SURVEILLANCE REPORT

Healthcare-associated infections acquired in intensive care units

Annual Epidemiological Report for 2019

Key facts

- In 2019, 8 874 (7.4%) of patients staying in an intensive care unit (ICU) for more than two days presented with at least one ICU-acquired healthcare-associated infection (HAI) under surveillance (pneumonia, bloodstream infection, or urinary tract infection).
- Of all patients staying in an ICU for more than two days, 4% presented with pneumonia, 3% with bloodstream infection (BSI), and 2% with urinary tract infection (UTI).
- Some 96% of pneumonia episodes were associated with intubation, 44% of BSI episodes were catheter-related, and 94% of UTI episodes were associated with the presence of a urinary catheter.
- The most frequently isolated microorganism was *Klebsiella* spp. in ICU-acquired pneumonia episodes, coagulase-negative staphylococci in ICU-acquired bloodstream infections, and *Escherichia coli* in ICU-acquired urinary tract infections.
- Antimicrobial use was empirical in 59% of days of therapy (DOTs), directed in 23% of DOTs, and prophylactic in 14% of DOTs.
- Some 11% of *Staphylococcus aureus* isolates were oxacillin-resistant (MRSA), and 14% of *Enterococcus* spp. isolates were glycopeptide-resistant. Resistance to third-generation cephalosporins was reported in 15% of *E. coli* isolates, 38% of *Klebsiella* spp. isolates, and 37% of *Enterobacter* spp. isolates. Carbapenem resistance was reported in 17% of *Klebsiella* spp. isolates, 26% of *P. aeruginosa* isolates, and 82% of *Acinetobacter baumannii* isolates.

Introduction

ICUs are the hospital wards with the highest prevalence of HAIs. The majority of HAIs in ICUs are associated with the use of invasive devices (e.g. endotracheal tubes, vascular and urinary catheters), and a significant proportion of these HAIs is considered preventable. Moreover, the burden of antimicrobial resistance is high in ICUs, due to the severity of the clinical condition of the patients, the frequent use of antibiotics, and varying infection prevention and control practices.

Methods

This report is based on data for 2019 retrieved from The European Surveillance System (TESSy) on 24 April 2023. TESSy is a system for the collection, analysis, and dissemination of data on communicable diseases. European Union (EU) Member States and European Economic Area (EEA) countries contribute to the system by uploading their infectious disease surveillance data at regular intervals.

Suggested citation: European Centre for Disease Prevention and Control. Annual Epidemiological Report for 2019 – Healthcare-associated infections acquired in intensive care units. In: ECDC. Annual epidemiological report for 2018. Stockholm: ECDC; 2023.

Stockholm, May 2023

For a detailed description of methods used to produce the Annual Epidemiological Report, please refer to the *Methods* chapter [1].

A patient-based ('standard') protocol and a unit-based ('light') protocol are used for European surveillance of HAIs acquired in ICUs. The patient-based protocol is used to collect data for all patients, regardless of infection, including information on risk factors allowing risk-adjusted inter-hospital comparisons. With the unit-based protocol, denominator data, i.e. patient-days, are collected at ICU level, while patient data are recorded only for patients with HAIs.

Inclusion criteria, risk factors, and case definitions of ICU-acquired HAIs are described in detail in the protocol [2]. Infections occurring after 48 hours in the ICU are considered as ICU-acquired in both protocols. With admission day being counted as day one, infections with onset from day three onwards should therefore be reported. One record per HAI is collected together with antimicrobial resistance markers for isolated microorganisms.

The minimal requirement for surveillance of ICU-acquired HAIs is to include BSI and pneumonia. Collection of data on urinary tract infections (UTIs) and central venous catheter (CVC)-related infections is optional.

A case of pneumonia is defined in accordance with clinical criteria (X-ray, fever >38°C, leucocytosis >12 000 white blood cells (WBC)/mm^3, purulent sputum) and further sub-categorised in five categories according to the level of microbiological confirmation: PN1, minimally contaminated lower respiratory tract sample with quantitative culture (10^4 colony-forming units (CFU)/ml for bronchoalveolar lavage, 10^3 CFU/ml for protected brush samples or distal protected aspirate); PN2, non-protected sample (endotracheal aspirate, ETA) with quantitative culture (10^6 CFU/ml); PN3, alternative microbiological criteria (e.g. positive blood culture); PN4, sputum bacteriology or non-quantitative ETA; and PN5, no microbiological documentation, clinical signs and symptoms only.

A BSI Is defined as a positive blood culture of a recognised pathogen or the combination of clinical symptoms (fever >38°C, chills, hypotension) and two positive blood cultures of a common skin contaminant from two separate blood samples drawn within 48 hours.

A UTI is defined as either (a) a microbiologically confirmed symptomatic UTI (UTI-A) whereby the presence of at least one sign or symptom coincides with a positive urine culture (defined as $\geq 10^5$ microorganisms per ml of urine, with no more than two species of microorganisms); or (b) a non-microbiologically-confirmed symptomatic UTI (UTI-B), whereby the presence of at least two signs or symptoms coincide with other criteria, e.g. a positive dipstick for leukocyte esterase and/or nitrate (see protocol for details of case definitions).

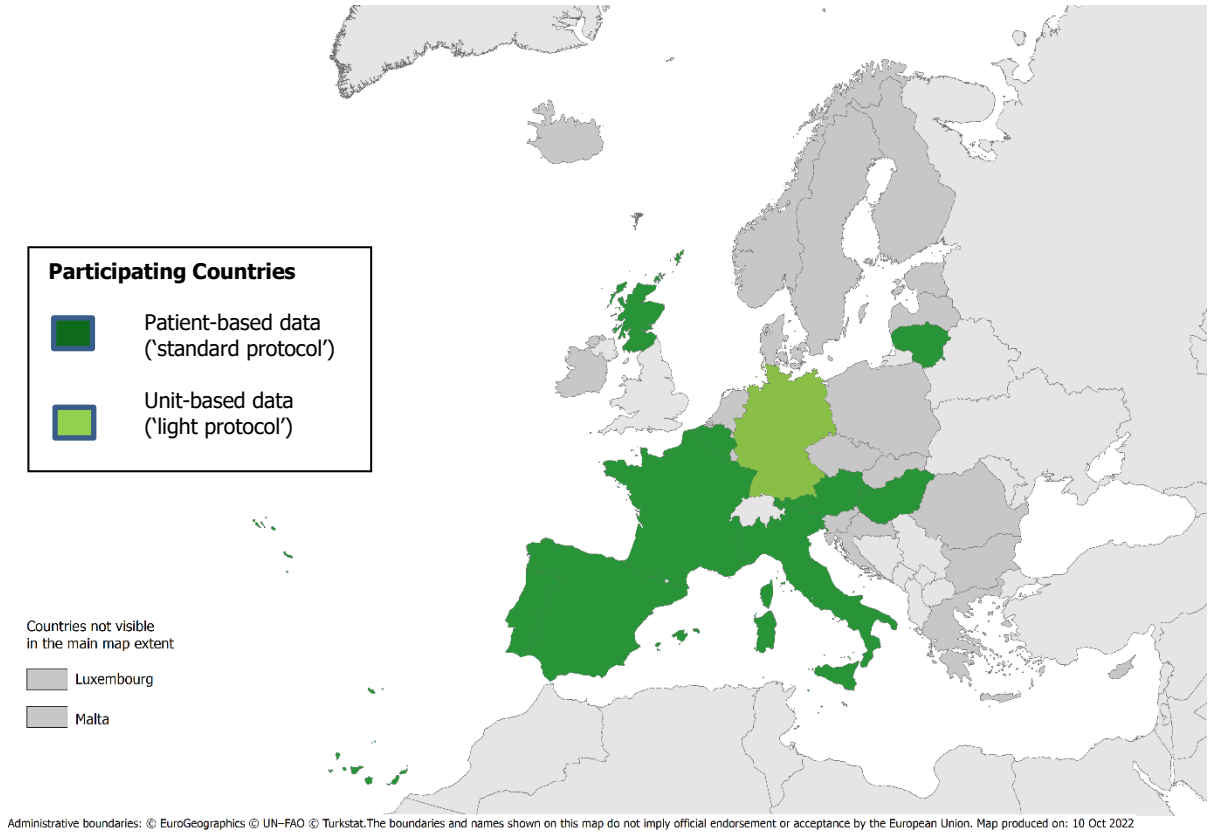
An HAI was defined as device-associated when the relevant device was used (even intermittently) in the 48 hours (two days) before onset of infection. For countries performing surveillance of catheter-related infections (CRIs), a microbiologically confirmed central vascular catheter (CVC)-related BSI was defined as a BSI occurring 48 hours before or after catheter removal, and a positive culture with the same microorganism of either (a) quantitative CVC culture $\geq 10^3$ CFU/ml or semi-quantitative CVC culture >15 CFU, or (b) quantitative blood culture ratio CVC blood sample/peripheral blood sample >5; or (c) differential delay of positivity of blood cultures; or (d) positive culture with the same microorganism from pus from insertion site. A central line-associated BSI (CLABSI) was defined as a primary BSI with use of a CVC in the 48 hours (two days) before the onset of the infection. For the calculation of device-associated BSI rates, CLABSIs were used rather than catheter-related BSIs only, as not all participating countries performed surveillance of catheter-related infection.

The number of HAIs, the percentage of HAIs associated with the presence of a relevant device, the incidence density of HAIs per 1 000 patient-days and the incidence density of HAIs adjusted per 1 000 days of device use were estimated. For the estimation of device-adjusted incidence from patient-based data, ICUs with fewer than 20 patients in the surveillance dataset and exposures to devices occurring before admission or after discharge to the ICU were excluded. Furthermore, we excluded submitted data on patients staying in the ICU for less than two days. The ten most frequently isolated microorganisms for each type of HAI and antimicrobial resistance percentages for *Staphylococcus aureus, Enterococcus* spp., *Escherichia coli, Klebsiella* spp., *Enterobacter* spp, *Pseudomonas aeruginosa* and *Acinetobacter baumannii* are presented. Trends in median device adjusted incidence rates of intubation-associated pneumonia (IAP) and CLABSI between 2008 and 2019 were analysed by linear regression. Countries that provided data without interruption during this entire period were included in the analysis.

Countries optionally submit data on antimicrobial use for each patient in the standard surveillance option. Antimicrobial indication per 100 treatment days and treatment days for each antimicrobial group per 100 patient-days are estimated. Countries also submit structure and process indicators of prevention of HAIs and antimicrobial stewardship, measured at the unit level in both standard and light surveillance options. These indicators include: a) alcohol hand rub consumption in previous year, b) staffing levels (in a period of seven days) of registered nurses and nurse aides in the ICU, c) audit results in approximately 30 patients for: i. post-prescription review within 72 hours after prescription; ii. Prevention of pneumonia in intubated patients: control of cuff pressure, oral decontamination, patient position; and iii. CVC maintenance care: catheter site dressing is not damp, loose, or visibly soiled.

In 2019, 11 networks in 10 countries reported data from 1 285 hospitals and 1 659 ICUs (Figure 1): Austria, Belgium, France, Germany, Hungary, Italy-GiViTI, Italy-SPIN-UTI, Lithuania, Portugal, Spain, and the United Kingdom (UK – Scotland). The median size of the participating ICUs was 12 beds, ranging from two to 54 beds. One country (Germany) only provided unit-based data, and one country (Belgium) provided both patient-based and unit-based data. The remaining eight countries/networks provided patient-based data. Seven countries/networks reported data on antimicrobial use: Austria, Belgium, Hungary, Italy-SPIN-UTI, Lithuania, Portugal, and Spain. Two countries/networks, Italy-SPIN-UTI and Lithuania, provided data on outcome of HAIs and the relationship of the HAI to death in case of death. Two countries/networks, Austria and Italy-SPIN-UTI, reported data on structure and process indicators of infection prevention and control and antimicrobial stewardship.

Figure 1. Participation in surveillance of healthcare-associated infections in intensive care units, EU/EEA, 2019



Source: ECDC, HAI-Net, 2022.

Epidemiology

Of 120 446 patients staying in an ICU for more than two days (patient-based data), 8 874 (7.4%) patients presented with at least one HAI.

ICU-acquired pneumonia

Of 4 706 cases of pneumonia reported, 95.8% were associated with intubation. Among patients staying in an ICU for more than two days, 3.9% were affected by at least one episode of pneumonia. The incidence of pneumonia was 4.4 episodes per 1 000 patient-days.

The mean incidence density per ICU was 4.4 pneumonia episodes per 1 000 patient-days (ICU IQR:0.0-6.3), varying from 1.3 in ICUs with less than 30% intubated patients to 4.6 in ICUs with 30-59% intubated patients, and 5.6 in ICUs with more than 60% intubated patients.

In patient-based surveillance, the mean device-adjusted rate was 7.8 intubation-associated pneumonia episodes per 1 000 intubation days and varied between 2.5 in UK-Scotland, and 14.4 in Belgium (Table 1).

Table 1. ICU-acquired intubation-associated pneumonia rates by country/network, EU/EEA, 2019

Country	Intubation use (Mean intubation-days per 100 patient days)	Intubation-associated pneumonia rate (episodes per 1 000 intubation days)			
		Country mean	25th percentile	Median	75th percentile
Austria	44.4	3.7	0.0	0.0	6.3
Belgium	34.7	14.4	11.4	15.8	18.1
France	46.6	12.8	5.4	12.5	19.2
Hungary	57.2	6.9	0.0	3.6	10.6
Italy-SPIN-UTI	56.9	6.0	2.1	4.7	7.3
Italy-GiViTI	59.9	10.8	3.6	11.7	16.1
Lithuania	37.3	8.3	0.0	0.0	16.8
Portugal	61.7	7.4	3.3	7.3	10.3
Spain	39.6	4.9	0.0	3.9	6.5
United Kingdom – Scotland	53.9	2.5	0.0	1.9	3.5

Source: ECDC, HAI-Net patient-based data 2019. Percentiles: distribution of incidence per ICU.

The most frequently isolated microorganisms in ICU-acquired pneumonia episodes were *Klebsiella* spp. Followed by *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli* (Table 2).

Table 2. Number of isolates and percentages of the 10 most frequently isolated microorganisms in ICU-acquired pneumonia episodes, by country/network, EU/EEA, 2019

Microorganism	Austria (n=654)	Belgium (n=34)	France (n=1099)	Germany (n= 5 395)	Hungary (n=51)	Italy-GiViTI (n=1 281)	Italy-SPIN-UTI (n=107)	Lithuania (n=144)	Portugal (n=354)	Spain (n=519)	United Kingdom – Scotland (n=105)	Total (n=9 743)
Klebsiella spp.	16.1	17.6	11.4	20	17.6	37.4	19.2	26.4	25.4	15.2	13.3	18.8
Staphylococcus aureus	9.0	14.7	20.8	19.2	11.8	14.0	20.1	31.9	15.0	15.8	31.4	18.7
Pseudomonas aeruginosa	13.5	11.8	20.0	13.1	43.1	17.8	19.4	14.6	27.4	26.8	3.8	16.1
Escherichia coli	10.1	23.5	11.6	16.0	7.8	6.5	10.9	9.7	5.6	7.1	8.6	13.3
Enterobacter spp.	6.4	2.9	13.3	9.0	3.9	6.5	8.7	11.1	9.0	12.7	11.4	9.4
Candida spp.	32.9	0.0	3.5	5.2	5.9	1.9	2.8	0.0	2.5	0.6	11.4	6.1
Serratia spp.	4.9	11.8	5.2	6.4	5.9	5.6	5.7	1.4	4.8	6.2	1.0	5.9
Haemophilus spp.	2.0	5.9	6.4	3.4	0.0	4.7	6.9	0.0	4.5	6.2	17.1	4.4
Proteus spp.	2.0	5.9	3.0	4.5	2.0	3.7	3.1	4.9	2.8	1.9	1.0	3.7
Stenotrophomonas maltophilia	3.2	5.9	4.9	3.4	2.0	1.9	3.1	0.0	2.8	7.5	1.0	3.6

n = number of isolates
Source: ECDC, HAI-Net patient-based and unit-based data, 2019. United Kingdom: data from UK–Scotland only.

ICU-acquired bloodstream infections (BSIs)

A total of 3 794 cases of ICU-acquired BSI were reported. On average, ICU-acquired BSIs occurred in 3.2% of patients staying in an ICU for more than two days. The mean incidence density per ICU was 3.5 BSI episodes per 1 000 patient-days (ICU IQR: 0.0-4.7). The respective mean incidence density of primary BSIs (including catheter-related BSIs and BSIs of unknown origin) per ICU was 2.1 episodes per 1 000 patient-days (ICU IQR: 0.0-2.7) (Table A4). BSIs were catheter-related in 43.9% of cases, secondary to another infection in 32.2% of cases, and of unknown origin in 17.2% of cases. When the BSI was secondary to another infection, the primary infection site was pulmonary (41.5% cases), gastrointestinal (11.0%), the urinary tract (22.6%), a surgical site (4.7%), skin and soft tissues (5.1%), and 'other' in 10.6% cases. In patient-based surveillance, the CVC utilisation rate was on average 74.1 CVC-

days per 100 patient-days. It was the lowest (49.0) in France and the highest (83.0) in Portugal. The mean device-adjusted rate in patients staying in an ICU for more than two days was 3.4 central line-associated BSI (CLABSI) episodes per 1 000 CVC-days (ICU IQR: 0.0-4.7), varying from 0.8 in Austria to 4.2 in Hungary (Table 3).

Table 3. ICU-acquired central line-associated bloodstream infection (CLABSI) rates by country, EU/EEA, 2019

Country	CVC use (Mean CVC-days per 100 patient-days)	CLABSI rate (episodes per 1 000 CVC days)			
		Country mean	25th percentile	Median	75th percentile
Austria	80.5	0.8	0.0	0.0	1.2
Belgium	68.2	1.1	0.8	1.6	1.7
France	49.0	2.3	0.0	0.0	3.9
Hungary	69.8	4.2	0.0	3.0	8.0
Italy-GiViTI	81.7	3.0	1.0	2.2	3.7
Italy-SPIN-UTI	77.0	3.8	0.0	0.0	4.9
Lithuania	45.0	1.2	0.0	0.0	0.0
Portugal	84.5	1.9	0.7	1.3	3.0
Spain	71.3	2.2	0.0	1.4	3.4
United Kingdom – Scotland	59.2	1.3	0.1	0.9	1.5

Source: ECDC, HAI-Net patient-based data 2019. Percentiles: distribution of incidence per ICU.

The incidence of microbiologically-confirmed CVC-related BSIs, among countries performing catheter-related infection surveillance is presented in Table A5. The incidence of BSIs that were classified as catheter-related either through microbiological confirmation or due to clinical improvement after removal of the catheter is displayed in Table A6.

The most frequently isolated microorganisms in BSI episodes (including microbiologically confirmed catheter-related BSIs) were coagulase-negative staphylococci followed by *Enterococcus* spp., *Klebsiella* spp and *Staphylococcus aureus* (Table 4).

Table 4. Number of isolates and percentages of the 10 most frequently isolated microorganisms in ICU-acquired bloodstream infection (BSI) episodes by country, EU/EEA, 2019

Microorganism	Austria (n=334)	Belgium (n=26)	France (n=423)	Germany (n=3 139)	Hungary (n=89)	Italy-GiViTI (N=1 410)	Italy-SPIN-UTI (n=59)	Lithuania (n=20)	Portugal (n=249)	Spain (n=867)	United Kingdom (n=2)	Total (n=5 146)
Coagulase-negative staphylococci	41.6	15.4	18.9	29.2	14.6	18.6	16.0	0.0	8.8	25.5	26.5	24.7
Enterococcus spp.	9.6	23.1	12.1	21.3	11.2	3.4	9.3	10.0	14.5	10.8	8.4	15.6
Klebsiella spp.	9.0	3.8	13.5	9.5	13.5	25.4	19.6	10.0	22.9	12.3	9.6	12.9
Staphylococcus aureus	7.5	11.5	13.0	13.1	7.9	6.8	9.8	50.0	8.4	7.0	20.5	11.1
Escherichia coli	6.9	23.1	11.6	8.9	7.9	3.4	7.7	20.0	8.4	8.2	12.0	8.6
Pseudomonas aeruginosa	5.1	11.5	8.0	4.7	15.7	3.4	12.3	5.0	8.0	12.5	3.6	7.8
Candida spp.	12.3	3.8	10.2	6.3	3.4	1.7	6.7	0.0	11.6	12.0	14.5	7.8
Enterobacter spp.	3.9	3.8	8.5	4.3	9.0	1.7	8.7	0.0	7.6	6.7	3.6	5.9
Serratia spp.	3.6	3.8	2.8	2.3	6.7	3.4	5.5	5.0	6.8	3.9	1.2	3.6
Acinetobacter spp.	0.6	0.0	1.4	0.5	10.1	32.2	4.3	0.0	2.8	1.0	0.0	1.9

n = number of isolates.
**Data from Germany only on primary bloodstream infections.*
Source: ECDC, HAI-Net patient-based and unit-based data 2019. United Kingdom: data from UK-Scotland only.
Coagulase-negative staphylococci: includes unspecified Staphylococcus spp.

ICU-acquired urinary tract infections (UTIs)

A total of 1 883 cases of ICU-acquired UTI were reported. On average, ICU-acquired UTIs occurred in 1.9% of patients staying in an ICU for more than two days, with 94.0% of UTI episodes being associated with the use of a urinary catheter. The mean incidence density per ICU was 2.2 urinary tract infection episodes per 1 000 patient-days (ICU IQR: 0.0-3.0).

On average, urinary catheters were used in 81% of the patient-days. The mean device-adjusted rate in patients staying in an ICU for more than two days was 2.8 catheter-associated UTI episodes per 1 000 catheter days (ICU IQR: 0.0-4.0).

The most frequently isolated microorganisms in UTI episodes were *Escherichia coli* followed by *Enterococcus* spp., *Pseudomonas aeruginosa,* and *Klebsiella* spp. (Table 5).

Table 5. Percentages of the 10 most frequently isolated microorganisms in ICU-acquired urinary tract infection (UTI) episodes, by country/network, EU/EEA, 2019

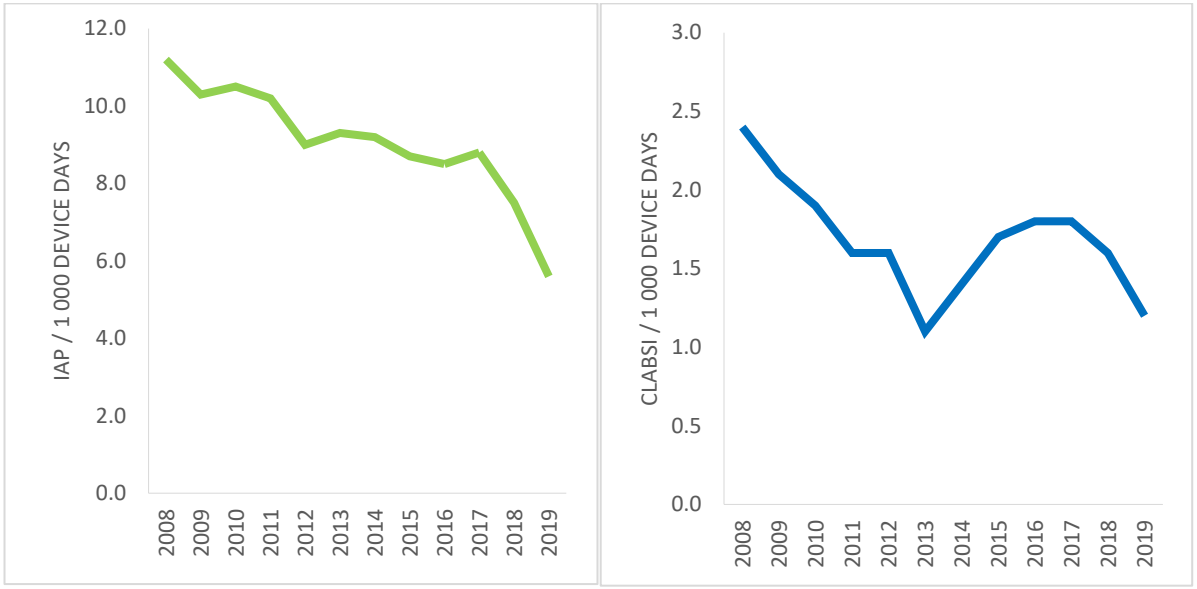
Microorganism	Austria (n=406)	Germany (n=3 622)	Hungary (n=15)	Italy-GiViTI (n=568)	Italy-SPIN-UTI (n=26)	Lithuania (n=53)	Portugal (n=131)	Spain (n=634)	Total (n=5 324)
Escherichia coli	18.7	33.6	26.7	25.5	11.5	34.0	39.7	30.6	31.1
Enterococcus spp.	21.7	20.6	13.3	21.0	26.9	24.5	10.7	18.6	20.5
Pseudomonas aeruginosa	11.8	15.1	26.7	12.9	11.5	15.1	9.9	14.8	14.6
Klebsiella spp.	9.1	13.9	20.0	14.6	30.8	13.2	16.8	11.2	13.4
Proteus spp.	3.2	8.0	0.0	6.7	3.8	5.7	6.9	5.7	7.1
Candida spp.	28.8	0.0	13.3	11.4	11.5	0.0	11.5	11.7	4.9
Enterobacter spp.	1.7	5.1	0.0	3.5	0.0	5.7	1.5	4.1	4.5
Citrobacter spp.	1.2	1.4	0.0	1.4	0.0	1.9	1.5	1.4	1.4
Serratia spp.	1.5	1.5	0.0	1.2	3.8	0.0	1.5	0.9	1.4
Coagulase-negative staphylococci	2.2	0.9	0.0	1.8	0.0	0.0	0.0	0.9	1.1

n = number of isolates.
Source: ECDC, HAI-Net ICU 2019.

Trends

Trend analysis of yearly median incidence in ICUs from six European countries/networks with uninterrupted participation since 2008 (Belgium, France, Italy (SPIN-UTI), Lithuania, Portugal, and Spain), demonstrated a decreasing trend for IAP ($p<0.001$) and CLABSI (p 0.04) (Figure 2).

Figure 2. Incidence trend of intubation-associated pneumonia (IAP, left) and central line-associated bloodstream infections (CLABSI, right), 2008-2019, six European countries/networks*



**Countries/networks with uninterrupted participation since 2008 (Belgium, France, Italy/SPIN-UTI, Lithuania, Portugal, and Spain)*

Antimicrobial use

In total, 554 067 days of therapy (DOTs) with antimicrobials were recorded in 2019. Antimicrobial treatment was empirical in 58.9% (range 53.2-70.1%) of DOTs, directed in 23.3% (range 21.3-33.7%), prophylactic in 13.6% (range 1.6-19.6%) and selective digestive decontamination 4.2% (range 0.0-5.9%). The reported use of selected antimicrobial agents or groups in DOTs per 100 patient-days were: carbapenems 14.1 (range 8.3-18.1), third- and fourth-generation cephalosporins 10.1 (range 3.6-13.3), piperacillin-tazobactam 10.4 (range 0.0-18.0), fluoroquinolones 7.3 (range 2.1-11.0), glycopeptides 4.9 (range 1.9-9.4) and polymyxins 1.1 (range 0.0-4.4) (Table 6).

Table 6. Antimicrobial use indication and selected groups of antimicrobials, by country, EU/EEA 2019

Country	Antimicrobial indication (% DOTs)				Antimicrobial group (DOTs/100 patient-days)					
	Empirical	Directed	Prophylactic	SDD	Carbapenems	Cephalosporins (3rd- and 4th-generation)	Piperacillin - tazobactam	Fluoroquinolones	Glycopeptides	Polymyxins
Austria	66.2	30.1	3.7	0.0	13.5	3.6	14.4	2.1	1.9	0.0
Belgium	65.8	32.6	1.6	0.0	12.8	7.3	11.3	3.7	8.1	0.0
Hungary	63.4	29.7	5.9	1.0	18.4	13.3	4.2	6.4	5.1	1.3
Italy-SPIN-UTI	53.2	26.7	19.6	0.4	11.2	13.3	18.0	11.0	5.6	4.4
Lithuania	59.5	33.7	6.4	0.5	8.3	7.8	4.2	3.3	4.7	1.2
Portugal	70.1	25.6	4.3	0.0	14.7	11.3	0.0	3.1	9.4	0.9
Spain	56.0	21.3	16.8	5.9	15.1	10.0	12.5	8.8	4.3	0.7

Source: ECDC, HAI-Net patient-based data 2019.
DOT: Day of therapy; SDD: selective digestive decontamination

Antimicrobial resistance

The reported percentages of antimicrobial-resistant isolates in selected bacteria associated with ICU-acquired HAIs were: oxacillin resistance (MRSA) in 11.0% of *S. aureus* isolates (n=2 275); vancomycin resistance in 13.5% of *Enterococcus* spp. isolates (n=2 523); ceftazidime resistance in 30.3% of *P. aeruginosa* isolates (n=651); and resistance to third-generation cephalosporins in 15.3% of *E. coli* isolates (n=1 612), 38.3% of *Klebsiella* spp. isolates (n=1 970) and 36.8% of *Enterobacter* spp. isolates (n=620).

Carbapenem resistance was reported in 16.9% of *Klebsiella* spp. isolates (n=1 812), 0.8% of *E. coli* isolates (n=1 509), 1.8% of *Enterobacter* spp. isolates (n=913), 25.5% of *P. aeruginosa* isolates (n=1 984) and 82.3% of *Acinetobacter baumannii* (n=203) isolates.

HAI outcome

Among 756 HAIs in two countries that provided data on the outcome and the relation of the outcome to the HAI, in 1 549 (72.6%) HAIs the patient was discharged alive, in 10 (1.3%) HAIs the patient died and the death was assessed as definitely linked to the HAI, in 100 (13.2%) HAIs the patient died and the death was assessed as not linked to the HAI, in 64 (8.4%) HAIs the patient died and the death was assessed as probably linked to the HAI, and in 33 (4.4%) HAIs the patient died and the relationship of the death to the HAI was unknown (Table 7).

Table 7. HAI outcome, EU/EEA, 2019

Country	HAIs (N)	Discharged alive (%)	Death, HAI definitely contributed to death (%)	Death, HAI possibly contributed to death (%)	Death, unrelated to HAI (%)	Death, relationship to HAI unknown (%)
Italy-SPIN-UTI	303	62.4	2.0	18.5	6.3	10.9
Lithuania	453	79.5	0.9	1.8	17.9	NA

Structure and process indicators of infection control and antimicrobial stewardship

Only two countries, Austria and Italy, reported structure and process indicators of infection control and antimicrobial stewardship (Tables 8 and 9).

Table 8. Structure and process indicators for infection prevention and control, EU/EEA, 2019

Country	ICUs (N)	ICU size (median)	Number of registered nurse hours per patient-day (median)	Number of nursing assistant hours per patient-day (median)	Alcohol hand rub consumption in the previous year (L/1 000 patient-days)
Austria	100	7	13.5	0	347.5
Italy-SPIN-UTI	22	8	11.9	2.9	85.5

NA: Not available

Table 9. Process indicators assessed through chart review or direct observation, EU/EEA, 2019

Country	ICUs (N)	Assessment of antimicrobial prescriptions after 48-72 hours (% total antimicrobial prescriptions)	Endotracheal cuff pressure check (% total observed intubation-days)	Oral decontamination (% total observed intubation-days)	Patient position not supine (% total observed intubation-days)	CVC dressing observation (% total observed catheter-days)
Austria	97	100.0	3.7	3.7	99.4	3.7
Italy-SPIN-UTI	14	63.4	59.1	92.2	85.2	70.8

Discussion

Ten countries submitted data on ICU-acquired HAIs in 2019.

HAI surveillance at the local and national levels is an essential component of HAI prevention and control. Participating ICUs benefit from a standardised tool that enables them to compare their own performance to that of other ICUs. 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 may also produce additional benefits at the local level, allowing comparisons with a wide range of ICUs both nationally and at the European level. Nevertheless, inter-country differences in surveillance methods persist, and there is an ongoing effort to further harmonise the methodology for surveillance of HAIs in ICUs in Europe.

There is substantial variability in HAI rates across the EU/EEA. Part of this variability can be attributed to variation in diagnostic practices. Characteristics of the participating ICUs and patient population, such as clinical severity and infection prevention and control practices may also affect the reported incidence of HAIs. Pneumonia is the most common HAI acquired in ICUs and is associated with intubation in the majority of cases. Among BSIs, more than one in three are catheter-related. Device-adjusted HAI rates of ICU-acquired pneumonia, BSIs and UTIs across the participating networks show a stable or decreasing trend compared to previous years [3,4], which may reflect increased efforts to prevent device-related infections. In particular, focusing on countries and networks with consistent participation since 2008, in 2019 there was a decreasing trend in IAP incidence density, as observed in previous years and, for the first time, a decreasing trend in CLABSI incidence density.

Antimicrobials continue to be prescribed for more DOTs empirically than as directed treatment in all participating countries that provided data on antimicrobial use. The distribution of prescribed antimicrobial agents differed among the participating countries and may reflect the prevalence of antimicrobial resistance in each country as well as local practices.

The distribution of microorganisms associated with HAIs in 2019 was similar to that of 2018, with the caveat that the overall results are not directly comparable due to the differences in reporting countries. In 2019, *K. pneumoniae* was the most common microorganism associated with pneumonia, followed by *S. aureus* and *P. aeruginosa*. For BSIs, coagulase-negative staphylococci remained the most commonly isolated microorganisms and are mostly associated with catheter-related BSIs. The relative contribution of gram-negative bacteria as a cause of HAIs in ICUs continues to vary geographically, with high proportions of HAIs caused by *Klebsiella* spp. in some countries. In 2019 and in the ten countries that reported data, *Acinetobacter* spp. was not among the ten most common bacteria isolated from either pneumonia or BSIs.

This report confirms the importance of antimicrobial resistance in gram-negative bacteria in ICUs in the EU/EEA in 2019, with resistance percentages being comparable to the report for previous years. The high percentages of resistance to carbapenems of *P. aeruginosa*, *A. baumannii* and *K. pneumoniae* isolates reflect the challenges of treating infections in ICU patients, a highly vulnerable patient population [5].

In 2019, only a minority of countries provided data on HAI outcomes and the relation of the HAI to death in patients who died. One in ten HAIs were assessed to have definitely or possibly contributed to death of the patient.

There was considerable variability in most of the structure and process indicators of infection prevention and control and of antimicrobial stewardship among the small number of countries reporting data in 2019. In these countries, these data can be used to identify targets for improvement of practices.

Public health implications

ICUs are the hospital wards with the highest prevalence of HAIs [6]. The majority of HAIs in ICUs are associated with the use of invasive devices (e.g. endotracheal tubes, vascular catheters, and urinary catheters), and a significant proportion of these HAIs is considered preventable. Moreover, the burden of antimicrobial resistance is high in ICUs, due to the severity of the clinical condition of the patients, the frequent use of antimicrobials, and varying infection prevention and control practices. Surveillance data can be used to identify targets for intervention both in terms of prevention of HAIs and for antimicrobial prescribing practices. Further understanding of the variation in incidence and of the burden of HAIs in ICUs is facilitated through the use of quality indicators of infection prevention and control and of antimicrobial stewardship, and information on HAI outcomes. These are included in the ECDC protocol for surveillance of HAIs in ICUs and are expected to increase the usefulness of surveillance data.

References

1. European Centre for Disease Prevention and Control (ECDC). Introduction to the Annual epidemiological report for 2015. In: ECDC. Annual epidemiological report for 2015. Stockholm: ECDC; 2017. Available at: https://ecdc.europa.eu/en/annual-epidemiological-reports-2016/methods
2. European Centre for Disease Prevention and Control (ECDC). European surveillance of healthcare-associated infections and prevention indicators in intensive care units – HAI-Net ICU protocol, version 2.2. Stockholm: ECDC; 2012017. Available at: https://www.ecdc.europa.eu/sites/default/files/documents/HAI-Net-ICU-protocol-v2.2_0.pdf
3. European Centre for Disease Prevention and Control (ECDC). Annual Epidemiological Report for 2018 – Healthcare-associated infections acquired in intensive care units. [Internet]. Stockholm: ECDC; 2022. Available at: https://www.ecdc.europa.eu/en/publications-data/healthcare-associated-infections-intensive-care-units-annual-report-2018
4. European Centre for Disease Prevention and Control (ECDC). Surveillance of healthcare-associated infections in intensive care units in Europe 2008–2012, including attributable mortality analyses. Stockholm: ECDC; 2018. Available at: https://www.ecdc.europa.eu/sites/default/files/documents/surveillance-report-HAI-Net-ICU-mortality-2008-2012.pdf
5. Lepape A, Jean A, De Waele J, Friggeri A, Savey A, Vanhems P, et al. European intensive care physicians' experience of infections due to antibiotic-resistant bacteria. Antimicrob Resist Infect Control. 2020 Jan 2;9(1):1. doi: 10.1186/s13756-019-0662-8.
6. European Centre for Disease Prevention and Control (ECDC). Point prevalence survey of healthcare-associated infections and antimicrobial use in European acute care hospitals. Stockholm: ECDC; 2013. Available at: http://ecdc.europa.eu/en/publications/Publications/healthcare-associated-infections-antimicrobial-use-PPS.pdf

Annex

Table A1. Healthcare-associated infections acquired in intensive care units (ICUs): surveillance systems overview, 2019

Country	Network acronym	Network name	Network website	Coordination
Austria	A-HAI	Austrian healthcare-associated infections	https://www.sozialministerium.at/Themen/Gesundheit/Antimikrobielle-Resistenzen-und-Gesundheitssystem-assoziierte-Infektionen/Gesundheitssystem-assoziierte-Infektionen/Bundesweite-Erfassung-der-Gesundheitssystem-assoziierten-Infektionen-(A-HAI).html	Federal Ministry of Social Affairs, Health, Care and Consumer Protection
Belgium	NSIH (NSIH-ICU)	National surveillance of healthcare-associated infections	www.nsih.be	Scientific Institute of Public Health, Brussels
France	SPIADI On behalf REPIAS	HAI-surveillance network in adult ICUs	https://www.spiadi.fr	Regional center for Infection control & Prevention (CPias CVDL) on behalf of the National Public Health Agency (REPIAS/ Santé publique France)
Germany	KISS (ITS-KISS)	German Nosocomial Infection Surveillance System (KISS)	http://www.nrz-hygiene.de/en/nrz/welcome	National Reference Centre for Nosocomial Infection Surveillance, Charité - University Medicine, Berlin
Hungary	NNSR	National Nosocomial Surveillance System	http://www.oek.hu/oek.web?to=1817&nid=921&pid=1&lang=eng	National Centre for Epidemiology, Budapest
Italy	SPIN-UTI	Italian Nosocomial Infection Surveillance in ICUs (SPIN-UTI) network	https://spinuti.unict.it	Italian Study Group of Hospital Hygiene – Italian Society of Hygiene, Preventive Medicine and Public Health (GISIO – SItI)
	GiViTI	Gruppo Italiano per la Valutazione degli Interventi in Terapia Intensiva	https://giviti.marionegri.it/portfolio/infezioni	
Lithuania			www.hi.lt/content/G0_hosp_inf.html	Institute of Hygiene, Vilnius
Portugal	PPCIRA (HELICS-UCI)		www.dgs.pt/programa-de-prevencao-e-controlo-de-infecoes-e-de-resistencia-aos-antimicrobianos.aspx	Directorate-General of Health, Lisbon Portuguese national programme for prevention and control of infections and antimicrobial resistance (PPCIRA)
Spain	ENVIN-HELICS	National surveillance of nosocomial infections in intensive care medicine	http://hws.vhebron.net/envin-helics	Working group of infectious diseases and sepsis (GTEIS). Spanish Society of Intensive Care Medicine (SEMICYUC). National Centre for Epidemiology. Health Institute Carlos III, Madrid

Country	Network acronym	Network name	Network website	Coordination
UK-Scotland	ARHAI Scotland	Antimicrobial Resistance and Healthcare Associated Infection Scotland	https://www.nss.nhs.scot/antimicrobial-resistance-and-healthcare-associated-infection/data-and-intelligence/surveillance-of-healthcare-associated-infections-in-intensive-care-units	Data and Intelligence, ARHAI Scotland, NHS National Services Scotland, Glasgow

* The European Surveillance System (TESSy) is a system for the collection, analysis and dissemination of data on communicable diseases. EU Member States and EEA countries contribute to the system by uploading their infectious disease surveillance data at regular intervals.

Table A2. Characteristics of intensive care units (ICUs) by country, unit-based and patient-based surveillance, EU/EEA, 2019

Country	Number of ICUs	ICU size (median no. beds)	Type of ICU (%)				
			Medical	Surgical	Mixed	Coronary	Other / unknown
Austria	100	7.0	27.0	67.0	1.0	0.0	5.0
Belgium	7	12.0	0.0	0.0	85.7	0.0	14.3
France	138	NA	7.3	10.1	70.3	0.7	8.7
Germany	916	13.0	12.5	16.4	56.8	1.8	10.8
Hungary	22	10.0	0.0	4.6	81.8	4.6	9.1
Italy-GiViTI	114	8.0	0.0	11.4	81.6	0.0	4.4
Italy-SPIN-UTI	33	8.0	6.1	0.0	81.8	9.1	0.0
Lithuania	41	6.0	4.9	2.4	80.5	4.9	4.9
Portugal	39	8.0	2.6	2.6	64.1	0.0	30.8
Spain	227	12.0	1.8	2.6	81.5	1.8	12.3
United Kingdom – Scotland	22	8.5	0.0	0.0	90.9	4.6	0.0

NA: Not available

Table A3. Patient demographics and risk factors at admission for patients staying more than two days in the intensive care unit (ICU) from countries that provided patient-based data, EU/EEA, 2019

Country	Number of patients	Number of patient - days	Average length of ICU stay (days)	Females (%)	Median age (years)	SAPS II score median	Patient from hospital (%)	Trauma (%)	Type of admission (%)			Intubation (%)	Urinary catheter (%)	Central vascular catheter (%)	Impaired immunity (%)	Mortality (%)
									Medical	Scheduled surgery	Urgent surgery					
Austria	19 542	187 926	9.6	40.5	69	35	57.0	9.5	45.7	29.0	21.3	59.0	70.8	77.2	3.4	10.9
Belgium	473	4 776	10.1	37.0	71	40	53.5	9.3	76.1	16.1	6.1	41.4	78.2	62.4	14.2	18.2
France	12 244	126 025	10.3	37.7	66	44	37.5	6.2	73.6	10.8	15.4	56.6	79.9	61.6	1.3	16.3
Hungary	2 266	20 011	8.8	44.7	66	NA	69.2	17.1	34.3	15.2	14.2	64.4	87.3	67.9	39.9	16.8
Italy-GiViTI	26 900	251 386	9.3	39.4	69	36	53.3	13.7	53.6	19.9	26.5	72.1	0.0	76.2	2.0	15.4
Italy-SPIN-UTI	1 351	15 142	11.2	38.1	69	42	64.5	2.4	51.8	21.8	26.4	59.5	74.8	42.5	8.0	25.8
Lithuania	3 197	26 524	8.3	43.7	65	8	53.6	11.0	63.3	7.0	27.4	46.4	76.7	50.0	13.0	15.9
Portugal	6 983	75 012	10.7	38.0	67	45	35.8	9.8	65.9	11.0	23.1	71.9	94.9	87.5	13.9	15.6
Spain	38 101	299 378	7.9	35.5	66	36	42.7	7.2	69.9	17.4	12.7	44.4	79.7	68.6	7.7	13.4
United Kingdom – Scotland	9 389	66 571	7.1	40.6	62	NA	71.0	5.5	48.7	25.4	21.3	62.2	NA	69.9	NA	11.8

NA: Not available

Table A4. Intensive care unit (ICU)-acquired primary bloodstream infection rates by country, EU/EEA, 2019

Country	Primary bloodstream infection rate (episodes per 1 000 patien- days)			
	Mean	25th percentile	Median	75th percentile
Austria	1.0	0.0	0.0	1.5
Belgium	1.8	0.6	1.2	2.6
France	1.8	0.0	1.2	2.7
Hungary	1.4	0.0	0.8	1.9
Italy-GiViTI	3.7	0.0	2.1	6.5
Italy-SPIN-UTI	2.6	0.9	1.9	3.4
Lithuania	4.0	0.0	3.0	5.3
Portugal	1.5	0.0	0.0	1.4
Spain	1.7	0.7	1.1	2.3
United Kingdom – Scotland	1.4	0.4	0.9	1.9

Table A5. Intensive care unit (ICU)-acquired microbiologically-confirmed central vascular catheter-related bloodstream infection rates by country among countries performing catheter-related infections surveillance, EU/EEA, 2019

Country	Central venous catheter -elated bloodstream infection rate (episodes per 1 000 CVC-days)			
	Country mean	25th percentile	Median	75th percentile
Austria	0.1	0.0	0.0	0.0
France	1.4	0.0	0.0	1.9
Hungary	4.9	0.0	3.0	8.7
Italy-GiViTI	1.7	0.3	1.1	2.2
Italy-SPIN-UTI	3.8	0.0	0.0	2.7
Lithuania	0.2	0.0	0.0	0.0
United Kingdom – Scotland	0.8	0.0	0.0	0.6

Table A6. Intensive care unit (ICU)-acquired central vascular catheter-related bloodstream infection rates by country (microbiologically confirmed or with clinical improvement after removal of the catheter), EU/EEA, 2019

Country	Central venous catheter-related bloodstream infection rate (episodes per 1 000 patient-days)			
	Mean	25th percentile	Median	75th percentile
Austria	0.5	0.0	0.0	0.4
Belgium	0.0	0.0	0.0	0.0
France	3.1	0.0	1.2	4.0
Hungary	4.9	0.0	3.0	8.7
Italy-GiViTI	1.7	0.3	1.1	2.2
Italy-SPIN-UTI	5.5	0.0	2.0	5.8
Lithuania	0.6	0.0	0.0	0.0
Portugal	1.1	0.2	0.7	1.4
Spain	1.4	0.0	0.3	1.8
United Kingdom – Scotland	0.8	0.0	0.0	0.6