SURVEILLANCE REPORT

Annual Epidemiological Report for 2016

Healthcare-associated infections acquired in intensive care units

Key facts

- In 2016, 12 735 (8.4%) of patients staying in an intensive care unit (ICU) for more than two days presented with at least one ICU-acquired healthcare-associated infection (HAI) under surveillance (pneumonia, bloodstream infection or urinary tract infection).
- Of all patients staying in an ICU for more than two days, 6% presented with pneumonia, 4% with bloodstream infection (BSI) and 2% with urinary tract infection (UTI).
- 97% of pneumonia episodes were associated with intubation, 44% of BSI episodes were catheter-related, and 99% 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 bloodstream infections, and *Escherichia coli* in ICU-acquired urinary tract infections.
- 30% of *Staphylococcus aureus* isolates were oxacillin-resistant (MRSA). Resistance to third-generation cephalosporins was reported in 18% of *E. coli* isolates, 38% of *Klebsiella spp.* isolates and 32% of *Enterobacter spp.* isolates. Carbapenem resistance was reported in 11% of *Klebsiella spp.* isolates, 27% of *P. aeruginosa* isolates and 66% of *Acinetobacter baumannii* isolates.

Methods

This report is based on data for 2016 retrieved from The European Surveillance System (TESSy) on 26 April 2018. 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].

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 risk-adjusted

Suggested citation: European Centre for Disease Prevention and Control. Healthcare-associated infections acquired in intensive care units. In: ECDC. Annual epidemiological report for 2016. Stockholm: ECDC; 2018.

Stockholm, May 2018

inter-hospital comparisons. With the unit-based protocol, denominator data, i.e. patient-days, are collected at ICU level, while patient data are only recorded 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 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 to include BSI and pneumonia. Collection of data on urinary tract infections (UTIs) and central venous catheter (CVC)-related infections is optional.

A case of pneumonia is defined in accordance with clinical criteria (X-ray, fever >38 °C, leucocytosis >12 000 white blood cells (WBC)/mm^3, purulent sputum) and further subcategorised 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.

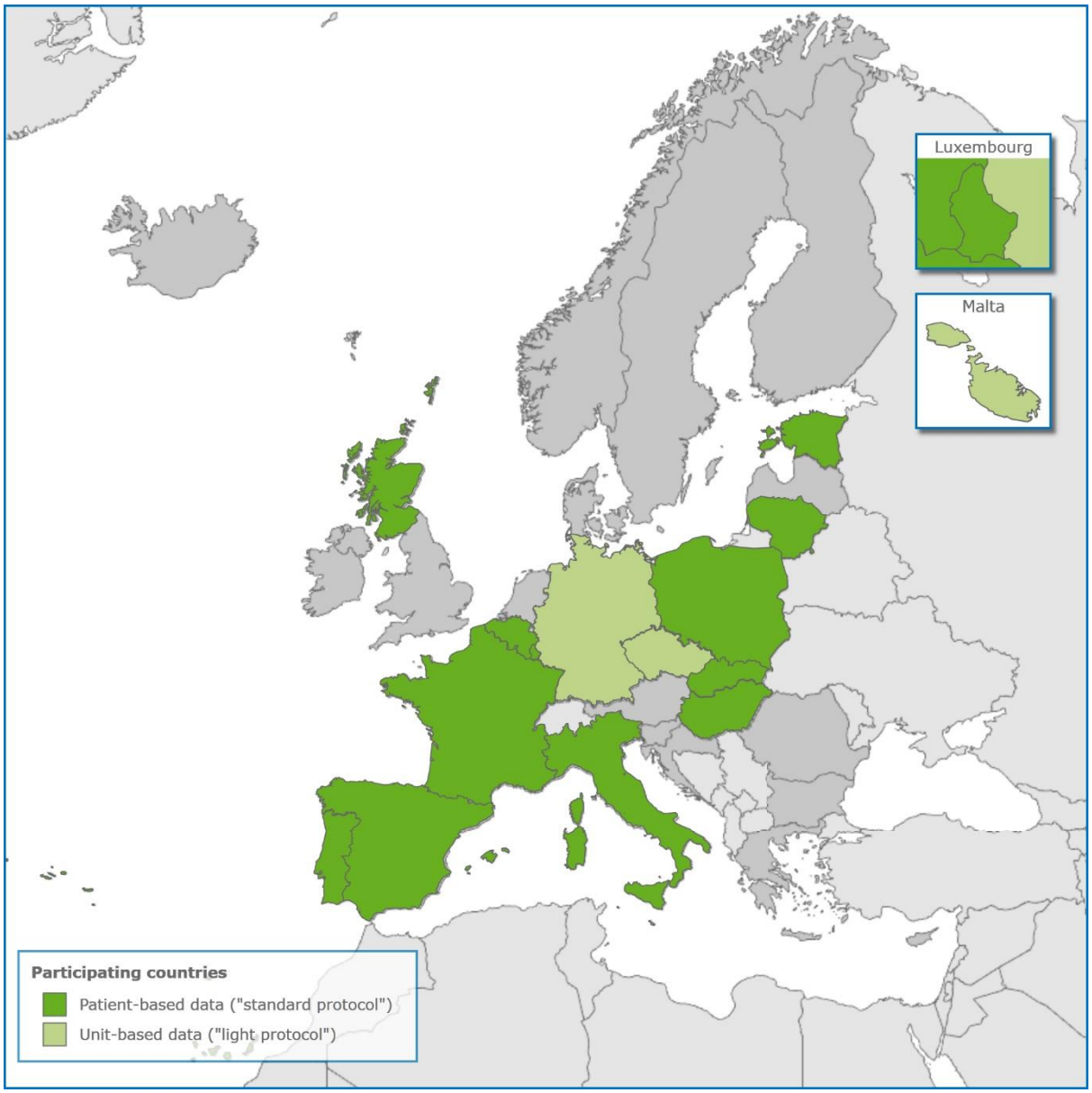
A central line-associated bloodstream infection (CLABSI) was defined as a primary BSI with use of a central vascular catheter in the 48 hours (two days) before the onset of the infection. For the calculation of device-associated BSI rates, CLABSIs were used rather than catheter-related BSIs only, as not all participating countries performed surveillance of CRIs.

The following parameters were estimated: 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. 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 2016 were analysed by linear regression. Networks that provided data without interruption during this period were included in the analysis.

In 2016, 15 countries reported data from 1 159 hospitals and 1 451 ICUs (Figure 1): Belgium, the Czech Republic, Estonia, France, Germany, Hungary, Italy, Lithuania, Luxembourg, Malta, Poland, Portugal, Slovakia, Spain and the United Kingdom (UK–Scotland). The median size of the participating ICUs was ten beds, ranging from 1 to 47 beds. Three countries (the Czech Republic, Germany and Malta) only provided unit-based data, and one country (Belgium) provided both patient-based and unit-based data. The remaining eleven countries provided patient-based data.

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, 2016



Source: ECDC, HAI-Net, 2016

Epidemiology

Of 151 709 patients staying in an ICU for more than two days (patient-based data), 12 735 (8.4%) patients presented with at least one HAI.

ICU-acquired pneumonia

Of 9 569 reported cases of pneumonia, 97.0% 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 in the pooled patient population was 6.5 episodes per 1 000 patient-days.

The mean incidence density per ICU was 4.0 pneumonia episodes per 1 000 patient-days (ICU IQR:1.0–4.9), varying from 1.8 in ICUs with less than 30% intubated patients to 3.8 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 9.8 intubation-associated pneumonia episodes per 1 000 intubation-days; this rate varied between 2.8 per 1 000 intubation-days in UK–Scotland and 17.8 per 1 000 intubation-days in Poland (Table 1).

Table 1. ICU-acquired intubation-associated pneumonia rates by country/network, EU/EEA, 2016

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	8	1909	8.5	41.0	11.3	5.2	10.2	13.5
Estonia	8	1562	9.9	64.4	6.3	4.3	5.8	9.6
France	200	67899	11.6	51.7	13.9	8.7	13.2	18.1
Italy/GiViTI	73	16275	9.4	58.2	6.1	2.1	4.5	8.3
Italy/SPIN-UTI	26	1478	10.6	67.9	16.4	7.0	15.3	22.7
Hungary	12	1695	8.3	60.7	10.4	6.7	10.2	12.2
Lithuania	32	3321	9.2	38.6	11.5	0.0	4.7	20.9
Luxembourg	9	3142	9.2	27.1	3.0	0.0	2.3	4.6
Poland	9	612	14.6	72.5	17.8	9.3	13.8	29.5
Portugal	41	7729	11.6	63.3	8.2	4.0	6.9	10.5
Slovakia	8	375	8.9	65.2	14.0	1.8	14.4	23.6
Spain	189	36556	8.2	44.7	6.2	2.1	4.8	8.5
United Kingdom – Scotland	21	8449	7.9	60.6	2.8	1.1	2.1	3.2

Source: ECDC, HAI-Net patient-based data 2016. Italy: data from two networks (GiViTI and SPIN-UTI, Table A1)
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 ten most frequently isolated microorganisms in ICU-acquired pneumonia episodes, by country, EU/EEA, 2016

Microorganism	Belgium (n=136)	Estonia (n=89)	France (n= 7 913)	Germany (n= 5 686)	Hungary (n=48)	Italy (n=1 101)	Lithuania (n=317)	Luxembourg (n=38)	Poland (n=129)	Portugal (n=514)	Slovakia (n=31)	Spain (n=738)	United Kingdom (n=129)	Total (n=16 869)
Pseudomonas aeruginosa	21.8	9.1	25.3	15.4	37.5	19.2	8.0	17.9	15.9	26.0	20.8	25.2	7.5	20.8
Staphylococcus aureus	12.9	25.8	16.9	19.8	15.0	17.0	13.9	17.9	3.2	17.0	4.2	15.6	27.4	17.8
Klebsiella spp.	22.8	16.7	12.3	19.5	15.0	20.2	21.9	10.7	30.2	17.6	20.8	16.9	14.2	16.1
Escherichia coli	10.9	10.6	12.8	16.5	7.5	11.1	8.8	14.3	7.9	5.8	8.3	8.5	14.2	13.3
Enterobacter spp.	9.9	10.6	12.4	9.4	10	6.1	4.4	10.7	4.8	7.5	4.2	8.5	11.3	10.3
Serratia spp.	11.9	6.1	4.7	6.3	2.5	3.4	0.4	3.6	2.4	7.5	4.2	5.3	2.8	5.2
Stenotrophomonas maltophilia	4.0	0.0	5.3	3.8	0.0	2.3	0.4	7.1	0.0	3.9	4.2	8.7	2.8	4.5
Haemophilus spp.	3.0	7.6	4.9	3.0	5.0	3.6	5.2	14.3	0.0	4.5	0.0	3.9	15.1	4.2
Acinetobacter spp.	2.0	4.5	2.2	1.5	7.5	14.4	34.7	0.0	35.7	8.8	20.8	5.4	1.9	4.1
Candida spp.	1.0	9.1	3.4	4.7	0.0	2.7	2.4	3.6	0.0	1.3	12.5	2.0	2.8	3.6

n = number of isolates
Source: ECDC, HAI-Net patient-based and unit-based data, 2016. United Kingdom: data from UK–Scotland only, Italy: data from both networks

ICU-acquired bloodstream infections (BSIs)

A total of 5 579 cases of ICU-acquired BSI 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: 0.2–2.0) (Table A4). BSIs were catheter-related in 43.6% of cases, secondary to another infection in 35.1% of cases, and of unknown origin in 21.4% of cases. When the BSI was secondary to another infection, the primary

infection site was pulmonary (41.8% cases), gastrointestinal (20.8%), the urinary tract (18.7%), a surgical site (4.1%), skin and soft tissues (5.6%), and 'other' in the remaining 8.7% cases. In patient-based surveillance, the central vascular catheter (CVC) utilisation rate was on average 70.4 CVC-days per 100 patient-days. It was the lowest (61.5) in Luxembourg and the highest (89.0) in Poland. The mean device-adjusted rate in patients staying in an ICU for more than two days was 3.6 central line-associated BSI (CLABSI) episodes per 1 000 CVC-days (ICU IQR: 0.9–4.8), varying from 1.4 in Luxembourg and Lithuania to 6.4 in Poland (Table 3).

Table 3. ICU-acquired central line-associated bloodstream infection (CLABSI) rates by country, EU/EEA, 2016

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 CVC-days)			
					Country mean	25th percentile	Median	75th percentile
Belgium	8	1909	8.5	76.5	1.8	0.8	1.2	1.7
Estonia	8	1562	9.9	82.1	2.7	0.8	1.7	2.6
France	200	67899	11.6	64.1	2.2	1.0	1.9	3.0
Hungary	12	1695	8.3	68.6	2.8	0.0	2.2	3.6
Italy/GiViTI	73	16275	9.4	82.9	2.8	1.1	2.0	3.7
Italy/SPIN-UTI	26	1478	10.6	85.4	5.6	1.6	5.1	8.6
Lithuania	31	3268	8.9	61.7	1.4	0.0	0.0	1.4
Luxembourg	9	3142	9.2	61.5	1.4	1.0	1.1	1.8
Poland	9	612	14.6	89.0	6.4	4.8	5.8	10.3
Portugal	41	7729	11.6	80.7	1.9	0.5	1.5	2.6
Slovakia	8	375	8.9	79.8	5.5	1.6	5.8	9.4
Spain	189	36556	8.21	76.0	2.4	0.0	1.9	3.5
United Kingdom – Scotland	21	8449	7.9	62.4	1.8	0.9	1.9	2.6

Source: ECDC, HAI-Net patient-based data 2016. Italy: data from two networks (GiViTI and SPIN-UTI, Table A1)
Percentiles: distribution of incidence per ICU

The incidence of microbiologically confirmed central vascular catheter-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 were coagulase-negative staphylococci followed by *Enterococcus* spp., *Klebsiella* spp. and *Staphylococcus 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, 2016

Microorganism	Belgium (n=66)	Czech Republic (n=102)	Estonia (n=78)	France (n=3 058)	Germany (n=2 626)	Hungary (n=59)	Italy (n=979)	Lithuania (n=89)	Luxembourg (n=31)	Malta (n=14)	Poland (n=48)	Portugal (n=308)	Slovakia (n=19)	Spain (n=1 079)	United Kingdom (n=103)	Total (n=8 659)
Coagulase-negative staphylococci	28.3	29.3	15.7	18.8	25.3	31.6	17.3	38.1	13.3	0.0	22.2	22.2	0.0	29.3	19.8	20.5
Klebsiella spp.	10	15.2	25.7	12.1	8.4	10.5	17.7	8.3	16.7	14.3	5.6	5.6	27.7	15.6	17.6	14.1
Enterococcus spp.	13.3	5.4	24.3	11.9	20.2	7.0	11.6	4.8	3.3	14.3	11.1	11.1	19.1	13.8	11.0	12.4
Pseudomonas aeruginosa	6.7	7.6	8.6	11.8	4.4	19.3	10.4	2.4	6.7	14.3	27.8	27.8	8.5	9.0	3.3	11.1
Escherichia coli	18.3	7.6	7.1	11.0	9.4	7.0	9.0	8.3	10.0	14.3	0.0	0.0	10.6	7.2	11.0	9.7
Staphylococcus aureus	8.3	12.0	1.4	10.2	14.9	3.5	9.0	7.1	16.7	7.1	5.6	5.6	4.3	5.7	9.9	8.7
Enterobacter spp.	5.0	3.3	7.1	11.2	5.3	5.3	6.6	6.0	20.0	35.7	5.6	5.6	0.0	4.0	5.5	8.5
Candida spp.	8.3	10.9	8.6	8.8	8.5	3.5	5.8	2.4	10.0	0.0	0.0	0.0	0.0	8.4	17.6	8.0
Acinetobacter spp.	0.0	4.3	1.4	1.4	0.8	12.3	9.2	19	3.3	0.0	22.2	22.2	23.4	2.4	1.1	3.6
Serratia spp.	1.7	4.3	0.0	2.8	2.8	0.0	3.4	3.6	0.0	0.0	0.0	0.0	6.4	4.6	3.3	3.3

n = number of isolates
** Data from Germany refer only to primary bloodstream infections; data from both Italian networks*
Source: ECDC, HAI-Net patient-based and unit-based data 2016. United Kingdom: data from UK–Scotland only.
Coagulase-negative staphylococci: includes unspecified Staphylococcus *spp.*

ICU-acquired urinary tract infections

A total of 1 395 cases of ICU-acquired urinary tract infections (UTIs) were reported. On average, ICU-acquired UTIs occurred in 1.9% of patients staying in an ICU for more than two days, with 99.3% of UTI episodes being associated with the use of a urinary catheter. The mean incidence density per ICU was 1.0 urinary tract infection episodes per 1 000 patient-days (ICU IQR: 0–1.7).

On average, urinary catheters were used in 87% of the patient-days. The mean device-adjusted rate in patients staying in an ICU for more than two days was 3.5 catheter-associated UTI episodes per 1 000 catheter-days (ICU IQR: 0.5–4.8).

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

Table 5. Percentages of the ten most frequently isolated microorganisms in ICU-acquired urinary tract infection (UTI) episodes by country, EU/EEA, 2016

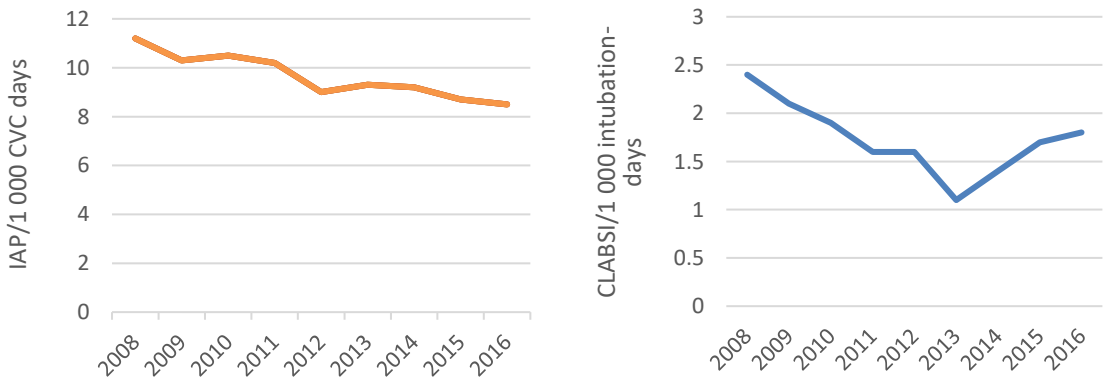
Microorganism	Estonia (n=10)	Germany (n=2 250)	Hungary (n=18)	Italy SPIN-UTI (n=46)	Lithuania (n=143)	Luxembourg (n=37)	Poland (n=21)	Portugal (n=163)	Slovakia (n=24)	Spain (n= 825)	Total (n=2 549)
Escherichia coli	30.0	34.0	11.8	31.0	19.3	13.5	10.5	30.7	29.2	26.8	25.8
Enterococcus spp.	20.0	23.7	17.6	14.3	16.3	27.0	26.3	13.7	20.8	19.4	18.5
Pseudomonas aeruginosa	20.0	12.6	29.4	11.9	5.9	18.9	10.5	18.3	16.7	15.2	14.7
Klebsiella spp.	20.0	12.7	29.4	21.4	16.3	29.7	26.3	13.7	4.2	10.7	13.3
Candida spp.	10.0	2.1	0.0	4.8	16.3	2.7	0.0	9.2	0.0	12.7	11.7
Proteus spp.	0.0	7.9	11.8	0.0	14.1	8.1	10.5	4.6	16.7	4.2	5.4
Enterobacter spp.	0.0	4.7	0.0	0.0	3.7	0.0	0.0	5.9	0.0	6.1	5.3
Acinetobacter spp.	0.0	0.2	0.0	11.9	8.1	0.0	15.8	2.0	12.5	1.2	2.6
Serratia spp.	0.0	1.2	0.0	0.0	0.0	0.0	0.0	1.3	0.0	2.2	1.6
Coagulase-negative staphylococci	0.0	0.9	0.0	4.8	0.0	0.0	0.0	0.7	0.0	1.2	1.1

n = number of isolates
Source: ECDC, HAI-Net ICU 2016

Trends

Trend analysis of yearly median incidence in ICUs from seven networks in EU/EEA countries with uninterrupted participation since 2008 (Belgium, France, Italy SPIN-UTI, Lithuania, Portugal, Slovakia, Spain) showed a decreasing trend for IAP ($p<0.001$). Although the incidence of CLABSI decreased in the same period, the trend was not statistically significant ($p=0.08$), with the decreasing trend from 2008 until 2013 followed by an increase from 2013 to 2016 (Figure 2).

Figure 2. Incidence trend of intubation-associated pneumonia (IAP) and central line-associated bloodstream infections (CLABSI), 2008–2016, six EU/EEA countries



Antimicrobial resistance

The reported percentages of antimicrobial-resistant isolates in selected bacteria associated with ICU-acquired HAIs were: oxacillin resistance (MRSA) in 29.9% of *S. aureus* isolates (n=2 025); vancomycin resistance in 7.3% of *Enterococcus* spp. isolates (n=2 407); ceftazidime resistance in 23.0% of *P. aeruginosa* isolates (n=2 647); and resistance to third-generation cephalosporins in 18.1% of *E. coli* isolates (n=3 334), 37.8% of *Klebsiella* spp. isolates (n=3 682) and 32.1% of *Enterobacter* spp. isolates (n=2 714). Carbapenem resistance was reported in 10.7% of *Klebsiella* spp. isolates (n=2 007), 0.8% of *E. coli* isolates (n=1 703), 2.6% of *Enterobacter* spp. isolates (n=1 435), 26.4% *of P. aeruginosa* isolates (n=2 850) and 66.1% of *Acinetobacter baumannii* (n=342) isolates.

Discussion

Fourteen countries submitted data on ICU-acquired HAIs in 2016. One country, Poland, participated in this type of HAI surveillance for the first time.

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, 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. In the majority of cases, it is associated with intubation. Among BSIs, a substantial proportion is 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. A trend analysis of device-adjusted IAP and CLABSI rates in six countries with uninterrupted participation since 2008 also supports the assumption that there is a declining trend for IAP. A limitation of this analysis is that the number of participating ICUs in the sample increased over the same period.

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 control practices may also affect the reported incidence of HAIs. Quality indicators for infection prevention and control and for antimicrobial stewardship are included in the new protocol for surveillance of HAIs in ICUs [6] and will allow for a more comprehensive assessment of the observed variability. In addition, the inclusion, in the new protocol, of metrics for HAI outcomes will allow for a better estimation of the burden of HAIs in ICUs.

The distribution of microorganisms associated with HAIs in 2016 remained virtually unchanged compared with 2015. 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 European ICUs in 2016, with resistance percentages comparable to the report for 2015. The high percentages of resistance to carbapenems of *P. aeruginosa*, *A. baumannii* and *K. pneumoniae* isolates reflect the challenges in the 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 to prevent HAIs and counteract the emergence and spread of antimicrobial resistance in ICUs. Further understanding of the variation in incidence and of the burden of HAIs in ICUs will be facilitated through the use of quality indicators for infection prevention and control and for antimicrobial stewardship, and information on HAI outcomes. These are included in the new ECDC protocol for surveillance of HAIs in ICUs and are expected to increase the usefulness of surveillance data.

References

1. European Centre for Disease Prevention and Control. Introduction to the Annual Epidemiological Report. In: ECDC. Annual epidemiological report for 2016. Stockholm: ECDC; 2018. Available from: https://ecdc.europa.eu/en/annual-epidemiological-reports-2016/methods

2. European Centre for Disease Prevention and Control. Surveillance systems overview [internet]. Stockholm: ECDC; 2017. Available from: https://ecdc.europa.eu/en/publications-data/surveillance-systems-overview-2016

3. European Centre for Disease Prevention and Control. European surveillance of healthcare-associated infections in intensive care units – HAI-Net ICU protocol, version 1.02. Stockholm: ECDC; 2015. Available from: http://ecdc.europa.eu/en/publications/Publications/healthcare-associated-infections-HAI-ICU-protocol.pdf

4. European Centre for Disease Prevention and Control. Annual Epidemiological Report for 2015 – Healthcare-associated infections acquired in intensive care units. [Internet]. Stockholm: ECDC; 2017. Available from: https://ecdc.europa.eu/sites/portal/files/documents/AER_for_2015-healthcare-associated-infections.pdf

5. European Centre for Disease Prevention and Control. Surveillance of healthcare-associated infections in intensive care units in Europe 2008–2012, including attributable mortality analyses. Stockholm: ECDC; 2018. [In press]

6. European Centre for Disease Prevention and Control. Surveillance of healthcare-associated infections and prevention indicators in European intensive care units. Stockholm: ECDC; 2017. Available from: https://ecdc.europa.eu/sites/portal/files/documents/HAI-Net-ICU-protocol-v2.2_0.pdf

7. European Centre for Disease Prevention and Control. Point prevalence survey of healthcare-associated infections and antimicrobial use in European acute care hospitals. Stockholm: ECDC; 2013. Available from: http://ecdc.europa.eu/en/publications/Publications/healthcare-associated-infections-antimicrobial-use-PPS.pdf

Tables

Table A1. Healthcare-associated infections acquired in intensive care units (ICUs): surveillance systems overview, 2015

Country	Network acronym	Network name	Network website	Coordination
Belgium	NSIH (NSIH-ICU)	National surveillance of healthcare-associated infections	www.nsih.be	Scientific Institute of Public Health, Brussels
Czech Republic	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			www.esid.ee	Estonian Society for Infectious Diseases (ESID)
France	RAISIN (REA-RAISIN)	French HAI Early Warning, Investigation and Surveillance Network (Raisin)	www.invs.sante.fr/raisin	Institut de Veille Sanitaire (InVS), Saint Maurice
			http://cclin-sudest.chu-lyon.fr/	South-East Interregional Infection Control Coordinating Centre (CClin Sud-Est)
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 Surveilance 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)
	GiViTI	Gruppo Italiano per la Valutazione degli Interventi in Terapia Intensiva	http://www.giviti.marionegri.it/SorveglianzaInfezioni.asp	
	SNICh (National coordination)	Surveillance of healthcare-associated infections	http://assr.regione.emilia-romagna.it/it/aree_attivita/rischio-infettivo/progetti/sostegno-attivita-ccm	Regional Health Authority of Emilia-Romagna, Bologna
Lithuania			www.hi.lt/content/G0_hosp_inf.html	Institute of Hygiene, Vilnius
Luxembourg				Ministry of Health, Luxembourg
Malta				Mater Dei Hospital, Msida
Poland	NPOA ECDC-ICU	National Antimicrobial Protection Programme	http://antybiotyki.edu.pl/szpitalna-polit-inten.php; icu.polska@gmail.com	National Medicines Institute (Warsaw)/Ludwik Rydygier Collegium Medicum, Bydgoszcz, Nicolaus Copernicus University, Toruń
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)

Country	Network acronym	Network name	Network website	Coordination
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/	Spain
UK–Scotland	SSHAIP	The Scottish Surveillance of Healthcare Associated Infection Programme (SSHAIP)	www.hps.scot.nhs.uk/haiic/sshaip/index.aspx	Health Protection Scotland, Glasgow

Table A2. Characteristics of intensive care units (ICUs) by country/network, unit-based and patient-based surveillance, EU/EEA, 2016

Country/Network	Number of ICUs	ICU size (median no. of beds)	Type of ICU (%)				
			Medical	Surgical	Mixed	Coronary	Other/unknown
Belgium	12	12	0.0	0.0	91.7	0.0	8.3
Czech Republic	10	8	10.0	30.0	30.0	10.0	10.0
Germany	828	12	13.5	18.0	56.6	1.7	8.1
Estonia	8	16.5	0.0	12.5	75.0	12.5	0.0
France	200	12	7.5	10.5	79.5	0.0	0.0
Italy/GiViTI	73	6	0.0	13.7	79.5	0.0	4.1
Italy/SPIN-UTI	34	8	2.9	2.9	79.4	5.9	8.8
Hungary	13	10	0.0	0.0	100	0.0	0.0
Lithuania	36	17	13.9	2.8	63.9	2.8	13.9
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
Poland	9	10	0.0	11.1	77.8	11.1	0.0
Portugal	41	8	4.9	0.0	73.2	0.0	22.0
Slovakia	8	8.5	0.0	0.0	100	0.0	0.0
Spain	190	12	3.2	2.1	82.1	1.1	11.6
United Kingdom – Scotland	21	7	0.0	0.0	90.5	4.8	0.0

Table A3. Patient demographics and risk factors at admission for patients staying more than two days in the intensive care unit (ICU) from countries/networks that provided patient-based data, EU/EEA, 2016

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 catheter (%)	Impaired immunity (%)	Mortality (%)
								Medical	Scheduled surgery	Urgent surgery					
Belgium	1909	15832	39.3	68	35	67.1	9.6	55.9	29.1	14.3	39.1	72.2	70.1	7.4	11.0
Estonia	1562	13624	38.8	67	99	59.6	11.5	59.5	17.2	22.9	69.9	91.0	77.1	6.2	10.5
France	67899	744305	38.1	67	43	37.6	7.7	70.4	11.9	17.5	61.1	84.3	64.2	14.8	17.2
Hungary	2007	12047	48	67	43	75.4	14.6	40.0	23.9	15.7	59.1	89.7	54.9	NA	19.0
Italy/GiViTI	16275	147145	40.5	69	37	57.5	11.4	50.9	22.5	26.7	73.1	NA	75.9	2.1	16.2
Italy/SPIN-UTI	1545	16007	36.9	69	44	65.7	3.6	48.6	18.4	32.6	61.4	76.6	44.6	8.4	23.2
Lithuania	3382	31777	43.1	63	33	63.1	12.0	51.9	15.4	32.3	57.4	82.3	61.4	2.9	17.7
Luxembourg	3368	31393	42.1	69	34	58.7	7.5	54.0	28.8	17.2	34.5	72.3	56.5	0.0	8.5
Poland	612	8052	35.6	68	49	76.8	7.2	57.7	27.6	13.9	95.3	99.2	98.7	10.3	27.6
Portugal	7729	87982	36.9	66	45	36.8	11.7	64.8	11.4	23.8	77.9	96.9	89.7	14.3	17.1
Slovakia	375	3186	38.4	67	51	55.5	18.1	73.1	10.7	14.7	81.9	96.5	78.1	9.9	25.3
Spain	36597	302454	35.8	66	33	42.9	6.6	68.0	19.3	12.7	46.3	79.1	68.3	7.4	12.9
United Kingdom – Scotland	8449	62204	41.2	62	NA	74.6	6.0	45.9	14.7	18.8	67.3	NA	74.2	NA	12.5

NA: Not available

Table A4. Intensive care unit (ICU)-acquired primary bloodstream infection rates by country/network, EU/EEA, 2016

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	8	1909	8.5	2.3	1.0	1.5	1.9
Estonia	8	1562	9.9	2.3	0.9	1.3	2.2
France	200	67899	11.6	2.0	1.0	1.7	2.5
Hungary	12	1695	8.3	2.1	0.0	1.9	3.5
Italy/GiViTI	73	16275	9.4	2.6	1.1	2.0	3.5
Italy/SPIN-UTI	26	1478	10.6	6.2	1.7	4.1	9.6
Lithuania	28	2 739	9.1	1.5	1.5	0.0	0.0
Luxembourg	9	3142	9.2	1.1	0.5	0.7	1.5
Poland	9	612	14.6	6.0	4.6	5.7	9.3
Portugal	41	7729	11.6	1.6	0.5	1.4	2.0
Slovakia	8	375	8.9	4.4	1.5	4.9	7.0
Spain	189	36556	8.2	1.9	0.0	1.4	3.0
United Kingdom – Scotland	21	8449	7.9	6.2	1.7	4.1	9.6

Table A5. Intensive care unit (ICU)-acquired microbiologically confirmed central venous catheter-related bloodstream infection rates by country among countries performing catheter-related infections surveillance, EU/EEA, 2016

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	8	1562	9.9	1.1	0.0	0.0	0.0
France	200	67899	11.6	0.9	0.0	0.7	1.2
Hungary	12	1695	8.3	1.9	0.0	0.0	2.3
Italy/GiViTI	73	16275	9.4	1.6	0.0	1.0	2.2
Italy/SPIN-UTI	26	1478	10.6	1.7	0.0	0.0	2.6
Poland	9	612	14.6	3.7	0.0	4.6	5.3
United Kingdom – Scotland	21	8449	7.9	0.3	0.0	0.0	0.3

Table A6. 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, 2016

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	8	1909	8.5	0.8	0.0	0.0	0.0
Estonia	8	1562	9.9	1.3	0.0	0.0	0.7
France	200	67899	11.6	1.1	0.4	0.8	1.6
Hungary	12	1695	8.3	1.9	0.0	0.0	2.3
Italy/GiViTI	73	16275	9.4	1.6	0.0	1.0	2.2
Italy/SPIN-UTI	26	1478	10.6	4.7	0.3	2.8	7.9
Lithuania	28	2 739	9.1	0.7	0.0	0.0	0.4
Luxembourg	9	3142	9.2	1.1	0.3	1.1	1.6
Poland	9	612	14.6	4.6	4.6	4.8	5.7
Portugal	41	7729	11.6	1.0	0.0	0.3	1.3
Slovakia	8	375	8.9	3.0	0.0	3.0	4.1
Spain	189	36556	8.2	1.2	0.0	0.5	2.0
United Kingdom – Scotland	21	8449	7.9	0.3	0.0	0.0	0.3