SURVEILLANCE & MONITORING

Healthcare-associated infections acquired in intensive care units

Annual Epidemiological Report for 2022

Key facts

- In 2022, 9 802 of 100 277 patients (9.8%) staying in an intensive care unit (ICU) for more than two days presented with at least one of the ICU-acquired healthcare-associated infections (HAI) under surveillance (pneumonia, bloodstream infection or urinary tract infection).
- Of all patients staying in an ICU for more than two days, 6% presented with pneumonia, 4% with bloodstream infection (BSI) and 3% with urinary tract infection (UTI).
- Eighty-three percent of pneumonia episodes were associated with intubation, 43% of BSI episodes were catheter-related, and 95% of UTI episodes were associated with presence of a urinary catheter.
- The most frequently isolated microorganism was *Pseudomonas aeruginosa* in ICU-acquired pneumonia episodes, coagulase-negative staphylococci in ICU-acquired BSIs, and *Escherichia coli* in ICU-acquired UTIs.
- Antimicrobial use was empirical in 55% of 'days of therapy' (DOTs), directed in 34% of DOTs and prophylactic in 11% of DOTs.
- Fourteen percent of *Staphylococcus aureus* isolates were oxacillin-resistant (MRSA) and 10% of *Enterococcus* spp. were glycopeptide-resistant. Resistance to third-generation cephalosporins was reported in 16% of *E. coli* isolates, 34% of *Klebsiella* spp. isolates and 40% of *Enterobacter* spp. isolates. Carbapenem resistance was reported in 14% of *Klebsiella* spp. isolates, 23% of *P. aeruginosa* isolates and 74% of *Acinetobacter baumannii* isolates.

Introduction

Intensive care units (ICUs) are the hospital wards with the highest prevalence of healthcare-associated infections (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 are considered preventable. Moreover, the burden of antimicrobial resistance (AMR) 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 2022 retrieved from EpiPulse on 20 February 2025. EpiPulse is the European surveillance portal for infectious diseases. European Union and European Economic Area (EU/EEA) countries contribute to the system by uploading their infectious disease surveillance data at regular intervals.

For a detailed description of methods used to produce this report, please refer to the Methods chapter [1].

An overview of the national surveillance systems is available online [2].

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Stockholm, February 2026

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, to allow 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 [3]. Infections occurring after 48 hours in the ICU are considered as ICU-acquired in both protocols. If the admission day is counted as day 1, infections with onset from day 3 onwards should be reported. One record per HAI is collected, together with data on AMR markers for each isolated microorganism.

The minimal requirement for surveillance of ICU-acquired HAIs is to include bloodstream infections (BSIs) and pneumonia. The 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).

A 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 isolated in pus from an insertion site. A central line-associated bloodstream infection (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 CRIs.

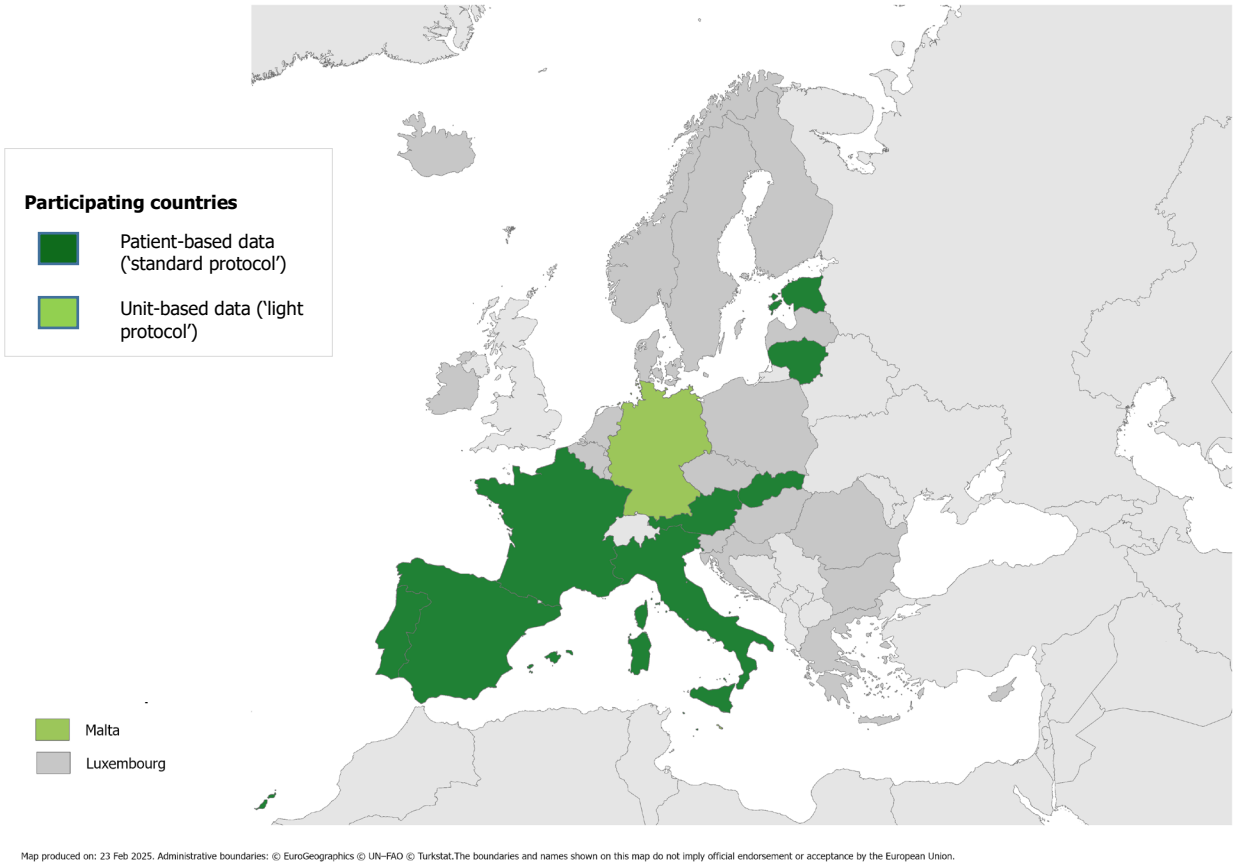
The number of HAIs, percentage of HAIs associated with the presence of a relevant device, the incidence density of HAIs per 1 000 patient-days and the incidence density of HAIs adjusted per 1 000 days of device use were estimated. For the estimation of device-adjusted incidence from patient-based data, ICUs with fewer than 20 patients in the surveillance dataset and exposure to devices occurring before admission, or after discharge to the ICU were excluded. Furthermore, we excluded data on patients who stayed in the ICU for less than two days. Data from Germany were excluded from the estimation of EU/EEA incidence, as the number of patients staying more than two days in the ICU, used as a denominator, was not available. The 10 most frequently isolated microorganisms for each type of HAI and AMR percentage are presented for *Staphylococcus aureus, Enterococcus* spp., Enterobacterales*, Pseudomonas aeruginosa* and *Acinetobacter baumannii*. Trends in median device-adjusted incidence rates of intubation-associated pneumonia (IAP) and CLABSI between 2008 and 2021 were analysed using linear regression. Only countries that provided data without interruption for the entire period were included in the analysis.

In the 'standard' surveillance option, countries submit antimicrobial usage data for each patient. Antimicrobial indication per 100 'treatment days' or 'days of therapy' (DOTs) and the incidence density of use for each antimicrobial group in DOTs per 100 patient-days are estimated. Countries also submit data on structure and process indicators for prevention of HAIs and antimicrobial stewardship, measured at the unit level in both the 'standard' and 'light' surveillance options. These indicators include:

- alcohol hand rub consumption in previous year;
- staffing levels (during a seven-day period) of registered nurses and nurse aides in the ICU;
- audit results in approximately 30 patients for:
  - post-prescription review within 72 hours of prescription,
  - prevention of pneumonia in intubated patients: control of cuff pressure, oral decontamination, patient position;
  - CVC maintenance care: catheter site dressing is not damp, loosened or visibly soiled.

In 2022, 11 networks in 10 countries (Austria, Estonia, France, Germany, Italy-GiViTI[1], Italy-SPIN-UTI[2], Lithuania, Malta, Portugal, Slovakia, and Spain) reported data from 1 166 hospitals and 1 509 ICUs (Figure 1). The median size of the participating ICUs was 12 beds, ranging from two to 60 beds. Two countries (Germany and Malta) only provided unit-based data. The remaining eight countries provided patient-based data. Malta only provided data on bloodstream infections. Seven countries (Austria, Estonia, Italy, Lithuania, Portugal, Slovakia, and Spain) reported data on antimicrobial use. Five countries/networks (Austria, Estonia, Italy-SPIN-UTI, Lithuania, and Slovakia) provided data on the outcome of HAIs and, in case of death, the relationship between HAI and death. Austria, the Italy SPIN-UTI network, and Slovakia reported data on structure and process indicators of infection prevention and control (IPC) and antimicrobial stewardship.

Figure 1. Participation in surveillance of healthcare-associated infections in intensive care units, EU/EEA, 2022



Source: ECDC, HAI-Net, 2022

Epidemiology

Of 100 277 patients staying in an ICU for more than two days (patient-based data), 9 802 patients (9.8%) presented with at least one HAI.

ICU-acquired pneumonia

Among patients staying in an ICU for more than two days, 5.7% were affected by at least one episode of pneumonia and 83.4% of episodes were associated with intubation. The incidence of pneumonia was 5.8 episodes per 1 000 patient-days.

The mean incidence density per ICU was 6.6 pneumonia episodes per 1 000 patient-days (Table 1), varying from 3.5 in ICUs with fewer than 30% intubated patients to 7.5 in ICUs with 30–59% intubated patients, and 7.1 in ICUs with more than 60% intubated patients.

[1] GiViTI – Gruppo Italiano per la Valutazione degli Interventi in Terapia Intensiva
[2] SPIN-UTI – Italian Nosocomial Infection Surveillance in ICUs (SPIN-UTI) network

Table 1. ICU-acquired pneumonia by country/network, EU/EEA, 2022

Country/network	Patient-days (n)	Pneumonia episodes (n)	Pneumonia incidence density (episodes per 1 000 patient-days)				
			Aggregated	Mean	25th percentile	Median	75th percentile
Austria	213 315	523	2.5	2.6	0.0	0.6	3.9
Estonia	3 514	23	6.6	6.3	5.6	6.9	7.6
France	73 526	961	13.1	13.3	6.3	12.6	17.8
Germany[a]	2 732 407	4 916	1.8	1.9	0.5	1.3	2.7
Italy-GiViTI[b]	220 550	1 546	7.0	5.9	2.7	4.7	8.6
Italy-SPIN-UTI	20 161	231	11.5	13.1	5.8	13.4	17.1
Lithuania	2 768	20	7.2	14.3	1.8	6.6	7.1
Portugal	82 790	629	7.6	7.2	4.4	6.4	9.4
Slovakia	922	2	2.2	1.8	0.9	1.8	2.7
Spain	364 668	1 744	4.8	4.4	1.8	3.7	6.0
EU/EEA[a]	**989 184**	**5 679**	**5.7**	**6.6**	**1.8**	**4.7**	**8.7**

Source: ECDC, HAI-Net data 2022.
Percentiles: distribution of incidence per ICU.
[a] Patient-days from Germany include patients staying in the ICU for less than two days and are not included in the EU/EEA results.
[b] In patients with more than one pneumonia episode during the surveillance period, Italy-GiViTI only records the first episode.

In patient-based surveillance, the mean device-adjusted rate per ICU was 10.0 intubation-associated pneumonia episodes per 1 000 intubation-days, and varied from 1.9 in Slovakia to 19.5 in France (Table 2).

Table 2. ICU-acquired intubation-associated pneumonia (IAP) rates by country/network, EU/EEA, 2022

Country/network	Intubation-days (n)	Intubation use (days per 100 patient-days)	IAP episodes (n)	IAP incidence density (episodes per 1 000 intubation-days)				
				Aggregated	Mean	25th percentile	Median	75th percentile
Austria	100 355	45.5	409	4.1	4.6	0.0	0.5	7.2
Estonia	2 087	53.6	13	6.2	5.2	3.0	5.7	7.9
France	37 000	47.1	728	19.7	19.5	12.0	18.4	25.5
Italy-GiViTI[a]	131 606	58.3	1 376	10.5	8.5	4.4	6.9	12.8
Italy-SPIN-UTI	8 739	49.7	133	15.2	17.7	7.6	16.6	21.8
Lithuania	982	35.6	11	11.2	10.0	2.7	10.9	14.9
Portugal	47 337	55.9	516	10.9	10.4	5.8	9.9	13.4
Slovakia	737	76.7	2	2.7	1.9	1.0	1.9	2.9
Spain	171 570	44.2	1 551	9.0	8.6	4.3	7.9	11.2
EU/EEA	**500 413**	**48.4**	**4 739**	**9.5**	**10.0**	**3.7**	**8.0**	**14.3**

Source: ECDC, HAI-Net patient-based data 2022.
IAP: intubation-associated pneumonia.
Percentiles: distribution of incidence per ICU.
[a] In patients with more than one pneumonia episode during the surveillance period, Italy-GiViTI only records the first episode.

The most frequently isolated microorganisms in ICU-acquired pneumonia episodes were *Klebsiella spp.,* followed by *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Escherichia coli* and *Enterobacter* spp. (Table 3).

Table 3. Distribution of the 10 most frequently isolated microorganisms in ICU-acquired pneumonia episodes, by country/network, EU/EEA, 2022

Microorganism	Austria (n=785)	Estonia (n=20)	France (n=886)	Germany (n=4 548)	Italy GiViTI (n=1 639)	Italy SPIN-UTI (n=203)	Lithuania (n=12)	Portugal (n=554)	Slovakia (n=1)	Spain (n=480)	Total (n=9 128)
Klebsiella spp.	17.8	25.0	15.7	20.5	21.5	33	33.3	24	0.0	17.5	20.3
Pseudomonas aeruginosa	11.6	30.0	21.6	14.5	19.2	21.7	50	23.6	0.0	26.7	17.2
Staphylococcus aureus	8.2	15.0	19.5	16.7	20.7	9.4	8.3	15.7	0.0	15.2	16.6
Escherichia coli	10.7	5.0	10.9	15.6	9.4	5.9	0.0	8.1	100.0	9.2	12.6
Enterobacter spp.	6.1	20	9.4	10.8	8.5	9.4	0.0	8.1	0.0	11.2	9.7
Candida spp.	32	0.0	3.7	4.4	4.5	8.4	0.0	4.2	0.0	0.8	6.6
Serratia spp.	6.2	0.0	4.7	7.3	5.6	4.9	8.3	5.1	0.0	7.9	6.5
Stenotrophomonas maltophilia	4.1	0.0	5.2	3.9	2.7	5.4	0.0	3.1	0.0	7.9	4.0
Haemophilus influenzae	1.1	0.0	6.2	2.5	5.1	0.0	0.0	5.1	0.0	2.3	3.3
Proteus spp.	2.2	5.0	3.0	3.8	2.7	2.0	0.0	3.1	0.0	1.3	3.2

Source: ECDC, HAI-Net patient-based and unit-based data, 2022.
n = number of isolates.

ICU-acquired bloodstream infections (BSIs)

ICU-acquired BSIs occurred in 4.3% of patients staying in an ICU for more than two days. The mean incidence density per ICU was 4.4 BSI episodes per 1 000 patient-days (Table 4). The respective mean incidence density of primary BSIs (including catheter-related infections and infections of unknown origin) per ICU was 2.7 episodes per 1 000 patient-days (Table A4). BSIs were catheter-related in 42.7% of cases, secondary to another infection in 30.0% of cases, and of unknown origin in 19.2% of cases. When the BSI was secondary to another infection, the primary infection site was pulmonary (48.5% cases), followed by the urinary tract (21.6%), gastrointestinal (10.9%), skin and soft tissue (4.1%), a surgical site (3.4%), and 'other' in 11.4% cases.

Table 4. ICU-acquired bloodstream infection (BSI) rates by country/network, EU/EEA, 2022

Country/network	Patient-days (n)	BSI episodes (n)	BSI incidence density (episodes per 1 000 patient-days)				
			Aggregated	Mean	25th percentile	Median	75th percentile
Austria	213 315	344	1.6	1.6	0.0	0.0	2.2
Estonia	3 514	32	9.1	5.2	0.0	0.8	6.0
France	73 526	364	5.0	4.8	0.9	3.6	6.1
Germany[a]	2 732 407	2 999	1.1	1.2	0.3	0.9	1.6
Italy-GiViTI[b]	220 550	1 371	6.2	5.9	3.2	5.1	7.5
Italy-SPIN-UTI	20 161	140	6.9	8.5	0.7	4.1	12.8
Lithuania	2 768	6	2.2	0.6	0.0	0.0	0.0
Malta	6 970	44	6.3	6.3	6.3	6.3	6.3
Portugal	82 790	316	3.8	3.9	3.0	3.9	5.0
Slovakia	922	8	8.7	8.1	6.8	8.1	9.4
Spain	364 668	1 730	4.7	4.3	1.8	3.5	6.1
EU/EEA[a]	989 184	4 355	4.4	4.4	0.8	3.3	6.0

Source: ECDC, HAI-Net data 2022.
Percentiles: distribution of incidence per ICU.
[a] Patient-days from Germany include patients staying in the ICU for less than two days and are not included in the EU/EEA results.
[b] In patients with more than one BSI episode during the surveillance period, Italy-GiViTI only records the first episode of primary BSI, and the first episode of secondary BSI related to a first episode of primary infection at each primary infection site.

In patient-based surveillance, the central vascular catheter (CVC) utilisation rate was on average 80.5 CVC-days per 100 patient-days. It was lowest (59.0) in Lithuania and highest (89.0) in Estonia. The mean device-adjusted rate in patients staying in an ICU for more than two days was 2.9 central line-associated BSI (CLABSI) episodes per 1 000 CVC days, varying from 0.6 in Lithuania to 6.3 in Italy-SPIN-UTI (Table 5).

Table 5. ICU-acquired central line-associated bloodstream infection (CLABSI) rates by country/ network, EU/EEA, 2022

Country/network	Catheter-days (n)	Catheter use (days per 100 patient-days)	CLABSI episodes (n)	CLABSI incidence density (episodes per 1 000 catheter-days)				
				Aggregated	Mean	25th percentile	Median	75th percentile
Austria	184 875	87.2	200	1.1	0.9	0.0	0.0	1.0
Estonia	3 144	89.5	23	7.3	4.2	0.0	1.0	5.2
France	499 83	68.9	126	2.5	2.4	0.0	1.4	3.7
Italy-GiViTI[a]	187 652	85.4	778	4.2	3.9	1.5	2.9	5.1
Italy-SPIN-UTI	11 346	65.1	62	5.5	6.3	0.0	4.8	9.5
Lithuania	1 451	60.2	3	2.1	0.6	0.0	0.0	0.0
Portugal	66 705	80.6	153	2.3	2.1	0.6	2.2	3.3
Slovakia	808	87.6	4	5.0	5.3	4.6	5.3	6.0
Spain	279 750	76.8	1 029	3.7	3.2	0.0	2.4	4.6
EU/EEA	**785 714**	**80.5**	**2 378**	**3.0**	**2.9**	**0.0**	**1.8**	**4.1**

Source: ECDC, HAI-Net patient-based data 2022.

Percentiles: distribution of incidence per ICU.

[a] In patients with more than one primary BSI episodes during the surveillance period, Italy-GiViTI only records the first episode.

The incidence of microbiologically-confirmed central vascular catheter-related BSIs among countries performing catheter-related infection surveillance is presented in Annex 1, Table A5. The incidence of BSIs classified as catheter-related, either through microbiological confirmation or due to clinical improvement after removal of the catheter, is displayed in Annex 1, 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 6).

Table 6. Distribution of the 10 most frequently isolated microorganisms in ICU-acquired bloodstream infection (BSI) episodes by country/network, EU/EEA, 2022

Microorganism	Austria (n=392)	Estonia (n=18)	France (n=374)	Germany (n=2 921)	Italy GiViTI (n=1 563)	Italy SPIN-UTI (n=128)	Lithuania (n=2)	Malta (n=33)	Portugal (n=308)	Slovakia (n=6)	Spain (n=549)	Total (n=6 288)
Coagulase-negative staphylococci	42.1	0.0	15.5	30.1	44.5	17.9	0.0	0.0	15.6	0.0	30.6	26.3
Enterococcus spp.	14.0	66.7	15.8	23.5	7.0	10.4	0.0	18.2	13.0	0.0	17.3	17.9
Klebsiella spp.	8.2	5.6	13.6	9.6	8.6	18.7	50.0	33.3	18.5	66.7	9.1	12.5
Staphylococcus aureus	6.1	5.6	11.0	10.6	1.6	9.7	0.0	6.1	7.1	0.0	6.0	9.3
Candida spp.	10.7	0.0	8.3	6.7	11.7	8.1	0.0	0.0	8.1	0.0	11.7	7.9
Escherichia coli	5.9	11.1	8.8	7.9	5.5	8.4	0.0	6.1	9.4	16.7	4.2	7.6
Pseudomonas aeruginosa	4.8	0.0	13.6	4.4	4.7	10.7	0.0	9.1	10.1	0.0	8.4	7.2
Enterobacter spp.	3.6	5.6	8.3	4.6	5.5	6.7	0.0	15.2	10.4	0.0	8.2	5.9
Serratia spp.	4.1	0.0	3.5	2.2	0.0	4.9	0.0	3.0	5.2	0.0	3.5	3.3
Acinetobacter spp.	0.5	5.6	1.6	0.4	10.9	4.6	50.0	9.1	2.6	16.7	1.1	2.0

Source: ECDC, HAI-Net patient-based and unit-based data, 2022. Data from Germany are only on primary bloodstream infections.

n = number of isolates.

Coagulase-negative staphylococci: includes unspecified Staphylococcus *spp.*

ICU-acquired urinary tract infections (UTIs)

A total of 2 569 cases of ICU-acquired UTI were reported. On average, ICU-acquired UTIs occurred in 2.7% of patients staying in an ICU for more than two days, with 95.4% of UTI episodes being associated with the use of a urinary catheter. The mean incidence density per ICU was 3.2 UTI episodes per 1 000 patient-days (Table 7).

Table 7. ICU-acquired urinary tract infection (UTI) rates by country/network, EU/EEA, 2022

Country/network	Patient-days (n)	UTI episodes (n)	UTI incidence density (episodes per 1 000 patient-days)				
			Aggregated	Mean	25th percentile	Median	75th percentile
Austria	213 315	271	1.3	1.2	0.0	0.0	1.2
Estonia	3 514	15	4.3	5.3	4.0	5.5	6.9
Germany[a]	2 732 407	2 790	1.0	1.1	0.0	0.7	1.6
Italy-GiViTI[b]	220 550	578	2.6	2.3	0.2	1.3	3.3
Italy-SPIN-UTI	20 161	88	4.4	7.9	0.6	4.1	6.9
Lithuania	2 768	15	5.4	4.2	0.0	0.0	7.1
Portugal	82 790	215	2.6	2.7	0.7	2.1	4.4
Slovakia	922	8	8.7	8.6	8.5	8.6	8.8
Spain	364 668	1 379	3.8	3.6	1.8	3.2	5.2
EU/EEA	**915 658**	**2 569**	**2.8**	**3.2**	**0.0**	**2.0**	**4.4**

Source: ECDC, HAI-Net data 2022.
Percentiles: distribution of incidence per ICU.
[a]Patient-days from Germany include patients staying in the ICU for less than two days and are not included in the EU/EEA results.
[b]In patients with more than one UTI episode during the surveillance period, Italy-GiViTI only records the first episode.

On average, urinary catheters were used in 83% of the patient-days. The mean device-adjusted rate in patients staying in an ICU for more than two days was 5.8 catheter-associated UTI episodes per 1 000 catheter-days (ICU IQR: 0.4–5.8).

The most frequently isolated microorganisms in urinary tract infection episodes were *Escherichia coli,* followed by *Enterococcus* spp., *Pseudomonas aeruginosa,* and *Klebsiella* spp. (Table 8).

Table 8. Distribution of the 10 most frequently isolated microorganisms in ICU-acquired urinary tract infection (UTI) episodes, by country/network, EU/EEA, 2022

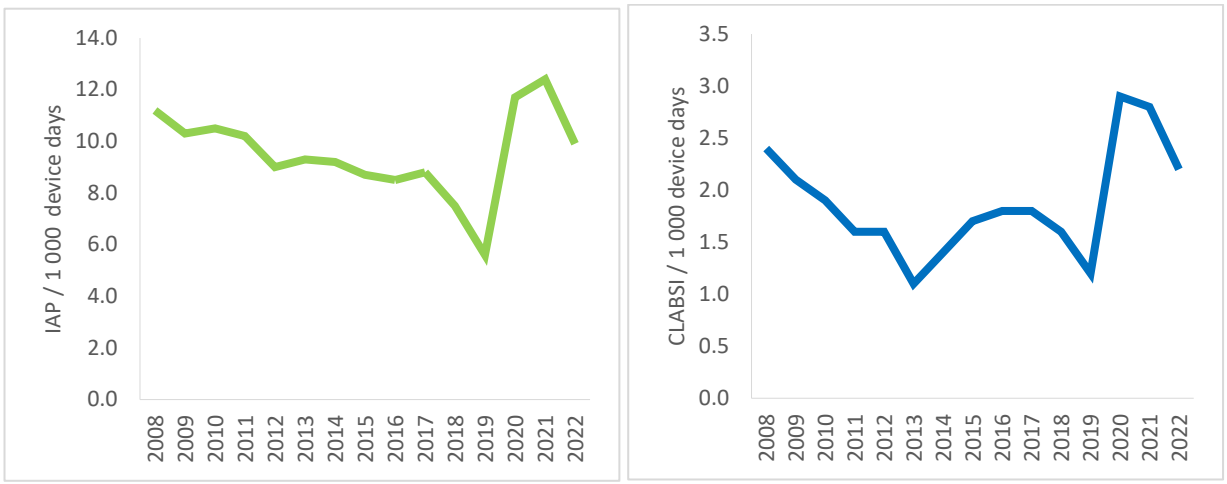
Microorganism	Austria (n=346)	Estonia (n=14)	Germany (n=3 045)	Italy GiViTI (n=644)	Italy SPIN-UTI (n=60)	Lithuania (n=11)	Portugal (n=221)	Slovakia (n=4)	Spain (n=345)	Total (n=4 646)
Escherichia coli	20.8	21.4	31.7	21.7	18.2	25.0	22.6	0.0	23.0	28.8
Enterococcus spp.	23.4	7.1	21.0	11.7	36.4	24.5	12.2	25.0	22.3	21.2
Pseudomonas aeruginosa	9.0	28.6	14.6	6.7	0.0	12.3	15.8	50.0	15.1	13.8
Klebsiella spp.	9.8	35.7	14.5	25.0	45.5	11.8	18.1	0.0	7.5	13.8
Proteus spp.	1.4	7.1	7.8	6.7	0.0	4.5	8.1	25.0	2.3	6.5
Candida spp.	24.6	0.0	0.0	23.3	0.0	15.4	10.4	0.0	18.4	6.0
Enterobacter spp.	4.0	0.0	6.2	1.7	0.0	2.5	4.5	0.0	5.6	5.3
Citrobacter spp.	2.6	0.0	1.9	0.0	0.0	2.5	2.7	0.0	2.0	2.1
Serratia spp.	1.7	0.0	1.3	0.0	0.0	0.6	3.6	0.0	1.3	1.3
Coagulase-negative staphylococci	2.6	0.0	1.0	3.3	0.0	0.9	1.8	0.0	2.6	1.3

n = number of isolates
Source: ECDC, HAI-Net ICU 2022
Coagulase-negative staphylococci: includes unspecified Staphylococcus *spp.*

Trends

Trend analysis of annual median incidence density in ICUs from five European countries/networks (France, Italy-SPIN-UTI, Lithuania, Portugal and Spain) with uninterrupted participation since 2008 demonstrated a change from the previous increasing trend (during the COVID-19 pandemic) to a sharp decrease in 2022 for both IAP and CLABSI (Figure 2).

Figure 2. Incidence density trend of intubation-associated pneumonia (IAP) and central line-associated bloodstream infection (CLABSI), five EU/EEA countries/networks[a], 2008–2022



[a] Countries/networks with uninterrupted participation since 2008: France, Italy-SPIN-UTI, Lithuania, Portugal and Spain.

Antimicrobial use

In total, 783 273 DOTs with antimicrobials were recorded in 2022. Antimicrobial treatment was empirical in 54.7% (range 44.6–74.0%) of DOTs, directed in 34.1% (range 22.7–44.1%), prophylactic in 11.2% (range 0.4–23.4%) and selective digestive decontamination in 0.05% (range 0.0–2.0%). The reported antimicrobial use of selected antimicrobials/antimicrobial groups was carbapenems, 14.2 (range 3.2–15.8) DOTs per 100 patient-days; third- and fourth-generation cephalosporins, 9.3 (range 1.1–12.1); piperacillin-tazobactam, 12.0 (range 0.0–11.0); fluoroquinolones, 5.2 (range 1.0–5.1); glycopeptides, 5.5 (range 1.5–6.8); and polymyxins, 0.7 (range 0.0–1.8) (Table 9).

Table 9. Antimicrobial use indication and selected antimicrobial groups, by country/network, EU/EEA, 2022

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	53.4	38.4	8.2	0.0	8.9	2.2	11.0	1.2	1.5	0.0
Estonia	62.9	31.7	5.3	0.0	15.8	1.1	7.5	4.2	6.8	0.2
Italy-GiViTI	44.6	44.1	11.3	0.0	5.9	4.2	10.5	1.5	3.7	0.0
Italy-SPIN-UTI	53.2	22.7	23.4	0.8	7.4	6.6	10.8	2.0	4.6	1.8
Lithuania	70.7	22.8	4.5	2.0	6.5	2.8	1.5	2.1	4.3	0.8
Portugal	70.1	25.3	4.4	0.1	8.3	6.1	0.0	1.0	5.1	0.2
Slovakia	74.0	25.6	0.4	0.0	3.2	12.1	1.4	4.3	2.2	1.7
Spain	55.7	25.2	19.1	0.0	11.0	7.6	7.6	5.1	2.7	0.5

Source: ECDC, HAI-Net patient-based data 2022.
DOTs: days 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-resistant (MRSA) in 14.0% of *S. aureus* isolates (n=506), vancomycin resistance in 9.7% of *Enterococcus* spp. isolates (n=870), ceftazidime resistance in 36.0% of *P. aeruginosa* isolates (n=1 108), and third-generation cephalosporin resistance in 15.8% of *E. coli* isolates (n=1 460), 34.0% of *Klebsiella* spp. isolates (n=2 338) and 39.8% of *Enterobacter* spp. isolates (n=970). Carbapenem resistance was reported in 13.7% of *Klebsiella* spp. isolates (n=1 354), 0.6% of *E. coli* isolates (n=834), 3.9% of *Enterobacter* spp. isolates (n=586), 22.5% of *P. aeruginosa* isolates (n=1 859) and 73.9% of *Acinetobacter baumannii* (n=88) isolates.

Outcome of healthcare-associated infections

Six countries provided data on the outcome of HAIs and the relation between HAI and outcome, for a total of 971 HAIs. In 698 (71.9%) HAIs, the patient was discharged alive; in 20 (2.1%) HAIs the patient died and the death was assessed as being definitely linked to the HAI; in 36 (3.7%) HAIs the patient died and the death was assessed as not being linked to the HAI; in 87 (9.0%) HAIs the patient died and the death was assessed as probably being linked to the HAI and in 130 (13.4%) HAIs the patient died and the relationship of the death to the HAI was unknown (Table 10).

Table 10. Healthcare-associated infection (HAI) outcome by country/network, EU/EEA, 2022

Country/network	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 (%)
Austria	384	76.0	0.5	1.6	1.6	20.3
Estonia	54	83.3	9.3	0.0	7.4	0.0
Italy-SPIN-UTI	436	69.3	3.0	3.9	13.8	10.1
Lithuania	39	61.5	0.0	15.4	23.1	0.0
Malta	44	70.5	0.0	11.4	6.8	11.4
Slovakia	14	28.6	0.0	14.3	35.7	21.4

Structure and process indicators of infection control and antimicrobial stewardship

Austria, the Italy SPIN-UTI network and Slovakia, reported structure and process indicators for infection prevention control and antimicrobial stewardship (Tables 11 and 12).

Table 11. Structure and process indicators for infection prevention and control in intensive care units (ICUs), EU/EEA, 2022

Country/network	ICUs (n)	ICU size (median number of beds)	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	12	8	22.6	1.6	337.5
Italy-SPIN-UTI	23	8	18.1	6.3	147.6
Slovakia	14	8	NA	NA	226.0

NA: not available.

Table 12. Process indicators assessed through chart review or direct observation by country/network, 2022

Country/network	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	12	100.0	98.3	99.7	96.7	98.3
Italy-SPIN-UTI	23	66.4	61.1	71.2	54.1	93.7

Discussion

Eleven networks in 10 EU/EEA countries submitted data on ICU-acquired HAIs in 2022.

HAI surveillance at the local and national level is an essential component of HAI prevention and control. The participating ICUs benefit from a standardised tool which 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 yield additional benefits at the local level, allowing comparisons with a wide range of ICUs 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 across Europe.

Pneumonia was the most common HAI acquired in ICUs and was associated with intubation in most cases. Among BSIs, almost half were catheter-related. In 2022, both crude and device-adjusted HAI rates of ICU-acquired pneumonia, BSIs and UTIs across the participating networks decreased after the considerable increases reported in 2020 and 2021 [4,5], which may have reflected the effect of the COVID-19 pandemic. The increases in the incidence density of HAIs during the COVID-19 pandemic may be related to differences in case-mix (i.e. decreases in patients admitted to the ICU after elective surgery, increased severity and prolonged hospital stay) or to changes in infection control practices.

There was substantial variability in HAI rates across the EU/EEA. Part of this variability can be attributed to variation in diagnostic practices. The characteristics of the participating ICUs and related patient population, such as clinical severity and infection prevention and control practices may also affect the reported incidence of HAIs.

In almost all countries providing data on antimicrobial use in ICUs, antimicrobials continue to be prescribed (i.e. more reported DOTs) as empirical rather than directed treatment. The distribution of prescribed antimicrobial agents differed among the participating countries and may reflect both the prevalence of antimicrobial resistance in each country and local practices.

The distribution of microorganisms associated with HAIs in 2022 was similar to that in previous years, with the caveat that the overall results were not directly comparable due to the differences in reporting countries. In 2022, *P. aeruginosa* was the most common microorganism associated with pneumonia, followed by *Klebsiella* spp. and *S. aureus*. Among BSIs, coagulase-negative staphylococci remained the most commonly isolated microorganisms, and were 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 higher proportions of HAIs caused by *Klebsiella* spp. in some countries. Similar to 2020 and 2021, *Acinetobacter* spp. was among the 10 most common bacterial species isolated from bloodstream infections.

This report confirms the importance of antimicrobial resistance in gram-negative bacteria as a cause of HAIs in ICUs in the EU/EEA in 2022, 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 HAIs in ICU patients, a highly vulnerable patient population.

In 2022, five participating countries provided data on HAI outcomes and the relation of the HAI to death in the patients who died. Almost one in three HAIs were assessed to have contributed to death, either definitely or possibly.

In the three country networks reporting data for structure and process indicators of infection prevention and control and antimicrobial stewardship for 2022, there was considerable inter-ICU variability. These data can be used to identify targets for improvement in the participating ICUs.

Public health implications

ICUs are the hospital wards with the highest prevalence of HAIs [5] and are associated with high mortality [7]. 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 are 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. Surveillance data can be used to identify targets for intervention, both in terms of prevention of HAIs and antimicrobial use. Further understanding of the variation in incidence density and of the burden of HAIs in ICUs should be facilitated by using quality indicators for infection prevention and control and 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 in the future. There is still a need to increase country participation in surveillance of ICU-acquired infections and collection of data on structure and process indicators of IPC and antimicrobial stewardship in order to benchmark ICUs in the countries/networks that already participate in HAI-Net ICU.

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). Surveillance systems overview. Stockholm: ECDC; 2017. Available at: https://ecdc.europa.eu/sites/portal/files/documents/Table-surveillance_systems_overview_0.xlsx
3. 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; 2017. Available at: https://www.ecdc.europa.eu/sites/default/files/documents/HAI-Net-ICU-protocol-v2.2_0.pdf
4. European Centre for Disease Prevention and Control (ECDC). Annual Epidemiological Report for 2020 – Healthcare-associated infections acquired in intensive care units. Stockholm: ECDC; 2024. Available at: https://www.ecdc.europa.eu/en/publications-data/healthcare-associated-infections-acquired-intensive-care-units-annual
5. European Centre for Disease Prevention and Control (ECDC). Healthcare-associated infections acquired in intensive care units. In: ECDC. Annual Epidemiological Report for 2021. Stockholm: ECDC; 2024. Available at: https://www.ecdc.europa.eu/en/publications-data/healthcare-associated-infections-acquired-intensive-care-units-annual-0
6. European Centre for Disease Prevention and Control (ECDC). Point prevalence survey of healthcare-associated infections and antimicrobial use in European acute care hospitals, 2022–2023. Stockholm: ECDC; 2024 Available at: https://www.ecdc.europa.eu/en/publications-data/PPS-HAI-AMR-acute-care-europe-2022-2023
7. 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

Annex 1. Supplementary information

Table A1. Healthcare-associated infections acquired in intensive care units: surveillance systems overview, 2022

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
Estonia				Health Board of Estonia
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
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)
Slovakia			https://www.uvzsr.sk/web/ruvztn/nrc_nn	National Reference Centre for prevention and control of nosocomial infections, Regional Authority of Public Health in Trenčín, Trenčín
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

Table A2. Characteristics of intensive care units by country, unit-based and patient-based surveillance, EU/EEA, 2022

Country/network	ICUs (n)	ICU size (median no. beds)	Type of ICU (%)				
			Medical	Surgical	Mixed	Coronary	Other/unknown
Austria	105	8	25.7	66.7	2.9	0.0	4.8
Estonia	4	9	0.0	0.0	100.0	0.0	0.0
France	93	12	8.6	6.5	72.0	2.2	9.7
Germany	899	12	11.9	14.7	59.5	1.9	9.8
Italy-GiViTI	104	8	0.0	14.4	76.0	0.0	5.8
Italy-SPIN-UTI	39	8	7.7	5.1	71.8	7.7	7.7
Lithuania	9	6	0.0	11.1	66.7	0.0	22.2
Malta	1	20	0.0	0.0	100.0	0.0	0.0
Portugal	36	9	5.6	5.6	50.0	0.0	38.9
Slovakia	2	8	0.0	0.0	100.0	0.0	0.0
Spain	217	13	1.8	3.2	81.6	1.8	11.5

Table A3. Patient demographics and risk factors on admission for patients staying more than two days in an intensive care unit, from countries that provided patient-based data, EU/EEA, 2022

Country/network	Patients (n)	Ppatient–days (n)	Average length of 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	22 475	213 315	9.5	39.4	67	39	51.8	9.0	47.9	27.2	22.1	61.4	55.3	80.4	2.1	11.8
Estonia	313	3 514	11.2	41.2	66	NA	51.8	6.4	63.6	9.3	26.5	59.1	97.4	87.9	10.9	11.8
France	6 413	73 526	11.5	35.8	65	40	3.4	6.4	76.6	9.6	13.6	53.5	78.5	62.1	2.5	18.4
Italy-GiViTI	21 409	220 550	10.3	38.1	67	35	51.8	13.1	53.2	20.2	26.6	NA	96.9	NA	2.7	16.7
Italy-SPIN-UTI	1 607	20 161	12.5	39.3	69	38	76.5	1.9	37.6	21.1	24.5	68.9	88.2	76.2	5.0	24.0
Lithuania	317	2 768	8.7	42.9	69	NA	64.0	8.8	89.3	1.9	8.8	31.5	79.5	54.3	25.2	33.8
Portugal	7 418	82 790	11.2	37.4	66	41	35.4	10.6	66.6	10.0	23.4	63.1	93.4	84.1	11.1	15.5
Slovakia	78	922	11.8	16.7	67.5	56	44.9	35.9	67.9	3.8	26.9	87.2	100.0	98.7	0.0	29.5
Spain	40 247	364 668	9.1	35.2	65	36	41.1	6.4	71.4	15.8	12.8	44.4	80.5	71.1	9.1	14.6

NA: Not available.

Table A4. Intensive care unit-acquired primary bloodstream infection rates by country, EU/EEA, 2022

Country/network	Patient-days (n)	Primary BSI episodes (n)	Primary BSI rate (episodes per 1 000 patient-days)				
			Aggregated	Mean	25th percentile	Median	75th percentile
Austria	212 029	271	1.3	1.2	0.0	0.0	1.7
Estonia	3 514	25	7.1	4.1	0.0	0.8	4.9
France	72 588	158	2.2	2.1	0.0	1.6	3.1
Italy-GiViTI[a]	219 716	815	3.7	3.4	1.4	2.7	4.2
Italy-SPIN-UTI	17 434	86	4.9	5.8	0.0	3.1	9.4
Lithuania	2 410	6	2.5	0.9	0.0	0.0	0.0
Portugal	82 790	161	1.9	1.8	0.5	1.8	2.6
Slovakia	922	4	4.3	4.6	4.1	4.6	5.1
Spain	364 437	1 109	3.0	2.7	0.6	2.0	3.8

Source: ECDC, HAI-Net patient-based data 2022.
BSI: bloodstream infection.
Percentiles: distribution of incidence per ICU.
[a] In patients with more than one primary BSI episode during the surveillance period, Italy-GiViTI only records the first episode.

Table A5. Intensive care unit-acquired microbiologically confirmed central venous catheter-related bloodstream infection rates by country, among countries performing catheter-related infection surveillance, EU/EEA, 2022

Country/network	CVC use days (n)	CVC use (days per 100 patient-days)	CRI episodes (n)	CVC- related bloodstream infection rate (episodes per 1 000 CVC-days)				
				Aggregated	Mean	25th percentile	Median	75th percentile
Austria	184 875	872	31	0.2	0.1	0.0	0.0	0.0
Estonia	3 144	895	11	3.5	2.0	0.0	1.0	3.0
France	49 983	689	76	1.5	1.7	0.0	0.0	2.6
Italy-GiViTI[a]	187 652	854	428	2.3	2.0	0.0	1.2	3.0
Italy-SPIN-UTI	11 346	651	41	3.6	4.6	0.0	0.0	4.9

Source: ECDC, HAI-Net patient-based data 2022
CRI: catheter-related infection; CVC: central venous catheter.
Percentiles: distribution of incidence per ICU.
[a] In patients with more than one CRI episode during the surveillance period, Italy-GiViTI only records the first episode.

Table A6. Intensive care unit (ICU)-acquired central venous catheter (CVC)-related bloodstream infection rates by country (microbiologically confirmed or with clinical improvement after removal of the catheter), EU/EEA, 2022

Country/network	CVC use days (n)	CVC use (days per 100 patient-days)	CRI episodes (n)	CVC- related bloodstream infection rate (episodes per 1 000 CVC-days)				
				Aggregated	Mean	25th percentile	Median	75th percentile
Austria	184 875	872	216	1.2	0.7	0.0	0.0	0.8
Estonia	3 144	895	11	3.5	2.0	0.0	1.0	3.0
France	49 983	689	119	2.4	2.4	0.0	1.1	3.4
Italy-GiViTI[a]	187 652	854	428	2.3	2.0	0.0	1.2	3.0
Italy-SPIN-UTI	11 346	651	60	5.3	6.2	0.0	0.0	7.0
Lithuania	1 451	602	0	0.0	0.0	0.0	0.0	0.0
Portugal	66 705	806	69	1.0	0.9	0.0	0.8	1.5
Slovakia	808	876	2	2.5	3.4	1.7	3.4	5.0
Spain	279 750	768	529	1.9	1.6	0.0	1.1	2.3

Source: ECDC, HAI-Net patient-based data 2022
CRI: catheter-related infection; CVC: central venous catheter.
Percentiles: distribution of incidence per ICU.
[a] In patients with more than one primary bloodstream infection episode during the surveillance period, Italy-GiViTI only records the first episode.