than EARS-Net are needed for colistin susceptibility surveillance. To better understand the capacity for colistin susceptibility testing and the distribution of colistin-resistant Enterobacterales in Europe, ECDC has included colistin in the surveillance panel of the CCRE survey. In addition, one of the survey objectives is to support technical capacity-building in EU Member States *(14)*.

WHO sees a critical need for research and development of new antibiotics targeting third-generation cephalosporin-resistant and CRE, including *K. pneumoniae* and *E. coli (27)*.

P. aeruginosa

Epidemiology

For 2020, 29 EU/EEA countries reported 20 675 isolates of *P. aeruginosa*. Of these, 19 695 (95%) isolates had AST results for piperacillin-tazobactam, 20 014 (97%) for ceftazidime, 20 279 (98%) for fluoroquinolones,

12 840 (62%) for aminoglycosides and 20 414 (99%) for carbapenems (Table 7a).

In the EU/EEA, 30.1% of the *P. aeruginosa* isolates reported to EARS-Net for 2020 were resistant to at least one of the antimicrobial groups under surveillance (piperacillin-tazobactam, fluoroquinolones, ceftazidime, aminoglycosides and carbapenems) (Table 10). The highest EU/EEA population-weighted mean resistance percentage in 2020 was reported for fluoroquinolones (19.6%), followed by piperacillin-tazobactam (18.8%), carbapenems (17.8%), ceftazidime (15.5%) and aminoglycosides (9.4%) (Table 7a).

Between 2016 and 2020, EU/EEA (excluding the United Kingdom) trends decreased significantly for all but two antimicrobial groups under surveillance (piperacillin-tazobactam and ceftazidime). When restricting the analysis to include only laboratories that consistently reported data for all five years, the trends for carbapenem resistance, fluoroquinolone and aminoglycoside resistance remained statistically significant (Table 7b). For *P. aeruginosa* and aminoglycosides there was a considerable change in the analysis for 2020 and a relatively large annual decrease in resistance percentage for 2020 (–3.2%) compared to the period 2016–2019 (Table 7b).

Resistance to two or more antimicrobial groups was common, being seen in 17.3% of all tested isolates (Table 10). Between 2016 and 2020, the EU/EEA (excluding the United Kingdom) population-weighted mean percentage of combined resistance, defined as resistance to at least three of the antimicrobial groups under surveillance, significantly decreased from 15.0% to 12.1% (Table 7b). Large intercountry variations were noted for all antimicrobial groups (Table 7a), with generally higher AMR percentages reported from southern and eastern Europe than northern Europe (Fig. 6).

Discussion

EARS-Net data showed that at EU/EEA (excluding the United Kingdom) level, trends in resistance decreased significantly for *P. aeruginosa* in relation to several antimicrobial groups under surveillance during the period 2016 to 2020. High AMR percentages and combined AMR nevertheless persisted in many countries, especially in the eastern and south-eastern parts of Europe. As *P. aeruginosa* is intrinsically resistant to many antimicrobial agents, additional acquired resistance is further complicating the treatment of *P. aeruginosa* infections.

The public health implications of AMR in *P. aeruginosa* should not be ignored, as *P. aeruginosa* remains one of the major causes of health-care-associated infection in Europe *(28)*. *P. aeruginosa* and *Acinetobacter* spp. bloodstream infections are proportionally far more commonly reported from some EU/EEA countries than others *(6)*. An analysis based on 2016 EARS-Net data highlighted that countries reporting high proportions of *P. aeruginosa*

Table 10 *P. aeruginosa*: total number of invasive isolates tested (N = 11 967)[a] and AMR percentage (%) per phenotype, EU/EEA, 2020

AMR pattern[b]	Number of isolates	Percentage of total[c]
Fully susceptible (to included antimicrobial groups)	**8 367**	**69.9**
Single resistance (to indicated antimicrobial group)		
Total (all single resistance types)	**1 529**	**12.8**
Fluoroquinolones	635	5.3
Carbapenems	598	5.0
Piperacillin-tazobactam	182	1.5
Other antimicrobial groups	114	1.0
Resistance to two antimicrobial groups		
Total (all two-group combinations)	**908**	**7.6**
Piperacillin-tazobactam + ceftazidime	423	3.5
Fluoroquinolones + carbapenems	212	1.8
Other antimicrobial group combinations	273	2.3
Resistance to three antimicrobial groups		
Total (all three-group combinations)	**477**	**4.0**
Piperacillin-tazobactam + ceftazidime + carbapenems	163	1.4
Piperacillin-tazobactam + ceftazidime + fluoroquinolones	139	1.2
Other antimicrobial group combinations	175	1.5
Resistance to four antimicrobial groups		
Total (all four-group combinations)	**321**	**2.7**
Piperacillin-tazobactam + fluoroquinolones + ceftazidime + carbapenems	170	1.4
Other antimicrobial group combinations	151	1.3
Resistance to five antimicrobial groups		
Piperacillin-tazobactam + fluoroquinolones + ceftazidime + aminoglycosides + carbapenems	365	3.1

[a] Only isolates with complete susceptibility information for at least three antimicrobial groups among piperacillin-tazobactam, ceftazidime, carbapenems (imipenem or meropenem), fluoroquinolones (ciprofloxacin or levofloxacin) and aminoglycosides (tobramycin) were included in the analysis. This represented 58% (11 967/20 675) of all reported *P. aeruginosa* isolates.
[b] Only AMR combinations > 1% of the total are specified.
[c] Not adjusted for population differences in the reporting countries.

and *Acinetobacter* spp. bloodstream infections among all reported bloodstream infections were also those where the percentage of isolates with acquired AMR in gram-negative bacteria generally was highest *(29)*. This finding is probably attributable to shared risk factors, such as a high proportion of consumption of broad-spectrum antimicrobials *(30)*. Addressing these factors and implementing high standards of IPC in health care across these countries probably will have a positive impact. Not only will it ease the burden of infections caused by bacteria with high levels of intrinsic AMR, such as *P. aeruginosa* and *Acinetobacter* spp., but it will also reduce the burden caused by bacteria with acquired AMR.

At global level, WHO has listed carbapenem-resistant *P. aeruginosa* as a pathogen of critical priority that requires research and the development of new antibiotics *(27)*.

Acinetobacter spp.

Epidemiology

For 2020, 29 EU/EEA countries reported 7622 isolates of *Acinetobacter* spp., with four EU/EEA countries each reporting fewer than 30 isolates. Of these, 7392 (97%) isolates had AST results for fluoroquinolones, 7306 (96%) for aminoglycosides and 7542 (99%) for carbapenems (Table 7a).

Almost two thirds (65.6%) of the *Acinetobacter* spp. isolates reported by EU/EEA countries to EARS-Net for 2020 were resistant to at least one of the antimicrobial groups under surveillance (fluoroquinolones, aminoglycosides and carbapenems) (Table 11). The highest EU/EEA population-weighted mean AMR percentage in 2020 was reported for fluoroquinolones (41.8%), followed by carbapenems (38.0%) and aminoglycosides (37.1%) (Table 7a).

Between 2016 and 2020, no significant trend was detected for carbapenem, fluoroquinolone or aminoglycoside resistance respectively in the EU/EEA (excluding the United Kingdom) (Table 7b). A quite large annual increase in resistance percentage nevertheless was seen for carbapenem at EU/EEA level in 2020 (1.1%) compared with the period 2016–2019 (Table 7b).

Resistance to one or two antimicrobial groups was considerably less common than combined resistance to all three groups under surveillance (Table 11). Between 2016 and 2020, the EU/EEA (excluding the United Kingdom) population-weighted mean percentage for combined resistance to carbapenems, fluoroquinolones and aminoglycosides significantly increased from 32.3% to 34.1%. This trend did not remain statistically significant, however, when restricting the analysis to include only laboratories consistently reporting data for all five years (Table 7b).

Large intercountry variations were noted for all antimicrobial groups (Table 7a), with generally higher AMR percentages reported from southern and eastern Europe than northern Europe (see country and area profiles in Chapter 4 and Fig. 7 in Chapter 3).

Discussion

Of all the bacterial species under surveillance by EARS-Net, *Acinetobacter* spp. is the least commonly reported and the one for which the intercountry range in AMR percentages is widest. In 2020, the percentage of isolates resistant to at least one of the antimicrobial groups under surveillance (fluoroquinolones, aminoglycosides or carbapenems) ranged between 0.0% and 98.2%, depending on the reporting country. In general, the highest AMR percentages were reported from southern and eastern Europe. The high levels of AMR in these countries are of great concern since the most frequently reported AMR phenotype was combined resistance to all

Table 11 *Acinetobacter* spp.: total number of invasive isolates tested (N = 7162)[a] and AMR percentage (%) per phenotype, EU/EEA, 2020

AMR pattern[b]	Number of isolates	Percentage of total[c]
Fully susceptible (to included antimicrobial groups)	**2 461**	**34.4**
Single resistance (to indicated antimicrobial group)		
Total (any single resistance)	**238**	**3.3**
Fluoroquinolones	146	2.0
Other antimicrobial groups	92	1.3
Resistance to two antimicrobial groups		
Total (any two-group combinations)	**358**	**5.0**
Fluoroquinolones + carbapenems	242	3.4
Fluoroquinolones + aminoglycosides	103	1.4
Other antimicrobial group combinations	13	0.2
Resistance to three antimicrobial groups		
Fluoroquinolones + aminoglycosides + carbapenems	4 105	57.3

[a] Only isolates with complete susceptibility information for carbapenems (imipenem or meropenem), fluoroquinolones (ciprofloxacin or levofloxacin) and aminoglycosides (gentamicin or tobramycin) were included in the analysis. This represented 94% (7162/7622) of all reported *Acinetobacter* spp. isolates.
[b] Only AMR combinations > 1% of the total are specified.
[c] Not adjusted for population differences in the reporting countries.

three antimicrobial groups under surveillance, severely limiting options for patient treatment.

As *Acinetobacter* spp. are intrinsically resistant to many antimicrobial agents, additional acquired AMR is further complicating treatment of *Acinetobacter* spp. infections. The presence of multidrug-resistant *Acinetobacter* spp. in the health-care environment is problematic: the bacterium can persist in the environment for long periods and is notoriously difficult to eradicate once established.

ECDC's risk assessment on carbapenem-resistant *Acinetobacter baumannii* (*A. baumannii*) in health-care settings highlights the need for increased efforts to face this significant threat to patients and health-care systems in all EU/EEA countries. The document outlines options to reduce risks through clinical management, prevention of transmission in hospitals and other health-care settings, prevention of cross-border transmission and improvement in the preparedness of EU/EEA countries. Options for response presented in the risk assessment include timely laboratory reporting, screening and pre-emptive isolation of high-risk patients, good infection control and antimicrobial stewardship programmes *(31)*.

WHO has listed carbapenem-resistant *A. baumannii* as a pathogen of critical priority in its global priority list of antibiotic-resistant bacteria requiring research and the development of new antibiotics *(27)*.

S. aureus

Epidemiology

For 2020, 29 EU/EEA countries reported 73 518 isolates of *S. aureus*. Of these, 72 314 (98%) isolates had AST results or molecular confirmation test results available to determine MRSA (Table 7a).

One fifth (20.1%) of the *S. aureus* isolates reported by EU/EEA countries to EARS-Net for 2020 were resistant to at least one of the antimicrobial groups under surveillance (methicillin/MRSA, fluoroquinolones and rifampicin) (Table 12).

The EU/EEA (excluding the United Kingdom) population-weighted mean MRSA percentage was 16.7% in 2020. This denotes a significantly decreasing trend for the period 2016–2020, from 19.3% to 16.7%, a trend that remained statistically significant when restricting the analysis to include only laboratories that consistently reported data for all five years (Table 7b).

Among MRSA, combined resistance to another antimicrobial group was common. The most common AMR combination was MRSA and resistance to fluoroquinolones (Table 12).

Large intercountry variations were noted for MRSA (Table 7a), with generally higher AMR percentages reported from southern and eastern Europe than northern Europe (Fig. 8).

Discussion

In 2020, MRSA percentages were stable or decreasing in several EU/EEA countries *(6)*, and a decreasing EU/EEA (excluding the United Kingdom) population-weighted mean MRSA percentage was noted. Several countries have developed and implemented national recommendations and guidance documents on preventing the spread of MRSA, focusing on improved IPC and prudent antimicrobial use *(23)*.

Despite this positive development, MRSA remains an important pathogen in Europe. *S. aureus* is one of the most common causes of bloodstream infections, exhibiting a high burden in terms of morbidity and mortality *(7)*. Although the EU/EEA (excluding the United Kingdom)

Table 12 *S. aureus*: total number of invasive isolates tested (N = 49 773)[a] and AMR percentage (%) per phenotype, EU/EEA, 2020

AMR pattern[b]	Number of isolates	Percentage of total[c]
Fully susceptible (to included antimicrobial groups)	**39 769**	**79.9**
Single resistance (to indicated antimicrobial group)		
Total (any single resistance)	**4 272**	**8.6**
Fluoroquinolones	2 446	4.9
Methicillin/MRSA	1 605	3.2
Other antimicrobial groups	221	0.4
Resistance to two antimicrobial groups		
Total (any two-group combinations)	**5 388**	**10.8**
Methicillin/MRSA + fluoroquinolones	5 298	10.6
Other resistance combinations	90	0.2
Resistance to three antimicrobial groups		
Methicillin/MRSA + fluoroquinolones + rifampicin	344	0.7

[a] Only isolates with complete susceptibility information for MRSA, fluoroquinolones and rifampicin were included in the analysis. This represented 68% (49 773/73 518) of all reported *S. aureus* isolates. MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported; data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results. For fluoroquinolones (ciprofloxacin, levofloxacin or ofloxacin) AST results for norfloxacin are also accepted if neither ciprofloxacin, levofloxacin nor ofloxacin results are available.
[b] Only AMR combinations > 1% of the total are specified.
[c] Not adjusted for population differences in the reporting countries.

population-weighted MRSA percentage, as reported by EARS-Net, has been decreasing for many years, ECDC's study of the health burden of AMR reported an increase in estimated MRSA incidence between 2007 and 2015. Further analysis of the age-group-specific incidence as part of the ECDC study found that this mainly related to infants and people aged 55 years or above *(7)*. The difference in the development over time of the MRSA percentage and the MRSA incidence indicates a need for further study of the distribution of *S. aureus* infections in the EU/EEA to obtain a better overview of the current epidemiological situation.

Comprehensive MRSA strategies targeting all health-care sectors are essential to slow down the spread of MRSA in Europe. Monitoring of MRSA in animals and food currently is voluntary and is performed only in a limited number of countries. This monitoring nevertheless noted the detection of MRSA, mainly livestock-associated MRSA (LA-MRSA), in food and food-producing animals in 2018–2019 *(11)*. LA-MRSA has gained attention, as it poses a zoonotic risk, particularly for those working in close contact with livestock. Although data collected through EARS-Net do not allow identification of LA-MRSA isolates, an ECDC survey documented an increasing detection and geographical dispersion of LA-MRSA in humans in the EU/EEA during the period 2007–2013 and highlighted the veterinary and public health significance of LA-MRSA as a One Health issue *(32)*.

S. pneumoniae

Epidemiology

For 2020, 28 EU/EEA countries reported 8689 isolates of *S. pneumoniae*. There was a decrease of 20% or more in the number of reported isolates in 2020 compared to the previous year in all but one of the reporting countries. Such a uniform decrease was not seen for the other bacterial species under EARS-Net surveillance. The decrease compared to previous years was also reflected in the number of reported isolates with AMR phenotype in the EU/EEA (excluding the United Kingdom) (Table 7b). Of the reported isolates, 8032 (92%) had AST results for penicillins and 8362 (96%) had AST results for macrolides (Table 7a).

For this report, the term penicillin non-wild-type refers to *S. pneumoniae* isolates reported by local laboratories as susceptible, increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of the wild-type isolates (› 0.06 mg/L). The analysis was based on the qualitative susceptibility categories S/I/R, since quantitative susceptibility information was missing for a large proportion of the reported data.

More than one fifth (22.6%) of the *S. pneumoniae* isolates reported by EU/EEA countries to EARS-Net for 2020 were resistant to at least one of the antimicrobial groups under surveillance (penicillins, third-generation cephalosporins, fluoroquinolones and macrolides) (Table 13). In 2020, the EU/EEA population-weighted mean percentage was 15.6% for penicillin non-wild-type and 16.9% for macrolide resistance (Table 7a).

Between 2016 and 2020, the EU/EEA (excluding the United Kingdom) trend decreased significantly for resistance to macrolides, from 18.2% to 16.9% (Table 7b). Although no significant increase in trend was noted for penicillin non-wild-type resistance, there nevertheless was a relatively large annual increase in AMR percentage

Table 13 *S. pneumoniae*: total number of invasive isolates tested (N = 5755)[a] and percentage non-wild-type/AMR (%) per phenotype, EU/EEA, 2020

AMR pattern[b]	Number of isolates	Percentage of total[c]
Fully susceptible (to included antimicrobial groups)	**4 452**	**77.4**
Single non-wild-type/resistance (to included antimicrobial groups)		
Total (any single resistance)	**844**	**14.7**
Macrolides	411	7.1
Penicillin non-wild-type[d]	360	6.3
Fluoroquinolones	73	1.3
Non-wild-type/resistance to two antimicrobial groups		
Total (any two-group combinations)	**439**	**7.6**
Penicillin non-wild-type + macrolides	421	7.3
Other antimicrobial group combinations	18	0.3
Non-wild-type/resistance to three antimicrobial groups		
Total (any three-group combinations)	**19**	**0.3**
Other antimicrobial group combinations	19	0.3
Non-wild-type/resistance to four antimicrobial groups		
Penicillin non-wild-type + third-generation cephalosporins + fluoroquinolones + macrolides	1	‹ 0.1

[a] Only isolates with complete susceptibility information for penicillins (based on penicillin or, if not available, oxacillin), third-generation cephalosporins (cefotaxime or ceftriaxone) and fluoroquinolones (levofloxacin or moxifloxacin – AST results for norfloxacin are also accepted if neither levofloxacin nor moxifloxacin results are available) and macrolides (azithromycin, clarithromycin or erythromycin) were included in the analysis. This represented 66% (5755/8689) of all reported *S. pneumoniae* isolates.
[b] Only AMR combinations › 1% of the total are specified.
[c] Not adjusted for population differences in the reporting countries.
[d] For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by local laboratories as susceptible, increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (› 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data.

at EU/EEA level in 2020 (2.4%) compared with the period 2016–2019 (Table 7b).

The EU/EEA (excluding the United Kingdom) population-weighted mean percentage for combined penicillin non-wild-type and resistance to macrolides was 9.0% in 2020 and decreased significantly during the period 2016 to 2020 (Table 7b). Resistance to antimicrobial groups other than penicillin and macrolides was less common (Table 13).

Large intercountry variations were noted for all antimicrobial groups (Table 7a, Fig. 9), with generally higher macrolide resistance percentages reported from southern and eastern Europe than northern Europe.

Discussion

The population-weighted EU/EEA (excluding the United Kingdom) mean percentages for penicillin non-wild-type and macrolide resistance did not uniformly decrease between 2016 and 2020. As in previous years, there were large intercountry variations. Differences in the clinical breakpoints used historically to determine penicillin susceptibility in *S. pneumoniae* (based on the guidelines used and the sites of infection) could introduce bias when comparing national data reported to EARS-Net before 2020. Limited information on the guidelines and breakpoints used for interpretation and incomplete quantitative susceptibility data hamper assessment of intercountry differences to some extent and may also thwart the assessment of changes over time.

In parallel with EARS-Net, invasive pneumococcal disease is also under separate surveillance, coordinated by ECDC. This surveillance collects additional data on invasive pneumococcal disease cases throughout the EU/EEA on, for example, outcome *(33)*. Data from this surveillance show that the percentage of resistance to penicillin was 2% and to erythromycin 18%, based on reporting of antimicrobial susceptibility data by 10 countries in 2018 *(33)*. It is, however, difficult to compare data from the two surveillance systems due to differences in, for instance, the number of reporting countries.

Most EU/EEA countries have implemented routine immunization for children with multivalent pneumococcal conjugated vaccines (PCVs). In some countries, high-risk adult groups, such as elderly people and immunocompromised individuals, are also targeted with the polysaccharide vaccine or with PCVs *(34)*. Changes in immunization and serotype coverage of the available PCVs will probably have an impact on the epidemiology of *S. pneumoniae* in the EU/EEA, both in terms of changes in the age-specific incidence and potential serotype replacement. It is also conceivable that the ongoing COVID-19 pandemic and related public health interventions may additionally affect *S. pneumoniae* epidemiology in the EU/EEA.

E. faecalis

Epidemiology

For 2020, 29 EU/EEA countries reported 28 163 isolates of *E. faecalis* – 14 279 (51%) with AST results for high-level gentamicin (Table 7a).

In 2020, the EU/EEA (excluding the United Kingdom) population-weighted mean percentage of high-level gentamicin resistance in *E. faecalis* was 29.0%, which represents a significant decrease from 2016, when the percentage was 31.8% (Table 7b). There nevertheless was a quite large annual increase in AMR percentage at EU/EEA level in 2020 (3.7%) for high-level gentamicin resistance compared with the period 2016–2019 (Table 7b).

Large intercountry variations were noted for high-level gentamicin resistance in *E. faecalis* (Table 7a), with generally higher AMR percentages reported from southern and eastern Europe than northern Europe, with a few exceptions (see country and area profiles in chapter 4). More information is provided in ECDC's Surveillance Atlas of Infectious Diseases *(5)*.

Discussion

Despite the decreasing trend in high-level gentamicin resistance in *E. faecalis* noted by EARS-Net, high levels of antimicrobial-resistant enterococci remain a major infection-control challenge and an important cause of health-care-associated infections in Europe. In addition to the fact that infections caused by resistant strains are difficult to treat, enterococci are also easily disseminated in health-care settings.

E. faecium

Epidemiology

For 2020, 29 EU/EEA countries reported 18 548 isolates of *E. faecium* – 18 151 (98%) with AST results for vancomycin (Table 7a).

More than nine tenths (92.0%) of the *E. faecium* isolates reported by EU/EEA countries to EARS-Net for 2020 were resistant to at least one of the antimicrobial groups under surveillance (aminopenicillins, gentamicin (high-level resistance) and vancomycin) (Table 14).

AMR to two or more antimicrobial groups was common, being seen in 52.4% of all tested isolates (Table 14).

The EU/EEA (excluding the United Kingdom) population-weighted mean percentage of vancomycin resistance in *E. faecium* was 16.8% in 2020, representing a significant increase since 2016 when the percentage was 11.6%. National percentages ranged from 0.0% to 56.6% (Table 7a) and only 11 of the 29 EU/EEA countries reported AMR percentages below 5% (Fig. 10).

Table 14 ***E. faecium*: total number of invasive isolates tested (N = 9354)[a] and AMR percentage (%) per phenotype, EU/EEA, 2020**

AMR pattern[b]	Number of isolates	Percentage of total[c]
Fully susceptible (to included antimicrobial groups)	**745**	**8.0**
Single resistance (to indicated antimicrobial group)		
Total (any single resistance)	**3 710**	**39.7**
Aminopenicillins	3 656	39.1
Other antimicrobial groups	54	0.6
Resistance to two antimicrobial groups		
Total (any two-group combinations)	**3 987**	**42.6**
Aminopenicillins + gentamicin (high-level resistance)	3 209	34.3
Aminopenicillins + vancomycin	774	8.3
Other resistance combinations	4	< 0.1
Resistance to three antimicrobial groups		
Aminopenicillins + gentamicin (high-level resistance) + vancomycin	912	9.7

[a] Only isolates with complete susceptibility information for aminopenicillins (ampicillin or amoxicillin), gentamicin (high-level resistance) and vancomycin were included in the analysis. This represented 50% (9354/18 548) of all reported *E. faecium* isolates.
[b] Only AMR combinations > 1% of the total are specified.
[c] Not adjusted for population differences in the reporting countries.

Discussion

The rapid and continuous increase in the percentage of vancomycin resistance in *E. faecium* in the EU/EEA is a cause for concern. ECDC's study of the health burden of AMR estimated that the median number of infections and deaths attributable to vancomycin-resistant enterococci almost doubled between 2007 and 2015 *(7)*, and the increase in resistance percentages reported since 2016 contributes to a further increase in the health burden of vancomycin-resistant enterococci infections. The significantly increasing trend, observed at EU/EEA (excluding the United Kingdom) level and in several individual countries, highlights the urgent need for close monitoring to better understand the epidemiology, clonal diversity and risk factors associated with vancomycin-resistant *E. faecium* infection. Contrary to many other bacterial species–antimicrobial group combinations under surveillance by EARS-Net, no distinct geographical pattern could be seen for vancomycin-resistant *E. faecium*, with high AMR levels reported from countries in southern, eastern and western Europe.

Enterococci have intrinsic resistance to several antimicrobial classes, and any additional acquired AMR severely limits the number of treatment options. WHO has listed vancomycin-resistant *E. faecium* as a pathogen of high priority in its global priority list of antibiotic-resistant bacteria, emphasizing the paucity of available and effective treatment options *(27)*. High levels of antimicrobial-resistant enterococci remain a major infection control challenge and an important cause of health-care-associated infections in Europe. In addition to the fact that infections caused by resistant strains are difficult to treat, enterococci are also easily disseminated in health-care settings.

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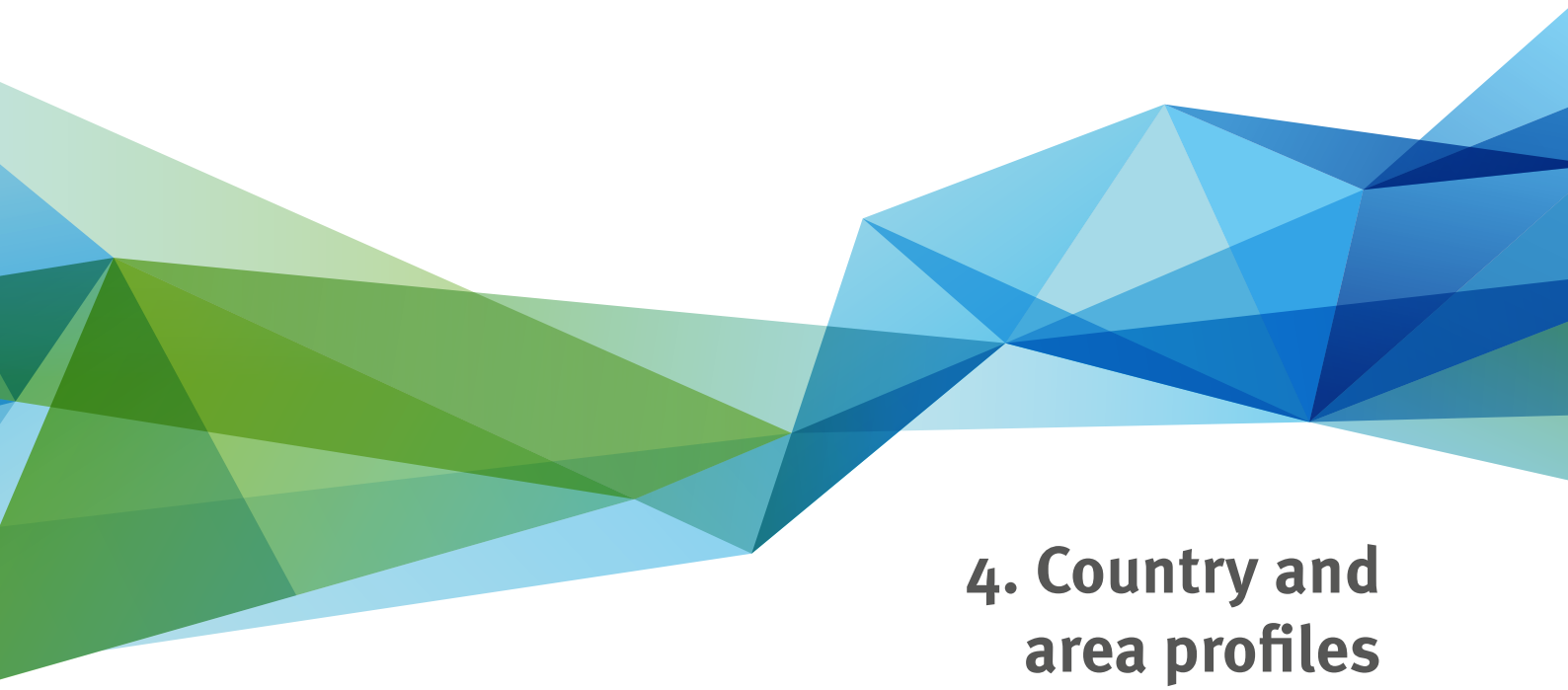


4. Country and area profiles

Austria

Participating institutions

Federal Ministry of Health and Women's Affairs
Medical University Vienna
Ordensklinikum Linz, Elisabethinen

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Austria, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	90	Unknown	Unknown	Unknown	Unknown
Geographical representativeness	High	Unknown	High	High	High
Hospital representativeness	Unknown	Unknown	High	High	High
Patient and isolate representativeness	Unknown	Unknown	High	High	High
Blood-culture sets/1 000 patient days	16.2	Unknown	24.2	Unknown	Unknown

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Austria, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	100	100	97	95	NA

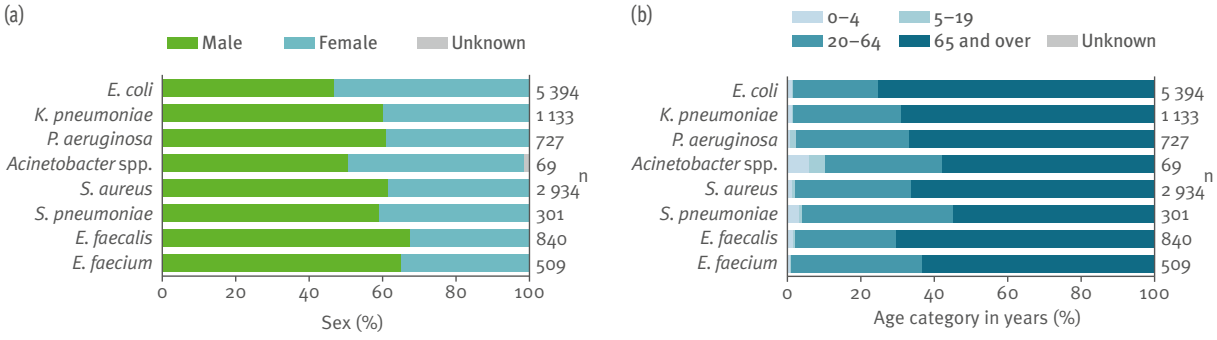
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Austria, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	39	5 285	9	39	5 381	9	38	5 686	9	38	6 305	8	37	5 394	8
K. pneumoniae	38	1 247	14	39	1 152	14	38	1 228	14	38	1 333	14	36	1 133	17
P. aeruginosa	39	697	17	39	725	16	38	737	16	38	808	13	36	727	18
Acinetobacter spp.	24	81	17	25	75	11	28	95	12	23	82	13	22	69	12
S. aureus	39	3 057	14	39	3 162	14	38	3 310	13	38	3 419	12	36	2 934	14
S. pneumoniae	39	457	24	39	513	19	38	567	18	37	550	18	34	301	10
E. faecalis	38	677	17	38	769	19	38	837	17	37	792	16	35	840	21
E. faecium	38	535	28	38	573	31	35	524	28	34	537	33	32	509	30

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Austria, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Austria, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	5 094	50.5	5 188	49.5	5 456	50.7	6 042	46.3	4 798	46.0	54.6 (34.1–67.5)	↓
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	5 267	10.0	5 129	9.6	5 672	10.2	6 106	9.3	5 376	9.5	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	5 134	0.0	5 227	0.0	5 564	0.1	5 935	0.0	5 141	0.1	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	5 278	19.8	5 367	20.5	5 679	21.9	6 111	18.2	5 373	17.3	23.8 (10.0–48.2)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	5 248	7.8	5 318	7.7	5 616	8.2	6 102	6.9	5 219	6.2	10.9 (5.5–34.2)	↓
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	5 235	3.5	5 071	3.3	5 598	3.6	6 072	2.7	5 192	2.8	5.7 (1.6–18.7)	↓
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	1 245	9.6	1 072	8.6	1 221	8.4	1 326	10.3	1 124	7.8	33.9 (0.0–79.1)	–
	Carbapenem (imipenem/meropenem) resistance	1 198	0.7	1 109	1.0	1 184	1.0	1 296	1.2	1 055	0.9	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	1 246	9.8	1 147	14.2	1 221	13.2	1 327	15.7	1 129	12.0	33.8 (0.0–74.4)	↑
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	1 157	4.8	1 141	4.8	1 214	4.8	1 319	5.5	1 085	3.7	23.7 (0.0–67.0)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	1 156	3.5	1 062	3.0	1 203	3.1	1 312	3.0	1 076	2.8	21.0 (0.0–58.3)	–
P. aeruginosa	Piperacillin-tazobactam resistance	674	11.4	628	10.4	650	10.6	665	9.5	624	9.0	18.8 (4.4–64.3)	–
	Ceftazidime resistance	628	11.3	620	8.7	729	10.3	781	8.5	688	9.4	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	696	12.9	725	13.9	736	12.8	786	13.4	683	15.1	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	694	7.2	721	12.3	736	14.0	805	10.7	676	14.3	19.6 (3.2–52.9)	↑
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	692	6.1	717	5.0	729	6.3	784	3.8	426	2.6	9.4 (0.0–37.1)	↓
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	697	6.5	724	6.1	736	6.7	787	5.5	709	4.9	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	81	12.3	75	6.7	91	4.4	81	7.4	69	7.2	38.0 (0.0–96.4)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	81	16.0	74	9.5	91	7.7	82	9.8	69	10.1	41.8 (0.0–98.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	81	16.0	75	9.3	92	8.7	82	7.3	66	7.6	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	81	8.6	74	6.8	88	4.5	81	6.2	66	6.1	34.1 (0.0–95.1)	–
S. aureus	MRSA[e]	3 053	7.2	3 158	6.0	3 307	6.4	3 323	5.2	2 843	4.4	16.7 (1.4–49.1)	↓
S. pneumoniae	Penicillin non-wild-type[f]	440	3.4	463	6.0	523	6.3	458	6.8	258	3.9	15.6 (3.9–56.3)	–
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	455	8.6	507	10.8	562	11.6	547	12.4	295	11.5	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	438	1.4	457	3.3	519	3.3	455	3.5	252	2.4	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	447	33.3	474	33.1	417	28.3	285	22.8	258	14.3	29.0 (4.1–51.6)	↓
E. faecium	Vancomycin resistance	533	4.3	570	3.2	524	2.1	537	3.2	507	3.6	16.8 (0.0–56.6)	–

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Belarus

Participating institution

Laboratory for Clinical and Experimental Microbiology, Republican Research and Practical Center for Epidemiology and Microbiology

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Belarus, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated population coverage (%)	80	› 90	› 90	› 90	99
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	Poor	Poor	Poor	Poor	Poor
Blood-culture sets/1 000 patient days[a]	Unknown	Unknown	Unknown	Unknown	6 (2–97)

Definitions provided on page 7.
[a] Data are presented as median (range).

Laboratories contributing data: use of clinical breakpoint guidelines and participation in CAESAR EQA, Belarus, 2016–2020

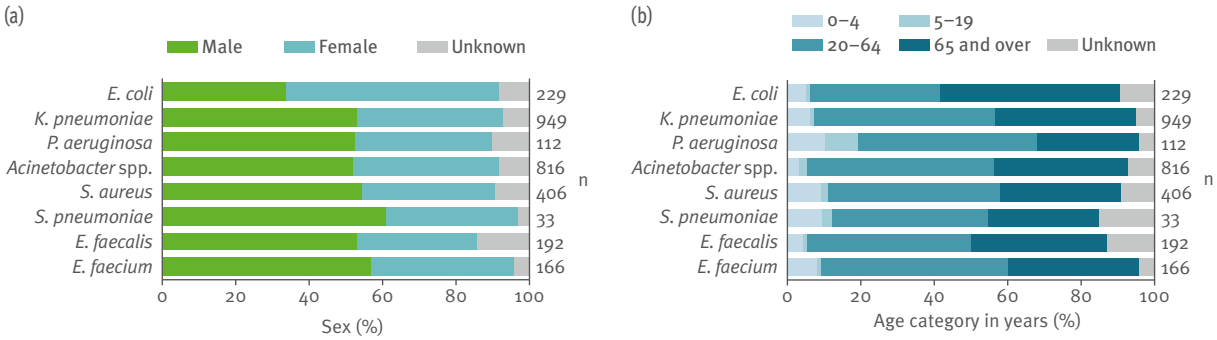
Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	Unknown	Unknown	25	25	25
Percentage of laboratories participating in CAESAR EQA	30	25	29	14	13

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Belarus, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	20	113	48	29	154	58	23	145	57	23	146	43	38	229	53
K. pneumoniae	22	327	50	29	494	59	27	589	64	35	575	61	39	949	66
P. aeruginosa	15	84	68	20	97	70	13	74	66	20	55	73	24	112	55
Acinetobacter spp.	20	336	59	24	359	63	23	406	64	27	359	74	39	816	72
S. aureus	28	352	49	35	329	43	30	365	46	38	353	43	43	406	42
S. pneumoniae	9	24	42	12	31	77	11	37	59	13	33	64	11	33	55
E. faecalis	20	120	44	21	145	48	16	116	48	18	112	42	24	192	53
E. faecium	15	82	51	18	98	58	13	112	59	20	81	52	20	166	67

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories may be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Belarus, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, Belarus, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020	
		n	%	n	%	n	%	n	%	n	%
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	66	75.8	71	70.4	39	69.2	89	65.2	132	74.2
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	109	61.5	150	48.0	137	52.6	135	43.0	216	50.5
	Carbapenem (imipenem/meropenem) resistance	106	12.3	150	8.7	136	2.9	137	4.4	218	5.0
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	106	47.2	145	44.8	140	45.0	139	41.7	219	45.2
	Aminoglycoside (gentamicin/tobramycin) resistance	81	30.9	81	25.9	56	30.4	109	12.8	165	23.0
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	78	21.8	79	24.1	55	21.8	101	8.9	159	14.5
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	315	86.7	474	86.9	535	86.5	535	87.3	864	91.2
	Carbapenem (imipenem/meropenem) resistance	321	65.1	464	72.6	563	76.4	548	75.9	930	85.1
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	315	81.6	471	84.5	568	85.0	531	87.4	887	89.7
	Aminoglycoside (gentamicin/tobramycin) resistance	275	78.2	286	76.2	184	74.5	357	70.6	572	73.1
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	264	76.9	266	74.4	168	72.0	322	71.7	534	72.1
P. aeruginosa	Piperacillin-tazobactam resistance	40	75.0	50	44.0	20	50.0[a]	24	45.8[a]	50	66.0
	Ceftazidime resistance	66	80.3	75	65.3	49	65.3	43	62.8	69	59.4
	Carbapenem (imipenem/meropenem) resistance	79	75.9	93	78.5	69	68.1	52	82.7	107	74.8
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	75	86.7	94	75.5	72	68.1	46	80.4	99	73.7
	Aminoglycoside (gentamicin/tobramycin) resistance[b]	45	86.7	53	62.3	29	65.5[a]	31	67.7	46	69.6
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[b]	23	82.6[a]	29	48.3[a]	14	50.0[a]	17	52.9[a]	34	73.5
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	330	79.1	349	87.4	393	93.6	346	93.4	798	94.0
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	317	89.9	348	94.3	396	93.2	345	95.1	746	96.4
	Aminoglycoside (gentamicin/tobramycin) resistance	260	67.7	206	73.3	141	68.8	181	68.5	479	84.8
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides	252	57.1	196	61.7	130	68.5	166	66.3	438	83.8
S. aureus	MRSA[c]	320	40.9	299	40.8	331	37.5	305	36.4	354	34.5
S. pneumoniae	Penicillin non-wild-type[d]	13	38.5[a]	17	29.4[a]	23	17.4[a]	16	37.5[a]	29	31.0[a]
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	21	42.9[a]	27	22.2[a]	34	26.5	25	32.0[a]	29	41.4[a]
	Combined penicillin non-wild-type and resistance to macrolides[d]	13	38.5[a]	17	17.6[a]	22	13.6[a]	13	15.4[a]	28	25.0[a]
E. faecalis	High-level gentamicin resistance	50	56.0	113	66.4	73	65.8	87	66.7	157	68.2
E. faecium	Vancomycin resistance	76	15.8	96	16.7	110	17.3	77	22.1	160	20.0

[a] A small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.
[b] The aminoglycoside group includes only tobramycin from 2020 onwards.
[c] MRSA is calculated as resistance to cefoxitin or, if not available, oxacillin.
[d] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints might define the cut-off values for the susceptibility categories differently.

Belgium

Participating institution

Sciensano

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Belgium, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	29	30	–	–	–
Laboratories collecting *S. pneumoniae*	–	–	86	87	91
Laboratories collecting others species	–	–	30	26	36
Geographical representativeness	High	High	–	–	–
Laboratories collecting *S. pneumoniae*	–	–	High	High	High
Laboratories collecting others species	–	–	Medium	Medium	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	High	High	High	High	High
Blood-culture sets/1 000 patient days	Unknown	Unknown	99.1[a]	87.5[a]	129.6[a]

Definitions provided on page 7.
[a] Not including *S. pneumoniae* network.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Belgium, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	65	68	91	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	100	90	82	91	NA

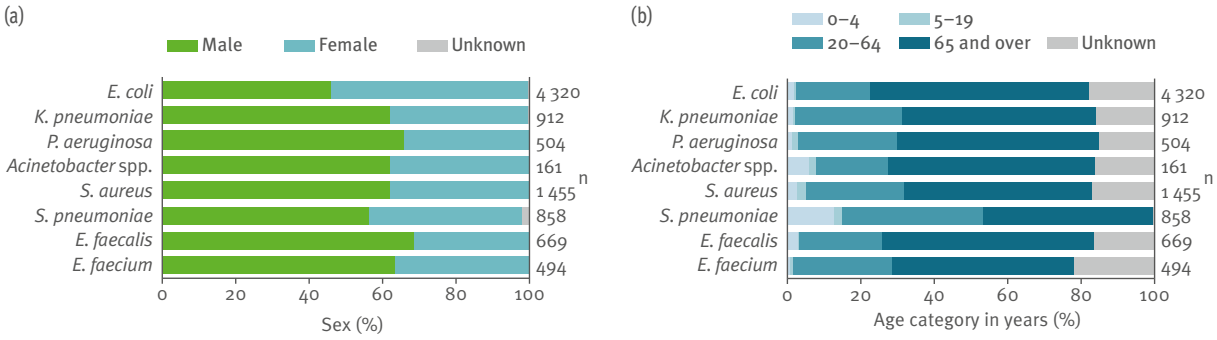
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Belgium, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	31	3 856	Unknown	32	4 676	Unknown	32	4 675	Unknown	27	3 940	Unknown	28	4 320	Unknown
K. pneumoniae	28	669	Unknown	31	803	Unknown	31	956	Unknown	26	759	Unknown	27	912	Unknown
P. aeruginosa	31	366	Unknown	31	474	Unknown	30	490	Unknown	27	441	Unknown	28	504	Unknown
Acinetobacter spp.	18	79	Unknown	21	131	Unknown	26	134	Unknown	23	94	Unknown	23	161	Unknown
S. aureus	31	1 368	Unknown	31	1 531	Unknown	31	1 750	Unknown	27	1 169	Unknown	28	1 455	Unknown
S. pneumoniae	97	1 327	Unknown	91	1 472	23	88	1 526	Unknown	89	1 548	Unknown	89	858	27
E. faecalis	30	465	Unknown	31	551	Unknown	31	615	Unknown	26	496	Unknown	29	669	Unknown
E. faecium	27	289	Unknown	30	418	Unknown	30	441	Unknown	25	343	Unknown	26	494	Unknown

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Belgium, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Belgium, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	3 736	58.0	4 669	57.5	4 445	55.8	3 601	56.5	4 009	56.5	54.6 (34.1–67.5)	–
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	3 737	10.5	4 672	9.7	4 644	9.0	3 937	10.0	4 320	9.9	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	3 845	0.1	4 672	0.0	4 641	0.1	3 926	0.1	4 126	0.0	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	3 854	24.5	4 382	23.8	4 211	21.8	3 925	19.1	4 320	18.1	23.8 (10.0–48.2)	⇩
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	3 499	8.4	3 769	8.1	3 822	7.4	3 922	6.9	4 312	7.5	10.9 (5.5–34.2)	⇩
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	3 496	3.8	3 765	3.5	3 809	3.1	3 920	3.0	4 312	2.9	5.7 (1.6–18.7)	⇩
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	669	22.9	803	19.3	935	21.4	759	19.5	912	19.7	33.9 (0.0–79.1)	–
	Carbapenem (imipenem/meropenem) resistance	669	2.4	791	1.1	935	1.4	757	1.1	881	1.1	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	669	23.6	803	23.7	932	22.6	757	19.8	911	22.8	33.8 (0.0–74.4)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	637	13.8	633	12.5	747	12.4	755	11.4	910	13.1	23.7 (0.0–67.0)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	637	9.3	633	8.5	742	9.8	755	8.7	909	10.3	21.0 (0.0–58.3)	–
P. aeruginosa	Piperacillin-tazobactam resistance	318	9.7	438	10.5	430	10.0	439	12.1	503	11.1	18.8 (4.4–64.3)	–
	Ceftazidime resistance	320	7.8	431	7.2	441	7.5	427	8.2	489	9.0	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	365	9.6	474	8.2	487	7.4	440	10.7	474	12.4	17.8 (3.6–48.9)	⇧#
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	366	14.5	430	10.5	451	14.0	440	14.3	503	14.7	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	327	11.0	377	7.7	406	8.4	438	7.1	304	6.3	9.4 (0.0–37.1)	⇩
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	366	6.3	439	6.6	454	5.3	440	5.9	503	6.6	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	78	2.6	131	6.9	132	3.8	94	0.0	160	1.3	38.0 (0.0–96.4)	⇩
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	78	7.7	130	10.8	134	12.7	93	8.6	141	15.6	41.8 (0.0–98.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	66	1.5	99	13.1	122	7.4	85	3.5	148	2.7	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	64	0.0	98	7.1	120	3.3	84	0.0	127	0.8	34.1 (0.0–95.1)	–
S. aureus	MRSA[e]	1 364	12.2	1511	8.5	1 735	9.1	1 168	6.7	1 455	6.9	16.7 (1.4–49.1)	⇩
S. pneumoniae	Penicillin non-wild-type[f]	1 327	0.4	1 472	0.2	1 526	0.1	1 548	9.7	858	14.5	15.6 (3.9–56.3)	⇧
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	1 327	15.7	1 472	15.1	1 526	15.2	1 548	15.7	858	19.1	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	1 327	0.3	1 472	0.1	1 526	0.1	1 548	5.7	858	8.7	9.0 (0.0–37.5)	⇧
E. faecalis	High-level gentamicin resistance	328	19.8	304	16.4	390	12.3	363	16.8	296	13.2	29.0 (4.1–51.6)	⇩#
E. faecium	Vancomycin resistance	289	1.7	417	5.5	436	1.8	343	0.6	491	2.9	16.8 (0.0–56.6)	–

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ⇧ and ⇩ indicate statistically significantly increasing and decreasing trends, respectively; # indicates a significant trend in the overall data, but not in data that only included laboratories reporting continuously for all five years; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Bosnia and Herzegovina

Participating institutions

Clinical Microbiology Department, Clinical Center University of Sarajevo
Department of Microbiology, Department of Clinical Microbiology/University Clinical Centre of Republika Srpska

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Bosnia and Herzegovina, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated population coverage (%)	77	77	77	77	77
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	Medium	Medium	Medium	Medium	Medium
Blood-culture sets/1 000 patient days[a]	7 (2–20)	9 (3–19)	7 (3–24)	8 (3–30)	9 (4–52)

Definitions provided on page 7.
[a] Data are presented as median (range).

Laboratories contributing data: use of clinical breakpoint guidelines and participation in CAESAR EQA, Bosnia and Herzegovina, 2016–2020

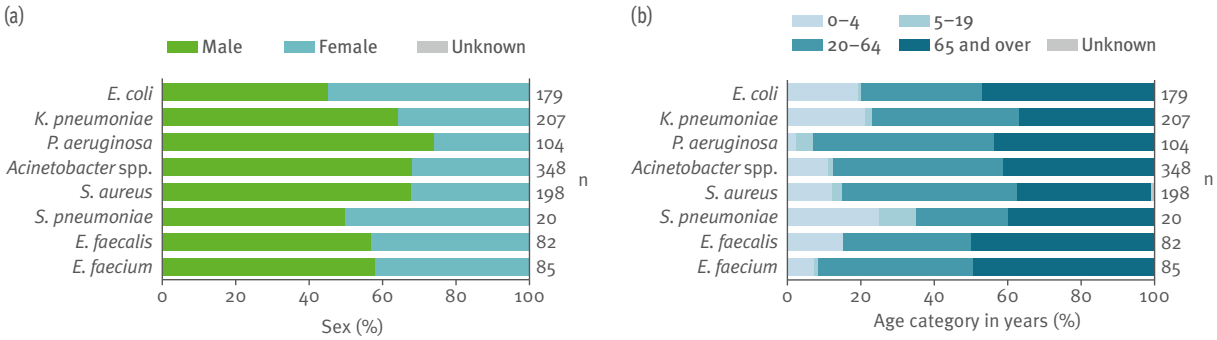
Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	67	92	92
Percentage of laboratories participating in CAESAR EQA	100	100	83	92	92

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Bosnia and Herzegovina, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	7	219	12	9	194	5	10	250	9	10	291	9	10	179	20
K. pneumoniae	6	154	20	8	150	20	11	207	34	11	211	34	10	207	48
P. aeruginosa	7	61	31	7	57	19	9	79	28	7	81	30	10	104	52
Acinetobacter spp.	6	157	66	6	122	48	8	141	61	8	229	64	10	348	69
S. aureus	7	180	21	9	156	19	11	228	15	9	237	15	11	198	27
S. pneumoniae	4	22	14	6	33	6	9	42	19	6	44	5	4	20	25
E. faecalis	4	58	19	7	70	20	9	93	22	8	81	21	8	82	24
E. faecium	5	37	51	5	40	50	6	48	33	7	65	61	9	85	53

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories may be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Bosnia and Herzegovina, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, Bosnia and Herzegovina, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020	
		n	%	n	%	n	%	n	%	n	%
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	212	70.8	158	73.4	250	68.8	290	71.4	179	66.5
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	219	22.8	194	24.7	250	20.0	290	20.7	179	24.0
	Carbapenem (imipenem/meropenem) resistance	191	0.0	183	1.1	249	0.0	290	0.0	179	0.0
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	214	28.0	188	26.6	248	24.2	289	29.8	179	19.6
	Aminoglycoside (gentamicin/tobramycin) resistance	207	22.7	189	24.9	250	17.2	290	20.3	179	31.3
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	204	12.7	186	13.4	248	10.5	289	9.7	179	12.8
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	154	70.1	150	60.7	207	70.5	211	79.6	207	75.8
	Carbapenem (imipenem/meropenem) resistance	150	8.0	145	11.0	207	18.4	211	41.7	207	43.5
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	149	56.4	145	54.5	207	59.4	210	67.6	207	61.4
	Aminoglycoside (gentamicin/tobramycin) resistance	148	72.3	148	63.5	207	68.6	211	78.7	207	72.0
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	147	52.4	143	43.4	207	54.6	210	63.3	207	55.1
P. aeruginosa	Piperacillin-tazobactam resistance	55	21.8	57	22.8	79	24.1	77	14.3	104	28.8
	Ceftazidime resistance	44	20.5	57	19.3	79	30.4	81	34.6	104	30.8
	Carbapenem (imipenem/meropenem) resistance	61	23.0	57	22.8	79	30.4	81	46.9	104	52.9
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	58	39.7	57	45.6	79	43.0	81	56.8	104	42.3
	Aminoglycoside (gentamicin/tobramycin) resistance[a]	59	52.5	57	43.9	79	40.5	81	48.1	101	27.7
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[a]	37	21.6	57	33.3	79	32.9	77	42.9	101	30.7
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	157	90.4	122	95.1	141	92.9	229	96.5	348	97.7
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	157	94.9	121	95.9	141	99.3	229	97.8	348	98.6
	Aminoglycoside (gentamicin/tobramycin) resistance	156	95.5	122	95.1	141	98.6	229	96.5	348	94.8
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides	156	86.5	121	93.4	141	92.9	229	93.4	348	94.3
S. aureus	MRSA[b]	180	13.3	156	26.3	228	16.2	237	10.5	198	19.2
S. pneumoniae	Penicillin non-wild-type[c]	22	27.3[d]	33	42.4	42	52.4	44	34.1	20	30.0[d]
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	21	23.8[d]	30	36.7	42	35.7	44	34.1	20	55.0[d]
	Combined penicillin non-wild-type and resistance to macrolides[c]	21	14.3[d]	30	33.3	42	28.6	44	25.0	20	25.0[d]
E. faecalis	High-level gentamicin resistance	57	57.9	69	59.4	92	37.0	81	70.4	82	72.0
E. faecium	Vancomycin resistance	37	21.6	40	35.0	48	37.5	65	38.5	85	52.9

[a] The aminoglycoside group includes only tobramycin from 2020 onwards.
[b] MRSA is calculated as resistance to cefoxitin or, if not available, oxacillin.
[c] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (› 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints might define the cut-off values for the susceptibility categories differently.
[d] A small number of isolates were tested (n ‹ 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.

Bulgaria

Participating institution

National Center of Infectious and Parasitic Diseases

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Bulgaria, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	30	30	46	45	45
Geographical representativeness	Medium	Medium	Medium	Medium	Medium
Hospital representativeness	Poor	Poor	Poor	Medium	Medium
Patient and isolate representativeness	High	High	Medium	Medium	Medium
Blood-culture sets/1 000 patient days	7.2	8.3	8.5	8.6	10.4

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Bulgaria, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	95	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	91	95	100	100	NA

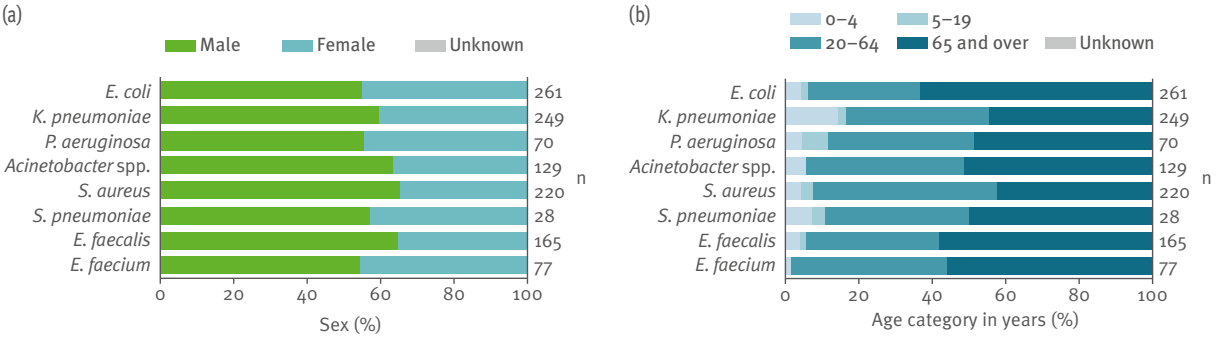
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Bulgaria, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	20	241	15	20	247	20	22	292	22	23	352	23	23	261	19
K. pneumoniae	17	161	41	18	169	41	21	193	47	20	267	53	19	249	48
P. aeruginosa	12	56	41	16	71	28	18	90	36	16	107	40	17	70	51
Acinetobacter spp.	15	106	52	15	92	64	19	110	66	15	132	60	14	129	60
S. aureus	18	231	22	18	227	25	22	313	29	23	324	23	23	220	22
S. pneumoniae	13	33	18	12	29	38	14	42	17	14	46	35	9	28	21
E. faecalis	17	114	26	17	133	28	20	150	34	20	150	35	19	165	41
E. faecium	12	45	53	17	84	42	20	91	49	17	99	31	16	77	57

Labs: laboratories.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Bulgaria, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Bulgaria, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	186	78.0	203	73.9	287	66.6	352	63.4	261	66.7	54.6 (34.1–67.5)	↓
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	238	41.6	247	41.3	292	38.7	352	38.6	261	41.4	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	224	0.9	247	0.0	292	1.4	352	0.0	261	0.8	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	237	42.2	247	42.1	292	41.8	352	38.6	261	42.9	23.8 (10.0–48.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	210	34.8	229	36.2	275	28.4	352	24.4	219	34.2	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	204	22.1	229	24.9	275	19.6	352	19.0	219	18.7	5.7 (1.6–18.7)	–
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	160	72.5	169	76.3	193	77.7	267	75.7	249	79.1	33.9 (0.0–79.1)	–
	Carbapenem (imipenem/meropenem) resistance	159	4.4	169	12.4	193	21.2	267	27.0	249	28.1	10.0 (0.0–66.3)	↑
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	160	55.6	169	59.8	193	62.7	267	60.7	249	67.1	33.8 (0.0–74.4)	↑
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	135	64.4	168	63.1	191	59.2	267	57.3	230	67.0	23.7 (0.0–67.0)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	133	45.9	168	50.0	191	47.6	267	44.9	230	57.4	21.0 (0.0–58.3)	–
P. aeruginosa	Piperacillin-tazobactam resistance	55	40.0	69	33.3	89	32.6	107	31.8	70	64.3	18.8 (4.4–64.3)	↑
	Ceftazidime resistance	54	38.9	71	38.0	90	20.0	107	30.8	70	54.3	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	56	30.4	71	25.4	90	25.6	107	25.2	70	42.9	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	56	35.7	71	28.2	90	30.0	107	29.9	70	52.9	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	39	48.7	71	28.2	90	24.4	107	31.8	50	32.0	9.4 (0.0–37.1)	–
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	56	35.7	71	26.8	90	25.6	107	30.8	70	47.1	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	103	74.8	92	80.4	110	74.5	132	72.0	129	82.9	38.0 (0.0–96.4)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	106	67.9	92	95.7	110	78.2	132	74.2	129	82.9	41.8 (0.0–98.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	79	81.0	92	89.1	110	73.6	132	78.0	129	76.0	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	76	72.4	92	78.3	110	66.4	132	69.7	129	72.9	34.1 (0.0–95.1)	–
S. aureus	MRSA[e]	231	14.3	227	13.7	313	17.6	324	14.8	220	11.8	16.7 (1.4–49.1)	–
S. pneumoniae	Penicillin non-wild-type[f]	33	27.3	29	27.6	42	9.5	46	8.7	28	7.1	15.6 (3.9–56.3)	↓
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	32	21.9	29	27.6	42	16.7	46	30.4	28	10.7	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	32	9.4	29	17.2	42	2.4	46	8.7	28	3.6	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	98	46.9	133	43.6	150	39.3	150	37.3	165	47.9	29.0 (4.1–51.6)	–
E. faecium	Vancomycin resistance	44	18.2	84	19.0	91	9.9	99	12.1	77	7.8	16.8 (0.0–56.6)	↓

Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).

[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; – indicates no statistically significant trend.

[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.

[d] The aminoglycoside group includes only tobramycin from 2020 onwards.

[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.

[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Croatia

Participating institutions

Reference Center for Antimicrobial Resistance Surveillance
Ministry of Health Zagreb University Hospital for Infectious Diseases "Dr Fran Mihaljević"

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Croatia, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	78	80	80	Unknown	80
Geographical representativeness	High	High	High	Unknown	High
Hospital representativeness	Unknown	Unknown	High	Unknown	High
Patient and isolate representativeness	Unknown	Unknown	High	Unknown	High
Blood-culture sets/1 000 patient days	Unknown	Unknown	Unknown	Unknown	109

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Croatia, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	94	94	100	100	NA

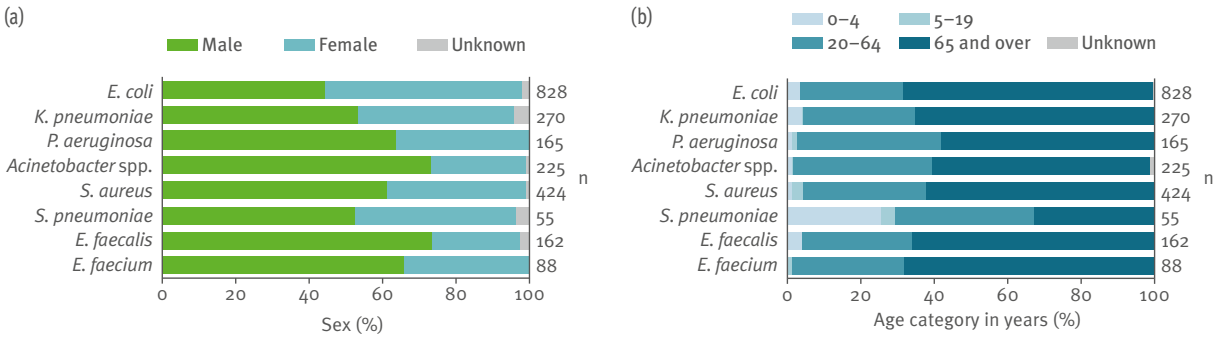
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Croatia, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	18	1 045	6	19	1 160	6	19	1 216	5	19	1 123	8	19	828	7
K. pneumoniae	17	323	19	19	313	18	19	332	14	17	328	14	16	270	20
P. aeruginosa	16	260	23	17	238	17	17	200	16	15	185	15	18	165	32
Acinetobacter spp.	14	182	41	17	208	42	14	155	26	16	143	31	14	225	73
S. aureus	18	458	12	18	520	16	18	458	11	15	360	11	19	424	16
S. pneumoniae	17	155	22	16	130	13	17	146	9	16	156	20	12	55	17
E. faecalis	15	179	12	17	171	11	16	145	12	14	127	16	16	162	23
E. faecium	15	104	17	12	89	12	11	71	13	11	74	19	16	88	28

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Croatia, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Croatia, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	1 043	57.3	1 135	58.8	1 214	57.7	1 108	57.1	827	57.7	54.6 (34.1–67.5)	–
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	1 045	14.7	1 148	16.5	1 168	14.8	1 085	15.9	827	16.6	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	1 045	0.0	1 132	0.0	1 190	0.0	1 090	0.2	820	0.0	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	1 041	27.9	1 150	28.2	1 199	30.0	1 108	27.3	826	29.7	23.8 (10.0–48.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	1 027	15.7	1 154	16.6	1 210	14.9	1 112	14.8	828	14.9	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	1 023	9.4	1 133	9.4	1 150	9.2	1 064	9.2	825	8.7	5.7 (1.6–18.7)	–
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	321	48.6	309	41.7	318	44.3	317	53.0	270	52.2	33.9 (0.0–79.1)	⇡
	Carbapenem (imipenem/meropenem) resistance	323	0.0	302	0.0	325	2.2	325	12.0	267	19.1	10.0 (0.0–66.3)	⇡
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	318	43.4	309	40.8	327	48.6	318	57.9	268	54.1	33.8 (0.0–74.4)	⇡
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	316	36.1	311	30.9	330	36.4	325	42.8	270	38.1	23.7 (0.0–67.0)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	309	27.5	305	23.0	312	28.2	312	38.1	268	35.8	21.0 (0.0–58.3)	⇡
P. aeruginosa	Piperacillin-tazobactam resistance	252	18.7	234	16.2	196	11.2	182	14.3	164	10.4	18.8 (4.4–64.3)	⇣#
	Ceftazidime resistance	240	20.8	231	19.5	195	17.9	173	20.2	164	18.9	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	260	42.3	238	30.7	199	27.6	183	26.2	165	30.3	17.8 (3.6–48.9)	⇣
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	259	37.5	237	32.9	200	29.0	181	29.8	165	23.0	19.6 (3.2–52.9)	⇣
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	260	33.5	237	26.6	199	21.6	183	20.2	ND	ND	9.4 (0.0–37.1)	NA
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	260	31.9	238	21.4	200	19.0	184	17.4	164	11.6	12.1 (0.0–47.1)	⇣
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	181	94.5	208	96.2	155	95.5	143	92.3	225	96.4	38.0 (0.0–96.4)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	176	94.9	204	98.0	155	96.1	142	93.7	224	98.2	41.8 (0.0–98.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	182	83.0	206	84.0	153	91.5	140	92.1	225	96.4	37.1 (0.0–96.4)	⇡
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	175	81.1	203	83.7	153	90.8	139	91.4	224	95.1	34.1 (0.0–95.1)	⇡
S. aureus	MRSA[e]	458	25.3	520	28.5	458	26.4	358	24.9	424	29.2	16.7 (1.4–49.1)	–
S. pneumoniae	Penicillin non-wild-type[f]	155	21.9	129	22.5	144	18.1	154	20.1	55	23.6	15.6 (3.9–56.3)	–
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	154	33.8	127	36.2	143	32.2	154	29.9	55	40.0	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	154	14.9	126	15.9	141	11.3	152	13.8	55	16.4	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	179	33.0	171	33.3	143	33.6	125	24.0	161	37.9	29.0 (4.1–51.6)	–
E. faecium	Vancomycin resistance	104	22.1	89	19.1	71	25.4	74	25.7	88	33.0	16.8 (0.0–56.6)	–

NA: not applicable as data were not reported for all years, a significant change in data source occurred during the period, or the number of isolates was < 20 in any year during the period.
ND: no data available.

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).

[b] ⇡ and ⇣ indicate statistically significantly increasing and decreasing trends, respectively; # indicates a significant trend in the overall data, but not in data that only included laboratories reporting continuously for all five years; – indicates no statistically significant trend.

[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.

[d] The aminoglycoside group includes only tobramycin from 2020 onwards.

[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.

[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Cyprus

Participating institution

Microbiology Department, Nicosia General Hospital

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Cyprus, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	85	85	85	35	85
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	High	High	High	High	High
Blood-culture sets/1 000 patient days	46.2	44.9	51.1	56.9	60.9

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Cyprus, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	0	20	20	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	80	100	100	100	NA

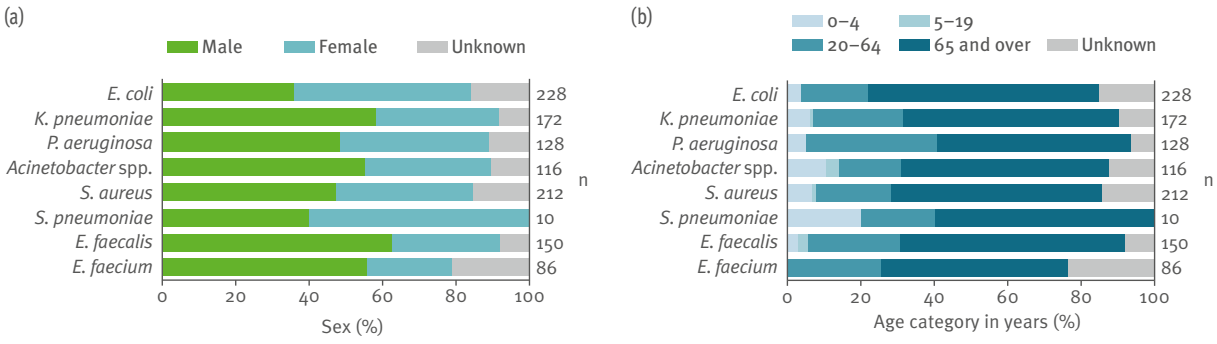
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Cyprus, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	5	149	16	5	156	15	4	151	19	1	92	Unknown	4	228	9
K. pneumoniae	5	75	30	5	71	33	4	87	33	1	60	Unknown	4	172	29
P. aeruginosa	5	64	40	4	53	33	4	55	39	1	33	25	4	128	37
Acinetobacter spp.	5	29	69	5	50	46	3	57	53	1	32	69	4	116	60
S. aureus	5	141	21	5	129	26	4	117	17	1	63	23	4	212	11
S. pneumoniae	4	10	11	4	19	37	3	16	8	1	8	< 10 isolates	3	10	0
E. faecalis	5	39	45	5	70	30	4	87	34	1	37	20	4	150	41
E. faecium	4	41	28	5	41	26	4	45	37	1	32	38	3	86	32

Labs: laboratories.
< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Cyprus, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Cyprus, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	149	69.1	156	65.4	151	64.9	92	71.7	228	67.5	54.6 (34.1–67.5)	–
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	149	30.2	156	30.8	151	37.1	92	20.7	228	29.8	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	149	0.0	156	1.3	150	2.0	92	0.0	228	0.0	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	149	47.0	156	42.9	151	42.4	92	43.5	228	48.2	23.8 (10.0–48.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	149	16.1	156	21.8	151	19.9	92	10.9	228	21.9	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	149	11.4	156	15.4	151	14.6	92	6.5	228	13.6	5.7 (1.6–18.7)	–
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	75	30.7	71	46.5	87	48.3	60	48.3	172	54.7	33.9 (0.0–79.1)	↑#
	Carbapenem (imipenem/meropenem) resistance	75	10.7	71	15.5	87	21.8	60	13.3	172	19.8	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	75	32.0	71	35.2	87	49.4	60	31.7	172	50.0	33.8 (0.0–74.4)	↑#
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	75	22.7	71	26.8	87	36.8	58	24.1	170	22.9	23.7 (0.0–67.0)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	75	18.7	71	25.4	87	32.2	58	20.7	170	18.2	21.0 (0.0–58.3)	–
P. aeruginosa	Piperacillin-tazobactam resistance	64	10.9	53	15.1	55	21.8	33	21.2	109	25.7	18.8 (4.4–64.3)	↑#
	Ceftazidime resistance	64	10.9	53	13.2	55	16.4	33	18.2	122	18.0	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	64	18.8	53	17.0	55	12.7	33	21.2	126	20.6	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	64	20.3	53	5.7	55	25.5	33	12.1	83	31.3	19.6 (3.2–52.9)	↑#
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	64	4.7	53	1.9	55	7.3	33	3.0	98	6.1	9.4 (0.0–37.1)	–
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	64	4.7	53	9.4	55	16.4	33	12.1	122	14.8	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	28	71.4	50	76.0	57	84.2	32	87.5	116	81.0	38.0 (0.0–96.4)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	28	71.4	50	76.0	55	89.1	32	90.6	113	85.0	41.8 (0.0–98.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	28	57.1	50	76.0	57	75.4	32	84.4	116	77.6	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	28	57.1	50	76.0	55	78.2	32	81.3	113	77.9	34.1 (0.0–95.1)	–
S. aureus	MRSA[e]	139	38.8	125	31.2	117	40.2	58	36.2	212	49.1	16.7 (1.4–49.1)	↑
S. pneumoniae	Penicillin non-wild-type[f]	10	40.0	11	45.5	16	6.3	2	< 10 isolates	10	40.0	15.6 (3.9–56.3)	NA
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	10	60.0	19	26.3	14	7.1	8	< 10 isolates	10	40.0	16.9 (3.5–43.8)	NA
	Combined penicillin non-wild-type and resistance to macrolides[f]	10	40.0	11	45.5	14	7.1	2	< 10 isolates	10	20.0	9.0 (0.0–37.5)	NA
E. faecalis	High-level gentamicin resistance	39	20.5	70	8.6	87	12.6	37	0.0	146	4.1	29.0 (4.1–51.6)	↓#
E. faecium	Vancomycin resistance	41	46.3	41	43.9	44	59.1	32	50.0	86	44.2	16.8 (0.0–56.6)	–

NA: not applicable as data were not reported for all years, a significant change in data source occurred during the period, or the number of isolates was < 20 in any year during the period.
< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).

[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; # indicates a significant trend in the overall data, but not in data that only included laboratories reporting continuously for all five years; – indicates no statistically significant trend.

[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.

[d] The aminoglycoside group includes only tobramycin from 2020 onwards.

[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.

[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Czechia

Participating institutions

National Institute of Public Health
National Reference Laboratory for Antibiotics

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Czechia, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	85	85	81	81	80
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	High	High	High	High	High
Blood-culture sets/1 000 patient days	18	18	17	16.8	19.7

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Czechia, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	98	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	96	100	98	100	NA

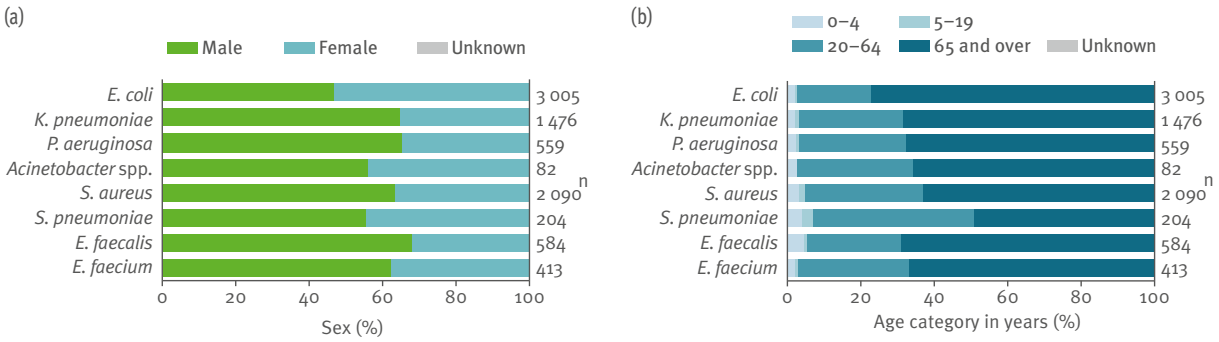
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Czechia, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	44	3 075	18	43	3 201	18	48	3 650	19	47	3 565	16	48	3 005	14
K. pneumoniae	45	1 385	32	46	1 330	29	48	1 485	31	48	1 563	27	48	1 476	30
P. aeruginosa	43	465	38	44	411	37	47	539	36	47	595	32	48	559	37
Acinetobacter spp.	15	57	26	17	55	31	21	91	32	20	95	48	20	82	44
S. aureus	45	1 887	25	47	1 944	24	48	2 244	24	49	2 108	23	48	2 090	24
S. pneumoniae	42	267	35	46	366	26	47	378	26	49	387	27	43	204	32
E. faecalis	42	515	35	41	529	33	44	594	35	43	528	30	44	584	35
E. faecium	38	259	39	39	264	38	41	358	37	39	350	38	44	413	36

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Czechia, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Czechia, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	3 055	55.1	3 198	53.0	3 640	54.2	3 556	54.6	2 997	52.7	54.6 (34.1–67.5)	–
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	3 061	15.1	3 199	14.2	3 641	15.2	3 557	15.9	2 997	13.3	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	1 483	0.0	1 431	0.0	1 752	0.1	1 689	0.0	1 500	0.1	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	3 061	27.6	3 199	24.5	3 638	24.3	3 554	23.0	2 997	20.2	23.8 (10.0–48.2)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	3 061	12.2	3 199	10.7	3 643	9.5	3 559	11.4	2 999	10.2	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	3 061	7.9	3 199	6.3	3 638	6.3	3 554	6.6	2 995	5.4	5.7 (1.6–18.7)	↓
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	1 384	51.8	1 329	53.2	1 482	50.1	1 563	50.7	1 474	45.9	33.9 (0.0–79.1)	↓
	Carbapenem (imipenem/meropenem) resistance	1 096	0.0	1 051	0.4	1 194	0.3	1 314	0.6	1 232	0.5	10.0 (0.0–66.3)	↑
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	1 384	50.5	1 329	49.2	1 482	47.2	1 562	48.7	1 474	44.2	33.8 (0.0–74.4)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	1 385	47.1	1 330	49.6	1 483	48.6	1 563	47.7	1 474	42.5	23.7 (0.0–67.0)	↓
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	1 384	40.8	1 329	41.8	1 482	38.7	1 562	39.3	1 473	34.6	21.0 (0.0–58.3)	↓
P. aeruginosa	Piperacillin-tazobactam resistance	446	23.3	405	20.7	531	22.6	584	23.6	550	20.4	18.8 (4.4–64.3)	–
	Ceftazidime resistance	464	19.2	411	13.4	539	20.4	594	22.7	559	19.0	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	464	8.8	411	14.8	539	18.0	595	14.5	559	15.7	17.8 (3.6–48.9)	↑
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	464	34.7	411	30.2	539	33.4	594	33.7	559	28.4	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	464	18.8	411	14.4	539	19.3	594	21.7	559	13.2	9.4 (0.0–37.1)	–
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	464	18.5	411	16.5	539	21.3	594	18.7	559	15.7	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	57	1.8	55	12.7	91	19.8	95	30.5	82	32.9	38.0 (0.0–96.4)	↑
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	57	17.5	55	20.0	91	24.2	95	32.6	82	35.4	41.8 (0.0–98.2)	↑
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	57	8.8	55	12.7	91	22.0	95	33.7	82	34.1	37.1 (0.0–96.4)	↑
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	57	0.0	55	5.5	91	18.7	95	29.5	82	30.5	34.1 (0.0–95.1)	↑
S. aureus	MRSA[e]	1 887	14.0	1 944	13.2	2 243	13.7	2 108	12.6	2 089	9.3	16.7 (1.4–49.1)	↓
S. pneumoniae	Penicillin non-wild-type[f]	266	4.5	366	4.9	378	5.0	387	4.9	204	4.4	15.6 (3.9–56.3)	–
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	263	7.2	366	9.0	378	10.1	387	10.3	204	6.9	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	263	1.1	366	3.0	378	2.6	387	2.3	204	2.0	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	515	37.1	526	34.0	594	33.7	527	31.5	583	30.2	29.0 (4.1–51.6)	↓
E. faecium	Vancomycin resistance	258	7.8	264	13.3	358	20.7	349	19.8	410	16.6	16.8 (0.0–56.6)	↑

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Denmark

Participating institutions

Statens Serum Institut
Danish Study Group for Antimicrobial Resistance Surveillance (DANRES)

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Denmark, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	100	100	100	100	100
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	High	High	High	High	High
Blood-culture sets/1 000 patient days	121.9	138.5	142.9	160.9	202.4

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Denmark, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	92	91	82	100	NA

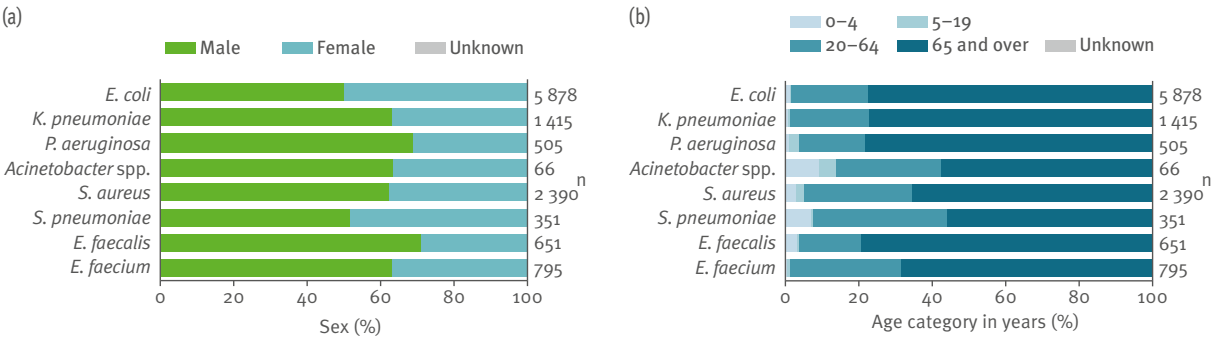
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Denmark, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	11	4 847	2	10	5 123	2	10	5 398	8	10	5 613	2	10	5 878	3
K. pneumoniae	11	1 156	4	10	1 186	3	10	1 280	7	10	1 361	3	10	1 415	5
P. aeruginosa	11	460	6	10	484	6	10	489	9	10	493	5	10	505	4
Acinetobacter spp.	11	72	8	9	68	5	8	55	8	9	72	6	9	66	6
S. aureus	10	1 963	Unknown	10	1 996	Unknown	10	2 181	Unknown	10	2 172	Unknown	10	2 390	5
S. pneumoniae	10	707	Unknown	10	727	Unknown	10	760	Unknown	10	601	2	10	351	Unknown
E. faecalis	11	600	9	10	674	6	10	606	8	10	632	5	10	651	7
E. faecium	11	685	31	10	786	30	10	782	28	10	737	23	10	795	20

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Denmark, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Denmark, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	4 698	45.0	4 885	45.6	5 383	46.0	5 593	46.3	5 864	44.1	54.6 (34.1–67.5)	–
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	4 659	6.6	4 883	6.9	4 833	7.7	5 091	7.5	5 286	6.7	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	4 671	0.0	5 117	0.0	4 640	0.0	5 577	0.1	5 840	0.2	0.2 (0.0–0.8)	⇡
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	4 827	11.0	5 123	12.8	5 386	13.3	5 605	11.5	5 870	11.2	23.8 (10.0–48.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	4 846	6.1	5 122	6.0	5 393	5.7	5 599	5.5	5 870	5.5	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	4 640	1.8	4 883	1.8	4 829	2.0	5 084	1.9	5 277	1.6	5.7 (1.6–18.7)	–
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	1 118	7.5	1 125	7.3	1 159	6.5	1 248	6.7	1 264	6.0	33.9 (0.0–79.1)	–
	Carbapenem (imipenem/meropenem) resistance	1 119	0.3	1 185	0.3	1 109	0.5	1 356	0.3	1 413	0.8	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	1 152	5.3	1 183	9.1	1 279	8.5	1 361	9.6	1 414	7.6	33.8 (0.0–74.4)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	1 154	3.2	1 186	3.2	1 278	3.3	1 358	3.5	1 412	3.3	23.7 (0.0–67.0)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	1 112	1.4	1 122	2.4	1 159	1.9	1 245	2.3	1 261	1.7	21.0 (0.0–58.3)	–
P. aeruginosa	Piperacillin-tazobactam resistance	460	3.5	484	2.9	489	2.9	493	4.1	505	4.4	18.8 (4.4–64.3)	–
	Ceftazidime resistance	447	4.5	461	3.5	458	3.3	471	4.0	471	3.2	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	458	2.4	484	2.5	422	5.2	491	3.3	503	4.4	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	460	3.7	484	5.0	489	4.3	493	5.5	505	3.2	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	460	1.7	484	1.0	489	0.6	490	2.7	61	0.0	9.4 (0.0–37.1)	–
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	460	1.3	484	0.4	489	1.2	493	1.6	505	1.2	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	69	0.0	66	0.0	47	6.4	72	0.0	64	4.7	38.0 (0.0–96.4)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	72	2.8	68	1.5	55	9.1	72	6.9	65	13.8	41.8 (0.0–98.2)	⇡
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	70	0.0	68	0.0	53	7.5	72	2.8	65	4.6	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	67	0.0	66	0.0	46	4.3	72	0.0	63	4.8	34.1 (0.0–95.1)	–
S. aureus	MRSA[e]	1 963	2.0	1 996	2.5	2 181	1.7	2 172	2.2	2 390	1.7	16.7 (1.4–49.1)	–
S. pneumoniae	Penicillin non-wild-type[f]	707	6.1	727	3.9	760	5.5	601	5.0	351	6.8	15.6 (3.9–56.3)	–
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	707	4.8	727	3.6	760	2.5	601	3.5	351	3.7	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	707	2.3	727	1.8	760	1.3	601	1.3	351	2.3	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	56	19.6	56	7.1	171	12.3	47	8.5	187	11.8	29.0 (4.1–51.6)	–
E. faecium	Vancomycin resistance	679	7.5	785	7.0	779	12.5	734	9.8	793	9.6	16.8 (0.0–56.6)	⇡

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ⇡ and ⇣ indicate statistically significantly increasing and decreasing trends, respectively; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Estonia

Participating institutions

Estonian Health Board
East-Tallinn Central Hospital
Tartu University Hospital

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Estonia, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	100	100	100	100	100
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	High	High	High	High	High
Blood-culture sets/1 000 patient days	26.6	34.1	31.9	33.4	35.8

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Estonia, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	100	100	100	100	NA

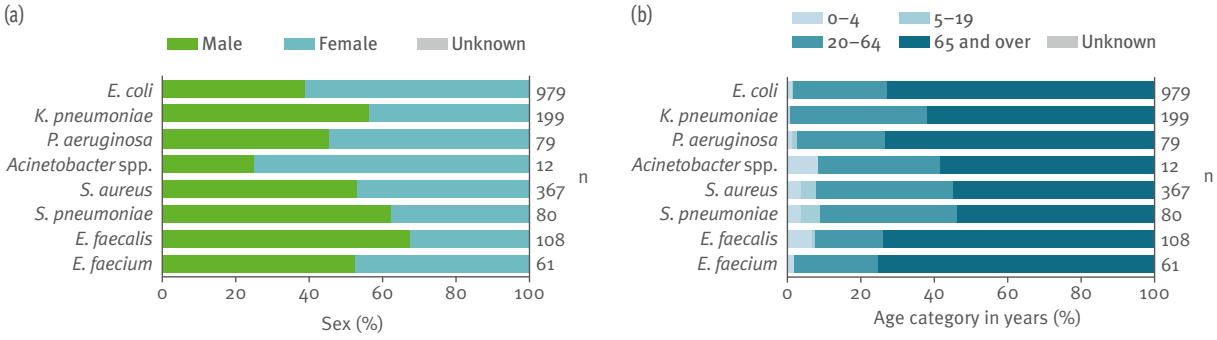
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Estonia, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	11	702	10	10	788	9	10	850	7	9	910	8	9	979	7
K. pneumoniae	10	183	20	10	161	20	9	206	17	9	179	18	9	199	13
P. aeruginosa	8	56	33	9	57	39	7	48	19	8	70	13	9	79	20
Acinetobacter spp.	3	8	< 10 isolates	9	16	19	7	14	21	5	16	19	4	12	0
S. aureus	11	314	12	10	290	8	9	360	8	9	366	11	9	367	11
S. pneumoniae	11	112	16	11	141	10	9	142	10	9	161	8	9	80	8
E. faecalis	9	56	25	10	71	23	8	88	20	9	93	18	9	108	19
E. faecium	8	64	38	10	52	37	7	64	36	7	74	43	8	61	16

Labs: laboratories.
< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Estonia, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Estonia, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	471	46.7	439	47.8	457	43.5	499	42.1	422	45.7	54.6 (34.1–67.5)	–
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	701	9.0	788	8.8	850	9.8	910	11.5	979	8.3	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	602	0.0	687	0.0	758	0.0	800	0.0	861	0.0	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	699	13.9	781	17.4	829	17.6	897	17.1	959	14.1	23.8 (10.0–48.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	702	7.4	786	5.7	849	6.2	907	5.3	968	5.5	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	698	4.0	780	3.7	828	3.0	894	2.1	948	1.6	5.7 (1.6–18.7)	⇩
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	183	32.8	161	21.1	206	13.6	179	10.6	199	11.6	33.9 (0.0–79.1)	⇩
	Carbapenem (imipenem/meropenem) resistance	168	0.0	143	0.0	179	0.6	152	0.0	173	0.0	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	183	29.5	161	24.8	205	21.0	179	16.2	197	17.3	33.8 (0.0–74.4)	⇩
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	183	21.3	161	12.4	205	10.2	179	6.1	197	8.1	23.7 (0.0–67.0)	⇩
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	183	16.9	161	11.8	204	8.8	179	5.6	196	7.1	21.0 (0.0–58.3)	⇩
P. aeruginosa	Piperacillin-tazobactam resistance	53	17.0	55	14.5	48	8.3	70	7.1	77	9.1	18.8 (4.4–64.3)	–
	Ceftazidime resistance	17	17.6	47	8.5	47	4.3	66	4.5	77	6.5	15.5 (2.9–54.3)	NA
	Carbapenem (imipenem/meropenem) resistance	54	20.4	55	9.1	48	16.7	69	5.8	79	12.7	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	56	3.6	56	12.5	45	13.3	68	5.9	76	10.5	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	54	7.4	56	5.4	48	4.2	67	3.0	1	< 10 isolates	9.4 (0.0–37.1)	NA
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	56	3.6	57	8.8	48	6.3	70	2.9	79	5.1	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	8	< 10 isolates	15	33.3	14	28.6	16	50.0	11	18.2	38.0 (0.0–96.4)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	5	< 10 isolates	11	36.4	11	45.5	10	80.0	7	< 10 isolates	41.8 (0.0–98.2)	NA
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	5	< 10 isolates	9	< 10 isolates	11	45.5	8	< 10 isolates	5	< 10 isolates	37.1 (0.0–96.4)	NA
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	5	< 10 isolates	9	< 10 isolates	11	36.4	8	< 10 isolates	5	< 10 isolates	34.1 (0.0–95.1)	NA
S. aureus	MRSA[e]	314	3.5	290	2.1	359	3.3	366	3.0	367	3.0	16.7 (1.4–49.1)	–
S. pneumoniae	Penicillin non-wild-type[f]	112	3.6	141	2.1	142	2.8	161	4.3	79	5.1	15.6 (3.9–56.3)	–
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	100	7.0	127	3.9	136	7.4	158	7.0	76	9.2	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	100	1.0	127	1.6	136	2.2	158	2.5	75	2.7	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	56	32.1	71	19.7	87	25.3	93	12.9	107	15.0	29.0 (4.1–51.6)	⇩
E. faecium	Vancomycin resistance	64	0.0	52	5.8	64	6.3	74	4.1	61	3.3	16.8 (0.0–56.6)	–

NA: not applicable as data were not reported for all years, a significant change in data source occurred during the period, or the number of isolates was < 20 in any year during the period.
< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ⇧ and ⇩ indicate statistically significantly increasing and decreasing trends, respectively; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Finland

Participating institutions

Finnish Institute for Health and Welfare, Department of Health Security
Finnish Study Group for Antimicrobial Resistance (FiRe)
Finnish Hospital Infection Program (SIRO)

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Finland, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	98	100	100	96	96
Geographical representativeness	High	High	High	High	High
Hospital representativeness	Unknown	High	High	High	High
Patient and isolate representativeness	Unknown	High	High	High	High
Blood-culture sets/1 000 patient days	Unknown	154.9	150.1	160.4	175.1

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Finland, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	100	94	94	89	NA

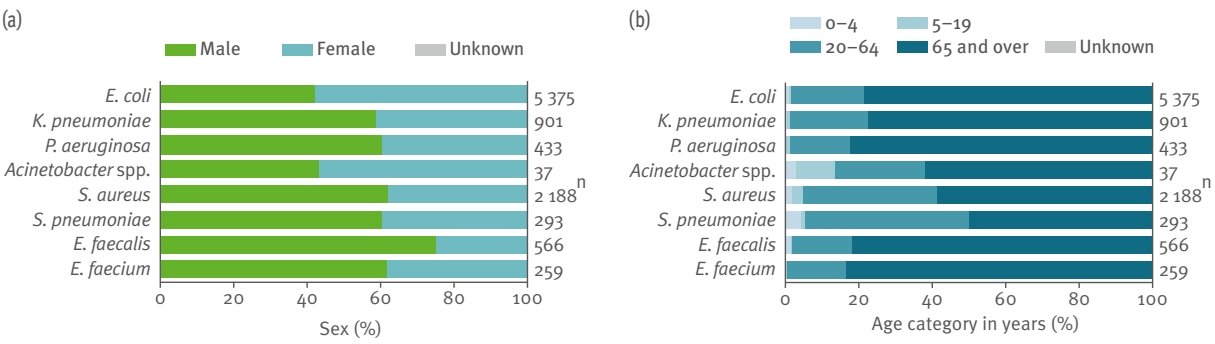
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Finland, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	20	4 833	Unknown	20	5 315	Unknown	19	5 057	Unknown	19	5 418	Unknown	18	5 375	Unknown
K. pneumoniae	20	770	Unknown	20	758	Unknown	19	810	Unknown	18	869	Unknown	17	901	Unknown
P. aeruginosa	20	352	Unknown	20	378	Unknown	19	391	Unknown	19	470	Unknown	17	433	Unknown
Acinetobacter spp.	12	28	Unknown	11	37	Unknown	14	28	Unknown	16	43	Unknown	12	37	Unknown
S. aureus	18	1 890	Unknown	20	2 439	Unknown	18	2 105	Unknown	19	2 473	Unknown	18	2 188	Unknown
S. pneumoniae	20	810	Unknown	20	835	Unknown	19	662	Unknown	18	678	Unknown	18	293	Unknown
E. faecalis	20	499	Unknown	20	549	Unknown	19	528	Unknown	19	592	Unknown	18	566	Unknown
E. faecium	20	295	Unknown	20	301	Unknown	19	290	Unknown	19	291	Unknown	18	259	Unknown

Labs: laboratories.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Finland, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Finland, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	2 690	35.8	2 874	35.2	3 129	35.3	3 000	35.5	2 928	34.1	54.6 (34.1–67.5)	–
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	4 742	6.9	5 223	6.9	5 020	7.6	5 413	7.8	5 367	7.2	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	4 832	0.0	5 315	0.0	5 057	0.0	5 331	0.0	5 375	0.0	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	4 808	11.5	5 305	12.0	5 043	11.4	5 410	11.4	5 354	10.5	23.8 (10.0–48.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	4 519	4.9	4 982	5.0	4 815	4.3	5 159	4.8	5 373	5.7	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	4 492	2.4	4 971	2.4	4 798	2.0	5 151	2.3	5 346	1.9	5.7 (1.6–18.7)	–
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	760	4.1	744	4.6	805	4.5	868	6.3	901	7.2	33.9 (0.0–79.1)	⇡
	Carbapenem (imipenem/meropenem) resistance	770	0.3	758	0.3	810	0.6	850	0.4	901	0.1	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	769	2.7	756	7.9	808	6.3	865	7.3	893	7.4	33.8 (0.0–74.4)	⇡
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	727	2.3	721	2.9	774	2.6	831	4.2	901	5.8	23.7 (0.0–67.0)	⇡
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	726	1.2	716	2.4	771	1.6	827	3.1	893	3.5	21.0 (0.0–58.3)	⇡
P. aeruginosa	Piperacillin-tazobactam resistance	351	9.4	377	6.4	391	6.6	457	6.6	433	5.5	18.8 (4.4–64.3)	–
	Ceftazidime resistance	352	5.4	378	6.1	390	4.4	463	4.5	433	5.3	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	352	6.0	377	6.1	391	4.9	462	6.3	433	3.7	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	292	7.9	356	11.2	376	12.8	468	8.5	431	10.2	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	352	2.3	378	1.9	391	1.0	458	0.7	433	1.4	9.4 (0.0–37.1)	–
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	352	3.4	378	3.4	391	1.8	462	2.4	433	3.5	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	28	0.0	37	2.7	28	0.0	43	0.0	37	5.4	38.0 (0.0–96.4)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	28	0.0	37	2.7	28	0.0	43	0.0	36	8.3	41.8 (0.0–98.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	28	3.6	36	0.0	27	7.4	42	0.0	37	2.7	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	28	0.0	36	0.0	27	0.0	42	0.0	36	2.8	34.1 (0.0–95.1)	–
S. aureus	MRSA[e]	1 890	2.2	2 439	2.0	2 105	2.0	2 473	2.1	2 188	2.5	16.7 (1.4–49.1)	–
S. pneumoniae	Penicillin non-wild-type[f]	706	10.3	698	10.5	600	11.5	594	12.0	252	11.5	15.6 (3.9–56.3)	–
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	791	11.4	808	15.0	653	12.1	655	10.5	288	11.8	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	687	6.1	671	6.7	591	5.8	571	6.3	247	7.3	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	29.0 (4.1–51.6)	NA
E. faecium	Vancomycin resistance	294	0.0	301	0.7	289	1.7	291	0.0	259	0.4	16.8 (0.0–56.6)	–

NA: not applicable as data were not reported for all years, a significant change in data source occurred during the period, or the number of isolates was < 20 in any year during the period.
ND: no data available.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ⇡ and ⇣ indicate statistically significantly increasing and decreasing trends, respectively; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

France

Participating institutions

Santé Publique France
Since 2020: Surveillance and Prevention of Antimicrobial RESistance in hospital settings (SPARES)
National Reference Centre for Pneumococci (CNRP)
Up to 2019: French National Observatory for the Epidemiology of Bacterial Resistance to Antimicrobials (ONERBA) through three participating networks: Azay-Résistance, Île-de-France, Réussir

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, France, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)[a]					
Laboratories collecting *S. pneumoniae* (CNRP)	51	58[b]	61	56	38
Laboratories collecting other species (SPARES network since 2020[c])	20	22	21	20	48
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	High	High	High	High	High
Blood-culture sets/1 000 patient days[d]	77.1	88.1	105.2	112.2	54.5

Definitions provided on page 7.
[a] Calculation based on proportion of hospital days in participating hospitals out of total hospital days in the country.
[b] Restricted to first half of the year.
[c] ONERBA laboratories up to 2019.
[d] Calculated excluding laboratories collecting *S. pneumoniae*.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, France, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	86	87	71	86	NA

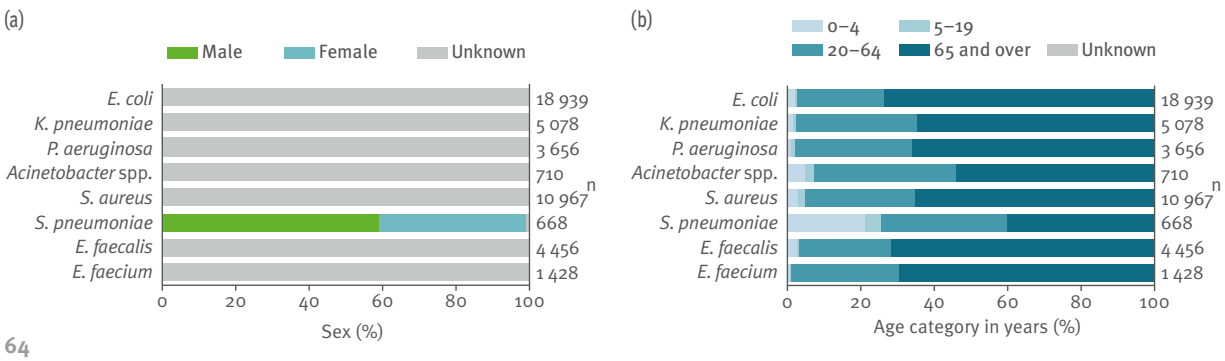
NA: not applicable
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] France, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	49	11 337	9	54	13 392	8	49	12 645	8	46	13 536	8	779	18 939	8
K. pneumoniae	49	2 608	17	54	2 904	16	49	3 043	17	46	3 170	15	558	5 078	16
P. aeruginosa	49	1 988	24	36	1 721	22	34	1 902	25	45	2 200	21	490	3 656	26
Acinetobacter spp.	48	454	19	52	475	17	47	498	11	45	515	17	241	710	10
S. aureus	50	5 699	15	54	6 668	16	49	7 097	15	46	6 723	14	672	10 967	12
S. pneumoniae	175	1 046	Unknown	169	614	Unknown	143	1 045	Unknown	193	1 264	Unknown	127	668	Unknown
E. faecalis	49	2022	20	53	2 259	20	48	2 300	20	46	2 526	19	508	4 456	21
E. faecium	48	819	29	53	1 000	27	49	1 001	27	46	1 080	24	295	1 428	28

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, France, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, France, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	11 248	57.2	13 293	55.6	12 553	55.6	13 415	54.5	17 674	53.9	54.6 (34.1–67.5)	NA
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	11 313	11.2	13 352	10.2	12 614	9.6	13 019	8.8	18 857	9.5	14.9 (5.8–41.4)	NA
	Carbapenem (imipenem/meropenem) resistance	10 929	0.0	12 843	0.0	12 399	0.0	12 636	0.0	17 838	0.0	0.2 (0.0–0.8)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	11 251	16.7	13 328	15.0	12 443	16.3	13 431	16.0	18 569	15.9	23.8 (10.0–48.2)	NA
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[b]	11 135	7.9	13 103	7.0	12 283	7.4	13 133	7.0	17 786	6.7	10.9 (5.5–34.2)	NA
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[b]	11 082	3.8	13 038	3.0	12 107	3.5	12 639	3.0	17 433	2.9	5.7 (1.6–18.7)	NA
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	2 597	28.9	2 892	28.8	3 033	30.8	3 075	30.2	5 045	27.8	33.9 (0.0–79.1)	NA
	Carbapenem (imipenem/meropenem) resistance	2 528	0.4	2 807	0.7	2 998	0.5	3 003	1.0	4 796	0.5	10.0 (0.0–66.3)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	2 589	27.7	2 886	26.8	2 997	30.4	3 143	30.9	5 001	28.1	33.8 (0.0–74.4)	NA
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[b]	2 569	26.2	2 857	23.8	2 990	24.8	3 103	23.4	4 767	18.8	23.7 (0.0–67.0)	NA
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[b]	2 556	21.3	2 844	19.4	2 948	21.5	3 004	19.8	4 692	16.4	21.0 (0.0–58.3)	NA
P. aeruginosa	Piperacillin-tazobactam resistance	1 949	16.0	1 684	16.7	1 850	17.4	1 879	16.7	3 417	17.1	18.8 (4.4–64.3)	NA
	Ceftazidime resistance	1 956	11.3	1 568	12.2	1 892	13.0	1 999	11.5	3 574	12.8	15.5 (2.9–54.3)	NA
	Carbapenem (imipenem/meropenem) resistance	1 968	15.6	1 710	13.9	1 896	16.0	2 076	12.7	3 583	12.6	17.8 (3.6–48.9)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	1 971	13.6	1 709	15.1	1 893	15.1	2 074	13.7	3 585	14.8	19.6 (3.2–52.9)	NA
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	1 976	10.7	1 713	10.9	1 898	9.3	2 086	7.8	3 059	5.6	9.4 (0.0–37.1)	NA
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[c]	1 972	10.3	1 709	10.1	1 894	10.5	2 073	8.0	3 594	8.4	12.1 (0.0–47.1)	NA
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	450	7.1	469	6.2	490	6.5	487	9.0	692	3.3	38.0 (0.0–96.4)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	452	15.0	473	12.3	491	12.0	481	13.3	653	9.0	41.8 (0.0–98.2)	NA
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[b]	449	12.2	474	9.1	482	8.9	473	14.6	661	8.3	37.1 (0.0–96.4)	NA
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[b]	447	6.7	468	5.3	470	5.5	458	8.5	628	1.9	34.1 (0.0–95.1)	NA
S. aureus	MRSA[d]	5 578	13.8	6 472	12.9	6 903	12.1	6 467	11.6	10 763	12.1	16.7 (1.4–49.1)	NA
S. pneumoniae	Penicillin non-wild-type[e]	1 046	25.3	614	25.9	1 045	29.1	1 264	25.3	668	32.3	15.6 (3.9–56.3)	NA
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	1 046	22.9	614	23.1	1 045	23.9	1 264	19.4	668	21.6	16.9 (3.5–43.8)	NA
	Combined penicillin non-wild-type and resistance to macrolides[b]	1 046	18.0	614	17.6	1 045	20.4	1 264	16.1	668	18.4	9.0 (0.0–37.5)	NA
E. faecalis	High-level gentamicin resistance	1 057	15.0	795	12.7	1 568	9.8	1 346	12.0	ND	ND	29.0 (4.1–51.6)	NA
E. faecium	Vancomycin resistance	808	0.6	986	0.8	987	0.6	1 062	0.7	1 385	0.6	16.8 (0.0–56.6)	NA

NA: not applicable as data were not reported for all years, a significant change in data source occurred during the period, or the number of isolates was < 20 in any year during the period.
ND: no data available.

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[c] The aminoglycoside group includes only tobramycin from 2020 onwards.
[d] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[e] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Georgia

Participating institution

National Center for Disease Control and Public Health

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Georgia, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated population coverage (%)	15	60	60	80	80
Geographical representativeness	Poor	High	High	Medium	High
Hospital representativeness	Medium	High	High	High	High
Patient and isolate representativeness	Poor	Poor	Poor	Poor	Poor
Blood-culture sets/1 000 patient days[a]	Unknown	Unknown	11 (4–66)	6 (2–13)	5 (0–33)

Definitions provided on page 7.
[a] Data are presented as median (range).

Laboratories contributing data: use of clinical breakpoint guidelines and participation in CAESAR EQA, Georgia, 2016–2020

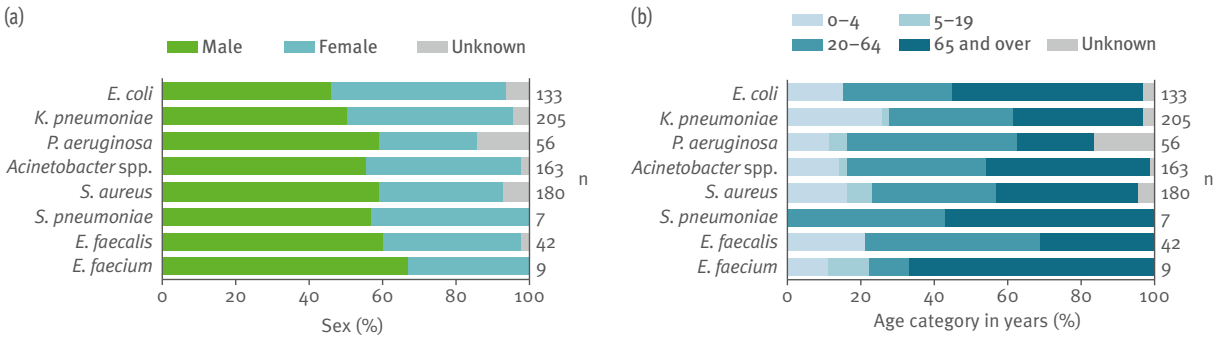
Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	40	50	60	60
Percentage of laboratories participating in CAESAR EQA	100	100	100	100	100

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Georgia, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	1	9	44	5	27	Unknown	11	56	70	6	80	Unknown	13	133	Unknown
K. pneumoniae	1	34	94	6	58	Unknown	11	81	76	7	162	Unknown	16	205	Unknown
P. aeruginosa	1	6	83	5	16	Unknown	10	23	73	8	64	78	9	56	Unknown
Acinetobacter spp.	1	7	100	6	35	Unknown	12	45	83	8	91	81	17	163	Unknown
S. aureus	1	10	67	6	38	Unknown	12	67	55	8	144	74	16	180	Unknown
S. pneumoniae	1	2	100	2	3	Unknown	3	3	100	4	8	Unknown	2	7	Unknown
E. faecalis	1	2	100	4	21	Unknown	5	12	50	6	16	75	9	42	Unknown
E. faecium	0	0	Unknown	3	3	Unknown	3	4	75	1	2	100	3	9	Unknown

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories may be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Georgia, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, Georgia, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020	
		n	%	n	%	n	%	n	%	n	%
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	7	< 10 isolates	6	< 10 isolates	18	83.3[a]	77	74.0	116	67.2
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	9	< 10 isolates	27	40.7[a]	56	55.4	80	57.5	133	43.6
	Carbapenem (imipenem/meropenem) resistance	9	< 10 isolates	27	0.0[a]	56	10.7	80	7.5	133	0.8
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	9	< 10 isolates	27	37.0[a]	55	50.9	80	43.8	133	43.6
	Aminoglycoside (gentamicin/tobramycin) resistance	9	< 10 isolates	25	32.0[a]	24	45.8[a]	67	16.4	128	10.9
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	9	< 10 isolates	25	16.0[a]	24	37.5[a]	67	6.0	128	5.5
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	33	100.0	57	91.2	81	87.7	159	74.8	205	79.0
	Carbapenem (imipenem/meropenem) resistance	33	9.1	57	47.4	81	28.4	162	30.9	205	62.0
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	29	34.5[a]	56	58.9	81	55.6	162	45.7	204	49.5
	Aminoglycoside (gentamicin/tobramycin) resistance	33	69.7	52	65.4	74	48.6	155	40.6	201	54.2
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	29	31.0[a]	50	40.0	74	35.1	152	23.0	200	29.0
P. aeruginosa	Piperacillin-tazobactam resistance	6	< 10 isolates	15	40.0[a]	20	35.0[a]	57	40.4	53	35.8
	Ceftazidime resistance	6	< 10 isolates	15	53.3[a]	23	69.6[a]	50	50.0	50	42.0
	Carbapenem (imipenem/meropenem) resistance	6	< 10 isolates	16	56.3[a]	23	43.5[a]	61	52.5	56	35.7
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	5	< 10 isolates	16	56.2[a]	23	47.8[a]	59	47.5	56	33.9
	Aminoglycoside (gentamicin/tobramycin) resistance[b]	6	< 10 isolates	14	50.0[a]	22	54.5[a]	53	45.3	43	34.9
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[b]	5	< 10 isolates	12	41.7[a]	20	45.0[a]	43	55.8	43	34.9
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	7	< 10 isolates	34	85.3	45	88.9	91	73.6	163	68.7
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	1	< 10 isolates	34	88.2	45	97.8	82	80.5	158	74.7
	Aminoglycoside (gentamicin/tobramycin) resistance	7	< 10 isolates	34	67.6	45	77.8	91	38.5	160	58.7
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides	1	< 10 isolates	33	57.6	45	71.1	82	30.5	155	47.1
S. aureus	MRSA[c]	9	< 10 isolates	35	11.4	53	15.1	112	16.1	179	16.2
S. pneumoniae	Penicillin non-wild-type[d]	2	< 10 isolates	2	< 10 isolates	3	< 10 isolates	5	< 10 isolates	6	< 10 isolates
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	2	< 10 isolates	3	< 10 isolates	3	< 10 isolates	7	< 10 isolates	6	< 10 isolates
	Combined penicillin non-wild-type and resistance to macrolides[d]	2	< 10 isolates	2	< 10 isolates	3	< 10 isolates	5	< 10 isolates	5	< 10 isolates
E. faecalis	High-level gentamicin resistance	0	ND	18	44.4[a]	5	< 10 isolates	9	< 10 isolates	38	60.5
E. faecium	Vancomycin resistance	0	ND	3	< 10 isolates	4	< 10 isolates	2	< 10 isolates	9	< 10 isolates

ND: no data available.
< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.
[a] A small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution.
[b] The aminoglycoside group includes only tobramycin from 2020 onwards.
[c] MRSA is calculated as resistance to cefoxitin or, if not available, oxacillin.
[d] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints might define the cut-off values for the susceptibility categories differently.

Germany

Participating institution

Robert Koch Institute

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Germany, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	26	30	27	27	Unknown
Geographical representativeness	High	High	High	High	Unknown
Hospital representativeness	Medium	Medium	Medium	Medium	Unknown
Patient and isolate representativeness	High	High	High	High	Unknown
Blood-culture sets/1 000 patient days	26.2	27.2	30.8	37.9	Unknown

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Germany, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	83	81	86	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	93	91	91	95	NA

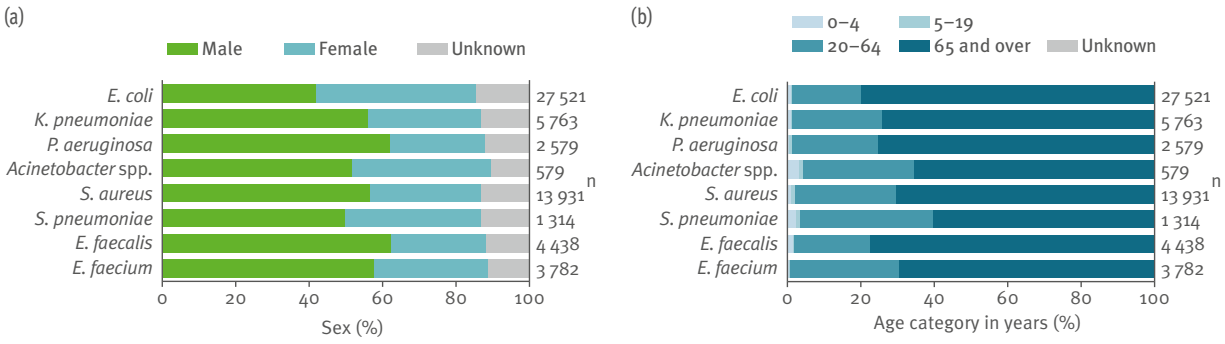
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Germany, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	41	17 199	14	56	22 945	14	48	21 994	15	47	23 415	15	50	27 521	15
K. pneumoniae	40	3 070	23	55	3 857	21	48	3 974	22	47	4 721	24	50	5 763	24
P. aeruginosa	39	1 423	27	55	1 896	26	47	1 792	26	46	2 108	27	50	2 579	25
Acinetobacter spp.	38	463	19	50	543	17	45	529	15	46	467	15	48	579	21
S. aureus	41	9 870	20	56	13 141	21	48	11 924	21	47	11 958	23	50	13 931	23
S. pneumoniae	40	1 403	23	54	2 049	22	48	1 916	24	46	2 035	24	50	1 314	27
E. faecalis	41	2 959	24	56	4 002	24	48	3 638	23	47	3 770	25	50	4 438	24
E. faecium	41	2 049	40	56	2 648	40	47	2 464	43	47	2 801	48	50	3 782	47

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Germany, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Germany, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	15 957	49.0	21 646	48.9	20 841	49.2	23 324	48.7	27 284	47.5	54.6 (34.1–67.5)	↓
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	17 190	11.1	22 929	12.3	21 989	12.2	23 413	11.5	27 520	10.3	14.9 (5.8–41.4)	↓
	Carbapenem (imipenem/meropenem) resistance	17 196	0.0	22 940	0.0	21 957	0.0	23 391	0.0	27 517	0.0	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	17 196	19.4	22 940	20.7	21 958	19.8	23 374	17.5	27 505	16.5	23.8 (10.0–48.2)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	17 023	7.0	22 478	7.0	21 634	6.9	22 990	8.3	26 358	7.5	10.9 (5.5–34.2)	↑
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	17 013	3.4	22 464	3.7	21 630	3.4	22 971	3.1	26 344	2.7	5.7 (1.6–18.7)	↓
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	3 068	13.6	3 854	14.6	3 973	12.9	4 719	12.2	5 762	11.0	33.9 (0.0–79.1)	↓
	Carbapenem (imipenem/meropenem) resistance	3 068	0.5	3 857	0.5	3 968	0.4	4 718	0.9	5 762	0.5	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	3 068	12.6	3 857	15.3	3 970	13.4	4 715	13.1	5 761	11.6	33.8 (0.0–74.4)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	3 042	7.7	3 776	8.2	3 918	6.2	4 654	7.3	5 545	5.6	23.7 (0.0–67.0)	↓
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	3 038	5.3	3 774	6.3	3 918	4.7	4 649	4.8	5 544	3.7	21.0 (0.0–58.3)	↓
P. aeruginosa	Piperacillin-tazobactam resistance	1 410	15.0	1 856	12.6	1 765	12.4	2 077	11.7	2 558	11.7	18.8 (4.4–64.3)	↓
	Ceftazidime resistance	1 421	10.1	1 883	9.8	1 784	9.1	2 104	10.0	2 576	10.0	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	1 422	14.5	1 892	12.6	1 790	12.1	2 108	12.9	2 579	13.8	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance[d]	1 423	12.4	1 895	13.9	1 789	12.4	2 108	13.4	2 579	10.6	19.6 (3.2–52.9)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[e]	1 421	6.8	1 869	4.8	1 788	3.5	2 107	4.1	2 348	2.0	9.4 (0.0–37.1)	↓
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[e]	1 423	7.3	1 894	6.6	1 790	5.8	2 108	6.3	2 579	6.6	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	452	4.9	540	4.1	527	4.4	462	2.2	578	3.5	38.0 (0.0–96.4)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	460	5.7	536	6.5	520	6.7	443	5.0	568	5.1	41.8 (0.0–98.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	436	3.0	498	3.4	498	3.4	430	4.2	527	4.9	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	435	2.3	495	1.2	498	2.2	425	1.4	527	2.5	34.1 (0.0–95.1)	–
S. aureus	MRSA[f]	9 866	10.2	13 128	9.1	11 918	7.7	11 950	6.7	13 927	5.5	16.7 (1.4–49.1)	↓
S. pneumoniae	Penicillin non-wild-type[g]	1 359	4.6	1 989	4.5	1 867	5.2	1 962	5.7	1 275	6.1	15.6 (3.9–56.3)	↑[#]
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	1 386	8.0	2 029	6.9	1 883	7.1	1 970	7.7	1 281	7.2	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[g]	1 342	2.2	1 969	2.2	1 839	2.5	1 903	3.0	1 242	2.2	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	2 341	25.2	2 930	25.3	2 273	22.9	1 561	18.0	2 288	16.3	29.0 (4.1–51.6)	↓
E. faecium	Vancomycin resistance	2 043	11.9	2 642	16.5	2 458	23.7	2 797	26.3	3 770	22.3	16.8 (0.0–56.6)	↑

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; [#] indicates a significant trend in the overall data, but not in data that only included laboratories reporting continuously for all five years; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] For 2020 only ciprofloxacin data was reported.
[e] The aminoglycoside group includes only tobramycin from 2020 onwards.
[f] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[g] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Greece

Participating institutions

National Public Health Organization, Central Public Health Laboratory
University of West Attica, Department of Public Health Policy, School of Public Health

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Greece, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	55	Unknown	68	Unknown	60
Geographical representativeness	Unknown	Unknown	High	Unknown	High
Hospital representativeness	Unknown	Unknown	High	Unknown	High
Patient and isolate representativeness	Unknown	Unknown	Medium	Unknown	Medium
Blood-culture sets/1 000 patient days	Unknown	Unknown	Unknown	Unknown	Unknown

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Greece, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	12	13	21	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	96	89	96	95	NA

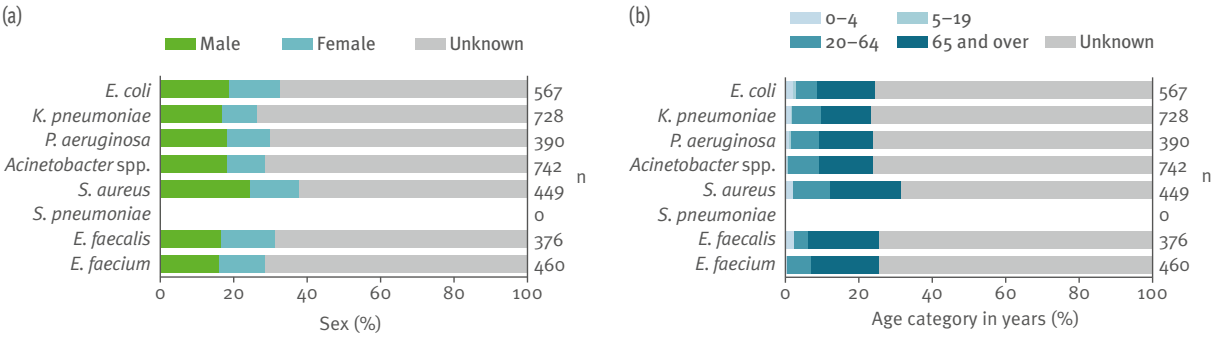
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Greece, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	31	1 306	4	32	1 472	5	37	1 642	5	6	204	6	13	567	6
K. pneumoniae	30	1 183	41	33	1 363	38	36	1 500	37	6	312	37	12	728	38
P. aeruginosa	31	705	42	31	821	37	37	859	37	6	141	45	12	390	35
Acinetobacter spp.	29	903	57	32	1 096	50	34	1 015	48	5	196	45	12	742	47
S. aureus	31	682	10	33	833	11	36	889	7	5	171	8	13	449	14
S. pneumoniae	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
E. faecalis	28	576	35	33	638	25	36	682	28	6	141	26	11	376	28
E. faecium	28	358	31	31	412	26	35	529	25	5	117	32	12	460	39

Labs: laboratories.
ND: no data available.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Greece, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Greece, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	1 170	56.9	1 306	57.5	1 444	57.5	154	57.1	452	55.5	54.6 (34.1–67.5)	NA
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	1 304	17.6	1 470	18.3	1 640	19.3	190	18.9	567	21.9	14.9 (5.8–41.4)	NA
	Carbapenem (imipenem/meropenem) resistance	1 303	0.9	1 467	1.6	1 640	1.0	203	1.0	566	0.5	0.2 (0.0–0.8)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	1 304	32.1	1 464	32.9	1 631	30.8	203	29.6	565	32.7	23.8 (10.0–48.2)	NA
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[b]	1 301	16.8	1 467	17.0	1 633	15.5	201	12.9	562	18.7	10.9 (5.5–34.2)	NA
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[b]	1 300	10.4	1 463	9.8	1 628	9.8	186	8.6	561	10.5	5.7 (1.6–18.7)	NA
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	1 181	72.5	1 362	69.2	1 500	70.7	310	66.5	726	74.5	33.9 (0.0–79.1)	NA
	Carbapenem (imipenem/meropenem) resistance	1 180	66.9	1 363	64.7	1 498	63.9	312	58.3	726	66.3	10.0 (0.0–66.3)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	1 180	68.6	1 346	66.9	1 488	68.1	311	66.9	726	74.4	33.8 (0.0–74.4)	NA
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[b]	1171	52.9	1 348	53.2	1 487	54.4	310	55.2	718	61.0	23.7 (0.0–67.0)	NA
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[b]	1171	48.4	1 345	47.9	1 487	50.4	307	53.1	714	58.3	21.0 (0.0–58.3)	NA
P. aeruginosa	Piperacillin-tazobactam resistance	644	23.3	771	23.7	815	21.5	109	34.9	270	35.6	18.8 (4.4–64.3)	NA
	Ceftazidime resistance	696	33.6	814	24.9	853	22.3	136	39.7	344	30.2	15.5 (2.9–54.3)	NA
	Carbapenem (imipenem/meropenem) resistance	699	42.1	821	39.3	856	37.5	141	48.9	378	35.7	17.8 (3.6–48.9)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	702	34.6	816	35.3	856	33.1	141	46.8	333	42.9	19.6 (3.2–52.9)	NA
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	701	28.0	815	30.2	856	26.5	141	42.6	301	28.6	9.4 (0.0–37.1)	NA
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[c]	701	31.5	816	32.0	855	28.7	141	44.7	360	30.6	12.1 (0.0–47.1)	NA
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	861	95.4	1 095	94.8	1 013	92.4	196	92.3	740	94.6	38.0 (0.0–96.4)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	862	94.9	1 060	96.0	998	93.5	189	95.8	729	95.7	41.8 (0.0–98.2)	NA
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[b]	878	85.0	1 064	85.6	1 003	81.6	194	88.7	727	90.4	37.1 (0.0–96.4)	NA
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[b]	838	84.0	1 059	84.3	995	81.3	187	91.4	715	90.8	34.1 (0.0–95.1)	NA
S. aureus	MRSA[d]	639	38.8	822	38.4	888	36.4	170	37.6	448	40.2	16.7 (1.4–49.1)	NA
S. pneumoniae	Penicillin non-wild-type[e]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	15.6 (3.9–56.3)	NA
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	16.9 (3.5–43.8)	NA
	Combined penicillin non-wild-type and resistance to macrolides[e]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.0 (0.0–37.5)	NA
E. faecalis	High-level gentamicin resistance	540	15.9	621	12.2	668	12.0	128	7.8	298	9.7	29.0 (4.1–51.6)	NA
E. faecium	Vancomycin resistance	358	27.9	412	30.8	527	28.1	117	47.0	445	41.8	16.8 (0.0–56.6)	NA

NA: not applicable as data were not reported for all years, a significant change in data source occurred during the period, or the number of isolates was < 20 in any year during the period. For Greece, the change comprises the decrease in the number of laboratories reporting data starting with 2019 data, as EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.
ND: no data available.
[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[c] The aminoglycoside group includes only tobramycin from 2020 onwards.
[d] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[e] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Hungary

Participating institution

National Public Health Center

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Hungary, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	90	Unknown	90	90	90
Geographical representativeness	High	Unknown	High	High	High
Hospital representativeness	Unknown	Unknown	High	High	High
Patient and isolate representativeness	Unknown	Unknown	High	High	High
Blood-culture sets/1 000 patient days	9.8	11.5	12.2	12.3	17.2

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Hungary, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	100	97	93	97	NA

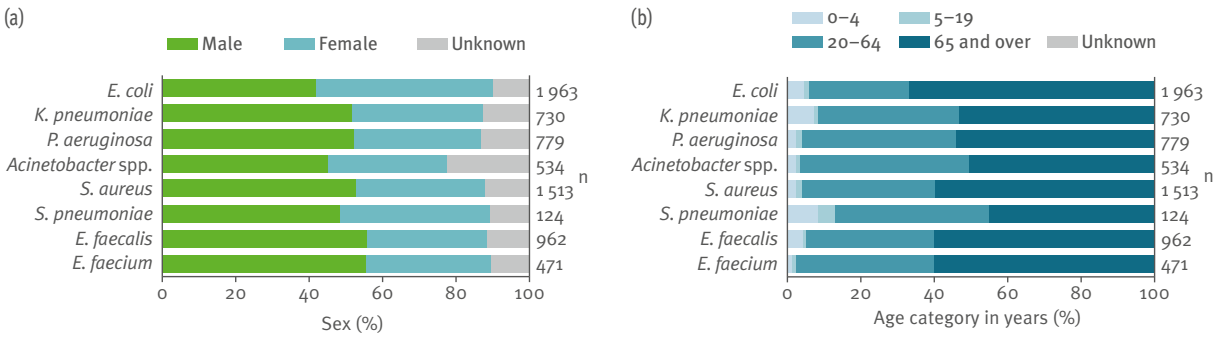
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Hungary, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	29	1 995	14	31	2 061	13	29	2 373	11	30	2 413	12	29	1 963	15
K. pneumoniae	29	723	29	29	693	28	28	850	24	29	912	26	26	730	32
P. aeruginosa	29	740	45	30	735	49	29	807	40	30	884	42	26	779	44
Acinetobacter spp.	26	401	57	31	358	51	26	358	54	27	420	56	24	534	Unknown
S. aureus	28	1 668	20	28	1 566	19	27	1 721	17	28	1 884	16	28	1 513	23
S. pneumoniae	27	174	24	27	204	16	25	207	20	27	222	19	21	124	25
E. faecalis	28	786	38	30	769	38	29	750	36	30	816	37	28	962	49
E. faecium	25	272	46	27	315	46	29	303	42	27	304	42	27	471	Unknown

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Hungary, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Hungary, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	1 969	57.4	2 021	60.3	2 312	62.7	2 363	59.3	1 804	58.6	54.6 (34.1–67.5)	–
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	1 993	16.7	2 058	20.1	2 370	22.6	2 413	20.6	1 962	20.1	14.9 (5.8–41.4)	⇡
	Carbapenem (imipenem/meropenem) resistance	1 905	0.0	1 987	0.1	2 279	0.0	2 326	0.0	1 917	0.0	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	1 986	26.8	2 051	30.6	2 364	33.2	2 398	30.3	1 958	30.3	23.8 (10.0–48.2)	⇡
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	1 992	13.3	2 060	15.1	2 264	17.4	2 411	15.7	1 954	16.7	10.9 (5.5–34.2)	⇡
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	1 981	6.4	2 047	8.2	2 254	11.4	2 397	10.4	1 950	8.8	5.7 (1.6–18.7)	⇡
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	722	37.5	693	41.1	848	40.2	911	36.7	728	40.4	33.9 (0.0–79.1)	–
	Carbapenem (imipenem/meropenem) resistance	703	0.4	681	0.1	827	0.2	890	0.9	721	0.7	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	713	35.2	685	41.5	842	38.0	909	36.7	728	40.8	33.8 (0.0–74.4)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	720	34.7	693	37.8	845	32.7	912	30.8	727	34.9	23.7 (0.0–67.0)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	711	30.1	685	33.1	837	28.9	908	26.4	723	31.8	21.0 (0.0–58.3)	–
P. aeruginosa	Piperacillin-tazobactam resistance	720	23.6	721	24.3	791	24.3	860	19.7	774	20.3	18.8 (4.4–64.3)	⇣
	Ceftazidime resistance	735	20.7	729	23.9	804	22.5	882	18.4	772	20.6	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	739	33.2	733	36.6	807	37.3	883	33.2	779	33.8	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	736	24.3	732	23.4	805	26.0	879	20.3	777	22.0	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	740	17.6	734	14.6	784	17.9	883	16.9	761	11.4	9.4 (0.0–37.1)	⇣
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	740	19.1	735	18.1	807	20.2	883	17.3	778	15.2	12.1 (0.0–47.1)	⇣[#]
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	401	57.1	358	52.0	357	55.2	418	51.0	534	73.0	38.0 (0.0–96.4)	⇡
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	397	68.0	352	67.0	356	66.0	412	63.3	530	77.0	41.8 (0.0–98.2)	⇡
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	401	59.1	358	56.1	343	48.7	419	50.6	532	72.4	37.1 (0.0–96.4)	⇡
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	397	51.4	352	48.6	341	41.3	410	45.6	529	69.4	34.1 (0.0–95.1)	⇡
S. aureus	MRSA[e]	1 668	25.2	1 566	23.6	1 721	23.1	1 884	19.4	1 513	21.0	16.7 (1.4–49.1)	⇣
S. pneumoniae	Penicillin non-wild-type[f]	174	15.5	204	6.9	207	10.1	222	6.3	124	8.9	15.6 (3.9–56.3)	⇣
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	166	13.3	187	11.8	190	14.7	215	12.1	115	17.4	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	166	7.8	187	6.4	190	7.9	215	5.1	115	8.7	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	786	42.2	769	41.5	750	38.0	816	33.7	962	42.6	29.0 (4.1–51.6)	–
E. faecium	Vancomycin resistance	272	22.4	315	28.3	301	39.5	304	35.9	471	34.8	16.8 (0.0–56.6)	⇡

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ⇡ and ⇣ indicate statistically significantly increasing and decreasing trends, respectively; [#] indicates a significant trend in the overall data, but not in data that only included laboratories reporting continuously for all five years; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (› 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Iceland

Participating institutions

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

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Iceland, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	100	Unknown	100	100	100
Geographical representativeness	High	Unknown	High	High	High
Hospital representativeness	Unknown	Unknown	High	High	High
Patient and isolate representativeness	Unknown	Unknown	High	High	High
Blood-culture sets/1 000 patient days	Unknown	Unknown	50.6	61.6	61.3

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Iceland, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	50	50	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	100	100	50	100	NA

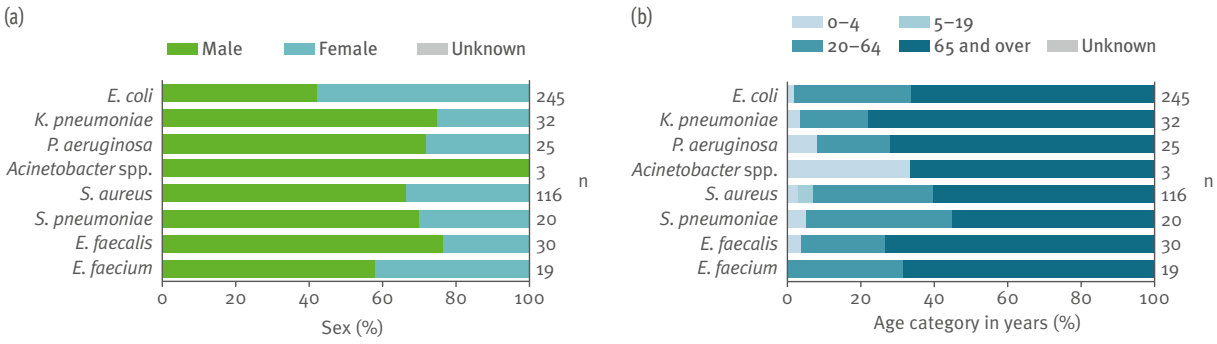
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Iceland, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	2	192	1	2	213	1	2	198	2	2	257	2	2	245	2
K. pneumoniae	2	25	4	2	17	0	2	16	7	2	23	0	2	32	3
P. aeruginosa	2	17	13	1	17	24	2	12	0	2	22	14	2	25	19
Acinetobacter spp.	1	3	‹ 10 isolates	1	6	‹ 10 isolates	1	2	‹ 10 isolates	1	3	‹ 10 isolates	1	3	‹ 10 isolates
S. aureus	2	76	4	2	69	10	2	82	9	2	121	4	2	116	6
S. pneumoniae	2	19	5	2	27	4	2	31	3	2	44	0	2	20	0
E. faecalis	2	24	10	2	33	9	2	30	7	2	35	9	2	30	7
E. faecium	1	16	13	1	17	12	2	16	21	2	13	31	2	19	24

Labs: laboratories.
‹ 10 isolates: no percentage is displayed if ‹ 10 isolates were available for analysis.
Note: a small number of isolates were tested (n ‹ 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Iceland, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Iceland, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	192	43.8	213	41.3	198	49.0	257	52.5	245	55.1	54.6 (34.1–67.5)	↑
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	192	4.2	213	6.1	198	8.1	257	7.0	245	11.0	14.9 (5.8–41.4)	↑
	Carbapenem (imipenem/meropenem) resistance	6	< 10 isolates	8	< 10 isolates	13	0.0	2	< 10 isolates	245	0.0	0.2 (0.0–0.8)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	178	9.6	199	11.6	192	17.2	252	13.1	245	11.8	23.8 (10.0–48.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	192	3.6	213	5.6	197	6.1	256	4.7	245	7.8	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	178	1.1	199	1.5	191	2.1	251	0.4	245	3.3	5.7 (1.6–18.7)	–
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	25	0.0	17	5.9	16	0.0	23	4.3	32	0.0	33.9 (0.0–79.1)	NA
	Carbapenem (imipenem/meropenem) resistance	1	< 10 isolates	ND	ND	1	< 10 isolates	ND	ND	32	0.0	10.0 (0.0–66.3)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	21	0.0	16	6.3	16	0.0	23	4.3	32	0.0	33.8 (0.0–74.4)	NA
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	25	0.0	17	11.8	16	0.0	23	8.7	32	0.0	23.7 (0.0–67.0)	NA
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	21	0.0	16	0.0	16	0.0	23	0.0	32	0.0	21.0 (0.0–58.3)	NA
P. aeruginosa	Piperacillin-tazobactam resistance	ND	ND	ND	ND	ND	ND	2	< 10 isolates	ND	ND	18.8 (4.4–64.3)	NA
	Ceftazidime resistance	17	0.0	17	0.0	12	0.0	22	13.6	25	8.0	15.5 (2.9–54.3)	NA
	Carbapenem (imipenem/meropenem) resistance	17	5.9	17	0.0	12	0.0	22	0.0	25	12.0	17.8 (3.6–48.9)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	17	17.6	17	11.8	12	8.3	22	4.5	25	4.0	19.6 (3.2–52.9)	NA
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	17	0.0	17	0.0	12	0.0	22	4.5	25	0.0	9.4 (0.0–37.1)	NA
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	17	0.0	17	0.0	12	0.0	22	4.5	25	0.0	12.1 (0.0–47.1)	NA
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	3	< 10 isolates	6	< 10 isolates	2	< 10 isolates	3	< 10 isolates	3	< 10 isolates	38.0 (0.0–96.4)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	3	< 10 isolates	6	< 10 isolates	2	< 10 isolates	3	< 10 isolates	3	< 10 isolates	41.8 (0.0–98.2)	NA
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	3	< 10 isolates	6	< 10 isolates	2	< 10 isolates	3	< 10 isolates	3	< 10 isolates	37.1 (0.0–96.4)	NA
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	3	< 10 isolates	6	< 10 isolates	2	< 10 isolates	3	< 10 isolates	3	< 10 isolates	34.1 (0.0–95.1)	NA
S. aureus	MRSA[e]	76	1.3	69	1.4	82	0.0	121	6.6	116	5.2	16.7 (1.4–49.1)	↑
S. pneumoniae	Penicillin non-wild-type[f]	19	10.5	27	18.5	31	9.7	44	15.9	20	30.0	15.6 (3.9–56.3)	NA
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	19	0.0	27	18.5	31	12.9	44	15.9	20	30.0	16.9 (3.5–43.8)	NA
	Combined penicillin non-wild-type and resistance to macrolides[f]	19	0.0	27	14.8	31	9.7	44	11.4	20	30.0	9.0 (0.0–37.5)	NA
E. faecalis	High-level gentamicin resistance	24	16.7	33	18.2	30	16.7	35	11.4	30	6.7	29.0 (4.1–51.6)	–
E. faecium	Vancomycin resistance	16	0.0	17	0.0	16	0.0	13	0.0	19	0.0	16.8 (0.0–56.6)	NA

NA: not applicable as data were not reported for all years, a significant change in data source occurred during the period, or the number of isolates was < 20 in any year during the period.
ND: no data available.
< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ↑ indicates statistically significantly increasing trend; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Ireland

Participating institution

Health Protection Surveillance Centre

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Ireland, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	99	100	100	96	76
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	High	High	High	High	High
Blood-culture sets/1 000 patient days	57.5	58	57.3	58.9	Unknown

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Ireland, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	91	94	97	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	90	85	87	84	NA

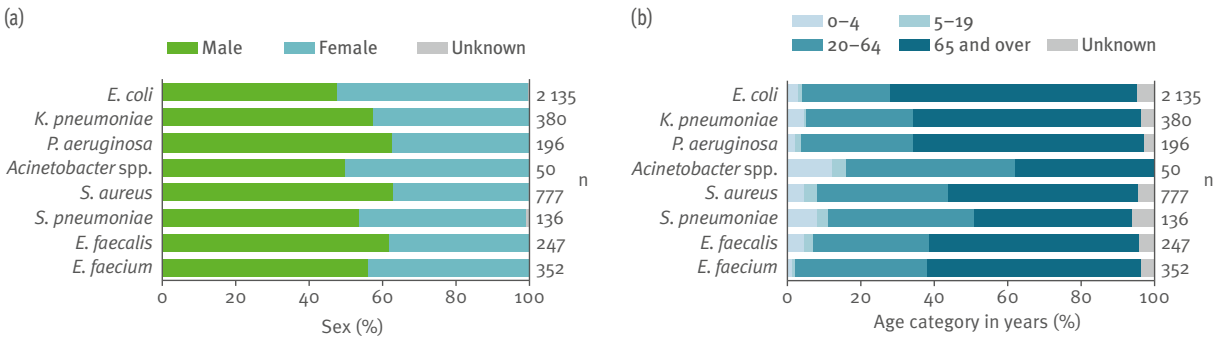
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Ireland, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	39	2 991	Unknown	39	3 125	Unknown	38	3 239	Unknown	34	3 233	Unknown	26	2 135	Unknown
K. pneumoniae	32	453	Unknown	35	479	Unknown	34	483	Unknown	30	527	Unknown	25	380	Unknown
P. aeruginosa	30	243	Unknown	33	288	Unknown	29	273	Unknown	27	276	Unknown	20	196	Unknown
Acinetobacter spp.	25	68	Unknown	23	66	Unknown	17	62	Unknown	21	66	Unknown	14	50	Unknown
S. aureus	37	1 143	Unknown	37	1 144	Unknown	37	1 188	Unknown	32	1 146	Unknown	25	777	Unknown
S. pneumoniae	31	363	Unknown	31	412	Unknown	32	455	Unknown	27	348	Unknown	21	136	Unknown
E. faecalis	34	290	Unknown	33	340	Unknown	36	332	Unknown	30	301	Unknown	24	247	Unknown
E. faecium	31	423	Unknown	33	442	Unknown	30	419	Unknown	27	443	Unknown	21	352	Unknown

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Ireland, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Ireland, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	2 990	68.1	2 991	69.8	3 237	67.6	3 201	67.5	2 126	64.8	54.6 (34.1–67.5)	↓
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	2 985	11.4	3 121	12.0	3 237	12.9	3 231	12.1	2 134	11.3	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	2 989	0.0	3 116	0.0	3 237	0.0	3 229	0.0	2 106	0.1	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	2 990	22.9	3 119	23.6	3 238	23.9	3 223	20.4	2 133	18.9	23.8 (10.0–48.2)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	2 991	11.2	3 123	11.9	3 238	11.7	3 232	11.8	2 134	10.1	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	2 984	5.3	3 116	5.7	3 235	6.1	3 222	5.6	2 131	4.6	5.7 (1.6–18.7)	–
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	452	13.5	478	14.6	483	14.5	527	17.6	380	18.4	33.9 (0.0–79.1)	↑
	Carbapenem (imipenem/meropenem) resistance	453	0.7	478	0.2	482	0.6	527	0.9	370	0.3	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	453	11.3	478	14.9	483	18.0	526	17.3	379	16.4	33.8 (0.0–74.4)	↑
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	453	11.5	479	11.9	483	13.0	526	11.0	379	10.8	23.7 (0.0–67.0)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	452	5.8	477	5.9	483	8.1	525	5.3	378	6.6	21.0 (0.0–58.3)	–
P. aeruginosa	Piperacillin-tazobactam resistance	242	12.4	286	14.0	270	8.1	276	10.9	174	14.4	18.8 (4.4–64.3)	–
	Ceftazidime resistance	243	10.7	272	9.6	261	8.4	272	9.2	172	12.8	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	243	6.2	288	9.0	273	6.6	275	6.5	193	7.8	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	243	11.9	287	13.9	272	8.8	276	9.4	194	12.9	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	243	10.3	288	8.7	273	5.5	276	6.5	113	1.8	9.4 (0.0–37.1)	↓
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	243	8.6	288	7.6	273	3.3	276	5.1	192	5.7	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	65	0.0	63	6.3	60	1.7	63	1.6	48	0.0	38.0 (0.0–96.4)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	68	1.5	66	7.6	61	0.0	64	7.8	37	5.4	41.8 (0.0–98.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	63	1.6	62	3.2	56	3.6	57	1.8	44	0.0	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	61	0.0	59	1.7	55	0.0	53	0.0	31	0.0	34.1 (0.0–95.1)	–
S. aureus	MRSA[e]	1 143	14.3	1 140	16.3	1 188	12.4	1 146	12.6	777	12.1	16.7 (1.4–49.1)	↓
S. pneumoniae	Penicillin non-wild-type[f]	363	16.5	412	15.8	455	20.7	348	14.4	136	17.6	15.6 (3.9–56.3)	–
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	354	13.3	396	12.9	419	13.6	340	12.6	130	13.8	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	354	9.6	396	9.3	419	10.0	340	8.2	130	11.5	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	265	29.4	302	30.8	292	23.6	243	23.0	134	17.2	29.0 (4.1–51.6)	↓
E. faecium	Vancomycin resistance	422	44.1	442	38.2	418	40.2	443	38.4	351	35.9	16.8 (0.0–56.6)	↓

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Italy

Participating institution

National Institute of Health

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Italy, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	17	21	36	41	47
Geographical representativeness	Unknown	Medium	High	High	High
Hospital representativeness	Unknown	Unknown	High	High	High
Patient and isolate representativeness	Unknown	Unknown	High	High	High
Blood-culture sets/1 000 patient days	Unknown	Unknown	55.4	Unknown	57

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Italy, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	92	97	95	95	NA

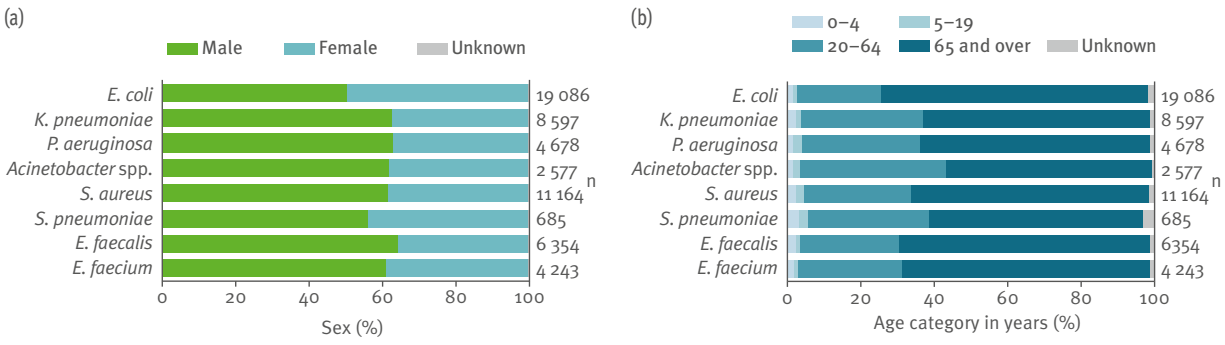
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Italy, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	46	6 110	8	54	7 478	7	97	16 539	7	128	18 866	6	151	19 086	6
K. pneumoniae	47	2 314	28	55	2 720	27	98	5 913	23	123	7 782	22	147	8 597	24
P. aeruginosa	43	1 207	25	54	1 455	25	95	3 050	23	124	3 895	23	145	4 678	27
Acinetobacter spp.	41	708	46	48	878	42	92	1 392	42	100	1 651	38	123	2 577	48
S. aureus	46	3 309	15	55	4 213	16	97	8 581	12	125	9 943	11	149	11 164	14
S. pneumoniae	43	515	11	52	673	9	80	1 160	9	100	1 351	10	109	685	10
E. faecalis	47	1 617	24	55	2 004	26	94	4 153	19	122	4 705	18	149	6 354	28
E. faecium	47	958	23	54	1 085	22	92	2 304	19	118	2 878	19	138	4 243	26

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Italy, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Italy, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	3 114	66.9	4 078	67.1	7 533	64.5	4 457	68.1	4 214	64.5	54.6 (34.1–67.5)	–
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	5 938	29.8	7 077	29.5	16 253	28.7	18 409	30.9	18 750	26.4	14.9 (5.8–41.4)	↓
	Carbapenem (imipenem/meropenem) resistance	6 106	0.3	7 280	0.3	15 452	0.4	17 086	0.4	18 001	0.5	0.2 (0.0–0.8)	↑#
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	5 950	43.3	6 945	44.9	16 043	41.7	18 417	40.6	18 840	37.6	23.8 (10.0–48.2)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	6 079	19.0	7 134	18.4	15 901	16.0	18 382	15.9	17 994	14.9	10.9 (5.5–34.2)	↓
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	5 763	12.9	6 454	13.7	15 622	11.4	17 961	11.6	17 593	9.8	5.7 (1.6–18.7)	↓
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	2 246	55.8	2 546	54.6	5 832	53.6	7 699	57.6	8 400	54.3	33.9 (0.0–79.1)	–
	Carbapenem (imipenem/meropenem) resistance	2 303	33.8	2 633	29.5	5 660	26.8	7 325	28.5	8 293	29.5	10.0 (0.0–66.3)	↓
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	2 248	56.0	2 562	55.7	5 752	52.7	7 692	54.7	8 486	52.4	33.8 (0.0–74.4)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	2 300	36.1	2 571	34.5	5 693	27.0	7 682	32.6	8 084	31.6	23.7 (0.0–67.0)	↓
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	2 174	32.7	2 352	31.6	5 587	24.8	7 560	30.3	7 842	29.5	21.0 (0.0–58.3)	–
P. aeruginosa	Piperacillin-tazobactam resistance	1 146	29.8	1 309	23.2	2 938	23.9	3 768	24.1	4 537	24.2	18.8 (4.4–64.3)	↓
	Ceftazidime resistance	1 160	23.0	1 332	20.0	2 974	19.9	3 798	19.0	4 473	19.3	15.5 (2.9–54.3)	↓#
	Carbapenem (imipenem/meropenem) resistance	1 206	23.3	1 433	19.6	3 014	15.8	3 794	13.7	4 615	15.9	17.8 (3.6–48.9)	↓
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	1 166	24.7	1 390	25.1	2 994	22.9	3 875	21.7	4 599	19.6	19.6 (3.2–52.9)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	1 203	19.1	1 428	18.0	2 983	12.8	3 859	11.4	ND	ND	9.4 (0.0–37.1)	NA
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	1 205	19.8	1 434	17.2	3 006	14.9	3 882	13.1	4 593	11.2	12.1 (0.0–47.1)	↓
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	702	78.5	868	78.7	1 383	79.2	1 588	79.3	2 552	80.8	38.0 (0.0–96.4)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	697	79.9	804	79.2	1 368	81.1	1 636	82.5	2 522	83.4	41.8 (0.0–98.2)	↑
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	704	76.4	836	76.1	1 369	77.0	1 637	78.8	2 496	80.2	37.1 (0.0–96.4)	↑
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	692	74.7	763	72.6	1 351	75.7	1 569	76.6	2 451	78.7	34.1 (0.0–95.1)	↑
S. aureus	MRSA[e]	2 981	33.6	3 591	33.9	8 263	34.0	9 681	34.3	10 923	33.5	16.7 (1.4–49.1)	–
S. pneumoniae	Penicillin non-wild-type[f]	399	6.5	522	10.5	928	9.2	1 017	11.9	516	13.4	15.6 (3.9–56.3)	↑
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	464	22.4	599	22.7	1 095	20.3	1 298	22.3	639	24.1	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	361	4.4	474	5.3	879	4.7	989	6.7	491	7.7	9.0 (0.0–37.5)	↑#
E. faecalis	High-level gentamicin resistance	1 441	45.3	1 630	45.9	2 927	39.9	2 395	34.9	3 028	37.4	29.0 (4.1–51.6)	↓
E. faecium	Vancomycin resistance	941	13.4	1 049	14.6	2 273	18.9	2 839	21.3	4 166	23.6	16.8 (0.0–56.6)	↑

NA: not applicable as data were not reported for all years, a significant change in data source occurred during the period, or the number of isolates was < 20 in any year during the period.
ND: no data available.

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).

[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; # indicates a significant trend in the overall data, but not in data that only included laboratories reporting continuously for all five years; – indicates no statistically significant trend.

[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.

[d] The aminoglycoside group includes only tobramycin from 2020 onwards.

[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.

[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Latvia

Participating institution

Disease Prevention and Control Center of Latvia

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Latvia, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	90	90	90	90	90
Geographical representativeness	High	High	High	High	High
Hospital representativeness	Medium	Medium	Medium	Medium	Medium
Patient and isolate representativeness	Medium	Medium	Medium	Medium	Medium
Blood-culture sets/1 000 patient days	6.6	6.1	8	9.5	13.8

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Latvia, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	27	21	53	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	94	88	100	100	NA

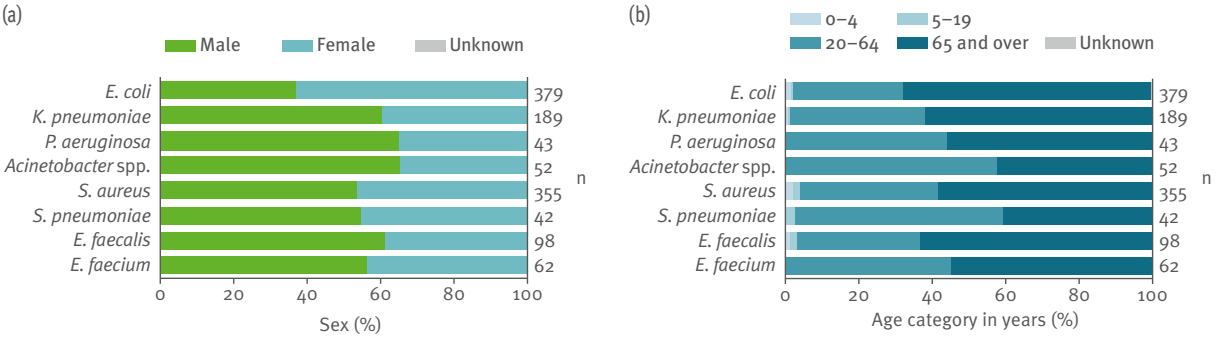
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Latvia, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	11	253	20	12	205	23	11	348	27	10	442	20	10	379	21
K. pneumoniae	8	95	37	7	116	41	13	204	36	9	198	32	9	189	29
P. aeruginosa	5	16	31	4	14	64	4	39	31	6	49	44	9	43	31
Acinetobacter spp.	7	82	62	7	34	62	7	51	65	8	46	61	7	52	54
S. aureus	14	286	21	11	229	22	14	376	20	11	422	20	10	355	21
S. pneumoniae	8	63	60	9	53	38	7	69	38	6	79	33	5	42	38
E. faecalis	12	89	37	8	74	38	10	89	38	10	100	25	9	98	28
E. faecium	6	56	46	5	39	54	7	49	41	8	58	43	9	62	48

Labs: laboratories.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Latvia, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Latvia, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	247	55.1	202	60.4	347	56.2	438	57.8	374	54.3	54.6 (34.1–67.5)	–
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	253	24.1	205	22.0	348	20.4	442	19.7	378	24.1	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	246	0.0	203	0.0	346	0.0	439	0.0	378	0.0	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	245	27.8	201	30.3	344	24.1	442	24.9	378	27.5	23.8 (10.0–48.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	244	12.7	201	13.4	348	8.9	440	11.6	377	11.4	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	242	10.3	197	11.2	344	7.0	440	9.3	376	10.6	5.7 (1.6–18.7)	–
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	95	47.4	116	33.6	204	37.7	198	36.9	188	48.4	33.9 (0.0–79.1)	–
	Carbapenem (imipenem/meropenem) resistance	90	2.2	116	1.7	204	0.5	198	0.0	189	1.1	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	91	41.8	116	32.8	200	38.5	198	36.9	188	41.5	33.8 (0.0–74.4)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	91	38.5	115	29.6	203	31.0	198	28.3	186	21.0	23.7 (0.0–67.0)	⇩
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	91	31.9	115	24.3	199	27.6	198	25.3	185	19.5	21.0 (0.0–58.3)	⇩
P. aeruginosa	Piperacillin-tazobactam resistance	15	26.7	14	35.7	39	35.9	45	35.6	14	28.6	18.8 (4.4–64.3)	NA
	Ceftazidime resistance	15	26.7	14	42.9	39	33.3	49	32.7	42	23.8	15.5 (2.9–54.3)	NA
	Carbapenem (imipenem/meropenem) resistance	16	31.3	14	57.1	39	28.2	49	32.7	43	25.6	17.8 (3.6–48.9)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	16	31.3	14	64.3	39	23.1	49	28.6	39	30.8	19.6 (3.2–52.9)	NA
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	15	20.0	14	42.9	39	28.2	49	22.4	7	< 10 isolates	9.4 (0.0–37.1)	NA
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	16	18.8	14	42.9	39	30.8	49	22.4	43	11.6	12.1 (0.0–47.1)	NA
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	82	73.2	34	79.4	51	78.4	46	84.8	52	82.7	38.0 (0.0–96.4)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	68	85.3	33	81.8	47	80.9	24	83.3	50	86.0	41.8 (0.0–98.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	81	77.8	33	78.8	48	60.4	44	68.2	52	63.5	37.1 (0.0–96.4)	⇩
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	67	67.2	32	75.0	44	56.8	22	50.0	50	64.0	34.1 (0.0–95.1)	–
S. aureus	MRSA[e]	284	4.2	210	5.7	315	5.7	421	7.4	353	9.3	16.7 (1.4–49.1)	⇧
S. pneumoniae	Penicillin non-wild-type[f]	61	11.5	51	17.6	69	10.1	79	10.1	41	17.1	15.6 (3.9–56.3)	–
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	52	5.8	28	3.6	66	9.1	76	5.3	27	11.1	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	51	3.9	28	3.6	66	6.1	76	3.9	27	3.7	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	87	46.0	72	45.8	86	32.6	93	44.1	89	38.2	29.0 (4.1–51.6)	–
E. faecium	Vancomycin resistance	56	28.6	39	25.6	48	35.4	58	39.7	62	29.0	16.8 (0.0–56.6)	–

NA: not applicable as data were not reported for all years, a significant change in data source occurred during the period, or the number of isolates was < 20 in any year during the period.
< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ⇧ and ⇩ indicate statistically significantly increasing and decreasing trends, respectively; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Lithuania

Participating institutions

National Public Health Surveillance Laboratory
Institute of Hygiene

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Lithuania, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	100	100	100	100	100
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	High	High	High	High	High
Blood-culture sets/1 000 patient days	7.1	6.3	5.3	6.1	8.1

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Lithuania, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	100	100	94	89	NA

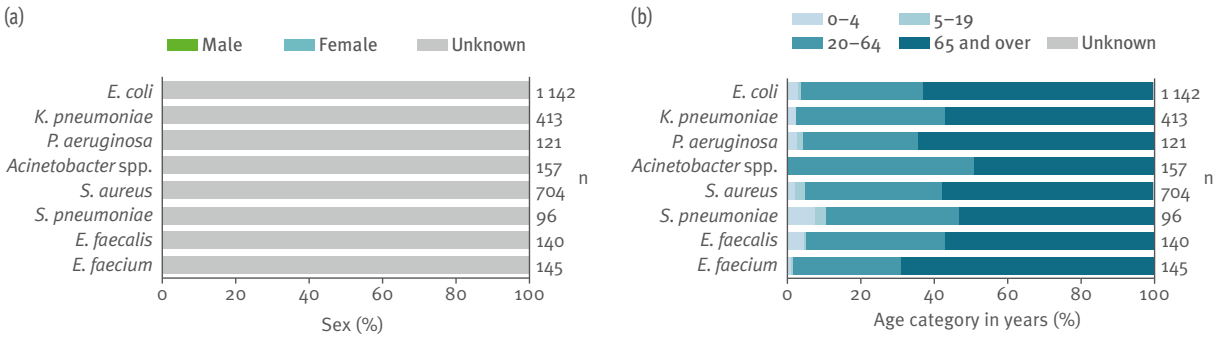
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Lithuania, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	17	797	21	16	852	19	17	1 109	17	18	1 132	20	17	1 142	18
K. pneumoniae	16	326	33	15	326	30	17	371	24	17	440	28	16	413	25
P. aeruginosa	13	74	36	13	89	36	13	101	32	17	104	32	15	121	26
Acinetobacter spp.	11	87	64	12	87	56	13	88	58	13	108	57	12	157	71
S. aureus	17	505	23	16	515	20	18	693	24	18	656	21	17	704	22
S. pneumoniae	12	99	28	14	109	27	13	93	29	16	120	38	14	96	22
E. faecalis	13	86	31	13	111	26	14	138	25	15	143	30	14	140	28
E. faecium	13	61	38	13	80	33	14	99	34	14	128	38	15	145	43

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Lithuania, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Lithuania, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	794	59.2	845	57.8	1 106	59.0	1 129	59.1	1 138	56.9	54.6 (34.1–67.5)	–
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	795	14.7	852	16.8	1 109	15.3	1 132	13.9	1 142	15.9	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	793	0.0	849	0.0	1 100	0.0	1 122	0.2	1 142	0.0	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	790	19.7	849	25.2	1 104	19.7	1 129	18.0	1 136	18.8	23.8 (10.0–48.2)	⇩
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	791	8.0	848	8.3	1 103	7.9	1 129	7.6	1 141	10.3	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	783	2.6	845	4.4	1 098	4.6	1 126	4.5	1 135	6.4	5.7 (1.6–18.7)	⇧
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	326	56.7	326	63.2	371	55.8	440	55.0	413	42.6	33.9 (0.0–79.1)	⇩
	Carbapenem (imipenem/meropenem) resistance	325	0.0	325	0.6	371	0.3	438	3.4	413	2.9	10.0 (0.0–66.3)	⇧
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	324	54.6	326	64.7	370	56.8	438	52.1	413	45.3	33.8 (0.0–74.4)	⇩
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	325	49.2	322	53.7	369	48.5	435	39.8	410	33.9	23.7 (0.0–67.0)	⇩
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	323	42.1	322	48.1	368	45.1	433	35.3	410	28.5	21.0 (0.0–58.3)	⇩
P. aeruginosa	Piperacillin-tazobactam resistance	74	13.5	89	18.0	101	17.8	102	23.5	121	23.1	18.8 (4.4–64.3)	–
	Ceftazidime resistance	74	10.8	88	14.8	101	11.9	103	15.5	119	16.8	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	74	16.2	89	24.7	101	21.8	104	16.3	121	25.6	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	73	15.1	89	21.3	101	12.9	104	17.3	120	18.3	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	74	14.9	89	13.5	101	9.9	103	12.6	ND	ND	9.4 (0.0–37.1)	NA
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	74	10.8	89	16.9	101	11.9	104	12.5	121	14.0	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	87	81.6	87	88.5	88	89.8	108	85.2	157	91.1	38.0 (0.0–96.4)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	87	87.4	86	91.9	88	90.9	108	91.7	154	92.9	41.8 (0.0–98.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	87	82.8	86	81.4	87	85.1	107	83.2	153	86.3	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	87	75.9	85	77.6	87	85.1	107	78.5	150	86.7	34.1 (0.0–95.1)	⇧
S. aureus	MRSA[e]	503	11.3	514	8.8	691	8.4	656	9.3	704	9.8	16.7 (1.4–49.1)	–
S. pneumoniae	Penicillin non-wild-type[f]	99	16.2	109	15.6	93	19.4	120	10.8	96	13.5	15.6 (3.9–56.3)	–
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	94	18.1	107	15.9	92	20.7	119	10.1	96	14.6	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides	94	12.8	107	11.2	92	13.0	119	7.6	96	9.4	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	45	35.6	60	36.7	65	27.7	78	41.0	68	13.2	29.0 (4.1–51.6)	⇩
E. faecium	Vancomycin resistance	61	21.3	80	36.3	99	31.3	128	39.8	145	56.6	16.8 (0.0–56.6)	⇧

NA: not applicable as data were not reported for all years, a significant change in data source occurred during the period, or the number of isolates was < 20 in any year during the period.
ND: no data available.

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).

[b] ⇧ and ⇩ indicate statistically significantly increasing and decreasing trends, respectively; – indicates no statistically significant trend.

[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.

[d] The aminoglycoside group includes only tobramycin from 2020 onwards.

[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.

[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Luxembourg

Participating institutions

National Health Laboratory
Microbiology Laboratory, Centre Hospitalier de Luxembourg

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Luxembourg, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	100	100	100	Unknown	99
Geographical representativeness	High	Unknown	High	Unknown	High
Hospital representativeness	Unknown	Unknown	High	Unknown	High
Patient and isolate representativeness	Unknown	Unknown	High	Unknown	High
Blood-culture sets/1 000 patient days	26.0	Unknown	28.2	Unknown	38.9

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Luxembourg, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	100	100	100	100	NA

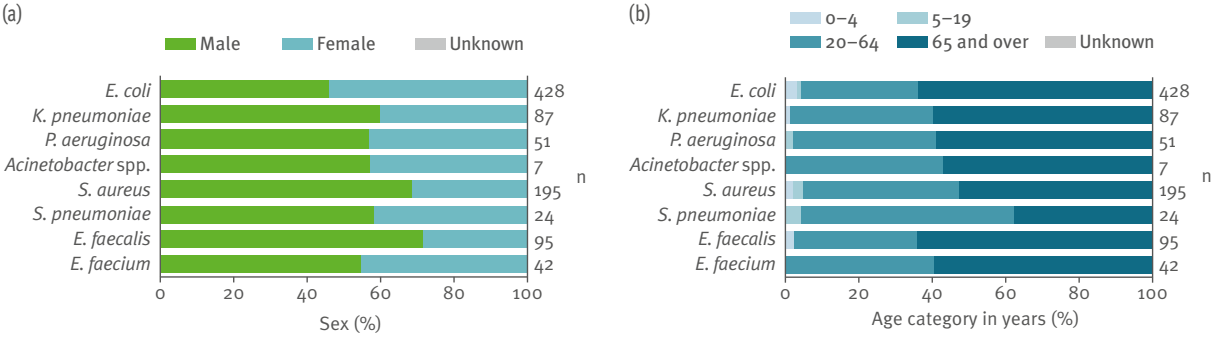
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Luxembourg, 2016–2020

Bacterial species	2016			2017			2018			2019			2020[c]		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	4	419	11	4	433	8	4	424	11	4	492	8	3	428	8
K. pneumoniae	4	78	25	4	99	21	4	85	18	4	103	18	3	87	23
P. aeruginosa	4	40	15	4	56	21	4	59	7	4	56	18	3	51	14
Acinetobacter spp.	2	8	< 10 isolates	2	8	< 10 isolates	2	11	9	3	10	20	2	7	< 10 isolates
S. aureus	4	188	25	4	200	17	4	181	13	4	209	15	3	195	18
S. pneumoniae	4	51	10	4	49	12	4	45	21	4	38	11	3	24	13
E. faecalis	4	48	24	4	87	27	4	51	20	4	82	24	3	95	37
E. faecium	4	31	20	4	34	32	4	29	18	4	37	32	3	42	20

Labs: laboratories.
< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.
[c] For 2020, Luxembourg data corresponds to data reported from four different laboratories. Data on the number of laboratories will be adjusted in 2022 output.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Luxembourg, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Luxembourg, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	419	53.2	433	55.9	420	55.2	492	57.5	427	52.5	54.6 (34.1–67.5)	–
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	418	13.6	433	9.7	424	12.5	492	12.6	428	11.4	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	418	0.0	433	0.0	424	0.0	492	0.6	428	0.0	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	418	28.9	433	22.9	418	21.8	492	20.5	428	21.7	23.8 (10.0–48.2)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	418	9.1	433	10.4	423	7.3	492	10.2	428	8.9	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	418	3.8	433	3.5	417	3.8	492	3.9	428	4.0	5.7 (1.6–18.7)	–
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	78	35.9	99	27.3	85	29.4	103	25.2	87	26.4	33.9 (0.0–79.1)	–
	Carbapenem (imipenem/meropenem) resistance	78	0.0	99	0.0	85	0.0	103	1.0	87	1.1	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	78	35.9	99	28.3	85	24.7	103	27.2	87	31.0	33.8 (0.0–74.4)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	78	26.9	99	18.2	85	20.0	103	17.5	87	20.7	23.7 (0.0–67.0)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	78	24.4	99	17.2	85	15.3	103	13.6	87	20.7	21.0 (0.0–58.3)	–
P. aeruginosa	Piperacillin-tazobactam resistance	40	12.5	54	11.1	56	12.5	44	2.3	51	5.9	18.8 (4.4–64.3)	–
	Ceftazidime resistance	40	5.0	56	12.5	59	8.5	56	3.6	50	4.0	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	31	6.5	56	10.7	54	11.1	31	9.7	47	8.5	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	40	12.5	56	12.5	59	22.0	56	8.9	50	22.0	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	40	15.0	56	5.4	53	3.8	56	1.8	40	2.5	9.4 (0.0–37.1)	↓
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	40	2.5	56	5.4	59	3.4	56	0.0	50	4.0	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	8	< 10 isolates	8	< 10 isolates	6	< 10 isolates	8	< 10 isolates	7	< 10 isolates	38.0 (0.0–96.4)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	8	< 10 isolates	8	< 10 isolates	11	0.0	10	10.0	7	< 10 isolates	41.8 (0.0–98.2)	NA
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	8	< 10 isolates	8	< 10 isolates	11	0.0	10	0.0	7	< 10 isolates	37.1 (0.0–96.4)	NA
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	8	< 10 isolates	8	< 10 isolates	6	< 10 isolates	8	< 10 isolates	7	< 10 isolates	34.1 (0.0–95.1)	NA
S. aureus	MRSA[e]	187	10.2	200	9.5	181	7.7	209	6.2	195	3.1	16.7 (1.4–49.1)	↓
S. pneumoniae	Penicillin non-wild-type[f]	51	13.7	45	6.7	45	11.1	38	21.1	24	16.7	15.6 (3.9–56.3)	–
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	51	15.7	49	8.2	45	11.1	38	7.9	24	12.5	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	51	7.8	45	4.4	45	4.4	38	2.6	24	0.0	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	48	12.5	82	22.0	45	6.7	82	4.9	95	10.5	29.0 (4.1–51.6)	↓#
E. faecium	Vancomycin resistance	31	0.0	34	0.0	28	0.0	37	2.7	42	11.9	16.8 (0.0–56.6)	↑

NA: not applicable as data were not reported for all years, a significant change in data source occurred during the period, or the number of isolates was < 20 in any year during the period.
< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).

[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; # indicates a significant trend in the overall data, but not in data that only included laboratories reporting continuously for all five years; – indicates no statistically significant trend.

[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.

[d] The aminoglycoside group includes only tobramycin from 2020 onwards.

[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.

[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Malta

Participating institution

Malta Mater Dei Hospital, Msida

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Malta, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	95	95	95	95	95
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	High	High	High	High	High
Blood-culture sets/1 000 patient days	25	26.3	29.2	28.5	35.2

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Malta, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	100	100	100	100	NA

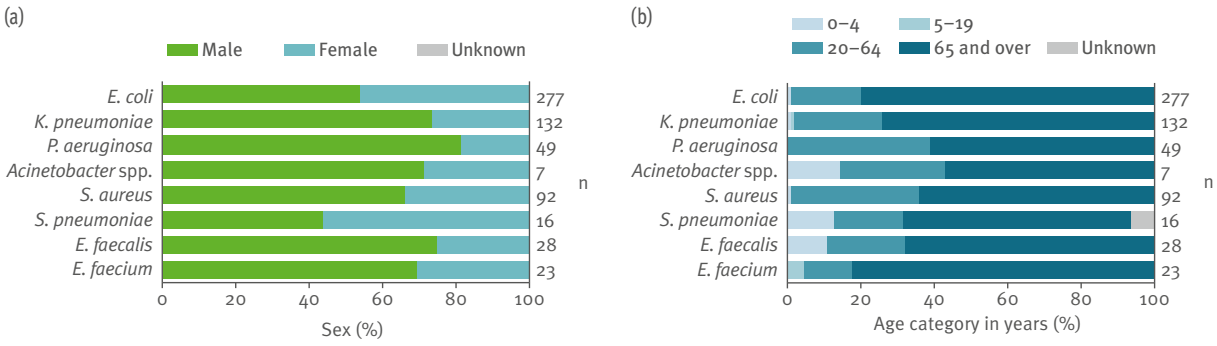
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Malta, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	1	328	4	1	314	1	1	332	2	1	332	1	1	277	2
K. pneumoniae	1	102	10	1	117	10	1	137	13	1	129	10	1	132	6
P. aeruginosa	1	40	5	1	37	19	1	29	14	1	39	23	1	49	13
Acinetobacter spp.	1	7	< 10 isolates	1	9	< 10 isolates	1	9	< 10 isolates	1	15	7	1	7	< 10 isolates
S. aureus	1	97	9	1	97	1	1	90	10	1	75	7	1	92	6
S. pneumoniae	1	10	0	1	19	7	1	37	0	1	27	0	1	16	0
E. faecalis	1	33	3	1	29	5	1	32	6	1	30	3	1	28	20
E. faecium	1	12	25	1	13	10	1	15	0	1	13	8	1	23	24

Labs: laboratories.
< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Malta, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Malta, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	328	60.1	314	59.6	332	59.6	332	64.8	277	58.5	54.6 (34.1–67.5)	–
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	328	14.6	314	15.6	332	15.4	332	17.5	277	12.3	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	328	0.0	314	0.0	332	0.0	332	0.0	277	0.0	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	328	41.5	314	43.3	332	41.9	332	40.1	277	35.4	23.8 (10.0–48.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	328	10.4	314	10.8	332	9.9	332	9.9	277	12.6	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	328	5.5	314	6.4	332	4.5	332	5.1	277	8.3	5.7 (1.6–18.7)	–
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	102	21.6	117	35.0	137	53.3	129	37.2	132	38.6	33.9 (0.0–79.1)	↑
	Carbapenem (imipenem/meropenem) resistance	102	5.9	117	10.3	136	15.4	129	7.8	132	7.6	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	102	33.3	117	39.3	137	55.5	129	44.2	132	37.1	33.8 (0.0–74.4)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	102	22.5	117	31.6	137	46.7	129	26.4	132	23.5	23.7 (0.0–67.0)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	102	14.7	117	28.2	137	43.8	129	22.5	132	18.9	21.0 (0.0–58.3)	–
P. aeruginosa	Piperacillin-tazobactam resistance	40	10.0	37	18.9	29	17.2	39	15.4	49	18.4	18.8 (4.4–64.3)	–
	Ceftazidime resistance	40	7.5	37	13.5	29	13.8	39	15.4	49	12.2	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	40	12.5	37	10.8	29	3.4	39	7.7	49	8.2	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	40	10.0	37	10.8	29	0.0	39	12.8	49	16.3	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	40	7.5	37	10.8	29	0.0	39	5.1	49	2.0	9.4 (0.0–37.1)	–
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	40	5.0	37	8.1	29	3.4	39	7.7	49	10.2	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	7	< 10 isolates	9	< 10 isolates	9	< 10 isolates	15	0.0	7	< 10 isolates	38.0 (0.0–96.4)	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	7	< 10 isolates	9	< 10 isolates	9	< 10 isolates	15	6.7	7	< 10 isolates	41.8 (0.0–98.2)	NA
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	7	< 10 isolates	9	< 10 isolates	8	< 10 isolates	14	0.0	7	< 10 isolates	37.1 (0.0–96.4)	NA
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	7	< 10 isolates	9	< 10 isolates	8	< 10 isolates	14	0.0	7	< 10 isolates	34.1 (0.0–95.1)	NA
S. aureus	MRSA[e]	97	37.1	95	42.1	88	36.4	75	24.0	92	19.6	16.7 (1.4–49.1)	↓
S. pneumoniae	Penicillin non-wild-type[f]	10	10.0	19	31.6	37	24.3	27	33.3	16	56.3	15.6 (3.9–56.3)	NA
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	9	< 10 isolates	19	36.8	37	24.3	25	28.0	16	43.8	16.9 (3.5–43.8)	NA
	Combined penicillin non-wild-type and resistance to macrolides[f]	9	< 10 isolates	19	26.3	37	13.5	25	20.0	16	37.5	9.0 (0.0–37.5)	NA
E. faecalis	High-level gentamicin resistance	33	39.4	29	34.5	31	22.6	30	26.7	28	25.0	29.0 (4.1–51.6)	–
E. faecium	Vancomycin resistance	12	8.3	13	0.0	15	26.7	13	0.0	23	21.7	16.8 (0.0–56.6)	NA

NA: not applicable as data were not reported for all years, a significant change in data source occurred during the period, or the number of isolates was < 20 in any year during the period.
< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Montenegro

Participating institution

Department of Bacteriology, Institute of Public Health

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Montenegro, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated population coverage (%)	76	100	100	100	100
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	Poor	Poor	Poor	Poor	Poor
Blood-culture sets/1 000 patient days[a]	2 (1–14)	3 (0–15)	3 (1–16)	4 (0–18)	3 (0–25)

Definitions provided on page 7.
[a] Data are presented as median (range).

Laboratories contributing data: use of clinical breakpoint guidelines and participation in CAESAR EQA, Montenegro, 2016–2020

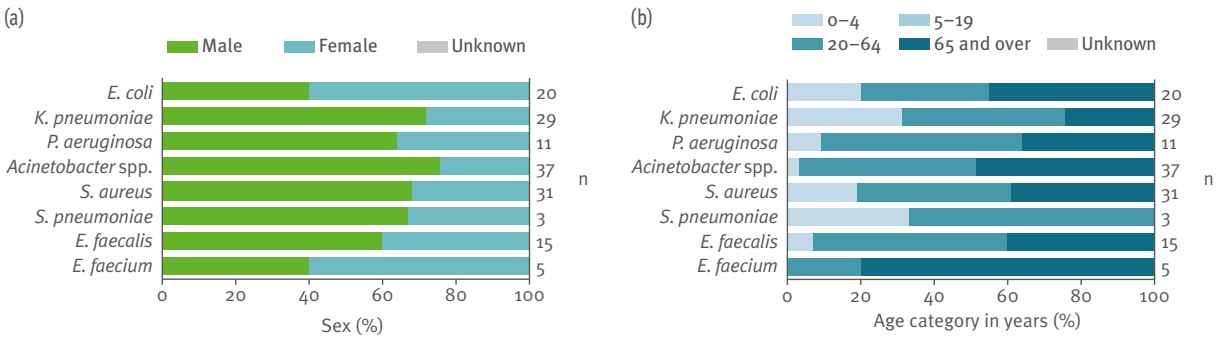
Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	0	0	75	88	88
Percentage of laboratories participating in CAESAR EQA	100	100	100	100	100

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Montenegro, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	1	19	11	1	21	10	4	29	21	2	24	67	4	20	26
K. pneumoniae	2	28	18	2	29	31	2	22	32	2	23	70	3	29	55
P. aeruginosa	1	5	40	2	14	43	2	11	55	1	16	63	2	11	45
Acinetobacter spp.	1	13	46	1	10	50	1	14	79	1	32	59	2	37	59
S. aureus	3	47	30	4	36	17	4	41	15	3	43	47	4	31	29
S. pneumoniae	3	7	0	2	4	25	2	7	43	2	4	75	2	3	0
E. faecalis	1	7	57	1	12	25	2	5	60	3	9	44	3	15	33
E. faecium	2	16	13	1	6	17	1	6	67	2	8	38	1	5	20

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories may be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Montenegro, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, Montenegro, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020	
		n	%	n	%	n	%	n	%	n	%
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	17	100.0[a]	18	88.9[a]	29	82.8[a]	23	73.9[a]	20	80.0[a]
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	19	84.2[a]	20	70.0[a]	29	62.1[a]	24	37.5[a]	20	40.0[a]
	Carbapenem (imipenem/meropenem) resistance	19	0.0[a]	20	0.0[a]	29	0.0[a]	24	0.0[a]	20	0.0[a]
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	19	15.8[a]	20	25.0[a]	29	55.2[a]	24	45.8[a]	20	40.0[a]
	Aminoglycoside (gentamicin/tobramycin) resistance	19	73.7[a]	20	45.0[a]	29	51.7[a]	24	33.3[a]	20	30.0[a]
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	19	5.3[a]	19	5.3[a]	29	37.9[a]	24	29.2[a]	20	15.0[a]
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	27	88.9[a]	29	96.6[a]	22	95.5[a]	23	87.0[a]	29	86.2[a]
	Carbapenem (imipenem/meropenem) resistance	27	3.7[a]	29	13.8[a]	22	4.5[a]	23	17.4[a]	29	13.8[a]
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	27	63.0[a]	29	58.6[a]	22	63.6[a]	23	47.8[a]	29	62.1[a]
	Aminoglycoside (gentamicin/tobramycin) resistance	28	82.1[a]	29	96.6[a]	22	90.9[a]	23	78.3[a]	29	86.2[a]
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	27	63.0[a]	29	58.6[a]	22	59.1[a]	23	34.8[a]	29	62.1[a]
P. aeruginosa	Piperacillin-tazobactam resistance	5	< 10 isolates	14	21.4[a]	11	72.7[a]	16	43.8[a]	11	63.6[a]
	Ceftazidime resistance	5	< 10 isolates	13	38.5[a]	10	50.0[a]	16	31.3[a]	9	< 10 isolates
	Carbapenem (imipenem/meropenem) resistance	5	< 10 isolates	14	35.7[a]	11	63.6[a]	16	43.8[a]	11	72.7[a]
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	5	< 10 isolates	14	50.0[a]	11	90.9[a]	15	53.3[a]	10	50.0[a]
	Aminoglycoside (gentamicin/tobramycin) resistance[b]	5	< 10 isolates	14	57.1[a]	11	81.8[a]	16	50.0[a]	9	< 10 isolates
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[b]	5	< 10 isolates	13	38.5[a]	10	90.0[a]	15	53.3[a]	8	< 10 isolates
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	13	92.3[a]	10	90.0[a]	14	85.7[a]	32	96.9	37	100.0
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	13	84.6[a]	9	< 10 isolates	14	85.7[a]	32	96.9	37	100.0
	Aminoglycoside (gentamicin/tobramycin) resistance	13	84.6[a]	10	90.0[a]	14	85.7[a]	32	81.3	37	91.9
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides	13	84.6[a]	9	< 10 isolates	14	85.7[a]	32	81.3	37	91.9
S. aureus	MRSA[c]	47	34.0	35	22.9	41	29.3	43	25.6	31	9.7
S. pneumoniae	Penicillin non-wild-type[d]	7	< 10 isolates	4	< 10 isolates	6	< 10 isolates	4	< 10 isolates	3	< 10 isolates
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	5	< 10 isolates	4	< 10 isolates	7	< 10 isolates	4	< 10 isolates	2	< 10 isolates
	Combined penicillin non-wild-type and resistance to macrolides[d]	5	< 10 isolates	4	< 10 isolates	6	< 10 isolates	4	< 10 isolates	2	< 10 isolates
E. faecalis	High-level gentamicin resistance	7	< 10 isolates	11	54.5[a]	5	< 10 isolates	9	< 10 isolates	15	40.0[a]
E. faecium	Vancomycin resistance	14	0.0[a]	6	< 10 isolates	6	< 10 isolates	8	< 10 isolates	5	< 10 isolates

< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.
[a] A small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.
[b] The aminoglycoside group includes only tobramycin from 2020 onwards.
[c] MRSA is calculated as resistance to cefoxitin or, if not available, oxacillin.
[d] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints might define the cut-off values for the susceptibility categories differently.

Netherlands

Participating institution

National Institute for Public Health and the Environment

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Netherlands, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	70	70	72	70	72
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	High	High	High	High	High
Blood-culture sets/1 000 patient days	Unknown	Unknown	Unknown	Unknown	Unknown

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Netherlands, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	85	85	92	89	NA

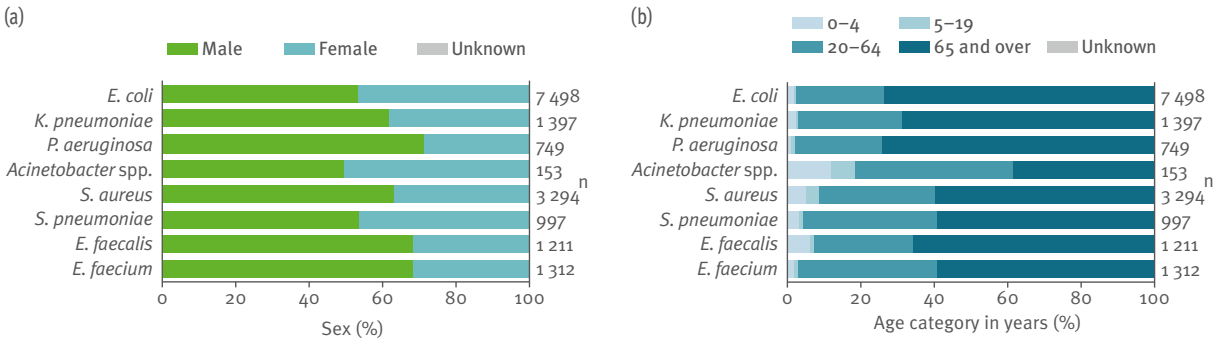
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Netherlands, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	36	7 251	7	37	7 515	6	39	8 276	5	35	7 302	5	38	7 498	4
K. pneumoniae	36	1 321	9	37	1 330	10	39	1 521	7	35	1 434	7	38	1 397	6
P. aeruginosa	36	660	13	37	738	14	39	808	11	35	683	12	37	749	11
Acinetobacter spp.	35	136	10	34	132	16	36	149	14	31	127	13	34	153	11
S. aureus	36	3 044	9	37	3 045	9	39	3 568	9	35	3 221	9	38	3 294	8
S. pneumoniae	36	1736	9	37	1 708	9	39	1 938	8	35	1 552	7	38	997	6
E. faecalis	36	933	18	37	1 014	15	39	1 087	15	35	984	14	38	1 211	24
E. faecium	35	867	44	37	882	39	39	1 008	35	35	789	37	37	1 312	53

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Netherlands, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Netherlands, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	7 246	46.1	7 512	46.0	8 272	46.0	7 301	45.4	7 494	42.7	54.6 (34.1–67.5)	↓
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	7 250	6.6	7 509	6.4	8 270	7.3	7 300	7.5	7 494	6.6	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	7 245	0.0	7 506	0.0	8 272	0.0	7 299	0.0	7 487	0.0	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	7 249	12.9	7 511	14.4	8 274	14.7	7 298	14.6	7 490	13.3	23.8 (10.0–48.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	7 248	6.2	7 512	5.9	8 275	6.3	7 301	7.0	7 495	6.4	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	7 247	2.3	7 504	2.1	8 268	2.2	7 296	2.6	7 486	1.9	5.7 (1.6–18.7)	–
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	1 320	10.5	1 329	10.9	1 520	10.7	1 434	9.6	1 397	11.2	33.9 (0.0–79.1)	–
	Carbapenem (imipenem/meropenem) resistance	1 317	0.1	1 330	0.5	1 520	0.5	1 433	0.2	1 396	0.1	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	1 320	7.1	1 330	11.7	1 521	11.6	1 432	11.1	1 395	13.1	33.8 (0.0–74.4)	↑
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	1 320	6.8	1 330	7.4	1 521	7.0	1 434	6.0	1 397	7.3	23.7 (0.0–67.0)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	1 320	3.9	1 329	4.7	1 520	4.4	1 432	3.5	1 395	4.3	21.0 (0.0–58.3)	–
P. aeruginosa	Piperacillin-tazobactam resistance	635	4.1	696	7.0	764	6.2	621	5.8	701	6.1	18.8 (4.4–64.3)	–
	Ceftazidime resistance	660	3.3	738	3.5	805	2.7	662	3.5	748	2.9	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	660	4.4	736	4.5	805	5.1	682	5.1	746	3.6	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	659	6.1	738	9.1	808	8.9	682	10.4	749	9.1	19.6 (3.2–52.9)	↑
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	658	2.4	738	3.7	808	2.4	683	1.6	748	1.1	9.4 (0.0–37.1)	↓
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	660	2.3	738	2.0	808	1.9	683	1.9	749	1.7	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	132	0.0	130	0.8	148	4.7	124	0.8	148	0.7	38.0 (0.0–96.4)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	134	2.2	132	3.0	149	7.4	127	7.9	147	4.1	41.8 (0.0–98.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	131	3.1	130	3.1	148	4.7	124	3.2	149	1.3	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	128	0.0	129	0.8	147	4.8	122	0.8	139	0.0	34.1 (0.0–95.1)	–
S. aureus	MRSA[e]	3 041	1.2	3 045	1.6	3 566	1.3	3 221	1.6	3 293	1.4	16.7 (1.4–49.1)	–
S. pneumoniae	Penicillin non-wild-type[f]	1 544	2.5	1 532	3.4	1 713	3.0	1 360	4.0	799	4.8	15.6 (3.9–56.3)	↑
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	1 602	3.1	1 597	5.1	1 806	3.9	1 406	4.8	919	3.5	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	1 410	0.5	1 422	1.0	1 583	0.9	1 215	1.3	722	0.8	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	661	25.3	708	23.6	757	22.5	604	20.0	544	29.6	29.0 (4.1–51.6)	–
E. faecium	Vancomycin resistance	866	1.0	881	1.4	1 006	1.3	786	0.9	1 310	0.5	16.8 (0.0–56.6)	–

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

North Macedonia

Participating institution

Laboratory for Bacteriology, Department of Microbiology, Institute of Public Health

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, North Macedonia, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated population coverage (%)	100	100	100	100	100
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	Poor	Poor	Poor	Poor	Poor
Blood-culture sets/1 000 patient days[a]	Unknown	3 (0–37)	4 (0–40)	Unknown	Unknown

Definitions provided on page 7.
[a] Data are presented as median (range).

Laboratories contributing data: use of clinical breakpoint guidelines and participation in CAESAR EQA, North Macedonia, 2016–2020

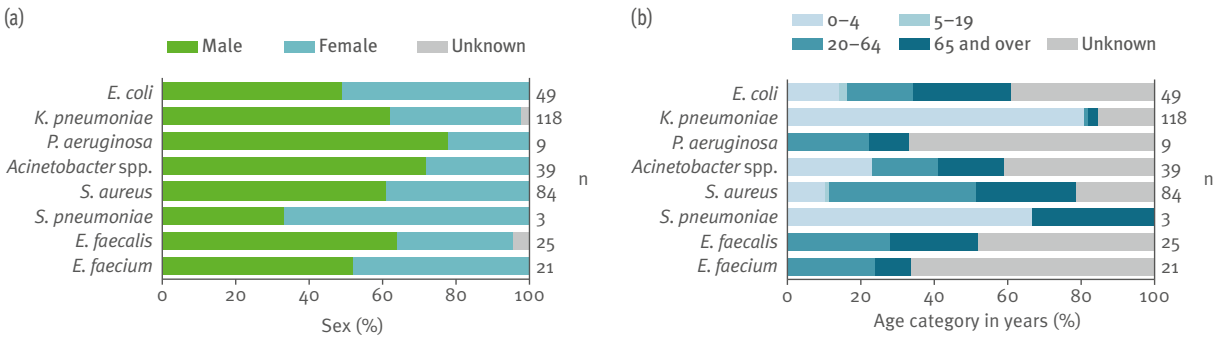
Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	Unknown	87	94	94	94
Percentage of laboratories participating in CAESAR EQA	Unknown	63	94	78	92

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] North Macedonia, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	8	64	6	5	77	0	7	54	6	11	82	10	9	49	14
K. pneumoniae	5	24	38	7	24	27	8	39	23	5	55	36	6	118	82
P. aeruginosa	5	17	18	7	17	25	3	11	9	4	21	10	2	9	0
Acinetobacter spp.	5	36	39	6	29	31	3	27	30	4	37	14	5	39	43
S. aureus	6	69	6	8	52	8	9	62	3	11	87	3	11	84	6
S. pneumoniae	2	12	8	1	6	0	4	5	0	4	14	0	2	3	0
E. faecalis	6	28	11	6	21	10	6	36	6	7	41	5	6	25	4
E. faecium	5	19	21	5	29	4	3	30	13	5	30	14	5	21	5

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories may be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, North Macedonia, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, North Macedonia, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020	
		n	%	n	%	n	%	n	%	n	%
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	42	92.9	35	82.9	53	96.2	66	87.9	47	93.6
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	64	73.4	76	71.1	53	79.2	82	62.2	49	87.8
	Carbapenem (imipenem/meropenem) resistance	64	0.0	77	0.0	54	3.7	82	1.2	49	2.0
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	63	77.8	77	62.3	54	74.1	80	58.7	49	69.4
	Aminoglycoside (gentamicin/tobramycin) resistance	64	60.9	76	50.0	53	50.9	82	39.0	49	46.9
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	63	52.4	75	38.7	52	40.4	80	23.8	49	28.6
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	24	95.8[a]	23	82.6[a]	39	94.9	55	92.7	118	99.2
	Carbapenem (imipenem/meropenem) resistance	24	12.5[a]	23	17.4[a]	39	20.5	55	7.3	118	5.1
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	24	62.5[a]	23	69.6[a]	39	87.2	55	87.3	118	75.4
	Aminoglycoside (gentamicin/tobramycin) resistance	24	95.8[a]	23	78.3[a]	38	89.5	55	96.4	118	97.5
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	24	58.3[a]	23	69.6[a]	38	78.9	55	85.5	118	73.7
P. aeruginosa	Piperacillin-tazobactam resistance	15	33.3[a]	17	35.3[a]	10	0.0[a]	21	19.0[a]	8	< 10 isolates
	Ceftazidime resistance	6	< 10 isolates	17	23.5[a]	11	36.4[a]	21	23.8[a]	9	< 10 isolates
	Carbapenem (imipenem/meropenem) resistance	17	41.2[a]	17	29.4[a]	11	9.1[a]	21	14.3[a]	9	< 10 isolates
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	17	35.3[a]	17	47.1[a]	11	27.3[a]	21	38.1[a]	9	< 10 isolates
	Aminoglycoside (gentamicin/tobramycin) resistance[b]	17	29.4[a]	17	29.4[a]	11	36.4[a]	20	30.0[a]	8	< 10 isolates
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[b]	6	< 10 isolates	17	23.5[a]	10	20.0[a]	20	25.0[a]	7	< 10 isolates
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	36	80.6	28	82.1[a]	27	77.8[a]	37	89.2	39	97.4
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	36	91.7	29	79.3[a]	27	96.3[a]	37	97.3	39	97.4
	Aminoglycoside (gentamicin/tobramycin) resistance	35	82.9	28	82.1[a]	27	88.9[a]	37	73.0	39	84.6
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides	35	74.3	28	75.0[a]	27	74.1[a]	37	73.0	39	84.6
S. aureus	MRSA[c]	69	47.8	49	53.1	61	54.1	87	44.8	83	43.4
S. pneumoniae	Penicillin non-wild-type[d]	11	27.3[a]	6	< 10 isolates	5	< 10 isolates	14	57.1[a]	3	< 10 isolates
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	11	36.4[a]	6	< 10 isolates	5	< 10 isolates	14	42.9[a]	3	< 10 isolates
	Combined penicillin non-wild-type and resistance to macrolides[d]	10	20.0[a]	6	< 10 isolates	5	< 10 isolates	14	42.9[a]	3	< 10 isolates
E. faecalis	High-level gentamicin resistance	20	75.0[a]	14	64.3[a]	30	76.7	35	54.3	16	68.7[a]
E. faecium	Vancomycin resistance	17	52.9[a]	29	51.7[a]	30	56.7	28	64.3[a]	21	66.7[a]

< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.

[a] A small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.

[b] The aminoglycoside group includes only tobramycin from 2020 onwards.

[c] MRSA is calculated as resistance to cefoxitin or, if not available, oxacillin.

[d] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints might define the cut-off values for the susceptibility categories differently.

Norway

Participating institutions

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

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Norway, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	100	100	94	94	94
Geographical representativeness	High	High	High	High	High
Hospital representativeness	Unknown	High	High	High	High
Patient and isolate representativeness	Unknown	High	High	High	High
Blood-culture sets/1 000 patient days	63.2	Unknown	47.4	86.7	91.9

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Norway, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	100	100	89	89	NA

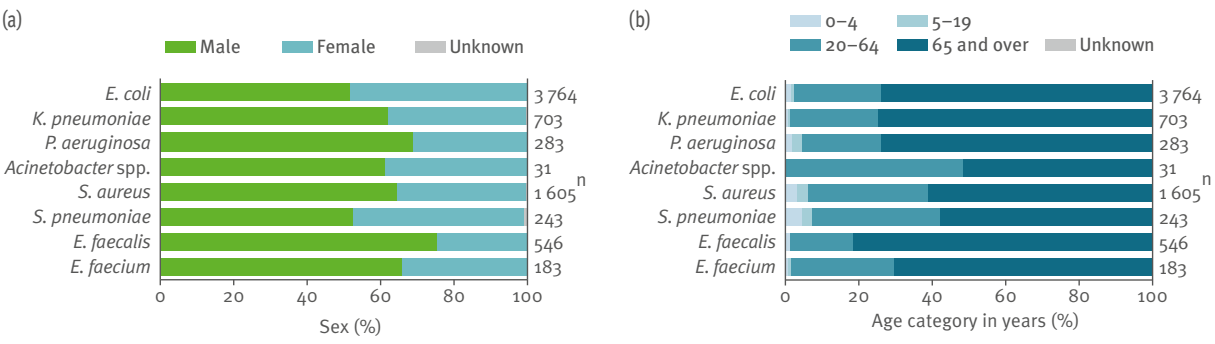
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Norway, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	18	3 618	4	18	3 734	4	18	3 880	3	18	4 075	3	18	3 764	4
K. pneumoniae	18	811	5	18	781	5	18	738	5	18	832	5	18	703	5
P. aeruginosa	18	227	5	18	205	5	18	250	5	18	296	4	18	283	5
Acinetobacter spp.	12	33	6	12	31	10	11	32	13	12	23	5	10	31	0
S. aureus	18	1 485	5	18	1 507	6	18	1 630	6	18	1 723	6	18	1 605	6
S. pneumoniae	18	504	3	18	482	6	18	506	6	18	507	5	18	243	3
E. faecalis	18	530	7	18	526	7	18	525	6	18	551	6	18	546	6
E. faecium	18	215	16	18	209	10	18	174	10	18	197	7	17	183	6

Labs: laboratories.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Norway, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Norway, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	3 615	42.9	3 731	42.2	3 880	42.3	4 072	41.0	3 758	39.8	54.6 (34.1–67.5)	↓
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	3 617	5.6	3 734	5.9	3 879	6.8	4 075	6.2	3 762	5.8	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	3 616	0.1	3 733	0.1	3 879	0.0	4 040	0.0	3 646	0.0	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	3 611	10.9	3 731	13.6	3 877	12.9	4 068	11.3	3 735	10.0	23.8 (10.0–48.2)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	3 614	5.5	3 732	7.2	3 880	5.7	4 074	5.6	3 763	5.7	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	3 609	1.9	3 729	2.4	3 876	2.0	4 068	1.7	3 734	1.6	5.7 (1.6–18.7)	↓
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	811	5.8	781	5.8	737	7.5	832	7.7	702	10.1	33.9 (0.0–79.1)	↑
	Carbapenem (imipenem/meropenem) resistance	810	0.0	781	0.0	736	0.1	826	0.2	687	0.1	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	808	4.3	781	10.2	735	13.1	832	8.8	696	11.2	33.8 (0.0–74.4)	↑
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	809	3.3	781	4.2	737	5.3	831	6.1	702	7.3	23.7 (0.0–67.0)	↑
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	807	2.6	781	3.2	735	3.8	831	3.9	696	4.7	21.0 (0.0–58.3)	↑
P. aeruginosa	Piperacillin-tazobactam resistance	215	7.4	183	6.0	227	5.7	270	4.1	254	5.9	18.8 (4.4–64.3)	–
	Ceftazidime resistance	224	7.1	197	5.1	240	6.3	282	3.9	277	5.4	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	225	6.7	205	3.4	250	4.8	296	7.4	282	6.4	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	227	5.7	205	4.9	250	10.4	296	5.7	282	8.5	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	213	0.9	183	0.5	236	0.8	292	0.3	281	0.4	9.4 (0.0–37.1)	–
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	227	2.6	205	1.5	250	2.4	296	2.0	282	2.5	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	33	0.0	31	0.0	32	0.0	23	0.0	31	0.0	38.0 (0.0–96.4)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	33	3.0	31	0.0	32	0.0	23	0.0	31	0.0	41.8 (0.0–98.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	32	3.1	31	0.0	32	0.0	23	4.3	30	0.0	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	32	0.0	31	0.0	32	0.0	23	0.0	30	0.0	34.1 (0.0–95.1)	–
S. aureus	MRSA[e]	1 448	1.2	1 462	1.0	1 547	0.9	1 644	1.1	1 552	1.7	16.7 (1.4–49.1)	–
S. pneumoniae	Penicillin non-wild-type[f]	500	4.4	480	4.8	500	5.0	504	6.3	242	7.4	15.6 (3.9–56.3)	↑
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	473	5.3	439	5.5	460	7.6	459	5.7	215	5.1	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	469	2.3	439	2.5	454	3.5	457	3.5	214	2.8	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	221	15.8	216	14.4	216	13.4	182	12.1	161	12.4	29.0 (4.1–51.6)	–
E. faecium	Vancomycin resistance	213	1.9	202	4.5	171	2.3	196	1.0	180	0.6	16.8 (0.0–56.6)	–

Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).

[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; – indicates no statistically significant trend.

[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.

[d] The aminoglycoside group includes only tobramycin from 2020 onwards.

[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.

[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Poland

Participating institutions

National Medicines Institute, Department of Epidemiology and Clinical Microbiology
National Reference Centre for Susceptibility Testing

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Poland, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	20	19	17	17	16
Geographical representativeness	Medium/high	Medium/high	Medium	Medium	Medium
Hospital representativeness	High	High	Medium	Medium	Medium
Patient and isolate representativeness	High	High	Medium	Medium	Medium
Blood-culture sets/1 000 patient days	30.3	38.1	38.6	39.8	45.6

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Poland, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	92	96	93	98	NA

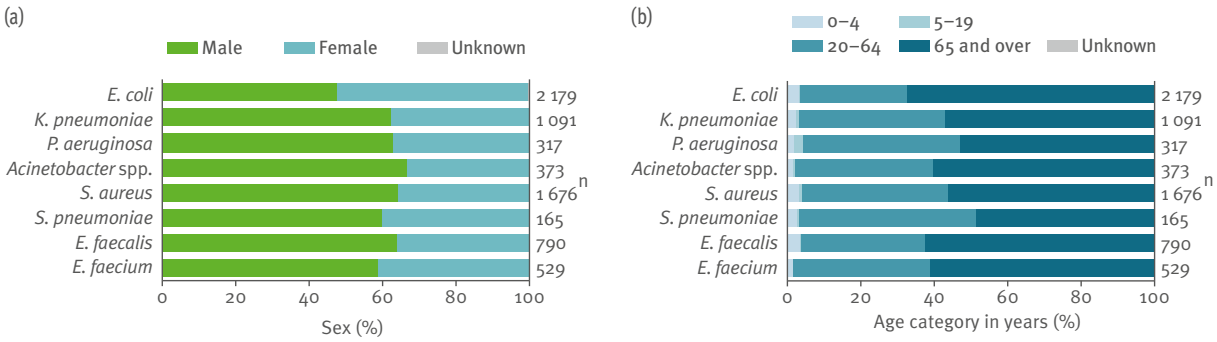
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Poland, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	67	2 735	15	65	2 881	30	55	2 627	27	54	2 809	31	49	2 179	25
K. pneumoniae	66	1 142	36	65	1 203	43	53	1 221	47	55	1 172	45	49	1 091	35
P. aeruginosa	60	403	32	64	417	46	54	394	45	54	421	40	48	317	38
Acinetobacter spp.	53	394	51	56	352	60	48	290	63	46	319	64	44	373	55
S. aureus	65	1 842	18	66	1 848	33	57	1 986	30	55	1 843	34	50	1 676	29
S. pneumoniae	57	343	15	60	374	30	53	369	28	49	364	29	40	165	33
E. faecalis	65	743	32	65	758	48	53	733	43	53	773	48	49	790	36
E. faecium	55	405	31	60	410	44	49	385	44	53	443	43	48	529	38

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Poland, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Poland, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	1 034	64.5	913	69.4	890	64.3	836	61.6	502	56.2	54.6 (34.1–67.5)	⇣
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	2 719	13.7	2 866	16.7	2 620	17.6	2 803	17.1	2 172	17.4	14.9 (5.8–41.4)	⇡
	Carbapenem (imipenem/meropenem) resistance	2 553	0.0	2 741	0.0	2 500	0.1	2 683	0.0	2 080	0.0	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	2 637	33.1	1 832	35.9	2 567	34.7	2 753	33.0	2 149	33.0	23.8 (10.0–48.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	2 521	13.3	2 719	14.0	2 449	15.1	2 614	12.6	2 033	14.5	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	2 411	8.5	1 666	8.2	2 386	10.5	2 564	9.3	1 998	9.4	5.7 (1.6–18.7)	–
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	1 142	64.4	1 203	63.0	1 219	64.6	1 166	58.3	1 088	63.0	33.9 (0.0–79.1)	–
	Carbapenem (imipenem/meropenem) resistance	1 123	2.1	1 161	6.4	1 183	8.1	1 155	7.7	1 074	8.2	10.0 (0.0–66.3)	⇡
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	1 119	66.8	739	66.3	1 207	68.2	1 159	61.3	1 085	65.2	33.8 (0.0–74.4)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	1 075	56.7	1 165	55.5	1 178	54.2	1 128	47.5	1 019	50.0	23.7 (0.0–67.0)	⇣
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	1 052	53.6	703	52.6	1 162	51.5	1 112	45.0	1 012	47.4	21.0 (0.0–58.3)	⇣
P. aeruginosa	Piperacillin-tazobactam resistance	370	27.6	374	31.0	366	34.4	409	26.4	266	32.3	18.8 (4.4–64.3)	–
	Ceftazidime resistance	401	19.5	415	24.6	390	26.9	418	20.1	312	21.8	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	397	26.2	393	24.2	374	33.2	409	24.4	316	28.5	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	400	31.0	358	37.2	389	39.1	417	34.1	270	32.6	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	367	25.6	384	25.5	384	26.0	402	19.7	239	19.7	9.4 (0.0–37.1)	⇣[#]
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	403	20.3	417	22.1	394	29.2	420	22.6	309	22.0	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	391	66.0	344	67.4	278	67.3	317	71.0	372	78.2	38.0 (0.0–96.4)	⇡
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	393	83.0	348	83.0	268	86.9	304	85.5	366	88.3	41.8 (0.0–98.2)	⇡[#]
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	387	72.6	344	72.7	285	67.4	315	70.8	363	70.8	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	383	59.3	333	59.5	251	62.9	299	63.2	355	64.2	34.1 (0.0–95.1)	–
S. aureus	MRSA[e]	1 772	16.4	1 805	15.2	1 959	15.9	1 841	14.9	1 351	13.8	16.7 (1.4–49.1)	–
S. pneumoniae	Penicillin non-wild-type[f]	337	19.3	290	16.6	343	15.7	310	15.5	158	10.8	15.6 (3.9–56.3)	⇣
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	277	30.3	253	24.5	309	24.9	312	25.0	123	22.8	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	271	16.6	241	14.1	285	10.9	268	13.4	116	9.5	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	666	43.1	660	41.2	645	41.6	706	40.2	703	51.6	29.0 (4.1–51.6)	⇡
E. faecium	Vancomycin resistance	405	26.2	400	31.5	374	35.8	432	44.0	527	38.5	16.8 (0.0–56.6)	⇡

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ⇡ and ⇣ indicate statistically significantly increasing and decreasing trends, respectively; [#] indicates a significant trend in the overall data, but not in data that only included laboratories reporting continuously for all five years; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Portugal

Participating institutions

National Institute of Health Doutor Ricardo Jorge
Ministry of Health Directorate-General of Health
Directorate-General of Health

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Portugal, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	97	97	97	97	97
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	High	High	High	High	High
Blood-culture sets/1 000 patient days	Unknown	148.1	206.9	244.2	244.2

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Portugal, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	99	100	98	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	88	88	83	93	NA

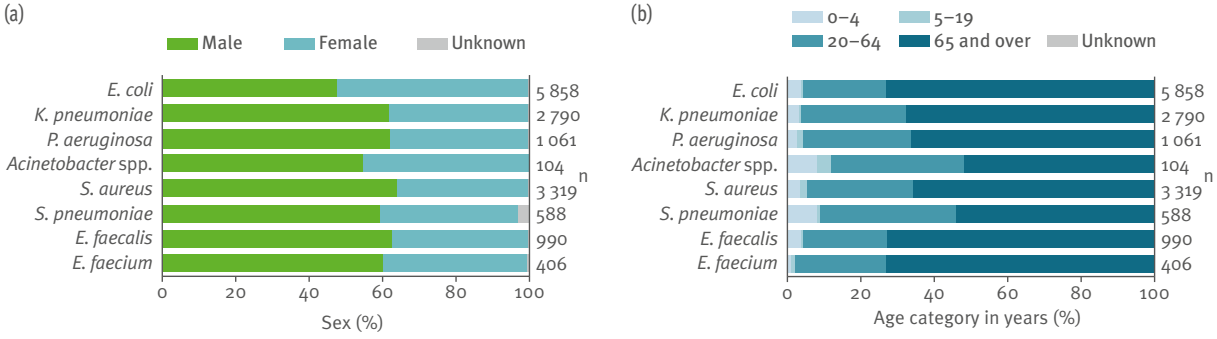
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Portugal, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	60	5 786	4	62	6 452	4	59	5921	4	58	6 433	4	63	5 858	4
K. pneumoniae	59	2 352	12	61	2 743	10	58	2 604	10	55	2 709	9	60	2 790	9
P. aeruginosa	57	1 230	13	57	1 220	13	55	1 115	12	54	1 061	11	57	1 061	9
Acinetobacter spp.	39	207	22	36	174	16	39	127	18	30	99	14	31	104	9
S. aureus	59	3 482	7	64	3 789	5	59	3 940	7	59	3 308	6	65	3 319	6
S. pneumoniae	57	928	3	54	1 056	1	55	1 062	Unknown	53	983	Unknown	48	588	Unknown
E. faecalis	56	972	2	58	1 014	8	56	979	9	54	945	9	58	990	10
E. faecium	45	411	2	46	467	16	47	440	16	43	411	15	43	406	12

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Portugal, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Portugal, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	5 772	59.2	6 245	56.2	5 895	55.1	5 933	58.5	5 849	54.4	54.6 (34.1–67.5)	↓
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	5 784	16.1	6 441	15.6	5 881	14.7	6 390	16.1	5 793	14.4	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	5 760	0.0	6 384	0.3	5 797	0.5	6 372	0.1	5 833	0.2	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	5 783	28.9	6 424	27.3	5 868	25.5	6 431	26.5	5 845	23.9	23.8 (10.0–48.2)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	5 765	13.1	6 387	11.9	5 825	12.2	6 428	12.1	5 788	11.7	10.9 (5.5–34.2)	↓
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	5 762	7.7	6 365	6.6	5 746	6.2	6 384	6.3	5 716	6.1	5.7 (1.6–18.7)	↓
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	2 349	46.7	2 743	44.9	2 579	50.0	2 697	47.6	2 762	47.6	33.9 (0.0–79.1)	–
	Carbapenem (imipenem/meropenem) resistance	2 340	5.2	2 720	8.6	2 563	11.7	2 690	10.9	2 780	11.6	10.0 (0.0–66.3)	↑
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	2 350	41.7	2 736	45.7	2 592	43.8	2 704	45.8	2 779	42.7	33.8 (0.0–74.4)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	2 337	35.0	2 717	33.5	2 572	34.4	2 708	32.2	2 759	28.2	23.7 (0.0–67.0)	↓
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	2 332	27.2	2 711	28.4	2 538	26.7	2 692	26.5	2 734	23.8	21.0 (0.0–58.3)	↓
P. aeruginosa	Piperacillin-tazobactam resistance	1 230	22.7	1 206	24.2	1 096	21.9	1 054	20.3	1 060	17.5	18.8 (4.4–64.3)	↓
	Ceftazidime resistance	1 228	18.0	1 216	18.6	1 090	18.6	1 054	17.6	977	14.4	15.5 (2.9–54.3)	↓#
	Carbapenem (imipenem/meropenem) resistance	1 227	19.2	1 215	18.3	1 108	15.7	1 052	17.8	1 057	13.4	17.8 (3.6–48.9)	↓
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	1 227	20.1	1 208	23.7	1 104	23.7	1 057	21.6	1 059	18.5	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	1 230	11.6	1 210	12.1	1 109	11.9	1 060	9.9	877	5.4	9.4 (0.0–37.1)	↓
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	1 230	14.8	1 214	16.1	1 108	15.3	1 056	14.1	1 060	10.8	12.1 (0.0–47.1)	↓#
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	206	51.9	172	40.7	127	30.7	90	31.1	104	15.4	38.0 (0.0–96.4)	↓
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	206	50.5	172	38.4	123	34.1	88	26.1	101	17.8	41.8 (0.0–98.2)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	206	39.3	168	28.6	126	25.4	93	24.7	104	12.5	37.1 (0.0–96.4)	↓
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	206	37.9	166	24.1	123	22.0	83	20.5	101	8.9	34.1 (0.0–95.1)	↓
S. aureus	MRSA[e]	3 454	43.6	3 728	39.2	3 810	38.1	3 265	34.8	3 299	29.7	16.7 (1.4–49.1)	↓
S. pneumoniae	Penicillin non-wild-type[f]	884	12.2	997	12.8	986	13.4	887	13.9	513	13.8	15.6 (3.9–56.3)	–
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	912	14.4	1 024	14.8	985	15.5	952	12.8	565	15.6	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	868	6.6	978	7.1	922	8.0	865	7.5	492	8.5	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	851	33.8	931	25.8	778	26.6	881	22.2	862	19.8	29.0 (4.1–51.6)	↓
E. faecium	Vancomycin resistance	411	7.5	461	7.2	436	4.4	410	9.0	399	7.8	16.8 (0.0–56.6)	–

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; # indicates a significant trend in the overall data, but not in data that only included laboratories reporting continuously for all five years; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Republic of Moldova

Participating institution

National Agency for Public Health, Ministry of Health

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Republic of Moldova, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated population coverage (%)	Unknown	Unknown	Unknown	70	70
Geographical representativeness	Unknown	Unknown	Unknown	High	High
Hospital representativeness	Unknown	Unknown	Unknown	High	High
Patient and isolate representativeness	Unknown	Unknown	Unknown	Poor	Poor
Blood-culture sets/1 000 patient days[a]	Unknown	Unknown	Unknown	1 (0–7)	4 (0–24)

Definitions provided on page 7.
[a] Data are presented as median (range).

Laboratories contributing data: use of clinical breakpoint guidelines and participation in CAESAR EQA, Republic of Moldova, 2016–2020

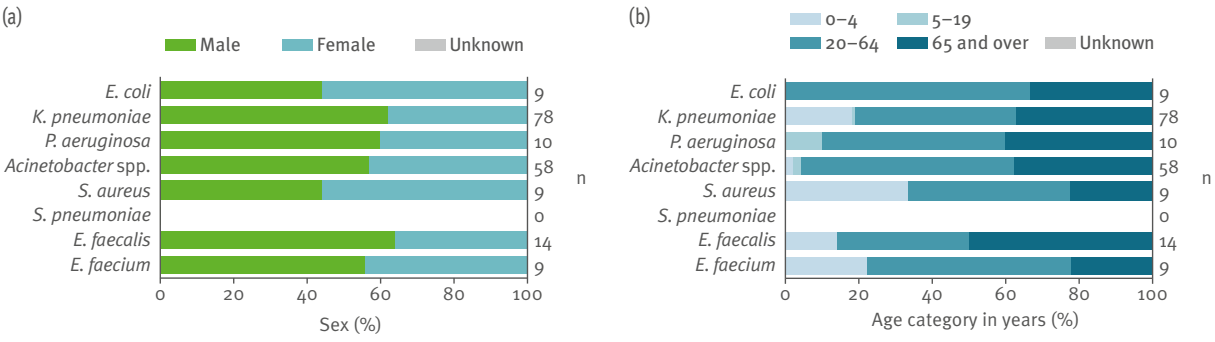
Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	Unknown	Unknown	Unknown	100	100
Percentage of laboratories participating in CAESAR EQA	Unknown	Unknown	Unknown	100	29

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Republic of Moldova, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	0	0	ND	0	0	ND	1	1	100	2	22	77	4	9	44
K. pneumoniae	0	0	ND	0	0	ND	0	0	ND	3	39	82	7	78	64
P. aeruginosa	0	0	ND	0	0	ND	0	0	ND	3	13	92	2	10	60
Acinetobacter spp.	0	0	ND	0	0	ND	0	0	ND	2	10	70	3	58	59
S. aureus	0	0	ND	0	0	ND	1	2	Unknown	5	23	39	4	9	67
S. pneumoniae	0	0	ND	0	0	ND	1	3	100	2	2	100	0	0	ND
E. faecalis	0	0	ND	0	0	ND	1	3	Unknown	2	6	50	5	14	50
E. faecium	0	0	ND	0	0	ND	0	0	ND	0	0	ND	4	9	56

Labs: laboratories.
ND: no data available.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories may be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Republic of Moldova, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, Republic of Moldova, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020	
		n	%	n	%	n	%	n	%	n	%
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	0	ND	0	ND	1	< 10 isolates	11	100.0[a]	9	< 10 isolates
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	0	ND	0	ND	1	< 10 isolates	22	59.1[a]	9	< 10 isolates
	Carbapenem (imipenem/meropenem) resistance	0	ND	0	ND	1	< 10 isolates	22	9.1[a]	9	< 10 isolates
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	0	ND	0	ND	1	< 10 isolates	22	50.0[a]	9	< 10 isolates
	Aminoglycoside (gentamicin/tobramycin) resistance	0	ND	0	ND	0	ND	22	18.2[a]	9	< 10 isolates
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	0	ND	0	ND	0	ND	22	9.1[a]	9	< 10 isolates
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	0	ND	0	ND	0	ND	39	79.5	76	96.1
	Carbapenem (imipenem/meropenem) resistance	0	ND	0	ND	0	ND	39	53.8	78	55.1
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	0	ND	0	ND	0	ND	39	82.1	78	94.9
	Aminoglycoside (gentamicin/tobramycin) resistance	0	ND	0	ND	0	ND	39	69.2	78	96.2
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	0	ND	0	ND	0	ND	39	69.2	76	90.8
P. aeruginosa	Piperacillin-tazobactam resistance	0	ND	0	ND	0	ND	13	76.9[a]	10	90.0[a]
	Ceftazidime resistance	0	ND	0	ND	0	ND	11	90.9[a]	10	90.0[a]
	Carbapenem (imipenem/meropenem) resistance	0	ND	0	ND	0	ND	13	76.9[a]	10	90.0[a]
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	0	ND	0	ND	0	ND	13	84.6[a]	10	100.0[a]
	Aminoglycoside (gentamicin/tobramycin) resistance[b]	0	ND	0	ND	0	ND	13	84.6[a]	9	< 10 isolates
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[b]	0	ND	0	ND	0	ND	11	90.9[a]	9	< 10 isolates
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	0	ND	0	ND	0	ND	10	50.0[a]	58	93.1
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	0	ND	0	ND	0	ND	9	< 10 isolates	58	98.3
	Aminoglycoside (gentamicin/tobramycin) resistance	0	ND	0	ND	0	ND	10	50.0[a]	58	98.3
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides	0	ND	0	ND	0	ND	9	< 10 isolates	58	93.1
S. aureus	MRSA[c]	0	ND	0	ND	1	< 10 isolates	23	21.7[a]	9	< 10 isolates
S. pneumoniae	Penicillin non-wild-type[d]	0	ND	0	ND	3	< 10 isolates	2	< 10 isolates	0	ND
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	0	ND	0	ND	3	< 10 isolates	2	< 10 isolates	0	ND
	Combined penicillin non-wild-type and resistance to macrolides[d]	0	ND	0	ND	3	< 10 isolates	2	< 10 isolates	0	ND
E. faecalis	High-level gentamicin resistance	0	ND	0	ND	3	< 10 isolates	4	< 10 isolates	13	84.6[a]
E. faecium	Vancomycin resistance	0	ND	0	ND	0	ND	0	ND	9	< 10 isolates

ND: no data available.
< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.
[a] A small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.
[b] The aminoglycoside group includes only tobramycin from 2020 onwards.
[c] MRSA is calculated as resistance to cefoxitin or, if not available, oxacillin.
[d] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints might define the cut-off values for the susceptibility categories differently.

Romania

Participating institution

National Institute of Public Health

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Romania, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	Unknown	Unknown	11	11	21
Geographical representativeness	Unknown	Unknown	Poor	Poor	Poor
Hospital representativeness	Unknown	Unknown	Poor	Poor	Poor
Patient and isolate representativeness	Unknown	Unknown	Poor	Poor	Poor
Blood-culture sets/1 000 patient days	Unknown	Unknown	34	21	26.4

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Romania, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	31	38	69	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	87	93	93	100	NA

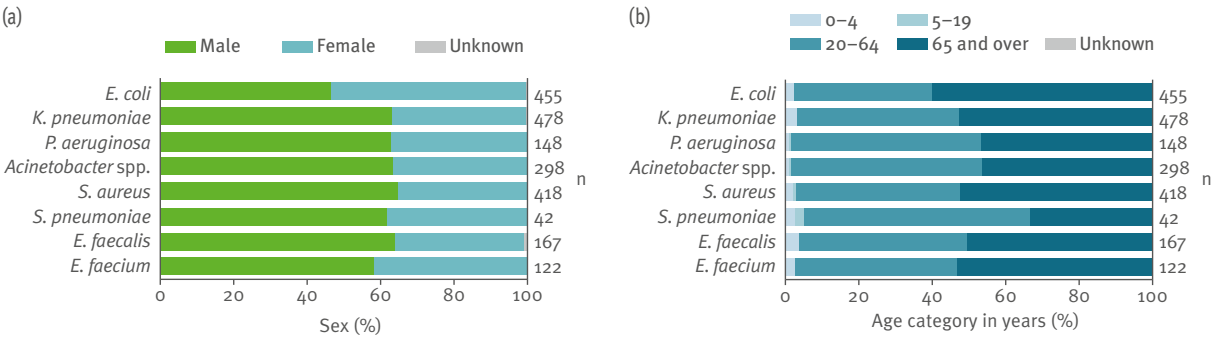
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Romania, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	13	420	10	14	518	14	17	654	13	15	671	12	15	455	17
K. pneumoniae	13	344	40	14	339	43	17	443	44	15	488	43	16	478	54
P. aeruginosa	13	93	39	14	132	46	17	156	40	14	192	44	15	148	53
Acinetobacter spp.	13	160	54	12	183	73	17	218	73	15	268	75	15	298	72
S. aureus	14	495	25	14	535	23	17	626	24	14	634	23	16	418	30
S. pneumoniae	8	60	12	11	81	22	12	93	24	11	107	15	11	42	20
E. faecalis	13	115	37	14	128	37	17	178	25	14	166	35	15	167	58
E. faecium	13	78	47	13	64	45	15	79	43	14	144	48	16	122	53

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Romania, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Romania, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	376	72.3	494	68.2	542	62.2	538	63.0	316	62.7	54.6 (34.1–67.5)	↓
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	418	23.4	518	18.7	654	20.2	664	20.3	452	19.7	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	411	1.0	510	0.4	653	0.0	666	0.6	454	0.7	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	418	30.6	518	26.4	646	29.1	654	28.3	450	26.0	23.8 (10.0–48.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	414	15.0	513	15.2	649	12.8	594	11.6	367	10.9	10.9 (5.5–34.2)	↓
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	410	11.7	513	9.7	641	7.2	576	7.3	360	5.8	5.7 (1.6–18.7)	↓
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	344	68.0	339	62.5	443	61.4	479	64.1	477	67.9	33.9 (0.0–79.1)	–
	Carbapenem (imipenem/meropenem) resistance	334	31.4	334	22.5	441	29.5	470	32.3	474	48.3	10.0 (0.0–66.3)	↑
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	342	60.8	337	64.1	441	57.4	471	62.0	474	66.2	33.8 (0.0–74.4)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	336	61.9	338	58.6	436	50.9	411	53.0	399	49.6	23.7 (0.0–67.0)	↓
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	335	55.2	336	55.4	434	46.3	402	52.0	397	47.9	21.0 (0.0–58.3)	↓
P. aeruginosa	Piperacillin-tazobactam resistance	86	48.8	131	52.7	135	45.9	178	52.8	121	42.1	18.8 (4.4–64.3)	–
	Ceftazidime resistance	86	44.2	127	55.9	152	46.7	180	52.2	144	41.0	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	93	51.6	131	63.4	156	55.1	184	55.4	148	43.9	17.8 (3.6–48.9)	↓[#]
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	89	51.7	132	62.1	155	52.3	184	52.2	140	46.4	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	87	50.6	132	57.6	146	50.7	176	48.9	124	37.1	9.4 (0.0–37.1)	↓[#]
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	90	48.9	132	59.1	154	49.4	185	49.7	144	39.6	12.1 (0.0–47.1)	↓[#]
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	160	85.0	182	87.4	218	85.3	264	88.3	297	93.3	38.0 (0.0–96.4)	↑
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	157	91.1	183	89.1	218	88.1	262	91.2	297	95.3	41.8 (0.0–98.2)	↑
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	152	89.5	183	83.6	210	80.0	241	83.8	253	90.1	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	152	82.9	182	81.3	210	77.6	236	83.5	251	88.8	34.1 (0.0–95.1)	↑
S. aureus	MRSA[e]	477	50.5	507	44.4	600	43.0	625	46.7	406	47.3	16.7 (1.4–49.1)	–
S. pneumoniae	Penicillin non-wild-type[f]	56	41.1	79	29.1	90	40.0	86	19.8	39	38.5	15.6 (3.9–56.3)	–
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	59	37.3	76	26.3	93	32.3	92	17.4	37	27.0	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	56	30.4	75	24.0	90	26.7	74	9.5	34	23.5	9.0 (0.0–37.5)	↓[#]
E. faecalis	High-level gentamicin resistance	87	56.3	89	44.9	168	37.5	155	40.6	148	43.2	29.0 (4.1–51.6)	–
E. faecium	Vancomycin resistance	77	39.0	64	34.4	77	40.3	140	35.7	112	39.3	16.8 (0.0–56.6)	–

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; [#] indicates a significant trend in the overall data, but not in data that only included laboratories reporting continuously for all five years; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Russian Federation

Participating institution

Institute of Antimicrobial Chemotherapy, Smolensk State Medical Academy

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Russian Federation, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated population coverage (%)	Unknown	Unknown	Unknown	Unknown	Unknown
Geographical representativeness	High	High	High	High	High
Hospital representativeness	Poor	Poor	Poor	Poor	Poor
Patient and isolate representativeness	Poor	Poor	Poor	Poor	Poor
Blood-culture sets/1 000 patient days[a]	Unknown	10 (0–50)	6 (1–86)	15 (12–55)	11 (1–21)

Definitions provided on page 7.
[a] Data are presented as median (range).

Laboratories contributing data: use of clinical breakpoint guidelines and participation in CAESAR EQA, Russian Federation, 2016–2020

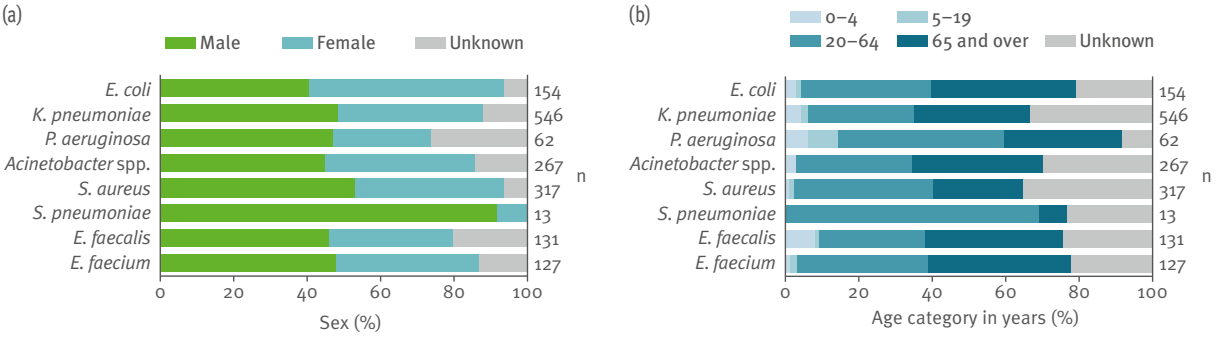
Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	Unknown	Unknown	Unknown	100	100
Percentage of laboratories participating in CAESAR EQA	Unknown	Unknown	72	0	100

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Russian Federation, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	15	54	24	18	52	50	25	82	50	13	216	61	13	154	58
K. pneumoniae	18	123	37	24	127	69	23	170	81	13	418	74	15	546	80
P. aeruginosa	11	43	24	16	45	64	18	50	76	10	76	71	12	62	69
Acinetobacter spp.	17	76	38	15	51	84	17	81	75	11	178	76	15	267	88
S. aureus	17	106	20	20	85	53	19	107	45	12	333	47	15	317	58
S. pneumoniae	0	0	ND	11	18	Unknown	0	0	ND	8	23	43	6	13	82
E. faecalis	6	27	28	8	27	30	10	27	59	13	100	46	14	131	66
E. faecium	6	21	30	6	14	50	7	19	68	11	63	49	12	127	93

Labs: laboratories.
ND: no data available.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories may be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Russian Federation, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, Russian Federation, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020	
		n	%	n	%	n	%	n	%	n	%
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	54	92.6	52	86.5	82	87.8	121	65.3	76	80.3
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	54	83.3	52	73.1	82	65.9	207	47.8	147	52.4
	Carbapenem (imipenem/meropenem) resistance	54	1.9	52	0.0	82	0.0	210	1.9	150	4.0
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	54	74.1	52	59.6	82	62.2	207	50.2	146	58.2
	Aminoglycoside (gentamicin/tobramycin) resistance	54	55.6	52	42.3	82	31.7	143	25.2	100	33.0
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	54	50.0	52	36.5	82	23.2	133	24.8	87	32.2
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	123	91.9	127	90.6	170	83.5	389	81.0	524	89.7
	Carbapenem (imipenem/meropenem) resistance	123	12.2	127	21.3	170	30.6	415	47.0	542	64.8
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	123	88.6	125	80.0	170	87.1	407	82.8	535	89.2
	Aminoglycoside (gentamicin/tobramycin) resistance	123	89.4	127	81.1	170	83.5	295	61.7	473	75.5
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	123	85.4	125	76.0	170	75.3	283	57.2	449	75.5
P. aeruginosa	Piperacillin-tazobactam resistance	43	48.8	45	64.4	49	40.8	23	43.5[a]	36	50.0
	Ceftazidime resistance	43	46.5	45	57.8	49	38.8	68	42.6	60	50.0
	Carbapenem (imipenem/meropenem) resistance	43	48.8	45	51.1	49	53.1	76	52.6	60	48.3
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	43	58.1	45	64.4	49	42.9	75	42.7	60	48.3
	Aminoglycoside (gentamicin/tobramycin) resistance[b]	43	55.8	45	60.0	49	36.7	45	42.2	29	44.8[a]
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[b]	43	51.2	45	62.2	49	40.8	10	40.0[a]	26	46.2[a]
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	76	73.7	51	92.2	81	79.0	174	78.2	263	93.9
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	76	93.4	51	94.1	81	97.5	173	80.9	263	94.7
	Aminoglycoside (gentamicin/tobramycin) resistance	76	75.0	51	90.2	81	88.9	106	88.7	217	89.9
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides	76	59.2	51	84.3	81	70.4	104	86.5	215	89.3
S. aureus	MRSA[c]	106	23.6	85	16.5	107	14.0	320	23.1	305	24.6
S. pneumoniae	Penicillin non-wild-type[d]	0	ND	18	27.8[a]	0	ND	22	13.6[a]	13	7.7[a]
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	0	ND	18	22.2[a]	0	ND	21	38.1[a]	10	10.0[a]
	Combined penicillin non-wild-type and resistance to macrolides[d]	0	ND	18	22.2[a]	0	ND	20	5.0[a]	10	10.0[a]
E. faecalis	High-level gentamicin resistance	27	59.3[a]	27	55.6[a]	27	40.7[a]	77	39.0	50	38.0
E. faecium	Vancomycin resistance	21	0.0[a]	14	0.0[a]	19	10.5[a]	62	4.8	127	11.8

ND: no data available.

[a] A small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.

[b] The aminoglycoside group includes only tobramycin from 2020 onwards.

[c] MRSA is calculated as resistance to cefoxitin or, if not available, oxacillin.

[d] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints might define the cut-off values for the susceptibility categories differently.

Serbia

Participating institutions

Department of Pyogenic, Respiratory and Sexually Transmitted Infections with the Reference Laboratory for Bacterial Resistance to Antimicrobials Centre for Microbiology, Institute of Public Health of Vojvodina, Novi Sad

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Serbia, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated population coverage (%)	75	75	78	78	78
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	Medium	Medium	Medium	Medium	Medium
Blood-culture sets/1 000 patient days[a]	Unknown	15 (0–82)	16 (1–85)	17 (1–88)	17 (1–111)

Definitions provided on page 7.
[a] Data are presented as median (range).

Laboratories contributing data: use of clinical breakpoint guidelines and participation in CAESAR EQA, Serbia, 2016–2020

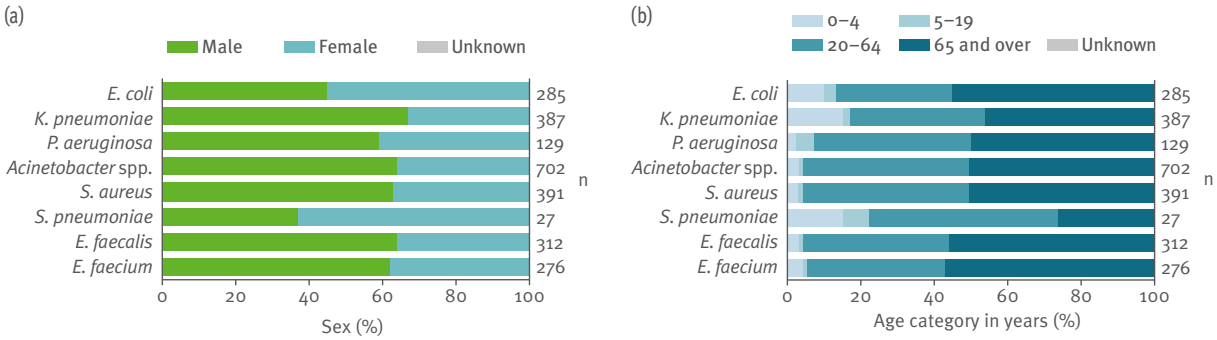
Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	95	100	100	100	100
Percentage of laboratories participating in CAESAR EQA	100	100	100	96	100

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Serbia, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	19	328	12	20	399	10	23	438	9	23	510	11	23	285	11
K. pneumoniae	19	444	33	20	416	24	23	511	25	21	513	18	22	387	28
P. aeruginosa	18	149	41	18	134	21	22	177	27	20	196	28	21	129	25
Acinetobacter spp.	18	417	50	20	429	39	23	516	32	22	532	41	21	702	48
S. aureus	22	469	15	22	542	14	24	616	13	24	628	14	21	391	13
S. pneumoniae	16	65	25	14	86	17	18	79	10	16	85	9	11	27	26
E. faecalis	18	181	28	20	208	19	23	261	18	22	272	24	22	312	37
E. faecium	14	110	39	15	112	23	19	154	18	22	159	22	21	276	35

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories may be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Serbia, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, Serbia, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020	
		n	%	n	%	n	%	n	%	n	%
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	320	71.9	365	63.0	416	67.3	474	63.9	275	68.0
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	328	34.8	399	29.3	437	28.1	509	25.3	284	28.5
	Carbapenem (imipenem/meropenem) resistance	325	0.6	399	1.0	437	0.9	502	0.4	284	1.4
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	313	44.7	394	40.4	436	39.2	509	34.8	283	36.7
	Aminoglycoside (gentamicin/tobramycin) resistance	290	33.4	382	34.6	432	28.0	491	30.3	278	45.3
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	275	22.2	377	20.7	429	17.0	489	13.1	276	14.5
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	443	89.6	416	85.8	511	85.5	512	87.7	387	87.3
	Carbapenem (imipenem/meropenem) resistance	443	34.5	416	34.9	511	36.2	512	39.3	384	47.9
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	427	73.8	407	75.9	509	72.7	508	78.0	383	76.8
	Aminoglycoside (gentamicin/tobramycin) resistance	434	80.9	393	75.8	502	69.7	466	77.3	357	85.4
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	416	63.5	384	64.3	500	58.6	461	65.1	354	69.2
P. aeruginosa	Piperacillin-tazobactam resistance	143	34.3	125	44.0	176	52.3	191	53.9	128	59.4
	Ceftazidime resistance	143	48.3	130	55.4	176	57.4	195	59.5	129	63.6
	Carbapenem (imipenem/meropenem) resistance	148	42.6	133	48.9	177	55.9	195	55.4	128	69.5
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	146	52.7	134	56.7	177	58.8	194	59.3	127	70.1
	Aminoglycoside (gentamicin/tobramycin) resistance[a]	141	56.0	132	59.8	177	58.8	195	58.5	90	58.9
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[a]	126	47.6	121	51.2	175	56.0	188	56.4	88	61.4
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	417	96.9	429	95.1	516	95.9	532	96.1	699	98.6
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	389	96.7	428	96.0	515	96.7	532	97.2	702	98.9
	Aminoglycoside (gentamicin/tobramycin) resistance	391	94.1	429	94.2	516	92.8	509	91.6	661	96.4
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides	385	92.2	428	91.8	515	91.7	509	90.2	660	95.9
S. aureus	MRSA[b]	463	26.6	541	25.9	612	29.2	628	26.4	386	35.8
S. pneumoniae	Penicillin non-wild-type[c]	61	42.6	86	38.4	77	32.5	85	36.5	27	48.1[d]
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	58	31.0	79	26.6	74	27.0	77	35.1	22	31.8[d]
	Combined penicillin non-wild-type and resistance to macrolides[c]	54	27.8	79	22.8	72	22.2	77	26.0	22	18.2[d]
E. faecalis	High-level gentamicin resistance	169	63.3	195	70.8	255	64.7	263	59.7	300	76.3
E. faecium	Vancomycin resistance	110	35.5	109	45.9	154	53.9	159	59.7	274	60.9

[a] The aminoglycoside group includes only tobramycin from 2020 onwards.
[b] MRSA is calculated as resistance to cefoxitin or, if not available, oxacillin.
[c] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints might define the cut-off values for the susceptibility categories differently.
[d] A small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.

Slovakia

Participating institutions

National Reference Centre for Antimicrobial Resistance
Public Health Authority of the Slovak Republic
Regional Public Health Authority Banska Bystrica

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Slovakia, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	70	68	64	56	56
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	Unknown	Unknown	High	High	High
Blood-culture sets/1 000 patient days	20.3	20.8	23.7	36.1	27.0

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Slovakia, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	100	100	100	100	NA

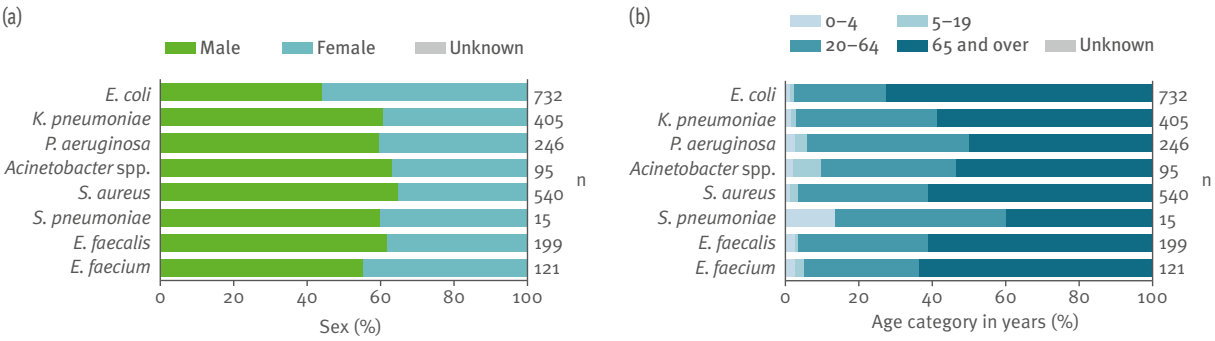
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Slovakia, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	13	829	15	13	882	15	12	983	14	10	851	14	11	732	17
K. pneumoniae	13	466	28	13	468	32	11	505	33	10	370	26	11	405	35
P. aeruginosa	12	191	37	13	211	30	11	259	32	10	201	30	11	246	35
Acinetobacter spp.	13	115	32	13	126	39	11	146	36	8	97	44	11	95	37
S. aureus	13	572	26	13	614	21	12	627	25	10	567	18	11	540	22
S. pneumoniae	5	13	31	10	40	30	9	47	13	6	40	20	5	15	27
E. faecalis	13	233	24	13	226	29	12	256	32	10	212	32	11	199	30
E. faecium	12	126	33	11	122	32	11	168	33	10	139	32	10	121	31

Labs: laboratories.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Slovakia, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Slovakia, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	817	62.3	853	64.9	967	61.7	849	57.8	728	57.1	54.6 (34.1–67.5)	↓
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	824	29.7	870	30.9	973	30.1	846	23.0	727	27.1	14.9 (5.8–41.4)	↓
	Carbapenem (imipenem/meropenem) resistance	751	0.0	844	0.0	924	0.0	785	0.1	705	0.1	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	826	40.4	882	43.2	969	42.1	850	34.0	729	34.2	23.8 (10.0–48.2)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	828	20.2	875	22.5	969	21.6	847	16.6	731	18.5	10.9 (5.5–34.2)	↓#
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	822	14.8	863	17.7	965	16.6	842	12.7	724	14.9	5.7 (1.6–18.7)	–
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	465	61.3	459	63.2	497	55.9	367	57.5	399	54.4	33.9 (0.0–79.1)	↓
	Carbapenem (imipenem/meropenem) resistance	435	2.5	450	4.4	488	3.5	351	4.6	392	8.2	10.0 (0.0–66.3)	↑#
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	466	66.3	466	66.7	497	61.0	367	56.9	403	53.8	33.8 (0.0–74.4)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	466	62.4	468	61.1	496	54.8	369	49.3	405	48.9	23.7 (0.0–67.0)	↓
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	465	55.7	457	57.1	491	49.5	366	45.1	399	44.4	21.0 (0.0–58.3)	↓
P. aeruginosa	Piperacillin-tazobactam resistance	165	27.3	180	33.3	236	28.0	175	28.0	213	33.3	18.8 (4.4–64.3)	–
	Ceftazidime resistance	164	31.1	180	35.6	237	32.1	178	31.5	214	32.7	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	182	42.3	202	47.0	248	44.0	197	39.1	231	48.9	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	190	47.4	211	46.9	252	52.4	201	46.3	246	49.6	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	191	33.0	211	36.0	254	37.4	199	33.2	242	33.1	9.4 (0.0–37.1)	–
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	183	33.3	202	38.1	248	35.5	197	30.5	231	35.5	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	109	28.4	120	31.7	141	44.0	96	55.2	91	30.8	38.0 (0.0–96.4)	↑#
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	115	46.1	126	52.4	141	56.0	94	61.7	95	38.9	41.8 (0.0–98.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	115	40.9	125	40.0	144	44.4	97	46.4	95	28.4	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	109	24.8	119	25.2	139	36.0	93	41.9	91	24.2	34.1 (0.0–95.1)	–
S. aureus	MRSA[e]	571	27.1	613	29.2	610	26.6	563	27.2	540	24.8	16.7 (1.4–49.1)	–
S. pneumoniae	Penicillin non-wild-type[f]	13	7.7	39	25.6	46	13.0	40	5.0	14	14.3	15.6 (3.9–56.3)	NA
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	12	8.3	31	35.5	45	24.4	36	11.1	15	20.0	16.9 (3.5–43.8)	NA
	Combined penicillin non-wild-type and resistance to macrolides[f]	12	0.0	30	23.3	44	11.4	36	2.8	14	7.1	9.0 (0.0–37.5)	NA
E. faecalis	High-level gentamicin resistance	213	45.1	213	25.8	215	40.0	201	32.8	195	35.9	29.0 (4.1–51.6)	–
E. faecium	Vancomycin resistance	125	26.4	122	32.0	161	32.3	137	29.2	120	40.0	16.8 (0.0–56.6)	–

NA: not applicable as data were not reported for all years, a significant change in data source occurred during the period, or the number of isolates was < 20 in any year during the period.
Note: a small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).

[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; # indicates a significant trend in the overall data, but not in data that only included laboratories reporting continuously for all five years; – indicates no statistically significant trend.

[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.

[d] The aminoglycoside group includes only tobramycin from 2020 onwards.

[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.

[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Slovenia

Participating institutions

National Institute of Public Health
Medical faculty, University of Ljubljana
National Laboratory of Health, Environment and Food

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Slovenia, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	99	99	99	99	99
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	High	High	High	High	High
Blood-culture sets/1 000 patient days	35	41.2	36.8	40.4	47.1

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Slovenia, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	91	91	91	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	100	100	100	91	NA

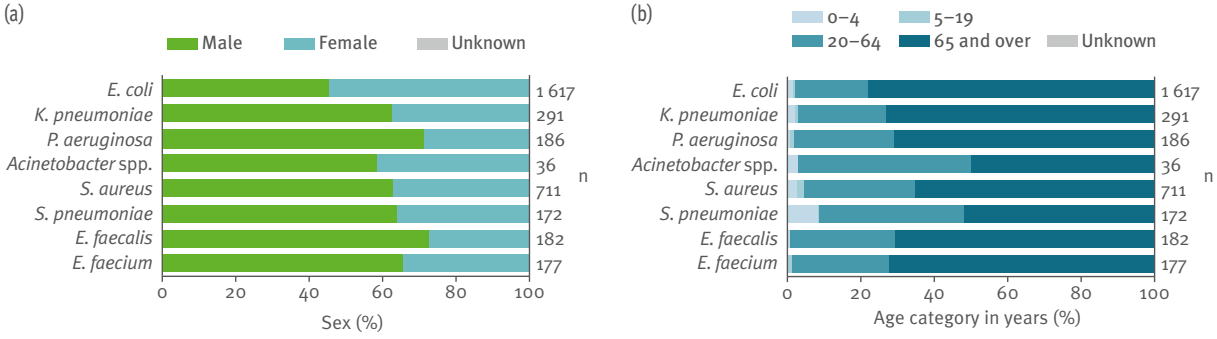
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Slovenia, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	10	1 420	11	10	1 435	9	10	1 668	7	10	1 610	6	10	1 617	6
K. pneumoniae	10	267	20	10	312	20	10	289	14	10	303	14	10	291	17
P. aeruginosa	10	143	40	10	138	30	10	174	24	10	175	26	10	186	35
Acinetobacter spp.	7	60	37	4	36	50	8	39	33	8	40	38	7	36	39
S. aureus	10	534	12	10	576	13	10	606	9	10	656	10	10	711	14
S. pneumoniae	10	269	12	10	319	10	10	271	13	10	283	10	10	172	9
E. faecalis	10	161	25	10	171	19	10	162	15	9	141	24	9	182	15
E. faecium	9	111	42	9	149	41	9	134	32	10	137	32	9	177	32

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Slovenia, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Slovenia, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	1 420	57.1	1 435	51.6	1 668	53.5	1 610	51.7	1 617	51.3	54.6 (34.1–67.5)	↓
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	1 420	12.5	1 435	12.5	1 668	11.3	1 610	9.8	1 617	10.6	14.9 (5.8–41.4)	↓
	Carbapenem (imipenem/meropenem) resistance	1 420	0.0	1 435	0.0	1 668	0.0	1 610	0.0	1 617	0.0	0.2 (0.0–0.8)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	1 420	25.6	1 383	24.9	1 668	22.8	1 610	19.0	1 617	18.1	23.8 (10.0–48.2)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	1 420	10.6	1 435	11.4	1 668	9.4	1 610	7.8	1 616	6.8	10.9 (5.5–34.2)	↓
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	1 420	6.9	1 383	6.3	1 668	4.7	1 610	4.0	1 616	3.6	5.7 (1.6–18.7)	↓
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	267	22.8	312	23.7	289	14.9	303	16.5	291	15.8	33.9 (0.0–79.1)	↓
	Carbapenem (imipenem/meropenem) resistance	267	0.0	312	0.0	289	0.7	303	0.3	291	0.0	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	267	29.6	306	30.4	289	27.3	303	19.5	291	24.7	33.8 (0.0–74.4)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	267	16.5	312	16.0	289	12.8	303	8.3	290	10.0	23.7 (0.0–67.0)	↓
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	267	13.1	306	16.0	289	10.0	303	7.6	290	7.6	21.0 (0.0–58.3)	↓
P. aeruginosa	Piperacillin-tazobactam resistance	143	19.6	138	13.0	174	16.1	175	14.9	186	14.5	18.8 (4.4–64.3)	–
	Ceftazidime resistance	143	17.5	138	13.0	174	14.9	175	16.0	186	13.4	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	143	19.6	138	17.4	174	14.9	175	20.0	186	13.4	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	143	20.3	123	20.3	174	21.8	175	18.9	186	15.6	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	143	13.3	138	8.7	174	6.9	175	4.0	56	3.6	9.4 (0.0–37.1)	↓
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	143	15.4	138	10.9	174	11.5	175	12.0	186	8.6	12.1 (0.0–47.1)	–
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	60	43.3	36	41.7	39	17.9	40	22.5	36	19.4	38.0 (0.0–96.4)	↓
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	60	55.0	36	47.2	39	28.2	40	27.5	36	27.8	41.8 (0.0–98.2)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	60	43.3	36	41.7	39	20.5	40	25.0	36	25.0	37.1 (0.0–96.4)	↓
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	60	38.3	36	41.7	39	17.9	40	20.0	36	16.7	34.1 (0.0–95.1)	↓
S. aureus	MRSA[e]	534	11.0	576	9.0	606	11.7	656	7.5	711	9.8	16.7 (1.4–49.1)	–
S. pneumoniae	Penicillin non-wild-type[f]	269	6.7	319	10.0	271	9.6	283	11.0	172	13.4	15.6 (3.9–56.3)	↑
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	269	13.4	216	15.7	271	10.3	283	9.9	172	14.5	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	269	3.3	216	6.5	271	4.8	283	4.9	172	7.6	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	152	43.4	167	33.5	161	20.5	138	22.5	179	18.4	29.0 (4.1–51.6)	↓
E. faecium	Vancomycin resistance	111	0.0	149	0.7	134	0.0	137	2.9	177	1.1	16.8 (0.0–56.6)	–

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Spain

Participating institutions

Health Institute Carlos lll
National Centre for Microbiology

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Spain, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	38	37	31	32	36
Geographical representativeness	High	High	Medium	Medium	Medium
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	High	High	High	High	High
Blood-culture sets/1 000 patient days	60.4	Unknown	57.3	67.6	109.5

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Spain, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	46	58	71	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	98	90	95	91	NA

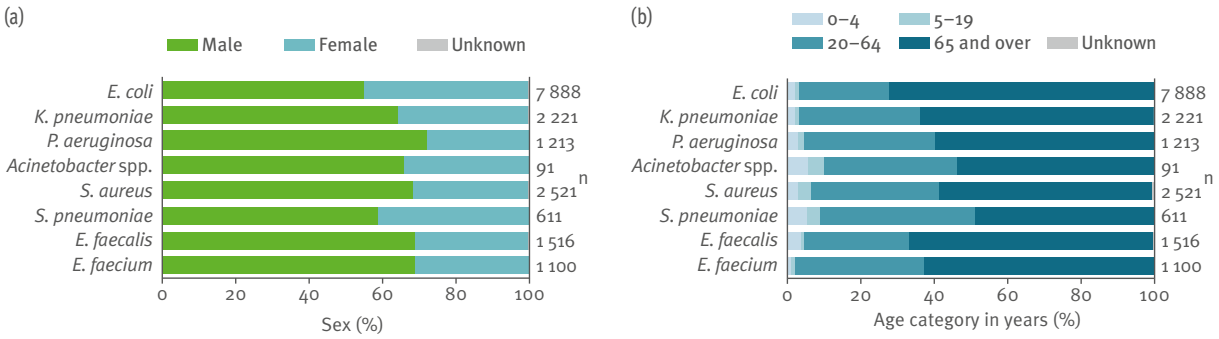
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Spain, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	38	6 804	6	37	6 032	Unknown	39	7 933	Unknown	39	8 353	Unknown	43	7 888	Unknown
K. pneumoniae	38	1 680	Unknown	36	1 514	Unknown	38	1 995	Unknown	39	2 403	Unknown	42	2 221	Unknown
P. aeruginosa	37	843	Unknown	36	869	Unknown	38	1 122	Unknown	39	1 108	Unknown	41	1 213	Unknown
Acinetobacter spp.	24	106	41	22	92	Unknown	18	81	Unknown	21	83	Unknown	21	91	Unknown
S. aureus	37	1 973	Unknown	37	1 925	Unknown	39	2 531	Unknown	41	2 719	Unknown	42	2 521	Unknown
S. pneumoniae	36	672	Unknown	34	752	Unknown	37	1 033	Unknown	37	1 038	Unknown	41	611	Unknown
E. faecalis	37	988	Unknown	36	969	Unknown	38	1 163	Unknown	38	1 301	Unknown	41	1 516	Unknown
E. faecium	35	630	Unknown	35	599	Unknown	37	769	Unknown	37	848	Unknown	42	1 100	Unknown

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Spain, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Spain, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	6 795	64.1	5 947	62.4	7 599	62.9	7 831	61.2	7 214	57.6	54.6 (34.1–67.5)	↓
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	6 800	15.0	6 027	12.8	7 923	13.8	8 345	14.1	7 695	14.1	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	6 794	0.1	6 026	0.0	7 924	0.0	8 346	1.9	7 797	0.4	0.2 (0.0–0.8)	↑
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	6 797	32.8	5 781	32.5	7 616	32.1	8 192	29.5	7 750	28.6	23.8 (10.0–48.2)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	6 800	14.5	6 029	13.7	7 924	14.1	8 304	13.6	7 778	13.6	10.9 (5.5–34.2)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	6 791	6.2	5 774	5.5	7 598	6.4	8 138	6.3	7 464	6.3	5.7 (1.6–18.7)	–
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	1 677	22.4	1 513	21.3	1 994	25.5	2 396	25.3	2 163	26.8	33.9 (0.0–79.1)	↑#
	Carbapenem (imipenem/meropenem) resistance	1 677	2.1	1 510	2.8	1 995	3.8	2 398	4.8	2 205	4.7	10.0 (0.0–66.3)	↑
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	1 676	22.7	1 486	22.5	1 927	23.8	2 375	24.0	2 201	25.7	33.8 (0.0–74.4)	↑#
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	1 678	15.5	1 513	17.4	1 995	19.3	2 370	18.2	2 207	20.2	23.7 (0.0–67.0)	↑#
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	1 674	12.4	1 484	12.8	1 926	15.7	2 339	15.5	2 129	16.4	21.0 (0.0–58.3)	↑#
P. aeruginosa	Piperacillin-tazobactam resistance	817	7.8	813	7.4	1 076	9.1	1 077	14.2	1 159	11.0	18.8 (4.4–64.3)	↑
	Ceftazidime resistance	836	10.2	862	9.6	1 087	8.7	1 098	11.1	1 152	9.6	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	842	21.4	861	18.4	1 120	18.5	1 107	21.8	1 211	16.6	17.8 (3.6–48.9)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	843	23.0	868	19.9	1 102	20.1	1 105	18.7	1 196	18.1	19.6 (3.2–52.9)	↓
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	843	15.3	864	12.4	1 121	11.6	1 083	15.0	1 182	8.7	9.4 (0.0–37.1)	↓
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	843	14.0	863	10.7	1 120	10.6	1 107	13.3	1 197	9.1	12.1 (0.0–47.1)	↓
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	106	62.3	92	66.3	81	54.3	83	56.6	91	61.5	38.0 (0.0–96.4)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	106	68.9	92	68.5	81	56.8	82	54.9	91	62.6	41.8 (0.0–98.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	106	50.9	92	52.2	81	49.4	83	47.0	91	53.8	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	106	44.3	92	48.9	81	44.4	82	47.6	91	51.6	34.1 (0.0–95.1)	–
S. aureus	MRSA[e]	1 945	25.8	1 856	25.1	2 444	24.2	2 711	22.4	2 292	23.3	16.7 (1.4–49.1)	↓
S. pneumoniae	Penicillin non-wild-type[f]	643	25.0	735	22.3	981	18.5	958	19.8	540	20.7	15.6 (3.9–56.3)	↓
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	630	24.9	717	21.8	1007	18.0	975	21.0	586	22.2	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	612	13.7	701	12.4	957	9.6	905	10.9	524	11.8	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	952	37.5	873	36.9	1002	34.8	1051	36.7	1326	33.9	29.0 (4.1–51.6)	–
E. faecium	Vancomycin resistance	628	2.1	570	1.8	764	2.5	846	1.2	1075	1.2	16.8 (0.0–56.6)	–

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).
[b] ↑ and ↓ indicate statistically significantly increasing and decreasing trends, respectively; # indicates a significant trend in the overall data, but not in data that only included laboratories reporting continuously for all five years; – indicates no statistically significant trend.
[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.
[d] The aminoglycoside group includes only tobramycin from 2020 onwards.
[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.
[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Sweden

Participating institution

The Public Health Agency of Sweden

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Sweden, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated national population coverage (%)	75	57	51	78	78
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	High	High	High	High	High
Blood-culture sets/1 000 patient days	139	156.7	107	105.6	105.6

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EARS-Net EQA, Sweden, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100[a]	100[a]
Percentage of laboratories participating in EARS-Net EQA	100	100	100	95	NA

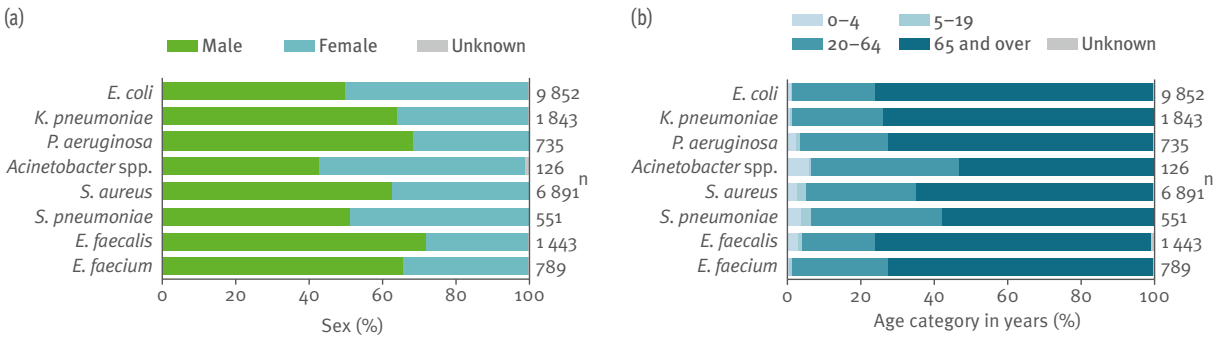
NA: not applicable.
[a] Starting with 2019 data, EARS-Net was restricted to laboratories using EUCAST or EUCAST-harmonized methodology and breakpoints.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Sweden, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	14	6 970	Unknown	10	5 807	Unknown	9	5 392	Unknown	19	9 424	Unknown	20	9 852	Unknown
K. pneumoniae	15	1 537	Unknown	10	1 034	Unknown	9	1 089	Unknown	19	1 795	Unknown	20	1 843	Unknown
P. aeruginosa	13	473	Unknown	10	446	Unknown	9	412	Unknown	19	707	Unknown	20	735	Unknown
Acinetobacter spp.	12	86	Unknown	1	54	Unknown	1	55	Unknown	1	113	Unknown	1	126	Unknown
S. aureus	15	3 903	Unknown	11	3 800	Unknown	9	3 640	Unknown	20	6 173	Unknown	20	6 891	Unknown
S. pneumoniae	14	904	Unknown	11	755	Unknown	9	676	Unknown	19	1 071	Unknown	20	551	Unknown
E. faecalis	14	1 019	Unknown	11	1 630	Unknown	9	687	Unknown	19	1 297	Unknown	20	1 443	Unknown
E. faecium	14	561	Unknown	11	622	Unknown	9	428	Unknown	19	703	Unknown	20	789	Unknown

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories might be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Sweden, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, 2020 EU/EEA range, population-weighted mean and trend, Sweden, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020		2020 EU/EEA range and population-weighted mean[a]	Trend 2016–2020[b]
		n	%	n	%	n	%	n	%	n	%		
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	54.6 (34.1–67.5)	NA
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	6 958	8.3	5 790	7.4	5 390	8.3	9 419	7.8	9 852	7.9	14.9 (5.8–41.4)	–
	Carbapenem (imipenem/meropenem) resistance	6 927	0.1	5 769	0.0	5 388	0.0	9 413	0.0	9 846	0.0	0.2 (0.0–0.8)	⇩#
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	6 947	13.7	5 762	15.8	5 378	18.1	9 412	15.9	9 798	14.1	23.8 (10.0–48.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	6 949	7.2	5 758	6.5	5 378	7.7	9 410	6.0	9 840	5.9	10.9 (5.5–34.2)	⇩
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	6 939	3.1	5 746	2.0	5 368	3.1	9 405	2.2	9 792	2.1	5.7 (1.6–18.7)	⇩
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	1 537	4.9	1 034	5.6	1 089	5.5	1 795	8.3	1 842	8.1	33.9 (0.0–79.1)	⇧
	Carbapenem (imipenem/meropenem) resistance	1 531	0.1	1 033	0.1	1 088	0.2	1 793	0.1	1 843	0.3	10.0 (0.0–66.3)	–
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	1 533	5.4	1 034	9.8	1 087	10.1	1 789	10.5	1 830	10.2	33.8 (0.0–74.4)	⇧
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	1 141	3.4	1 033	4.7	1 087	3.0	1 794	4.2	1 839	3.6	23.7 (0.0–67.0)	–
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides[c]	1 141	2.1	1 033	3.3	1 086	2.6	1 789	3.2	1 827	2.4	21.0 (0.0–58.3)	–
P. aeruginosa	Piperacillin-tazobactam resistance	472	7.4	446	6.3	411	7.8	706	6.8	735	5.4	18.8 (4.4–64.3)	–
	Ceftazidime resistance	473	7.4	446	4.5	412	6.1	706	5.1	735	5.0	15.5 (2.9–54.3)	–
	Carbapenem (imipenem/meropenem) resistance	472	11.0	446	9.0	412	4.4	706	9.8	733	4.2	17.8 (3.6–48.9)	⇩#
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	469	6.0	445	9.0	408	7.1	706	9.2	733	7.4	19.6 (3.2–52.9)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	471	0.8	444	0.9	411	1.0	707	2.3	464	0.6	9.4 (0.0–37.1)	–
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[d]	472	5.3	446	3.1	412	1.9	706	3.5	735	1.4	12.1 (0.0–47.1)	⇩#
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	84	1.2	54	0.0	54	3.7	112	3.6	126	7.1	38.0 (0.0–96.4)	⇧#
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	86	4.7	54	0.0	55	7.3	113	8.0	126	7.1	41.8 (0.0–98.2)	–
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[c]	85	5.9	51	0.0	55	5.5	113	5.3	125	8.0	37.1 (0.0–96.4)	–
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[c]	84	1.2	51	0.0	54	3.7	112	2.7	125	7.2	34.1 (0.0–95.1)	⇧#
S. aureus	MRSA[e]	3 450	2.3	3 787	1.2	3 639	1.9	5 948	1.8	6 871	2.3	16.7 (1.4–49.1)	–
S. pneumoniae	Penicillin non-wild-type[f]	882	7.1	750	6.1	676	5.2	1 070	6.5	544	8.5	15.6 (3.9–56.3)	–
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	899	5.3	750	4.7	674	4.5	1 069	6.5	549	6.6	16.9 (3.5–43.8)	–
	Combined penicillin non-wild-type and resistance to macrolides[f]	877	4.0	745	3.0	674	2.7	1 068	3.7	542	2.8	9.0 (0.0–37.5)	–
E. faecalis	High-level gentamicin resistance	722	13.4	945	13.3	627	12.8	1 225	10.0	1 238	10.1	29.0 (4.1–51.6)	⇩#
E. faecium	Vancomycin resistance	546	0.4	530	0.0	428	1.4	693	1.0	600	0.2	16.8 (0.0–56.6)	–

NA: not applicable as data were not reported for all years, a significant change in data source occurred during the period, or the number of isolates was < 20 in any year during the period.
ND: no data available.

[a] Lowest and highest national resistance percentage among reporting EU/EEA countries (n = 29).

[b] ⇧ and ⇩ indicate statistically significantly increasing and decreasing trends, respectively; # indicates a significant trend in the overall data, but not in data that only included laboratories reporting continuously for all five years; – indicates no statistically significant trend.

[c] The aminoglycoside group includes only gentamicin and tobramycin from 2020 onwards.

[d] The aminoglycoside group includes only tobramycin from 2020 onwards.

[e] MRSA is based on oxacillin or cefoxitin, but AST results reported as cloxacillin, dicloxacillin, flucloxacillin or methicillin are accepted as a marker for oxacillin resistance if oxacillin is not reported. Data from molecular confirmation tests (detection of *mecA* gene by PCR or a positive PBP2A-agglutionation test) are given priority over phenotypic AST results.

[f] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints in the period 2016–2018 might define the cut-off values for the susceptibility categories differently.

Switzerland

Participating institution

Swiss Centre for Antibiotic Resistance, Institute for Infectious Diseases, University of Bern

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Switzerland, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated population coverage (%)	70	80	87	86	86
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	High	High	High	High	High
Blood-culture sets/1 000 patient days	Unknown	Unknown	Unknown	Unknown	Unknown

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in CAESAR EQA, Switzerland, 2016–2020

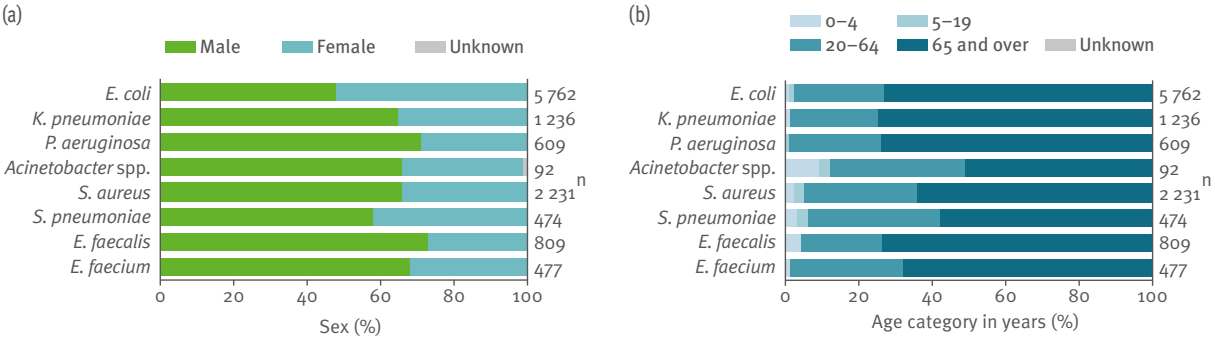
Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	90	90	97	97	97
Percentage of laboratories participating in CAESAR EQA	0	0	0	0	64

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Switzerland, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	20	4 729	4	23	5 400	4	29	5 884	3	33	5 774	3	36	5 762	3
K. pneumoniae	19	927	9	22	962	6	28	1 035	7	31	1 184	7	34	1 236	7
P. aeruginosa	20	458	10	23	536	9	26	522	8	31	545	8	32	609	10
Acinetobacter spp.	14	73	22	20	92	9	21	69	7	26	65	12	25	92	13
S. aureus	20	1 630	9	23	2 027	7	29	2 001	6	33	2 159	7	34	2 231	8
S. pneumoniae	18	562	6	23	753	5	29	776	5	31	715	5	34	474	6
E. faecalis	20	619	9	23	676	7	29	713	8	30	737	8	34	809	12
E. faecium	20	426	19	21	469	17	26	439	17	27	401	16	30	477	22

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories may be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Switzerland, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, Switzerland, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020	
		n	%	n	%	n	%	n	%	n	%
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	4 346	46.3	5 394	49.3	5 581	49.3	5 407	48.6	5 349	46.9
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	4 706	9.2	5 397	9.4	5 881	10.4	5 771	10.1	5 753	9.9
	Carbapenem (imipenem/meropenem) resistance	4 723	0.0	5 378	0.0	5 860	0.1	5 734	0.0	5 729	0.0
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	4 686	15.7	5 397	17.4	5 880	17.6	5 765	15.9	5 752	15.6
	Aminoglycoside (gentamicin/tobramycin) resistance	4 665	8.8	5 388	8.2	5 851	8.6	5 675	8.6	5 566	8.2
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	4 630	3.3	5 385	3.0	5 848	3.5	5 667	3.7	5 557	2.8
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	921	7.2	961	7.0	1 034	8.6	1 183	7.6	1 231	6.9
	Carbapenem (imipenem/meropenem) resistance	926	0.8	959	0.3	1 033	1.0	1 179	0.4	1 227	0.3
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	920	5.7	961	8.0	1 033	10.9	1 183	9.0	1 236	6.8
	Aminoglycoside (gentamicin/tobramycin) resistance	911	4.5	961	4.7	1 033	5.5	1 169	4.2	1 206	3.5
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	906	2.6	959	2.5	1 030	4.5	1 169	3.2	1 205	1.7
P. aeruginosa	Piperacillin-tazobactam resistance	440	9.5	536	9.0	510	11.8	521	9.8	578	8.8
	Ceftazidime resistance	441	6.8	510	8.4	490	9.2	522	7.9	568	6.3
	Carbapenem (imipenem/meropenem) resistance	452	8.2	533	8.4	522	8.6	542	10.3	607	8.4
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	455	7.3	535	8.0	519	11.0	543	10.3	604	10.9
	Aminoglycoside (gentamicin/tobramycin) resistance[a]	457	2.0	535	2.6	522	4.4	543	5.2	446	1.6
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[a]	423	4.3	508	3.7	478	6.9	494	5.9	441	4.8
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	73	6.8	91	9.9	69	2.9	64	3.1	90	10.0
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	73	13.7	91	14.3	69	2.9	65	7.7	91	13.2
	Aminoglycoside (gentamicin/tobramycin) resistance	73	15.1	89	15.7	65	4.6	63	11.1	87	12.6
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides	73	6.8	89	9.0	65	3.1	63	3.2	86	10.5
S. aureus	MRSA[b]	1 621	4.3	1 983	4.2	1 689	4.7	2 099	3.3	2 157	4.5
S. pneumoniae	Penicillin non-wild-type[c]	548	5.8	723	5.8	732	5.7	671	5.8	439	5.7
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	543	8.1	650	9.2	628	10.2	587	7.8	402	8.0
	Combined penicillin non-wild-type and resistance to macrolides[c]	530	3.4	621	3.4	588	4.1	543	3.5	368	3.3
E. faecalis	High-level gentamicin resistance	200	11.5	273	11.0	276	5.4	413	9.9	397	12.1
E. faecium	Vancomycin resistance	374	1.6	465	2.2	438	3.4	399	1.8	477	3.1

[a] The aminoglycoside group includes only tobramycin from 2020 onwards.
[b] MRSA is calculated as resistance to cefoxitin or, if not available, oxacillin.
[c] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints might define the cut-off values for the susceptibility categories differently.

Turkey

Participating institution

Department of Microbiology Reference Laboratories and Biological Products, General Directorate of Public Health, Ministry of Health

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Turkey, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated population coverage (%)	22	28	28	28	28
Geographical representativeness	High	High	High	High	High
Hospital representativeness	High	High	High	High	High
Patient and isolate representativeness	Medium	Medium	Medium	Medium	Medium
Blood-culture sets/1 000 patient days[a]	Unknown	31 (4–110)	32 (4–110)	23 (1–99)	28 (2–106)

Definitions provided on page 7.
[a] Data are presented as median (range).

Laboratories contributing data: use of clinical breakpoint guidelines and participation in CAESAR EQA, Turkey, 2016–2020

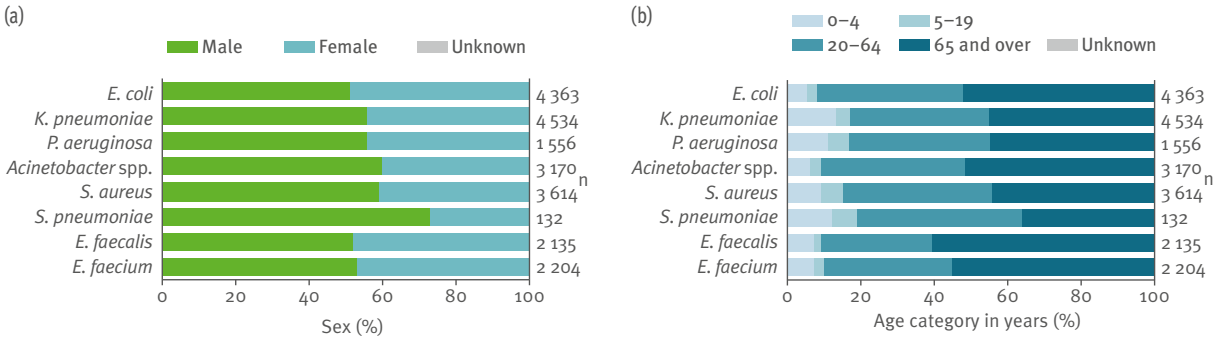
Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	64	100	100	100	100
Percentage of laboratories participating in CAESAR EQA	77	68	79	58	94

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Turkey, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	65	3 986	12	69	4 459	16	67	5 056	13	70	4 999	12	70	4 363	14
K. pneumoniae	66	2 915	32	68	3 232	36	67	3 833	34	69	4 167	28	70	4 534	32
P. aeruginosa	63	1 332	27	66	1 605	33	65	1 771	31	64	1 727	29	66	1 556	26
Acinetobacter spp.	64	2 463	40	67	2 620	45	66	2 754	44	68	2 477	42	69	3 170	45
S. aureus	65	2 499	15	68	3 230	23	66	3 354	21	69	3 475	14	70	3 614	20
S. pneumoniae	39	183	13	45	235	24	43	253	12	40	227	16	39	132	17
E. faecalis	62	1 589	30	65	1 735	37	67	1 944	35	66	1 976	32	69	2 135	34
E. faecium	60	1 522	28	65	1 585	34	65	1 669	32	66	1 829	27	68	2 204	31

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories may be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Turkey, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, Turkey, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020	
		n	%	n	%	n	%	n	%	n	%
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	2 886	78.7	3 652	77.7	4 154	76.7	4 290	78.8	3 562	76.1
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	3 897	52.7	4 337	52.7	4 923	53.2	4 847	54.7	4 342	53.4
	Carbapenem (imipenem/meropenem) resistance	3 863	3.1	4 321	2.7	4 759	2.6	4 966	3.0	4 347	3.7
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	3 670	50.3	4 022	52.3	4 606	52.2	4 853	51.7	4 193	50.1
	Aminoglycoside (gentamicin/tobramycin) resistance	3 677	27.4	4 083	26.6	4 785	24.4	4 617	25.8	4 211	23.7
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	3 433	19.2	3 755	18.8	4 477	17.7	4 496	18.3	4 078	16.5
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	2 862	72.2	3 157	72.0	3 766	72.0	3 977	74.0	4 501	76.9
	Carbapenem (imipenem/meropenem) resistance	2 836	29.5	3 165	32.5	3 641	34.4	4 028	39.4	4 517	48.2
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	2 769	54.9	3 009	61.1	3 557	62.6	3 933	64.8	4 276	69.0
	Aminoglycoside (gentamicin/tobramycin) resistance	2 711	47.6	2 991	44.6	3 632	45.9	3 925	44.8	4 405	46.6
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	2 611	38.3	2 821	38.9	3 442	39.9	3 689	40.5	4 156	43.3
P. aeruginosa	Piperacillin-tazobactam resistance	1 203	30.9	1 491	37.2	1 646	34.0	1 533	34.1	1 365	32.1
	Ceftazidime resistance	1 286	24.3	1 481	30.0	1 700	26.8	1 645	28.0	1 468	27.2
	Carbapenem (imipenem/meropenem) resistance	1 281	37.3	1 552	37.4	1 682	37.5	1 712	38.4	1 547	36.2
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	1 252	35.1	1 525	35.6	1 674	32.7	1 637	35.2	1 503	31.0
	Aminoglycoside (gentamicin/tobramycin) resistance[a]	1 305	27.2	1 519	26.7	1 730	19.0	1 681	20.8	769	15.7
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[a]	1 090	28.2	1 279	31.7	1 451	27.8	1 424	30.1	672	27.5
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	2 373	91.6	2 540	91.5	2 643	92.2	2 390	90.4	3 165	93.1
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	2 324	92.1	2 505	92.6	2 575	94.4	2 391	90.7	3 064	93.6
	Aminoglycoside (gentamicin/tobramycin) resistance	2 408	77.7	2 558	78.3	2 704	79.1	2 404	80.3	3 117	86.1
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides	2 266	75.6	2 421	77.8	2 526	79.3	2 362	79.6	3 039	84.7
S. aureus	MRSA[b]	1 887	22.7	3 142	25.8	3 316	29.6	3 407	31.3	3 591	33.4
S. pneumoniae	Penicillin non-wild-type[c]	174	47.1	213	46.0	243	43.6	212	50.9	128	53.9
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	163	39.3	205	39.5	217	37.3	211	37.0	119	34.5
	Combined penicillin non-wild-type and resistance to macrolides[c]	155	29.7	186	29.0	211	28.0	200	32.5	117	27.4
E. faecalis	High-level gentamicin resistance	767	60.2	1 125	38.0	1 337	36.9	1 914	33.5	2 040	29.6
E. faecium	Vancomycin resistance	1 467	14.6	1 551	13.2	1 570	13.6	1 797	13.3	2 201	15.4

[a] The aminoglycoside group includes only tobramycin from 2020 onwards.
[b] MRSA is calculated as resistance to cefoxitin or, if not available, oxacillin.
[c] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints might define the cut-off values for the susceptibility categories differently.

Ukraine

Participating institution

Reference Laboratory for Microbiological and Parasitological Research, Public Health Center, Ministry of Health

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Ukraine, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated population coverage (%)	Unknown	Unknown	0.45	0.74	1.96
Geographical representativeness	Unknown	Medium	Medium	Medium	Medium
Hospital representativeness	Unknown	Poor	Poor	Medium	Medium
Patient and isolate representativeness	Unknown	Poor	Poor	Poor	Poor
Blood-culture sets/1 000 patient days[a]	Unknown	Unknown	9 (3–12)	3 (1–12)	3 (2–15)

Definitions provided on page 7.
[a] Data are presented as median (range).

Laboratories contributing data: use of clinical breakpoint guidelines and participation in CAESAR EQA, Ukraine, 2016–2020

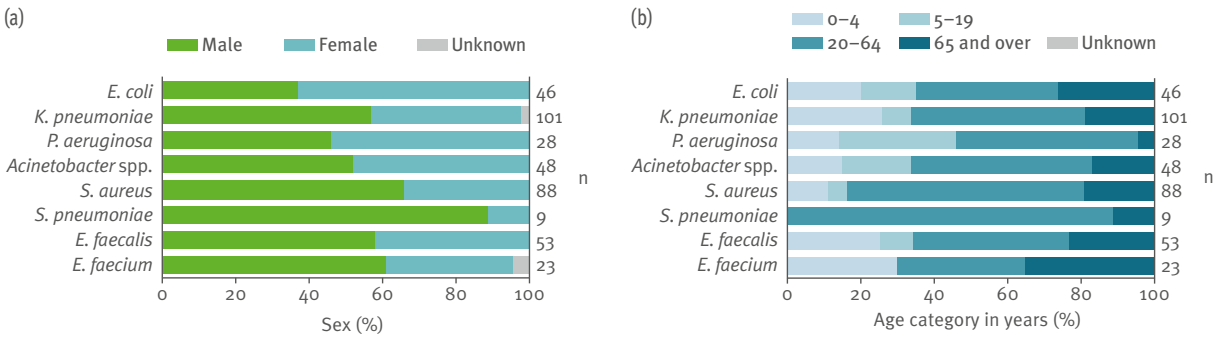
Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	Unknown	75	100	100	100
Percentage of laboratories participating in CAESAR EQA	Unknown	100	100	100	100

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Ukraine, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	0	0	ND	3	11	18	4	18	39	6	39	31	7	46	15
K. pneumoniae	0	0	ND	4	30	50	4	38	50	6	75	58	9	101	Unknown
P. aeruginosa	0	0	ND	2	9	56	3	10	40	5	16	50	6	28	50
Acinetobacter spp.	0	0	ND	4	32	32	4	29	48	7	44	65	7	48	50
S. aureus	0	0	ND	4	20	20	4	22	41	7	68	40	9	88	10
S. pneumoniae	0	0	ND	2	6	17	1	1	0	3	8	75	2	9	43
E. faecalis	0	0	ND	4	31	23	4	29	21	7	46	33	9	53	28
E. faecium	0	0	ND	2	12	17	2	8	50	4	12	18	7	23	Unknown

Labs: laboratories.
ND: no data available.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories may be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Ukraine, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, Ukraine, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020	
		n	%	n	%	n	%	n	%	n	%
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	0	ND	11	81.8[a]	12	58.3[a]	17	76.5[a]	21	71.4[a]
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	0	ND	11	36.4[a]	18	44.4[a]	39	41.0	45	53.3
	Carbapenem (imipenem/meropenem) resistance	0	ND	11	0.0[a]	18	0.0[a]	31	6.5	45	4.4
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	0	ND	11	45.5[a]	18	44.4[a]	37	35.1	43	41.9
	Aminoglycoside (gentamicin/tobramycin) resistance	0	ND	10	30.0[a]	18	22.2[a]	35	20.0	42	35.7
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	0	ND	10	30.0[a]	18	16.7[a]	34	11.8	40	17.5
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	0	ND	30	56.7	37	83.8	72	91.7	95	84.2
	Carbapenem (imipenem/meropenem) resistance	0	ND	29	27.6[a]	37	43.2	67	61.2	99	53.5
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	0	ND	29	69.0[a]	38	78.9	71	83.1	95	78.9
	Aminoglycoside (gentamicin/tobramycin) resistance	0	ND	25	56.0[a]	35	65.7	69	76.8	82	61.0
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	0	ND	25	40.0[a]	34	58.8	68	70.6	78	57.7
P. aeruginosa	Piperacillin-tazobactam resistance	0	ND	7	< 10 isolates	9	< 10 isolates	12	41.7[a]	24	54.2[a]
	Ceftazidime resistance	0	ND	8	< 10 isolates	10	70.0[a]	15	60.0[a]	27	59.3[a]
	Carbapenem (imipenem/meropenem) resistance	0	ND	9	< 10 isolates	10	100.0[a]	16	56.3[a]	27	70.4[a]
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	0	ND	8	< 10 isolates	9	< 10 isolates	15	73.3[a]	26	57.7[a]
	Aminoglycoside (gentamicin/tobramycin) resistance[b]	0	ND	7	< 10 isolates	9	< 10 isolates	15	53.3[a]	25	56.0[a]
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[b]	0	ND	7	< 10 isolates	9	< 10 isolates	12	41.7[a]	22	54.5[a]
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	0	ND	30	40.0	28	75.0[a]	44	72.7	48	77.1
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	0	ND	25	80.0[a]	29	86.2[a]	41	90.2	47	87.2
	Aminoglycoside (gentamicin/tobramycin) resistance	0	ND	18	50.0[a]	27	81.5[a]	40	85.0	43	76.7
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides	0	ND	18	50.0[a]	26	65.4[a]	38	76.3	42	64.3
S. aureus	MRSA[c]	0	ND	19	0.0[a]	20	0.0[a]	60	1.7	83	18.1
S. pneumoniae	Penicillin non-wild-type[d]	0	ND	6	< 10 isolates	1	< 10 isolates	8	< 10 isolates	9	< 10 isolates
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	0	ND	6	< 10 isolates	1	< 10 isolates	8	< 10 isolates	9	< 10 isolates
	Combined penicillin non-wild-type and resistance to macrolides[d]	0	ND	6	< 10 isolates	1	< 10 isolates	8	< 10 isolates	9	< 10 isolates
E. faecalis	High-level gentamicin resistance	0	ND	18	44.4[a]	19	63.2[a]	29	51.7[a]	36	41.7
E. faecium	Vancomycin resistance	0	ND	12	16.7[a]	8	< 10 isolates	12	0.0[a]	19	0.0[a]

ND: no data available.
< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.
[a] A small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution. See Annex 3 for more information.
[b] The aminoglycoside group includes only tobramycin from 2020 onwards.
[c] MRSA is calculated as resistance to cefoxitin or, if not available, oxacillin.
[d] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints might define the cut-off values for the susceptibility categories differently.

United Kingdom

Data from Scotland and Wales were not included.

Participating institutions

Public Health England
Public Health Agency Northern Ireland

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, United Kingdom, 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated population coverage (%)	Unknown	Unknown	Unknown	Unknown	Unknown
Geographical representativeness	Unknown	Unknown	Medium	Medium	Medium
Hospital representativeness	Unknown	Unknown	High	High	High
Patient and isolate representativeness	Unknown	Unknown	High	High	High
Blood-culture sets/1 000 patient days	60	52	Unknown	Unknown	Unknown

Definitions provided on page 7.

Laboratories contributing data: use of clinical breakpoint guidelines and participation in EQA,[a] United Kingdom, 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	98	96	100	100	100
Percentage of laboratories participating in EQA[a]	88	82	82	84	NA

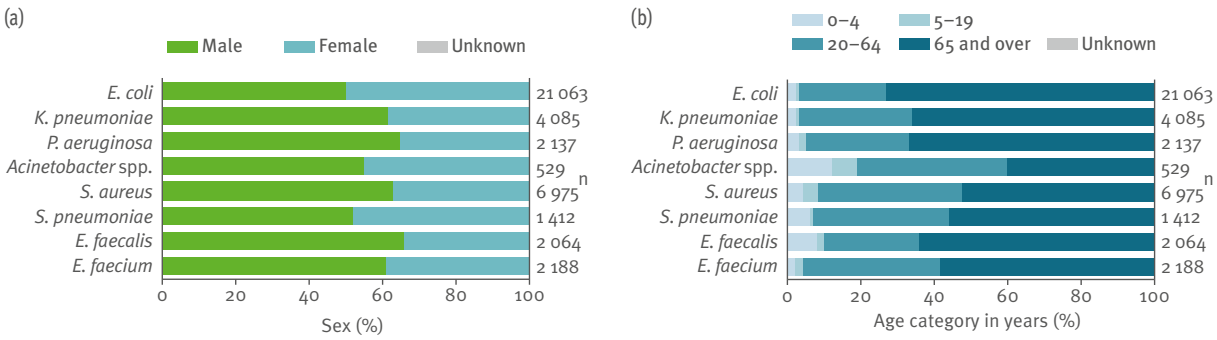
NA: not available.
[a] During the years 2016–2019, the United Kingdom participated in the EARS-Net EQA.

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] United Kingdom, 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	68	19 636	Unknown	73	24 105	Unknown	73	25 102	Unknown	72	25 846	Unknown	72	21 063	Unknown
K. pneumoniae	67	3 531	Unknown	73	4 286	Unknown	72	4 560	Unknown	72	4 685	Unknown	71	4 085	Unknown
P. aeruginosa	68	1 924	Unknown	72	2 418	Unknown	72	2 312	Unknown	71	2 478	Unknown	71	2 137	Unknown
Acinetobacter spp.	61	530	Unknown	71	665	Unknown	67	620	Unknown	70	666	Unknown	69	529	Unknown
S. aureus	71	6 301	Unknown	73	7 603	Unknown	73	7 948	Unknown	72	8 014	Unknown	72	6 975	Unknown
S. pneumoniae	70	2 927	Unknown	72	3 348	Unknown	70	3 547	Unknown	71	3 468	Unknown	71	1 412	Unknown
E. faecalis	66	1 603	Unknown	71	2 100	Unknown	71	2 268	Unknown	69	2 274	Unknown	69	2 064	Unknown
E. faecium	64	1 539	Unknown	71	1 825	Unknown	71	2 196	Unknown	71	2 191	Unknown	70	2 188	Unknown

Labs: laboratories.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories may be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, United Kingdom, 2020



Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, United Kingdom, 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020	
		n	%	n	%	n	%	n	%	n	%
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	17 105	62.0	20 672	61.7	21 412	60.1	22 889	59.8	19 454	58.1
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	17 438	9.8	20 396	10.5	21 081	11.1	21 530	11.9	18 015	11.0
	Carbapenem (imipenem/meropenem) resistance	18 109	0.0	22 037	0.0	23 172	0.1	24 409	0.0	20 236	0.1
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	18 249	16.5	22 128	17.3	23 187	17.6	24 362	17.8	20 311	16.3
	Aminoglycoside (gentamicin/tobramycin) resistance	18 558	9.8	22 787	9.9	23 994	10.4	25 083	10.5	20 638	10.2
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	16 202	4.3	18 716	4.2	19 563	4.5	20 616	4.7	17 522	4.1
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	3 141	9.4	3 683	11.8	3 872	13.4	3 959	14.0	3 515	13.5
	Carbapenem (imipenem/meropenem) resistance	3 237	0.3	3 896	0.8	4 173	0.8	4 337	0.7	3 910	0.4
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	3 241	8.1	3 919	9.1	4 186	12.9	4 345	12.7	3 915	12.3
	Aminoglycoside (gentamicin/tobramycin) resistance	3 312	7.1	4 021	8.3	4 305	9.0	4 440	8.4	3 978	8.1
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	2 882	4.1	3 348	4.2	3 544	5.5	3 713	5.4	3 410	5.2
P. aeruginosa	Piperacillin-tazobactam resistance	1 705	5.9	2 124	5.1	1 993	5.6	2 197	5.6	2 012	6.4
	Ceftazidime resistance	1 745	4.1	2 166	4.6	2 108	5.1	2 316	5.1	2 016	5.3
	Carbapenem (imipenem/meropenem) resistance	1 780	5.6	2 227	5.6	2 160	6.3	2 362	6.5	2 070	6.4
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	1 794	6.9	2 221	8.3	2 157	10.0	2 370	8.7	2 088	9.1
	Aminoglycoside (gentamicin/tobramycin) resistance[a]	1 821	3.6	2 281	3.5	2 210	4.5	2 408	4.3	1 138	1.6
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[a]	1 529	2.6	1 841	2.7	1 762	2.8	2 021	3.2	1 073	4.2
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	484	1.4	615	2.8	573	2.1	639	2.0	508	1.8
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	494	4.9	629	5.7	587	3.2	635	6.9	490	7.3
	Aminoglycoside (gentamicin/tobramycin) resistance	501	3.0	629	4.3	593	5.6	639	4.9	508	2.0
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides	452	1.1	574	1.4	530	1.1	596	1.2	466	0.4
S. aureus	MRSA[b]	5 007	6.9	6 163	6.6	7 042	7.4	7 325	6.4	6 012	5.6
S. pneumoniae	Penicillin non-wild-type[c]	2 582	4.2	2 913	5.1	3 089	5.6	3 084	5.7	1 322	7.4
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	2 804	5.8	3 234	5.6	3 396	5.9	3 340	5.4	1 373	6.0
	Combined penicillin non-wild-type and resistance to macrolides[c]	2 501	2.4	2 824	1.8	2 958	2.2	2 976	2.4	1 286	2.7
E. faecalis	High-level gentamicin resistance	0	ND	0	ND	0	ND	19[d]	36.8[e]	14[d]	7.1[e]
E. faecium	Vancomycin resistance	1 380	20.8	1 671	22.5	2 002	22.2	2 066	19.3	2 127	19.2

ND: no data available.
[a] The aminoglycoside group includes only tobramycin from 2020 onwards.
[b] MRSA is calculated as resistance to cefoxitin or, if not available, oxacillin.
[c] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints might define the cut-off values for the susceptibility categories differently.
[d] Data from England not included.
[e] A small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution.

Kosovo[16]

Participating institution

Department of Medical Microbiology, Institute of Public Health

Population and hospitals contributing data: coverage, representativeness and blood-culture rate, Kosovo,[1] 2016–2020

Parameter	2016	2017	2018	2019	2020
Estimated population coverage (%)	90	90	90	90	90
Geographical representativeness	Medium	Medium	Medium	High	High
Hospital representativeness	Poor	Poor	Poor	High	High
Patient and isolate representativeness	Poor	Poor	Poor	Poor	Poor
Blood-culture sets/1 000 patient days[a]	5	6	5	5 (5–6)	6 (6–6)

Definitions provided on page 7.
[a] Data are presented as median (range).
1 All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999).

Laboratories contributing data: use of clinical breakpoint guidelines and participation in CAESAR EQA, Kosovo,[1] 2016–2020

Parameter	2016	2017	2018	2019	2020
Percentage of laboratories using EUCAST or EUCAST-harmonized guidelines	100	100	100	100	100
Percentage of laboratories participating in CAESAR EQA	100	100	100	100	50

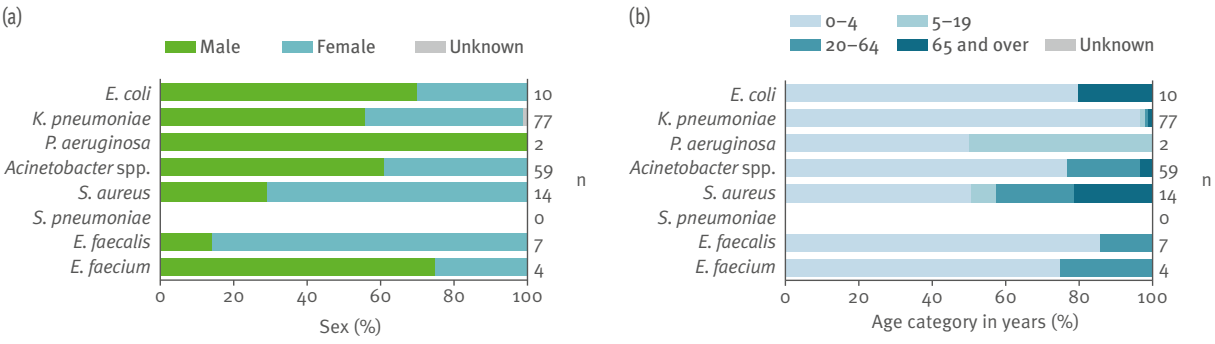
1 All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999).

Annual number of reporting laboratories,[a] number of reported isolates and percentage of isolates reported from patients in ICUs,[b] Kosovo,[1] 2016–2020

Bacterial species	2016			2017			2018			2019			2020		
	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)	Labs (n)	Isolates (n)	Isolates from ICU (%)
E. coli	1	18	6	1	19	5	1	12	17	2	17	53	2	10	40
K. pneumoniae	1	42	2	1	38	3	1	66	94	2	55	84	2	77	91
P. aeruginosa	1	8	0	1	19	21	1	13	85	2	14	36	1	2	50
Acinetobacter spp.	1	40	10	1	70	10	1	70	93	1	45	98	2	59	88
S. aureus	1	12	8	1	19	16	1	26	54	2	29	31	2	14	21
S. pneumoniae	1	7	0	1	4	0	1	4	0	1	3	0	0	0	ND
E. faecalis	1	13	8	1	11	9	1	11	55	2	16	19	2	7	71
E. faecium	1	13	8	1	8	13	1	5	40	2	7	71	2	4	25

Labs: laboratories.
ND: no data available.
[a] Number of laboratories reporting at least one isolate during the specific year. The total number of participating laboratories may be higher.
[b] Isolates with missing information on hospital department are excluded, and results are presented only if data on hospital department are available for ≥ 70% of isolates.
1 All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999).

Percentage of isolates by patient sex (a) and age group (b), by bacterial species, Kosovo,[1] 2020



1 All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999).

16 All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999).

Total number of invasive isolates tested (n) and percentages of isolates with resistance phenotype (%), by bacterial species and antimicrobial group/agent, Kosovo,[1] 2016–2020

Bacterial species	Antimicrobial group/agent	2016		2017		2018		2019		2020	
		n	%	n	%	n	%	n	%	n	%
E. coli	Aminopenicillin (amoxicillin/ampicillin) resistance	18	77.8[a]	19	78.9[a]	12	91.7[a]	17	76.5[a]	10	50.0[a]
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	18	61.1[a]	19	47.4[a]	12	58.3[a]	17	41.2[a]	10	30.0[a]
	Carbapenem (imipenem/meropenem) resistance	18	0.0[a]	19	0.0[a]	12	0.0[a]	17	0.0[a]	10	0.0[a]
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	18	33.3[a]	19	26.3[a]	12	58.3[a]	17	35.3[a]	10	20.0[a]
	Aminoglycoside (gentamicin/tobramycin) resistance	18	44.4[a]	19	47.4[a]	12	58.3[a]	17	29.4[a]	10	10.0[a]
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	18	22.2[a]	19	26.3[a]	12	58.3[a]	17	23.5[a]	10	10.0[a]
K. pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	42	85.7	38	97.4	66	97.0	55	85.5	77	92.2
	Carbapenem (imipenem/meropenem) resistance	42	0.0	38	0.0	66	1.5	55	0.0	77	0.0
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	42	9.5	38	7.9	66	6.1	55	16.4	77	0.0
	Aminoglycoside (gentamicin/tobramycin) resistance	42	85.7	38	97.4	66	95.5	55	81.8	77	90.9
	Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides	42	9.5	38	7.9	66	6.1	55	16.4	77	0.0
P. aeruginosa	Piperacillin-tazobactam resistance	8	< 10 isolates	19	42.1[a]	13	46.2[a]	14	14.3[a]	2	< 10 isolates
	Ceftazidime resistance	8	< 10 isolates	19	31.6[a]	13	23.1[a]	14	14.3[a]	2	< 10 isolates
	Carbapenem (imipenem/meropenem) resistance	8	< 10 isolates	19	73.7[a]	13	76.9[a]	14	14.3[a]	2	< 10 isolates
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	8	< 10 isolates	19	42.1[a]	13	53.8[a]	14	21.4[a]	2	< 10 isolates
	Aminoglycoside (gentamicin/tobramycin) resistance[b]	8	< 10 isolates	19	47.4[a]	13	69.2[a]	14	14.3[a]	2	< 10 isolates
	Combined resistance to ≥ 3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[b]	8	< 10 isolates	19	52.6[a]	13	61.5[a]	14	14.3[a]	2	< 10 isolates
Acinetobacter spp.	Carbapenem (imipenem/meropenem) resistance	40	95.0	70	88.6	70	88.6	45	93.3	59	84.7
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	40	95.0	70	88.6	70	87.1	45	91.1	59	84.7
	Aminoglycoside (gentamicin/tobramycin) resistance	40	95.0	70	92.9	70	90.0	45	91.1	59	72.9
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides	40	95.0	70	88.6	70	87.1	45	91.1	59	71.2
S. aureus	MRSA[c]	12	25.0[a]	19	57.9[a]	26	57.7[a]	29	34.5[a]	14	64.3[a]
S. pneumoniae	Penicillin non-wild-type[d]	7	< 10 isolates	4	< 10 isolates	4	< 10 isolates	3	< 10 isolates	0	ND
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	7	< 10 isolates	4	< 10 isolates	4	< 10 isolates	3	< 10 isolates	0	ND
	Combined penicillin non-wild-type and resistance to macrolides[d]	7	< 10 isolates	4	< 10 isolates	4	< 10 isolates	3	< 10 isolates	0	ND
E. faecalis	High-level gentamicin resistance	13	46.2[a]	11	63.6[a]	11	72.7[a]	16	50.0[a]	7	< 10 isolates
E. faecium	Vancomycin resistance	13	15.4[a]	8	< 10 isolates	5	< 10 isolates	7	< 10 isolates	4	< 10 isolates

ND: no data available.
< 10 isolates: no percentage is displayed if < 10 isolates were available for analysis.
[a] A small number of isolates were tested (n < 30), and the percentage resistance should be interpreted with caution.
[b] The aminoglycoside group includes only tobramycin from 2020 onwards.
[c] MRSA is calculated as resistance to cefoxitin or, if not available, oxacillin.
[d] Penicillin results are based on penicillin or, if not available, oxacillin. For *S. pneumoniae*, the term penicillin non-wild-type is used in this report, referring to *S. pneumoniae* isolates reported by the local laboratories as susceptible increased exposure (I) or resistant (R) to penicillin, assuming MIC to benzylpenicillin above those of wild-type isolates (> 0.06 mg/L). The qualitative susceptibility categories (S/I/R) as reported by the laboratory are used, since quantitative susceptibility information is missing for a large part of the data. Laboratories not using EUCAST clinical breakpoints might define the cut-off values for the susceptibility categories differently.
[1] All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999).

Recommended reading[17]

European Centre for Disease Prevention and Control. EARS-NET reporting protocol 2021. Stockholm: European Centre for Disease Prevention and Control; 2021 (https://www.ecdc.europa.eu/en/publications-data/ears-net-reporting-protocol-2021).

European Centre for Disease Prevention and Control. Surveillance atlas of infectious diseases. In: European Centre for Disease Prevention and Control [website]. Stockholm: European Centre for Disease Prevention and Control; 2021 (https://www.ecdc.europa.eu/en/surveillance-atlas-infectious-diseases).

17 All weblinks accessed on 29 November 2021.

7. Annexes

Annex 1. Participating institutions

Country/area	Participating institutions
EU/EEA	
Austria	Federal Ministry of Health and Women's Affairs
	Medical University Vienna
	Ordensklinikum Linz, Elisabethinen
Belgium	Sciensano
Bulgaria	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
Czechia	National Institute of Public Health
	National Reference Laboratory for Antibiotics
Denmark	Statens Serum Institut
	Danish Study Group for Antimicrobial Resistance Surveillance (DANRES)
Estonia	Estonian Health Board
	East-Tallinn Central Hospital
	Tartu University Hospital
Finland	Finnish Institute for Health and Welfare, Department of Health Security
	Finnish Study Group for Antimicrobial Resistance (FiRe)
	Finnish Hospital Infection Program (SIRO)
France	Santé Publique France
	Since 2020:
	Surveillance and Prevention of Antimicrobial RESistance in hospital settings (SPARES)
	National Reference Centre for Pneumococci
	Up to 2019:
	French National Observatory for the Epidemiology of Bacterial Resistance to Antimicrobials (ONERBA) through three participating networks:
	Azay-Résistance
	Île-de-France
	Réussir
Germany	Robert Koch Institute
Greece	National Public Health Organization, Central Public Health Laboratory
	University of West Attica, Department of Public Health Policy, School of Public Health
Hungary	National Public Health Center
Iceland	National University Hospital of Iceland
	Centre for Health Security and Infectious Disease Control
Ireland	Health Protection Surveillance Centre
Italy	National Institute of Health
Latvia	Disease Prevention and Control Center of Latvia
Liechtenstein	–
Lithuania	National Public Health Surveillance Laboratory
	Institute of Hygiene
Luxembourg	National Health Laboratory
	Microbiology Laboratory, Centre Hospitalier de Luxembourg
Malta	Malta Mater Dei Hospital, Msida
Netherlands	National Institute for Public Health and the Environment
Norway	University Hospital of North Norway
	Norwegian Institute of Public Health
	St Olav University Hospital, Trondheim
Poland	National Medicines Institute, Department of Epidemiology and Clinical Microbiology
	National Reference Centre for Susceptibility Testing
Portugal	National Institute of Health Doutor Ricardo Jorge
	Ministry of Health Directorate-General of Health
	Directorate-General of Health
Romania	National Institute of Public Health
Slovakia	National Reference Centre for Antimicrobial Resistance
	Public Health Authority of the Slovak Republic
	Regional Public Health Authority Banska Bystrica

Country/area	Participating institutions
Slovenia	National Institute of Public Health
	Medical Faculty, University of Ljubljana
	National Laboratory of Health, Environment and Food
Spain	Health Institute Carlos lll
	National Centre for Microbiology
Sweden	The Public Health Agency of Sweden
Non-EU/EEA	
Albania	Institute of Public Health
Armenia	Public Health Department, Ministry of Health
Azerbaijan	Sector of Sanitary Epidemiological Surveillance, Ministry of Health
Belarus	Laboratory for Clinical and Experimental Microbiology, Republican Research and Practical Center for Epidemiology and Microbiology
Bosnia and Herzegovina	Clinical Microbiology Department, Clinical Center University of Sarajevo
	Department of Microbiology, Department of Clinical Microbiology/University Clinical Centre of Republika Srpska
Georgia	National Center for Disease Control and Public Health
Kazakhstan	National Center on Public Health Development, Ministry of Health
Kyrgyzstan	Public Health Department, Ministry of Health
Montenegro	Department of Bacteriology, Institute of Public Health
North Macedonia	Laboratory for Bacteriology, Department of Microbiology, Institute of Public Health
Republic of Moldova	National Agency for Public Health, Ministry of Health
Russian Federation	Institute of Antimicrobial Chemotherapy, Smolensk State Medical Academy
Serbia	Department of Pyogenic, Respiratory and Sexually Transmitted Infections with the Reference Laboratory for Bacterial Resistance to Antimicrobials Centre for Microbiology Institute of Public Health of Vojvodina Novi Sad
Switzerland	Swiss Centre for Antibiotic Resistance, Institute for Infectious Diseases, University of Bern
Tajikistan	State Sanitary Epidemiology Surveillance Service, Ministry of Health and Social Protection of the Population
Turkey	Department of Microbiology Reference Laboratories and Biological Products, General Directorate of Public Health, Ministry of Health
Turkmenistan	Department of Acute Dangerous Disease Surveillance, State Sanitary Epidemiology Service, Ministry of Health and Medical Industry
Ukraine	Reference Laboratory for Microbiological and Parasitological Research, Public Health Center, Ministry of Health
United Kingdom	UK Health Security Agency
	Public Health Agency Northern Ireland
Uzbekistan	AMR Reference Center, Research Institute of Epidemiology, Microbiology and Infectious Diseases
Kosovo[1]	Department of Medical Microbiology, Institute of Public Health of Kosovo[1]

[1] All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999).

Annex 2. Tripartite antimicrobial resistance country self-assessment (TrACSS) 2020–2021 questionnaire

Multi-sector and One Health collaboration/coordination (Indicator 2 in Table 6)
A. No formal multisectoral governance or coordination mechanism on antimicrobial resistance (AMR) exists.
B. Multisectoral working group(s) or coordination committee on AMR established with Government leadership.
C. Multisectoral working group(s) is (are) functional, with clear terms of reference, regular meetings, and funding for working group(s) with activities and reporting/accountability arrangements defined.
D. Joint working on issues including agreement on common objectives.
E. Integrated approaches used to implement the national AMR action plan with relevant data and lessons learned from all sectors used to adapt implementation of the action plan.
Country progress with development of a national action plan on AMR (Indicator 3 in Table 6)
A. No national AMR action plan.
B. National AMR action plan under development.
C. National AMR action plan developed.
D. National AMR action plan being implemented.
E. National AMR action plan being implemented and actively monitored through a monitoring and evaluation framework.
National surveillance system for AMR in humans (Indicator 4 in Table 6)
A. No capacity for generating data (antibiotic susceptibility testing and accompanying clinical and epidemiological data) and reporting on antibiotic resistance.
B. AMR data is collated locally for common bacterial infections in hospitalized and community patients, but data collection may not use a standardized approach and lacks national coordination and/or quality management.
C. AMR data are collated nationally for common bacterial infections in hospitalized and community patients, but national coordination and standardization are lacking.
D. There is a standardized national AMR surveillance system collecting data on common bacterial infections in hospitalized and community patients, with established network of surveillance sites, designated national reference laboratory for AMR, and a national coordinating centre producing reports on AMR.
E. The national AMR surveillance system links AMR surveillance with antimicrobial consumption and/or use data for human health.
Infection prevention and control (IPC) in human health care (Indicator 8 in Table 6)
A. No national IPC programme or operational plan is available.
B. A national IPC programme or operational plan is available. National IPC and water, sanitation and hygiene and environmental health standards exist but are not fully implemented.
C. A national IPC programme and operational plan are available and national guidelines for health care IPC are available and disseminated. Selected health facilities are implementing the guidelines, with monitoring and feedback in place.
D. National IPC programme available according to the WHO IPC core components guidelines and IPC plans and guidelines implemented nationwide. All health care facilities have a functional built environment (including water and sanitation), and necessary materials and equipment to perform IPC, per national standards.
E. IPC programmes are in place and functioning at national and health facility levels according to the WHO IPC core components guidelines. Compliance and effectiveness are regularly evaluated and published. Plans and guidance are updated in response to monitoring.
Optimizing antimicrobial use in human health (Indicator 9 in Table 6)
A. No/weak national policies for appropriate use.
B. National policies for antimicrobial governance developed for the community and health care settings.
C. Practices to assure appropriate antimicrobial use being implemented in some healthcare facilities and guidelines for appropriate use of antimicrobials available.
D. Guidelines and other practices to enable appropriate use are implemented in most health facilities nationwide. Monitoring and surveillance results are used to inform action and to update treatment guidelines and essential medicines lists.
E. Guidelines on optimizing antibiotic use are implemented for all major syndromes and data on use is systematically fed back to prescribers.

Source: WHO *(1)*.

Reference

1. Tripartite AMR country self-assessment survey – TrACSS (5.0) 2020–2021. Geneva: World Health Organization; 2021 (https://www.who.int/publications/m/item/tripartite-amr-country-self-assessment-survey-(tracss)-2020-2021, accessed 29 November 2021).

Annex 3. Data quality and interpretation

The results presented in this report – regional results, intercountry/area comparisons and, in some cases, national/area trends – should be interpreted with caution. Several factors may influence the estimates and may result in over- as well as underestimation of antimicrobial resistance (AMR) percentages.

Random versus systematic error

Every measurement includes a risk of deviation from the true value due to either random or systematic error. Random error, also known as natural variation or chance variation, may not be error in the strict sense, but arises from unknown or unpredictable factors influencing the measurement. As a consequence, results will differ across measurements, even when measurement conditions are the same. Some measurement outcomes will be higher than the true value, others will be lower. Systematic error, on the other hand, is consistent, repeated error associated with the study design or data analysis, or with flawed measurement equipment. Systematic error consistently under- or overestimates the true value in the same direction for all measurements.

When combining results from multiple measurements, deviations due to random error (under- and overestimations occurring in single measurements) cancel out and the average is a good estimation of the true average, assuming no systematic error and provided that the number of measurements is sufficiently large (see section on "Sampling variation" below). However, as systematic error leads to either under- or overestimation of the true value for all measurements, the average will also be under- or overestimated. This deviation from the true average is called bias. The overall degree of bias in the data collected is the net result of different sources of systematic error that can each lead to deviation from the true average in a different direction (under- or overestimation) and to a different extent.

Random error will occur with every measurement, and investigators can reduce the amount of error only to a certain extent. Systematic error, on the other hand, can be significantly reduced by careful consideration of certain aspects of the data-generation process. When systematic error cannot be avoided, it is important (if possible) to evaluate the resulting bias, its extent and direction. Common sources of error and bias in AMR surveillance data are described in detail below and summarized in Table A3.1.

Random error

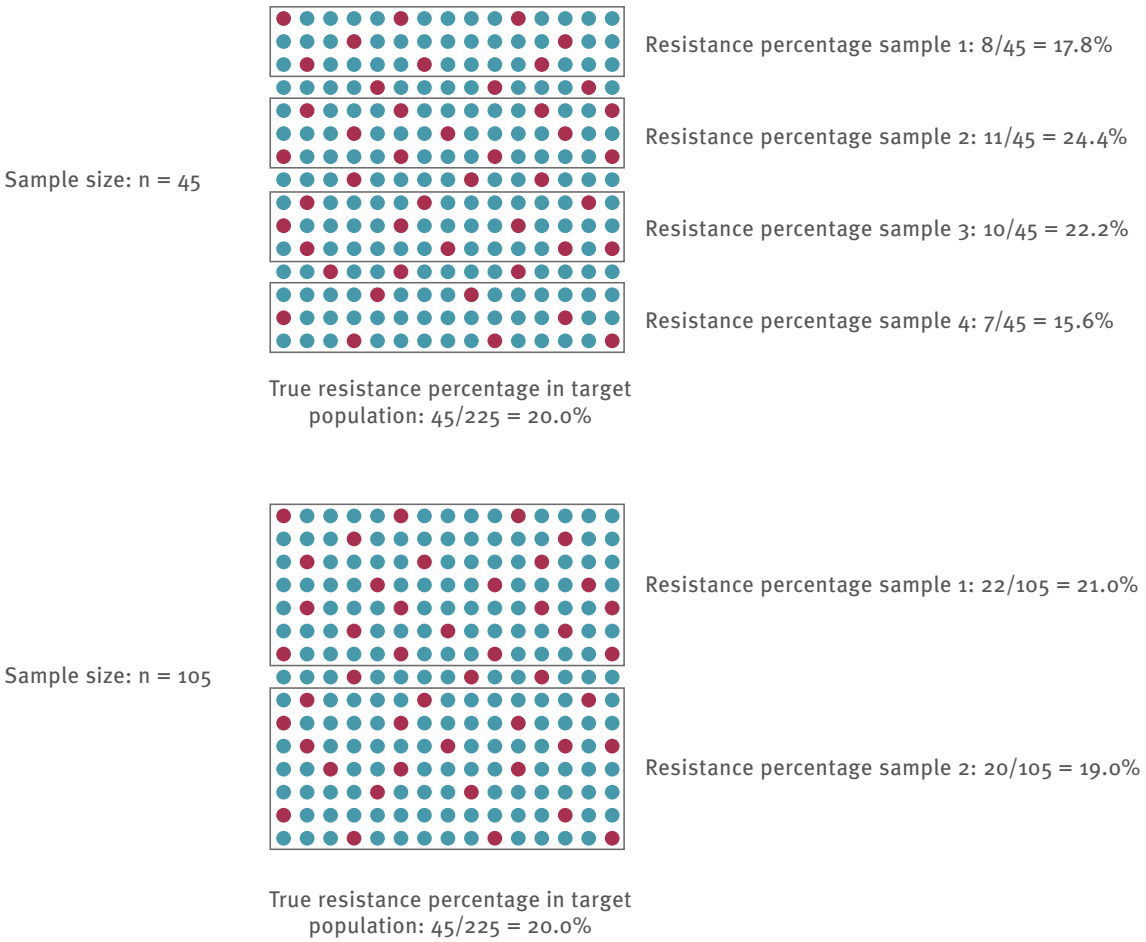
Sampling variation

The aim of the European Antimicrobial Resistance Surveillance Network (EARS-Net) and the Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR) network is to provide an overview of average AMR percentages in invasive isolates in a certain country or area. The population of interest (target population) are all patients with those infections. However, for practical reasons it often is not possible to include data from blood or cerebrospinal fluid (CSF) samples for all these patients, so data may instead be collected from a selection (sample) of them. Each patient from whom a blood or CSF sample is taken, and each bacterial strain isolated from them, is different from another. When all measurements of these patients are combined, the average reflects the group of patients who were sampled. When the group is small, the average may not reflect the true average for the target population because it is possible that, by chance, a lower or higher proportion of patients with resistant infections are sampled than the distribution in the target population. Fig. A3.1 shows that the larger the sample size, the closer the average in the sample is to the average in the target group. Finding (by chance) only one more or one less resistant isolate in a sample affects the average found in smaller samples much more than the average of larger samples. In other words, AMR percentages based on small sample sizes are, to a larger extent, affected by random sampling variation and potential outbreaks of resistant pathogens, whereas percentages based on large sample sizes are more likely to approximate the true average (provided there is no systematic error).

Measurement variation

Random error also arises from slight variations in how measurement procedures are applied across measurements. For example, the concentration of an inoculum that is plated out when testing antimicrobial susceptibility using disk diffusion will vary each time. Random variation in the concentration of the inoculum will result in larger inhibition zones for some samples and smaller zones for others. Depending on the specific breakpoints applied to these zones, this may lead to variation in categorizing isolates as susceptible, standard dosing regimen (S), susceptible, increased exposure (I) or resistant (R). Random measurement variation will be a combination of variation in both directions, and the larger the sample, the more likely it is that these will cancel out when results are combined. In antimicrobial susceptibility testing (AST), the variation depends on the skills of laboratory technicians and the variation that arises from measurements taken by different technicians. Standardizing procedures, training laboratory staff and ensuring quality are essential to minimize random measurement variation.

Fig. A3.1 AMR percentages obtained in various small and larger samples from a target population with a true AMR percentage of 20%



Systematic error

Bias related to sampling

Participating sites

Ideally, all medical microbiology laboratories should be included to obtain a representative assessment of AMR in a country or area. As this may not be feasible in practice, the selection of participating laboratories in the surveillance system should be representative of all laboratories. Laboratories from different geographical and climatic regions of the country/area, rural and urban areas and processing samples from different patient populations (hospital types and departments) should therefore be included. For reasons of convenience, it is often only the more advanced laboratories, which are most likely to be located in urban areas and providing services for specialized or tertiary-care facilities, that are included. Consequently, the data will reflect an underrepresentation of patients treated in general hospitals in rural areas, in whom AMR generally is lower. The results therefore will be biased towards higher percentages and will not necessarily be generalizable to the overall patient population.

Patients

When surveillance is based on routine diagnostic testing (passive surveillance), as in this report, data should be interpreted with extra caution. The data used in this type of surveillance are not generated with surveillance as the primary objective, but as part of routine patient care. The data therefore reflect only patients who were judged by clinicians to be eligible for bacteriology diagnostics, taking clinical predictions into consideration. Often, samples predominantly are taken from severely ill patients, patients with recurrent infections for whom treatment is problematic or patients strongly suspected of having resistant infections. Healthy patients with uncomplicated infections are less likely to have a sample taken. The data therefore will reflect an underrepresentation of patients with uncomplicated infections – in whom AMR generally is lower – and AMR results will be biased towards higher percentages. In

active surveillance, by contrast, clear case definitions generally are used to identify patients who need to be sampled – to reduce the influence of clinical judgement or other factors leading to selective patient sampling – and specific efforts are made to attain a representative sample of the target population.

Obtaining results that are representative of the target population requires ensuring that all patients fitting the case definition are sampled. In the case of EARS-Net and CAESAR, all patients presenting with signs of a bloodstream infection, sepsis or meningitis should be sampled. Sampling only specific patient categories (such as patients in intensive care units (ICU) or tertiary-care institutions), or patients with chronic or recurring infection, relapses or treatment failure, will overestimate the AMR proportion, as these patients will have been subjected to selective pressure of antimicrobial agents and therefore are more likely to be infected with a resistant microorganism.

The use of microbiological diagnostics depends on financial and logistic possibilities outside the control of a surveillance system. For example, not every eligible patient may be sampled in routine clinical care if bacteriology diagnostics are not reimbursed through health insurance, laboratory capacity is limited, or results are not communicated in a sufficiently timely manner to influence clinical decision-making. Sampling of patients may occur after antimicrobial therapy has already been started or following self-treatment in settings where over-the-counter sales of antibiotics is common, resulting in an underrepresentation of infections that respond to first-line antibiotics with consequent overestimation of AMR percentages.

Timing

The timing of sample collection may also influence the AMR proportions found. Ad hoc or convenience sampling for a limited period, especially during outbreaks, will bias results. This can to some extent be overcome by sampling throughout the year.

Bias related to laboratory procedures

Measurement error

Measurement values vary whenever measurements are taken. In addition to random variation, systematic error in measurements may occur. For example, when the agar depth of plates used for disk diffusion consistently is too small, inhibition zones will be overestimated for all isolates. Depending on the specific breakpoints applied to these zones, this may lead to isolates being categorized S when they should be I, or I when they should be R. Since the error is made in the same direction for all isolates, they do not cancel out and AMR will be underestimated when combining the results. Systematic measurement error occurs when laboratory procedures are not followed, when poor-quality laboratory materials are used (such as old growth media or expired antimicrobial disks) or when automated systems are damaged or not properly calibrated. Systematic error can also occur in species identification. Correctly identifying species is important for interpreting the percentages of AMR. Some species are more clinically relevant than others, and their capacity to acquire AMR or their intrinsic AMR varies. Sometimes the data suggest clear indications of problems with species identification. For example, a high proportion of ampicillin resistance in *Enterococcus faecalis* may be the result of *Enterococcus faecium* being misclassified as *Enterococcus faecalis*.

A laboratory quality-management system and regular application of internal quality-assurance procedures allow the timely detection and correction of systematic error in laboratory procedures. Auditing and accreditation schemes in conjunction with external quality assessment (EQA) programmes ensure that laboratories adhere to national/area quality standards.

Importantly, specific highly resistant microorganisms or exceptional antimicrobial-resistant phenotypes (such as carbapenem-resistant Enterobacterales) may need confirmation by additional testing to assess whether the findings are correct or a result of laboratory error. This double-checking of results is important because finding these types of organisms may have considerable consequences for empirical antimicrobial therapy and for infection prevention and control policies.

AST procedures and interpretation

To ensure accurate results, AST should be performed according to scientifically validated guidelines. Both the European Committee on Antimicrobial Susceptibility Testing (EUCAST) and the Clinical and Laboratory Standards Institute provide comprehensive methodological guidelines for routine AST, confirmatory testing and interpretation of results. Laboratory methods and interpretive criteria (clinical breakpoints) may differ depending on the guidelines and change over time. For example, a *Klebsiella pneumoniae* isolate with an inhibition zone of 16 mm for imipenem is considered I when EUCAST breakpoints 2018 are applied, but R with EUCAST 2019 breakpoints. AST results may therefore be incomparable across laboratories using different (versions of) guidelines, and time trends in the AMR percentage may be affected by, or a result of changes in, breakpoints used by laboratories over time.

In practice, expert rules are often used in addition to clinical breakpoints when interpreting AST results in the context of routine patient care. For example, if *Staphylococcus aureus* is resistant to cefoxitin, it is reported resistant to all beta-lactam antimicrobial agents, with the possible exception of ceftaroline and/or ceftobiprole. Expert rules are provided by EUCAST, but different laboratories or surveillance systems may also use different expert rules, which complicates the comparison of data obtained in different laboratories or countries/areas.

It is important that susceptibility to all indicated antimicrobial agents is tested for each isolate included in

surveillance. Differential or sequential testing, such as testing carbapenems only when resistance to third-generation cephalosporins is found or only for patients suspected of a resistant infection, will lead to underrepresentation of isolates susceptible to carbapenems and overestimation of the resistance percentage.

Bias related to data-analysis procedures

Patients are often sampled repeatedly during their infection episode for diagnostic purposes or to assess therapeutic response. Follow-up samples more often are required in patients with infections caused by resistant microorganisms than those with infections due to susceptible microorganisms, since the latter are more likely to be treated successfully with antimicrobial therapy. If all follow-up isolates from the same patient are included when calculating the proportion of AMR, resistant isolates will be overrepresented, leading to overestimation of the AMR percentage. To prevent this, EARS-Net and CAESAR include only the first isolate per bacterial species per person per year in analyses.

Data interpretation and generalizability

When interpreting AMR surveillance data, it is important to evaluate the extent to which the results obtained in the sample are likely to be a good estimate of the average AMR percentage in the target population. The true AMR percentage in the target population is always unknown if not all patients can be sampled, but assumptions can be made according to the representativeness of the sample. Whether they involve the selection of participating sites or of patients eligible for bacteriology diagnostics in routine clinical care, the issues related to sampling mentioned in the section "Bias related to sampling" above may lead to a sample of specific patients in which the average AMR percentage deviates from that in the target population – a biased estimate of the AMR percentage in which EARS-Net and CAESAR are interested. It therefore is important to realize that results obtained in a population of ICU patients in tertiary-care facilities, for instance, can and should be interpreted as applicable to this specific patient population, but may not be generalizable to types of patients that were not included (such as those in general hospitals). However, for the purposes of obtaining an estimate of the AMR proportion in a target population of ICU patients in tertiary-care facilities (to develop empirical therapy guidelines for this specific population, for example), a sample of ICU patients from a selection of tertiary-care facilities in the country/area would probably result in a fairly unbiased estimate. In other words, the conclusion as to whether results obtained in a sample are biased depends on the target population of interest.

Data quality by country/area

To be able to evaluate the quality and representativeness of data from individual countries/areas presented in this report, Table A3.2 presents information on coverage of the surveillance system, data representativeness and blood-culture rate, by country/area.

Table A3.1 Common sources of error and bias in antimicrobial resistance surveillance data

Type of error/bias		Mechanism	Solution
Random error	Sampling variation	Natural variation between patients	Increase sample size
	Measurement variation	Test-to-test variation in application of laboratory procedures	Increase sample size Standardize procedures Provide continuous training of laboratory staff Set up quality-assurance systems
Systematic error	**Bias related to sampling**		
	Selection of participating sites	Selecting sites for specific patient populations only, such as specialized or tertiary-care hospitals in urban areas	Select a mixture of hospital types from different geographical regions
	Selection of patients	Sampling of severe cases only, patients with treatment failure, or patients strongly suspected of having a resistant infection	Improve case ascertainment: promote sampling of all cases with signs of bloodstream infection or meningitis from all types of hospital departments and prior to treatment initiation (active case-finding)
	Timing of sampling	Sampling cases over a limited period of time	Sample cases continuously throughout the year
	Bias related to laboratory procedures		
	Measurement error	Improper application of laboratory methods, such as errors in preparing media for disk diffusion Use of inadequate laboratory materials, such as expired or non-quality-controlled antimicrobial disks Damaged and/or poorly calibrated equipment, such as out-of-date firmware used with automated systems	Provide continuous training of laboratory staff Procure high-quality and quality-controlled materials and consider expiration dates Set up and implement laboratory quality-assurance systems Perform confirmatory testing of isolates with rare or unusual AMR, or with AMR phenotypes of consequence to clinical practice
	AST procedures and interpretation	Use of non-uniform AST methods, such as out-of-date guidelines Use of different expert rules across laboratories for interpretation of AST Sequential or differential testing of antibiotics, such as testing susceptibility for carbapenems only if isolate is resistant to third-generation cephalosporins	Use national/area standards based on international guidelines for AST (such as EUCAST) Collect crude quantitative data Test susceptibility to all indicator antimicrobials (uniform test panel) for all isolates
	Bias related to data analysis procedures		
	Isolates inclusion criteria	Inclusion of follow-up isolates from individual patients	Use standardized data-analysis methods with the aim of achieving equal representation of all patients in the data

Table A3.2 Population and hospitals contributing data: coverage, representativeness and blood-culture rate, WHO European Region, 2020 (or latest available data)

Country/area	Estimated population coverage[a] (%)	Geographical representativeness[b]	Hospital representativeness[c]	Patient and isolate representativeness[d]	Blood-culture rate (blood-culture sets/1 000 patient days)[e]
EU/EEA					
Austria	Unknown	High	High	High	Unknown
Belgium	36[f]	High	High	High	129.6[f]
Bulgaria	45	Medium	Medium	Medium	10.4
Croatia	80	High	High	High	109
Cyprus	85	High	High	High	60.9
Czechia	80	High	High	High	19.7
Denmark	100	High	High	High	202.4
Estonia	100	High	High	High	35.8
Finland	96	High	High	High	175.1
France	48[f]	High	High	High	54.5[f]
Germany[g]	27	High	Medium	High	37.9
Greece	60	High	High	Medium	Unknown
Hungary	90	High	High	High	17.2
Iceland	100	High	High	High	61.3
Ireland	76	High	High	High	Unknown
Italy	47	High	High	High	57
Latvia	90	High	Medium	Medium	13.8
Liechtenstein	–	–	–	–	–
Lithuania	100	High	High	High	8.1
Luxembourg	99	High	High	High	38.9
Malta	95	High	High	High	35.2
Netherlands	72	High	High	High	Unknown
Norway	94	High	High	High	91.9
Poland	16	Medium	Medium	Medium	45.6
Portugal	97	High	High	High	244.2
Romania	21	Poor	Poor	Poor	26.4
Slovakia	56	High	High	High	27.0
Slovenia	99	High	High	High	47.1
Spain	36	Medium	High	High	109.5
Sweden	78	High	High	High	105.6
Non-EU/EEA					
Belarus	99	High	High	Poor	6 (2–97)
Bosnia and Herzegovina	77	High	High	Medium	9 (4–52)
Georgia	80	High	High	Poor	5 (0–33)
Montenegro	100	High	High	Poor	3 (0–25)
North Macedonia	100	High	High	Poor	Unknown
Republic of Moldova	70	High	High	Poor	4 (0–24)
Russian Federation	Unknown	High	Poor	Poor	11 (1–21)
Serbia	78	High	High	Medium	17 (1–111)
Switzerland	86	High	High	High	Unknown
Turkey	28	High	High	Medium	28 (2–106)
Ukraine	1.96	Medium	Medium	Poor	3 (2–15)
United Kingdom	Unknown	Medium	High	High	Unknown
Kosovo[i]	90	High	High	Poor	6 (6–6)

[a] For EARS-Net, as estimated by the ECDC national focal points for AMR and/or operational contact points for AMR. Estimated national population coverage: mean population coverage (%) of laboratories capable of reporting *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Enterococcus faecalis* and *Enterococcus faecium*. Due to outliers in some countries, *Streptococcus pneumoniae* and *Acinetobacter* species are not included in the calculation. For CAESAR, an estimate of the population coverage is based on the best estimates of the overall catchment population of the hospitals included in the AMR surveillance network, as reported by the WHO AMR focal point.

[b] Geographical representativeness. High: all main geographical regions are covered, and the selection of urban and regional areas is considered to be representative of the country/area population. Medium: most geographical regions are covered, and the selection of urban and regional areas is considered to be partly representative of the country/area population. Poor: only one or a few geographical areas are covered, and the selection of urban and regional areas is considered to be poorly representative of the country/area population. Unknown: unknown or no data provided.

[c] Hospital representativeness. High: the hospital selection is representative of the country/area distribution of hospital types where blood samples are taken. Medium: the hospital selection is partly representative of the country/area distribution of hospital types where blood samples are taken. Poor: the hospital selection is poorly representative of the country/area distribution of hospital types where blood samples are taken. Unknown: unknown or no data provided.

[d] Patient and isolate representativeness. High: the patient selection is representative of the patient mix for the hospitals included and of microorganisms causing invasive infections. Medium: the patient selection is partly representative of the patient mix for the hospitals included and of microorganisms causing invasive infections. Poor: the patient selection is poorly representative of the patient mix for the hospitals included and of microorganisms causing invasive infections. Unknown: unknown or no data provided.

Table A3.2 contd

[e] Blood-culture rate, blood-culture sets/1000 patient days: refers to the number of blood-culture sets per 1000 patient days in hospitals served by EARS-Net/CAESAR laboratories. The definition of a blood-culture set and a patient day might differ between countries/areas and influence the estimate. Blood-culture rates are presented as the number of blood-culture sets taken per 1000 patient days in hospitals providing AMR data. For EARS-Net this is calculated by dividing the mean of the blood-culture sets with the mean total number of patient days of hospitals served by laboratories that provided the number of blood-culture sets performed for the following bacterial species: *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Enterococcus faecalis* and *Enterococcus faecium*. For CAESAR this is calculated as the median (with the range included in parentheses) in hospitals providing data on the number of blood-culture sets. When the range is not presented, data apply to one hospital only.
[f] Not including *Streptococcus pneumoniae* network.
[g] 2019 data.
[1] All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999).

Recommended reading

Cornaglia G, Hryniewicz W, Jarlier V, Kahlmeter G, Mittermayer H, Stratchounski L et al. European recommendations for antimicrobial resistance surveillance. Clin Microbiol Infect. 2004;10(4):349–83.

Hindler JF, Stelling J. Analysis and presentation of cumulative antibiograms: a new consensus guideline from the Clinical and Laboratory Standards Institute. Clin Infect Dis. 2007;44(6):867–73.

Rempel OR, Laupland KB. Surveillance for antimicrobial resistant organisms: potential sources and magnitude of bias. Epidemiol Infect. 2009;137(12):1665–73.

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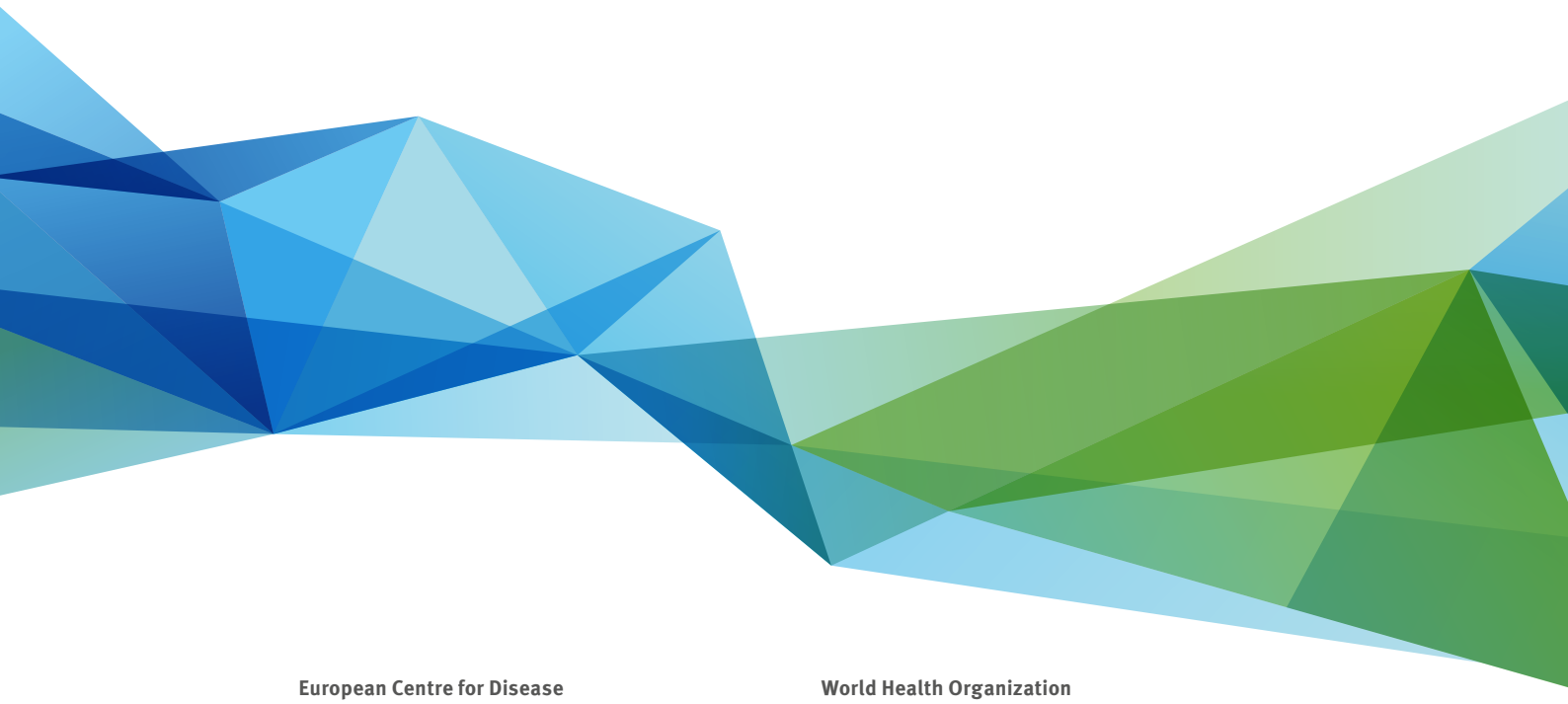

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