SURVEILLANCE REPORT

Healthcare-associated infections acquired in intensive care units

Annual Epidemiological Report for 2021

Key facts

- In 2021, 11 551 (15.6%) of patients staying in an intensive care unit (ICU) for more than two days presented with at least one of the ICU-acquired healthcare-associated infections (HAI) under surveillance (pneumonia, bloodstream infection or urinary tract infection).
- Of all patients staying in an ICU for more than two days, 10% presented with pneumonia, 8% with bloodstream infection (BSI) and 4% with urinary tract infection (UTI).
- Sixty-six percent of pneumonia episodes were associated with intubation, 38% of BSI episodes were catheter-related, and 97% of UTI episodes were associated with presence of a urinary catheter.
- The most frequently isolated microorganism was *Pseudomonas aeruginosa* in ICU-acquired pneumonia episodes, coagulase-negative staphylococci in ICU-acquired BSIs, and *Escherichia coli* in ICU-acquired UTIs.
- Antimicrobial use was empirical in 53% of 'days of therapy' (DOTs), directed in 38% of DOTs and prophylactic in 9% of DOTs.
- Fifteen percent of *Staphylococcus aureus* isolates were oxacillin-resistant (MRSA) and 7% of *Enterococcus* spp. were glycopeptide-resistant. Resistance to third-generation cephalosporins was reported in 20% of *E. coli* isolates, 42% of *Klebsiella* spp. isolates and 46% of *Enterobacter* spp. isolates. Carbapenem resistance was reported in 12% of *Klebsiella* spp. isolates, 30% of *P. aeruginosa* isolates and 85% of *Acinetobacter baumannii* isolates.

Introduction

Intensive care units (ICUs) are the hospital wards with the highest prevalence of healthcare-associated infections (HAIs). The majority of HAIs in ICUs are associated with the use of invasive devices (e.g. endotracheal tubes, vascular and urinary catheters), and a significant proportion of these HAIs are considered preventable. Moreover, the burden of antimicrobial resistance (AMR) is high in ICUs, due to the severity of the clinical condition of the patients, the frequent use of antibiotics and varying infection prevention and control practices.

Methods

This report is based on data for 2021 retrieved from EpiPulse on 26 June 2024. EpiPulse is the European surveillance portal for infectious 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.

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

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

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Stockholm, October 2024

A patient-based ('standard') protocol and a unit-based ('light') protocol are used for European surveillance of HAIs acquired in ICUs. The patient-based protocol is used to collect data for all patients, regardless of infection, including information on risk factors, to allow risk-adjusted inter-hospital comparisons. With the unit-based protocol, denominator data (i.e. patient-days) are collected at ICU level, while patient data are recorded only for patients with HAIs.

Inclusion criteria, risk factors and case definitions of ICU-acquired HAIs are described in detail in the protocol [3]. Infections occurring after 48 hours in the ICU are considered as ICU-acquired in both protocols. If the admission day is counted as day 1, infections with onset from day 3 onwards should be reported. One record per HAI is collected, together with data on AMR markers for each isolated microorganism.

The minimal requirement for surveillance of ICU-acquired HAIs is to include bloodstream infections (BSIs) and pneumonia. Collection of data on urinary tract infections (UTIs) and central venous catheter (CVC)-related infections is optional.

A case of pneumonia is defined in accordance with clinical criteria (X-ray, fever >38°C, leucocytosis >12 000 white blood cells (WBC)/mm^3, purulent sputum) and further sub-categorised in five categories according to the level of microbiological confirmation: PN1, minimally contaminated lower respiratory tract sample with quantitative culture (10^4 colony-forming units (CFU)/ml for bronchoalveolar lavage, 10^3 CFU/ml for protected brush samples or distal protected aspirate); PN2, non-protected sample (endotracheal aspirate, ETA) with quantitative culture (10^6 CFU/ml); PN3, alternative microbiological criteria (e.g. positive blood culture); PN4, sputum bacteriology or non-quantitative ETA; and PN5, no microbiological documentation, clinical signs and symptoms only.

A BSI is defined as a positive blood culture of a recognised pathogen or the combination of clinical symptoms (fever >38°C, chills, hypotension) and two positive blood cultures of a common skin contaminant from two separate blood samples drawn within 48 hours.

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

A HAI was defined as device-associated when the relevant device was used (even intermittently) in the 48 hours (two days) before onset of infection. For countries performing surveillance of catheter-related infections (CRIs), a microbiologically-confirmed central vascular catheter (CVC)-related BSI was defined as a BSI occurring 48 hours before or after catheter removal, and a positive culture with the same microorganism of either (a) quantitative CVC culture $\geq 10^3$ CFU/ml or semi-quantitative CVC culture >15 CFU, or (b) quantitative blood culture ratio CVC blood sample/peripheral blood sample >5, or (c) differential delay of positivity of blood cultures, or (d) positive culture with the same microorganism isolated in pus from an insertion site. A central line-associated bloodstream infection (CLABSI) was defined as a primary BSI with use of a CVC in the 48 hours (two days) before the onset of the infection. For the calculation of device-associated BSI rates, CLABSIs were used rather than catheter-related BSIs only, as not all participating countries performed surveillance of CRIs.

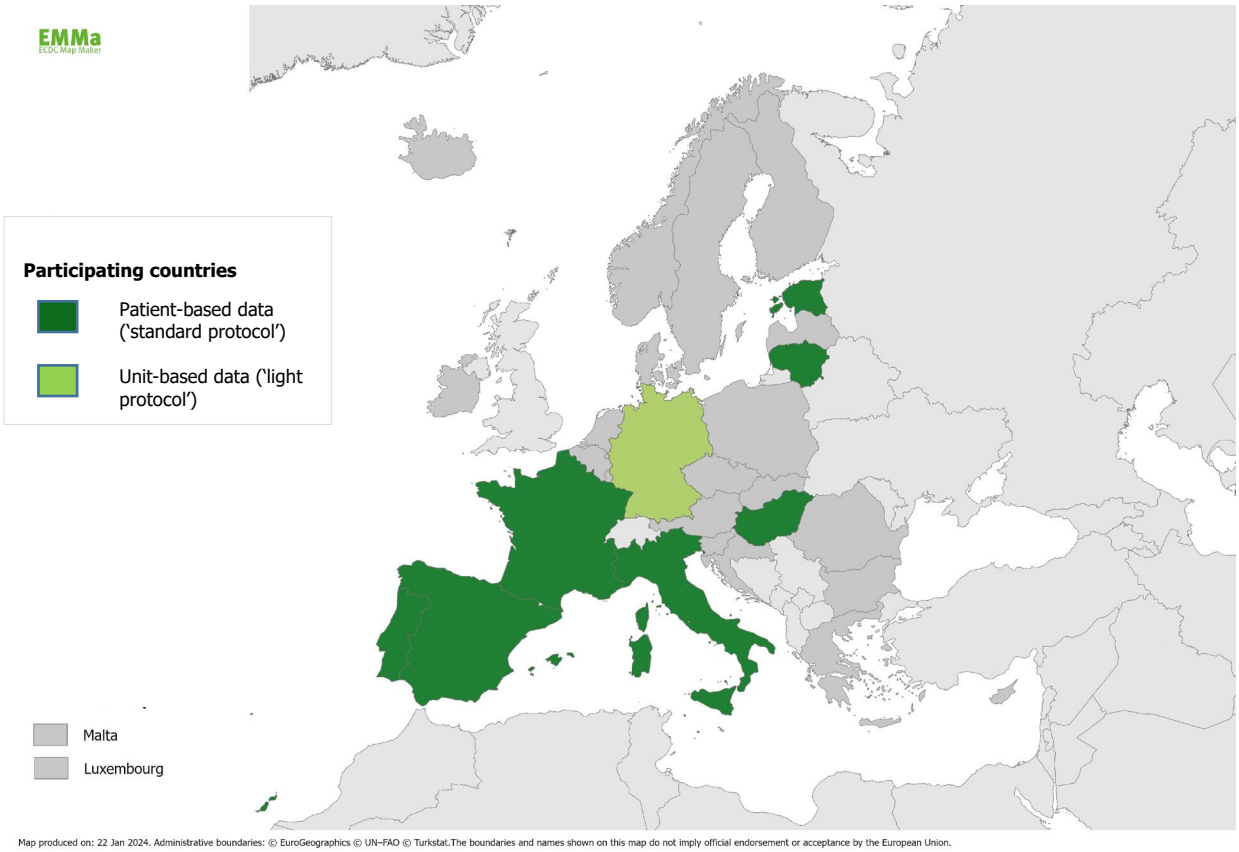
The number of HAIs, percentage of HAIs associated with the presence of a relevant device, the incidence density of HAIs per 1 000 patient-days and the incidence density of HAIs adjusted per 1 000 days of device use were estimated. For the estimation of device-adjusted incidence from patient-based data,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

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

- alcohol hand rub consumption in previous year;
- staffing levels (during a 7-day period) of registered nurses and nurse aides in the ICU;
- audit results in approximately 30 patients for:
  - post-prescription review within 72 hours of prescription,
  - prevention of pneumonia in intubated patients: control of cuff pressure, oral decontamination, patient position
  - CVC maintenance care: catheter site dressing is not damp, loosened or visibly soiled.

In 2021, nine networks in eight countries (Estonia, France, Germany, Hungary, Italy-GiViTI[1], Italy-SPIN-UTI[2], Lithuania, Portugal and Spain) reported data from 1 015 hospitals and 1 305 ICUs (Figure 1). The median size of the participating ICUs was 12 beds, ranging from two to 58 beds. One country (Germany) only provided unit-based data. The remaining seven countries provided patient-based data. Six countries (Estonia, Hungary, Italy, Lithuania, Portugal and Spain) reported data on antimicrobial use. Two countries/networks (Estonia and Italy-SPIN-UTI) provided data on the outcome of HAIs and, in case of death, the relationship between HAI and death. The Italy SPIN-UTI network reported data on structure and process indicators of infection prevention and control (IPC) and antimicrobial stewardship.

Figure 1. Participation in surveillance of healthcare-associated infections in intensive care units, EU/EEA, 2021



Source: ECDC, HAI-Net, 2021

Epidemiology

Of 73 872 patients staying in an ICU for more than two days (patient-based data), 11 551 patients (15.6%) presented with at least one HAI.

ICU-acquired pneumonia

Of 7 405 cases of pneumonia reported, 66.0% were associated with intubation. Among patients staying in an ICU for more than two days, 10.0% were affected by at least one episode of pneumonia. The incidence of pneumonia was 8.9 episodes per 1 000 patient-days.

The mean incidence density per ICU was 8.6 pneumonia episodes per 1 000 patient-days (ICU IQR:2.9-12.6) (Table 1), varying from 4.0 in ICUs with less than 30% intubated patients to 8.6 in ICUs with 30–59% intubated patients, and 9.7 in ICUs with more than 60% intubated patients.

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

Table 1. ICU-acquired pneumonia by country/network, EU/EEA, 2021

Country/network	Patient-days (n)	Pneumonia episodes (n)	Pneumonia incidence density (episodes per 1 000 patient-days)				
			Aggregated	Mean	25th percentile	Median	75th percentile
Estonia	3 986	12	3.0	3.5	2.3	3.6	4.9
France	76 649	1 085	14.2	12.9	5.9	12.9	18.0
Germany*	2 632 354	4 998	1.9	1.8	0.5	1.2	2.6
Hungary	6 986	36	5.2	4.6	0.0	2.6	9.2
Italy-GiViTI**	275 540	2 202	8.0	6.7	3.0	5.2	10.4
Italy-SPIN-UTI	14 131	190	13.5	12.5	0.0	10.9	20.0
Lithuania	23 776	249	10.5	7.0	0.0	4.8	11.3
Portugal	77 074	772	10.0	9.6	5.1	9.2	12.7
Spain	351 698	2 859	8.1	7.6	3.0	6.4	10.7
EU/EEA*	**829 840**	**7 405**	**8.9**	**8.6**	**2.9**	**6.7**	**12.6**

Source: ECDC, HAI-Net data 2021.

Percentiles: distribution of incidence per ICU

**Patient-days from Germany include patients staying in the ICU for less than two days and are not included in the EU/EEA results.*

*** In patients with more than one pneumonia episode during the surveillance period, Italy-GiViTI only records the first episode.*

In patient-based surveillance, the mean device-adjusted rate per ICU was 12.6 intubation-associated pneumonia episodes per 1 000 intubation-days and varied from 2.2 in Estonia to 19.1 in France (Table 2).

Table 2. ICU-acquired intubation-associated pneumonia (IAP) rates by country/network, EU/EEA, 2021

Country/network	Intubation-days (n)	Intubation use (days per 100 patient-days)	IAP episodes (n)	IAP incidence density (episodes per 1 000 intubation-days)				
				Aggregated	Mean	25th percentile	Median	75th percentile
Estonia	2 822	68.3	7	2.5	2.2	1.2	2.0	3.0
France	41 715	52.0	853	20.5	19.1	12.1	19.0	26.3
Hungary	4 078	58.0	32	7.9	6.5	0.0	7.6	11.2
Italy-GiViTI*	179 626	63.1	2 022	11.3	9.4	4.7	7.6	15.1
Italy-SPIN-UTI	7 683	61.3	131	17.1	16.9	5.9	12.5	24.3
Lithuania	10 877	42.8	178	16.4	14.4	1.1	11.0	23.6
Portugal	49 060	63.1	671	13.7	13.0	6.5	13.3	16.9
Spain	196 638	52.9	2 386	12.1	11.4	5.5	10.3	17.0
EU/EEA	**492 499**	**55.7**	**6 280**	**12.8**	**12.6**	**5.1**	**10.8**	**18.8**

Source: ECDC, HAI-Net patient-based data 2021.

IAP: intubation-associated pneumonia.

Percentiles: distribution of incidence per ICU.

** In patients with more than one pneumonia episode during the surveillance period, Italy-GiViTI only records the first episode.*

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

Table 3. Distribution of the ten most frequently isolated microorganisms in ICU-acquired pneumonia episodes, by country/network, EU/EEA, 2021

Microorganism	Estonia (n=12)	France (n=1 044)	Germany (n= 4 427)	Hungary (n=24)	Italy GiViTI (n=1 726)	Italy SPIN-UTI (n=114)	Lithuania (n=274)	Portugal (n=697)	Spain (n=1 914)	Total (n=10 232)
Pseudomonas aeruginosa	8.3	21.7	14.1	12.5	26.4	13.2	11.3	25.8	28.3	20.3
Klebsiella spp.	25.0	14.2	20.9	8.3	18.4	18.4	14.6	26.4	15.2	18.9
Staphylococcus aureus	8.3	21.4	17.7	12.5	14.8	13.2	6.9	16.4	23.0	18.1
Escherichia coli	8.3	10.2	14.1	4.2	9.1	7.9	6.6	4.6	7.7	10.7
Enterobacter spp.	16.7	13.8	11.7	4.2	9.2	5.3	8.0	9.2	8.5	10.6
Serratia spp.	0.0	5.6	7.9	0.0	4.2	1.8	2.2	8.0	5.8	6.4
Acinetobacter spp.	0.0	1.6	1.1	45.8	11.6	25.4	39.1	2.0	1.5	4.5
Candida spp.	25.0	4.7	4.7	0.0	3.1	12.3	6.9	1.9	1.5	3.8
Stenotrophomonas maltophilia	8.3	3.9	3.5	8.3	1.6	2.6	1.5	3.6	6.4	3.7
Proteus spp.	0.0	3.0	4.3	4.2	1.4	0.0	2.9	2.2	2.2	3.0

n = number of isolates
Source: ECDC, HAI-Net patient-based and unit-based data, 2021.

ICU-acquired bloodstream infections (BSIs)

A total of 5 707 cases of ICU-acquired BSI were reported. On average, ICU-acquired BSIs occurred in 7.7% of patients staying in an ICU for more than two days. The mean incidence density per ICU was 5.9 BSI episodes per 1 000 patient-days (ICU IQR: 2.2–8.4) (Table 4). The respective mean incidence density of primary BSIs (including catheter-related infections and infections of unknown origin) per ICU was 4.3 episodes per 1 000 patient-days (ICU IQR: 0.8–5.4) (Table A4). BSIs were catheter-related in 38.3% of cases, secondary to another infection in 29.2% of cases, and of unknown origin in 22.5% of cases. When the BSI was secondary to another infection, the primary infection site was pulmonary (55.0% cases), followed by the urinary tract (22.7%), gastrointestinal (7.3%), skin and soft tissue (2.5%), a surgical site (2.1%), and 'other' in 10.3% cases.

Table 4. ICU-acquired bloodstream infection (BSI) rates by country/network, EU/EEA, 2021

Country/network	Patient-days (n)	BSI episodes (n)	BSI incidence density (episodes per 1 000 patient-days)				
			Aggregated	Mean	25th percentile	Median	75th percentile
Estonia	3 986	30	7.5	5.7	3.1	4.3	6.9
France	76 649	444	5.8	5.9	2.0	4.3	7.9
Germany*	2 632 354	3 521	1.3	1.3	0.4	0.9	1.8
Hungary	6 986	61	8.7	8.8	0.0	8.7	13.6
Italy-GiViTI**	275 540	2 266	8.2	7.4	3.2	6.4	10.4
Italy-SPIN-UTI	14 131	87	6.2	6.0	0.0	3.4	8.6
Lithuania	23 776	81	3.4	1.9	0.0	0.0	1.5
Portugal	77 074	401	5.2	5.1	3.1	4.4	7.0
Spain	351 698	2 337	6.6	6.0	3.0	5.4	8.0
EU/EEA*	**829 840**	**5 707**	**6.9**	**5.9**	**2.2**	**4.7**	**8.4**

Source: ECDC, HAI-Net data 2021.
Percentiles: distribution of incidence per ICU.
**Patient-days from Germany include patients staying in the ICU for less than two days and are not included in the EU/EEA results.*
***In patients with more than one BSI episode during the surveillance period, Italy-GiViTI only records the first episode of primary BSI, and the first episode of secondary BSI related to a first episode of primary infection at each primary infection site.*

In patient-based surveillance, the central vascular catheter (CVC) utilisation rate was on average 81.0 CVC-days per 100 patient-days. It was lowest (65.0) in Lithuania and highest (89.0) in Estonia. The mean device-adjusted rate in patients staying in an ICU for more than two days was 4.1 central line-associated BSI (CLABSI) episodes per 1 000 CVC days (ICU IQR: 1.0–6.0), varying from 1.7 in Lithuania to 7.7 in Hungary (Table 5).

Table 5. ICU-acquired central line-associated bloodstream infection (CLABSI) rates by country/network, EU/EEA, 2021

Country/network	Catheter-days (n)	Catheter use (days per 100 patient-days)	CLABSI episodes (n)	CLABSI incidence density (episodes per 1 000 catheter-days)				
				Aggregated	Mean	25th percentile	Median	75th percentile
Estonia	3 561	89.3	18	5.1	3.3	1.0	1.3	3.6
France	53 445	71.1	160	3.0	2.8	0.0	2.0	3.7
Hungary	4 900	71.4	42	8.6	7.7	0.0	7.6	12.9
Italy-GiViTI*	238 147	86.8	1345	5.7	5.2	1.6	3.9	7.1
Italy-SPIN-UTI	9 969	78.7	57	5.7	6.4	0.4	5.8	8.0
Lithuania	14 780	65.9	61	4.1	1.7	0.0	0.0	1.3
Portugal	63 203	82.0	218	3.5	3.4	1.7	2.9	4.9
Spain	279 296	79.6	1312	4.7	4.2	1.8	3.6	5.7
EU/EEA	**667 301**	**81.0**	**3 213**	**4.8**	**4.1**	**1.0**	**3.2**	**6.0**

Source: ECDC, HAI-Net patient-based data 2021.

Percentiles: distribution of incidence per ICU.

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

The incidence of microbiologically-confirmed central vascular catheter-related BSIs among countries performing catheter-related infection surveillance is presented in Annex 1, Table A5. The incidence of BSIs classified as catheter-related, either through microbiological confirmation or due to clinical improvement after removal of the catheter, is displayed in Annex 1, Table A6.

The most frequently isolated microorganisms in BSI episodes (including microbiologically-confirmed catheter-related BSIs) were coagulase-negative staphylococci, followed by *Enterococcus* spp., *Klebsiella* spp. and *Staphylococcus aureus* (Table 6).

Table 6. Distribution of the ten most frequently isolated microorganisms in ICU-acquired bloodstream infection (BSI) episodes by country/network, EU/EEA, 2021

Microorganism	Estonia (n=28)	France (n=421)	Germany (n=3 484)	Hungary (n=63)	Italy GiViTI (n=2 075)	Italy SPIN-UTI (n=70)	Lithuania (n=84)	Portugal (n=373)	Spain (n=1 874)	Total (n=8 472)
Coagulase-negative staphylococci	53.6	20.0	28.2	14.3	19.4	35.7	15.5	16.1	27.9	24.9
Enterococcus spp.	21.4	14.7	24.3	7.9	11.5	20.0	8.3	12.3	21.0	19.1
Klebsiella spp.	0.0	13.8	8.8	15.9	14.7	10.0	9.5	25.2	9.1	11.3
Staphylococcus aureus	3.6	11.4	11.8	17.5	7.2	2.9	11.9	8.6	8.5	9.7
Pseudomonas aeruginosa	0.0	13.3	4.0	11.1	11.6	4.3	2.4	7.5	8.9	7.6
Candida spp.	10.7	5.9	6.4	3.2	8.0	4.3	1.2	8.8	8.4	7.3
Escherichia coli	10.7	7.1	8.0	6.3	6.2	2.9	3.6	4.6	4.4	6.5
Enterobacter spp.	0.0	9.5	4.6	7.9	7.5	1.4	11.9	8.6	5.9	6.0
Serratia spp.	0.0	2.4	3.1	3.2	3.7	1.4	2.4	7.8	5.4	3.9
Acinetobacter spp.	0.0	1.9	0.7	12.7	10.3	17.1	33.3	0.5	0.5	3.6

n = number of isolates

**Data from Germany only on primary bloodstream infections.*

Source: ECDC, HAI-Net patient-based and unit-based data 2021.

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

ICU-acquired urinary tract infections (UTIs)

A total of 2 859 cases of ICU-acquired UTI were reported. On average, ICU-acquired UTIs occurred in 4.2% of patients staying in an ICU for more than two days, with 97.3% of UTI episodes being associated with the use of a urinary catheter. The mean incidence density per ICU was 3.6 UTI episodes per 1 000 patient-days (ICU IQR: 0.6–5.6) (Table 7).

Table 7. ICU-acquired urinary tract infection (UTI) rates by country/network, EU/EEA, 2021

Country/network	Patient-days (n)	UTI episodes (n)	UTI incidence density (episodes per 1 000 patient-days)				
			Aggregated	Mean	25th percentile	Median	75th percentile
Estonia	3 986	9	2.3	2.2	2.1	2.3	2.4
Germany*	2 632 354	3 048	1.2	1.1	0.1	0.7	1.5
Hungary	6 986	18	2.6	2.7	0.0	0.0	6.8
Italy-GiViTI**	275 540	767	2.8	2.7	0.4	1.4	3.6
Italy-SPIN-UTI	14 131	56	4.0	4.7	0.0	2.8	5.4
Lithuania	23 776	104	4.4	3.0	0.0	0.0	4.5
Portugal	77 074	180	2.3	2.2	0.8	1.5	3.0
Spain	351 698	1 725	4.9	4.4	1.5	3.9	6.3
EU/EEA	**753 191**	**2 859**	**3.8**	**3.6**	**0.6**	**2.3**	**5.6**

Source: ECDC, HAI-Net data 2021.

Percentiles: distribution of incidence per ICU.

**Patient-days from Germany include patients staying in the ICU for less than two days and are not included in the EU/EEA results.*

***In patients with more than one UTI episode during the surveillance period, Italy-GiViTI only records the first episode.*

On average, urinary catheters were used in 89% of the patient-days. The mean device-adjusted rate in patients staying in an ICU for more than two days was 4.4 catheter-associated UTI episodes per 1 000 catheter-days (ICU IQR: 0.7–6.7).

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

Table 8. Distribution of the ten most frequently isolated microorganisms in ICU-acquired urinary tract infection (UTI) episodes, by country/network, EU/EEA, 2021

Microorganism	Estonia (n=10)	Germany (n=3 321)	Hungary (n=15)	Italy GiViTI (n=721)	Italy SPIN-UTI (n=21)	Lithuania (n=89)	Portugal (n=183)	Spain (n=1 449)	Total (n=4 987)
Escherichia coli	10.0	31.8	6.7	22.2	4.8	12.4	23.5	20.9	27.1
Enterococcus spp.	30.0	19.9	20.0	30.2	23.8	30.3	15.8	29.4	23.6
Pseudomonas aeruginosa	30.0	14.7	13.3	12.3	4.8	9.0	14.8	15.8	14.6
Klebsiella spp.	0.0	14.0	53.3	8.7	19.0	15.7	21.3	10.1	12.7
Proteus spp.	20.0	7.7	6.7	4.9	4.8	10.1	9.3	4.3	6.6
Enterobacter spp.	0.0	6.3	0.0	3.5	4.8	2.2	5.5	4.1	5.3
Candida spp.	10.0	0.0	0.0	14.4	28.6	14.6	8.7	10.9	5.1
Citrobacter spp.	0.0	2.6	0.0	1.4	4.8	3.4	0.5	1.8	2.2
Coagulase-negative staphylococci	0.0	1.2	0.0	2.2	0.0	2.2	0.5	1.4	1.4
Serratia spp.	0.0	1.7	0.0	0.1	4.8	0.0	0.0	1.3	1.4

n = number of isolates

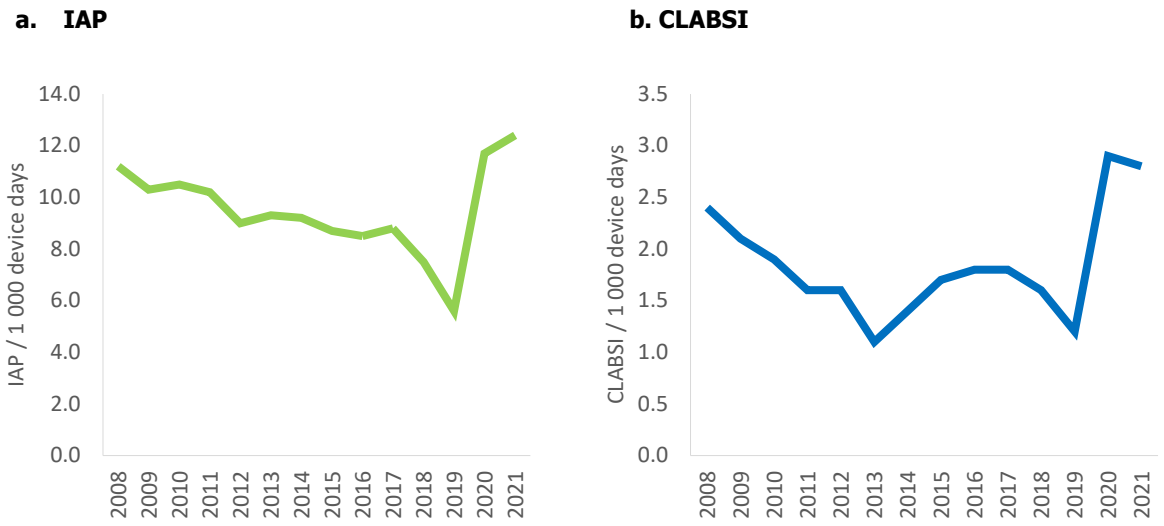
Source: ECDC, HAI-Net ICU 2021

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

Trends

Trend analysis of yearly median incidence density in ICUs from five European countries/networks (France, Italy-SPIN-UTI, Lithuania, Portugal and Spain) with uninterrupted participation since 2008 demonstrated a change from the previous decreasing trend (before the COVID-19 pandemic) to a sharp increase in 2020 and a small decrease in 2021 for IAP, and a sharp increase in 2020, with small decrease in 2021 for CLABSI (Figure 2).

Figure 2. Incidence density trend of intubation-associated pneumonia (IAP) and central line-associated bloodstream infection (CLABSI), five EU/EEA countries/networks*, 2008–2021



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

Antimicrobial use

In total, 778 005 DOTs with antimicrobials were recorded in 2021. Antimicrobial treatment was empirical in 52.9% (range 40.1–70.5%) of DOTs, directed in 38.0% (range 26.2–52.1%), prophylactic in 9.1% (range 1.9–21.6%) and selective digestive decontamination in 0.3% (range 0.0–0.5%). The reported antimicrobial use of selected antimicrobials/antimicrobial groups was carbapenems, 14.5 (range 9.8–39.0) DOTs per 100 patient-days; third- and fourth-generation cephalosporins, 10.2 (range 2.6–16.1); piperacillin-tazobactam, 11.2 (range 0.0–21.1); fluoroquinolones, 4.9 (range 2.1–8.1); glycopeptides, 5.8 (range 4.7–11.2); and polymyxins, 1.2 (range 0.0–4.9) (Table 9).

Table 9. Antimicrobial use indication and selected antimicrobial groups, by country/network, EU/EEA 2021

Country	Antimicrobial indication (% DOTs)				Antimicrobial group (DOTs/100 patient-days)					
	Empirical	Directed	Prophylactic	SDD	Carbapenems	Cephalosporins (3rd- and 4th-generation)	Piperacillin/tazobactam	Fluoroquinolones	Glycopeptides	Polymyxins
Estonia	46.8	50.1	3.1	0.0	39.0	2.6	9.8	6.6	11.2	0.0
Hungary	65.9	32.2	1.9	0.0	18.4	9.3	4.6	4.7	5.4	2.1
Italy-GiViTI	40.1	52.1	7.8	0.0	9.8	7.4	16.0	2.2	6.2	0.0
Italy-SPIN-UTI	47.3	30.6	21.6	0.5	12.4	16.1	21.1	8.1	8.0	4.9
Lithuania	63.3	31.7	4.9	0.1	11.1	8.3	8.3	2.1	5.0	3.3
Portugal	70.5	26.2	3.3	0.1	17.5	9.3	0.0	2.3	9.5	0.6
Spain	57.8	30.6	11.6	0.0	17.2	11.7	9.9	7.2	4.7	1.0

Source: ECDC, HAI-Net patient-based data 2021.

DOTs: days of therapy

SDD: selective digestive decontamination.

Antimicrobial resistance

The reported percentages of antimicrobial-resistant isolates in selected bacteria associated with ICU-acquired HAIs were oxacillin resistance (MRSA) in 15.3% of *S. aureus* isolates (n=1 033), vancomycin resistance in 7.2% of *Enterococcus* spp. isolates (n=1 490), ceftazidime resistance in 34.9% of *P. aeruginosa* isolates (n=1 172), and third-generation cephalosporin resistance in 20.4% of *E. coli* isolates (n=1 002), 41.7% of *Klebsiella* spp. isolates (n=1 630) and 46.3% of *Enterobacter* spp. isolates (n=801). Carbapenem resistance was reported in 11.6% of *Klebsiella* spp. isolates (n=414), 0.5% of *E. coli* isolates (n=185), 2.1% of *Enterobacter* spp. isolates (n=236), 29.9% of *P. aeruginosa* isolates (n=1 361) and 85.0% of *Acinetobacter baumannii* (n=234) isolates.

Outcome of healthcare-associated infections

Two countries provided data on the outcome of HAIs and the relation between HAI and outcome, for a total of 396 HAIs. In 194 (49.0%) HAIs, the patient was discharged alive; in 17 (4.3%) HAIs the patient died and the death was assessed as being definitely linked to the HAI; in 28 (7.1%) HAIs the patient died and the death was assessed as not being linked to the HAI; in 115 (29.0%) HAIs the patient died and the death was assessed as probably being linked to the HAI and in 42 (10.6%) HAIs the patient died and the relationship of the death to the HAI was unknown (Table 10).

Table 10. Healthcare-associated infection (HAI) outcome by country/network, EU/EEA, 2021

Country/network	HAIs (n)	Discharged alive (%)	Death, HAI definitely contributed to death (%)	Death, HAI possibly contributed to death (%)	Death, unrelated to HAI (%)	Death, relationship to HAI unknown (%)
Estonia	40	72.5	2.5	25.0	0.0	0.0
Italy-SPIN-UTI	356	46.3	4.5	29.5	7.9	11.8

Structure and process indicators of infection control and antimicrobial stewardship

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

Table 11. Structure and process indicators for infection prevention and control in intensive care units (ICUs), Italy-SPIN-UTI network, 2021

Country/network	ICUs (n)	ICU size (median number of beds)	Number of registered nurse hours per patient day (median)	Number of nursing assistant hours per patient day (median)	Alcohol hand rub consumption in the previous year (L/1 000 patient-days)
Italy-SPIN-UTI	15	7	11.0	3.6	147.6

Table 12. Process indicators assessed through chart review or direct observation by country/network, Italy-SPIN-UTI network, 2021

Country/network	ICUs (n)	Assessment of antimicrobial prescriptions after 48-72 hours (% total antimicrobial prescriptions)	Endotracheal cuff pressure check (% total observed intubation-days)	Oral decontamination (% total observed intubation-days)	Patient position not supine (% total observed intubation-days)	CVC dressing observation (% total observed catheter-days)
Italy-SPIN-UTI	15	50.6	88.6	76.8	44.9	85.5

Discussion

Nine networks in eight EU/EEA countries submitted data on ICU-acquired HAIs in 2021.

HAI surveillance at the local and national level is an essential component of HAI prevention and control. The participating ICUs benefit from a standardised tool which enables them to compare their own performance to that of other ICUs. In addition, participation in the European surveillance network encourages compliance with existing guidelines and helps to correct or improve specific practices, as well as evaluate new preventive practices. Participation in the European network may also yield additional benefits at the local level, allowing comparisons with a wide range of ICUs nationally and at the European level. Nevertheless, inter-country differences in surveillance methods persist, and there is an ongoing effort to further harmonise the methodology for surveillance of HAIs in ICUs across Europe.

Pneumonia was the most common HAI acquired in ICUs and was associated with intubation in most cases. Among BSIs, almost half were catheter-related. There were considerable increases in both crude and device-adjusted HAI rates of ICU-acquired pneumonia, BSIs and UTIs across the participating networks compared to previous years [4,5], which may reflect the effect of the COVID-19 pandemic. These results are consistent with previously published data from Europe [6] and the US [7], but should be interpreted with caution due to differences in the participating countries and networks over the years. The increases in the incidence density of HAIs during the COVID-19 pandemic may be related to differences in case-mix (i.e. decreases in patients admitted to the ICU after elective surgery, increased severity and prolonged hospital stay) or to changes in infection control practices. Further in-depth analysis is required to identify the extent that each of these factors contributed to this increase.

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

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

The distribution of microorganisms associated with HAIs in 2021 was similar to that in 2020, with the caveat that the overall results were not directly comparable due to the differences in reporting countries. In 2021, *P. aeruginosa* was the most common microorganism associated with pneumonia, followed by *Klebsiella* spp. and *S. aureus*. Among BSIs, coagulase-negative staphylococci remained the most commonly-isolated microorganisms and were mostly associated with catheter-related BSIs. The relative contribution of gram-negative bacteria as a cause of HAIs in ICUs continues to vary geographically, with higher proportions of HAIs caused by *Klebsiella* spp. in some countries. Similar to 2020 and in contrast to 2019, *Acinetobacter* spp. was among the ten most common bacterial species isolated from both pneumonia and bloodstream infections, consistent with reported increases in incidence of *Acinetobacter* spp. BSIs reported by EARS-Net [8].

This report confirms the importance of antimicrobial resistance in gram-negative bacteria as a cause of HAIs in ICUs in the EU/EEA in 2021, with resistance percentages being comparable to the report for previous years. The high percentages of resistance to carbapenems of *P. aeruginosa*, *A. baumannii* and *K. pneumoniae* isolates reflect the challenges of treating HAIs in ICU patients, a highly vulnerable patient population.

In 2021, only two participating countries provided data on HAI outcomes and the relation of the HAI to death in the patients who died. Almost one in three HAIs were assessed to have contributed to death, either definitely or possibly.

In the only country network reporting data for structure and process indicators of infection prevention and control and antimicrobial stewardship for 2021, there was considerable inter-ICU variability. These data can be used to identify targets for improvement in the participating ICUs.

Public health implications

ICUs are the hospital wards with the highest prevalence of HAIs [9]. The majority of HAIs in ICUs are associated with the use of invasive devices (e.g. endotracheal tubes, vascular and urinary catheters), and a significant proportion of these HAIs are considered preventable. Moreover, the burden of antimicrobial resistance is high in ICUs, due to the severity of the clinical condition of the patients, the frequent use of antibiotics and varying infection prevention and control practices. Surveillance data can be used to identify targets for intervention, both in terms of prevention of HAIs and antimicrobial use. Further understanding of the variation in incidence density and of the burden of HAIs in ICUs should be facilitated by using quality indicators for infection prevention and control and antimicrobial stewardship, and information on HAI outcomes. These are included in the ECDC protocol for surveillance of HAIs in ICUs and are expected to increase the usefulness of surveillance data in the future. There is still a need to increase country participation in surveillance of ICU-acquired infections and collection of data on structure and process indicators of IPC and antimicrobial stewardship in order to benchmark ICUs in the countries/networks that already participate in HAI-Net ICU.

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Annex 1.Supplementary information

Table A1. Healthcare-associated infections acquired in intensive care units: surveillance systems overview, 2021

Country	Network acronym	Network name	Network website	Coordination
Estonia				Health Board of Estonia
France	SPIADI On behalf REPIAS	HAI-surveillance network in adult ICUs	https://www.spiadi.fr	Regional center for Infection control & Prevention (CPias CVDL) on behalf of the National Public Health Agency (REPIAS/Santé publique France)
Germany	KISS (ITS-KISS)	German Nosocomial Infection Surveillance System (KISS)	http://www.nrz-hygiene.de/en/nrz/welcome/	National Reference Centre for Nosocomial Infection Surveillance, Charité - University Medicine, Berlin
Hungary	NNSR	National Nosocomial Surveillance System	http://www.oek.hu/oek.web?to=1817&nid=921&pid=1&lang=eng	National Centre for Epidemiology, Budapest
Italy	SPIN-UTI	Italian Nosocomial Infection Surveillance in ICUs (SPIN-UTI) network	https://spinuti.unict.it/	Italian Study Group of Hospital Hygiene – Italian Society of Hygiene, Preventive Medicine and Public Health (GISIO – SItI)
	GiViTI	Gruppo Italiano per la Valutazione degli Interventi in Terapia Intensiva	https://giviti.marionegri.it/portfolio/infezioni/	
Lithuania			www.hi.lt/content/G0_hosp_inf.html	Institute of Hygiene, Vilnius
Portugal	PPCIRA (HELICS-UCI)		www.dgs.pt/programa-de-prevencao-e-controlo-de-infecoes-e-de-resistencia-aos-antimicrobianos.aspx	Directorate-General of Health, Lisbon Portuguese national programme for prevention and control of infections and antimicrobial resistance (PPCIRA)
Spain	ENVIN-HELICS	National surveillance of nosocomial infections in intensive care medicine	http://hws.vhebron.net/envin-helics/	Working group of infectious diseases and sepsis (GTEIS). Spanish Society of Intensive Care Medicine (SEMICYUC). National Centre for Epidemiology. Health Institute Carlos III, Madrid

Table A2. Characteristics of intensive care units by country, unit-based and patient-based surveillance, EU/EEA, 2021

Country/network	ICUs (n)	ICU size (median no. beds)	Type of ICU (%)				
			Medical	Surgical	Mixed	Coronary	Other/unknown
Estonia	4	10	0.0	0.0	100.0	0.0	0.0
France	85	12	7.1	3.5	78.8	2.4	7.1
Germany	811	13	12.3	16.3	56.0	1.7	11.2
Hungary	13	8	0.0	7.7	76.9	0.0	15.4
Italy-GiViTI	109	8	0.0	12.8	78.0	0.0	4.6
Italy-SPIN-UTI	29	8	3.5	3.5	65.5	10.3	17.2
Lithuania	44	6	6.8	4.6	68.2	6.8	11.4
Portugal	31	11	6.5	0.0	58.1	0.0	35.5
Spain	179	13	1.7	2.2	80.5	2.2	13.4

NA: Not available

Table A3. Patient demographics and risk factors on admission for patients staying more than two days in an intensive care unit, from countries that provided patient-based data, EU/EEA, 2021

Country/network	Patients (n)	Ppatient–days (n)	Average length of stay (days)	Females (%)	Median age (years)	SAPS II score median	Patient from hospital (%)	Trauma (%)	Type of admission (%)			Intubation (%)	Urinary catheter (%)	Central vascular catheter (%)	Impaired immunity (%)	Mortality (%)
									Medical	Scheduled surgery	Urgent surgery					
Estonia	337	3 986	11.8	41.3	63	NA	63.8	2.4	73.6	4.2	21.1	75.1	97.6	88.1	5.9	17.2
France	6 422	76 649	11.9	34.7	65	38	3.5	4.5	82.1	6.2	11.6	55.5	73.7	63.0	1.3	19.7
Hungary	727	6 986	9.6	40.0	64	NA	58.5	14.0	66.3	7.0	12.4	67.7	89.6	69.7	28.5	32.1
Italy-GiViTI	23 730	275 540	11.6	36.7	67	34	52.5	11.5	60.7	16.2	23.0	0.0	96.1	0.0	2.1	20.0
Italy-SPIN-UTI	1 186	14 131	11.9	34.4	70	40	74.1	2.0	67.7	11.1	21.3	38.7	75.8	34.1	3.3	42.6
Lithuania	2 669	23 776	8.9	41.8	63	NA	58.8	8.6	60.2	8.8	23.7	56.6	85.7	65.0	13.8	25.9
Portugal	6 288	77 074	12.3	35.6	66	40	43.2	7.7	72.4	9.9	17.7	66.7	92.6	84.1	10.0	16.6
Spain	32 513	351 698	10.8	34.4	64	35	48.8	5.7	74.0	14.9	11.1	51.3	82.3	74.4	7.4	16.1

NA: Not available

Table A4. Intensive care unit-acquired primary bloodstream infection rates by country, EU/EEA, 2021

Country/network	Patient-days (n)	Primary BSI episodes (n)	Primary BSI rate (episodes per 1 000 patient-days)				
			Aggregated	Mean	25th percentile	Median	75th percentile
Estonia	3 986	18	4.5	2.9	0.9	1.2	3.2
France	76 649	230	3.1	3.0	0.7	2.4	4.0
Hungary	6 863	51	7.4	7.2	0.0	6.9	10.0
Italy-GiViTI*	274 363	1 436	5.2	4.8	1.6	3.6	6.6
Italy-SPIN-UTI	12 662	72	5.7	6.5	0.5	4.4	9.7
Lithuania	22 424	68	3.0	2.0	0.0	0.0	2.4
Portugal	77 074	233	3.0	3.0	1.5	2.3	4.3
Spain	350 983	1 491	4.3	3.8	1.7	3.3	5.2

Source: ECDC, HAI-Net patient-based data 2021.

BSI: bloodstream infection

Percentiles: distribution of incidence per ICU

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

Table A5. Intensive care unit-acquired microbiologically confirmed central venous catheter-related bloodstream infection rates by country, among countries performing catheter-related infection surveillance, EU/EEA, 2021

Country/network	CVC use days (n)	CVC use (days per 100 patient-days)	CRI episodes (n)	CVC- related bloodstream infection rate (episodes per 1 000 CVC-days)				
				Aggregated	Mean	25th percentile	Median	75th percentile
Estonia	3 561	89.3	8	2.3	1.1	0.0	0.0	1.1
France	53 445	71.1	83	1.6	1.7	0.0	0.0	2.5
Hungary	4 900	71.4	42	8.6	6.7	0.0	5.6	9.7
Italy-GiViTI*	238 147	86.8	743	3.1	2.8	0.5	2.0	4.2
Italy-SPIN-UTI	9 969	78.7	31	3.1	2.5	0.0	0.0	2.4
Lithuania	14 780	65.9	21	1.4	1.9	0.0	0.0	0.0

Source: ECDC, HAI-Net patient-based data 2021.

CRI: catheter-related infection

CVC: central venous catheter

Percentiles: distribution of incidence per ICU.

** In patients with more than one CRI episode during the surveillance period, Italy-GiViTI only records the first episode.*

Table A6. Intensive care unit (ICU)-acquired central venous catheter (CVC)-related bloodstream infection rates by country (microbiologically confirmed or with clinical improvement after removal of the catheter), EU/EEA, 2021

Country/network	CVC use days (n)	CVC use (days per 100 patient-days)	CRI episodes (n)	CVC- related bloodstream infection rate (episodes per 1 000 CVC-days)				
				Aggregated	Mean	25th percentile	Median	75th percentile
Estonia	3 561	89.3	10	2.8	1.8	1.0	1.3	2.2
France	53 445	71.1	177	3.3	2.8	0.0	1.7	3.7
Hungary	4 900	71.4	42	8.6	6.7	0.0	5.6	9.7
Italy-GiViTI*	238 147	86.8	743	3.1	2.8	0.5	2.0	4.2
Italy-SPIN-UTI	9 969	78.7	52	5.2	4.1	0.0	1.2	6.4
Lithuania	14 780	65.9	42	2.84	2.69	0	0	1.41
Portugal	63 203	82.0	111	1.8	1.7	0.7	1.6	2.3
Spain	279 296	79.6	608	2.2	2.0	0.3	1.6	2.9

Source: ECDC, HAI-Net patient-based data 2021.

CRI: catheter-related infection

CVC: central venous catheter.

Percentiles: distribution of incidence per ICU.

** In patients with more than one primary bloodstream infection episode during the surveillance period, Italy-GiViTI only records the first episode.*