SURVEILLANCE REPORT

Healthcare-associated infections acquired in intensive care units

Annual Epidemiological Report for 2018

Key facts

- In 2018, 9 860 (7.8%) 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, 6% presented with pneumonia, 3% with bloodstream infection (BSI), and 2% with urinary tract infection (UTI).
- Some 97% of pneumonia episodes were associated with intubation, 41% of BSI episodes were catheter-related, and 99% 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 bloodstream infections, and *Escherichia coli* in ICU-acquired urinary tract infections.
- Antimicrobial use was empirical in 59% of days of therapy (DOTs), directed in 25% of DOTs, and prophylactic in 12% of DOTs.
- 16% of *Staphylococcus aureus* isolates were oxacillin-resistant (MRSA) and 13% of *Enterococcus* spp. isolates were glycopeptide-resistant. Resistance to third-generation cephalosporins was reported in 15% of *E. coli* isolates, 40% of *Klebsiella* spp. isolates and 36% of *Enterobacter* spp. isolates. Carbapenem resistance was reported in 12% of *Klebsiella* spp. isolates, 28% of *P. aeruginosa* isolates and 71% 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 2018 retrieved from The European Surveillance System (TESSy) on 10 November 2022. 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.

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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 bloodstream infections (BSIs) and pneumonia. Collection of data on urinary tract infections (UTIs) and central vascular 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).

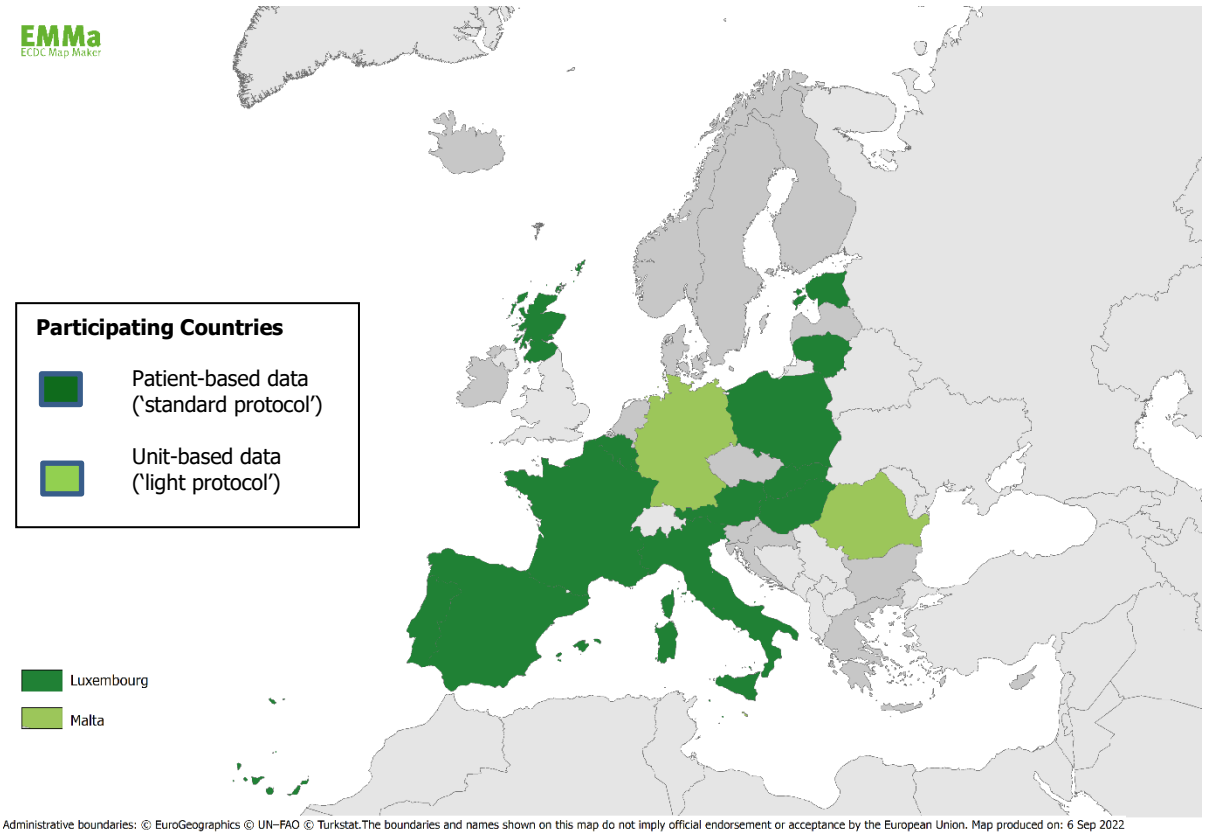
An HAI was defined as device-associated when the relevant device was used (even intermittently) in the 48 hours (two days) before onset of infection. For countries performing surveillance of catheter-related infections , a microbiologically confirmed central vascular catheter (CVC)-related BSI was defined 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 BSI. 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 infections.

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 device-adjusted incidence rates of intubation-associated pneumonia (IAP) and CLABSI between 2008 and 2016 were analysed by linear regression. Only countries and surveillance networks that provided data without interruption during this 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 were estimated. Countries also submit structure and process indicators of prevention of HAIs and antimicrobial resistance, measured at the unit level in both the standard and 'light' (unit-based) surveillance options. These indicators include: a) alcohol hand rub consumption in the previous year, b) staffing levels (in a period of 7 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 2018, 16 countries reported data from 1 175 hospitals and 1 488 ICUs (Figure 1): Austria, Belgium, Estonia, France, Germany, Hungary, Italy, Lithuania, Luxembourg, Malta, Poland, Romania, Portugal, Slovakia, Spain, and the United Kingdom (UK–Scotland). The median size of the participating ICUs was 12 beds ranging from 1 to 65 beds. Three countries (Germany, Malta and Romania) only provided unit-based data, and one country (Belgium) provided both patient-based and unit-based data. The remaining 12 countries provided patient-based data. Eight countries (Belgium, Estonia, Hungary, Italy, Lithuania, Poland, Portugal, and Spain) reported data on antimicrobial use. Three countries (Italy, Poland and Slovakia) provided data on outcome of HAIs and the relationship of the HAI to death in case of death. Four countries (Italy, Malta, Poland, and Romania) reported data on structure and process indicators of infection prevention and control and antimicrobial stewardship. France and Slovakia reported data on alcohol hand rub consumption in the previous year.

Figure 1. Participation in surveillance of healthcare-associated infections in intensive care units, EU/EEA, 2018



Source: ECDC, HAI-Net, 2022

Epidemiology

Of 126 791 patients staying in an ICU for more than two days (patient-based data), 9 860 (7.8%) patients presented with at least one HAI.

ICU-acquired pneumonia

Of 7 515 cases of pneumonia reported, 96.5% were associated with intubation. Among patients staying in an ICU for more than two days, 5.9% were affected by at least one episode of pneumonia. The incidence of pneumonia was 6.3 episodes per 1 000 patient-days.

The mean incidence density per ICU was 3.7 pneumonia episodes per 1 000 patient-days (ICU IQR:0.7-4.6), varying from 1.7 in ICUs with less than 30% intubated patients to 3.1 in ICUs with 30-59% intubated patients, and 7.2 in ICUs with more than 60% intubated patients.

In patient-based surveillance, the mean device-adjusted rate was 9.3 intubation-associated pneumonia episodes per 1 000 intubation-days and varied between 2.3 in Luxembourg, and 16.7 in Slovakia (Table 1).

Table 1. ICU-acquired intubation-associated pneumonia rates by country/network, EU/EEA, 2018

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
Belgium	37.4	6.2	2.2	3.4	8.9
Estonia	54.3	8.2	5.5	5.6	9.6
France	50.6	13.4	8.5	13.4	16.8
Hungary	56.8	9.8	4.4	8.2	17.1
Italy	57.0	13.5	2.9	14.9	19.7
Lithuania	38.2	10.3	0.0	0.0	15.4
Luxembourg	27.1	2.3	0.9	1.3	3.7
Poland	76.2	14.9	7.1	13.1	16.1
Portugal	62.9	6.6	3.8	6.3	8.2
Slovakia	66.9	16.7	16.7	16.7	16.7
Spain	38.7	5.8	0.0	4.2	7.7
United Kingdom – Scotland	54.0	4.0	1.1	3.0	5.6

Source: ECDC, HAI-Net patient-based data 2018. Percentiles: distribution of incidence per ICU

The most frequently isolated microorganisms in ICU-acquired pneumonia episodes were *Pseudomonas aeruginosa* followed by *Staphylococcus aureus*, *Klebsiella* spp. 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, EU/EEA, 2018

Microorganism	Belgium (n=68)	Estonia (n=7)	France (n= 5 295)	Germany (n= 5 199)	Hungary (n=23)	Italy (n=118)	Lithuania (n=179)	Luxembourg (n=5)	Poland (n=223)	Portugal (n=379)	Romania (n=296)	Slovakia (n=4)	Spain (n=481)	United Kingdom - Scotland (n=108)	Total (n=14 870)
Pseudomonas aeruginosa	14.7	14.3	23	14.9	17.4	20.3	10.1	20	23.3	23.2	19.3	25.0	27	8.3	19.3
Staphylococcus aureus	13.2	28.6	16.8	19.6	21.7	15.3	12.3	20	12.6	17.9	5.7	0.0	17.3	22.2	17.7
Klebsiella spp.	7.4	28.6	11.9	19.9	21.7	20.3	24.6	20	22	19.8	18.6	75	15.2	13.9	16.3
Escherichia coli	17.6	14.3	11.7	16.6	13	2.5	9.5	20	9.4	5.5	3.0	0.0	10.2	15.7	13.2
Enterobacter spp.	7.4	14.3	14.1	9.8	4.3	6.8	9.5	20	9.4	9.5	1.0	0.0	9.6	2.8	11.3
Serratia spp.	10.3	0.0	5.4	6.4	0.0	4.2	2.2	0.0	3.1	6.3	0.0	0.0	6.4	4.6	5.7
Haemophilus spp.	13.2	0.0	5.7	3.3	0.0	3.4	3.4	0.0	0.0	4.5	0.0	0.0	5.0	20.4	4.5
Acinetobacter spp.	2.9	0.0	2.8	1.6	13	22.9	19.6	0.0	17.5	3.7	49.7	0.0	4.0	1.9	4.2
Stenotrophomonas maltophilia	5.9	0.0	5	3.6	4.3	1.7	2.2	0.0	0.0	6.1	0.0	0.0	3.5	3.7	4.1
Proteus spp.	7.4	0.0	3.7	4.2	4.3	2.5	6.7	0.0	2.7	3.4	2.7	0.0	1.9	6.5	3.9

n = number of isolates. Source: ECDC, HAI-Net patient-based and unit-based data, 2018. United Kingdom: data from UK–Scotland only.

ICU-acquired bloodstream infections (BSIs)

A total of 4 174 cases of ICU-acquired BSI were reported. On average, ICU-acquired BSIs occurred in 3.3% of patients staying in an ICU for more than two days. The mean incidence density per ICU was 1.7 BSI episodes per 1 000 patient-days (ICU IQR: 0.3-2.6). The respective mean incidence density of primary BSIs (including catheter-related BSIs and BSIs of unknown origin) per ICU was 1.1 episodes per 1 000 patient-days (ICU IQR: 0.0-1.7) (Table A4). BSIs were catheter-related in 41.0% of cases, secondary to another infection in 33.9% of cases, and of unknown origin in 19.3% of cases. When the BSI was secondary to another infection, the primary infection site was pulmonary (44.3% cases), gastrointestinal (18.7%), the urinary tract (21.8%), a surgical site (1.9%), skin and soft tissues (5.5%), and 'other' in the remaining 6.8% cases. In patient-based surveillance, the CVC utilisation rate

was on average 68.7 CVC-days per 100 patient-days. It was the lowest (42.3) in Hungary and the highest (95.1) in Poland. The mean device-adjusted rate in patients staying in an ICU for more than two days was 3.3 central line-associated BSI (CLABSI) episodes per 1 000 CVC-days (ICU IQR: 0.0-4.8), varying from 0.0 in Estonia to 15.3 in Slovakia (Table 3).

Table 3. ICU-acquired central line-associated bloodstream infection (CLABSI) rates by country, EU/EEA, 2018

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
Belgium	69.5	1.7	0.0	0.8	1.1
Estonia	83.1	0.0	0.0	0.0	0.0
France	64.8	2.2	1.0	1.9	2.9
Hungary	43.9	3.1	0.0	2.3	4.5
Italy	72.9	4.8	0.0	1.9	8.7
Lithuania	44.1	1.1	0.0	0.0	1.7
Luxembourg	59.6	1.5	1.1	1.9	2.0
Poland	89.0	3.3	1.2	2.1	4.1
Portugal	83.9	2.5	0.7	1.9	2.9
Slovakia	91.6	15.3	15.3	15.3	15.3
Spain	69.4	2.1	0.0	1.6	3.4
United Kingdom – Scotland	59.3	1.7	0.0	1.4	2.6

Source: ECDC, HAI-Net patient-based data 2018. 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, 2018

Microorganism	Belgium (n=44)	Estonia (n=15)	France (n=2 216)	Germany * (n=3 053)	Hungary (n=49)	Italy (n=62)	Lithuania (n=41)	Luxembourg (n=24)	Malta (n=15)	Poland (n=139)	Portugal (n=259)	Romania (n= 107)	Slovakia (n=3)	Spain (n=860)	United Kingdom – Scotland (n=97)	Total (n=6 984)
Coagulase-negative staphylococci	13.6	18.3	27.0	12.2	17.7	39.0	20.8	0.0	12.0	1.4	12.0	5.6	0.0	28.4	23.7	22.7
Enterococcus spp.	31.8	12.3	20.8	22.4	4.8	2.4	8.3	6.7	14.3	23.0	14.3	6.5	66.7	12.2	11.3	16.3
Klebsiella spp.	20.5	10.2	10.7	4.1	19.4	9.8	29.2	60	22.0	28.1	22.0	35.5	0.0	12.3	6.2	12.2
Staphylococcus aureus	4.5	11.7	11.8	8.2	6.5	14.6	4.2	6.7	8.9	9.4	8.9	9.3	33.3	5.9	18.6	10.7
Escherichia coli	4.5	9.7	9.0	14.3	9.7	12.2	12.5	6.7	5.8	7.2	5.8	3.7	0.0	8.5	15.5	9.0
Pseudomonas aeruginosa	4.5	11.0	5.6	12.2	9.7	2.4	4.2	0.0	10.4	12.9	10.4	6.5	0.0	10.0	1.0	8.3
Enterobacter spp.	4.5	11.8	4.8	12.2	4.8	4.9	4.2	20	8.9	11.5	8.9	1.9	0.0	7.8	5.2	7.8
Candida spp.	11.4	10.4	6.2	6.1	9.7	0.0	4.2	0.0	6.9	0.7	6.9	0.0	0.0	7.4	13.4	7.5
Serratia spp.	4.5	3.3	3.2	0.0	4.8	4.9	12.5	0.0	8.1	2.2	8.1	1.9	0.0	4.0	4.1	3.5
Acinetobacter spp.	0.0	1.4	0.8	8.2	12.9	9.8	0.0	0.0	2.7	3.6	2.7	29.0	0.0	3.5	1.0	2.1

*n = number of isolates. * Data from Germany only on primary bloodstream infections.*
Source: ECDC, HAI-Net patient-based and unit-based data 2018. United Kingdom: data from UK – Scotland only.
Coagulase-negative staphylococci: includes unspecified Staphylococcus spp.

ICU-acquired urinary tract infections (UTIs)

A total of 1 189 cases of ICU-acquired UTI were reported. On average, ICU-acquired UTIs occurred in 2.2% of patients staying in an ICU for more than two days, with 99.1% of UTI episodes being associated with the use of a urinary catheter. The mean incidence density per ICU was 1.2 urinary tract infection episodes per 1 000 patient-days (ICU IQR: 0.0-1.9).

On average, urinary catheters were used in 84% of the patient-days. The mean device-adjusted rate in patients staying in an ICU for more than two days was 4.1 catheter-associated UTI episodes per 1 000 catheter-days (ICU IQR: 0.0-4.6).

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, EU/EEA, 2018

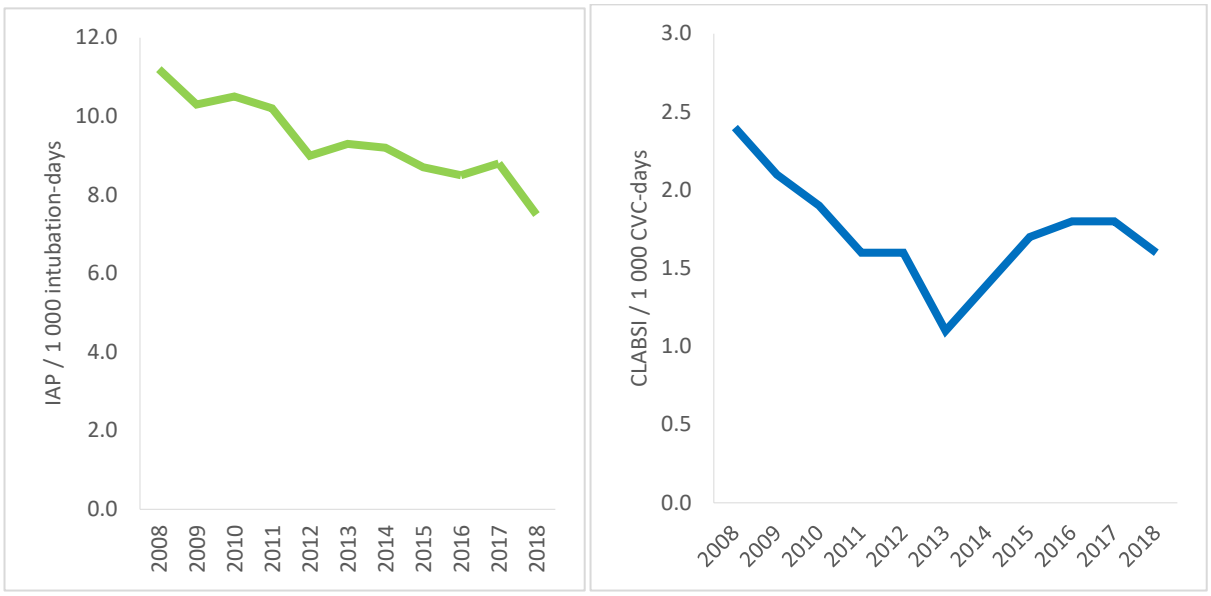
Microorganism	Estonia (n=5)	Germany (n=3 466)	Hungary (n=11)	Italy (n=15)	Lithuania (n=59)	Luxembourg (n=30)	Poland (n=53)	Portugal (n=131)	Romania (n=38)	Spain (n= 669)	Total (n=4 477)
Escherichia coli	40.0	33.4	0.0	20.0	25.4	36.7	15.1	28.2	5.3	31.5	32.7
Enterococcus spp.	40.0	22.6	27.3	26.7	20.3	30.0	26.4	15.3	21.1	18.4	22.0
Pseudomonas aeruginosa	0.0	14.6	36.4	20.0	8.5	10.0	9.4	11.5	13.2	12.6	14.2
Klebsiella spp.	0.0	13.4	9.1	26.7	22.0	3.3	32.1	17.6	50.0	12.1	13.5
Proteus spp.	0.0	6.2	0.0	0.0	8.5	3.3	1.9	9.9	10.5	4.2	5.8
Enterobacter spp.	20.0	5.8	18.2	0.0	1.7	13.3	9.4	5.3	0.0	5.1	5.8
Candida spp.	0.0	0.0	9.1	6.7	10.2	0.0	3.8	9.2	0.0	12.3	2.1
Citrobacter spp.	0.0	1.8	0.0	0.0	1.7	3.3	1.9	1.5	0.0	1.0	1.6
Serratia spp.	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.8	0.0	1.5	1.2
Coagulase-negative staphylococci	0.0	1.0	0.0	0.0	1.7	0.0	0.0	0.8	0.0	1.3	1.1

n = number of isolates.
Source: ECDC, HAI-Net ICU 2018.

Trends

Trend analysis of yearly median incidence in ICUs from seven European countries/networks with uninterrupted participation since 2008 (Belgium, France, Italy (SPIN-UTI), Lithuania, Portugal, Slovakia, Spain), demonstrated a decreasing trend for IAP ($p<0.001$) while there was no clear trend for CLABSI (p=NS) despite an overall decrease from 2.4 to 1.6 CLABSI/1 000 central line-days over this period (Figure 2).

Figure 2. Incidence trend of intubation-associated pneumonia (IAP, left) and central line-associated bloodstream infections (CLABSI, right), 2008-2018, seven European countries/networks*



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

Antimicrobial use

In total, 507 282 days of therapy (DOTs) with antimicrobials were recorded in 2018. Antimicrobial treatment was empirical in 59.0% (range 48.3-70.8%) of DOTs, directed in 24.9% (range 21.6-35.3%) and prophylactic in 12.2% (range 2.9-18.4%). The reported use of selected antimicrobial agents or groups in DOTs per 100 patient-days were: carbapenems 14.2 (range 7.0-29.6), third- and fourth-generation cephalosporins 1.4 (range 1.8-14.6), piperacillin-tazobactam 8.9 (range 0.0-17.8), fluoroquinolones 8.2 (range 2.6-59.1), glycopeptides 5.2 (range 4.1-32.8), and polymyxins 1.8 (range 0.0-6.3) (Table 6).

Table 6. Antimicrobial use indication and selected groups of antimicrobials, by country, EU/EEA 2018

Country	Antimicrobial indication (% DOTs)			Antimicrobial group (DOTs/100 patient-days)					
	Empirical	Directed	Prophylactic	Carbapenems	Cephalosporins, 3rd- and 4th- generation	Piperacillin - tazobactam	Fluoroquinolones	Glycopeptides	Polymyxins
Belgium	63.9	31.1	5.0	7.0	9.3	6.1	4.2	4.7	0.4
Estonia	66.5	30.7	2.9	29.6	1.8	10.0	3.9	8.3	0.0
Hungary	70.8	23.5	5.6	18.3	13.2	4.9	9.4	5.0	2.0
Italy	48.3	29.2	18.4	12.7	14.6	17.8	12.0	5.7	6.3
Lithuania	57.1	35.3	6.2	9.3	8.7	2.3	2.6	5.2	2.3
Poland	52.8	42.8	4.1	16.9	14.0	9.0	6.3	8.5	3.2
Portugal	68.0	28.3	3.7	16.3	11.2	0.0	3.9	8.9	1.5
Slovakia	48.6	33.8	17.6	14.9	4.5	0.0	59.1	32.8	3.1
Spain	57.1	21.6	15.6	14.6	9.8	10.8	9.4	4.1	1.0

Source: ECDC, HAI-Net patient-based data 2018. DOT: Day of therapy.

Antimicrobial resistance

The reported percentages of antimicrobial-resistant isolates in selected bacteria associated with ICU-acquired HAIs were: oxacillin resistance (MRSA) in 15.9% of *S. aureus* isolates (n=2 963); vancomycin resistance in 13.3% of *Enterococcus* spp. isolates (n=2 417); ceftazidime resistance in 27.2% of *P. aeruginosa* isolates (n=2 182); and resistance to third-generation cephalosporins in 15.3% of *E. coli* isolates (n=2 473), 39.8% of *Klebsiella* spp. isolates (n=2 752) and 36.2% of *Enterobacter* spp. isolates (n=2 480).

Carbapenem resistance was reported in 11.9% of *Klebsiella* spp. isolates (n=1 694), 0.3% of *E. coli* isolates (n=1 491), 1.8% of *Enterobacter* spp. isolates (n=1 364), 28.4% of *P. aeruginosa* isolates (n=2 404) and 70.5% of *Acinetobacter baumannii* (n=485) isolates.

HAI outcome

Among 635 HAIs in the three countries that provided data on the outcome and the relation of the outcome to the HAI, in 377 (59.4%) HAIs the patient was discharged alive, in 50 (7.9%) HAIs the patient died and the death was assessed as definitely linked to the HAI, in 45 (7.1%) HAIs the patient died and the death was assessed as not linked to the HAI, in 85 (13.4%) HAIs the patient died and the death was assessed as possibly linked to the HAI, and in 78 (12.3%) HAIs the patient died and the relationship of the death to the HAI was unknown (Table 7).

Table 7. HAI outcome, EU/EEA, 2018

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	308	54.9	3.2	17.5	8.8	15.6
Poland	318	63.5	12.6	9.4	5.3	9.1
Slovakia	9	66.7	0.0	11.1	11.1	11.1

Structure and process indicators of infection control and antimicrobial stewardship

Six countries reported data on 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, 2018

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)
France	174	12	NA	NA	114.2
Italy	22	8	6.5	2.0	35.5
Malta	1	20	27.3	5.1	104.3
Poland	11	8	7.8	0.2	113.7
Romania	35	15	4.7	2.6	30.1
Slovakia	1	10	NA	NA	53.0

NA: Not available

Table 9. Process indicators assessed through chart review or direct observation, EU/EEA 2018

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)
Italy	9	51.1	72.0	78.0	96.2	54.9
Malta	1	100.0	29.0	29.0	100.0	24.0
Poland	24	66.2	73.0	76.7	93.4	72.2
Romania	64	99.4	5.0	5.0	99.8	3.4

Discussion

Sixteen countries submitted data on ICU-acquired HAIs in 2018.

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.

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 a non-significantly decreasing trend in CLABSI incidence density.

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.

Antimicrobials continued to be prescribed for more treatment days 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 2018 remained virtually unchanged compared to 2017. *P. aeruginosa* remains the most common microorganism associated with pneumonia, followed by *S. aureus* and *K. pneumoniae*. For BSIs, coagulase-negative staphylococci are 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 high proportions of HAIs caused by *Klebsiella* spp. and *Acinetobacter* spp. in some countries.

This report confirms the importance of antimicrobial resistance in gram-negative bacteria in European ICUs in 2018, with resistance percentages being comparable to previous years. The high percentages of resistance to carbapenems in *P. aeruginosa*, *A. baumannii* and *K. pneumoniae* isolates reflect the challenges of treating infections in ICU patients, a highly vulnerable patient population [5].

In 2018, only a minority of countries provided data on HAI outcomes and the relation of the HAI to death in patients who died. One in five HAIs were assessed to have definitely or possibly contributed to the 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 2018. 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 improving 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.

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Annex

Table A1. Healthcare-associated infections acquired in intensive care units (ICUs): surveillance systems overview*, 2018

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
Czechia	CZ-HAI-Net	Czech HAI Network	http://www.szu.cz/narodni-referencni-centrum-pro-infekce-spojene-se-zdravotni	National Reference Centre for HAI, Centre for Epidemiology and Microbiology, National Institute of Public Health, Prague
Estonia				Estonian Health Board
France	REA-REZO On behalf REA-Raisin	HAI-surveillance network in adult ICUs	https://rearezo.chu-lyon.fr	Regional center for Infection control & Prevention (CPias Auvergne-Rhône-Alpes, Lyon), on behalf of the National Public Health Agency (REA-RAISIN/ 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	http://www.lpss.unict.it/activities/research/spin-uti	Italian Study Group of Hospital Hygiene – Italian Society of Hygiene, Preventive Medicine and Public Health (GISIO – SitI)
Lithuania			www.hi.lt/content/G0_hosp_inf.html	Institute of Hygiene, Vilnius
Luxembourg				Ministry of Health, Luxembourg
Malta				Mater Dei Hospital, Msida
Poland				Uniwersytet Mikolaja Kopernika, Ludwik Rydygier Collegium Medicum, Bydgoszcz

Country	Network acronym	Network name	Network website	Coordination
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)
Romania		National Centre for Communicable Diseases Surveillance and Control	http://www.insp.gov.ro/cnscbt	National Institute of Public Health, Bucharest
Slovakia	NNSS	National nosocomial Surveillance system (NNSS)	http://www.epis.sk	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
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, 2018

Country	Number of ICUs	ICU size (median no. beds)	Type of ICU (%)				
			Medical	Surgical	Mixed	Coronary	Other / unknown
Austria	1	6	100.0	0.0	0.0	0.0	0.0
Belgium	10	12	0.0	0.0	90.0	0.0	10.0
Estonia	3	10	0.0	0.0	100.0	0.0	0.0
France	174	12	8.1	9.8	80.5	0.0	0.0
Germany	888	12	12.4	16.3	57.4	1.8	10.4
Hungary	13	12	0.0	0.0	92.3	0.0	7.7
Italy	33	8	3.0	3.0	75.8	9.1	6.1
Lithuania	42	6	4.8	2.4	83.3	2.4	4.8
Luxembourg	10	9	0.0	0.0	80.0	10.0	0.0
Malta	1	20	0.0	0.0	100.0	0.0	0.0
Poland	11	8	9.1	0.0	90.9	0.0	0.0
Portugal	40	8	2.5	2.5	80.0	0.0	15.0
Romania	18	15	5.6	16.7	55.6	0.0	16.7
Slovakia	1	10	0.0	0.0	100.0	0.0	0.0
Spain	221	12	1.8	2.7	82.8	1.8	10.9
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, 2018

Country	Number of admissions	Number of patient - days	Average length of stays (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	7	166	23.7	28.6	70	NA	42.9	0.0	100.0	0.0	0.0	28.6	14.3	42.9	NA	NA
Belgium	1 051	8 612	8.2	40.2	68	36	57.2	12.7	68.0	17.5	13.0	39.8	84.4	62.4	11.3	11.6
Estonia	148	1 525	10.3	40.5	66	NA	56.8	15.5	60.8	9.5	29.7	66.2	98.6	89.9	13.5	7.4
France	61 510	638 967	10.4	36.9	67	43	36.5	7.5	68.7	13.8	17.4	60.3	84.0	63.8	14.3	16.2
Hungary	1 658	14 026	8.5	44.1	66	0	64.0	13.4	27.7	16.1	11.0	65.6	92.3	66.8	48.5	14.5
Italy	1 294	13 437	10.4	37.6	68	41	65.2	9.3	37.8	32.2	30.0	62.4	78.1	48.1	7.8	20.0
Lithuania	2 904	27 079	9.3	43.8	66	42	58.2	11.9	54.5	14.8	29.2	56.4	83.2	56.3	6.5	18.0
Luxembourg	3 300	30 776	9.3	43.0	69	33	59.3	6.3	56.8	26.8	16.3	29.9	69.3	51.7	NA	8.8
Poland	1 300	20 953	16.1	36.8	67	54	69.7	10.7	65.4	8.4	25.3	92.8	98.9	26.4	14.7	32.0
Portugal	6 359	71 600	11.3	39.0	68	45	35.3	8.4	66.5	11.8	21.7	73.6	96.3	88.6	13.8	16.4
Slovakia	35	357	10.2	42.9	62	40	60.0	28.6	80.0	2.9	17.1	68.6	91.4	91.4	NA	14.3
Spain	38 359	299 194	7.8	36.0	66	35	42.6	6.9	68.6	18.6	12.8	45.2	80.0	69.0	7.1	13.1
United Kingdom – Scotland	8 866	63 581	7.2	40.4	62	NA	72.7	6.4	47.2	25.7	21.8	63.1	NA	71.5	NA	12.0

NA: Not available.

Table A4. Intensive care unit (ICU)-acquired primary bloodstream infection rates by country/network, EU/EEA, 2018

Country	Primary bloodstream infection rate (episodes per 1 000 patient-days)			
	Mean	25th percentile	Median	75th percentile
Belgium	1.4	0.0	0.4	0.9
Estonia	0.0	0.0	0.0	0.0
France	1.9	1.0	1.6	2.5
Hungary	1.8	0.4	1.5	2.5
Italy	3.7	0.0	3.2	5.9
Lithuania	0.8	0.0	0.0	1.4
Luxembourg	1.0	0.8	1.1	1.2
Poland	8.9	1.5	3.0	13.3
Portugal	2.3	0.7	1.9	3.0
Slovakia	14.0	14.0	14.0	14.0
Spain	1.8	0.0	1.4	2.7
United Kingdom – Scotland	1.5	0.7	1.4	2.3

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, 2018

Country	Central vascular catheter -elated bloodstream infection rate (episodes per 1 000 CVC-days)			
	Country mean	25th percentile	Median	75th percentile
France	0.9	0.3	0.7	1.3
Hungary	5.8	0.0	0.8	1.6
Italy	4.1	0.0	0.0	2.6
Poland	1.8	0.6	0.9	1.7
United Kingdom – Scotland	0.4	0.0	0.0	0.1

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, 2018

Country	Central vascular catheter-related bloodstream infection rate (episodes per 1 000 patient-days)			
	Mean	25th percentile	Median	75th percentile
Belgium	0.2	0.0	0.0	0.0
Estonia	0.0	0.0	0.0	0.0
France	1.2	0.5	0.9	1.6
Hungary	5.8	0.0	0.5	1.6
Italy	5.2	0.0	1.3	4.0
Lithuania	0.1	0.0	0.0	0.0
Luxembourg	1.3	0.9	1.2	1.7
Poland	3.4	1.3	2.7	5.1
Portugal	1.1	0.0	0.8	1.6
Slovakia	0.0	0.0	0.0	0.0
Spain	1.2	0.0	0.0	1.8
United Kingdom – Scotland	0.4	0.0	0.0	0.1