Surveillance of antimicrobial resistance in Europe, 2022 data

Executive summary

WHO European Region

This executive summary showcases results derived from 2022 antimicrobial resistance (AMR) data, sourced from invasive isolates reported to both the Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR) network and the European Antimicrobial Resistance Surveillance Network (EARS-Net). Of the compiled data, CAESAR received reports from 17 countries, whereas EARS-Net amassed data from 30 countries, encompassing all European Union/European Economic Area (EU/EEA) nations. Although both EARS-Net and CAESAR utilize similar methodologies for data gathering and analysis, the information originates from distinct surveillance systems across different countries. Given that each country's surveillance is shaped by unique protocols and practices, it is important to exercise caution when contrasting AMR patterns between them.

Epidemiology

The AMR situation in bacterial species reported to the AMR surveillance networks in 2022 varied widely depending on species, antimicrobial group and geographical region. Within the WHO European Region, pronounced disparities are evident, echoing trends highlighted in past reports. A notable resistance gradient emerges, with a clear pattern from north-to-south and west-to-east. The northern and western regions predominantly show lower resistance rates, while the eastern and southern regions tend to register higher ones. Resistance to third-generation cephalosporins (3GC) and carbapenems was generally higher in *Klebsiella pneumoniae* (*K. pneumoniae*) than *Escherichia coli* (*E. coli*). While carbapenem resistance remained rare in *E. coli* for most countries, 32% reported resistance percentages of 25% or higher in *K. pneumoniae*. Carbapenem resistance was also common in *Pseudomonas aeruginosa* (*P. aeruginosa*) and *Acinetobacter* species (*Acinetobacter* spp.) and generally at a higher percentage than in *K. pneumoniae*.

Seven (41%) of the 17 countries that reported data to CAESAR reported that their participating laboratories had an estimated population coverage of over two thirds of the overall population, including two countries reporting having an estimated population coverage of 100%. However, six countries reported an estimated population coverage of less than half of their population. Four did not report data on population coverage.

One (6%) of the 17 countries that reported data to CAESAR indicated that the reported data had a high representativeness, in terms of three metrics: geographical representativeness, hospital representativeness and isolate representativeness. A further nine countries reported that representativeness was high for two of these three metrics, while one

reported that representativeness was medium or low for two of these three metrics and four reported that the representativeness of their data was low for all three metrics. Two countries did not report data on these metrics.

The blood culture rate in hospitals served by laboratories participating in CAESAR in 2022 was reported by 12 countries. For the single country that reported a high representativeness according to all three metrics listed above, no data was available on the blood culture rate. In the eight countries reporting high representativeness according to two of the three metrics listed above that also had data available on blood culture rate, the median rate was 3.6 times higher than in the four countries reporting medium or low representativeness according to at least two of the three metrics that also had data available on the blood culture rate (16.0 versus 4.5 blood culture sets per 1000 patient-days, respectively).

Among the 16 countries that provided data to CAESAR in both 2021 and 2022, there was an increase in the total number of isolates reported in 2022 compared with 2021. This overall tendency was not always observed at country level.

Of the 17 countries submitting data to CAESAR in 2022, 14 reported data for all eight bacterial species. Among these 17 countries that submitted data to CAESAR in 2022, the majority of isolates (72%) consisted of *E. coli* (39%), *Staphylococcus aureus* (*S. aureus*) (18%) and *K. pneumoniae* (15%).

Concerning bacterial species-specific results from 2022, resistance to fluoroquinolones in *E. coli* was generally lowest in the northern parts of the WHO European Region and highest in the south. A resistance percentage below 10% was observed in one (2%) of 46 countries that reported data on this microorganism-antimicrobial group combination. A resistance percentage of 25% or above was reported in 21 (46%) countries. A resistance percentage of 50% or above was observed in four (9%) countries. For 3GC resistance in *E. coli*, 13 (28%) of 47 countries reported percentages below 10%, whereas resistance percentages equal to or above 50% were observed in five countries (11%). Eight (17%) of 46 countries reported carbapenem-resistant *E. coli* percentages of 1% or above.

Since 2019, over 40% of countries have consistently shown resistance percentages of 50% or higher for 3GC in *K. pneumoniae*. This trend is particularly pronounced in the southern and eastern parts of the WHO European Region, where this specific microorganism-antimicrobial combination appears to be increasingly prevalent. In 2022 percentages below 10% were observed in eight (18%) of 44 countries in the Region reporting data on this microorganism-antimicrobial group combination, while 20 (45%), particularly in the southern and eastern parts of the Region, reported resistance percentages of 50% or above. Carbapenem resistance was more frequently reported in *K. pneumoniae* than in *E. coli*: 12 (27%) of 44 countries reported resistance percentages below 1%. Fourteen (32%) countries reported percentages equal to or above 25%, eight of which (18% of 44 countries) reported resistance percentages equal to or above 50%.

Large differences were observed in the percentages of carbapenem-resistant *P. aeruginosa* in the WHO European Region. In 2022 resistance percentages of below 5% were observed in two (4%) of the 45 countries reporting data on this microorganism-antimicrobial group combination, whereas six (13%) countries reported percentages equal to or above 50%.

The percentages of carbapenem-resistant *Acinetobacter* spp. varied widely within the Region in 2022, from below 5% in ten (25%) of the 40 countries that reported data on this microorganism-antimicrobial group combination, to equal to or above 50% in 22 (55%) countries, mostly in southern and eastern Europe.

In 2022, 12 (27%) of 45 countries reporting data on *S. aureus* reported methicillin-resistant *S. aureus* (MRSA) percentages below 5%. MRSA percentages equal to or above 25% were found in 11 (24%) of 45 countries.

The percentages of penicillin non-wild-type *Streptococcus pneumoniae* (*S. pneumoniae*) varied markedly across the Region. Out of the 41 countries reporting data on this microorganism-antimicrobial group combination, five (12%) registered percentages below 5%, while seven (17%) recorded rates of 25% or higher.

Resistance to vancomycin in *Enterococcus faecium* (*E. faecium*) varied substantially among countries in the Region. In 2022, resistance percentages of below 1% were reported by five (11%) of 44 countries reporting data on this microorganism-antimicrobial group combination, while percentages equal to or above 25% were found in 19 (43%), five of which (11% of 44 countries) reported resistance percentages equal to or above 50%.

Country-specific information for each bacterial species, including information on patient age group and sex, are available on the WHO European Region website *(1)*.

Discussion

The results from CAESAR and EARS-Net clearly show that AMR remains widespread in the WHO European Region. Although assessing the exact magnitude of AMR is challenging and the interpretation of results should be made with caution, the presence of specific AMR patterns across clinical settings covered by these surveillance networks is apparent. High percentages of resistance to 3GC and carbapenems in *K. pneumoniae* and high percentages of carbapenem-resistant *Acinetobacter* spp. in several countries are of serious concern. They suggest the dissemination of resistant clones in health-care settings and indicate that many countries have serious limitations in treatment options

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*, *P. aeruginosa* and *Acinetobacter* spp.), it is less obvious for gram-positive bacteria (*S. aureus*, *S. pneumoniae* and *E. faecium*). The COVID-19 pandemic clearly illustrated that microorganisms know no borders or regional constraints. These findings underscore the imperative need to address AMR, not just within the WHO European Region, but globally. Hence, it becomes paramount to usher in a new era of international cooperation, where governments unite in their efforts to tackle shared health challenges head-on.

The shift away from COVID-19 related activities is reflected in the differing AMR data from many surveillance systems. A large number of countries that provided AMR data to CAESAR reported a higher count of *S. pneumoniae* isolates in 2022 compared with 2021. This trend could be attributed to the increasing circulation of respiratory pathogens in communities following the lifting of lockdowns. Likewise, typical health-care-associated pathogens such as *Acinetobacter* spp. and *E. faecium* were noted less often in 2022 compared with 2021.

Overall, more and more laboratories have been reporting data to the European surveillance networks since both networks were initiated, which is an encouraging step in the right direction. Nevertheless, when looking at surveillance capacity in the WHO European Region, 27% (14/51) of countries still reported that they only collect AMR data at local level or without a standardized approach. This highlights the ongoing need to strive for enhanced standardization of surveillance efforts as systems and networks continue to grow and mature *(2)*.

Antimicrobial consumption patterns across the EU/EEA countries have shown notable variations in adherence to WHO targets. During 2022, 17 of 28 (61%) EU/EEA countries reported, through the European Surveillance of Antimicrobial Consumption Network (ESAC-Net), data for both the community and the hospital sector that meet or exceed the WHO country-level target of 60% of total antibacterial consumption coming from WHO's Access category, as defined in the Access, Watch, Reserve (AWaRe) classification list *(3,4)*. In contrast, only two out of 10 countries that reported 2021 consumption data to the WHO Regional Office for Europe Antimicrobial Medicines Consumption (AMC) Network achieved this target in 2021 *(5)*.

Since 2011, activities to contain AMR in the WHO European Region have been guided by the Global Action Plan on AMR *(6)* and were further reinforced by the European Strategic Action Plan on Antibiotic Resistance that concluded in 2020. By 2022 it was evident that while 86% (44/51) of the countries in the Region had developed their National Action Plan (NAP) on AMR, a mere 18% (9/51) had factored in operational strategies and financial resources for its execution *(2)*.

Addressing this critical gap, the new Roadmap on antimicrobial resistance for the WHO European Region 2023–2030 *(7)* is more than just a strategic document. It is an innovative tool designed to support countries to assess national AMR capacity to implement action areas and enablers, facilitate consensus on priorities, set targets and guide implementation, and enable them to measure progress. With clear objectives of reducing the burden and impact of infectious diseases, controlling AMR levels and ensuring continued treatment capabilities, the Roadmap serves as a compass to provide direction for action. It recognizes not just the need for interventions based on the best available evidence but also understands the importance of adaptability, allowing countries to tailor their efforts to local contexts. Additionally, the Roadmap highlights the importance of leveraging digital transformations and emphasizes a focus on environmental and social determinants of AMR, underscoring its holistic approach. By identifying impactful interventions and offering tools for consensus and investment, the Roadmap aims to provide a robust framework for countries in their efforts to tackle AMR.

Public health implications

AMR is one of the top 10 global public health threats facing humanity *(8)*. In 2022 the European Commission and the EU Member States deemed it one of the top three priority health threats *(9)*. Many countries in the WHO European Region have responded to the global call *(10,11)* to develop NAPs on AMR and are even revising them for the next phase of their plans. However, some countries are still in the early stages of implementing effective interventions against AMR. The new Roadmap offers a structured path forward, with the aim that all countries, regardless of their current stage, have a comprehensive and adaptable guide to prioritizing interventions for implementation to tackle AMR effectively. Surveillance has been identified as one of the enabling areas in the Roadmap, as the successful implementation of interventions in most action areas depends on the availability of high-quality data and information. Continued effort and investment are required to better the representativeness, comparability, quantity and quality of AMR surveillance data. Current trends, such as the high percentages of carbapenem-resistant *Acinetobacter* spp. isolates, which are challenging to eliminate once endemic, highlight the imperative to bolster measures in infection prevention and control (IPC), ensuring timely detection to prevent the spread of these resistant organisms.

There is still a lack of high-level support and sustained funding for comprehensive programmes and interventions on IPC, antimicrobial stewardship and surveillance. Commitment from the highest level of government continues to be crucial to advance the AMR agenda *(10)*.

Following the COVID-19 pandemic, it is hoped that addressing AMR will be given a higher priority

when rebuilding health systems and taking the interconnectedness of countries and continents into account. As the world adjusts to the effects of this pandemic on population and public health, efforts to tackle AMR have begun to find a balance after the repurposing of health-care professionals to support the COVID-19 response throughout the WHO European Region. Across the globe, governments were confronted with a need for more coordinated action and collaboration, and this has paved the way for a more united front against current and future health threats, including AMR. It is hoped that such a front will enable more effective responses to the threat represented by AMR in the coming years.

In the backdrop of global health priorities, the WHO European Region has been confronted with challenges in strengthening and expanding the AMR agenda. Ongoing geopolitical conflicts and natural disasters disrupt core operations such as data collection and training. Subsequent large-scale migrations of populations place additional strain on already taxed health-care and surveillance systems.

Despite such a scenario, particularly in Ukraine, WHO has been unwavering in its efforts to combat AMR. A testament to this commitment is the universal and mandatory adoption of the European Committee on Antimicrobial Susceptibility Testing (EUCAST) methodology across the whole country. Moreover, the AMR surveillance network in Ukraine has seen a substantial expansion, with the number of laboratories participating in CAESAR growing from 4 in 2018 to 48 in 2022. Recognizing the unique health challenges arising from the war, separate data collection initiatives have been implemented specifically for AMR among wounded patients, reflecting both the scale and significance of the issue. Furthermore, in a bid to bolster the country's response capabilities, WHO has made significant investments, channelling over US$ 1 million into the procurement of state-of-the-art equipment. This has resulted in an increased capacity for blood culturing and antimicrobial susceptibility testing, therefore fortifying the country's defences against the spread of AMR.

These challenges hinder activities pertaining to the AMR agenda and highlight the increased relevance and urgency of public health initiatives. Now, more than ever, there is a pressing need for more resilient and collaborative public health strategies.

EU/EEA countries

Epidemiology

In 2023 all EU Member States and EEA countries reported data for 2022 to EARS-Net. Of these 30 countries, 20 (66.7%) reported that their participating laboratories had population coverage of over two thirds of the population, including 14 countries that reported having a population coverage of 90.0% or more. However, seven countries reported data for less than half of their population.

Of the 30 participating countries, 22 (73.3%) indicated that their reported data had high representativeness in terms of three metrics: geographical areas covered, acute care hospitals included and the microorganisms that caused invasive infections in those hospitals. A further three countries reported representativeness that was high for two of the three metrics and one country reported that no data were available for two of the three metrics.

In hospitals served by the laboratories that reported data to EARS-Net in 2022, the blood culture rate was reported by 25 countries. In the 18 countries that reported a high representativeness for all three representativeness metrics and provided a blood culture rate, the average blood culture rate was 3.7 times higher than in the five countries reporting medium, low or no data on representativeness for at least two of the metrics (84.8 versus 22.9 blood culture sets per 1000 patient-days, respectively). The reported blood culture rates were highest in Belgium, Denmark, Finland, Portugal and Spain (> 100 sets per 1000 patient-days) and lowest in Bulgaria, Hungary, Latvia, Liechtenstein and Lithuania (< 20 sets per 1000 patient-days).

All but one country reported isolate data for all eight bacterial species under EARS-Net surveillance (*E. coli*, *K. pneumoniae*, *P. aeruginosa*, *Acinetobacter* spp., *S. pneumoniae*, *S. aureus*, *Enterococcus faecalis* (*E. faecalis)* and *E. faecium*), while one country (Liechtenstein) reported isolate data for *E. coli*, *S. pneumoniae* and *S. aureus* only.

The number of laboratories participating in EARS-Net has increased since 2018, indicating a strengthening of national AMR surveillance systems in the EU/EEA. In 2022, 1845 laboratories reported data, 942 of which were in France. Based on the laboratory identifiers provided by the countries, there were 692 laboratories identifiable as having reported data for each year during the period 2018–2022.

Compared with 2021, the total number of reported isolates increased from 366 794 to 392 602 and among continuously reporting laboratories, from 237 630 to 246 944. In 2022 the most commonly reported bacterial species from all reporting laboratories were *E. coli* (39.2%), followed by *S. aureus* (22.1%), *K. pneumoniae* (12.3%), *E. faecalis* (8.2%), *P. aeruginosa* (6.1%), *E. faecium* (5.9%), *S. pneumoniae* (3.7%) and *Acinetobacter* spp. (2.5%). This ranking was different to that from 2021, with *P. aeruginosa* and *S. pneumoniae* both one rank higher in 2022.

Although the representativeness of EARS-Net data is high, restricting analysis to laboratories known to have reported data continuously throughout 2018–2022 (a so-called "restricted dataset") is a way of further confirming trends. As the years 2020 and

2021 coincided with extreme pressures on health-care associated with the COVID-19 pandemic, it is also informative and valid to compare 2022 data with data from 2019. To analyse changes in the reported number of isolates over time, two countries were excluded from the restricted dataset: France, due to changes to its national surveillance system, and Greece for *S. pneumoniae*, as this country only started reporting on *S. pneumoniae* with 2022 data. Within this restricted group of laboratories and when comparing 2019 to 2022, the largest increases in the number of reported isolates were for *Acinetobacter* spp. (+35.2%; 3528 and 4770, respectively), *E. faecium* (+33.2%; 10 584 and 14 097, respectively), *E. faecalis* (+18.5%; 16 096 and 19 075, respectively), *P. aeruginosa* (+12.5%; 12 711 and 14 299, respectively) and *K. pneumoniae* (+11.8%; 26 836 and 29 996, respectively), followed by *S. aureus* (+9.0%; 49 064 and 53 467, respectively). There was a decrease in the number of *E. coli* (-1.6%; 101 415 and 99 743, respectively) and *S. pneumoniae* isolates reported (-12.4%; 12 379 and 10 842, respectively). However, more recently, from 2021 to 2022, a different pattern has emerged: *S. pneumoniae* has increased (+71.2%; 6333 and 10 842, respectively) and *Acinetobacter* spp. has decreased (-29.0%; 6714 and 4770, respectively). The remaining pathogens saw changes of ≤ 6% (*E. faecium* and *E. faecalis* decreasing; *P. aeruginosa*, *E. coli*, *S. aureus* and *K. pneumoniae* increasing). This more recent pattern indicates that some of the most pronounced changes in the number of isolates reported between 2019 and 2022 are possibly on their way to being reversed.

The AMR outlook reported by EU/EEA countries to EARS-Net for 2022 varied widely depending on bacterial species, antimicrobial group and geographical region, as demonstrated by both the varying AMR percentages and the estimated incidences of bloodstream infections with selected pathogens with AMR. Overall, for the EU/EEA (excluding the United Kingdom), most bacterial species–antimicrobial combinations showed either a significantly decreasing trend or no significant trend in the population-weighted mean AMR percentage during 2018–2022. The exceptions were carbapenem resistance in *K. pneumoniae*, piperacillin-tazobactam resistance in *P. aeruginosa*, penicillin non-wild-type and macrolide resistance (including a combination of these two types of resistance) in *S. pneumoniae* and vancomycin resistance in *E. faecium*, for which there was a significant increase during the period 2018–2022.

In 2022 more than half of the *E. coli* isolates reported to EARS-Net and almost 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. With one notable exception − carbapenem resistance in *K. pneumoniae* − both *E. coli* and *K. pneumoniae* saw either decreasing trends in the EU/EEA (excluding the United Kingdom) population-weighted mean AMR percentages or no trend. For 3GC-resistant *E. coli*, a decreasing trend in the estimated incidence of bloodstream infections was also noted from 2018 to 2022 for the EU with a 16.8% decrease in 2022 against the baseline year 2019. Among antimicrobial groups monitored for both species, EU/EEA population-weighted mean AMR percentages were generally higher in *K. pneumoniae* than in *E. coli*.

Carbapenem resistance remained rare in *E. coli*, but almost one third of EU/EEA countries reported carbapenem resistance percentages above 10% in *K. pneumoniae*. It is noteworthy that the largest increase (+2.4%) in population-weighted mean AMR percentage under EARS-Net surveillance during 2018–2022 occurred in carbapenem-resistant *K. pneumoniae*, resulting in a significantly increasing trend. In addition, there was a significantly increasing trend in the estimated incidence of bloodstream infections with carbapenem-resistant *K. pneumoniae* with a 49.7% increase in 2022 against the baseline year 2019. Carbapenem resistance was also common in *P. aeruginosa* and *Acinetobacter* spp., with a higher EU/EEA population-weighted mean percentage than in *K. pneumoniae*. For most gram-negative bacteria under surveillance, increases in the EU/EEA (excluding the United Kingdom) population-weighted mean AMR percentages between 2018 and 2022 were moderate. However, AMR remained at high levels, as previously reported. It is also worth noting that, compared with 2021, the EU/EEA population-weighted mean AMR percentages in *Acinetobacter* spp. for 2022 showed decreases for all antimicrobial groups under surveillance.

For *S. aureus*, a significantly decreasing trend in the EU/EEA (excluding the United Kingdom) population-weighted mean percentage of MRSA isolates, as well as in the estimated EU incidence of bloodstream infections with MRSA, was reported during the period 2018–2022. Moreover, in 2022, there was a 12.2% decrease in the estimated incidence against the baseline year 2019. Nevertheless, MRSA remains an important pathogen in the EU/EEA, with levels remaining high in several countries and combined resistance to another antimicrobial group quite common.

In addition to the increase in the number of reported isolates in 2022 compared with 2021, the last 5 years have seen a significantly increasing trend for the EU/EEA (excluding the United Kingdom) population-weighted mean percentage of macrolide resistance and penicillin non-wild-type, including combined resistance in *S. pneumoniae*.

One development of particular concern was the fact that the significantly increasing trend in the EU/EEA (excluding the United Kingdom) population-weighted mean percentage of vancomycin-resistant isolates of *E. faecium* further increased, from 16.2% in 2018 to 17.6% in 2022.

The reported AMR percentages and estimated incidences of bloodstream infections with resistant bacteria varied widely among EU/EEA countries, often with a north-to-south and west-to-east gradient. 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 of Europe.

In addition to this executive summary, published jointly by the European Centre for Disease Prevention and Control (ECDC) and the WHO Regional Office for Europe, an Annual Epidemiological Report on Antimicrobial resistance in the EU/EEA (EARS-Net) using 2022 data has been published by the ECDC (Antimicrobial resistance in the EU/EEA (EARS-Net): Annual Epidemiological Report 2022, in publication). For each bacterial species, country-specific information on the estimated incidence of bloodstream infections (EU recommended targets), data availability and age group, sex and intensive care unit patient percentages is available in country profiles that are published as an annex to the Report. Results by age group and sex for specific AMR phenotypes are available in the ECDC's Surveillance Atlas of Infectious Diseases *(12)*.

Discussion

For the first time, in 2022 all EU/EEA countries reported data to EARS-Net. Representativeness was reported as high for over 70% of countries. This indicates that although all EU/EEA countries are included in EARS-Net, work still needs to be done in some to improve surveillance representativeness.

Overall, the EU/EEA population-weighted mean AMR percentages for bacterial species–antimicrobial group combinations under surveillance continued to be high for the EU/EEA in 2022.

Specifically, in 2022 the largest increase in the EU/EEA population-weighted mean percentage AMR from 2018, excluding the United Kingdom, and compared with all other bacterial species antimicrobial group combinations, was in carbapenem-resistant *K. pneumoniae*. The continuing increasing trend in the percentage when also considering the significantly increasing trend in the estimated incidence of bloodstream infections at EU level for the same period is of considerable concern. Similarly, the increase in reports of *E. faecium* since 2019, with a significantly increasing trend in the EU/EEA population-weighted mean vancomycin resistance percentage since 2018 indicates that AMR remains a serious challenge in the EU/EEA.

Another development of concern in 2022 was the fact that, following a decline in 2020–2021 when more COVID-19 nonpharmaceutical interventions were in place in the EU/EEA *(13)*, the number of reports of *S. pneumoniae* invasive infections showed signs of returning to a level similar to that for 2019. In addition, there was an increasing trend in EU/EEA population-weighted mean combined penicillin non-wild-type and macrolide resistance.

As in previous years, overall there was a large variability in the AMR percentages across EU/EEA countries in 2022, highlighting the opportunities for significant AMR reduction through interventions to improve IPC and antimicrobial stewardship practices.

Equally, indications of potential improvements were seen. The previous worsening of the *Acinetobacter* spp. situation *(14,15)* showed signs of improving in 2022, with decreasing numbers of isolates and EU/EEA population-weighted mean resistance percentages reported compared with 2021. This suggests a continued requirement for *Acinetobacter* spp.-specific control interventions in affected hospitals *(16)*, while indicating that interventions may have had some effect. In addition, *E. coli* showed either no trend or a decreasing trend in EU/EEA population-weighted mean resistance percentages, further supported by a decreasing trend in the estimated incidence of 3GC-resistant *E. coli* bloodstream infections at EU level. *S. aureus* also displayed a declining trend in the EU/EEA population-weighted mean percentage of MRSA, as well as in the estimated EU incidence of MRSA bloodstream infections from 2018 to 2022. Nevertheless, despite these encouraging developments, AMR percentages remain high in EU/EEA countries. The ECDC estimated that in 2020 alone, the number of infections with antibiotic-resistant bacteria in the EU/EEA falling under EARS-Net surveillance was more than 800 000, resulting in over 35 000 deaths *(17)*.

On 13 June 2023 the Council of the EU adopted a Council Recommendation on stepping up EU actions to combat antimicrobial resistance in a One Health approach (2023/C 220/01), which recommends targets to be achieved in the EU by 2030 *(18)*. These include three AMR targets aimed at reducing total incidence of bloodstream infections with MRSA, 3GC-resistant *E. coli* and carbapenem-resistant *K. pneumoniae* by 15%, 10% and 5%, respectively, by 2030 compared with the baseline year (2019). Data for 2022 have shown favourable decreasing trends in the estimated incidence of bloodstream infections at EU level for the EU targets on MRSA and 3GC-resistant *E. coli*.

Data relevant to the third EU target on the total incidence of bloodstream infections with carbapenem-resistant *K. pneumoniae*, showed an increase of almost 50% during the period 2019–2022. Therefore, instead of progressing towards the 5% reduction target by 2030, the situation in the EU has worsened since 2019. This increase indicates the *need* to rapidly strengthen prevention and control action in EU Member States, as highlighted in the EU Council recommendation *(18)*. The widely varying estimated incidences of bloodstream infections with resistant bacteria and AMR percentages among countries suggest that there are further opportunities for reduction. For specifically carbapenem-resistant *K. pneumoniae* and other carbapenem-resistant *Enterobacterales* (CRE), options for action are highlighted in the 2019 update of the ECDC's rapid risk assessment on CRE, including timely and appropriate diagnosis, high standards of IPC and antimicrobial stewardship *(19)*.

Data for the years 2020 and 2021 coincided with the first years of the COVID-19 pandemic. Changes to human behaviour through 2020–2021 aimed at control of the pandemic, and then again in 2022 as the number of nonpharmaceutical interventions was reduced, may have modified the risk of infection by pathogens with AMR. However, unlike antimicrobial consumption in the EU/EEA (Antimicrobial consumption in the EU/EEA (ESAC-Net): Annual Epidemiological Report 2022, in publication), for AMR under EARS-Net surveillance there was no uniform pattern across surveillance data. Some bacterial species such as *Acinetobacter* spp. and *S. pneumoniae* showed indications of having been affected by the COVID-19 pandemic and actions taken during this time. However, these two species followed different patterns: increases and decreases, respectively, during 2020–2021 and a reversal of these changes in 2022. These changes indicate the importance of IPC in health-care settings, as well as nonpharmaceutical interventions in the community.

The impact of the war in Ukraine on the data reported to EARS-Net is unclear. In 2022 there were reports from EU/EEA countries of the detection of multidrug-resistant organisms in patients recently hospitalized in Ukraine *(20,21)*. On 8 March 2022 the ECDC published a report entitled Operational public health considerations for the prevention and control of infectious diseases in the context of Russia's aggression towards Ukraine *(22)*. This report recommended that hospitalized patients in the EU/EEA whether transferred from hospitals in Ukraine or with a history of hospitalization in Ukraine during the previous 12 months, should be isolated pre-emptively and screened for carriage of multidrug-resistant organisms.

The results in this summary provide an overview of the AMR situation in the EU/EEA. However, when interpreting EARS-Net data, it is important to be mindful of the structure of the surveillance system itself, including the large variation in blood culture rates, and changes in national surveillance systems and in EARS-Net over time. It is also of note that there has not been a systematic assessment of the characteristics of, and AMR data provided by, the EU/EEA laboratories that do not report to EARS-Net. Nevertheless, EARS-Net surveillance data do reflect the overall AMR situation in the EU/EEA.

The European Health Union has been created to better protect the health of EU citizens *(23)*. This includes strengthened mandates for ECDC and the European Medicines Agency, the creation of the European Health Emergency preparedness and Response Authority and a new regulation on serious cross-border threats to health adopted by the Council on 24 October 2022 *(24)*. Additionally, a large budget has been made available under the EU4Health programme (€5.3 billion for the period 2021–2027), one of the main instruments for the European Health Union, dedicated to wider policy areas and including action on AMR. In line with this, the recently adopted Council of the EU Recommendation on stepping up EU actions to combat antimicrobial resistance in a One Health approach not only includes AMR and antimicrobial consumption targets, but also encourages Member States to improve surveillance where needed and develop NAPs against AMR, including implementation and regular updates. In addition, the Recommendation highlights the need for Member States to provide the necessary resources to implement the NAPs, with the European Commission providing support for this where required.

Public health implications

Public health action to tackle AMR in the EU/EEA 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. More specifically, there is a concern that more infections with bacteria resistant to antibiotics will be harder to treat, leading to an increase in suffering and deaths. Estimates based on data from EARS-Net show that in 2020, more than 800 000 infections in the EU/EEA were due to bacteria resistant to antibiotics and that more than 35 000 people died as a direct consequence of these infections *(17)*.

Data from 2022 not only indicate the necessity for IPC in health-care settings, even during trying circumstances such as a pandemic, but also the potential effects of nonpharmaceutical interventions. Data from 2022 also show that AMR levels remain high in the EU/EEA and that there are specific AMR issues of concern, such as the continuing increase in carbapenem-resistant *K. pneumoniae* and vancomycin-resistant *E. faecium*.

Further investment in public health interventions is urgently needed to tackle AMR. This would have a significant positive impact on population health and future health-care expenditure in the EU/EEA. These interventions could include IPC measures, such as promotion of better hand hygiene in health-care to prevent transmission; antibiotic stewardship programmes, such as rapid testing of patients to discriminate viral from bacterial infections and the promotion of prudent antibiotic usage to prevent bacteria from developing AMR; and mass media campaigns, to raise public awareness of AMR. In 2019 the Organisation for Economic Co-operation and Development estimated that a mixed intervention package including enhanced hygiene, antibiotic stewardship programmes, 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 package could pay for itself within just 1 year and save around €1.4 billion per year in the EU/EEA *(25)*.

References

1. World Health Organization Regional Office for Europe (WHO/Europe). AMR Dashboard [website]. Copenhagen: WHO/Europe; 2023 (https://worldhealthorg.shinyapps.io/WHO-AMR-Dashboard-main/, accessed 3 November 2023).
2. Global database for the tripartite antimicrobial resistance country self-assessment survey (TrACSS). Geneva: World Health Organization; 2021 (https:/amrcountryprogress.org/#/map-view, accessed 3 November 2023).
3. 2019 WHO AWaRe classification database for antibiotics for evaluation and monitoring of use [online database]. In: WHO/Publications/Overview. Geneva: World Health Organization; 2019 (https:/www.who.int/publications/i/item/WHOEMPIAU2019.11, accessed 3 November 2023).
4. EU/EEA consumption characteristics. In: Latest surveillance data on antimicrobial consumption [online database]. Stockholm: European Centre for Disease Prevention and Control; 2023 (https:/qap.ecdc.europa.eu/public/extensions/AMC2_Dashboard/AMC2_Dashboard.html#eu-consumption-tab, accessed 3 November 2023).
5. WHO Regional Office for Europe Antimicrobial Medicines Consumption (AMC) Network: AMC data 2020–2021. Copenhagen: WHO Regional Office for Europe; 2023 (https://iris.who.int/handle/10665/373913, accessed 13 November 2023).
6. Global action plan on antimicrobial resistance. Geneva: World Health Organization; 2015 (https://www.who.int/publications/i/item/9789241509763, accessed 3 November 2023).
7. Seventy-third Regional Committee for Europe: Astana, 24–26 October 2023: roadmap on antimicrobial resistance for the WHO European Region 2023–2030. Copenhagen: WHO Regional Office for Europe; 2023 (https://iris.who.int/handle/10665/372503, accessed 3 November 2023).
8. Ten threats to global health in 2019. In: WHO/Newsroom/Spotlight. Geneva: World Health Organization; 2019 (https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019, accessed 3 November 2023).
9. Health union: identifying top 3 priority health threats. Brussels: European Commission; 2022 (https://health.ec.europa.eu/system/files/2022-07/hera_factsheet_health-threat_mcm.pdf, accessed 3 November 2023).
10. G7 Finance Ministers' Statement on Actions to Support Antibiotic Development. London: Government of the United Kingdom; 2021 (https:/www.gov.uk/government/publications/g7-finance-ministers-statement-on-actions-to-support-antibiotic-development, accessed 3 November 2023).
11. A European One Health Action Plan against Antimicrobial Resistance (AMR). Brussels: European Commission; 2017 (https:/ec.europa.eu/health/sites/default/files/antimicrobial_resistance/docs/amr_2017_action-plan.pdf, accessed 3 November 2023).
12. Surveillance atlas of infectious diseases. Stockholm: European Centre for Disease Prevention and Control; 2023 (https:/www.ecdc.europa.eu/en/surveillance-atlas-infectious-diseases, accessed 3 November 2023).
13. Data on country response measures to COVID-19. Stockholm: European Centre for Disease Prevention and Control; 2022 (https:/www.ecdc.europa.eu/en/publications-data/download-data-response-measures-covid-19, accessed 3 November 2023).
14. Kinross P, Gagliotti C, Merk H, Plachouras D, Monnet DL, Högberg LD, et al. Large increase in bloodstream infections with carbapenem-resistant *Acinetobacter* species during the first 2 years of the COVID-19 pandemic, EU/EEA, 2020 and 2021. Euro Surveill. 2022;27(46):2200845. doi: 10.2807/1560-7917.ES.2022.27.46.2200845.
15. Antimicrobial resistance in the EU/EEA (EARS-Net): Annual Epidemiological Report for 2021. Stockholm: European Centre for Disease Prevention and Control; 2022 (https:/www.ecdc.europa.eu/en/publications-data/surveillance-antimicrobial-resistance-europe-2021, accessed 3 November 2023).
16. Rapid risk assessment: Carbapenem-resistant *Acinetobacter baumannii* in healthcare settings: 8 December 2016. Stockholm: European Centre for Disease Prevention and Control; 2016 (https://www.ecdc.europa.eu/sites/default/files/media/en/publications/Publications/8-Dec-2016-RRA-Acinetobacter%20baumannii-Europe.pdf, accessed 3 November 2023).
17. Health burden of infections with antibiotic-resistant bacteria in the European Union and the European Economic Area, 2016–2020. Stockholm: European Centre for Disease Prevention and Control; 2022 (https://www.ecdc.europa.eu/en/publications-data/health-burden-infections-antibiotic-resistant-bacteria-2016-2020, accessed 3 November 2023).
18. Council Recommendation on stepping up EU actions to combat antimicrobial resistance in a One Health approach. Brussels: Council of the European Union; 2023 (2023/C 220/01; https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023H0622(01), accessed 3 November 2023).
19. Rapid risk assessment: carbapenem-resistant Enterobacteriaceae, second update – 26 September 2019. Stockholm: European Centre for Disease Prevention and Control; 2019 (https:/www.ecdc.europa.eu/sites/default/files/documents/carbapenem-resistant-enterobacteriaceae-risk-assessment-rev-2.pdf, accessed 3 November 2023).
20. Zwittink RD, Wielders CC, Notermans DW, Verkaik NJ, Schoffelen AF, Witteveen S, et al. Multidrug-resistant organisms in patients from Ukraine in the Netherlands, March to August 2022. Euro Surveill. 2022;27(50):2200896. doi: 10.2807/1560-7917.ES.2022.27.50.2200896.
21. Schultze T, Hogardt M, Velázquez ES, Hack D, Besier S, Wichelhaus TA, et al. Molecular surveillance of multidrug-resistant Gram-negative bacteria in Ukrainian patients, Germany, March to June 2022. Euro Surveill. 2023;28(1):2200850. doi: 10.2807/1560-7917.ES.2023.28.1.2200850.
22. Operational public health considerations for the prevention and control of infectious diseases in the context of Russia's aggression towards Ukraine, 8 March 2022. Stockholm: European Centre for Disease Prevention and Control; 2022 (https:/www.ecdc.europa.eu/en/publications-data/operational-public-health-considerations-prevention-and-control-infectious, accessed 3 November 2023).
23. European Health Union: Protecting our health together. Brussels: European Commission; 2020 (https:/commission.europa.eu/strategy-and-policy/priorities-2019-2024/promoting-our-european-way-life/european-health-union_en, accessed 3 November 2023).
24. European Health Union: building a stronger EU health response. Brussels: European Commission; 2022 (https:/ec.europa.eu/commission/presscorner/detail/en/ip_22_6363, accessed 3 November 2023).
25. Antimicrobial resistance: tackling the burden in the European Union, Briefing note for EU/EEA countries. Paris: Organisation for Economic Co-operation and Development; 2019 (https:/www.oecd.org/health/health-systems/AMR-Tackling-the-Burden-in-the-EU-OECD-ECDC-Briefing-Note-2019.pdf, accessed 3 November 2023).

Suggested citation: WHO Regional Office for Europe and European Centre for Disease Prevention and Control. Surveillance of antimicrobial resistance in Europe, 2022 data: executive summary. Copenhagen: WHO Regional Office for Europe; 2023.

ECDC ISBN 978–92–9498–664–1

WHO ISBN 978-92-890-6038-7