The European Centre for Disease Prevention and Control (ECDC) pilot point prevalence survey of healthcare-associated infections and antimicrobial use

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A standardised methodology for a combined point prevalence survey (PPS) on healthcare-associated infections (HAIs) and antimicrobial use in European acute care hospitals developed by the European Centre for Disease Prevention and Control was piloted across Europe. Variables were collected at national, hospital and patient level in 66 hospitals from 23 countries. A patient-based and a unit-based protocol were available. Feasibility was assessed via national and hospital questionnaires. Of 19,888 surveyed patients, 7.1% had an HAI and 34.6% were receiving at least one antimicrobial agent. Prevalence results were highest in intensive care units, with 28.1% patients with HAI, and 61.4% patients with antimicrobial use. Pneumonia and other lower respiratory tract infections (2.0% of patients; 95% confidence interval (CI): 1.8–2.2%) represented the most common type (25.7%) of HAI. Surgical prophylaxis was the indication for 17.3% of used antimicrobials and exceeded one day in 60.7% of cases. Risk factors in the patient-based protocol were provided for 98% or more of the included patients and all were independently associated with both presence of HAI and receiving an antimicrobial agent. The patient-based protocol required more work than the unit-based protocol, but allowed collecting detailed data and analysis of risk factors for HAI and antimicrobial use.

Introduction

Healthcare-associated infections (HAIs) and antimicrobial resistance are well known major public health threats. The European Centre for Disease Prevention and Control (ECDC) proposed in 2008 that the total burden of HAIs should be measured regularly and in a standardised manner throughout the European Union (EU) [1]. The initial steps towards standardisation of surveillance of HAIs in Europe had been carried out on surgical site infections and infections in intensive care units by the 'Hospitals in Europe Link for Infection Control through Surveillance (HELICS)' project, from 2000 to 2003 [2-6].

Subsequently, HELICS implemented standardised surveillance of HAIs in 2004 and 2005, and later as part of the 'Improving Patient Safety in Europe (IPSE)' network from 2005 to 2008 [7] which was transferred to ECDC in July 2008. Continuous surveillance, especially prospective active surveillance, is the gold standard [8]. However, repeated point prevalence surveys (PPSs) represent a more feasible alternative for hospital-wide surveillance of all HAIs, while still allowing the estimation of disease burden by HAIs in acute hospitals, and helping to prioritise areas requiring interventions [9]. Based on a review of 30 national or multicentre PPSs in 19 countries that had been carried out between 1996 and 2007 and included a total of 837,450 patients, ECDC estimated in 2008 the prevalence of HAIs in EU acute care hospitals to be on average of 7.1% [1].

However, major methodological differences between these PPSs made comparison between countries impossible [1,10-13]. When coordination of the IPSE network was transferred to ECDC in July 2008, ECDC recommended that surveillance in the EU should include all types of HAIs. Subsequently, the ECDC prepared a protocol for a PPS of HAIs in acute care hospitals, which was finalised in March 2011 [14].

Although most antimicrobials are prescribed in the community [15], the selective pressure they exert is

much higher in hospitals, where the proportion of patients receiving antimicrobial agents is much higher there than in the community [16]. This is considered to be the main reason why microorganisms isolated from hospital infections show more resistant profiles than microorganisms from community infections [17]. Various hospital PPSs on antimicrobial use were carried out in the last three decades [18-22]. Also these PPS varied greatly in aims, protocols and populations surveyed, thus making comparison of their results difficult. The 'European Surveillance of Antimicrobial Consumption (ESAC)' project initiated standardisation of the methodology for measuring antimicrobial consumption across Europe [23-26]. This methodology has proven feasible and reliable [24,25,27]. In view of the transition of the ESAC network to ECDC in July 2011, the ESAC methodology for PPS of antimicrobial use was integrated as part of an ECDC protocol for PPS of HAIs and antimicrobial use in acute care hospitals. Combined PPSs of HAIs and antimicrobial use had also previously been carried out in different populations [28-32], but again with large methodological differences between surveys.

The main aim of this ECDC pilot PPS was to test a common European methodology for PPSs of HAIs and antimicrobial use in acute care hospitals before its implementation across the EU, with the specific objectives to estimate the total burden of HAIs and antimicrobial use and disseminate the results at local, regional, national and EU level. The ECDC pilot PPS protocol met the objectives of the Council Recommendation of 9 June 2009 on patient safety, including the prevention and control of HAIs (2009/C 151/01), and specifically article II.8.c of this recommendation, i.e. "to establish or strengthen active surveillance at institution, regional and national level" [33]. In addition, the ECDC pilot PPS also met the objectives of Council Recommendation of 15 November 2001 on the prudent use of antimicrobial agents in human medicine (2002/77/EC) [34].

Methods

Participating countries and hospitals

In January 2010, ECDC invited all national contact points for HAI surveillance and/or experts designated as national expert for the ECDC PPS to participate in the pilot PPS study and enter at least one institution qualified as acute care hospital according to national definitions. Two or more hospitals per country were preferred to allow testing of both the patient-based ('standard') and unit-based ('light') version of the protocol in the same country. In total, 23 countries (22 EU Member States and one EU enlargement country) participated in the survey with 66 hospitals and including 19,888 patients.

The number of hospitals per country was: Belgium (n=7 hospitals), Bulgaria (n=2), Croatia (n=2), Cyprus (n=3), Czech Republic (n=2), Estonia (n=2), Finland (n=16), France (n=3), Germany (n=1), Greece (n=1), Hungary (n=2), Italy (n=4), Latvia (n=2), Lithuania (n=3), Luxembourg (n=1), Malta (n=1), Poland (n=1), Portugal (n=2), Romania (n=1), Slovakia (n=2), Slovenia (n=2), Spain (n=5), and the United Kingdom, Scotland (n=1).

The national contact points acted as national PPS coordinators and invited hospitals to participate on a voluntary basis. As this was a pilot survey, we did not aim for a representative sample of hospitals in the countries. It was recommended to include both large and small hospitals in order to test the feasibility of the protocol in different settings. Information on the size and type (primary, secondary, tertiary and specialised) of each hospital was collected through a specific hospital questionnaire. National questionnaires were used to collect data on the number of acute care hospitals and beds for the entire country and by hospital type.

Case definitions

European case definitions for HAIs were used where these had been developed previously by HELICS or other European projects [35-38], whereas case definitions from the National Healthcare Safety Network (NHSN, formerly NNIS) at the United States Centers for Disease Control and Prevention (CDC) were used otherwise [39,40]. In the HAI section, data on microorganisms and the respective resistant phenotype were collected. Only results that were already available on the date of the survey were included.

For the purposes of this protocol, an infection was defined as active on the day of the survey when:

1. signs and symptoms were present on the date of the survey;
OR
2. signs and symptoms were no longer present but the patient was still receiving treatment for that infection on the date of the survey. In this case, the symptoms and signs occurring from the start of treatment until the date of the survey were checked to ascertain that the infection matched one of the case definitions of HAI.

An active infection was defined as healthcare-associated (associated to acute care hospital stay only, for the purpose of this protocol) when:

1. the onset of the signs and symptoms was on Day 3 of the current admission or later (with Day 1 the day of admission);
OR
2. the signs and symptoms were present at admission or became apparent before Day 3, but the patient had been discharged from an acute care hospital less than two days before admission;
OR
3. the signs and symptoms of an active surgical site infection were present at admission or started before Day 3, and the surgical site infection occurred within 30 days of a surgical intervention (or in the case of

surgery involving an implant, a deep or organ/space surgical site infection that developed within a year of the intervention);
OR
4. the signs and symptoms of a *Clostridium difficile* infection were present at admission or started before Day 3, with the patient having been discharged from an acute care hospital less than 28 days before the current admission.

For antimicrobial use, the Anatomical Therapeutic Chemical (ATC) classification system of the World Health Organization Collaborating Centre for Drug Statistics Methodology was used [41]. Antimicrobial agents for systemic use within the ATC groups A07AA (intestinal anti-infectives), D01BA (dermatological antifungals for systemic use), J01 (antibacterials for systemic use), J02 (antimycotics for systemic use), J04AB02 (rifampicin) and P01AB (nitroimidazole-derived antiprotozoals) were included. Antiviral agents and antimicrobials for the treatment of tuberculosis were not included.

As in the former ESAC hospital PPS protocol [23-26], antimicrobial treatment was recorded if, at the time of survey, the antimicrobial agent was still prescribed on the treatment chart. In the case of surgical prophylaxis, any single dose of an antimicrobial agent given within the 24-hour period before 8:00 am on the day of the survey was recorded. This time window for surgical prophylaxis allowed making the distinction between single dose prophylaxis, one day prophylaxis, or prophylactic doses given over more than one day.

Data collection and inclusion criteria

Two data collection protocols were available for use by participating hospitals. The first was patient-based: Denominator data, including risk factors, were collected for each individual patient irrespective of whether the patient had a HAI and/or received antimicrobials. The patient form for this protocol also included more detailed information, such as the presence of invasive devices, the specialty area of the patient's disease or consultant in charge of the patient and the McCabe score (the McCabe score classifies the severity of underlying medical conditions) [42]. The second protocol was unit-based: Denominator data were aggregated at ward level, and a patient form was used only for patients with a HAI and/or receiving antimicrobials. For both protocols, data were also collected at both ward level (ward name and specialty) and hospital level, including hospital type, size and whether or not any wards were excluded from the survey.

Each participating hospital had to choose one of the two data collection protocols. For each ward, all patients registered on the ward census before 8:00 am and not discharged from the ward at the time of the survey were assessed. Patients who were temporarily absent from the ward (e.g. for medical imaging, endoscopy, surgery) were included in the survey. Day admissions, outpatients (including patients attending the hospital for haemodialysis) and patients at the Accident and Emergency department were excluded. In addition, given that the agreed objective of the EU-wide ECDC PPS was to estimate the burden of HAIs and antimicrobial use in acute care hospitals only, long-term care units in acute care hospitals were excluded from the survey; however, long-term patients within an acute care ward were included. It was recommended that each participating hospital should include all eligible patients in the survey. Despite this recommendation, five of the 66 hospitals excluded one or several wards that were eligible for inclusion, because the hospital staff considered that being exhaustive was not needed for a pilot study.

The ECDC pilot PPS protocol recommended that personnel experienced in reading patient charts/notes and in identifying HAIs (e.g. infection control professionals, clinical microbiologists, infectious disease physicians) should act as survey team leaders in the hospitals. To obtain better information, collaboration with the clinical team in charge of patient care was recommended rather than exclusively reading the patient chart/notes and laboratory results. The number and type of healthcare workers (HCWs) performing the PPS in the hospital was assessed by questionnaire.

Data collectors in the hospital were trained by the national PPS coordinators to become familiar with the protocol and case definitions. Training material in English language was provided by ECDC through a contract with the Health Protection Agency, London (contract ECD.1842).

Time window

The ECDC pilot PPS had to be carried out any time between May and October 2010. The ideal duration of a 'point' prevalence survey is a single day but this was not feasible for the majority of participants due to the size of the hospital and/or the lack of trained personnel. To ensure feasibility of the survey, the maximum total time allowed to complete data collection in each hospital was three weeks and preferably not more than two weeks. Each individual ward, and if possible each respective department (e.g. all medical wards), had to be surveyed on the same day.

Data entry

Each country was free to organise its own system for data entry and processing, as long as all variables were collected in accordance with the ECDC methodology. It was not possible for a hospital to use a mixture of the patient-based and unit-based protocols. Most hospitals entered their data directly into an adapted version of the ESAC WebPPS located on the server of the University of Antwerp [24,25]. Only one country (Slovenia), participating with two hospitals, used its local software, whilst Belgium used the WebPPS installed on the server of the Belgian Scientific Institute for Public Health (WIV-ISP) in Brussels. Belgian data were uploaded on the WIV-ISP server and were

later incorporated into the European data set at the University of Antwerp. Data from Slovenia were converted by ECDC and then transferred to the University of Antwerp for incorporation into the central database.

Feasibility and workload

An additional feasibility questionnaire was sent to the national contact points of the 23 participating countries and to the corresponding 66 hospital contact points. At the national level, we requested information about whether a list of hospitals by type (primary, secondary, tertiary and specialised) and size was available, thus assessing the feasibility of a systematic sampling design using these variables in future surveys. National contact points were also asked to give any other feedback regarding the feasibility of obtaining a representative sample of hospitals in their country. In addition, data about the workload needed for training, data collection and data entry were requested both at the national and hospital level. The number and type of HCWs involved in the survey were also collected.

Data analysis

Data were analysed at the University of Antwerp and at ECDC using Stata 10.1 (StataCorp Texas, US). Binomial exact confidence limits were calculated where appropriate. Risk factor analysis was performed separately for HAIs and for antimicrobial use using multiple logistic regression. Presence of a peripheral and central vascular catheter were excluded from the multiple logistic regression model since the time relationship between insertion of a catheter and start of parenteral antimicrobial use cannot be deduced from the protocol. In both models, p values below 0.05 were considered as statistically significant. Individual hospital reports (Microsoft Excel spreadsheets) summarising the hospital's prevalence figures, compared to the aggregated prevalence figures of all participating hospitals in the country, were produced by ECDC using Stata 10.1 and sent to the national contact points for further distribution and feedback to the hospital contact points. We did not receive any feedback from the hospitals that these reports were not concordant with local hospital data.

Results

A total of 19,888 patients from 66 hospitals in 23 countries were included in the ECDC pilot PPS. Fifty hospitals used the patient-based protocol and 16 hospitals used the unit-based protocol.

Hospital characteristics were available for 65 hospitals. University or other teaching hospitals (defined as 'tertiary' hospitals in the protocol) represented 52.3% of participating hospitals, secondary hospitals 24.6%, primary hospitals 15.4% and specialised hospitals 7.7%, with an average hospital size of 614 beds, 431 beds, 215 beds and 300 beds, respectively. The overall average hospital size in the study sample was 483 beds (median: 400 beds). At national level, only 13 countries (representing 29 hospitals in the study sample) were able to provide national numbers of hospitals by type. Tertiary hospitals represented 7.7% of all acute care hospitals in these countries, secondary hospitals 31.1%, primary hospitals 49.3% and specialised hospitals 11.9%. The total number of hospitals in these 13 countries was 2,609 with on average 298

Table 1

Prevalence of healthcare-associated infections and antimicrobial use in surveyed patients, by specialty, during the ECDC pilot point prevalence survey, 2010 (n=19,888)

Specialty	Surveyed patients		Patients with HAI[a]		Patients with antimicrobial use[b]	
	n[c]	%[d]	n[c]	%[e]	n[c]	%[e]
Surgery	6,653	33.5	518	7.8	2,584	38.8
Medicine	7,833	39.4	505	6.4	2,888	36.9
Paediatrics	1,024	5.1	38	3.7	310	30.3
Intensive care	915	4.6	257	28.1	562	61.4
Obstetrics and Gynaecology	1,711	8.6	32	1.9	313	18.3
Geriatrics	502	2.5	33	6.6	117	23.3
Psychiatry	828	4.2	2	0.2	18	2.2
Other/mixed	422	2.1	23	5.5	83	19.7
All specialties	**19,888**	**100**	**1,408**	**7.1**	**6,875**	**34.6**

ECDC: European Centre for Disease Prevention and Control; HAI: healthcare-associated infection.

[a] Patients with a least one HAI.
[b] Patients receiving at least one antimicrobial agent.
[c] Number of patients in category.
[d] Percentage of total (column percent).
[e] Percentage within category (category percent).

beds (median: 261 beds), for a total population of 160 million inhabitants in 2010.

Healthcare-associated infections

Overall, 7.1% patients had at least one HAI, ranging from 0.2% in psychiatry to 28.1% in intensive care departments (Table 1). The prevalence of HAIs was 5.8% in primary hospitals, 6.3% in secondary hospitals, 7.4% in tertiary hospitals and 7.8% in specialised hospitals.

The most common type of HAI was pneumonia and other lower respiratory tract infections, representing 25.7% of all reported HAIs (Table 2). The second most frequently reported type of HAI was surgical site infection (18.9%), followed by urinary tract infection (17.2%), bloodstream infection (14.2%) and gastro-intestinal infection (7.8%). *Clostridium difficile* infections represented 1.4% of all HAIs. On average, there were 1.09 HAIs per infected patient (or a total of 1,531 HAIs in 1,408 patients with HAI). The median length of stay before onset of HAI acquired during the current hospitalisation (n=1,159) was 12 days (range: 4–65 days). Of 372 (24%) HAIs present at admission, 58% were associated with a previous stay in the same hospital.

For 59.1% of the HAIs, a positive microbiology result was available, ranging from 40.3% for gastro-intestinal infections to 94.0% in bloodstream infections (Table 3).

The most commonly isolated groups of microorganisms were Gram-negative non-*Enterobacteriaceae* in pneumonia (36.5%), *Enterobacteriaceae* in urinary tract infections (63.8%) and Gram-positive cocci in surgical site infections (54.3%). Overall, the most commonly isolated microorganism was *Escherichia coli* (15.2% overall, and 37.1% in urinary tract infections), followed by *Staphylococcus aureus* (12.1% overall and 21.5% in surgical site infections).

Carbapenem resistance was reported in 3.2% of *Enterobacteriaceae*, 23.4% of *Pseudomonas aeruginosa* and 20.4% of *Acinetobacter* spp. The percentage of meticillin-resistant *S. aureus* (MRSA) was 34.2% and that of glycopeptide-resistant *Enterococcus* spp. was 5.4%.

Antimicrobial use

A total of 6,875 patients (34.6%) received at least one antimicrobial agent at the time of the survey, ranging from 2.2% in psychiatry to 61.4% in intensive care departments (Table 1). The prevalence of antimicrobial use was 36.2% in primary hospitals, 32.1% in secondary hospitals, 35.7% in tertiary hospitals and 28.7% in specialised hospitals. Analysing the antimicrobial agents used by main indication (treatment, surgical prophylaxis and medical prophylaxis) revealed differences in the use of different antimicrobial classes (Table 4).

Pneumonia or other lower respiratory tract infection was the most common indication (29.2%) for antimicrobial treatment, and accounted for 31.6% of intentions for treatment of community infection, and 24.8% of intentions for treatment of hospital infection.

The most widely used antimicrobial agents at ATC 4th level were combinations of penicillins with beta-lactamase inhibitors (16.3%), mainly for treatment intention (18.0%). For surgical prophylaxis, first- and second-generation cephalosporins were mostly chosen: 26.8% and 20.0%, respectively. For medical prophylaxis, fluoroquinolones, primarily ciprofloxacin, were the most widely used antimicrobial agents.

Table 5 summarises the indications for antimicrobial use, their route of administration and whether the reason for antimicrobial use was indicated on the patient chart. Community infection was the most common treatment intention (41.3%), followed by hospital infection (24.0%). Surgical prophylaxis (17.3%) was prolonged for more than one day in 60.7% of cases. Medical prophylaxis accounted for 13.5% of antimicrobial use. The parenteral route of administration was used for 71.9% of administered antimicrobial agents. A reason was included in the chart of 69.3% of the patients on antimicrobials (Table 5).

Risk factors

Data from the 50 hospitals that used the patient-based protocol, including patient characteristics and risk factors, are shown in Table 6. Using multiple logistic regression, the presence of an HAI was independently associated with age (highest adjusted odds ratio in children under five years-old, $p<0.001$), male sex ($p<0.05$), length of stay before onset of HAI (p for trend<0.001), the McCabe score (p for trend<0.001), the number of invasive devices (urinary catheter and intubation) before onset of infection (p for trend<0.001) and surgery since admission ($p<0.001$). Antimicrobial use was independently associated with age (highest adjusted odds ratio in the age category 1–4 years, $p<0.001$), male sex ($p<0.001$), the McCabe score (p for trend<0.001), the number of invasive devices (urinary catheter and intubation, p for trend <0.001), length of stay in the hospital (p for trend<0.05) and surgery since admission ($p<0.001$).

Feasibility

Thirteen countries (Belgium, Bulgaria, Cyprus, Estonia, France, Greece, Italy, Lithuania, Malta, Portugal, Romania, Slovakia and Spain) responded to the national feasibility questionnaire. Fifty hospitals responded to the hospital feasibility questionnaire.

Overall, the average number of HCW involved in data collection, excluding ward staff, was six, with a maximum of 21. In five hospitals, one single HCW was involved in the data collection process. Ward staff was involved in 20 hospitals. On average per hospital, 3,7 different types of HCW were involved in the survey for

Table 2

Prevalence of healthcare-associated infections and antimicrobial use in surveyed patients, by specialty, during the ECDC pilot point prevalence survey, 2010 (n=19,888)

Type of infection	HAIs				Antimicrobial use (treatment only)a					
					All treatment intentions[b]		Treatment intended for community infection		Treatment intended for hospital	
	n patients[c]	% patients [95% CI][d]	n HAIs[e]	Relative % HAIs[f]	n intentions	Relative %	n intentions	Relative %	n intentions	Relative %
Pneumonia or other lower respiratory tract infection	392	2.0 [1.8–2.2]	394	25.7	1,328	29.2	922	31.6	382	24.8
Surgical site infection	290	1.5 [1.3–1.6]	290	18.9	–[g]	–[g]	–[g]	–[g]	–[g]	–[g]
Urinary tract infection	263	1.3 [1.2–1.5]	264	17.2	679	14.9	412	14.1	237	15.4
Bloodstream infection (BSI)[h]	216	1.1 [0.9–1.2]	217	14.2	219	4.8	67	2.3	145	9.4
Gastrointestinal infection	118	0.6 [0.5–0.7]	119	7.8	593	13.0	466	16.0	117	7.6
Skin and soft tissue infection	59	0.3 [0.2–0.4]	59	3.9	646	14.2	357	12.2	279	18.1
Bone or joint infection	38	0.2 [0.1–0.3]	39	2.5	154	3.4	92	3.2	60	3.9
Eye, ear, nose or mouth infection	47	0.2 [0.2–0.3]	47	3.1	211	4.6	170	5.8	41	2.7
Systemic infection[h]	40	0.2 [0.1–0.3]	40	2.6	668	14.7	318	10.9	334	21.7
Cardiovascular system infection	26	0.1 [0.1–0.2]	26	1.7	76	1.7	40	1.4	36	2.3
Central nervous system infection	15	0.1 [0.0–0.1]	15	1.0	67	1.5	54	1.8	12	0.8
Catheter-related infections without bloodstream infection	11	0.1 [0.0–0.1]	11	0.7	–[g]	–[g]	–[g]	–[g]	–[g]	–[g]
Reproductive tract infection	10	0.1 [0.0–0.1]	10	0.7	65	1.4	49	1.7	16	1.0
Missing/unknown	0	NA	NA	NA	65	1.4	39	1.3	25	1.6
Total	**1,408**	**7.1 [6.7–7.5]**	**1,531**	**100**	**4,552**	**100**	**2,919**	**100**	**1,539**	**100**

CI: confidence interval; ECDC: European Centre for Disease Prevention and Control; HAI: healthcare-associated infection; NA: not applicable.

[a] This table does not include antimicrobials used for prophylaxis or for unknown indications (shown in Table 5).

[b] The category "Treatment intended for infections acquired in long-term care facilities" represented 2.0% of all treatment intentions and is not shown in the table.

[c] Number of patients with HAI (site-specific number)

[d] Percentage of patients with HAI (site-specific prevalence)

[e] Number of HAIs.

[f] Percentage of total number of HAIs (relative percentage)

[g] For used antimicrobials, the types of infection 'surgical site infection' and 'catheter-related infection without bloodstream infection' were not specifically recorded and could be included within the category 'skin and soft tissue infection'.

[h] Includes catheter-related infections with positive blood culture, and neonatal bloodstream infections and clinical sepsis. For used antimicrobials, some bloodstream infections (bacteraemia) may have been included in the category 'systemic infection'.

Table 3

Distribution of microorganisms isolated in healthcare-associated infections, by main type of infection, ECDC pilot point prevalence survey, 2010 (n=1,165)

	All types of infection	Pneumonia or other lower respiratory tract infection	Surgical site infection	Urinary tract infection	Bloodstream infection	Gastrointestinal infection
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
HAIs and microorganisms						
HAIs, total	1,531 (100)	394 (25.7)	290 (18.9)	264 (17.2)	200 (13.1)	119 (7.8)
HAIs with microorganisms	905 (59.1)	191 (48.5)	172 (59.3)	187 (70.8)	188 (94.0)	48 (40.3)
Microorganisms, total	1,165 (100)	249 (100)	247 (100)	210 (100)	228 (100)	65 (100)
Major groups of microorganisms						
Gram-positive cocci	410 (35.2)	46 (18.5)	134 (54.3)	39 (18.6)	95 (41.7)	21 (32.3)
Enterobacteriaceae	404 (34.7)	80 (32.1)	58 (23.5)	134 (63.8)	79 (34.7)	18 (27.7)
Gram-negative bacteria, non-*Enterobacteriaceae*	226 (19.4)	91 (36.5)	36 (14.6)	29 (13.8)	30 (13.2)	7 (10.8)
Fungi	69 (5.9)	23 (9.2)	5 (2.0)	7 (3.3)	17 (7.5)	4 (6.2)
Top 15 microorganisms (accounting for (92.4% of total number microorganisms)						
Escherichia coli	177 (15.2)	24 (9.6)	29 (11.7)	78 (37.1)	29 (12.7)	10 (15.4)
Staphylococcus aureus	141 (12.1)	26 (10.4)	53 (21.5)	2 (1.0)	26 (11.4)	5 (7.7)
Pseudomonas aeruginosa	131 (11.2)	44 (17.7)	24 (9.7)	21 (10.0)	17 (7.5)	6 (9.2)
Enterococcus spp.	114 (9.8)	4 (1.6)	33 (13.4)	32 (15.2)	21 (9.2)	11 (16.9)
Coagulase-negative staphylococci	97 (8.3)	3 (1.2)	33 (13.4)	3 (1.4)	38 (16.7)	1 (1.5)
Klebsiella spp.	94 (8.1)	22 (8.8)	7 (2.8)	30 (14.3)	25 (11.0)	3 (4.6)
Candida spp.	56 (4.8)	15 (6.0)	3 (1.2)	6 (2.9)	16 (7.0)	3 (4.6)
Enterobacter spp.	49 (4.2)	13 (5.2)	10 (4.0)	6 (2.9)	10 (4.4)	1 (1.5)
Acinetobacter spp.	49 (4.2)	18 (7.2)	5 (2.0)	5 (2.4)	9 (4.0)	1 (1.5)
Streptococcus spp.	45 (3.9)	13 (5.2)	11 (4.5)	2 (1.0)	4 (1.8)	4 (6.2)
Proteus spp.	35 (3.0)	5 (2.0)	6 (2.4)	15 (7.1)	4 (1.8)	0 (0)
Anaerobic bacilli	24 (2.1)	1 (0.4)	5 (2.0)	0 (0)	5 (2.2)	11 (16.9)
Serratia spp.	17 (1.5)	11 (4.4)	1 (0.4)	0 (0)	5 (2.2)	0 (0)
Other *Enterobacteriaceae*	17 (1.5)	3 (1.2)	0 (0)	1 (0.5)	4 (1.8)	3 (4.6)
Stenotrophomonas maltophilia	16 (1.4)	11 (4.4)	3 (1.2)	0 (0)	1 (0.4)	0 (0)
Citrobacter spp.	15 (1.3)	2 (0.8)	5 (2.0)	4 (1.9)	2 (0.9)	1 (1.5)

ECDC: European Centre for Disease Prevention and Control; HAI: healthcare-associated infection.

The table only shows details for the main infection types. The total also includes all other HAI types.

Table 4

Distribution of antimicrobial agents (ATC 4th and 5th levels) by main indication for use, ECDC pilot point prevalence survey, 2010 (n=9,588 antimicrobial agents)

	All indications	Treatment	Surgical prophylaxis	Medical prophylaxis
	n (%)	n (%)	n (%)	n (%)
Antimicrobial agents, total	**9,588 (100)**	**6,365 (100)**	**1,654 (100)**	**1,293 (100)**
Top antimicrobial agents at ATC 4th level (accounting for 93.1% of use)				
Combinations of penicillins, incl. beta-lactamase inhibitors (J01CR)	1,566 (16.3)	1,147 (18.0)	217 (13.1)	145 (11.2)
Fluoroquinolones (J01MA)	1,293 (13.5)	948 (14.9)	133 (8.0)	168 (13.2)
Second-generation cephalosporins (J01DC)	900 (9.4)	475 (7.5)	330 (20.0)	76 (5.9)
Third-generation cephalosporins (J01DD)	701 (7.3)	521 (8.2)	94 (5.7)	67 (5.2)
First-generation cephalosporins (J01DB)	599 (6.2)	121 (1.9)	444 (26.8)	23 (1.8)
Carbapenems (J01DH)	583 (6.1)	503 (7.9)	25 (1.5)	37 (2.9)
Imidazole derivatives (J01XD)	494 (5.2)	278 (4.4)	151 (9.1)	51 (3.9)
Glycopeptide antibacterials (J01XA)	449 (4.7)	365 (5.7)	41 (2.5)	31 (2.4)
Aminoglycosides (J01GB)	427 (4.5)	277 (4.4)	72 (4.4)	69 (5.3)
Triazole derivatives (J02AC)	424 (4.4)	246 (3.9)	11 (0.7)	153 (11.8)
Penicillins, extended spectrum without anti-pseudomonal activity (J01CA)	289 (3.0)	200 (3.1)	18 (1.1)	65 (5.0)
Combinations of sulfonamides and trimethoprim, incl. derivatives (J01EE)	252 (2.6)	70 (1.1)	7 (0.4)	163 (12.6)
Lincosamides (J01FF)	232 (2.4)	183 (2.9)	38 (2.3)	11 (0.9)
Macrolides (J01FA)	185 (1.9)	144 (2.3)	4 (0.2)	26 (2.0)
Beta-lactamase-resistant penicillins (J01CF)	160 (1.7)	138 (2.2)	16 (1.0)	5 (0.4)
Nitroimidazole derivatives (P01AB)	134 (1.4)	102 (1.6)	17 (1.0)	9 (0.7)
Beta-lactamase-sensitive penicillins (J01CE)	133 (1.4)	90 (1.4)	9 (0.5)	32 (2.5)
Other antibacterials (J01XX)	102 (1.1)	80 (1.3)	4 (0.2)	11 (0.9)
Top antimicrobial agents at ATC 5th level (accounting for 70.8% of use)				
Amoxicillin and enzyme inhibitor (J01CR02)	1,045 (10.9)	696 (10.9)	193 (11.7)	104 (8.0)
Cefuroxime (J01DC02)	866 (9.0)	466 (7.3)	318 (19.2)	63 (4.9)
Ciprofloxacin (J01MA02)	844 (8.8)	607 (9.5)	100 (6.0)	113 (8.7)
Metronidazole (J01XD01)	493 (5.1)	277 (4.4)	151 (9.1)	51 (3.9)
Cefazolin (J01DB04)	473 (4.9)	57 (0.9)	396 (23.9)	12 (0.9)
Piperacillin and enzyme inhibitor (J01CR05)	432 (4.5)	374 (5.9)	19 (1.1)	36 (2.8)
Ceftriaxone (J01DD04)	396 (4.1)	282 (4.4)	52 (3.1)	47 (3.6)
Vancomycin (parenteral) (J01XA01)	376 (3.9)	310 (4.9)	36 (2.2)	26 (2.0)
Meropenem (J01DH02)	375 (3.9)	322 (5.1)	9 (0.5)	29 (2.2)
Fluconazole (J02AC01)	319 (3.3)	201 (3.2)	11 (0.7)	96 (7.4)
Levofloxacin (J01MA12)	310 (3.2)	246 (3.9)	13 (0.8)	34 (2.6)
Gentamicin (J01GB03)	265 (2.8)	151 (2.4)	62 (3.7)	46 (3.6)
Sulfamethoxazole and trimethoprim (J01EE01)	235 (2.5)	66 (1.0)	7 (0.4)	150 (11.6)
Clindamycin (J01FF01)	228 (2.4)	183 (2.9)	34 (2.1)	11 (0.9)
Imipenem and enzyme inhibitor (J01DH51)	141 (1.5)	120 (1.9)	11 (0.7)	7 (0.5)

ATC: Anatomical Therapeutic Chemical; ECDC: European Centre for Disease Prevention and Control; HAI: healthcare-associated infection.

The category "Unknown indication" represented 2.9% of the total and is included in the first column.

Table 5

Antimicrobial use: prevalence, indication, route of administration and reason in patient charts/notes, ECDC pilot point prevalence survey, 2010 (n=6,875 patients)

	Patients with antimicrobial use[a]		Antimicrobial agents	
	n	%[b] [95% CI]	n	Relative %[c]
Total	**6,875**	**34.6 [33.8–35.4]**	**9,588**	**100**
Indication				
Treatment	4,500	22.6 [22.0–23.3]	6,365	66.4
Intended for community infection	2,919	14.7 [14.1–15.2]	3,957	41.3
Intended for hospital infection	1,539	7.7 [7.–-8.1]	2,300	24.0
Intended for other healthcare-associated infection	94	0.5 [0.4–0.6]	108	1.1
Surgical prophylaxis	1,396	7.0 [6.7–7.4]	1,654	17.3
Single dose	336	1.7 [1.5–1.9]	357	3.7
One day	265	1.3 [1.2–1.5]	293	3.1
More than one day	810	4.1 [3.8–4.4]	1,004	10.5
Medical prophylaxis	979	4.9 [4.6–5.2]	1,293	13.5
Unknown indication	211	1.1 [0.9–1.2]	276	2.9
Route of administration				
Parenteral	5,098	25.6 [24.9–26.3]	6,891	71.9
Oral	2,218	11.2 [10.7–11.6]	2,648	27.6
Other/unknown	49	0.2 [0.2–0.3]	49	0.5
Reason in patient charts/notes				
Yes	4,819	24.2 [23.6–24.9]	6,647	69.3
No	2,171	10.9 [10.5–11.4]	2,939	30.7
Unknown	2	0.0 [0.0–0.0]	2	0.0

CI: confidence interval; HAI: healthcare-associated infection.

[a] Patients receiving a least one antimicrobial agent.
[b] Prevalence of antimicrobial use in each category.
[c] Percentage of total number of antimicrobials (relative frequency).

Table 6

Prevalence of healthcare-associated infections and antimicrobial use, by patient risk factors (standard patient-based protocol only, 50 hospitals), ECDC pilot point prevalence survey, 2010 (n=14,329)

	Surveyed patients		Patients with HAIs[a]		Patients with antimicrobial use[b]	
	n[c]	%[d]	n	%[e]	n	%[e]
All patients	**14,329**	**100**	**1,072**	**7.5**	**5,201**	**36.3**
Age group (years)						
<1	746	5.2	58	7.8	181	24.3
1–4	267	1.9	18	6.7	135	50.6
5–14	393	2.7	12	3.1	148	37.7
15–24	699	4.9	30	4.3	228	32.6
25–34	1,224	8.5	34	2.8	313	25.6
35–44	1,160	8.1	75	6.5	385	33.2
45–54	1,527	10.7	106	6.9	570	37.3
55–64	2,325	16.2	212	9.1	939	40.4
65–74	2,582	18.0	241	9.3	1,012	39.2
75–84	2,481	17.3	202	8.1	903	36.4
≥85	925	6.5	84	9.1	387	41.8
Sex						
Female	7,267	50.7	456	6.3	2,364	32.5
Male	7,062	49.3	616	8.7	2,837	40.2
Length of stay (days)[f]						
1–3	4,622	32.3	104	2.3	1,352	29.3
4–7	3,916	27.3	300	7.7	1,608	41.1
8–14	2,824	19.7	272	9.6	1,137	40.3
>14	2,966	20.7	396	13.4	1,104	37.2
Surgical intervention since hospital admission						
No	10,089	70.4	569	5.6	3,163	31.4
Yes	4,240	29.6	503	11.9	2,038	48.1
McCabe score						
Non-fatal	9,705	67.7	491	5.1	3,088	31.8
Ultimately fatal	3,666	25.6	430	11.7	1,645	44.9
Rapidly fatal	791	5.5	143	18.1	419	53.0
Missing/unknown	167	1.2	8	4.8	49	29.3
Central vascular catheter						
No	12,621	88.1	651	5.2	4,033	32.0
Yes	1,594	11.1	411	25.8	1,117	70.1
Missing/unknown	114	0.8	10	8.8	51	44.7
Peripheral vascular catheter						
No	7,455	52.0	389	5.2	1,565	21.0
Yes	6,763	47.2	674	10.0	3,592	53.1
Missing/unknown	111	0.8	9	8.1	44	39.6
Urinary catheter						
No	11,702	81.7	612	5.2	3,594	30.7
Yes	2,512	17.5	452	18.0	1,558	62.0
Missing/unknown	115	0.8	8	7.0	49	42.6
Intubation						
No	13,734	95.8	888	6.5	4,775	34.8
Yes	486	3.4	173	35.6	369	75.9
Missing/unknown	109	0.8	11	10.1	57	52.3

ECDC: European Centre for Disease Prevention and Control; HAI: healthcare-associated infection.

[a] Patients with a least one HAI.
[b] Patients receiving at least one antimicrobial agent.
[c] Number of patients in category.
[d] Percentage of total (column percent).
[e] Percentage within category (category percent).
[f] Length of stay until onset of HAI in case of HAI during current hospitalisation.

data collection and 1.3 for data entry. Eighteen hospitals were surveyed by an external team (either national or regional coordination staff) (Table 7).

A large variation among responding countries was identified in the workload associated with the PPS. The calculation of workload included preparation and training before the actual PPS, as well as data collection and data entry. National PPS coordinators provided on average 12.4 hours (median: 6 hours) of training to the hospital staff and spent on average an additional 6.5 hours (median: 4 hours) on answering questions during the survey. The time needed for collection and entry of data for 100 patients, was estimated at about four working days (ca. 32 hours) with the patient-based protocol and about 2.5 working days (ca. 20 hours) with the unit-based protocol. This means that performing the survey with the unit-based protocol took about 37.5% less time than with the patient-based protocol.
The feasibility of the data collection was also evaluated by the analysis of missing data in the database. At the national level, 11 of 23 countries were unable to provide national hospital denominator data by hospital type as defined in the protocol. At hospital level however, the hospital type was always available and the number of beds was only missing for one hospital. Ward level data were complete because all fields were mandatory in the software. Similarly, some patient level data (age, sex, hospital admission date and medical specialty of the patient's disease or the consultant), infection data and antimicrobial use data were mandatory in the software. For the other, non-mandatory variables of the patient-based protocol (n=14,329 patients), the percentage of missing values ranged from less than 1% for the presence of invasive devices, 1.2% for McCabe score, and 1.9% for surgery since admission, to 7.6% for surgery in the previous 30 days.

Discussion

The ECDC pilot PPS of HAIs and antimicrobial use was successfully performed from May to October 2010 in 66 acute care hospitals from 23 countries. In total, 19,888 patients were surveyed. The number of participating hospitals was higher than the anticipated minimum of 25 hospitals. The collected data allowed for the estimation of the prevalence of HAIs and antimicrobial use, which was the primary objective set by ECDC. Both the patient-based protocol, preferred by the majority (76%) of hospitals, and the unit-based protocol (applied by 24% of hospitals) provided the necessary data.

Main study limitations

An important limitation of our study is that the hospitals participating in this ECDC pilot PPS were not representative of the total hospital patient population in the EU. Hospitals were not randomly selected, and

Table 7

Type of healthcare workers involved in data collection and data entry for the ECDC pilot point prevalence survey, 2010 (n=50 hospitals)

Type of healthcare worker	Hospitals where this type of healthcare worker was involved		Involved in data collection		Involved in data entry	
	n	%[a]	n	%[b]	n	%[b]
Infection control nurse	25	50	25	100	9	36
Infection control physician or equivalent	31	62	31	100	12	39
Ward nurse	18	36	18	100	0	0
Ward physician	15	30	15	100	0	0
Infectious disease physician	12	24	12	100	3	25
Hospital microbiologist	6	12	6	100	3	50
Medical specialist trainee	10	20	10	100	2	20
Hospital pharmacist	6	12	6	100	1	17
Infection control link nurse	5	10	5	100	1	20
Data nurse	4	8	3	75	2	50
Nurse aid	1	2	0	0	1	100
Medical student	1	2	1	100	0	0
Other hospital staff	10	20	6	60	6	60
National PPS coordination staff	13	26	12	92	6	46
Regional PPS coordination staff	5	10	5	100	2	40
Other	6	12	4	67	3	50

ECDC: European Centre for Disease Prevention and Control; PPS: point prevalence survey.

[a] Percentage of total number of responding hospitals (n=50).
[b] Percentage of number of healthcare workers in category.

tertiary or teaching hospitals were overrepresented in the study sample (52.3% instead of less than 10%, according to available national hospital statistics). This selection had consequences both for the results of the feasibility test of the protocol and for the interpretation of the epidemiological results of the study (see below).

In addition, since inference from the epidemiological study results to the total acute care hospital population in Europe was not an objective of the pilot study, we did not apply any statistical methods that could take into account the effects of the hierarchical design of the study (e.g. regions within countries, hospitals within regions, wards within hospitals, and types of patients within wards). Methods such as multilevel modelling for risk factor analysis and complex survey analysis to adjust confidence intervals for the prevalence estimates at the national and EU level will be used to analyse the EU-wide PPS of HAIs and antimicrobial use that was conducted in 2011–12. The pilot study database was also used to estimate the expected design effect (DEFF) for different average sizes of hospitals (patient clusters) in order to estimate the required sample size for each country in the EU-wide PPS [14]. The overall DEFF in the pilot PPS was 5.3 for the prevalence of HAIs and 22.7 for the prevalence of antimicrobial use, indicating indeed that the sample design for representative samples at the national level should be adjusted for the important clustering of the main survey outcomes within the hospitals.

Feasibility study

A minority of respondents to the feasibility questionnaire mentioned that the participating included hospitals in their country had had experience in performing PPSs and that it is unlikely that randomly selected hospitals would be able to participate in an ECDC EU-wide PPS. ECDC therefore provided training material to help national contact points improve the skills of hospital staff during preparation of the future EU-wide PPS. Part of this training material was already available before the pilot PPS and was used to organise the training of the hospital contact points in the current study.

Training is also of key importance for the standardisation of data collection in participating hospitals, including interpretation of the case definitions. The large variation in the number and type of HCWs involved in data collection for this pilot PPS (Table 7) illustrates the challenge of standardising data collection for an EU-wide PPS. For example, failure to consult the clinical team in charge of patient care during data collection, as recommended in the protocol, may impact on the ascertainment of variables such as the medical specialty of the patient's disease or of the consultant in charge of the patient (patient/consultant specialty), the McCabe score, the physician's motive for prescribing antimicrobials, or even the signs and symptoms of a suspected HAI. The fact that ward staff was not involved in the data collection in more than half of the hospitals may indeed indicate that physicians were not sufficiently consulted. Also, the fact that in 18 of the 66 hospitals the survey was performed by an external team may indicate that the pilot PPS was not always performed in real-life conditions since this scenario is unlikely to be a feasible option for the ECDC EU-wide PPS or a full-scale national PPS.

Another frequently mentioned feasibility issue was the difficulty to categorise hospitals at the national level according to the hospital types defined in the protocol (primary, secondary, tertiary and specialised). Information on hospital categories used in the different countries are needed for the future EU-wide PPS to ensure that all categories are represented proportionally in the national representative sample. In addition, national denominator data (e.g. number of hospitals and discharges per year) by hospital type would be needed (i) to extrapolate the PPS results by hospital type (category-specific burden estimates), and (ii) to adjust the national and EU burden estimates in case hospital types are not proportionally represented in the national samples. Only 13 of 23 countries were able to provide some categorisation of their national list of hospitals according to the categories of the protocol, using the national hospital type categories.

Therefore, for the purpose of drawing a representative systematic sample of hospitals for the EU-wide PPS, the standardised EU types of hospitals were replaced by the national hospital categories in the final protocol of the ECDC EU-wide PPS. This means that, for the analysis of the data collected in the ECDC EU-wide PPS, it will not be possible to stratify or adjust the estimates of the burden of HAIs and antimicrobial use (based on extrapolation to the total national denominator data) according to types of hospitals.

Patient-based versus unit-based protocol

Despite a higher workload, the patient-based protocol was used more often than the unit-based protocol, thus allowing a better description of patients and invasive procedures. During an expert meeting held in Brussels in November 2010, it was recommended that PPSs of HAIs and antimicrobial use should be carried out at least once every five years, and the patient-based protocol was selected as the preferred methodology for future PPSs [43]. This expert recommendation is anticipating the fact that, because of hospital changes and medical advances, a patient-based protocol would be required to allow for detailed adjustment for patient case-mix. The patient-based protocol allows for assessment of the prevalence of HAIs and antimicrobial use according to the presence or absence of various risk factors and enables categorisation of hospitals by patient case-mix at national and/or European level. Indeed, adjustment for patient case-mix has been used in other studies, including for outcomes in intensive care [44,45] and surgical patients [46], and for comparing HAI rates [47]. Patient-based PPSs can also be used to identify patient-related factors that influence

the prevalence of HAIs and thus help focus surveillance and infection prevention initiatives [48].

The unit-based protocol, however, will be kept, to offer a less labour-intensive option for countries and hospitals where human resources are limited. This protocol might also be more appropriate for very large hospitals and in situations that require repeated PPSs at short intervals. A limitation is that its only denominator variable is the number of patients per ward, for the total ward and for the specialty of each patient's disease within each ward. This only allows an estimation of the prevalence of HAIs and antimicrobial use by ward or patient's disease specialty.

The ECDC pilot PPS also aimed at identifying any issue with the methodology that required modification, e.g. availability of data for any of the collected variables, or applicability of the case definitions for HAIs, before finalising the patient-based and unit-based protocols for the ECDC EU-wide PPS that was started in May 2011. Denominator data in the unit-based protocol did not require any modification whereas, for the patient-based protocol, the only variable that was difficult to obtain was 'surgery in the previous 30 days'. This variable also overlapped with 'surgery since admission' which was less difficult to determine. It was therefore decided that, for the ECDC EU-wide PPS, the data for the variable 'surgery in previous 30 days' would eventually not be collected [14]. With respect to case definitions for HAIs, a major change was the decision to add the case definition of clinical sepsis in adults, because possible bloodstream infections for which microbiological results were not yet available at the time of the PPS would otherwise remain unreported.

Epidemiological results

The two sections of the ECDC pilot PPS, i.e. HAIs and antimicrobial use, were independent of each other and did not follow the same definitions: data on HAIs were recorded following standardised epidemiological case definitions, whilst the indication for antimicrobial use was based on clinical judgment by the treating physician. For example, a patient could have been registered in the antimicrobial use section as receiving antimicrobials with the intention to treat a hospital infection, but the same patient did not fulfil the case definition for HAI and therefore was not included as having a HAI in the HAI section. Conversely, a patient may have presented the symptoms and signs of a HAI, but not have been treated with an antimicrobial. Hence, among other things, the different proportions for hospital-acquired pneumonia in Table 2.

While the protocol for the EU-wide PPS foresees a representative systematic random sample of hospitals in the participating countries [14], the data collected through this ECDC pilot PPS were not representative of the epidemiology of HAIs in the EU and the results must be interpreted with caution. The HAI prevalence of 7.1% (inter-quartile range: 4.2–9.4%) observed in our study is likely to be slightly overestimated because of the overrepresentation of tertiary hospitals which had a higher prevalence of HAIs (7.4%) than secondary and primary hospitals. Nevertheless, the overall HAI prevalence in this pilot PPS is comparable to that reported in other European studies [9,11,12] and to the European prevalence of HAIs of 7.1%, estimated by ECDC based on a review of 30 national or multicentre PPSs in 19 countries in its Annual Epidemiological Report for 2008 [1]. The range of reported prevalence results in studies that used CDC definitions for HAIs in non-EU countries, ranged from 4.9% in Mauritius in 1992 to 19.1% in Malaysia in 2001 [30]. Such a wide range in the prevalence of HAIs could be explained by differences in methodology and patient case-mix, and should not immediately be interpreted as an indication of variations in performance.

The distribution of isolated microorganisms in patients with HAI in this pilot PPS was also similar to that previously reported in the review of national or multicentre point prevalence surveys, with *E. coli* being most frequent [1]. The fact that only 59.1% of the HAIs were documented by microbiological results was also in line with previous findings [9,49,50] and was expected because, with few exceptions, case definitions of HAIs are primarily based on clinical criteria.

With respect to antimicrobial use, the ECDC pilot PPS showed a prevalence about 5% higher than shown by previous ESAC hospital PPSs using an identical methodology [23,25,26]. Nevertheless, the ranking order of the most used antimicrobials was comparable to that observed in ESAC hospital PPSs, with the various beta-lactams (penicillins, cephalosporins and carbapenems) accounting for more than half of all antimicrobials used. Other PPSs have reported a wide range of prevalence of antimicrobial use in acute care hospitals due to varying inclusion criteria [23].

A final aspect that should be considered for the interpretation of the epidemiological results of this and future surveys is the fact that the ECDC pilot PPS was not performed on a single day. For feasibility reasons, hospitals were allowed to organise the PPS within a period of three weeks, with the only restriction being that a ward had to be surveyed on a single day. In practice, hospitals and countries performed the pilot PPS survey from May until October 2010. For the EU-wide PPS, ECDC agreed with the national PPS coordinating centres in November 2010 on three possible periods to organise the first national PPS using the ECDC methodology [43]. These periods (May–June 2011, September–October 2011 and May–June 2012) were selected to avoid the winter period because of the higher incidence of respiratory tract infections and the summer holiday period because shortage of staff and lower activity in the hospital during this period could influence the practical organisation as well as the main outcomes of the survey. Despite these considerations, the potentially long time span between the different

surveys may influence comparability of the results between hospitals, regions or countries, e.g. because of rapidly changing incidences of HAIs with epidemic pathogens or the implementation of local or national infection control measures.

In conclusion, the ECDC pilot PPS methodology was successfully implemented by the national contact points, the hospital contact points and the HCWs involved in data collection and entry in the participating hospitals, without any major feasibility issues that could have led hospitals to cancel their participation. The pilot PPS showed that the aim of estimating the burden of HAIs and antimicrobial use in European acute care hospitals was realistic, irrespective of the protocol used. The patient-based protocol, even if more resource-intensive, was used more widely and provided more detailed and valuable data than the unit-based protocol. It was therefore selected as the preferred option for the ECDC EU-wide PPS of HAIs and antimicrobial use.

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