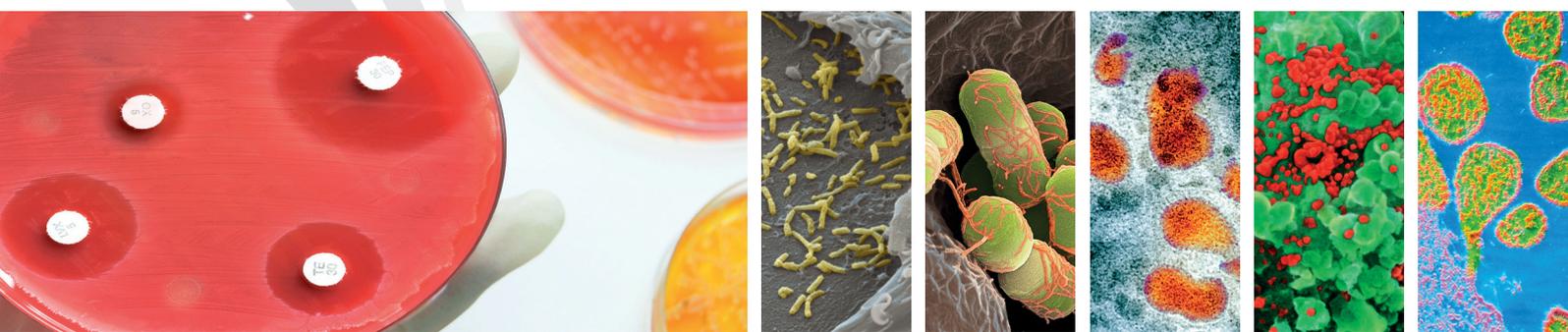


# SURVEILLANCE REPORT



## Annual epidemiological report

Antimicrobial resistance and  
healthcare-associated infections

# 2014

**ECDC SURVEILLANCE REPORT**

# **Annual epidemiological report**

Antimicrobial resistance and healthcare-associated infections

2014



This report of the European Centre for Disease Prevention and Control (ECDC) was coordinated by Catalin Albu, Sergio Brusin and Bruno Ciancio.

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In order to facilitate more timely publication, this year's edition of the Annual Epidemiological Report is being first published a disease group at a time and will later be compiled into one comprehensive report. This report presents the epidemiological situation for antimicrobial resistance and healthcare-associated infections as of 2012.

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## Abbreviations

AMR	Antimicrobial resistance
ATC	The WHO Anatomical Therapeutic Chemical
DDD	Daily defined doses
EARS-Net	European Antimicrobial Resistance Surveillance Network
ESBL	Extended-spectrum beta-lactamase
EU/EEA	European Union/European Economic Area
HAI	Healthcare-associated infections
HAI-Net	Healthcare-associated Infections Surveillance Network
ICU	Intensive care unit
IQR	Interquartile range
LTCF	Long-term care facilities
PPS	Point prevalence survey
SSI	Surgical site infections
UTI	Urinary tract infection

# Introduction

## A note to the reader

The Annual Epidemiological Report 2014 gives an overview of the epidemiology of communicable diseases of public health significance in Europe, drawn from surveillance information on the 52 communicable diseases and health issues for which surveillance is mandatory in the European Union (EU) and European Economic Area (EEA) countries<sup>i,ii,iii,iv</sup>.

In order to facilitate more timely publication, this year's edition of the Annual Epidemiological Report is being first published a disease group at a time and will later be compiled into one comprehensive report. This report presents the epidemiological situation for antimicrobial resistance and healthcare-associated infections as of 2012 and describes the statistical and epidemiological methods used.

Produced annually, the report is intended for policymakers and health sector leaders, epidemiologists, scientists and the wider public. It is hoped that readers will find it a useful overview and reference to better understand the present situation in relation to communicable diseases in Europe. It should also usefully assist policymakers and health leaders in making evidence-based decisions to plan and improve programmes, services and interventions for preventing, managing and treating these diseases.

This year's edition of the report draws on surveillance data for 2012, submitted by Member States to the European Surveillance System. The report gives an outline description of the epidemiology for each disease, in a standard format, covering the years 2008–2012. In addition, updates from epidemic intelligence in relation to emerging public health threats for 2013 are given, by disease as relevant. Information on these is either directly reported to ECDC through Member State notifications on the Early Warning and Response System (EWRS), according to defined criteria<sup>v</sup> or found through active screening of various sources, including national epidemiological bulletins and international networks, and various additional formal and informal sources. In-depth reviews of the epidemiology of particular diseases (e.g. tuberculosis, HIV) or disease groups (e.g. vaccine-preventable diseases) are published separately, sometimes in collaboration with other European agencies or the World Health Organization's Regional Office for Europe. These are referenced, for convenience, with the description of each disease. In addition, further information relating to most of the diseases reported here is available on the ECDC website health topics pages at <http://ecdc.europa.eu/en/healthtopics>.

The reader will appreciate that most surveillance systems capture only a proportion of the cases occurring in their countries. Some cases of disease remain undiagnosed ('under-ascertainment'), and some are diagnosed but not reported to public health authorities ('underreporting'). The pattern of this under-ascertainment and underreporting varies by disease and country, involving a complex mix of healthcare-seeking behaviour, access to health services, availability of diagnostic tests, reporting practices by doctors and others, and the operation of the surveillance system itself.

The direct comparison of disease rates between countries should therefore be undertaken with caution. The reader should be aware that in most cases, differences in case rates reflect not only differences in the occurrence of the disease, but also in systematic differences in health and surveillance systems as described here.

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<sup>i</sup> 2000/96/EC: Commission Decision of 22 December 1999 on the communicable diseases to be progressively covered by the Community network under Decision No 2119/98/EC of the European Parliament and of the Council. Official Journal, OJ L 28, 03.02.2000, p. 50–53.

<sup>ii</sup> 2003/534/EC: Commission Decision of 17 July 2003 amending Decision No 2119/98/EC of the European Parliament and of the Council and Decision 2000/96/EC as regards communicable diseases listed in those decisions and amending Decision 2002/253/EC as regards the case definitions for communicable diseases. Official Journal, OJ L 184, 23.07.2003, p. 35–39.

<sup>iii</sup> 2007/875/EC: Commission Decision of 18 December 2007 amending Decision No 2119/98/EC of the European Parliament and of the Council and Decision 2000/96/EC as regards communicable diseases listed in those decisions. Official Journal, OJ L 344, 28.12.2007, p. 48–49.

<sup>iv</sup> Commission Decision 2119/98/EC of the Parliament and of the Council of 24 September 1998 setting up a network for the epidemiological surveillance and control of communicable diseases in the Community. Official Journal, OJ L 268, 03/10/1998 p. 1–7.

<sup>v</sup> 2009/547/EC: Commission Decision of 10 July 2009 amending Decision No 2000/57/EC on the early warning and response system for the prevention and control of communicable diseases under the Decision No 2119/98/EC of the European Parliament and of the Council. Official Journal, OJ L 181, 14.07.2009 p. 57–60.

Each year, we observe improvements in the harmonisation of systems, definitions, protocols and data at Member State and EU levels. Nevertheless, data provided by the Member States continue to show a number of inconsistencies. In several situations, the quality and comparability of the data are not optimal, and more work is planned, in conjunction with Member States, to see how best to improve this situation.

This report aims to be consistent with previously published ECDC surveillance reports for 2012 relating to specific diseases and disease groups. However, Member States update their data continually and a number have made specific corrections for this report, including corrections to data reported for earlier years. Accordingly, some minor differences will be seen when comparing the data in this report to previous Annual Epidemiological and disease-specific reports.

## Description of methods

### Data sources: indicator-based surveillance (disease cases)

All EU Member States and three EEA countries (Iceland, Liechtenstein and Norway) send information at least annually from their surveillance systems to ECDC relating to occurrences of cases of the 52 communicable diseases and health issues under mandatory EU-wide surveillance. Reports are sent according to case definitions established by the EU<sup>i</sup>.

Data upload by Member States occurs continually throughout the year. In conjunction with annual ECDC reports for particular diseases or disease groups, and the consolidated annual report, ECDC issues 'data calls,' with specified end dates, to facilitate accurate and up-to-date submission of data for the previous calendar year.

The information submitted by Member States to ECDC is defined through a 'metadataset' for each disease under surveillance. The metadataset includes the case classification for the disease (particularly whether the case is confirmed or probable) according to official case definitions as determined by the European Commission. It also defines the information to be included with each case report. Most data are submitted as anonymised individual case data, but aggregated data are reported by some Member States for some diseases. Countries actively report zero cases for particular diseases, as applicable.

Data are uploaded and validated by the Member States using ECDC's online system for the collection of surveillance data, the European Surveillance System (TESSy). Member States' information specialists transform the data in their surveillance systems into an appropriate format before uploading to TESSy. System reports generated by TESSy allow Member States to review uploaded data and to make modifications where necessary. TESSy performs automatic validation and additional data validation is conducted by ECDC staff, in liaison with designated disease experts and epidemiologists in the Member States. Once the draft report is produced, it is sent to Member States' National Surveillance Coordinators for final validation. Any final corrections are uploaded to TESSy.

For each disease under surveillance, TESSy also holds a description of the key attributes of the surveillance systems for that disease in each Member State. This information is included in the report to aid the interpretation of surveillance data for each reported disease. Member States are asked to verify and update this information each year.

### Data sources: event-based surveillance

The report also presents information relating to health threats identified by ECDC through epidemic intelligence activities, from formal and validated informal sources. These threats are documented and monitored by using a dedicated database, called the Threat Tracking Tool (TTT). Data analysed in this report are extracted from the TTT and the EWRS database. The analysis of monitored threats covers the period from the activation of the TTT in June 2005 until the end of 2013; EWRS entries are covered from January 2005 to the end of 2013.

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<sup>i</sup> 2002/253/EC: Commission Decision of 19 March 2002 laying down case definitions for reporting communicable diseases to the Community network under Decision No 2119/98/EC of the European Parliament and of the Council. Official Journal, OJ L 86, 03.04.2002, p. 44–62.

The expression 'opening a threat' refers to the way ECDC assesses threats during its daily threat review meetings. ECDC experts evaluate potential threats and validate events that require further attention or action from ECDC, based on their relevance to public health or the safety of EU citizens. The following criteria are used to open a threat and further monitor an event:

- more than one Member State is affected
- a disease is new or unknown, even if there are no cases in the EU
- there is a request from a Member State or from a third party for ECDC to deploy a response team
- there is a request for ECDC to prepare a risk assessment of the situation
- there is a documented failure in an effective control measure (vaccination, treatment or diagnosis)
- there is a documented change in the clinical/epidemiological pattern of the disease, including changes in disease severity, the mode of transmission, etc.
- the event matches any of the criteria under the International Health Regulations (IHR) or EWRS.

Events are considered relevant to be reported to the EWRS if one or more of the criteria below are met. After the revised International Health Regulations (IHR) entered into force on 15 June 2007, the decision was amended, and criteria now include both IHR notifications and the need to exchange details following contact tracing<sup>1</sup>.

The Commission Decision on serious cross-border threats to health<sup>ii</sup>; 'lays down rules on epidemiological surveillance, monitoring, early warning of, and combating serious cross border threats to health, including preparedness and response planning related to those activities, in order to coordinate and complement national policies'.

With reference to this Decision, the following criteria are applied for reporting to the EWRS:

- outbreaks of communicable diseases extending to more than one EU Member State
- spatial or temporal clustering of cases of a disease of a similar type if pathogenic agents are a possible cause and there is a risk of propagation between Member States within the Union
- spatial or temporal clustering of cases of disease of a similar type outside the EU if pathogenic agents are a possible cause and there is a risk of propagation to the Union
- the appearance or resurgence of a communicable disease or an infectious agent which may require timely coordinated EU action to contain it
- any IHR notification (also reported through EWRS)
- any event related to communicable diseases with a potential EU dimension necessitating contact tracing to identify infected persons or persons potentially in danger, which may involve the exchange of sensitive personal data of confirmed or suspected cases between concerned Member States.

## Data analysis

### General principles

All analyses are based on confirmed cases where possible. For some diseases, some Member States do not distinguish confirmed from other cases; in these situations, total case reports from these countries are used in the analyses and the country concerned is identified in a footnote to the summary table. For some diseases (e.g. tuberculosis, Legionnaires' disease), confirmed cases are defined on a specific basis, described in the relevant sections. For other diseases the reporting of only confirmed cases would result in a severe underestimation of the true disease burden, hence both probable and confirmed cases are reported. The 'month' variable used in the seasonality analyses is based on the date that the country chooses as its preferred date for reporting. This could be either date of onset of disease, date of diagnosis, date of notification, or some other date at the country's discretion.

### Population data

Population data for the calculation of rates are obtained from Eurostat, the statistical office of the EU. Data for overall calculations are extracted from the Eurostat database 'Demographic balance and crude rates' (DEMO\_PJAN). The population as of 1 January of each year is used. Totals per year and per country are available for all countries for 2012. For calculation of age- and gender-specific rates, the data are aggregated into the following age groups for the analyses: 0–4, 5–14, 15–24, 25–44, 45–64 and ≥65 years.

<sup>i</sup> Commission Decision of 10 July 2009 amending Decision No 2000/57/EC on the early warning and response system for the prevention and control of communicable diseases under the Decision No 2119/98/EC of the European Parliament and of the Council, in Official Journal of the European Union. 2009. p. L 181: 57-9.

<sup>ii</sup> Commission Decision 1082/2013/EU, of 5th November 2013 of the European Parliament and the Council of 22 October 2013 on serious cross-border threats to health.in Official Journal of the European Union 2013.p.L293:1-15.

## Data protection

The data received in TESSy from Member States are subject to Regulation (EC) No 45/2001 of the European Parliament and of the Council of 18 December 2000, providing for 'the protection of individuals with regard to the processing of personal data by the Community institutions and bodies, and on the free movement of such data.' High standards of data protection consistent with these requirements are applied, supervised by the ECDC Data Protection Officer. ECDC data protection arrangements are also under the review of the European Data Protection Supervisor.

Data are made available on request to other European Agencies, Institutions and approved researchers, under procedures in accordance with the above requirements, approved by the ECDC Management Board.

# Antimicrobial resistance and healthcare-associated infections

## Antimicrobial resistance

- Antimicrobial resistance (AMR) is a serious threat to public health. The percentages of organisms exhibiting AMR, especially resistance to multiple antibiotics, continued to increase in Europe in 2012.
- Data from the European Antimicrobial Resistance Surveillance Network (EARS-Net) show large variations in percentages of AMR in Europe depending on microorganism, antimicrobial agent and geographical region.
- In 2012, the occurrence of methicillin-resistant *Staphylococcus aureus* (MRSA) was stabilising, or even decreasing, in several European countries. However, the percentage of MRSA among all *Staphylococcus aureus* isolates remained above 25% in seven of the 29 EU/EEA reporting countries.
- Over the last four years, there has been a significant increasing trend of combined resistance to multiple antibiotics in both *Escherichia coli* and *Klebsiella pneumoniae* in more than one third of the EU/EEA countries. Options for treatment of patients who are infected with such multidrug-resistant bacteria are limited to only a few last-line antibiotics, such as carbapenems. However, carbapenem-resistance is increasing and is already high in some countries, which further limits options for the treatment of infected patients.
- Continued efforts to promote prudent use of antimicrobial agents and comprehensive infection control measures are paramount to reduce the selection and control transmission of antimicrobial-resistant bacteria.

## Surveillance systems

The data presented in this section were collected by the European Antimicrobial Resistance Surveillance Network (EARS-Net). Data collection was coordinated by ECDC. EARS-Net collects data on invasive bacterial isolates from around 900 clinical microbiological laboratories serving approximately 1 400 hospitals in Europe. For detailed information on EARS-Net, surveillance results and analysis methods, please refer to the EARS-Net Annual Report 2012 [1] and the EARS-Net interactive database [2].

## Enhanced surveillance in 2012

### *Escherichia coli*

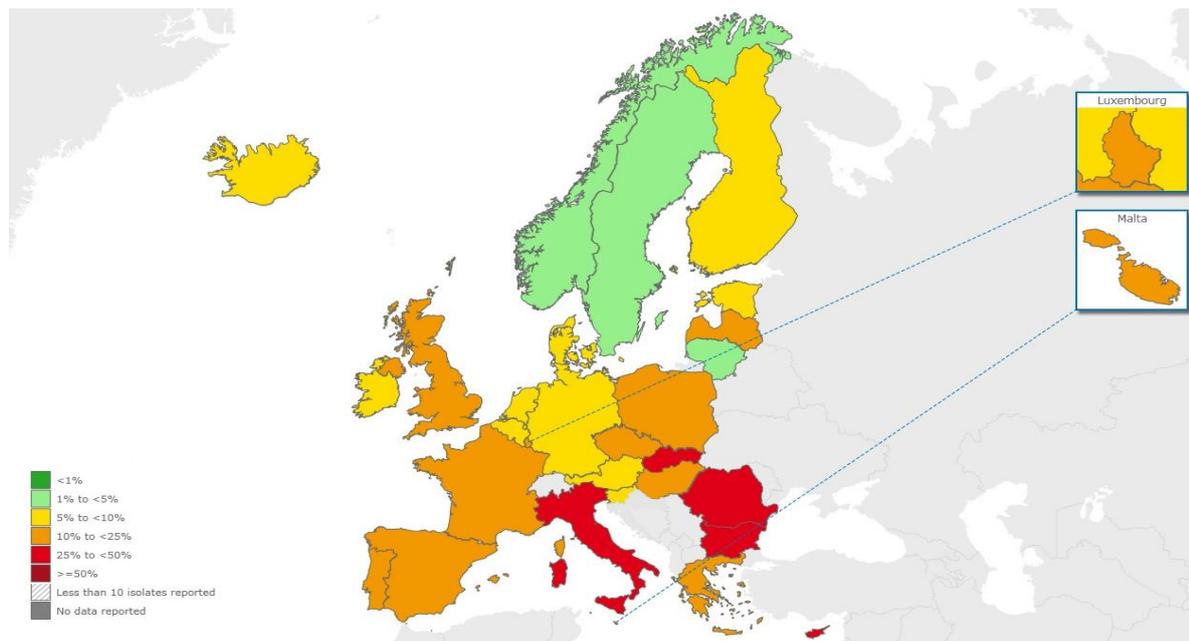
*Escherichia coli* are among the most frequently isolated Gram-negative bacteria in blood cultures and a major cause of urinary tract infection. Antimicrobial resistance in *E. coli* requires close attention as the percentages of isolates resistant to commonly used antimicrobials continue to increase throughout Europe. A majority of the isolates reported to EARS-Net in 2012 were resistant to at least one of the antimicrobials under surveillance.

In 2012, the EU/EEA population-weighted mean percentage of *E. coli* isolates resistant to third-generation cephalosporins was 11.9%, while national percentages ranged from 4.4% (Sweden) to 38.1% (Bulgaria) (Figure 1). Between 2009 and 2012, the EU/EEA population-weighted mean percentage increased significantly, as well as the percentages of resistant isolates for 19 of 27 reporting countries. The percentages of third-generation cephalosporin-resistant isolates, reported as extended-spectrum beta-lactamase (ESBL)-positive, ranged between 70.5% and 100% depending on the reporting country.

The EU/EEA population-weighted mean percentage for combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides was 4.4 % in 2012, with national percentages ranging from less than 1% (Iceland) to 16.1% (Bulgaria). Combined resistance increased significantly in 14 of the 27 reporting countries. Only one country (Lithuania) reported a decreasing trend.

Resistance to carbapenems in *E. coli* remains very low in Europe with an EU/EEA population-weighted mean percentage of less than 0.1% and national percentages of resistant isolates ranging from 0 to 2.6% (Bulgaria).

**Figure 1. *Escherichia coli*: percentage (%) of invasive (blood and cerebrospinal fluid) isolates resistant to third-generation cephalosporins, EU/EEA, 2012**



Source: EARS-Net. Only data from countries reporting more than 10 isolates are shown.

### ***Klebsiella pneumoniae***

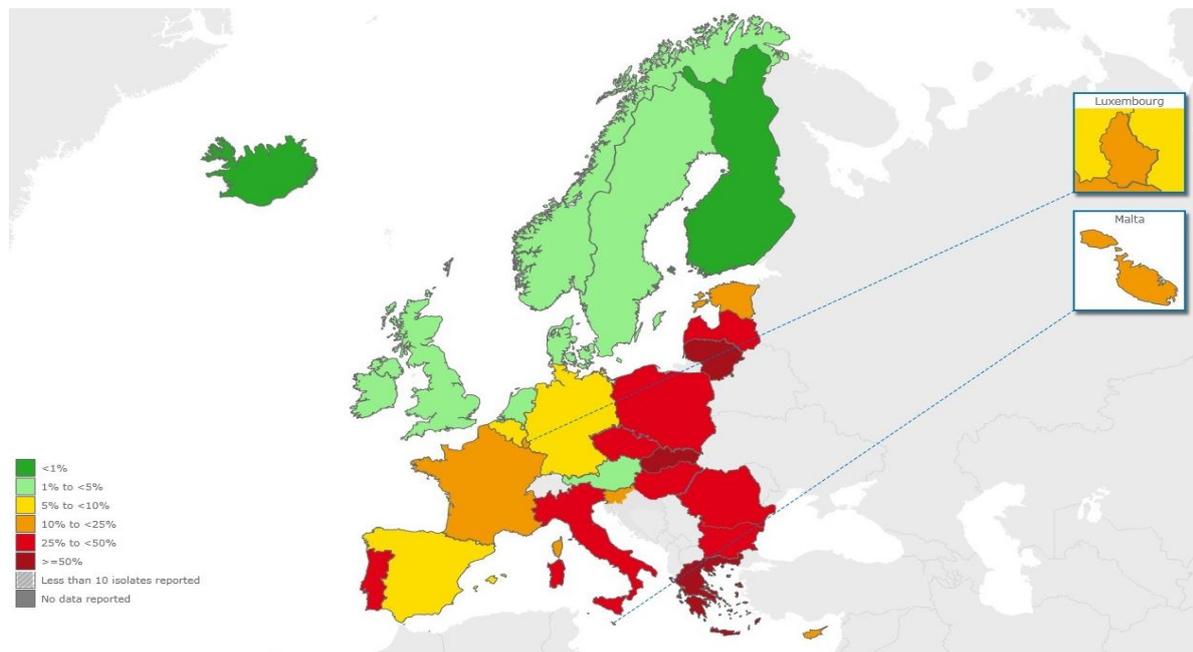
*Klebsiella pneumoniae* is an important cause of infection in persons with an impaired immune system and patients with indwelling devices. Urinary tract infections, respiratory tract infections and bloodstream infections are frequently encountered. *K. pneumoniae* can spread rapidly between patients in healthcare settings and is a frequent cause of hospital outbreaks. The increasing percentage of antimicrobial-resistant *K. pneumoniae* is a public health concern of growing importance in Europe and worldwide. A majority of the isolates reported to EARS-Net in 2012 were resistant to at least one of the antimicrobials under surveillance, and combined resistance to multiple antimicrobials was common. High percentages of antimicrobial-resistant *K. pneumoniae* were reported by countries in southern, central and eastern Europe.

In 2012, the EU/EEA population-weighted mean percentage of *K. pneumoniae* isolates resistant to third-generation cephalosporins was 25.6%, with national percentages ranging from 1.7% (Finland) to 74.8% (Bulgaria). Trend analyses for the period 2009 to 2012 showed a significantly increasing trend for the EU/EEA population-weighted mean percentage, as well as for 8 of the 27 reporting countries. None of the reporting countries had a statistically significant decreasing trend during the same period. The percentages of third-generation cephalosporin-resistant isolates reported as ESBL-positive, ranged between 62% and 100% depending on reporting country.

The EU/EEA population-weighted mean percentage for combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides was 18.2% in 2012, with national percentages ranging from zero (Iceland) to 59.9% (Greece) (Figure 2). The population-weighted EU/EEA mean percentage increased significantly during the period 2009 to 2012. Significantly increasing trends of combined resistance were also reported from 11 of 26 reporting countries, while only Denmark reported a decreasing trend.

Carbapenem-resistant *K. pneumoniae* is becoming increasingly common in Europe (Figure 3). In 2012, the percentage of *K. pneumoniae* isolates resistant to carbapenems ranged from zero (7 countries) to 60.5% (Greece). Trend analyses for the period 2009 to 2012 showed a significantly increasing trend for the EU/EEA population-weighted mean percentage, and 5 of the 24 reporting countries had significant increasing trends. None of the countries had a significant decreasing trend. The increasing percentage of carbapenem resistance is of particular concern as carbapenems are among the few effective antimicrobials available for the treatment of infections caused by multidrug-resistant *K. pneumoniae*.

**Figure 2. *Klebsiella pneumoniae*: percentage (%) of invasive (blood and cerebrospinal fluid) isolates with combined resistance (resistant to third-generation cephalosporins, fluoroquinolones and aminoglycosides), EU/EEA, 2012**



Source: EARS-Net. Only data from countries reporting more than 10 isolates are shown.

**Figure 3. *Klebsiella pneumoniae*: percentage (%) of invasive (blood and cerebrospinal fluid) isolates resistant to carbapenems, EU/EEA, 2012**



Source: EARS-Net. Only data from countries reporting more than 10 isolates are shown.

### *Pseudomonas aeruginosa*

*Pseudomonas aeruginosa* is an important cause of infection among patients with impaired immune systems.

In 2012, high percentages of *P. aeruginosa* isolates resistant to aminoglycosides, ceftazidime, fluoroquinolones, piperacillin/tazobactam and carbapenems were reported from several countries, especially in Southern and Eastern Europe. Resistance to carbapenems was above 10% in 19 of 29 reporting countries. Combined resistance was also common, with 14% of the isolates reported as resistant to at least three antimicrobial classes.

Despite the high percentages of resistance in invasive *P. aeruginosa* isolates, trend analyses for the period 2009 to 2012 showed a generally stable situation in Europe, with few countries reporting significantly increasing or decreasing trends of resistance to various antimicrobial agents.

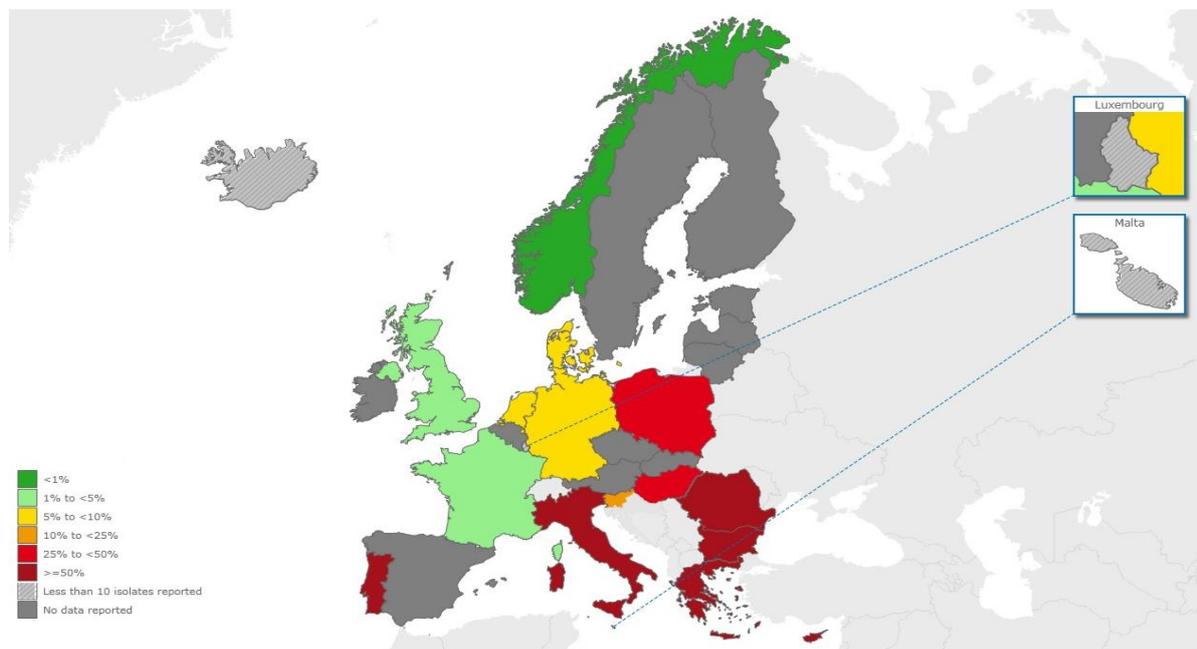
### *Acinetobacter* species

*Acinetobacter* species were included for the first time in the 2013 EARS-Net data call. Eighteen countries were able to report data for 2012.

More than half of *Acinetobacter* spp. isolates reported by these countries in 2012 were resistant to all antimicrobial groups under surveillance (carbapenems, fluoroquinolones and aminoglycosides). The percentage of isolates resistant to carbapenems was high (Figure 4), and in most cases carbapenem resistance was combined with resistance to the two other antimicrobial groups under surveillance. Treatment alternatives for patients infected with bacteria showing combined resistance to carbapenems and other key antimicrobials are confined to combination therapy, and to older antimicrobials such as polymyxins. Moreover, although data on polymyxin susceptibility test results as part of EARS-Net are limited, the reporting of isolates with polymyxin resistance, especially in countries with already high levels of carbapenem resistance, is an indication of the further loss of effective antimicrobial treatment options for gram-negative bacterial infections.

Large inter-country variation was observed, with generally higher resistance percentages reported from southern Europe than northern Europe.

**Figure 4. *Acinetobacter* spp.: percentage (%) of invasive (blood and cerebrospinal fluid) isolates resistant to carbapenems, EU/EEA, 2012**



Source: EARS-Net. Only data from countries reporting more than 10 isolates are shown.

### *Streptococcus pneumoniae*

*Streptococcus pneumoniae* is a common cause of infection, especially in young children, elderly people and patients with impaired immune systems. The clinical spectrum of *S. pneumoniae* infections ranges from upper respiratory tract infections such as sinusitis and otitis media to bloodstream infections and meningitis.

*Streptococcus pneumoniae* is also one of the major causes of pneumonia worldwide and is associated with high morbidity and mortality.

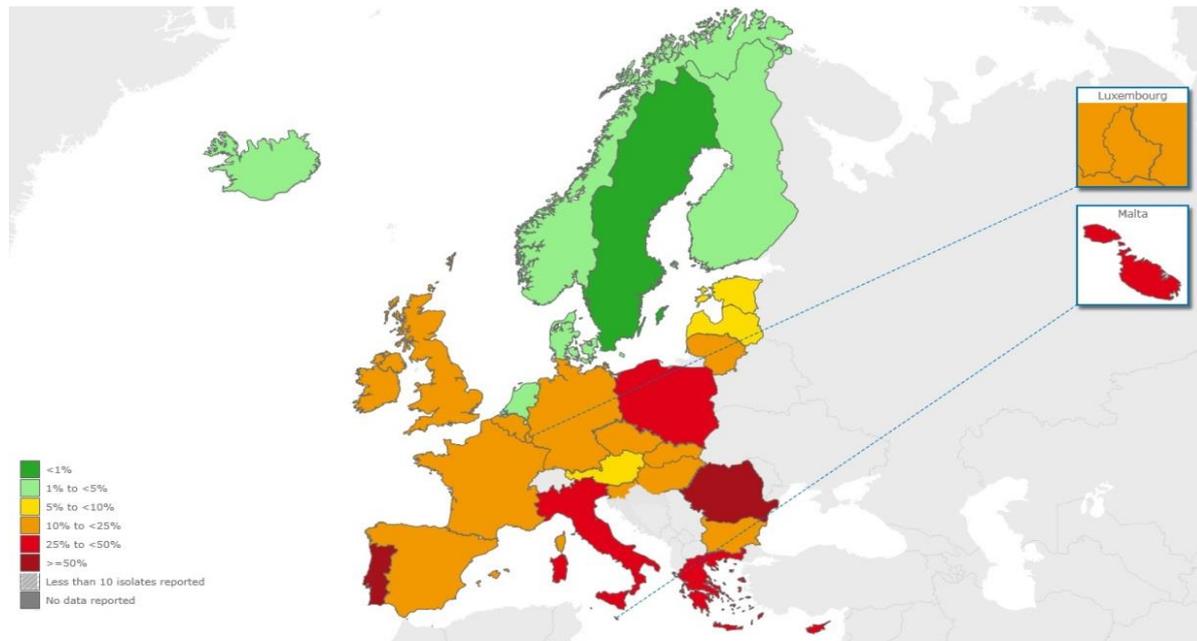
The percentage of *S. pneumoniae* isolates non-susceptible to penicillin was above 10% in 10 of 28 reporting countries. For most countries, percentages of macrolide non-susceptibility were higher than the percentages of penicillin non-susceptibility. Combined non-susceptibility to both penicillin and macrolides was above 10% in 10 of 28 countries.

### *Staphylococcus aureus*

*Staphylococcus aureus* in its oxacillin-resistant form (meticillin-resistant *S. aureus*, MRSA) is one of the most important causes of antimicrobial-resistant healthcare-associated infections worldwide. During the past decade, several European countries implemented national action plans targeted at reducing the spread of MRSA in healthcare facilities.

The percentage of *S. aureus* isolates reported as MRSA is now stabilising or decreasing in most European countries, and the EU/EEA population-weighted mean MRSA percentage has decreased significantly over the last four years. Although these observations provide reasons for optimism, MRSA remains a public health priority as the percentage of MRSA is still above 25% in seven of 29 reporting countries, mainly in Southern and Eastern Europe (Figure 5).

**Figure 5. *Staphylococcus aureus*: percentage (%) of invasive (blood and cerebrospinal fluid) isolates resistant to meticillin (MRSA), EU/EEA, 2012**



Source: EARS-Net. Only data from countries reporting more than 10 isolates are shown.

### *Enterococcus faecalis* and *Enterococcus faecium*

Enterococci belong to the normal bacterial flora of the gastrointestinal tract of humans, but may also cause a variety of clinical infections including endocarditis, bacteraemia, meningitis, wound and urinary tract infections, and are associated with peritonitis and intra-abdominal abscesses.

High-level aminoglycoside resistance in *E. faecalis* occurs frequently, with a majority of the countries reporting percentages of resistant isolates between 25% and 50%. A statistically significant decrease over the last four-year period was observed for Cyprus, Germany, Greece and Spain, while no country showed a significantly increasing trend.

The occurrence of vancomycin resistance in *E. faecium* shows large inter-country variations, with a majority of the countries reporting percentages below 5% in 2012, and only a few countries reporting estimates above 10%.

## Discussion

The occurrence of antimicrobial resistance in Europe varies depending on the microorganism, the antimicrobial agent and the geographical region. For several antimicrobial agent and microorganism combinations, a geographical gradient is evident, with generally lower resistance percentages reported from northern Europe compared to eastern and southern Europe. These geographical differences may reflect differences in antimicrobial use and infection control practices in the reporting countries.

The high levels and increasing trends of antimicrobial resistance in Gram-negative bacteria in Europe highlighted by EARS-Net surveillance results illustrate the continuous loss of effective antimicrobial therapy, and emphasise the need for comprehensive response strategies targeting all health sectors. Options for treatment of patients who are infected with multidrug-resistant bacteria are limited to a few remaining last-line antimicrobials, such as the carbapenems. The high proportion of ESBL-production, and the increase of carbapenem-resistance observed in recent years further limits the number of available treatment options for patients infected with these bacteria. These multi-resistance traits are frequently acquired through plasmid-mediated resistance determinants that can spread between bacteria of the same species or even between different species. Transfer of patients across borders, both within and from outside the EU has been shown to be a documented risk factor for the introduction of bacteria carrying these genetic elements.

The problem of antimicrobial resistance calls for international cooperation, as well as concerted efforts at the national level. Continued efforts to promote prudent use of antimicrobial agents and comprehensive infection prevention and control measures are paramount to reduce the selection and control transmission of antimicrobial-resistant bacteria.

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1. European Centre for Disease Prevention and Control. Antimicrobial resistance surveillance in Europe 2012. Annual report of the European Antimicrobial Resistance Surveillance Network (EARS-Net). Stockholm: ECDC; 2013.
2. European Antimicrobial Resistance Surveillance Network. Antimicrobial resistance interactive database (EARS-Net). 2013 [cited 2014 Jan 28]. Available from: [http://ecdc.europa.eu/en/healthtopics/antimicrobial\\_resistance/database/Pages/database.aspx](http://ecdc.europa.eu/en/healthtopics/antimicrobial_resistance/database/Pages/database.aspx).

## Antimicrobial consumption

- The European Surveillance of Antimicrobial Consumption Network (ESAC-Net) provides data on antimicrobial consumption in the community and in the hospital sector from 29 EU/EEA countries. In 2012, all participating countries reported data for the community and 19 countries reported data for the hospital sector.
- In 2012, consumption of antibacterials ('antibiotics') for systemic use (the WHO Anatomical Therapeutic Chemical -ATC group J01) in the community displayed a large variation and ranged from 11.3 to 31.9 defined daily doses (DDD) per 1 000 inhabitants and per day, depending on the country. The EU/EEA population-weighted mean was 21.5 DDD per 1 000 inhabitants and per day.
- In 2012, consumption of antibacterials for systemic use (ATC group J01) in the hospital sector ranged from 1.0 to 2.8 DDD per 1 000 inhabitants and per day, depending on the country. The EU/EEA population-weighted mean was 2.0 DDD per 1 000 inhabitants and per day.
- Over the five-year period 2008–2012, the EU/EEA population-weighted mean consumption of antibacterials for systemic use in the community did not show any significant trend. Among the 29 reporting countries, consumption in the community showed a significant increase in five of the 29 reporting countries while only one country reported a significant decrease.
- Introducing a new ESAC-Net protocol for collecting data at the hospital level and by using additional denominators for hospital consumption would allow identifying areas for improvement, to be addressed by national, regional and local antimicrobial stewardship programmes. In addition, it would allow linking of hospital antimicrobial consumption data from ESAC-Net with antimicrobial resistance data from the European Antimicrobial Resistance Surveillance Network (EARS-Net), as well as surveillance data on antimicrobial use and healthcare-associated infections from the Healthcare-associated Infections Surveillance Network (HAI-Net) provided that countries use one single code per hospital for the three surveillance networks.
- Providing comparable and reliable data on antimicrobial consumption is a prerequisite for the development of indicators and when setting up national targets for monitoring progress towards a more prudent use of antimicrobials.

## Surveillance systems

The European Surveillance of Antimicrobial Consumption Network (ESAC-Net) is a Europe-wide network of national surveillance systems, collecting European reference data on antimicrobial consumption. ESAC-Net collects and analyses data on antimicrobial consumption from 29 EU/EEA countries, both in the community and in the hospital sector [1]. Data for the period prior to 2010 were collected by the ESAC project [2].

The data sources for ESAC-Net are national sales or reimbursement data, depending on the country, and include information from national drug registers. The WHO Anatomical Therapeutic Chemical (ATC) classification system is used for the allocation of antimicrobials into groups [3]. Data on antimicrobial consumption are collected at the product level for antibacterials ('antibiotics') for systemic use (ATC group J01), antimycotics for systemic use and antifungals for systemic use (ATC groups J02 & D01BA), antimycobacterials (ATC group J04) and antivirals for systemic use (ATC group J05). In addition, data on a few other antimicrobials (outside of ATC group J) are also collected. Antimicrobial consumption is expressed as a number of WHO defined daily doses (DDD) per 1 000 inhabitants and per day.

Twenty-nine EU/EEA countries reported data for 2012. All countries reported data on antimicrobial consumption in the community. Three countries (Cyprus, Iceland and Romania) were only able to report data on total consumption in the country. Nineteen countries reported data on antimicrobial consumption specifically in the hospital sector. Lithuania re-uploaded 2010 data and Romania re-uploaded 2011 data as total care data (data had previously been reported separately for the community and the hospital sector, see Table 1).

For both the community and the hospital sector, these data were mainly on sales of antimicrobials in the country, or a combination of sales and reimbursement data.

## Enhanced surveillance in 2012

### *Consumption of antibacterials ('antibiotics') for systemic use in the community*

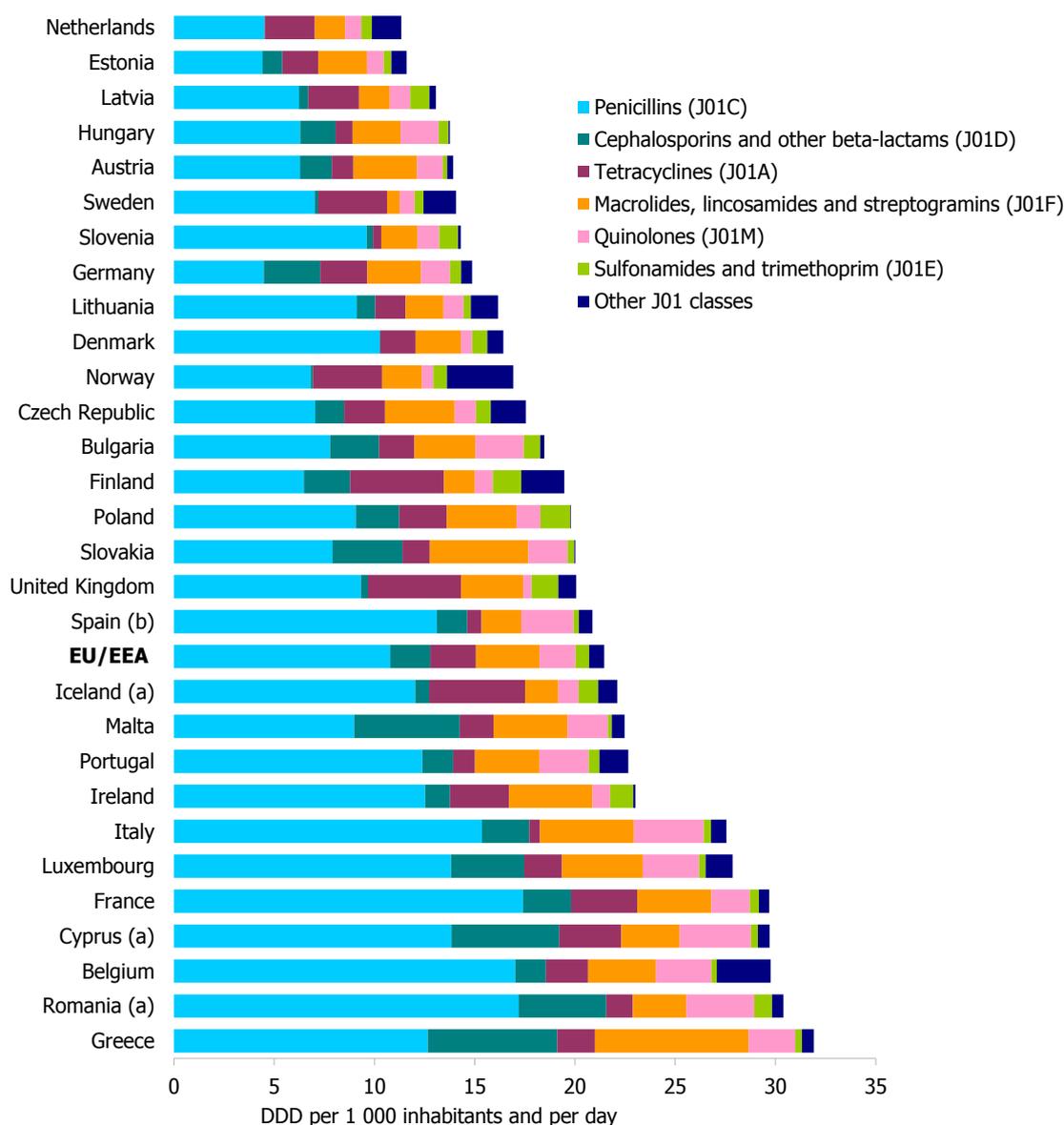
Consumption of antibacterials ('antibiotics') for systemic use in the community (i.e. outside hospitals) ranged from 11.3 DDD per 1 000 inhabitants and per day in the Netherlands to 31.9 DDD per 1 000 inhabitants and per day in Greece (Figure 1). The population-weighted mean consumption was 21.5 DDD per 1 000 inhabitants and per day.

As in previous years, penicillins were the most frequently prescribed antibacterials in all countries, ranging from 30.1% (Germany) to 67.3% (Slovenia), whereas the proportion of consumption of other antibacterial classes varied widely among countries, e.g. cephalosporins and other beta-lactams, from 0.2% (Denmark) to 23.5% (Malta); macrolides, lincosamides and streptogramins, from 4.5% (Sweden) to 24.5% (Slovakia); and quinolones, from 2.1% (United Kingdom) to 13.9% (Hungary) (Figure 1).

In 21 (72%) of the 29 EU/EEA countries, more than half of the consumption in the community corresponded to three or fewer antibacterial agents out of a list of 12 antibacterial agents. The two most often consumed antibacterials for systemic use, i.e. amoxicillin (with and without enzyme inhibitor) in most of the countries and phenoxymethylpenicillin in the Nordic countries, were from the penicillin group.

Temporal trends in the consumption of antibacterials ('antibiotics') for systemic use from 2008 to 2012 are presented in Table 1. Using linear regression, a significant increase in consumption - expressed in DDD per 1 000 inhabitants and per day - during the period from 2008 to 2012 was observed for five countries (Belgium, Latvia, Norway, Spain and the United Kingdom) while consumption decreased in Austria during the same period. The EU/EEA population-weighted mean consumption of antibacterials for systemic use for the 29 EU/EEA countries that reported data for the period 2008–2012 did not show any statistically significant trend (Table 1).

**Figure 6. Distribution of consumption of antibacterials for systemic use (ATC group J01) in the community (outside of hospitals) at ATC group level 3, expressed as DDD per 1 000 inhabitants and per day, EU/EEA, 2012**



(a) Cyprus, Iceland and Romania provided total care data, i.e. including the hospital sector. On average, 90% of total care data correspond to consumption in the community.

(b) Spain provided reimbursement data, i.e. not including consumption without a prescription and other non-reimbursed courses. EU/EEA refers to the population-weighted mean consumption in the participating EU/EEA countries.

**Table 1. Trends of consumption of antibacterials for systemic use (ATC group J01) in the community (outside of hospitals), expressed as DDD per 1 000 inhabitants and per day, reported in EU/EEA countries, 2008–2012**

Country	2008	2009	2010	2011	2012	Trends in antimicrobial consumption, 2008–2012	Average annual change 2008–2012	Statistical significance
Netherlands	11.2	11.4	11.2	11.4	11.3		0.02	n.s.
Estonia	11.9	11.1	11.1	12.1	11.6		0.04	n.s.
Latvia	11.4	10.9	11.8	12.8	13.1		0.53	significant
Hungary (c)	15.2	16.0	15.7	14.7	13.8			n.a.
Austria	15.1	15.9	15.0	14.5	13.9		-0.34	significant
Sweden	14.6	13.9	14.2	14.3	14.1		-0.09	n.s.
Slovenia	15.0	14.4	14.4	14.4	14.3		-0.12	n.s.
Germany	14.5	14.9	14.5	14.1	14.9		-0.02	n.s.
Lithuania	25.1*	19.5*	17.7*	19.0*	16.2			n.a.
Denmark	16.0	16.0	16.5	17.4	16.4		0.35	n.s.
Norway	15.5	15.2	15.8	16.5	16.9		0.40	significant
Czech Republic	17.4	18.4	17.9	18.5	17.5		0.02	n.s.
Bulgaria	20.6	18.6	18.2	19.5	18.5		-0.25	n.s.
Finland	18.3	18.0	18.5	20.1	19.5		0.55	n.s.
Poland (c)	20.7	23.6	21.0	21.9	19.8			n.a.
Slovakia (a)	23.4	23.8		23.8*	20.0			n.a.
United Kingdom	16.9	17.3	18.7	18.8	20.1		0.76	significant
Spain (b)	19.7	19.7	20.3	20.9	20.9		0.34	significant
<b>EU/EEA</b>	<b>21.0</b>	<b>20.9</b>	<b>20.9</b>	<b>21.5</b>	<b>21.5</b>		<b>0.18</b>	<b>n.s.</b>
Iceland	20.6	19.4	22.3*	22.3*	22.1*			n.a.
Malta	20.8	21.6	21.3	23.4	22.5		0.51	n.s.
Portugal	22.6	22.9	22.4	23.2	22.7		0.02	n.s.
Ireland	22.4	20.8	20.3	22.6	23.0		0.30	n.s.
Italy	28.5	28.7	27.3	28.2	27.6		-0.22	n.s.
Luxembourg	27.1	28.2	28.6	27.6	27.9		0.09	n.s.
France	28.0	29.6	28.2	28.7	29.7		0.24	n.s.
Cyprus	32.8*	34.4*	31.0*	32.0*	29.7*		-0.88	n.s.
Belgium	27.7	27.5	28.4	29.0	29.8		0.55	significant
Romania (a, b, c)		10.2		30.9*	30.4*			n.a.
Greece	45.2*	38.6	39.4*	35.1	31.9			n.a.

\*Total care data; including the hospital sector.

(a) Croatia (2008–2011), Romania (2008 and 2010) and Slovakia (2010) did not report data for these years.

(b) Spain (2008–2012) and Romania (2009) reported reimbursement data, i.e. not including consumption without a prescription and other non-reimbursed courses.

(c) Hungary, Poland and Romania changed the type of data reported between 2008 and 2012 (reimbursement versus sales data).

EU/EEA refers to the corresponding population-weighted mean consumption.

n.a. not applicable: linear regression was not applied due to missing data, changes in the type of data and changes of sector for which data were reported (community versus total care data) between 2008 and 2012.

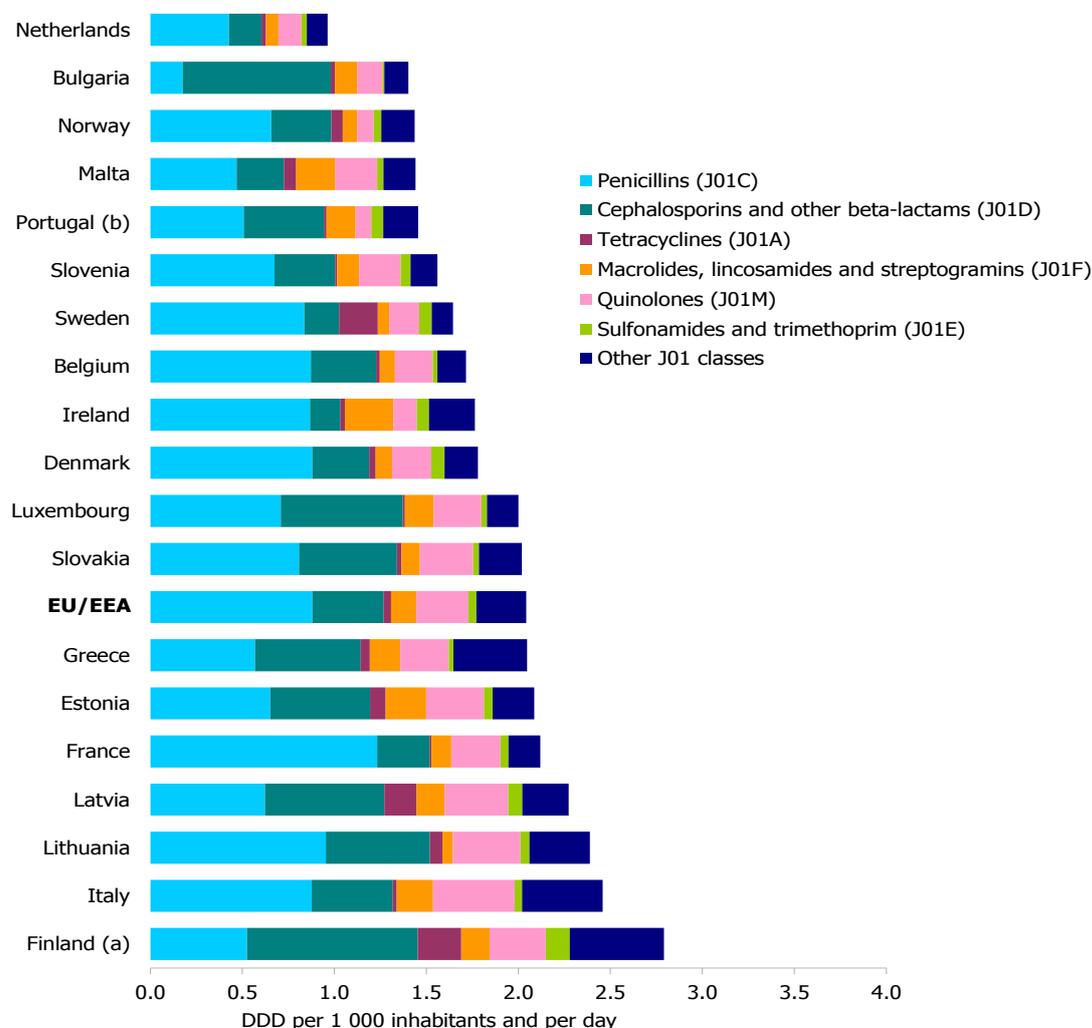
n.s. not significant.

#### Consumption of antibacterials ('antibiotics') for systemic use in the hospital sector

Consumption of antibacterials ('antibiotics') for systemic use in the hospital sector ranged from 1.0 DDD per 1 000 inhabitants and per day in the Netherlands to 2.8 DDD per 1 000 inhabitants and per day in Finland (Figure 2). The EU/EEA population-weighted mean consumption (based on 19 member states that provided data specifically on the hospital sector) was 2.0 DDD per 1 000 inhabitants and per day. The relative high consumption in Finland is explained by the fact that Finnish data for the hospital sector also include antimicrobial consumption in remote primary healthcare centres and nursing homes.

The relative proportion of consumption of various antibacterial classes in the hospital sector varied widely among the countries (Figure 2). In contrast to prescription practices in the community, penicillins were not the most frequently prescribed antibiotic group in all countries. In the hospital sector, substantial variations were reported: consumption of cephalosporins and other beta-lactams, including carbapenems, ranged from 9.3% in Ireland to 57.4 % in Bulgaria, consumption of macrolides, lincosamides and streptogramins ranged from (from 2.4% in Lithuania to 14.9% in Ireland, and consumption of quinolones ranged from 6.0% in Portugal to 18.1% in Italy.

**Figure 7. Distribution of consumption of antibacterials for systemic use (ATC group J01) at ATC group level 3 in the hospital sector, expressed as DDD per 1 000 inhabitants and per day, EU/EEA, 2012**



(a) Finland: data include consumption in remote primary healthcare centres and nursing homes.

(b) Portugal: data only correspond to public hospitals.

EU/EEA refers to the corresponding population-weighted mean consumption based on 19 Member States that provided data.

## Discussion

Increasingly, EU/EEA countries are implementing actions to control antimicrobial resistance in the community through rational use of antimicrobials, including awareness campaigns on the prudent use of antibiotics. Reliable and comparable antimicrobial consumption data are essential in the evaluation of the effect of such national campaigns.

In line with observations made in previous years, consumption of antibacterials ('antibiotics') for systemic use in 2012 varied widely among EU/EEA countries with a 2.8-fold difference between the country with the highest consumption and the country with the lowest consumption. Such differences are likely to reflect differences of policies in the countries as well as being driven by cultural determinants [4].

Antimicrobial consumption, and in particular the consumption of antibacterials ('antibiotics') for systemic use expressed in DDD per 1000 inhabitants and per day, is a potential indicator [5] for healthcare professionals and policy makers to monitor progress towards a more prudent use of antimicrobials.

Certain countries report on total consumption, i.e. both the community and the hospital sector, rather than consumption in only the community, and the type of reported data may vary from year to year, even in the same country. In addition, there are differences in the sources of national data and in the availability of a national registry of all antimicrobials available on the market in each country; the latter being a prerequisite for proper calculations of antimicrobial consumption. For this reason, inter-country comparisons should be made with caution after checking for possible changes in the source of data.

The largest proportion of antimicrobial consumption in humans takes place in the community (i.e. outside of hospitals) and in three quarters of the participating countries, only three or less different antibacterial agents account for half of the national consumption in the community.

Reliable national data on antimicrobial consumption are paramount for our understanding of the epidemiology of antimicrobial resistance because they provide information on the ecological selection pressure due to antimicrobial use. Countries reporting a high consumption generally have a higher level of antimicrobial resistance than countries reporting a low consumption [6]. Healthcare-associated infections with *Klebsiella pneumoniae* strains that have become resistant to multiple agents, including to last-line antimicrobials such as carbapenems are now prevalent in hospitals in some EU/EEA countries. At the level of each individual hospital, specific antimicrobial resistance problems are reported depending on the patient case-mix, varying infection prevention and control practices, and antimicrobial prescribing practices. There is a need to improve surveillance of antimicrobial consumption at the level of each individual hospital in EU/EEA countries. Development of a specific module for this type of surveillance at hospital level represents the next challenge for ESAC-Net.

Such development should allow for the identification of areas for improvement, which could be addressed by national, regional and local antimicrobial stewardship programmes and for linking of hospital antimicrobial consumption data from ESAC-Net with antimicrobial resistance data from the European Antimicrobial Resistance Surveillance Network (EARS-Net), as well as surveillance data on antimicrobial use and healthcare-associated infections from the Healthcare-Associated Infections Surveillance Network (HAI-Net).

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## Healthcare-associated infections

### Point prevalence survey of healthcare-associated infections (HAIs) and antimicrobial use in European long-term care facilities, 2013

Between April and May 2013, 1 181 long-term care facilities (LTCFs) from 17 European countries participated in the point prevalence survey (PPS) of healthcare-associated infections (HAIs) and antimicrobial use in European LTCFs [1]. This was the second time a Europe-wide PPS in LTCFs was organised. In 2010, a first PPS was conducted in 722 LTCFs from 25 European countries [2].

A two-day train-the-trainers course was organised to familiarise the national coordinators from participating countries with the curriculum and training materials so that they could deliver a corresponding national one-day training course for data collectors in their respective countries.

Data were collected from each LTCF on a single day, either by a local or by an external data collector, i.e. a person from the LTCF or recruited by the national centre. Two types of questionnaires had to be completed: an institutional questionnaire and a resident questionnaire. One institutional questionnaire was completed per LTCF, and one resident questionnaire was completed for each resident on a course of systemic antimicrobial(s) and/or presenting signs or symptoms of an active HAI on the day of the PPS. These data were entered into dedicated stand-alone software. HAI case definitions were based on the US Centers for Disease Control and Prevention/the Society for Healthcare Epidemiology of America case definitions, which are in turn based on the McGeer criteria [3].

The crude prevalence of residents with at least one HAI in 2013 was 3.4%. The total annual number of residents with a HAI in European long-term care facilities in 2013 was estimated at 116 416 residents on any given day, with an estimated total of 4.2 million HAIs for the entire year. This estimate was higher than the estimate based on the 2010 survey [5], partially because the reported number of LTCF beds in Member States increased from 3.1 million in 2010 to 3.6 million in 2013, but also because of differences in definitions of healthcare-associated infections between the 2010 and 2013 PPS. In both PPSs, the main types of infection were respiratory tract infections (31.2% in 2010 vs. 33.6% in 2013), symptomatic urinary tract infections (31.2% vs. 22.3%) and skin infections (22.8% vs. 21.4%).

The crude prevalence of antimicrobial use in LTCFs in 2013 was 4.4%, the same as in 2010. A large proportion of antimicrobials were prescribed for prophylaxis of urinary tract infections (27.7% in 2010 and 22.0% in 2013). Written therapeutic guidelines were available for urinary tract infections in 29.1% LTCFs in 2010 and 34.8% LTCFs in 2013, for respiratory tract infections in 29.3% LTCFs in 2010 and 28.9% LTCFs in 2013, and for wound and soft tissue infections in 32.3% LTCFs in 2010 and 35.3% LTCFs in 2013.

An infection prevention and control committee was in place in 29.1% of LTCFs in 2010 and 42.6% of LTCFs in 2013. Almost all LTCFs had a written protocol for hand hygiene (96.1% in 2010 and 95.9% in 2013) and the large majority had a protocol for the management of MRSA and/or other multidrug-resistant microorganisms (72.6% in 2010 and 76.9% in 2013), for the management of urinary catheters (80.9% in 2010 and 84.0% in 2013) and for enteral feeding (69.1% in 2010 and 76.8% in 2013). Only half of the LTCFs had a protocol for the management of venous catheters/lines (49.2% in 2010 and 50.0% in 2013).

In 2013, over half (56.2%) of LTCFs reported using alcohol hand rubs as the most frequent hand hygiene product. Alcohol hand rub consumption for the previous year was reported by 836 LTCFs in 2013 and varied between less than 5 litres per 1 000 resident-days in Belgium, Croatia, Hungary, Italy and UK-England to more than 20 litres per 1 000 resident-days in Denmark and UK-Northern Ireland, with a median consumption of 4.5 litres per 1 000 resident-days.

The median percentage of single rooms (as a percentage of the total number of rooms) in participating LTCFs was 57.5% (2013 data, not assessed in 2010) varying from less than 10% in the Czech Republic, Greece and Hungary to up to 100% in Denmark, the Netherlands, Norway, Sweden, UK-England and UK-Wales.

The collected PPS data provide a valuable insight into the HAI, antimicrobial use and infection prevention and control situation in LTCFs in participating countries in 2013. Reports were fed back to each participating LTCF and contained a detailed comparison of the results of the LTCF with that of other LTCFs at the national and European level. These reports were designed to increase awareness of the local situation, thus empowering LTCF staff to take targeted infection prevention and control actions. These also allowed national PPS coordinators to compare national results with European results. Finally, the training offered to LTCF staff provided an important step forward in improving HAI surveillance skills of LTCF staff.

## Targeted surveillance of surgical site infections and of infections acquired in intensive care units

### Surveillance of surgical site infections

Surveillance data for surgical site infections (SSIs) in 2012 (with partial follow-up of patients who had undergone orthopaedic surgery until December 2013) were received from 19 surveillance networks in 16 countries and included 422 201 surgical operations from 1 332 hospitals (compared with 422 177 surgical operations from 1 557 hospitals in 2011). The types and numbers of surgical operations reported by each country are shown in Table 1. Estonia reported SSI data for the first time in 2012. Unit-based data were provided by Romania, Czech Republic and UK-Scotland. The unit-based protocol allows for the reporting of patient-based data for SSIs (numerator), but only records aggregated denominator data by type of operation. Since a stratified analysis by risk factor was not possible for data obtained following the unit-based protocol, these data were analysed separately. The methodology for SSI surveillance is described in the HAI-Net SSI protocol [5].

**Table 2. Number of reported operations by country and type of operation, EU/EEA, 2012**

Country	Type of operation							Total	
	CABG	CHOL	COLO	CSEC	HPRO	KPRO	LAM	N	%
<b>Patient-based data</b>									
Austria	397	414	148	4 179	5 185	536		10 859	2.6
Estonia	66			489				555	0.1
Finland					5 896	5 470		11 366	2.7
France		8 984	3 820	13 811	17 920	10 554	1 265	56 354	13.3
Germany	12 766	14 312	6 997	16 321	39 688	17 436	3 115	110 635	26.2
Hungary	86	1 807	609	2 561	747	186	177	6 173	1.5
Italy	611	4 746	4 015	7 551	2 139	627	579	20 268	4.8
Lithuania	656	1 019	383	1 725	383	229		4 395	1.0
Malta	184			422				606	0.1
Netherlands		2 235	2 600	3 937	4 663	3 136	670	17 241	4.1
Norway	821	1 499	1 023	3 000	3 743	0	0	10 086	2.4
Portugal		1 692	1 011	1 102	970	861	65	5 701	1.4
Slovakia		647						647	0.2
United Kingdom*	5 744		3 770	13 911	57 354	48 943	369	130 091	30.8
<b>Subtotal</b>	<b>21 331</b>	<b>37 355</b>	<b>24 376</b>	<b>69 009</b>	<b>138 688</b>	<b>87 978</b>	<b>6 240</b>	<b>384 977</b>	<b>91.2</b>
<b>Unit-based data</b>									
Czech Republic			403					403	0.1
Romania		2 862	1 472	1 683	216		1 102	7 335	1.7
United Kingdom**				15 768	7 886	5 832		29 486	7.0
<b>Subtotal</b>	<b>0</b>	<b>2 862</b>	<b>1 875</b>	<b>17 451</b>	<b>8 102</b>	<b>5 832</b>	<b>1 102</b>	<b>37 224</b>	<b>8.8</b>
<b>EU/EEA</b>	<b>21 331</b>	<b>40 217</b>	<b>26 251</b>	<b>86 460</b>	<b>146 790</b>	<b>93 810</b>	<b>7 342</b>	<b>422 201</b>	<b>100.0</b>

Source: Country reports; CABG: Coronary artery bypass graft; CHOL: Cholecystectomy; COLO: Colon surgery; CSEC: Caesarean section; HPRO: Hip prosthesis; KPRO: Knee prosthesis; LAM: Laminectomy.

\* Data reported by three networks in the UK: UK-England (CABG, COLO, HPRO, KPRO), UK-Northern Ireland (CSEC, HPRO, KPRO, LAM) and UK-Wales (CSEC, HPRO, KPRO).

\*\* Data reported by one network in the UK: UK-Scotland.

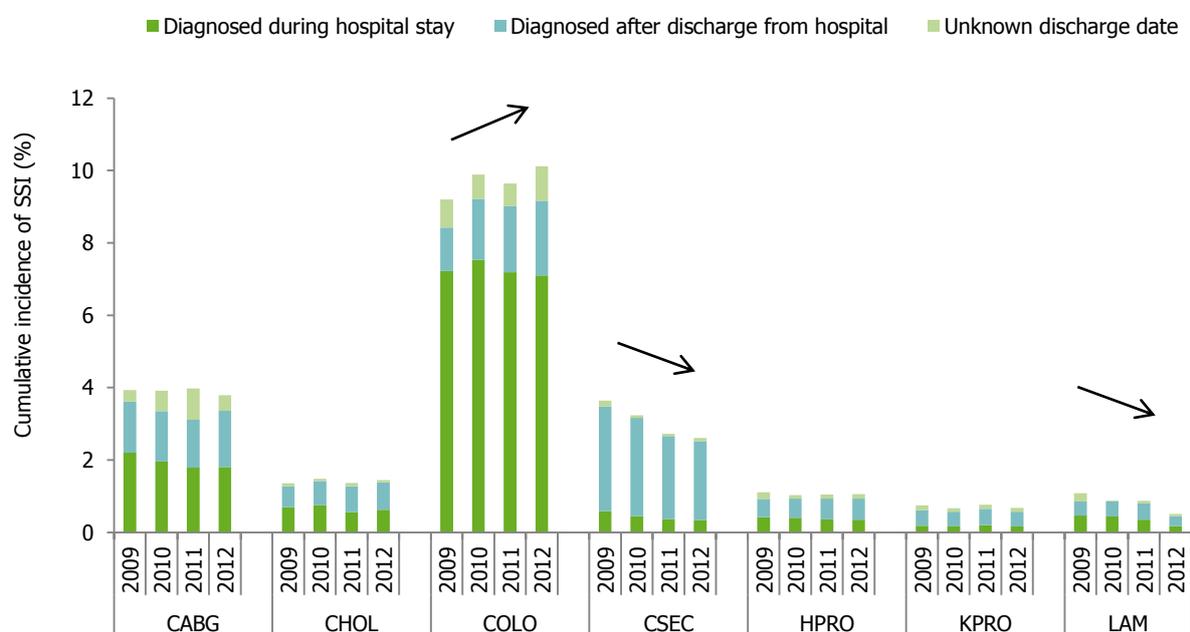
The percentage of SSIs (cumulative incidence, which includes SSIs diagnosed in-hospital and post-discharge) varied by type of operation, with the highest rate (9.7%) reported for colon surgery and the lowest rate (0.5%) for laminectomy. The cumulative incidence of SSIs in coronary artery bypass grafts was 3.8% (all reported SSIs) (87% of these SSIs were reported within 30 days after surgical procedure). The cumulative incidence of SSIs was 2.5% in caesarean sections, 1.4% in cholecystectomies, 1.0% in hip prostheses, and 0.6% in knee prostheses.

Trends for SSI rates were analysed for the last four years (2009–2012) and included networks that participated for at least three years during this period. The trends were analysed for the cumulative incidence of SSIs, adjusting for patient case-mix (risk index) by means of logistic regression, and for the in-hospital incidence density of SSIs (only for SSIs diagnosed during hospital stay) by means of Poisson regression analysis.

For the cumulative incidence of SSIs, significant overall, risk index-adjusted decreasing trends during the period 2009–2012 were observed for SSIs after caesarean section ( $p < 0.001$ ) and laminectomy ( $p < 0.01$ ) (Figure 1). During the same period, an increasing trend for the cumulative incidence of SSIs was observed for colon surgery ( $p < 0.05$ ). No trend in the cumulative incidence of SSIs was observed in other types of surgery (CABG, CHOL, HPRO and KPRO) during 2009–2012.

For incidence density of SSIs diagnosed during hospital stay, significant decreasing trends during the period 2009–2012 -were observed for five types of operations: coronary artery bypass graft ( $p<0.05$ ), cholecystectomy ( $p<0.05$ ), caesarean section ( $p<0.001$ ), hip prosthesis ( $p<0.001$ ) and laminectomy ( $p<0.01$ ). No trend in the incidence density was observed for coronary artery graft and knee prosthesis surgery during 2009–2012 (Figure 2).

**Figure 8. Cumulative incidence of surgical site reported infections by year and operation type, EU/EEA, 2009–2012**



Source: ECDC, HAI-Net SSI patient-based data 2009-2012.

Countries (networks) participating at least three years from 2009 to 2012 by type of operation:

- CABG: AT, DE, ES, FR, HU, IT, LT, MT, NO, UK (England);
- CHOL: AT, DE, ES, FR, HU, IT, LT, NL, NO, PT;
- COLO: AT, DE, ES, FR, HU, IT, LT, NL, NO, PT, UK (England);
- CSEC: AT, DE, ES, FR, HU, IT, LT, MT, NL, NO, PT, UK (Northern Ireland, Scotland and Wales);
- HPRO: AT, DE, ES, FI, FR, HU, IT, LT, NL, NO, PT, UK (England, Northern Ireland, Scotland and Wales);
- KPRO: AT, DE, ES, FI, FR, HU, IT, LT, NL, PT, UK (England, Northern Ireland, Scotland and Wales);
- LAM: DE, ES, FR, HU, IT, NL, PT, UK (Northern Ireland).

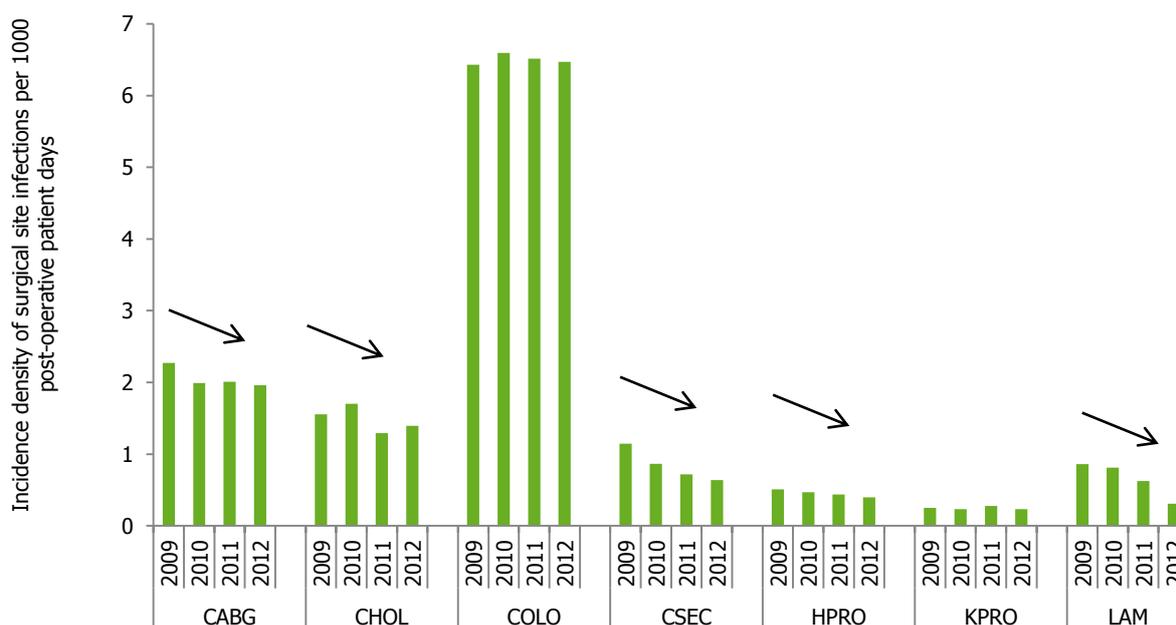
Finland updated 2011 year data. Spain did not provide data for 2012 due to changes in the national surveillance system.

SSIs reported within one year of the operation are included in CABG, HPRO and KPRO. SSIs reported within 30 days of the operation are included in CHOL, COLO, CSEC and LAM.

Arrows indicate a significant trend for cumulative incidence ( $p<0.05$ ).

Post-discharge surveillance methods and practices differ considerably among countries. .

**Figure 9. Incidence density of surgical site reported infections diagnosed during hospital stay, by year and operation type, EU/EEA, 2009–2012**



Source: ECDC, HAI-Net SSI patient-based data 2009-2012.

Countries (networks) participating at least three years from 2009 to 2012 by type of operation:

- CABG: AT, DE, ES, FR, HU, IT, LT, MT, NO, UK (England);
- CHOL: AT, DE, ES, FR, HU, IT, LT, NL, NO, PT;
- COLO: AT, DE, ES, FR, HU, IT, LT, NL, NO, PT, UK (England);
- CSEC: AT, DE, ES, FR, HU, IT, LT, MT, NL, NO, PT, UK (Northern Ireland, Scotland and Wales);
- HPRO: AT, DE, ES, FI, FR, HU, IT, LT, NL, NO, PT, UK (England, Northern Ireland, Scotland and Wales);
- KPRO: AT, DE, ES, FI, FR, HU, IT, LT, NL, PT, UK (England, Northern Ireland, Scotland and Wales);
- LAM: DE, ES, FR, HU, IT, NL, PT, UK (Northern Ireland).

Arrows indicate a significant trend for incidence density ( $p < 0.05$ ). Note: Only in-hospital diagnosed surgical site infections are included.

Overall, the percentage of SSIs detected after discharge from hospital in 2012 was 55% (all types of operations combined). High proportions of SSIs detected post-discharge were observed in the following networks: UK-Northern Ireland (95%), UK-Wales (88%), UK-Scotland (77%), Estonia (77%) and Norway (77%). For 9% ( $n=666$ ) of SSIs, the discharge date or the date of onset of the SSI were unknown and it was not possible to differentiate between SSIs diagnosed during hospital stay or post-discharge. This applied to 95% of all SSIs in Finland, 37% in Italy, and 16% in Germany. SSIs diagnosed post-discharge were predominant in caesarean sections (85%), knee prostheses (70%), hip prostheses (62%), laminectomies (57%) and cholecystectomies (53%), while they only represented less than half of SSIs in colon surgeries (22%) and coronary artery bypass grafts (46%).

Thirteen networks in 13 EU/EEA countries provided data about microorganisms isolated from SSIs. Overall, 41% of SSIs were reported with at least one microorganism, varying from 10% of caesarean sections to 62% of laminectomies. The most frequently isolated microorganisms ( $n=4\ 553$ ) in SSI episodes were Gram-positive cocci (50%), Enterobacteriaceae (32%), Gram-negative non-fermentative bacilli (7%), anaerobes (4%), and other bacteria or fungi (7%) (Table 2).

**Table 3. Percentages of microorganisms identified in surgical site infections, by operation type, pooled data from 13 EU/EEA countries, 2012 (n=4 553)**

	CABG	CHOL	COLO	CSEC	HPRO	KPRO	LAM	Total
Number of identified microorganisms	569	274	1 856	281	1 139	409	25	4 553
Gram-positive cocci (%)	60.3	38.0	31.3	55.9	66.0	73.8	68.0	49.5
<i>Staphylococcus aureus</i>	26.7	8.4	4.6	26.7	33.5	38.1	52.0	19.5
Coagulase-negative staphylococci	24.6	6.2	2.6	12.8	19.3	20.5	12.0	12.1
<i>Enterococcus</i> spp.	8.3	20.4	21.1	9.3	9.0	8.8	0	14.5
<i>Streptococcus</i> spp.	0.5	2.9	2.9	6.8	3.5	6.1	4.0	3.3
Other Gram-positive cocci	0.2	0	0.1	0.4	0.6	0.2	0	0.3
Gram-negative cocci (%)	0.0	0	0.2	0	0	0	0	<0.1
Gram-positive bacilli (%)	1.2	0.4	0.5	2.8	2.4	2.7	0	1.4
Gram-negative bacilli Enterobacteriaceae (%)	23.0	45.3	46.6	30.6	17.4	15.2	16.0	32.3
<i>Escherichia coli</i>	5.1	25.9	28.0	16.7	5.7	3.9	4.0	16.5
<i>Citrobacter</i> spp.	1.1	1.1	1.8	1.1	0.4	1.0	0	1.2
<i>Enterobacter</i> spp.	5.4	6.6	3.9	3.2	3.6	2.4	4.0	4.0
<i>Klebsiella</i> spp.	3.9	8.8	4.7	4.3	1.7	1.7	0	3.8
<i>Proteus</i> spp.	3.2	1.5	2.3	4.3	3.6	2.0	8.0	2.8
<i>Serratia</i> spp.	1.8	0.4	0.6	0.4	0.6	1.2	0	0.8
Other Enterobacteriaceae	2.6	1.1	5.3	0.7	1.8	2.9	0	3.3
Gram-negative non-fermentative bacilli (%)	7.4	4.0	8.4	3.6	7.0	4.2	12.0	7.0
<i>Acinetobacter</i> spp.	0.0	1.5	0.4	0.7	1.0	0.5	4.0	0.6
<i>Haemophilus</i> spp.	0.0	0	<0.1	0	0	0	0	<0.1
<i>Pseudomonas aeruginosa</i>	6.0	2.6	7.1	1.8	5.2	2.0	4.0	5.4
Pseudomonadaceae family, other	1.4	0	0.5	0.4	0.7	1.2	0	0.7
<i>Stenotrophomonas maltophilia</i>	0.0	0	<0.1	0	<0.1	0.5	4.0	0.1
Other Gram-negative non-fermentative bacilli	0.0	0	0.3	0.7	<0.1	0	0	0.2
Anaerobes (%)	0.5	4.4	6.1	3.9	1.1	1.5	0	3.5
<i>Bacteroides</i> spp.	0.0	1.8	4.3	2.5	0	0.2	0	2.0
Other anaerobes	0.5	2.6	1.8	1.4	1.1	1.2	0	1.4
Other bacteria (%)	6.0	5.5	3.9	3.2	5.4	2.4	4.0	4.5
Fungi, parasites (%)	1.6	2.6	3.0	0	0.8	0.2	0	1.8
<i>Candida</i> spp.	1.2	1.8	2.6	0	0.8	0	0	1.5
Other fungi / parasites	0.4	0.7	0.4	0	0	0.2	0	0.3

Source: ECDC, HAI-Net SSI patient-based and unit-based data 2012.

### Surveillance of infections acquired in intensive care units

There are two protocols for the surveillance of infections acquired in intensive care units (ICUs): a patient-based ('standard') protocol and a unit-based ('light') protocol. In patient-based surveillance, data include risk factors for risk-adjusted inter-hospital comparisons and are collected for each patient, whether the patient is infected or not. In unit-based surveillance, denominator data, i.e. patient-days, are collected for the entire ICU and not individually for each patient.

In 2012, 15 countries (Austria, Belgium, Czech Republic, Estonia, France, Germany, two networks in Italy, Lithuania, Luxembourg, Malta, Portugal, Romania, Slovakia, Spain and the United Kingdom-Scotland) reported data from 1 047 hospitals and 1 249 ICUs on 12 047 episodes of ICU-acquired pneumonia and 5 849 episodes of ICU-acquired bloodstream infections. Four countries (the Czech Republic, Germany, Malta and Romania) only provided unit-based data and one country (Belgium) provided patient-based and unit-based data. The remaining ten countries only provided patient-based data. As in previous years, Germany did not provide denominator data for patients staying in an ICU for more than two days. Therefore, data from Germany were only included in the descriptive analysis of ICU-acquired infections and excluded from the calculation of infection rates.

### ICU-acquired pneumonia

Of 110 945 patients staying in an ICU for more than two days (patient-based data), 5.3% acquired pneumonia, which in 92% of the cases was associated with intubation. The mean incidence density per ICU was 6.4 pneumonia episodes per 1 000 patient-days (ICU IQR: 2.1–9.1), varying from 2.2 in ICUs with less than 30% intubated patients to 5.7 in ICUs with 30–59% intubated patients, and 7.8 in ICUs with ≥60% intubated patients. In patient-based surveillance, the mean device-adjusted rate was 10.1 intubation-associated pneumonia episodes per 1 000 intubation-days and varied between 3.4 (United Kingdom), and 18.0 per 1 000 intubation-days (Lithuania) (Table 3).

**Table 4. Intubation-associated pneumonia rates by country, patient-based surveillance, EU/EEA, 2012**

Country	Number of ICUs	Number of patients	Average length of ICU stay (days)	Intubation use (days per 100 patient days)	Intubation-associated pneumonia rate (episodes per 1 000 intubation-days)			
					Pooled country mean	25th percentile	Median	75th percentile
Austria	28	5 687	9.8	54.6	10.6	4.5	8.0	16.8
Belgium	10	1 939	7.5	30.6	15.1	4.1	9.9	19.9
Estonia	6	1 231	10.3	68.1	10.6	6.8	12.1	16.8
France	196	29 553	11.6	60.7	13.7	8.4	12.8	18.3
Italy	140	23 480	9.7	60.6	8.2	3.0	6.6	10.3
Lithuania	26	2 438	8.8	46.9	18.0	0.0	3.7	32.0
Luxembourg	9	2 983	9.3	39.5	3.9	2.7	3.2	3.9
Portugal	27	4 154	11.7	69.2	10.2	4.2	7.3	13.2
Slovakia	8	348	9.5	71.7	12.3	1.6	6.4	18.8
Spain	177	32 399	8.2	46.4	7.4	3.5	6.5	10.9
United Kingdom (a)	1	5 853	8.1	64.9	3.4	3.4	3.4	3.4
All countries	628	110 065	9.7	56.3	10.1	3.9	8.4	14.3

Source: ECDC, HAI-Net ICU, patient-based data 2012. ICUs that reported data on less than 20 patients were excluded.

(a) Only data from UK-Scotland; all ICUs combined (ICU identifiers were not provided)

Pooled country mean: global incidence (all patients combined)

Percentiles: distribution of incidence per ICU

Overall, the most frequently isolated microorganisms in ICU-acquired pneumonia episodes were *Pseudomonas aeruginosa*, *Staphylococcus aureus* (with an average percentage of meticillin-resistant isolates (MRSA) of 43.0%), *Klebsiella* spp., *Escherichia coli* and *Candida* spp. (Table 4). The highest relative frequencies of *Acinetobacter* spp. were observed in Italy, Lithuania, Portugal and Romania. *Klebsiella* spp. isolates were most frequently reported from Estonia, Italy, Lithuania, Luxembourg, Romania and Slovakia.

**Table 5. Percentages of the ten most frequently isolated microorganisms in ICU-acquired pneumonia episodes by country, EU/EEA, 2012**

	Austria	Belgium	Estonia	France	Germany	Italy	Lithuania	Luxembourg	Portugal	Romania	Slovakia	Spain	United Kingdom	Total
Number of isolates	449	403	96	3760	5406	1435	251	62	347	393	33	928	109	13672
<i>Pseudomonas aeruginosa</i> (%)	23.2	17.6	17.7	21.0	11.5	16.8	13.1	16.1	19.9	18.3	18.2	24.6	5.5	16.6
<i>Staphylococcus aureus</i> (%)	7.6	8.7	7.3	15.1	15.1	14.6	9.2	6.5	19.9	19.3	6.1	13.8	18.3	14.6
<i>Klebsiella</i> spp. (%)	9.1	7.9	15.6	7.3	10.9	16.9	18.7	19.4	11.0	18.8	18.2	10.1	11.0	10.8
<i>Escherichia coli</i> (%)	8.0	9.9	8.3	9.7	12.3	7.5	6.8	3.2	6.9	4.6	15.2	7.3	16.5	10.0
<i>Candida</i> spp. (%)	16.0	1.0	5.2	5.5	13.5	4.9	5.2	11.3	0.0	0.0	12.1	1.8	5.5	8.3
<i>Enterobacter</i> spp. (%)	8.0	11.2	8.3	7.8	6.3	5.9	3.6	4.8	8.4	1.5	3.0	7.4	7.3	6.8
<i>Acinetobacter</i> spp. (%)	0.7	2.0	6.3	2.2	1.6	13.2	18.7	1.6	14.1	26.2	9.1	7.9	2.8	4.8
<i>Enterococcus</i> spp. (%)	4.2	2.0	1.0	1.9	5.7	2.6	2.0	4.8	0.9	2.8	3.0	3.0	0.0	3.6
<i>Stenotrophomonas maltophilia</i> (%)	4.2	7.4	4.2	3.8	3.6	2.4	0.8	9.7	2.3	0.5	0.0	4.6	5.5	3.6
<i>Serratia</i> spp. (%)	2.2	4.2	0.0	3.2	3.9	3.0	3.2	0.0	3.5	1.3	0.0	4.5	7.3	3.5

Source: ECDC, HAI-Net ICU, 2012. United Kingdom: data from UK-Scotland only

### ICU-acquired bloodstream infections

On average, ICU-acquired bloodstream infections occurred in 3.0% of patients staying in an ICU for more than two days. The mean incidence density per ICU was 3.3 bloodstream infection episodes per 1 000 patient-days (ICU IQR: 1.2–4.7). Bloodstream infections were catheter-related in 43.3% of cases, secondary to another infection in 36.2% of cases, and of unknown origin in 20.5% of cases. When the bloodstream infection was secondary to another infection, the primary infection site was pulmonary in 47.4%, gastrointestinal (19.2%), the urinary tract (12.9%), a surgical site (5.8%), skin and soft tissues (4.8%), and other/unknown in the remaining 10.0%. In patient-based surveillance, the central vascular catheter (CVC) utilisation rate was on average 74.4 CVC-days per 1 000 patient-days. It was the lowest (61.6) in Belgium and the highest (87.5) in Austria. The mean device-adjusted rate in patients staying in an ICU for more than two days was 3.0 CVC-associated bloodstream infection episodes per 1 000 CVC-days (ICU IQR: 0.5–4.1), varying from 1.7 in Luxembourg to 4.2 in Slovakia. The most frequently isolated microorganisms in bloodstream infection episodes were coagulase-negative staphylococci, followed by *Enterococcus* spp., *S. aureus*, *Klebsiella* spp. and *P.aeruginosa* (Table 5). The percentage of *Acinetobacter* spp. isolates was the highest in Estonia, Italy, Romania and Slovakia.

**Table 6. Percentages of the ten most frequently isolated microorganisms in ICU-acquired bloodstream infections by country, EU/EEA, 2012**

	Austria	Belgium	Czech Republic	Estonia	France	Germany	Italy	Lithuania	Luxembourg	Malta	Portugal	Romania	Slovakia	Spain	United Kingdom	Total
Number of isolates	262	78	9	47	1175	2008	992	51	46	14	213	84	15	1238	81	6313
Coagulase-negative <i>staphylococci</i> (%)*	43.1	14.1	22.2	21.3	16.8	27.1	13.6	39.2	21.7	0.0	15.0	14.3	6.7	24.9	17.3	22.3
<i>Enterococcus</i> spp. (%)	8.8	12.8	0.0	10.6	10.1	16.3	9.8	9.8	15.2	0.0	11.3	7.1	13.3	12.4	14.8	12.5
<i>Staphylococcus aureus</i> (%)	4.2	5.1	33.3	6.4	9.4	15.0	8.7	11.8	6.5	21.4	11.7	15.5	0.0	4.8	12.3	10.1
<i>Klebsiella</i> spp. (%)	6.5	6.4	11.1	10.6	6.8	5.7	15.6	11.8	10.9	21.4	12.7	16.7	40.0	9.2	8.6	8.9
<i>Pseudomonas</i> spp. (%)	6.9	15.4	0.0	6.4	9.7	3.2	11.2	5.9	8.7	28.6	9.4	10.7	6.7	12.2	6.2	8.2
<i>Candida</i> spp. (%)	9.2	19.2	11.1	12.8	8.9	8.5	6.7	0.0	13.0	0.0	7.5	0.0	0.0	8.2	8.6	8.2
<i>Escherichia coli</i> (%)	4.2	3.8	22.2	4.3	11.9	6.9	7.4	2.0	10.9	0.0	7.0	6.0	6.7	6.5	4.9	7.6
<i>Enterobacter</i> spp. (%)	2.7	5.1	0.0	6.4	8.2	3.9	5.5	7.8	8.7	0.0	9.4	1.2	6.7	5.3	7.4	5.4
<i>Acinetobacter</i> spp. (%)	1.1	0.0	0.0	12.8	0.9	1.2	9.2	3.9	0.0	0.0	3.8	20.2	13.3	4.7	1.2	3.5
<i>Serratia</i> spp. (%)	2.3	3.8	0.0	4.3	1.7	2.1	3.8	2.0	0.0	0.0	4.7	3.6	0.0	3.5	4.9	2.7

Source: ECDC, HAI-Net ICU 2012. United Kingdom: data from UK-Scotland only; coagulase-negative staphylococci: includes unspecified *Staphylococcus* spp.

### ICU-acquired urinary tract infections

ICU-acquired urinary tract infections (UTIs) were reported in 3.1% of patients staying in an ICU for more than two days, with 96.7% of UTI episodes being associated with the use of a urinary catheter. The mean device-adjusted UTI rate per ICU was 3.9 catheter-associated UTI episodes per 1 000 urinary catheter-days (median: 2.9, ICU IQR: 1.0–5.4). On average, urinary catheters were used in 83.9% of the patient-days. The most frequently isolated microorganisms in UTI episodes were *E. coli*, *Candida* spp. and *Enterococcus* spp. (Table 6).

**Table 7. Percentages of the ten most frequently isolated microorganisms in ICU-acquired urinary tract infections by country, EU/EEA, 2012**

	Austria	Belgium	Estonia	France	Italy	Lithuania	Luxembourg	Portugal	Romania	Slovakia	Spain	Total
Number of isolates	400	41	17	1315	23	84	108	74	108	20	984	3174
<i>Escherichia coli</i> (%)	12.8	26.8	29.4	32.8	34.8	26.2	24.1	20.3	10.2	30.0	25.0	26.2
<i>Candida</i> spp. (%)	32.8	0.0	11.8	12.8	8.7	16.7	5.6	12.2	0.0	10.0	20.4	16.9
<i>Enterococcus</i> spp. (%)	20.5	19.5	11.8	13.8	21.7	15.5	24.1	20.3	10.2	20.0	15.9	15.9
<i>Pseudomonas aeruginosa</i> (%)	10.0	12.2	11.8	14.0	4.3	6.0	15.7	16.2	33.3	15.0	14.4	14.1
<i>Klebsiella</i> spp. (%)	6.5	17.1	17.6	6.3	4.3	9.5	13.0	10.8	25.9	20.0	6.8	7.8
<i>Enterobacter</i> spp. (%)	1.8	4.9	11.8	5.6	0.0	6.0	5.6	9.5	0.0	0.0	3.0	4.2
<i>Proteus</i> spp. (%)	3.0	7.3	0.0	3.8	4.3	3.6	2.8	4.1	0.0	5.0	4.4	3.7
Coagulase-negative <i>staphylococci</i> (%)	7.3	0.0	0.0	2.1	0.0	1.2	0.9	1.4	0.0	0.0	2.0	2.5
<i>Morganella</i> spp. (%)	0.0	4.9	0.0	1.8	8.7	0.0	1.9	2.7	0.0	0.0	1.8	1.6
<i>Acinetobacter</i> spp. (%)	1.0	0.0	5.9	0.2	4.3	9.5	0.0	1.4	13.0	0.0	1.6	1.5

Source: ECDC, HAI-Net ICU 2012

The reported percentages of resistant isolates in selected bacteria associated with ICU-acquired infections were: oxacillin resistance (MRSA) in 46.1% of *S. aureus* isolates (n=1 556); vancomycin resistance in 9.5% of *Enterococcus* spp. isolates (n=1 033); ceftazidime resistance in 26.6% of *P. aeruginosa* isolates (n=1 861); and resistance to third-generation cephalosporins in 26.3% of *E. coli* isolates (n=1 665), 46.5% of *Klebsiella* spp. isolates (n=1 411) and 52.0% of *Enterobacter* spp. isolates (n=900). Carbapenem resistance was reported in 6.1% of *Klebsiella* spp. isolates (n=816), 1.1% of *E. coli* isolates (n=1 261), 5.1% of *Enterobacter* spp. isolates (n=687), 31.0% of *P. aeruginosa* isolates (n=2 122) and 68.8% of *Acinetobacter baumannii* (n=324) isolates.

## Discussion

Nineteen countries submitted data for at least one of the two targeted surveillance components. The number of included surgical operations and ICU patients increased compared with last year's report (2011 data) [6, 7]. In 2012, the extension of the surveillance network continued with one additional country (Estonia) reporting surveillance data on SSIs.

HAI surveillance at the national level is an essential component of HAI prevention and control. Participating hospitals benefit from a standardised tool which enables them to compare their own performance to that of other hospitals. In addition, participation in the European surveillance network encourages compliance with existing guidelines and helps to correct or improve specific practices as well as evaluate new preventive practices. Participation in the European network could also produce additional benefits at the local level as international comparisons may stimulate interpretations which are not possible at the regional or national level. Nevertheless, inter-country differences in surveillance methods persist and further emphasis should be put on harmonisation of surveillance methods in Europe. For a detailed discussion of possible biases when making inter-country comparisons of SSI rates, please refer to previously published reports [4, 5].

In ICUs, device-adjusted infection rates of ICU-acquired pneumonia, ICU-acquired bloodstream infections and ICU-acquired UTIs remained stable in 2012 compared with 2011 [7]. The importance of antimicrobial resistance in Gram-negative bacteria in European ICUs was confirmed in this report (2012 data).

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