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Prevalence survey of healthcare-associated infections in a large teaching hospital

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Abstract

Background. *Healthcare-associated infection (HAI) is the most frequent adverse event in healthcare settings. It is associated with increased mortality and antimicrobial resistance, leading to prolonged hospital stays and consistent financial loss for healthcare systems. The objective of this study was to estimate the burden of HAIs and antimicrobial use in the Teaching Hospital Policlinico Umberto I (THPUI) of Rome and to identify the most critical areas for intervention.*

Methods. *Data were collected according to the most recent ECDC point prevalence survey protocol in November 2018. Descriptive statistics for all variables were calculated. Univariate analysis was used to assess possible associations between variables and HAIs. Variables with a significance level of p<0.25 were included in a multiple logistic regression model.*

Results. *A total of 799 patients were included in the analysis; of these, 13.3% presented with at least one HAI. Bloodstream infection was the most common, accounting for 30.9% of total infections. Overall, 125 microorganisms were isolated, with Enterobacteriaceae being the most frequent (32%). At the time of the survey, 49.1% patients were receiving antimicrobial therapy. The multivariate analysis showed a significant association between HAI and use of medical devices (OR=34.30; 95% CI:3.69-318.66), length of stay (OR=1.01; 95% CI:1.00-1.02) and exposure to prophylactic antimicrobial therapy (OR=0.23; 95% CI:0.11-0.47).*

Conclusions. *The ECDC methodology proved to be applicable to THPUI, where HAI prevalence was higher than the European standard (6.7%). This highlights the need to implement targeted measures to prevent and control HAIs, including continuous monitoring to evaluate the effectiveness of such interventions.*

Introduction

Healthcare-associated infection (HAI) is the most frequent adverse event in healthcare settings and is associated with higher morbidity and mortality rates, leading to prolonged hospital stays, increased antimicrobial resistance and consistent financial losses for healthcare systems (1-3). The prevalence of HAI worldwide ranges from 4 to 19% with a significant difference between high and

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middle-low income countries (3.5-12.0% vs 5.7-19.1%) (3-14). In Europe and Italy the prevalence of infected patients is 6.8-9.3% and the prevalence of HAI is 7.6-10.3%, which is usually higher in large hospitals (7).

Depending on the origin of the infection, a HAI can be classified as endogenous, where the sources of infection are sites on or within the body of the patient (such as the gastrointestinal tract or skin), or exogenous, where the microorganisms are transmitted by visitors, patient care personnel, equipment, medical devices or the healthcare environment (15). Patients in intensive care units (ICUs) or patients using invasive devices, such as a urinary catheter (UC), an intubation system or a vascular line, or patients who are very young or very old have a greater risk of HAI (5, 7, 16, 17). The most frequently reported types of HAI are central line-associated bloodstream infections (CLABSIs) (14.0%-35.8%), catheter-associated urinary tract infections (CAUTIs) (23.6%-30.9%), surgical site infections (SSIs) (12.2%) and ventilator-associated pneumonia (VAP) (15%-28.6%) (3, 5-7, 9, 10, 12, 14, 18).

In Italy, the National Prevention Plan 2014–2018 emphasizes the importance of collecting data on HAIs and antibiotic consumption in all healthcare units to contrast the spread of multi-drug resistant microorganisms (19). For these reasons, several point prevalence surveys (PPSs) have been conducted in recent years. Additionally, such surveys have proved to be an effective instrument for comparisons between settings (5, 11, 14, 16, 20, 21). There are several advantages to conducting PPSs: they are not expensive, they take little time to carry out, they need few human resources and they are easily repeatable (22). One of the most-used PPS protocols is that created by the European Centre for Disease Prevention and Control (ECDC), which allows the collection of data about HAI and antibiotic therapy (23). These data can provide the scientific basis for the planning and improvement of interventions aimed at controlling the spread of HAIs. The data can also inform surveillance protocols, influence hospital policy and allow relevant activities to be rational and evidence-based.

This study describes the methodology and results of a PPS carried out at the Policlinico Umberto I, which is the teaching hospital of Sapienza University of Rome.

Methodology

Specific objectives

The objectives of the PPS we conducted at Teaching Hospital Policlinico Umberto I (THPUI) in Rome were: 1) to estimate the total burden (prevalence) of HAIs and antimicrobial use at THPUI; 2) to describe and categorise patients, invasive procedures, infections (sites, microorganisms including markers of antimicrobial resistance) and antimicrobial prescriptions (compounds, indications) by type of patient, specialty or healthcare facility; 3) to disseminate the results in order to raise awareness, enhance surveillance strategies and interventions, and draw attention to the problem.

Methodology and definitions (in particular, definitions of active infection and HAI) were based on the most recent ECDC PPS protocol (23). Since the hospital indicator data would have been applied only to one hospital, we did not use them (24, 25). Investigators were trained to follow the protocol during a two-hour session conducted by the Department of Public Health and Infectious Diseases of Sapienza University of Rome. According to the literature (23), spring and autumn are recognised as the optimal periods to perform a PPS study, because hospital activity is “normal” and there are no seasonal outbreaks. For these reasons, data were collected in November 2018.

Inclusion/exclusion criteria

All wards in the hospital, including chronic and long-term care wards, acute psychiatric wards and neonatal ICUs, were included in the study. Emergency departments (except for wards attached to emergency departments where patients are monitored for more than 24 hours) were excluded. All patients admitted to the ward before 8 a.m. and not discharged from the ward at the time of the survey were included in the analysis; as a result, patients transferred in/out after 8 a.m. from/ to another ward were not included. Neonates born before/at 8 a.m. within maternity wards were also included. Patients undergoing same-day treatment or surgery, patients seen at an outpatient department, patients in the emergency room and dialysis patients (outpatients) were excluded.

Data collection

Data collection was performed by a multidisciplinary team composed of hospital infection control personnel, medical doctors and nurses in charge of the patients, and the Hospital Hygiene Unit of the THPUI. Medical and nursing coordinators were previously identified for each ward of the hospital and were informed about the modalities and methods of the study by the Health Directorate. Data were collected in a single day for each ward/unit. The total time frame for data collection for all wards did not exceed three weeks. Data collection included variables at ward and patient level. Specifically, data were collected using two forms, form W and form A, provided by the ECDC PPS protocol: Form W - one form per ward, includes structure and process indicators (optional) and denominator data for all patients present in the ward at 8 a.m. and not discharged at the time of the survey. Form A - one form per patient (for all patients present in the ward at 8 a.m. and not discharged at the time of the survey), collecting risk factors for each eligible patient, including having undergone NHSN (National Healthcare Survey Network) surgery before survey and a McCabe Score (26); healthcare-associated infection data (to be collected for all patients with an infection that matches the definition of an active healthcare-associated infection) and/or antimicrobial use data (to be collected for all patients receiving an antimicrobial agent) are collected on the same form. All patient data were anonymized.

Data analysis

Data were collected on forms and subsequently entered into a computer after verification using the ECDC free software tool for data, named HelicsWin.Net. Univariate analysis was performed with the Wilcoxon-Mann-Whitney test for continuous variables and with the chi-squared test, or with the exact Fisher test when appropriate, for categorical and dichotomous variables. All tests were two-tailed. A value of $p<0.05$ was considered statistically significant. "Rapidly fatal" McCabe score, age groups, having a medical device in place during the survey, and having undergone surgery following the NHSN criteria before survey were tested in the univariate analysis. Variables with a significance level of $p<0.25$ were included in a multivariate logistic regression model. The following variables were included in the model as continuous: age of the patient and length of hospitalization (from admission to HAI onset); the other variables were included as dichotomous: having a "rapidly fatal" McCabe score (0=no; 1=yes); patient's sex (0=female; 1=male); admission in ICUs, geriatric or surgery wards (0=no; 1=yes); exposure to medical devices (0=no; 1=yes); antibiotic prophylaxis exposure (0=no; 1=yes); having undergone NHSN surgery (0=no; 1=yes). All analyses were performed using STATA 13 software (StataCorp LP, Lakeway Drive, TX, USA).

Results

Patient demographics, risk factors and specialties

The PPS took place from 5th to 23rd November 2018. In accordance with the inclusion/exclusion criteria, 58 wards were included in the survey.

A total of 869 beds out of 994 were occupied at 00:01 a.m. of the day of the survey, corresponding to a median occupancy rate of 87.4%. In total, 799 patients were included in the analysis. The average length of stay (LOS) was 15.6 days (hospital median: 8 days, IQR 3-17.5 days). Specifically, the length of stay was less than five days for 288 patients (36.1%), between 6 and 10 for 168 patients (21.0%), between 11 and 20 days for 181 patients (22.6%) and more than 20 days for 162 patients (20.3%) (Table 1).

Surgical and medical specialties were the most represented, accounting for 41.6% and 38.8% of all patients, respectively. Patients in ICUs represented 6.8% of the total. The number of single rooms was 67 and the mean percentage of single-bed rooms was 16.7% of the total number of rooms.

The median age of the surveyed patients was 67 years (IQR 53-78 years): 25 patients (3.1%) were newborns and 429 patients (53.7%) were over 65 years old. There were 441 (55.2%) males and 358 (44.8%) females with a male-to-female ratio of 1:0.81 (Table 1).

According to the McCabe score, patients are classified into three categories: patients with a rapidly fatal diagnosis (e.g. prognosis <1 year), accounting for 5.2% of the total; patients with an ultimately fatal diagnosis (e.g. prognosis between 1 and 5 years), accounting for 18.6% of the total; and patients without a fatal diagnosis (e.g. prognosis >5 years), accounting for 70.2% of the total. Data were missing for 48 patients (6%) (Table 1).

In general, 227 patients (28.4%) had undergone surgery since admission and 80

Table 1 - Patient demographics, risk factors and specialties according to the point prevalence survey conducted at the Teaching Hospital Policlinico Umberto I of Rome in November 2018.

	N	(%)
	799	(100.0)
Length of stay (days)		
≤5	288	(36.1)
6-10	168	(21.0)
11-20	181	(22.6)
>20	162	(20.3)
Speciality		
Geriatrics	20	(2.5)
Gynaecology/Obstetrics	22	(2.7)
Intensive Care Unit	54	(6.8)
Medicine	310	(38.8)
Paediatrics	39	(4.9)
Rehabilitation	22	(2.7)
Surgery	332	(41.6)
Age category		
< 1 month	25	(3.1)
1-11 months	7	(0.9)
1-17 years	27	(3.4)
18-64 years	311	(38.9)
65-84 years	342	(42.8)
≥85 years	87	(10.9)
Sex		
Male	441	(55.2)
Female	358	(44.8)
McCabe Score		
No fatal	561	(70.2)
Ultimately fatal	149	(18.6)
Rapidly fatal	41	(5.2)
Missing	48	(6.0)
Surgery since admission		
No	569	(71.2)
Non-NHSN[a]	147	(18.4)
NHSN[a]	80	(10.0)
Missing	3	(0.4)
Invasive Device Use		
Central venous catheter	128	(16.0)
Peripheral venous catheter	594	(74.3)
Urinary catheter	276	(34.5)
Mechanical Ventilation	25	(3.1)

[a]NHSN= National Healthcare Survey Network

Table 2 - Prevalence of healthcare-associated infections (HAIs) by infection type according to the point prevalence survey conducted at the Teaching Hospital Policlinico Umberto I of Rome in November 2018.

	N of HAI	% of HAI	N of patients with HAI/total of patients	% of patients with HAI
All HAI types	123	100.0	106/799	13.3
Bloodstream infections	38	30.9	28/799	3.5
Urinary tract infections	31	25.2	29/799	3.6
Pneumonia	24	19.5	24/799	3.0
Surgical site infections	17	13.8	16/799	2.0
Gastro-intestinal Infections	6	4.9	6/799	0.8
Meningitis	1	0.8	1/799	0.1
Osteomyelitis	1	0.8	1/799	0.1
Sinusitis	1	0.8	1/799	0.1
Other/Unknown	4	3.3	0/799	0.0

of them (10%) had had a NHSN surgical operation. Regarding invasive device use, a peripheral venous catheter was present in 594 patients (74.3%), while 276 patients (34.5%) had a UC, 128 patients (16.0%) had a central venous catheter and 25 patients (3.1%) required mechanical ventilation (MV) (Table 1).

Prevalence and type of HAIs

The prevalence of patients presenting with at least one HAI was 13.3%, corresponding to 106 infected patients. Of these, 96 patients (12%) acquired the infection in the THPUI, while the remaining 10 patients had acquired the infection elsewhere. The total number of HAIs within the THPUI was 123. Ninety patients (84.9%) presented with one infection, 15 patients (14.1%) developed two infections, and one patient (0.9%) developed three infections. Table 2 shows the prevalence of HAI, the types of infection and their breakdown. The most common reported infections were bloodstream infections (BSIs) (30.9%), urinary tract infections (25.2%), pneumonia (19.5%) and SSIs (13.8%).

HAI characteristics: origin of HAIs, association with invasive device use, origin of BSIs

Of the 123 HAIs within THPUI, 27 (21.9%) were present at hospital admission and 96 (78.1%) occurred during hospitalization (Table 3). Concerning the timing of the HAI onset, two infections (1.6%) were acquired in the first two days of hospitalization; eight infections (6.5%) were acquired between the third and fourth day of hospitalization; eight infections (6.5%) were acquired between the fifth and seventh day of hospitalization; 20 infections (16.3%) were acquired between the eighth and 14th day of hospitalization; 13 infections (10.6%) were acquired between the 15th and 21st day of hospitalization; and 36 infections were acquired after the 21st day of hospitalization (29.3%). Data were not available for 36 infections (29.3%).

Thirty-eight of the 123 HAIs were device-related: twenty infections (16.3%) were CAUTIs; twelve infections (9.7%) were CLABSIs and six infections (4.9%) were VAP (Table 3).

BSIs were the most common type of HAI; of these, 12 (31.6%) infections were device-associated (central vascular catheter, CVC; or peripheral vascular catheter, PVC); two (23.7%) were primitive BSIs and 24 (44.7%) were secondary infections (Table 3).

Microorganisms isolated from HAIs and antibiotic resistance

Overall, a total of 125 microorganisms were isolated from patients affected by HAIs (Table 4). One-hundred seven

Table 3 - Characteristics of healthcare-associated infections (HAIs) according to the point prevalence survey conducted at the Teaching Hospital Policlinico Umberto I of Rome in November 2018, with a specific focus on the origin of the 38 bloodstream infections (BSIs).

	N of HAI	% of HAI
Total number of HAIs	123	100.0
Origin of HAI		
HAI present on admission	27	21.9
HAI with onset during current hospitalization	96	78.1
Day of HAI onset		
Day 1-2	2	1.6
Day 3-4	8	6.5
Day 5-7	8	6.5
Day 8-14	20	16.3
Day 15-21	13	10.6
> Day 21	36	29.3
Missing date of HAI onset	36	29.3
Non-Device Associated HAI	85	69.1
Device Associated HAI	38	30.9
Catheter associated urinary tract infections	20	16.3
Central Line Associated Bloodstream Infections	12	9.7
Ventilator Associated Pneumonia	6	4.9
Origin of BSI		
Total BSI	38	100.0
Catheter-related BSI	12	31.6
CVC[a]	8	21.1
PVC[b]	4	10.5
Primitive BSI	2	23.7
Secondary BSI	24	44.7
Pulmonary infection	3	7.9
Urinary tract infection	4	10.5
Surgical site infections	1	2.6
Skin/soft tissue infection	1	2.6
Digestive tract infection	0	0.0
Other infection sites	2	5.3
Unknown	13	15.8

[a]Central venous catheter; [b]Peripheral venous catheter

microorganisms were bacteria (85.6%) and 18 were fungi (14.4%). The most commonly isolated bacteria associated with HAI were *Klebsiella pneumoniae* (20%), *Pseudomonas aeruginosa* (12.8%), *Staphylococcus aureus* (8%), *Enterococcus faecalis* (7.2%), *Escherichia coli* (6.4%) and *Acinetobacter baumannii* (5.6%). *Candida albicans* was the most frequently isolated fungal species (8%) (Table 4).

Selected antimicrobial susceptibility testing data were available on the day of the survey for 97 microorganisms (77.6%). All bacteria were classified either as non-multidrug-resistant (N-MDR), multidrug-resistant (MDR), extensively

Table 4 - Microorganisms isolated from the 123 healthcare-associated infections by infection type according to the point prevalence survey conducted at the Teaching Hospital Policlinico Umberto I of Rome in November 2018.

		Infection Type					
	N (%)	Pneu[a] (N)	SSI[b] (N)	UTI[c] (N)	BSI[d] (N)	GitI[e] (N)	OI[f] (N)
Number of microorganisms, all	125[g] (100.0)	18	18	32	42	6	9
Gram-Neg., Non-Enterobacteriaceae	25 (20.0)	10	4	4	6	0	1
Acinetobacter Species	8 (6.4)	5	2	0	1	0	0
Acinetobacter baumannii	7 (5.6)	5	1	0	1	0	0
Acinetobacter spp., other	1 (0.8)	0	1	0	0	0	0
Haemophilus Species	1 (0.8)	1	0	0	0	0	0
Haemophilus influenzae	1 (0.8)	1	0	0	0	0	0
Pseudomonas Species	16 (12.8)	4	2	4	5	0	1
Pseudomonas aeruginosa	16 (12.8)	4	2	4	5	0	1
Gram-Positive Bacilli	4 (3.2)	0	2	0	2	0	0
Bacillus spp.	3 (2.4)	0	1	0	2	0	0
Corynebacterium spp.	1 (0.8)	0	1	0	0	0	0
Anaerobic Bacilli	7 (5.6)	0	1	0	0	6	0
Clostridium Species	6 (4.8)	0	0	0	0	6	0
Clostridium difficile	6 (4.8)	0	0	0	0	6	0
Other Anaerobes	1 (0.8)	0	1	0	0	0	0
Propionibacterium spp.	1 (0.8)	0	1	0	0	0	0
Enterobacteriaceae	40 (32.0)	6	5	17	9	0	3
Enterobacter Species	3 (2.4)	1	1	0	1	0	0
Enterobacter aerogenes	1 (0.8)	0	1	0	0	0	0
Enterobacter cloacae	2 (1.6)	1	0	0	1	0	0
Escherichia Coli	8 (6.4)	0	1	4	3	0	0
Escherichia coli	8 (6.4)	0	1	4	3	0	0
Klebsiella Species	25 (20.0)	4	2	11	5	0	3
Klebsiella pneumoniae	25 (20.0)	4	2	11	5	0	3
Proteus Species	3 (2.4)	0	1	2	0	0	0
Proteus mirabilis	3 (2.4)	0	1	2	0	0	0
Serratia Species	1 (0.8)	1	0	0	0	0	0
Serratia marcescens	1 (0.8)	1	0	0	0	0	0
Gram-Positive Cocci	31 (24.8)	1	5	5	15	0	5
Enterococcus Species	10 (8.0)	1	1	5	2	0	1
Enterococcus faecalis	9 (7.2)	1	1	5	1	0	1
Enterococcus faecium	1 (0.8)	0	0	0	1	0	0
Staphylococcus Species	10 (8.0)	0	4	0	5	0	1
Staphylococcus aureus	10 (8.0)	0	4	0	5	0	1
Staphylococcus epidermidis	6 (4.8)	0	0	0	5	0	1
Staphylococcus haemolyticus	1 (0.8)	0	0	0	1	0	0
Other Coagulase Negative Staphylococci	3 (2.4)	0	0	0	1	0	2
Streptococcus Species	1 (0.8)	0	0	0	1	0	0
Streptococcus spp.	1 (0.8)	0	0	0	1	0	0
Fungi	18 (14.4)	1	1	6	10	0	0
Aspergillus Species	1 (0.8)	1	0	0	0	0	0
Aspergillus spp.	1 (0.8)	1	0	0	0	0	0
Candida Species	17 (13.6)	0	1	6	10	0	0
Candida albicans	10 (8.0)	0	1	4	5	0	0
Candida parapsilosis	5 (4.0)	0	0	1	4	0	0
Candida tropicalis	2 (1.6)	0	0	1	1	0	0

[a]Pneu: Pneumonia; [b]SSI: Surgical site infections; [c]UTI: Urinary uract infections; [d]BSI: Bloodstream infections; [e]GitI: Gastro-intestinal tract infections: [f]OI: Other infections

drug-resistant (XDR) or pan-drug-resistant (PDR), following the definition for acquired resistance proposed by *Magiorakos* et al (27). Of the 97 bacteria with a well-known antibiotic-resistance profile, the prevalence of bacteria showing at least a MDR profile was 86.6%. In particular, the prevalence of MDR bacteria was 28.9%, while the prevalence of XDR and PDR bacteria was 47.4% and 10.3%, respectively. The most prevalent species had antimicrobial resistance profiles as follows: *A. baumannii* (14.3% N-MDR and 85.7% PDR); *P. aeruginosa* (6.2% N-MDR, 50.0% MDR, 31.3% XDR and 12.5% PDR); *K. pneumoniae* (45.4% N-MDR, 9.0% MDR, 36.6% XDR and 9.0% PDR); *S. aureus* (44.4% MDR, 55.6% XDR, all methicillin resistant) (data not shown).

Antimicrobial use

Of the total of 799 patients, 407 (50.9%) were not receiving any antimicrobial agent during data collection day, while 392 patients (49.1%) were receiving at least one antimicrobial. Collectively, over 75% of the antimicrobial classes prescribed, by decreasing order of frequency, were represented by penicillins (21.7%), cephalosporins (18.3%), carbapenems (10.5%), azoles (9.6%), fluoroquinolones (7.8%) and glycopeptides (7.2%). Antimicrobials were most frequently prescribed for the following reasons: surgical prophylaxis (43.8%); treatment of hospital infections (29.6%); treatment of community infections (25.5%); other or unknown indication (0.49%) (data not shown).

Patient risk factors for HAI - univariate analysis and multivariate analysis

Univariate comparisons revealed no statistically significant differences in the hospital-acquired HAI rate among different classes of patient age (< 1 month: 0.0%; 1-11 months: 0.0%; 1-17 years: 22.2%; 18-64 years: 10.6%; 65-84 years: 12.9%; >85 years: 14.9%; p=0.118), between male and female patients (12.9% vs 10.9%; p=0.346), among patients who had surgery or not (no surgery: 11.2%; no-NHSN surgery: 14.3%; surgery NHSN:10.0%; p=0.559) and among different specialities (geriatric: 15.0%; gynaecology/obstetrics: 4.5%; ICUs: 22.2%; medicine: 13.5%; paediatrics: 7.7%; rehabilitation: 4.5%; surgery: 10.2%; p=0.130)

Statistically significant associations between the development of HAI inside the hospital and various patient risk factors were revealed by the univariate analysis. In particular, the prevalence of HAI increased with duration of hospitalization (<5 days 1.1%; 6-10 days: 10.9%; 11-20 days: 15%; >20 days: 30.4%; p<0.001); the prevalence of patients with HAI was associated with the patient's clinical severity, as indicated by the McCabe score (no fatal disease: 9.3%; ultimately fatal disease: 16.8%; rapidly fatal disease: 19.5%; p<0.001); the rate of HAI was associated with non-use of antibiotic prophylaxis (15.2% vs 3.8%; p<0.001) and with use of a medical device, in particular CVC (25.8% vs 9.4%; p<0.001), PVC (14.5% vs 4.9%; p=0.001), UC (23.6% vs 6.0%; p<0.001) and MV (40.0% vs 11.1%; p<0.001).

A multiple logistic regression model was built to further investigate the determinants of the overall HAI prevalence (Table 5). Hospital-acquired HAI prevalence significantly increased among patients with medical devices (OR = 28.21; 95% CI: 3.25-244,64; p=0.002) and with the length of stay (OR=1.01; 95% CI: 1.00-1.02; p<0.001). By contrast, the prevalence of HAI was significantly lower where antibiotics were used for prophylaxis (OR=0.22; 95% CI: 0.10-0.47; p<0.001).

Discussion and Conclusions

The present study analysed the results of a PPS aimed at detecting HAIs and estimating antimicrobial use within the THPUI in Rome.

Table 5 - Multiple logistic regression model of the 96 patients with hospital-acquired healthcare-associated infections.

	Multivariate analysis		
	OR	95% CI	p-value
Rapidly fatal McCabe score (0=no; 1= yes)	1.57	0.63-3.93	0.332
Age (years, continuous)	0.99	0.98-1.01	0.553
Sex (0=female; 1= male)	1.21	0.78-1.88	0.395
Intensive care unit (0=no; 1= yes)	1.74	0.76-4.00	0.189
Geriatric (0=no; 1= yes)	0.91	0.23-3.48	0.893
Surgery (0=no; 1= yes)	0.77	0.41-1.41	0.394
Medical devices (0=no; 1= yes)	28.21	3.25-244.64	0.002
Antibiotic prophylaxis (0=no; 1= yes)	0.22	0.10-0.47	<0.001
NHSH[a] surgery (0=no; 1= yes)	1.62	0.79-3.34	0.188
Length of stay (days, continuous)	1.01	1.00-1.02	<0.001

[a]NHSN= National Healthcare Survey Network

We found that the overall prevalence of HAIs in THPUI patients (13.3%) was higher than that reported both for Europe (3.5-11.6%) and for Italy as a whole (5.0-8.0%) (9, 23, 28). However, a few considerations should be outlined when comparing such rates: first, while THPUI is one of the largest hospitals in Italy, the ECDC survey refers mostly to small or medium-sized facilities (7, 13, 16, 18, 23); second, since THPUI is a teaching hospital, it may represent a setting in which HAI rates are usually higher; third, a large proportion of the patients included in this study had severe comorbidities (4, 7). In particular, when compared with the ECDC PPS report, the proportion of patients within THPUI aged >65, as well as the average length of stay, was consistently higher (53.7% vs 48.9%; 15.6 vs 5.1, respectively). Additionally, we also found a larger proportion of patients with a rapidly fatal or ultimately fatal diagnosis (23.8% vs 21.3%). Lastly, both invasive device use (CVC: 16% vs 7.5%; PVC: 74.3% vs 46.7%; UC: 34.5% vs 17.2%; MV: 3.1% vs 2.3%) and the proportion of patients having surgery (28.4% vs 26.9%) was greater in THPUI patients than in patients enrolled in the ECDC PPS (23).

In contrast to the ECDC PPS and several other European studies (9, 11, 14, 23), BSI emerged as the most frequent type of infection detected. Our data also showed that one third of the BSIs involved Gram-negative bacteria, most of which were non-susceptible pathogens. It is well-known that BSIs cause severe clinical conditions with high rates of mortality and poor outcomes, particularly in critical patients and high-risk settings (e.g. ICUs) (29-35). Additionally, the BSI rate is a key indicator of clinical performance in hospitals (29). For these reasons, effective strategies to limit the spread of these infections within the THPUI should be immediately devised (6).

Reducing the risk factors for the occurrence of HAIs is of primary importance (36). Many studies have highlighted various conditions that can predispose patients to develop HAIs (5, 12, 16, 23, 37). In our study, LOS, antibiotic prophylaxis and the utilization of devices were strongly associated with HAIs, in line with other studies (5, 38, 39). Interestingly, in contrast with other findings (7, 10, 14, 18) our data showed instead that older age, McCabe score and surgery were not significantly associated with the onset of HAIs.

The use of a standardized methodology enabled a comparison among healthcare specialties and the subsequent identification of high-risk clinical settings. However, although no association between ward specialty and risk of HAI was found in our study (18) a high rate of infections was registered in our ICUs, in line with other Italian and European studies (16, 23, 40). Nevertheless, the HAI prevalence in the main adult and neonatal ICU of the hospital, was lower than the overall ICU prevalence of HAIs in Europe (23). In our opinion, this could be the result of the ongoing active surveillance that, since 2016, has been carried out by the Unit of Hospital Hygiene of THPUI, which aims to contain the spread of HAIs and monitor the trend of infections (41-43).

With regard to antibiotic consumption, the ranking order of the most-used antimicrobials in our study was consistent with the data described in the ECDC PPS report (9, 14, 22, 23). However, our antimicrobial consumption rate was higher than the European benchmark defined using the same protocol (49.1% vs 35%) (11, 13, 23). This may be because many of the microorganisms we found within the THPUI are at least MDR. Despite this, it is important to remember that inappropriate use of antibiotics may contribute to the increase in antibiotic resistance (11). Therefore, since the proportion of bacteria resistant to antibiotics is escalating worldwide with a concomitant increase in morbidity, mortality and hospital costs (3, 44), optimizing clinical management of antimicrobial use will be necessary to reduce and contain antimicrobial resistance within the THPUI (6).

The results of the study provide a first assessment of the epidemiological picture of HAI across the entire Hospital. This information could be used as the scientific basis for the planning and improvement of surveillance and control activities, and give the Heath Directorate an instrument for stratifying the risk of HAI in the wards and addressing specific interventions in critical areas. Furthermore, to better understand the basis of this issue, it would be helpful to carry out a survey of the knowledge, attitudes and practices of healthcare workers towards HAIs, which should make it possible to raise awareness, enhance surveillance strategies and promote educational interventions. The effectiveness of the corrective interventions adopted needs to be evaluated in the midterm, i.e., by means of repeated prevalence investigations, particularly in critical settings.

This survey has some strengths and limitations. The main strength is that it represents the first PPS conducted in the THPUI using the ECDC protocol, enabling us both to test such a tool in a large hospital and to estimate HAI prevalence and antimicrobial use rates. Second, the implementation of a standardized methodology allowed the identification of the most critical clinical settings. Third, this study allowed us to compare our results at national and international level. Additionally, this study represents the starting point for the monitoring of the HAI trend over time and is a useful instrument by which to evaluate the effectiveness of the containment measures that will be adopted. In particular, even though prospective active surveillance is considered the gold standard, repeated PPSs may represent a more feasible and useful alternative for hospital-wide HAI surveillance (14). An important limitation is that the study was conducted in only a single teaching hospital, and multicentre studies or national surveys are needed to quantify and monitor HAIs and antimicrobial use on a broader scale. Second, since this was a cross-sectional study, it did not allow us to establish a causality relation between some variables and the onset of infections. Furthermore, there was a lack of patient follow-up, meaning that post-discharge HAIs could not be detected (5, 7).

The monitoring of infectious events is of paramount importance for the implementation of successful strategies to prevent and limit the further spread of HAIs. At the same time, minimising the circulation of multi-resistant microorganisms requires a multi-faceted approach based on correct antimicrobial stewardship, the correct use and maintenance of devices and good compliance with standard hygiene practices (42, 45). In this context, PPSs using the ECDC protocol could represent an effective way of collecting and analysing data, and of evaluating the trend of HAIs and the effectiveness of the strategies implemented to minimize the risk of HAIs.

Conflict of interests
The authors declare that they have no competing interests.
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Riassunto

Indagine di prevalenza delle infezioni correlate all'assistenza in un policlinico universitario

Introduzione. Le infezioni correlate all'assistenza (ICA) sono il più frequente evento avverso in ambito ospedaliero. Si associano ad un aumento della mortalità e dell'antibiotico-resistenza, ad una degenza prolungata e a consistenti perdite economiche per i sistemi sanitari. Lo scopo di questo studio è quello di quantificare il problema delle ICA e dell'uso di antimicrobici nell'Azienda Ospedaliera Universitaria Policlinico Umberto I di Roma, per identificare le maggiori aree critiche su cui programmare interventi.

Metodi. I dati sono stati raccolti nel novembre 2018 secondo il più recente protocollo di Indagine di prevalenza puntuale dell'ECDC. È stata fatta un'analisi descrittiva di tutte le variabili disponibili. L'analisi univariata è stata eseguita per valutare possibili associazioni tra tali variabili e l'insorgenza di ICA. Le variabili con un livello di significatività inferiore a p=0.25 sono state inserite in un modello di regressione logistica multivariata.

Risultati. Il totale dei pazienti inclusi nell'analisi è stato 799, di cui 13.3% presentava almeno un'ICA. Le infezioni del torrente ematico risultavano essere le più frequenti, attestandosi al 30,9% del totale delle infezioni. In totale, sono stati isolati 125 microrganismi e i più frequenti risultavano essere appartenenti alla famiglia delle Enterobacteriaceae (32%). Al momento della survey, il 49.1% dei pazienti stava ricevendo terapia antibiotica. L'analisi multivariata ha evidenziato un'associazione significativa tra la presenza di ICA e l'utilizzo di *device* (OR=34.30; IC95%:3.69-318.66), la durata di degenza (OR=1.01; IC95%:1.00-1.02), l'esposizione a profilassi antimicrobica (OR=0.23; IC95%:0.11-0.47).

Conclusioni. La prevalenza di ICA è risultata essere più alta rispetto alla media europea (6.7%). Questo studio dimostra la necessità di implementare misure di prevenzione e controllo delle ICA e di effettuare un continuo monitoraggio per valutare l'efficacia di questi interventi.

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