SURVEILLANCE REPORT

Healthcare-associated infections acquired in intensive care units

Annual Epidemiological Report for 2020

Key facts

- In 2020, 11 124 (12.7%) 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, 8% presented with pneumonia, 6% with bloodstream infection (BSI), and 3% with urinary tract infection (UTI).
- Seventy-one percent of pneumonia episodes were associated with intubation, 38% of BSI episodes were catheter-related, and 95% of UTI episodes were associated with the 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 51% of 'days of therapy' (DOTs), directed in 37% of DOTs, and prophylactic in 10% of DOTs.
- Fourteen percent of *Staphylococcus aureus* isolates were oxacillin-resistant (MRSA) and 16% of *Enterococcus* spp. were glycopeptide resistant. Resistance to third-generation cephalosporins was reported in 22% of *E. coli* isolates, 38% of *Klebsiella* spp. Isolates, and 39% of *Enterobacter* spp. isolates. Carbapenem resistance was reported in 11% of *Klebsiella* spp. isolates, 26% of *P. aeruginosa* isolates, and 54% 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 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.

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Stockholm, March 2024

Methods

This report is based on data for 2020 retrieved from EpiPulse on 4 December 2023. EpiPulse is the European surveillance portal for infectious diseases. EU Member States and 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].

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

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

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 from pus from insertion site. A central line-associated bloodstream infection (CLABSI) was defined as a primary BSI with use of a central vascular catheter 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.

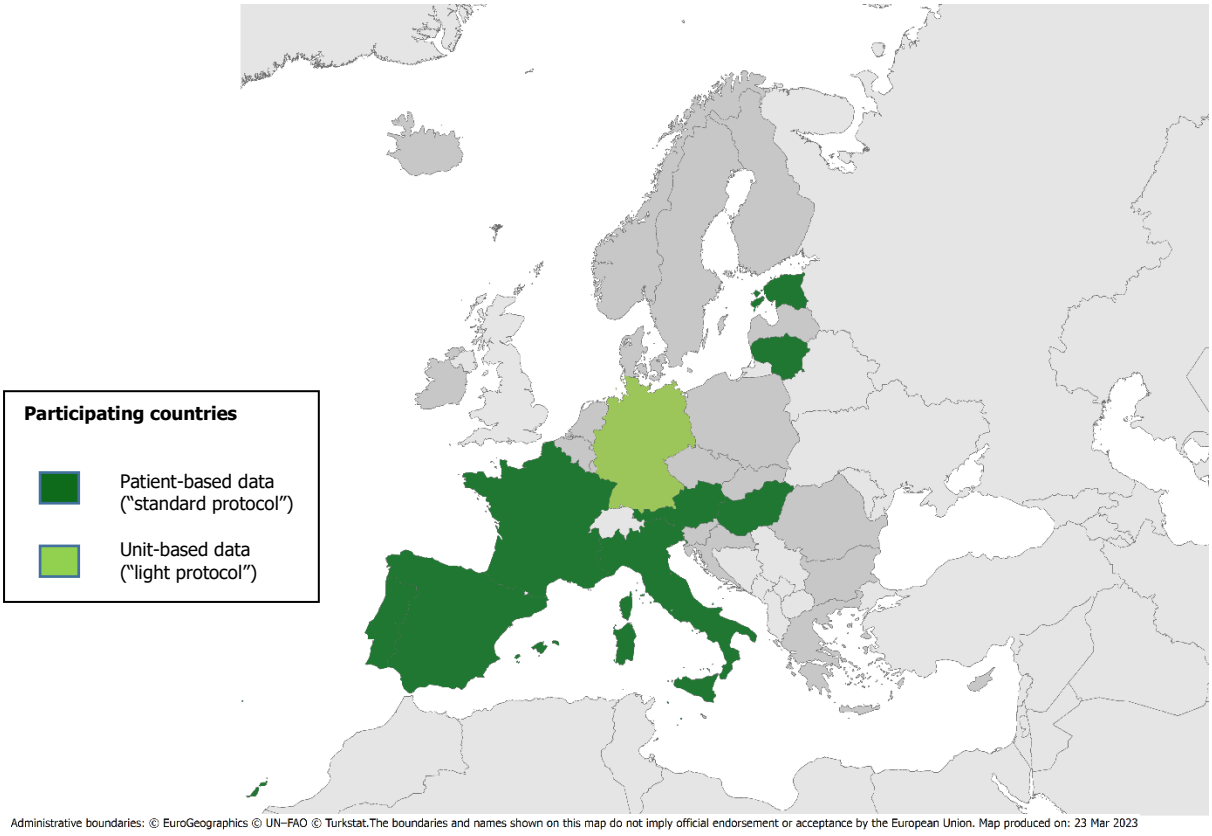
The number of HAIs, percentage of HAIs associated with the presence of a relevant device, the incidence density of HAIs per 1 000 patient-days and the incidence density of HAIs adjusted per 1 000 days of device use were estimated. For the estimation of device-adjusted incidence from patient-based data, ICUs with fewer than 20 patients in the surveillance dataset and 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. Data from Germany were excluded from the estimation of EU/EEA incidence, as the number of patients staying only more than two days in the ICU used as denominator was not available. The 10 most frequently isolated microorganisms for each type of HAI and antimicrobial resistance percentages for *Staphylococcus aureus, Enterococcus* spp., *Enterobacteriaceae, Pseudomonas aeruginosa*, and *Acinetobacter baumannii* are presented. Trends in median device-adjusted incidence rates of intubation-associated pneumonia (IAP) and CLABSI between 2008 and 2020 were analysed by linear regression. Only countries that provided data without interruption during this entire period were included in the analysis.

Optionally, countries submit antimicrobial use data for each patient as 'treatment-days' or 'days of therapy' (DOTs) in the 'standard' surveillance option. Antimicrobial indication per 100 DOTs and the incidence density of use of each

antimicrobial group in DOTs 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 the 'standard' and 'light' surveillance options. These indicators include: a) alcohol hand rub consumption in the 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 2020, 10 networks in nine countries (Austria, Estonia, France, Germany, Hungary, Italy/GiViTI, Italy/SPIN-UTI, Lithuania, Portugal, and Spain) reported data from 1 058 hospitals and 1 378 ICUs (Figure 1). The median size of the participating ICUs was 12 beds ranging from two to 54 beds. One country (Germany) only provided unit-based data. The remaining eight countries provided patient-based data. Six countries (Estonia, Hungary, Italy, Lithuania, Portugal, and Spain) reported data on antimicrobial use. Two countries/networks (Estonia and Italy/SPIN-UTI) provided data on the outcome of HAIs and, in case of death, the relationship between HAI and death. The Italy/SPIN-UTI network reported data on structure and process indicators of infection prevention and control and of antimicrobial stewardship.

Figure 1. Participation in surveillance of healthcare-associated infections in intensive care units, EU/EEA, 2020



Source: ECDC, HAI-Net, 2020

Epidemiology

Of 87 513 patients staying in an ICU for more than two days (patient-based data), 11 124 patients (12.7%) presented with at least one HAI.

ICU-acquired pneumonia

Of 6 699 cases of pneumonia, 70.8% were associated with intubation. Among patients staying in an ICU for more than two days, 7.7% were affected by at least one episode pneumonia. The incidence density of pneumonia was 7.0 episodes per 1 000 patient-days.

The mean incidence density per ICU was 7.3 pneumonia episodes per 1 000 patient-days (ICU IQR:1.6-10.2) (Table 1), varying from 4.1 in ICUs with less than 30% intubated patients to 6.2 in ICUs with 30–59% intubated patients, and 8.5 in ICUs with more than 60% intubated patients.

Table 1. ICU-acquired pneumonia by country/network, EU/EEA, 2020

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	148 509	267	1.8	1.8	0.0	0.0	2.7
Estonia	2 919	14	4.8	3.8	1.9	2.9	4.9
France	131 279	1 543	11.8	10.5	4.9	8.1	14.0
Germany	2 532 411*	4 819	1.9	1.9	0.6	1.3	2.7
Hungary	6 847	39	5.7	5.2	0.4	3.4	6.7
Italy/GiViTI	256 970	1 675	6.5	5.7	2.5	4.9	8.6
Italy/SPIN-UTI	17 224	196	11.4	14.8	2.7	9.0	15.3
Lithuania	17 205	132	7.7	6.8	0.0	2.0	11.1
Portugal	56 438	472	8.4	7.5	3.6	6.8	9.7
Spain	313 615	2 361	7.5	7.2	2.3	6.2	10.8
EU/EEA**	**951 006****	**6 699****	**7.0**	**7.3**	**1.6**	**5.6**	**10.2**

Source: ECDC, HAI-Net data 2020.
Percentiles: distribution of incidence per ICU.
**Patient-days from Germany include patients staying in the ICU for less than two days.*
*** Does not include Germany (see above).*

In patient-based surveillance, the mean device-adjusted rate per ICU was 10.2 intubation-associated pneumonia episodes per 1 000 intubation-days and varied between 3.4 in Austria, and 16.6 per 1 000 intubation-days in Italy/SPIN-UTI (Table 2).

Table 2. ICU-acquired intubation-associated pneumonia (IAP) rates by country/network, EU/EEA, 2020

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	77 727	49.5	234	3.0	3.4	0.0	0.0	4.7
Estonia	1 731	57.1	11	6.4	5.5	3.6	5.1	7.0
France	70 034	50.8	1 128	16.1	14.3	8.7	13.7	19.9
Hungary	3 920	64.3	31	7.9	7.0	1.5	4.9	11.7
Italy/GiViTI	169 603	65.1	1 556	9.2	7.8	3.6	7.3	11.4
Italy/SPIN-UTI	9 903	64.5	153	15.5	16.6	8.9	14.4	20.8
Lithuania	7 728	41.8	102	13.2	12.1	0.0	9.5	20.1
Portugal	36 049	62.9	411	11.4	10.2	5.1	9.0	13.9
Spain	179 614	54.7	1 935	10.8	10.8	5.0	10.0	15.3
EU/EEA	**556 309**	**55.4**	**5 561**	**10.0**	**10.2**	**3.5**	**8.8**	**15.1**

Source: ECDC, HAI-Net patient-based data 2020.
Percentiles: distribution of incidence per ICU.

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

Table 3. Distribution of the 10 most frequently isolated microorganisms in ICU-acquired pneumonia (IAP) episodes, by country/network, EU/EEA, 2020

Microorganism	Austria (n=322)	Estonia (n=9)	France (n=1 505)	Germany (n= 4 014)	Hungary (n=35)	Italy/GiViTI (n=1 316)	Italy/SPIN-UTI (n=126)	Lithuania (n=104)	Portugal (n=412)	Spain (n=1 633)	Total (n=9 719)
Pseudomonas aeruginosa	14.0	22.2	23.3	14.2	17.1	27.0	19.8	8.7	29.1	31.2	21.1
Klebsiella spp.	20.5	33.3	13.4	20.3	5.7	17.5	21.4	23.1	24.0	18.6	19.0
Staphylococcus aureus	10.6	0.0	19.4	18.6	20.0	12.4	15.1	19.2	14.1	15.5	16.6
Escherichia coli	12.1	22.2	9.8	15.6	2.9	9.7	1.6	12.5	5.1	6.3	11.5
Enterobacter spp.	10.9	0.0	13.2	10.8	11.4	9.6	3.2	10.6	10.0	9.3	10.5
Serratia spp.	6.8	22.2	4.7	7.5	2.9	4.0	5.6	3.8	2.9	5.9	6.1
Candida spp.	18.9	0.0	4.1	4.8	0.0	3.4	15.1	1.0	3.4	1.6	4.5
Acinetobacter spp.	0.6	0.0	2.3	1.5	28.6	12.9	11.1	15.4	4.1	1.7	3.8
Stenotrophomonas maltophilia	2.8	0.0	1.9	3.6	5.7	0.0	5.6	1.0	2.2	8.0	3.7
Haemophilus spp.	2.8	0.0	4.1	3.1	5.7	3.5	1.6	4.8	5.1	1.8	3.3

n = number of isolates.
Source: ECDC, HAI-Net patient-based and unit-based data, 2020.

ICU-acquired bloodstream infections

A total of 5 578 cases of ICU-acquired BSI were reported. On average, ICU-acquired BSIs occurred in 6.4% of patients staying in an ICU for more than two days. The mean incidence density per ICU was 5.9 BSI episodes per 1 000 patient-days (ICU IQR: 0.7–8.0) (Table 4). The respective mean incidence density of primary BSIs (including catheter-related infections and infections of unknown origin) per ICU was 3.8 episodes per 1 000 patient-days (ICU IQR: 0.0–5.0) (Table A4). BSIs were catheter-related in 37.7% of cases, secondary to another infection in 29.3% of cases, and of unknown origin in 24.7% of cases. When the BSI was secondary to another infection, the primary infection site was pulmonary (53.4%), gastrointestinal (7.6%), the urinary tract (20.1%), a surgical site (3.4%), skin and soft tissues (4.1%), or 'other' (11.4%).

Table 4. ICU-acquired bloodstream infection (BSI) rates by country, EU/EEA, 2020

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	148 509	243	1.6	1.5	0.0	0.0	1.8
Estonia	2 919	12	4.1	2.3	0.0	0.0	2.3
France	131 279	636	4.8	4.7	1.4	3.3	6.2
Germany	2 532 411*	2 694	1.1	1.1	0.3	0.8	1.5
Hungary	6 847	32	4.7	3.2	0.2	3.3	3.7
Italy/GiViTI	256 970	1 759	6.9	6.6	3.3	5.8	9.3
Italy/SPIN-UTI	17 224	84	4.9	3.9	0.0	2.8	6.1
Lithuania	17 205	24	1.4	1.4	0.0	0.0	0.0
Portugal	56 438	234	4.2	4.1	1.7	3.0	6.4
Spain	313 615	2 553	8.1	7.4	3.4	6.7	10.1
EU/EEA**	**951 006****	**5 578****	**5.9**	**5.2**	**0.7**	**3.9**	**8.0**

Source: ECDC, HAI-Net data 2020.
Percentiles: distribution of incidence per ICU.
**Patient-days from Germany include patients staying in the ICU for less than two days.*
*** Does not include Germany (see above).*

In patient-based surveillance, the central vascular catheter (CVC) utilisation rate was on average 80.9 CVC-days per 100 patient-days. It was the lowest (58.0) in Lithuania and the highest (88.0) in the Italy/GiViTI network. The

mean device-adjusted rate in patients staying in an ICU for more than two days was 4.9 central line-associated BSI (CLABSI) episodes per 1 000 CVC-days (ICU IQR: 0.0–7.6), varying from 0.6 in Lithuania to 5.8 in Spain (Table 5).

Table 5. ICU-acquired central line-associated bloodstream infection (CLABSI) rates by country, EU/EEA, 2020

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	125 884	84.8	108	0.9	0.8	0.0	0.0	0.4
Estonia	2 477	84.9	7	2.8	1.5	0.0	0.0	1.5
France	84 956	65.3	265	3.1	3.0	0.0	2.0	4.3
Hungary	4 911	77.3	20	4.1	3.1	0.0	1.2	4.9
Italy/GiViTI	224 894	87.9	1 024	4.6	4.4	1.6	3.7	6.3
Italy/SPIN-UTI	12 258	77.3	50	4.1	3.7	0.0	3.7	6.3
Lithuania	9 772	60.5	12	1.2	0.6	0.0	0.0	0.0
Portugal	47 816	84.7	123	2.6	2.4	0.2	1.5	3.1
Spain	250 091	80.4	1 436	5.7	5.8	2.2	4.8	7.4
EU/EEA	**763 059**	**80.9**	**3 045**	**4.0**	**3.6**	**0.0**	**2.5**	**5.7**

Source: ECDC, HAI-Net patient-based data 2020.
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 *Pseudomonas aeruginosa* (Table 6).

Table 6. Distribution of the 10 most frequently isolated microorganisms in ICU-acquired bloodstream infection (BSI) episodes by country/network, EU/EEA, 2020

Microorganism	Austria (n=254)	Estonia (n=8)	France (n=638)	Germany (n=2 637)	Hungary (n=26)	Italy/GiViTI (n=1 641)	Italy/SPIN-UTI (n=70)	Lithuania (n=24)	Portugal (n=219)	Spain (n=2 147)	Total (n=7 445)
Coagulase-negative staphylococci	46.1	0.0	15.5	30.2	7.7	17.8	25.7	25.0	19.2	30.6	26.7
Enterococcus spp.	11.0	62.5	12.1	23.2	7.7	12.9	15.7	8.3	13.2	21.2	18.9
Klebsiella spp.	11.0	12.5	16.1	8.7	15.4	15.6	17.1	16.7	18.3	10.2	11.5
Pseudomonas aeruginosa	3.5	0.0	14.6	4.5	7.7	13	7.1	8.3	12.8	9.5	8.7
Staphylococcus aureus	6.7	0.0	10.2	10.3	15.4	6.5	2.9	12.5	8.7	6.0	8
Candida spp.	7.1	0.0	8	7.1	0.0	8	11.4	0.0	8.2	8.1	7.6
Escherichia coli	7.9	0.0	7.8	8.5	15.4	6.7	2.9	8.3	5.9	3.7	6.6
Enterobacter spp.	4.3	25.0	11.3	4.2	7.7	8	2.9	0.0	5.9	5.1	5.9
Serratia spp.	2.4	0.0	2.5	2.8	3.8	3.4	5.7	4.2	6.4	4.1	3.3
Acinetobacter spp.	0.0	0.0	1.9	0.5	19.2	8.2	8.6	16.7	1.4	1.4	2.7

n = number of isolates.
**Data from Germany only on primary bloodstream infections.*
Source: ECDC, HAI-Net patient-based and unit-based data 2020.
Coagulase-negative staphylococci: includes unspecified Staphylococcus *spp.*

ICU-acquired urinary tract infections

A total of 2 475 cases of ICU-acquired UTI were reported. On average, ICU-acquired UTIs occurred in 3.2% of patients staying in an ICU for more than two days, with 95.2% of UTI episodes being associated with the use of a urinary catheter. The mean incidence density per ICU was 3.0 urinary tract infection episodes per 1 000 patient-days (ICU IQR: 0.0–4.4) (Table 7).

Table 7. ICU-acquired urinary tract infection (UTI) rates by country/network, EU/EEA, 2020

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	148 509	173	1.16	1.0	0.0	0.0	0.8
Estonia	2 919	8	2.7	2.9	2.0	2.1	3.1
Germany	2 532 411*	2 608	1.0	1.0	0.0	0.6	1.3
Hungary	6 847	10	1.5	1.2	0.0	0.5	1.9
Italy/GiViTI	256 970	658	2.6	2.5	0.5	1.4	3.5
Italy/SPIN-UTI	17 224	55	3.2	5.1	0.0	2.4	4.0
Lithuania	17 205	47	2.7	2.5	0.0	0.0	3.9
Portugal	56 438	107	1.9	1.7	0.4	1.1	1.7
Spain	313 615	1 417	4.5	3.9	0.5	3.2	5.8
EU/EEA**	**819 727****	**2 475****	**3.0**	**2.9**	**0.0**	**1.4**	**4.4**

Source: ECDC, HAI-Net data 2020.
Percentiles: distribution of incidence per ICU.
**Patient-days from Germany include patients staying in the ICU for less than two days.*
*** Does not include Germany (see above).*

On average, urinary catheters were used in 80% of the patient-days. The mean device-adjusted rate in patients staying in an ICU for more than two days was 4.0 catheter-associated UTI episodes per 1 000 catheter-days (ICU IQR: 0.0–6.0).

The most frequently isolated microorganisms in UTI 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, 2020

Microorganism	Austria (n=225)	Estonia (n=8)	Germany (n=2 823)	Hungary (n=9)	Italy/GiViTI (n=628)	Italy/SPIN-UTI (n=19)	Lithuania (n=40)	Portugal (n=106)	Spain (n=1 129)	Total (n=4 987)
Escherichia coli	16.4	37.5	32.8	33.3	28.2	21.1	40.0	21.7	18.0	27.9
Enterococcus spp.	20.4	12.5	20.1	33.3	24.2	5.3	10.0	12.3	31.9	23.0
Pseudomonas aeruginosa	9.8	37.5	14.4	22.2	15.3	15.8	2.5	14.2	14.5	14.3
Klebsiella spp.	10.7	12.5	13.5	11.1	9.6	21.1	20.0	23.6	10.7	12.6
Candida spp.	27.6	0.0	0.0	0.0	12.9	15.8	7.5	12.3	15.5	6.8
Proteus spp.	2.2	0.0	7.8	0.0	2.9	10.5	7.5	6.6	2.6	5.7
Enterobacter spp.	4.9	0.0	6.0	0.0	3.2	0.0	7.5	4.7	4.3	5.1
Citrobacter spp.	3.1	0.0	2.5	0.0	1.1	5.3	2.5	1.9	0.7	1.9
Coagulase-negative staphylococci	3.6	0.0	1.1	0.0	2.1	5.3	2.5	0.9	1.2	1.4
Serratia spp.	1.3	0.0	1.8	0.0	0.6	0.0	0.0	1.9	0.6	1.3

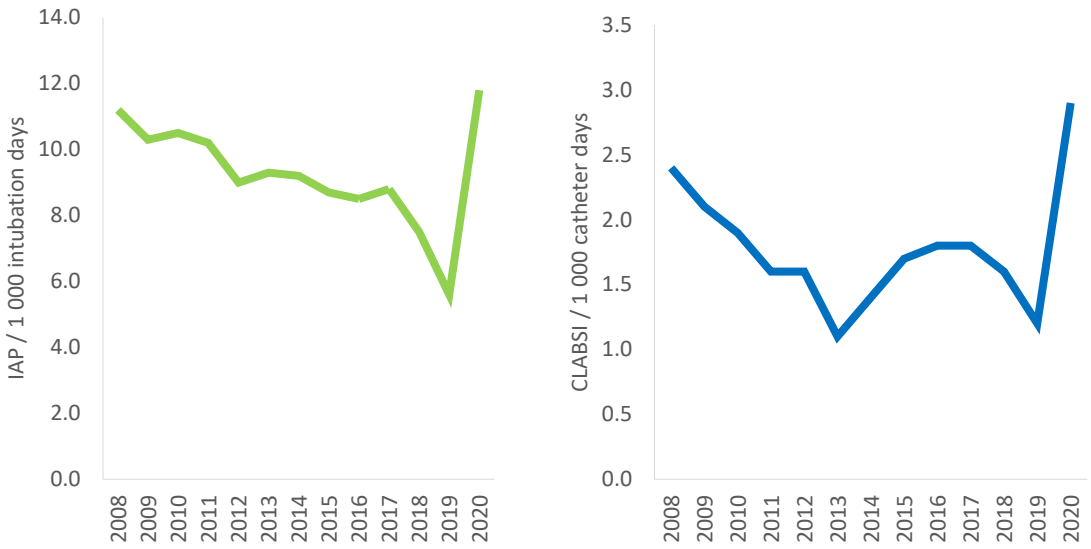
n = number of isolates.
Source: ECDC, HAI-Net ICU 2020

Trends

Trend analysis of yearly 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 decreasing trend to a sharp increase in 2020, both for IAP and CLABSI (Figure 2)

Figure 2. Incidence density trend of intubation-associated pneumonia (IAP) and central line-associated bloodstream infections (CLABSI), five EU/EEA countries/networks*, 2008–2020

a. IAP **b. CLABSI**



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

Antimicrobial use

In total, 756 012 days of therapy (DOT) with antimicrobials were recorded in 2020. Antimicrobial treatment was empirical in 50.8% (range 38.8-71.9%) of DOTs, directed in 36.6% (range 24.3–52.1%), prophylactic in 9.7% (range 2.0–17.6%) and selective digestive decontamination 2.9% (range 0.0–6.1%). The reported antimicrobial use of selected antimicrobials/antimicrobial groups was: carbapenems, 13.4 DOT per 100 patient-days (range 10.1-29.3); third- and fourth-generation cephalosporins, 11.5 (range 4.0–19.5); piperacillin-tazobactam, 10.1 (range 0.0–13.7); fluoroquinolones, 5.6 (range 2.1-9.8); glycopeptides, 5.3 (range 3.9-8.9); and polymyxins, 0.9 (range 0.0–1.8) (Table 9).

Table 9. Antimicrobial use indication and selected groups of antimicrobials, by country/network, EU/EEA, 2020

Country/Network	Antimicrobial indication (% DOT)				Antimicrobial use (DOT/100 patient-days)					
	Empirical	Directed	Prophylactic	SDD	Carbapenems	Cephalosporins (3rd- and 4th-generation)	Piperacillin - tazobactam	Fluoroquinolones	Glycopeptides	Polymyxins
Estonia	59.8	36.6	3.5	0.1	29.3	4.0	13.7	4.4	7.8	0.1
Hungary	61.6	36.4	2.0	0.0	15.9	14.4	4.4	6.1	5.0	1.1
Italy/GiViTI	38.8	52.1	9.1	0.0	10.1	6.7	12.6	2.9	6.7	0.0
Italy/SPIN-UTI	48.6	33.4	17.6	0.3	14.4	19.5	17.6	9.8	6.0	4.9
Lithuania	63.9	31.7	3.6	0.8	10.9	8.2	4.6	2.1	4.9	1.8
Portugal	71.9	24.3	3.7	0.0	16.3	10.1	0.0	2.6	8.9	0.7
Spain	55.3	27.3	11.3	6.1	14.6	14.0	10.3	7.6	3.9	0.8

Source: ECDC, HAI-Net patient-based data 2020.
DOT: 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 resistance (MRSA) in 13.8% of *S. aureus* isolates (n=1 949), vancomycin resistance in 15.7% of *Enterococcus* spp. isolates (n=1 793), ceftazidime resistance in 23.0% of *P. aeruginosa* isolates (n=1 793), and resistance to third-generation cephalosporins in 22.0% of *E. coli* isolates (n=1 133), 38.2% of *Klebsiella* spp. isolates (n=2 043) and 38.7% of *Enterobacter* spp. isolates (n=1 151). Carbapenem resistance was reported in 11.2% of *Klebsiella* spp. isolates (n=1 662), 0.5% of *E. coli* isolates (n=979), 5.1% of *Enterobacter* spp. isolates (n=956), 25.8% of *P. aeruginosa* isolates (n=2 527), and 54.3% of *Acinetobacter baumannii* (n=151) isolates.

Outcome of healthcare-associated infections

Two countries provided data for a total of 402 HAIs on the outcome of HAIs and the relation of the outcome to the HAI. In 172 (42.8%) HAIs, the patient was discharged alive, in 23 (5.7%) HAIs the patient died and the death was assessed as definitely linked to the HAI, in 45 (11.2%) HAIs the patient died and the death was assessed as not linked to the HAI, in 96 (23.9%) HAIs the patient died and the death was assessed as probably linked to the HAI, and in 66 (16.4%) 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, 2020

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 (%)
Estonia	33	66.7	0.0	33.3	0.0	0.0
Italy/SPIN-UTI	354	41.8	6.5	21.5	11.6	18.6

Structure and process indicators of infection prevention and control and of antimicrobial stewardship

Only one network, Italy/SPIN-UTI, reported structure and process indicators of infection prevention and control and of antimicrobial stewardship (Tables 11 and 12).

Table 11. Structure and process indicators for infection prevention and control in intensive care units (ICUs), Italy/SPIN-UTI network, 2020

Country/Network	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)
Italy/SPIN-UTI	26	8	12.6	4.7	162.2

Table 12. Process indicators assessed through chart review or direct observation in intensive care units (ICUs), Italy/SPIN-UTI, 2020

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)
Italy/SPIN-UTI	26	55.8	85.5	81.5	47.4	73.4

Discussion

Ten networks in nine EU/EEA countries submitted data on surveillance of ICU-acquired HAIs in 2020.

HAI surveillance at the local and national levels 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 produce 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 in 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 2020, there were considerable increases in device-adjusted HAI rates of ICU-acquired pneumonia, BSIs and UTIs across the participating networks compared to previous years [4,5], which may reflect the effect of the COVID-19 pandemic. These results are consistent with previously published data from Europe [6] and the U.S. [7] but should be interpreted with caution due to differences in the participating countries and networks over the years. The increases in the incidence 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. Further in-depth analysis is required to identify the extent that each of these factors contributed to this increase.

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 participating countries providing data on antimicrobial use, antimicrobials continued to be prescribed, i.e. more reported DOTs, as empirical 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 as well as local prescribing practices.

The distribution of microorganisms associated with HAIs in 2020 was similar to that in 2019, with the caveat that the overall results were not directly comparable due to the differences in reporting countries. In 2020, *P. aeruginosa* was the most common organism associated with pneumonia followed by *Klebsiella* spp. and *S. aureus*. Among BSIs, coagulase-negative staphylococci remained the most commonly isolated organisms 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 higher proportions of HAIs caused by *Klebsiella* spp. in some countries. In 2020 and in contrast to 2019, *Acinetobacter* spp. was among the 10 most common organisms isolated from both pneumonia and bloodstream infections, consistent with reported increases in the incidence of *Acinetobacter* spp. BSIs reported by EARS-Net [8].

This report confirms the importance of antimicrobial resistance in gram-negative bacteria as a cause of HAIs in ICUs in the EU/EEA in 2020, with resistance percentages being comparable to previous years. The high percentages of resistance to carbapenems of *P. aeruginosa*, *Acinetobacter* spp. and *K. pneumoniae* isolates reflect the challenges of treating HAIs in ICU patients, a highly vulnerable patient population.

In 2020, only two participating countries provided data on HAI outcomes and the relation of the HAI to death in patients who died. Almost one in three HAIs were assessed to have contributed to death, either definitely or possibly.

There was considerable inter-ICU variability in most of the structure and process indicators of infection prevention and control and of antimicrobial stewardship in the only country/network reporting such data in 2020. 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 [9]. 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 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 of antimicrobial use. Further understanding of the variation in incidence density and of the burden of HAIs in ICUs should be facilitated by 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 ICU surveillance data in the future. There is still a need to increase participation of countries to surveillance of ICU-acquired infections and collection of data on structure and process indicators of IPC and antimicrobial stewardship for benchmarking of ICUs in the countries/networks that already participate in HAI-Net ICU.

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Annex

Table A1. Healthcare-associated infections acquired in intensive care units (ICUs): surveillance systems overview, 2020

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 of REPIAS	HAI-surveillance network in adult ICUs	https://www.spiadi.fr	Regional Centre 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

** The European Surveillance System (TESSy) is a system for the collection, analysis and dissemination of data on communicable diseases. EU/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, 2020

Country/Network	Number of ICUs	ICU size (median no. beds)	Type of ICU (%)				
			Medical	Surgical	Mixed	Coronary	Other / unknown
Austria	79	6	27.9	72.2	0.0	0.0	0.0
Estonia	4	10	0.0	0.0	100.0	0.0	0.0
France	147	12	6.1	7.5	50.3	2.7	32.7
Germany	815	13	12.2	16.4	55.7	2.0	11.4
Hungary	10	9	0.0	10.0	70.0	0.0	20.0
Italy/GiViTI	105	8	0.0	13.3	79.1	0.0	4.8
Italy/SPIN-UTI	26	8	0.0	3.9	65.4	11.5	19.2
Lithuania	29	6	3.5	6.9	72.4	3.5	10.3
Portugal	30	10	6.7	0.0	50.0	0.0	43.3
Spain	188	12	1.6	4.3	77.7	1.6	14.9

NA: Not available.

Table A3. Patient demographics and risk factors at admission for patients staying more than 2 days in the intensive care unit (ICU) from countries that provided patient-based data, EU/EEA, 2020

Country/Network	Patients (n)	Number of patient-days	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	15 821	148 509	9.4	39.4	70	NA	52.9	11.2	52.0	21.2	22.6	60.7	58.6	81.2	0.1	13.1
Estonia	284	2 919	10.3	45.1	68	NA	62.7	4.6	68.7	6.0	25.4	70.4	95.8	91.6	7.4	12.7
France	11 120	131 279	11.8	36.7	66	42	5.4	5.8	76.4	8.9	14.4	61.3	81.8	66.0	1.3	11.8
Hungary	743	6 847	9.2	39.8	66	0	56.7	21.9	35.9	6.9	18.4	68.0	90.6	70.9	24.0	21.5
Italy/GiViTI	23 185	256 970	11.1	36.0	68	36	52.9	10.5	60.3	17.3	22.5	NA	NA	NA	2.1	19.4
Italy/SPIN-UTI	1 289	17 224	13.4	34.7	69.5	41	71.2	1.8	67.3	10.9	21.8	40.0	71.0	36.7	4.5	42.1
Lithuania	2 048	17 205	8.4	39.6	66	NA	47.7	15.2	62.8	4.7	31.4	50.4	77.7	57.4	13.1	17.4
Portugal	4 881	56 438	11.6	35.2	66	43	41.2	8.2	71.4	9.8	18.8	71.8	94.0	88.6	12.0	17.4
Spain	28 142	313 615	11.1	34.3	64	36	50.5	5.8	74.0	15.3	10.8	54.1	85.0	76.9	7.2	18.2

NA: Not available.

Table A4. Intensive care unit (ICU)-acquired primary bloodstream infection (BSI) rates by country, EU/EEA, 2020

Country/Network	Patient-days (n)	Primary BSI episodes (n)	Primary BSI incidence density (episodes per 1 000 patient-days)				
			Aggregated	Mean	25th percentile	Median	75th percentile
Austria	148 509	163	1.1	1.0	0.0	0.0	0.5
Estonia	2 919	152	2.4	1.3	0.0	0.0	1.3
France	131 279	391	3.0	2.9	0.6	2.1	4.2
Hungary	6 847	1 075	3.5	2.6	0.0	1.1	4.2
Italy/GiViTI	256 970	75	4.2	4.0	1.5	3.5	5.8
Italy/SPIN-UTI	17 224	14	4.7	4.4	1.3	4.1	6.4
Lithuania	17 205	136	0.9	0.7	0.0	0.0	0.2
Portugal	56 438	1 697	2.4	2.3	0.8	1.3	3.1
Spain	313 615	163	5.5	5.2	2.1	4.5	6.9

Table A5. Intensive care unit (ICU)-acquired microbiologically confirmed central venous catheter (CVC)-related bloodstream infection rates by country among countries performing catheter-related infections surveillance, EU/EEA, 2020

Country/Network	CVC days (n)	CVC use (days per 100 patient-days)	CRI episodes (n)	Central venous catheter-related bloodstream infection incidence density (episodes per 1 000 CVC-days)				
				Aggregated	Mean	25th percentile	Median	75th percentile
Estonia	2 477	84.9	3	1.2	0.6	0.0	0.0	0.6
France	84 956	65.3	97	1.1	0.8	0.0	0.0	1.1
Hungary	4 911	77.3	19	3.9	3.0	0.0	1.2	4.7
Italy/GiViTI	224 894	87.9	549	2.4	2.4	0.6	1.6	3.5
Italy/SPIN-UTI	12 258	77.3	28	2.3	2.4	0.0	0.0	4.7
Lithuania	9 772	60.5	2	0.2	0.1	0.0	0.0	0.0

CRI, catheter-related infection.

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, 2020

Country/Network	CVC days (n)	CVC use (days per 100 patient-days)	CRI episodes (n)	Central venous catheter-related bloodstream infection incidence density (episodes per 1 000 CVC-days)				
				Aggregated	Mean	25th percentile	Median	75th percentile
Austria	125 884	84.8	108	0.9	0.8	0.0	0.0	0.4
Estonia	2 477	84.9	7	2.8	1.5	0.0	0.0	1.5
France	84 956	65.3	148	1.7	1.1	0.0	0.0	1.9
Hungary	4 911	77.3	20	4.1	3.1	0.0	1.2	4.9
Italy/GiViTI	224 894	87.9	1024	4.6	4.4	1.6	3.7	6.3
Italy/SPIN-UTI	12 258	77.3	50	4.1	3.7	0.0	3.7	6.3
Lithuania	9 772	60.5	12	1.2	0.6	0.0	0.0	0.0
Portugal	47 816	84.7	123	2.6	2.4	0.2	1.5	3.1
Spain	250 091	80.4	1436	5.7	5.8	2.2	4.8	7.4

CRI, catheter-related infection.