

# Healthcare-associated infections acquired in intensive care units

Annual Epidemiological Report for 2017

## Key facts

- In 2017, 8.3% (11 787) of the patients who stayed in intensive-care units (ICUs) 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, 4% with bloodstream infection (BSI), and 2% with urinary tract infection (UTI).
- Ninety-seven per cent of pneumonia episodes were associated with intubation, 37% of BSI episodes were catheter-related, and 98% 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.
- Twenty-four per cent 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, 40% of *Klebsiella* spp. isolates and 34% of *Enterobacter* spp. isolates. Carbapenem resistance was reported in 15% of *Klebsiella* spp. isolates, 26% of *P. aeruginosa* isolates and 64% of *Acinetobacter baumannii* isolates.

## Methods

This report is based on data for 2017 retrieved from The European Surveillance System (TESSy) on 26 April 2019. 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.

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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A patient-based ('standard') protocol and a unit-based ('light') protocol are used for European surveillance of healthcare-associated infections (HAIs) acquired in intensive care units (ICUs). The patient-based protocol is used to collect data for all patients, regardless of infection, including information on risk factors, allowing for 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. Infections with onset from day 3 onwards should therefore be reported, with admission day counted as day 1. One record per HAI is collected together with antimicrobial resistance markers for isolated microorganisms. ICUs with fewer than 20 patients in the surveillance database were excluded from unit-based analyses.

The minimal requirement for surveillance of ICU-acquired HAIs is that BSI and pneumonia are included. 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  $>38^{\circ}\text{C}$ , leucocytosis  $>12\,000$  white blood cells (WBC)/ $\text{mm}^3$ , 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 broncho-alveolar 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  $>38^{\circ}\text{C}$ , chills, hypotension) and two positive blood cultures of a common skin contaminant from two separate blood samples drawn within 48 hours.

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

An HAI was defined as device-associated when the relevant device was used (even intermittently) in the 48 hours (two days) before onset of infection. For countries performing surveillance of catheter-related infections (CRIs), a microbiologically confirmed central vascular catheter (CVC)-related BSI was defined as a BSI occurring 48 hours before or after catheter removal, and a positive culture with the same microorganism of either a) quantitative CVC culture  $\geq 10^3$  CFU/ml or semi-quantitative CVC culture  $>15$  CFU, or b) quantitative blood culture ratio CVC blood sample/peripheral blood sample  $>5$ , or c) differential delay of positivity of blood cultures, or d) positive culture with the same microorganism from pus from insertion site. A central line-associated 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.

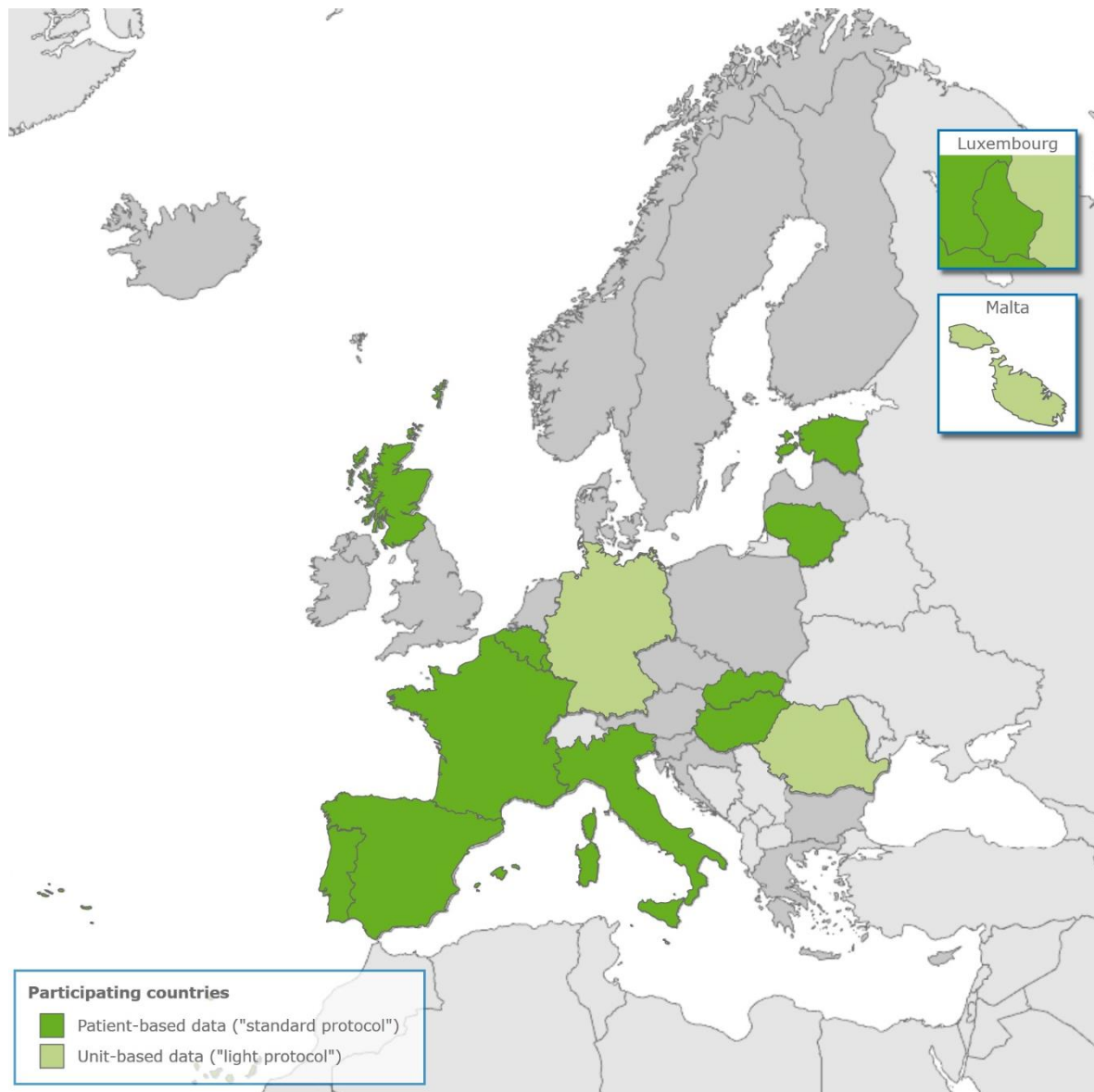
The number of HAIs, the percentage of HAIs associated with the presence of a relevant device, the incidence density of HAIs per 1 000 patient-days, and the incidence density of HAIs adjusted per 1 000 days of device use were estimated. The ten most frequently isolated microorganisms for each type of HAI and antimicrobial resistance percentages for *Staphylococcus aureus*, *Enterococcus* spp., *Enterobacteriaceae*, *Pseudomonas aeruginosa* and *Acinetobacter baumannii* are presented. Trends in device-adjusted incidence rates of intubation-associated pneumonia (IAP) and CLABSI between 2008 and 2017 were analysed by linear regression. Countries and surveillance networks that provided data without interruption during this period were included in the analysis.

Collection of patient-based data on antimicrobial use, including date of treatment onset, date of discontinuation, and date of indication is optional. Information is collected for the following groups of antimicrobials: ATC group J01 (antibacterials for systemic use), J02 (antimycotics for systemic use), A07AA (intestinal anti-infectives), P01AB (nitroimidazole-derived antiprotozoals), D01BA (antifungals for systemic use) and J04AB02 (antibiotic antimycobacterials). We calculate days of therapy (DOT) for selected groups of antimicrobials.

In 2017, 14 countries reported data from 1 192 hospitals and 1 480 ICUs (Figure 1): Belgium, Estonia, France, Germany, Hungary, Italy, Lithuania, Luxembourg, Malta, Romania, Portugal, Slovakia, Spain and the United Kingdom (UK–Scotland). The median size of the participating ICUs was ten beds, ranging from 1 to 43 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 ten countries provided patient-based data. All countries reported data on pneumonia and BSIs. Ten countries (Estonia, Germany, Hungary, Italy, Lithuania, Luxembourg, Portugal, Romania, Slovenia and Spain) reported data on UTIs. Eight countries (Belgium, Estonia, Hungary, Italy, Lithuania, Portugal, Slovakia and Spain) reported data on antimicrobial use.

As in previous years, Germany did not provide selective denominator data for patients staying in an ICU for more than two days. Therefore, data from Germany were only included in the descriptive analysis of ICU-acquired HAIs and excluded from the calculation of HAI rates.

**Figure 1. Participation in surveillance of healthcare-associated infections in intensive care units, EU/EEA, 2017**



Source: ECDC, HAI-Net, 2017

## Epidemiology

Of 142 805 patients staying in an ICU for more than two days (patient-based data), 11 787 (8.3%) patients presented with at least one HAI.

### ICU-acquired pneumonia

Of 8 983 reported cases of pneumonia, 97.3% were associated with intubation. Among patients staying in an ICU for more than two days, 6.3% were affected by at least one episode of pneumonia.

The incidence of pneumonia was 6.6 episodes per 1 000 patient-days.

The mean incidence density per ICU was 3.7 pneumonia episodes per 1 000 patient-days (ICU IQR:0.8-4.9), varying from 1.8 in ICUs with less than 30% intubated patients to 3.5 in ICUs with 30–59% intubated patients, and 6.6 in ICUs with more than 60% intubated patients.

In patient-based surveillance, the mean device-adjusted rate was 9.5 intubation-associated pneumonia episodes per 1 000 intubation-days; it varied between 2.5 per 1 000 intubation-days in Luxembourg and 20.4 per 1 000 intubation-days in Belgium (Table 1).

**Table 1. ICU-acquired intubation-associated pneumonia rates by country/network, EU/EEA, 2017**

Country/Network	Number of ICUs	Number of patients	Average length of ICU stay (days)	Intubation use (days per 100 patient-days)	Intubation-associated pneumonia rate (episodes per 1 000 intubation-days)			
					Country mean	25th percentile	Median	75th percentile
Belgium	3	614	8.6	34.5	20.1	8.0	10.7	27.4
Estonia	4	309	12.1	60.4	4.3	2.9	3.5	4.9
France	198	68 568	11.1	51.0	14.4	10.2	13.3	17.8
Hungary	8	797	9.6	70.2	15.0	8.2	13.7	18.9
Italy/GiViTI	63	13 950	9.8	57.8	6.0	2.3	5.3	8.9
Italy/SPIN-UTI	27	1 483	11.4	66.5	12.6	4.0	10.8	19.4
Lithuania	22	2 279	8.5	42.7	12.3	0.0	12.6	22.1
Luxembourg	8	2 843	9.8	31.6	2.3	0.0	2.1	4.2
Portugal	43	7 361	11.5	61.1	7.2	3.9	5.7	8.2
Slovakia	8	387	9.3	61.2	7.4	0.0	5.2	12.9
Spain	183	34 119	7.8	39.6	5.1	0.0	3.3	7.0
United Kingdom – Scotland	22	8 729	7.3	55.9	3.6	1.1	2.6	4.5

Source: ECDC, HAI-Net patient-based data 2017

Percentiles: distribution of incidence per ICU

The most frequently isolated microorganisms in ICU-acquired pneumonia episodes were *P. aeruginosa* followed by *S. aureus*, *Klebsiella* spp. and *E. coli* (Table 2).

**Table 2. Number of isolates and percentages of the ten most frequently isolated microorganisms in ICU-acquired pneumonia episodes, by country, EU/EEA, 2017**

Microorganism	Belgium (n=82)	Estonia (n=11)	France (n= 6 216)	Germany (n= 5 069)	Hungary (n=37)	Italy (n=811)	Lithuania (n=23)	Luxembourg (n=25)	Portugal (n=442)	Romania (n=420)	Slovakia (n=30)	Spain (n=546)	United Kingdom (n=111)	Total (n=14 033)
<i>Pseudomonas aeruginosa</i>	17.1	9.1	23.1	16.1	32.4	19.4	14.6	20.0	29.2	23.3	33.3	24	7.2	19.9
<i>Staphylococcus aureus</i>	12.2	0.0	18.0	19.8	8.1	20.1	13.3	24.0	13.8	8.6	3.3	18.9	30.6	18.5
<i>Klebsiella</i> spp.	13.4	27.3	11.5	18.2	16.2	17.6	27	20.0	19.7	21.9	36.7	13.2	9.0	15.2
<i>Escherichia coli</i>	20.7	18.2	12.2	16.3	13.5	9.7	6.9	16.0	5.2	6.4	3.3	11.0	18.9	13.5
<i>Enterobacter</i> spp.	3.7	45.5	13.0	9.4	5.4	6.5	5.6	4.0	9.7	0.2	0.0	10.1	5.4	10.4
<i>Serratia</i> spp.	9.8	0.0	4.7	7.1	2.7	3.3	2.1	4.0	5.7	0.0	0.0	6.8	4.5	5.3
<i>Haemophilus</i> spp.	9.8	0.0	5.6	3.4	2.7	3.3	3.9	4.0	6.3	0.0	0.0	4.2	20.7	4.5
<i>Stenotrophomonas maltophilia</i>	8.5	0.0	5.6	3.9	0.0	3.1	1.3	4.0	3.4	0.0	0.0	5.7	0.9	4.5

Microorganism	Belgium (n=82)	Estonia (n=11)	France (n=6 216)	Germany (n=5 069)	Hungary (n=37)	Italy (n=811)	Lithuania (n=23)	Luxembourg (n=25)	Portugal (n=442)	Romania (n=420)	Slovakia (n=30)	Spain (n=546)	United Kingdom (n=111)	Total (n=14 033)
<i>Acinetobacter</i> spp.	0.0	0.0	2.7	1.5	16.2	14.7	16.7	4.0	4.3	39.5	20.0	4.6	1.8	4.5
<i>Proteus</i> spp.	4.9	0.0	3.6	4.4	2.7	2.2	8.6	0.0	2.7	0.0	3.3	1.6	0.9	3.8

*n* = number of isolates

Source: ECDC, HAI-Net patient-based and unit-based data, 2017. Italy: data from both networks; United Kingdom: data from UK-Scotland only

## ICU-acquired bloodstream infections

A total of 5 298 cases of ICU-acquired bloodstream infections (BSIs) were reported. On average, ICU-acquired BSIs occurred in 3.7% of patients staying in an ICU for more than two days. The mean incidence density per ICU was 1.9 BSI episodes per 1 000 patient-days (ICU IQR: 0.4–3.1). The respective mean incidence density of primary BSIs (including catheter-related infections and infections of unknown origin) per ICU was 1.3 episodes per 1 000 patient-days (ICU IQR: 0.3–1.9) (Table A4). BSIs were catheter-related in 36.5% of cases, secondary to another infection in 35.0% of cases, and of unknown origin in 20.5% of cases. When the BSI was secondary to another infection, the primary infection site was pulmonary (45.4% cases), gastrointestinal (20.2%), the urinary tract (18.5%), a surgical site (2.7%), skin and soft tissues (5.4%), and 'other' in the remaining 7.1% cases. In patient-based surveillance, the central vascular catheter (CVC) utilisation rate was on average 70.1 CVC-days per 100 patient-days. It was the lowest (22.0) in Hungary and the highest (88.0) in IT-SPIN-UTI. The mean device-adjusted rate in patients staying in an ICU for more than two days was 3.7 central line-associated BSI (CLABSI) episodes per 1 000 CVC-days (ICU IQR: 0.7–4.7), varying from 1.7 in Luxembourg to 4.8 in IT-SPIN-UTI (Table 3).

**Table 3. ICU-acquired central line-associated bloodstream infection (CLABSI) rates by country, EU/EEA, 2017**

Country/Network	Number of ICUs	Number of patients	Average length of ICU stay (days)	CVC use (days per 100 patient days)	CLABSI rate (episodes per 1 000 catheter-days)			
					Country mean	25th percentile	Median	75th percentile
Belgium	3	614	8.6	71.2	2.7	1.9	3.2	3.8
Estonia	4	309	12.1	86.7	3.6	1.1	3.6	6.0
France	198	68 568	11.1	64.7	2.2	0.9	1.8	2.8
Hungary	8	797	9.6	21.7	4.3	0.0	0.0	7.9
Italy/GiViTI	63	13 950	9.8	82.8	3.0	1.3	2.3	4.1
Italy/SPIN-UTI	27	1 483	11.4	88.7	4.8	0.9	4.1	6.6
Lithuania	22	2 279	8.5	66.5	1.9	0.0	0.8	2.8
Luxembourg	8	2 843	9.8	66.4	1.7	0.0	1.7	2.8
Portugal	43	7 361	11.5	80.4	1.7	0.0	1.0	1.9
Slovakia	8	387	9.3	79.3	4.7	2.5	3.6	6.5
Spain	183	34 119	7.8	75.2	2.6	0.0	1.8	3.8
United Kingdom – Scotland	22	8 729	7.3	62.2	1.7	0.7	1.3	3.0

Source: ECDC, HAI-Net patient-based data 2017

Percentiles: distribution of incidence per ICU

The incidence of microbiologically-confirmed central vascular catheter-related BSIs in 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 *S. aureus* (Table 4).

**Table 4. Number of isolates and percentages of the ten most frequently isolated microorganisms in ICU-acquired bloodstream infection (BSI) episodes by country, EU/EEA, 2017**

Microorganism	Belgium (n=47)	Estonia (n=15)	France (n=2 467)	Germany (n=2 974)	Hungary (n=28)	Italy (n=743)	Lithuania (n=40)	Luxembourg (n=43)	Malta (n=16)	Portugal (n=380)	Romania(n= 187)	Slovakia (n=21)	Spain (n=865 )	United Kingdom (n=103)	Total (n=7 929)
Coagulase-negative staphylococci	19.1	0.0	19.5	30.3	10.7	17.9	45.0	11.6	0.0	10.8	0.0	9.5	29.7	19.4	23.6
<i>Enterococcus</i> spp.	14.9	53.3	12.4	20.2	10.7	9.3	10.0	25.6	6.2	7.9	9.1	9.5	12.1	13.6	14.9
<i>Klebsiella</i> spp.	8.5	6.7	12.8	7.5	25.0	18.0	5.0	14	43.8	21.1	34.8	23.8	13.3	15.5	12.4
<i>Staphylococcus aureus</i>	17.0	6.7	12.0	13.9	3.6	11.8	17.5	4.7	6.2	9.7	18.2	9.5	5.0	16.5	12.0
<i>Pseudomonas aeruginosa</i>	8.5	13.3	12.8	4.9	35.7	11.4	2.5	7.0	25	19.2	13.4	19	9.2	2.9	9.5
<i>Escherichia coli</i>	14.9	13.3	11.6	8.5	0.0	10.2	7.5	7.0	6.2	6.3	4.3	4.8	6.4	13.6	9.2
<i>Enterobacter</i> spp.	4.3	6.7	14.1	4.6	7.1	5.7	2.5	14	6.2	10.0	1.1	4.8	8.1	3.9	8.3
<i>Candida</i> spp.	6.4	0.0	0.0	6.4	0.0	5.1	7.5	9.3	0.0	6.8	0.0	4.8	9.5	10.7	4.5
<i>Serratia</i> spp.	6.4	0.0	3.6	3.1	0.0	2.4	0.0	7.0	6.2	5.5	0.0	0.0	4.5	2.9	3.4
<i>Acinetobacter</i> spp.	0.0	0.0	1.3	0.6	7.1	8.1	2.5	0.0	0.0	2.6	19.3	14.3	2.2	1.0	2.3

*n* = number of isolates

\* Data from Germany only on primary bloodstream infections

Source: ECDC, HAI-Net patient-based and unit-based data 2017. Italy: data from both networks; United Kingdom: data from UK-Scotland only

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

## ICU-acquired urinary tract infections (UTIs)

A total of 1 274 cases of ICU-acquired UTI were reported. On average, ICU-acquired UTIs occurred in 2.0% of patients staying in an ICU for more than two days, with 97.9% of UTI episodes being associated with the use of a urinary catheter. The mean incidence density per ICU was 2.4 urinary tract infection episodes per 1 000 patient-days (ICU IQR: 0–3.7).

On average, urinary catheters were used in 77% of the patient-days. The mean device-adjusted rate in patients staying in an ICU for more than two days was 3.6 catheter-associated UTI episodes per 1 000 catheter-days (ICU IQR: 0.0–5.0).

The most frequently isolated microorganisms in urinary tract infection episodes were *E. coli* followed by *Enterococcus* spp., *Klebsiella* spp., and *P. aeruginosa* (Table 5).

**Table 5. Percentages of the ten most frequently isolated microorganisms in ICU-acquired urinary tract infection (UTI) episodes, by country, EU/EEA, 2017**

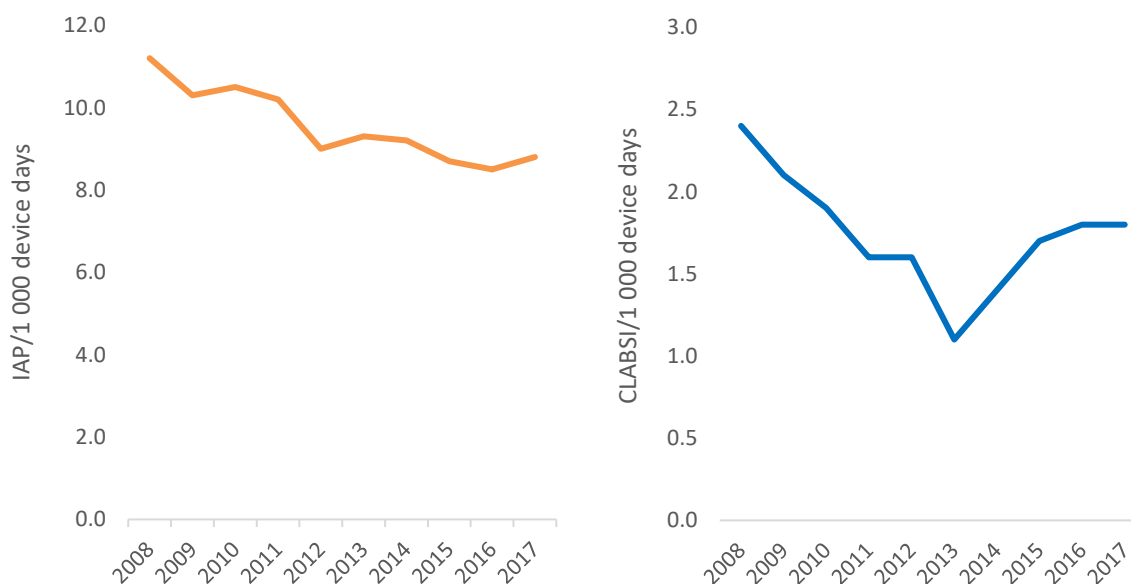
	Estonia (n=9)	Germany (n=3 073)	Hungary (n=7)	Italy (n=42)	Lithuania (n=91)	Luxembourg (n=48)	Portugal (n=173)	Romania (n=298)	Slovakia (n=19)	Spain (n=710)	Total (n=4 470)
<i>Escherichia coli</i>	44.4	35.2	42.9	31	18.7	18.8	29.5	14.1	21.1	29.3	32.1
<i>Enterococcus</i> spp.	11.1	21.5	14.3	11.9	17.6	37.5	9.2	19.8	31.6	19.2	20.6
<i>Klebsiella</i> spp.	0.0	11.8	14.3	33.3	26.4	12.5	17.9	38.3	5.3	13.4	14.5
<i>Pseudomonas aeruginosa</i>	33.3	14.6	14.3	7.1	7.7	10.4	16.2	16.8	21.1	12.7	14.3
<i>Proteus</i> spp.	11.1	7.4	0.0	4.8	8.8	2.1	5.8	0.0	15.8	4.8	6.4
<i>Enterobacter</i> spp.	0.0	5.2	0.0	4.8	4.4	10.4	4.0	0.0	0.0	4.1	4.7
<i>Candida</i> spp.	0.0	0.0	0.0	0.0	13.2	2.1	11	0.0	0.0	13.1	2.8
<i>Citrobacter</i> spp.	0.0	2.3	0.0	0.0	0.0	6.2	1.7	0.0	0.0	1.1	1.9
<i>Serratia</i> spp.	0.0	1.5	0.0	0.0	0.0	0.0	1.7	0.0	0.0	1.8	1.4
<i>Acinetobacter</i> spp.	0.0	0.4	14.3	7.1	3.3	0.0	2.9	11.1	5.3	0.6	1.4

*n* = number of isolates

Source: ECDC, HAI-Net ICU 2017. Italy: data from SPIN-UTI network

## Trends

Trend analysis of yearly median incidence of HAIs acquired in ICUs from seven European countries 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 ( $p = \text{NS}$ ) despite an overall decrease from 2.4 to 1.8 infections/1 000 device-days over this period (Figure 2).

**Figure 2: Incidence trend of intubation-associated pneumonia (IAP) and central line-associated bloodstream infections (CLABSI), seven EU/EEA countries and networks, 2008–2017**



## Antimicrobial use

In total, 484 221 antimicrobial days of therapy (DOTs) were recorded in 2017. Antimicrobial treatment was empirical in 57.8% (range 45.3–75.6%) of DOTs, directed in 24.3% (range 21.2–44.8%) and prophylactic in 13.2% (range 1.7–19.7%). The reported antimicrobial use of selected antimicrobials/antimicrobial groups were: carbapenems 14.5 DOTs per 100 patient-days (range 8.7–34.5), third and fourth generation cephalosporins 10.5 (range 0.0–18.2), piperacillin/tazobactam 8.5 (range 1.7–32.4), fluoroquinolones 9.2 (range 3.5–32.4), glycopeptides 5.3 (range 4.4–9.8) and polymyxins 2.3 (range 0.0–11.0) (Table 6).

**Table 6. Antimicrobial use indication and selected groups of antimicrobials, by country, EU 2017**

Country	Antimicrobial indication (% days of therapy)			Antimicrobial group (days of therapy/100 patient-days)					
	Empirical	Directed	Pro-phylactic	Carbapenems	Cephalosporins (3rd and 4th generation)	Piperacillin/ tazobactam	Fluoro- quinolones	Glycopeptides	Polymyxins
Belgium	56.9	41.4	1.7	10.5	6.7	10.0	4.2	6.9	0.0
Estonia	55.6	21.2	16.4	34.5	12.7	1.7	8.5	9.8	2.0
Hungary	75.6	21.3	2.9	14.2	6.0	10.3	8.1	4.8	4.6
Italy	45.3	33.8	19.7	13.5	18.2	12.4	15.5	5.9	7.2
Lithuania	59.0	26.8	8.5	8.7	1.3	10.3	4.6	4.4	1.5
Portugal	67.7	28.2	4.1	16.6	0.0	9.4	3.5	9.6	2.7
Slovakia	52.1	44.5	3.4	13.4	5.9	32.4	20.6	5.1	11.0
Spain	47.0	44.8	8.2	15.1	9.9	9.6	9.8	4.4	0.9

Source: ECDC, HAI-Net patient-based data 2017

## Antimicrobial resistance

The reported percentages of antimicrobial-resistant isolates in selected bacteria associated with ICU-acquired HAIs were: oxacillin resistance (MRSA) in 23.5% of *S. aureus* isolates (n=1 980); vancomycin resistance in 9.5% of *Enterococcus* spp. isolates (n=2 414); ceftazidime resistance in 26.5% of *P. aeruginosa* isolates (n=2 683); and resistance to third-generation cephalosporins in 15.9% of *E. coli* isolates (n=3 264), 39.9% of *Klebsiella* spp. isolates (n=3 653) and 34.3% of *Enterobacter* spp. isolates (n=2 792).

Carbapenem resistance was reported in 15.2% of *Klebsiella* spp. isolates (n=2 088), 0.8% of *E. coli* isolates (n=1 770), 1.7% of *Enterobacter* spp. isolates (n=1 510), 25.9% of *P. aeruginosa* isolates (n=2 816) and 63.9% of *A. baumannii* (n=38) isolates.

## Discussion

Fourteen countries submitted data on ICU-acquired HAIs in 2017.

HAI surveillance at the local and national levels is an essential component of HAI prevention and control. 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 is the most common HAI acquired in ICUs and, in the majority of cases, associated with intubation. 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 with previous years [4,5], which may reflect increased efforts to prevent device-related infections.

There is substantial variability in HAI rates across participating EU/EEA countries. Part of this variability can be attributed to variations 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. Quality indicators for infection prevention and control and antimicrobial stewardship are included in the new protocol for surveillance of HAIs in ICUs [6] and allow for a more comprehensive assessment of the observed



variability. In addition, the inclusion of metrics for HAI outcomes in the new protocol will allow for a better estimation of the burden of HAIs in ICUs.

In EU/EEA countries that provided data on antimicrobial use, DOTs of antimicrobials were higher for empiric than for 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 2017 remained virtually unchanged compared with 2016. *P. aeruginosa* remains the most common microorganism associated with pneumonia, followed by *S. aureus* and *K. pneumoniae*. Among BSIs, coagulase-negative staphylococci were the most commonly isolated microorganisms; they were mostly associated with catheter-related BSIs.

In 2017, *Enterococcus* spp. replaced *Klebsiella* spp. as the second most common microorganism isolated in BSI. 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. and *Acinetobacter* spp. in some countries.

This report confirms the importance of antimicrobial resistance in gram-negative bacteria in ICUs in the EU/EEA in 2017, with resistance percentages being comparable to the levels reported in previous years. The high percentages of resistance to carbapenems of *P. aeruginosa*, *A. baumannii* and *K. pneumoniae* isolates reflect the challenges of treatment of ICU patients, a highly vulnerable patient population.

## Public health implications

ICUs are the hospital wards with the highest prevalence of HAIs [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 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.

Strengthening infection prevention and control practices and implementing antimicrobial stewardship are essential measures to prevent HAIs and the emergence and spread of antimicrobial resistance in ICUs. Further understanding of the variation in incidence and of the burden of HAIs in ICUs is facilitated through the use of quality indicators for infection prevention and control and for antimicrobial stewardship, and information on HAI outcomes. These quality indicators are included in the new 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: Characteristics of intensive care units (ICUs) by country/network, unit-based and patient-based surveillance, EU/EEA, 2017**

Country/Network	Number of ICUs	ICU size (median no. beds)	Type of ICU (%)				
			Medical	Surgical	Mixed	Coronary	Other/unknown
Belgium	8	12	0.0	0.0	100.0	0.0	0.0
Estonia	4	10	0.0	0.0	100.0	0.0	0.0
France	199	12	8.5	10.6	78.4	0.0	2.5
Germany	838	12	12.3	16.6	57.4	1.8	11.9
Hungary	9	8	0.0	0.0	100.0	0.0	0.0
Italy/GiViTI	63	7	0.0	6.3	87.3	0.0	6.3
Italy/SPIN-UTI	41	8	2.4	2.4	80.5	14.6	0.0
Lithuania	36	7.5	11.1	0.0	83.3	2.8	2.8
Luxembourg	10	9	0.0	0.0	80.0	10.0	10.0
Malta	1	20	0.0	0.0	100.0	0.0	0.0
Portugal	43	8	4.7	2.3	79.1	0.0	14.0
Romania	10	42	0.0	10.0	90.0	0.0	0.0
Slovakia	8	8.5	0.0	0.0	100.0	0.0	0.0
Spain	188	12	2.1	2.7	84.6	0.5	10.1
United Kingdom – Scotland	22	7.5	0.0	0.0	90.9	4.5	0.0

**Table A2: Patient demographics and risk factors at admission for patients staying more than two days in an intensive care unit (ICU) in countries/networks that provided patient-based data, EU/EEA, 2017**

Country/Network	Number of patients	Number of patient-days	Females (%)	Median age (years)	SAPS II score median	Patient from hospital (%)	Trauma (%)	Type of admission (%)			Intubation (%)	Urinary catheter (%)	Central vascular	Impaired immunity (%)	Mortality (%)
								Medical	Scheduled surgery	Urgent surgery					
Belgium	614	5 892	42.8	71	38	56.5	7.5	74.4	17.3	7.7	46.7	78.8	67.3	10.9	16.9
Estonia	309	3 465	40.8	66	NA	65.0	7.1	64.7	10.4	24.6	63.1	95.8	86.1	16.2	11.7
France	68 581	715 387	37.3	67	43	37.0	8.1	69.9	12.2	17.8	60.0	84.0	63.3	15.3	16.6
Hungary	1 132	7 100	42.3	67	0	63.9	13.4	42.4	10.0	14.2	63.6	91.3	63.1	58.9	19.4
Italy/GiViTI	13 950	130 951	41.0	70	38	53.8	13.2	54.1	19.2	26.7	72.4	0.0	76.1	2.0	17.4
Italy/SPIN-UTI	1 882	18 875	36.8	70	39	57.9	2.8	60.4	16.4	22.4	63.4	84.0	66.6	6.0	20.2
Lithuania	2 463	21 268	40.7	66	31	58.3	13.8	50.2	15.2	33.9	60.3	58.7	58.7	3.6	18.1
Luxembourg	3 219	30 068	42.0	69	35	60.3	6.9	55.5	26.3	18.2	33.4	73.2	57.3	0.0	10.5
Portugal	7 361	85 049	37.2	67	45	36.6	11.0	65.1	11.4	23.5	74.6	95.8	88.5	14.8	17.1
Slovakia	387	3 521	40.1	66	53.5	51.7	18.1	77.0	10.9	11.9	83.5	96.1	82.7	10.9	23.5
Spain	34 178	272 204	35.1	66	34	42.2	7.0	68.7	18.6	12.7	44.8	79.6	69.0	7.7	12.7
United Kingdom – Scotland	8 729	62 824	39.8	62	NA	72.8	6.4	46.6	25.2	18.6	65.4	0.0	73.8	NA	13.0

NA: Not available

**Table A3: Intensive care unit (ICU)-acquired primary bloodstream infection rates by country/network, EU/EEA, 2017**

Country/Network	Number of ICUs	Number of patients	Average length of ICU stay (days)	Primary bloodstream infection rate (episodes per 1 000 patient-days)			
				Mean	25th percentile	Median	75th percentile
Belgium	3	614	8.6	2.6	2.5	2.7	2.8
Estonia	4	309	12.1	3.1	1.0	3.0	5.1
France	198	68 568	11.1	2.0	0.9	1.7	2.7
Hungary	8	797	9.6	2.6	2.0	2.5	3.4
Italy/GiViTI	63	13 950	9.8	2.6	1.3	2.2	3.5
Italy/SPIN-UTI	27	1 483	11.4	5.5	1.9	4.0	8.5
Lithuania	21	2 244	8.6	1.4	0.0	1.1	2.3
Luxembourg	8	2 843	9.8	1.3	0.0	1.0	1.9
Portugal	43	7 361	11.5	2.5	0.9	2.1	3.0
Slovakia	8	387	9.3	4.1	2.3	2.7	5.6
Spain	183	34 119	7.8	2.0	0.0	1.6	3.1
United Kingdom – Scotland	22	8 729	7.3	1.2	0.5	0.9	2.1

**Table A4: Intensive care unit (ICU)-acquired microbiologically-confirmed central venous catheter-related bloodstream infection rates in countries performing catheter-related infections surveillance, EU/EEA, 2017**

Country/Network	Number of ICUs	Number of patients	Average length of ICU stay (days)	Central venous catheter related bloodstream infection rate (episodes per 1 000 catheter-days)			
				Country mean	25th percentile	Median	75th percentile
Estonia	4	309	12.1	0.6	0.0	0.0	0.6
France	198	68 568	11.1	0.9	0.0	0.7	1.3
Hungary	8	797	9.6	17.4	4.8	11.7	26.2
Italy/GiViTI	63	13 950	9.8	1.8	0.0	1.2	2.2
Italy/SPIN-UTI	27	1 483	11.4	1.8	0.0	0.0	2.8
United Kingdom – Scotland	22	8 729	7.3	0.3	0.0	0.0	0.5

**Table A5: Intensive care unit (ICU)-acquired central venous catheter-related bloodstream infection rates by country (microbiologically confirmed or with clinical improvement after removal of the catheter), EU/EEA, 2017**

Country/Network	Number of ICUs	Number of patients	Average length of ICU stay (days)	Central venous catheter related bloodstream infection rate (episodes per 1 000 patient-days)			
				Mean	25th percentile	Median	75th percentile
Belgium	3	614	8.6	0.2	0.0	0.0	0.3
Estonia	4	309	12.1	1.1	0.0	0.9	2.0
France	198	68 568	11.1	1.1	0.3	0.9	1.8
Hungary	8	797	9.6	17.4	4.8	11.7	26.2
Italy/GiViTI	63	13 950	9.8	1.8	0.0	1.2	2.2
Italy/SPIN-UTI	27	1 483	11.4	3.7	0.0	3.2	6.8
Lithuania	21	2 244	8.6	0.6	0.0	0.0	0.0
Luxembourg	8	2 843	9.8	1.0	0.0	0.8	1.3
Portugal	43	7 361	11.5	3.5	0.0	0.6	1.5
Slovakia	8	387	9.3	2.8	0.0	2.1	2.7

Country/Network	Number of ICUs	Number of patients	Average length of ICU stay (days)	Central venous catheter related bloodstream infection rate (episodes per 1 000 patient-days)			
				Mean	25th percentile	Median	75th percentile
Spain	183	34 119	7.8	1.4	0.0	1.0	2.0
United Kingdom – Scotland	22	8 729	7.3	0.3	0.0	0.0	0.5