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Point prevalence survey of antibiotic use and healthcare-associated infections in acute care hospitals: a comprehensive report from the Marche Region of Italy

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S U M M A R Y

Background: Healthcare-associated infections (HAIs) and antimicrobial resistance (AMR) are serious health challenges. Point prevalence surveys (PPSs) are valuable tools for monitoring HAIs and AMR.
Aim: To describe results of the ECDC PPS 2022 dealing with the prevalence of HAIs, antimicrobial consumption, and associated factors, in acute care hospitals.
Methods: The survey was performed in November 2022 in 14 hospitals according to the protocol proposed by the European Centre for Disease Prevention and Control. Multilevel logistic regression was performed using geographical area/hospital type as cluster variable to evaluate the factors independently associated with HAIs and antibiotics.
Findings: The point prevalence of HAIs was 7.43%. Patients hospitalized for longer periods were more likely to have an HAI as well as those aged 15–44 years, with a rapidly fatal disease, intubated, and with one or two devices. Antibiotics prevalence was 47.30%. Males, unknown McCabe scores, minimally invasive/non-National Healthcare Safety Network (NHSN) surgery, patients with HAIs, hospitals with a higher alcohol hand-rub consumption, hospitals with a greater number of IPC personnel, geriatric wards, and hospitals with 300–600 beds were more likely to be under antimicrobial therapy.

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Conclusion: This PPS provided valuable information on the prevalence of HAIs and antimicrobial consumption and variables associated. The high prevalence of HAIs highlights the need for improved infection control measures.

Introduction

Healthcare-associated infections (HAIs) and antimicrobial resistance (AMR) are among the most serious health challenges that the world is facing [1]. Modern medicine relies on effective antibiotics to fight bacterial infections and the high rates of drug-resistant organisms found by the World Health Organization (WHO) in all the world's regions presents a pressing health and socioeconomic problem [2]; in this context, AMR has been recognized by the WHO as being among the top ten global health threats in 2019 [1].

Approximately 33,000 deaths in the European Union/European Economic Area (EU/EEA) each year are due to bacteria-resistant infections and the World Bank estimated that by 2050 up to 3.8% of the global gross domestic product could be lost due to AMR [3,4]. According to Cassini *et al.*, Italy has a substantially higher estimated burden of antibiotic-resistant bacteria than other EU and EEA countries [5].

Despite huge efforts and investments in the research and development of new antimicrobial drugs, the overall burden of AMR is likely to become even more significant in the years to come if the indications from the scientific community and public health agencies on the misuse and overuse of currently available antibiotics are ignored [6,7].

The 'National Plan to Combat Antibiotic Resistance 2022–2025' is a recently developed strategic document in the Italian context that addresses AMR through a multidisciplinary and one-health approach, emphasizing international collaboration and building upon past successes and challenges; the plan focuses on surveillance, antimicrobial stewardship, education, and research to combat AMR effectively [8].

Preventing HAIs and optimizing antimicrobial usage are essential strategies in tackling AMR in the context of a one-health approach, which recognizes the necessity of a multidisciplinary, multisectoral, and coordinated action [9,10].

In Italy since 1985 the Ministry of Health, through Circular 52/1985, has advocated the start of infection control programmes in each hospital, creating multidisciplinary committees, establishing operational groups, and assigning dedicated nursing staff [11].

In 2016, the last countrywide point prevalence survey (PPS) of HAIs in Italian acute care hospitals highlighted that the prevalence of patients with at least one HAI was about 8.0% at the time of the survey (one of the highest frequencies in Western Europe), confirming the importance of infectious complications in Italy [12]. To ensure informed decision-making, adequate risk assessment is necessary; in this context PPSs are valuable tools for monitoring antimicrobial use in a cost-effective and reliable way that can also be repeated over time to assess the effects of the interventions performed [13–19]. The aim of this study is to describe results of the ECDC-PPS 2022 dealing with the prevalence of HAIs and antimicrobial consumption, as well as selected associated factors, in acute care hospitals of the Marche Region, Italy.

Methods

Setting

The Marche region is a part of central Italy, located in the Adriatic–Ionian Region and the total resident population, as of January 1st, 2022, is 1,487,150 inhabitants [20]. This PPS was performed during a four-week period in November 2022 in 14 hospitals, representing all the acute care hospitals operating in the Marche region. Of these, the majority were secondary hospitals ($N = 11$), one was a primary hospital, one was a tertiary hospital, and one was a specialized geriatric hospital.

Protocol

The study was performed according to the protocol proposed by the European Centre for Disease Prevention and Control (ECDC) [21]. Study data were collected and managed using REDCap electronic data capture tools hosted at Università degli Studi di Torino (Italian National coordinating centre of the survey). The healthcare professionals collected data from patient medical records, treatment sheets, and nurses' notes [22,23]. According to the study protocol, data from a single ward was collected on one single day; the timeframe for data collection for all wards of a single hospital has not exceeded four weeks.

Ethical approval

The Italian version of the survey protocol was approved by the ethics committee of the Università degli Studi di Torino (Prot. No. 0421518 of July 29th, 2022). Any information relating to a patient participating in the surveillance was collected and treated in pseudonymized form. Furthermore, the data are retained in compliance with current legislation on the processing of personal data (EU Regulation No. 2016/679, D.lgs.196/2003 amended by D.lgs.101/2018) by the Data Controller, that has been identified in the Italian national Institute of Health (Istituto Superiore di Sanità, ISS).

Statistical analysis

After initial description of the study population, bivariate analyses were performed to study the association between presence of HAIs and antibiotic use with relevant variables using χ^2-tests. Multilevel logistic regression was performed using geographical area/hospital type as cluster variable to evaluate the factors independently associated with HAIs and antibiotics accounting for the difference in local healthcare organizations. Missing values were excluded in all analyses and included in bivariate tables just for completeness of data description. $P<0.05$ was considered significant. Analyses have been performed with Stata/SE 15.1 (StataCorp, College Station, TX, USA).

Results

Patient characteristics

Our study sample included 2653 patients (50.21% females; mean age: 63.78 ± 24.96 years; median: 71; interquartile range (IQR): 29; range: 0–102) with an average duration of hospitalization of 9.85 ± 13.91 days at the time of the study (median: 6; IQR: 10; range: 0–232).

Based on the McCabe score, 67.17% (*N*=1782) of patients had a non-fatal disease, 17.83% (*N*=473) had an ultimately fatal disease, and 4.98% (*N*=132) had been diagnosed with a rapidly fatal disease.

The majority of patients (*N*=1804, 68%) were treated in a secondary hospital, 681 (25.67%) in a tertiary hospital, 132 (4.97%) in a specialized hospital, and 36 (1.36%) in a primary hospital.

Dealing with selected characteristics of the stay, 19.64% (*N*=521) of our sample underwent a National Healthcare Safety Network (NHSN)-defined surgery, 6.41% (*N*=170) underwent a non-NHSN procedure, and 72.33% (*N*=1919) had no surgical procedure.

Almost half of the patients (*N*=1212, 45.68%) had at least one medical device in place (central vascular catheter, urinary catheter, or intubation), the most common being the urinary catheter (*N*=1012, 38.51%) followed by the central vascular catheter and intubation (*N*=557, 21.21% and *N*=102, 3.88%, respectively).

Prevalence and types of HAIs

HAI prevalence was 7.43% (*N*=197; 95% confidence interval (CI): 6.46–8.49) and 11 patients (0.41%) had more than one HAI. Urinary tract infections were the most frequently reported type of HAI (*N*=57, prevalence of 2.15%), followed by respiratory tract infections (*N*=45, prevalence of 1.70%), bloodstream infections (*N*=43, prevalence of 1.62%), surgical site infections (SSIs) (*N*=18, prevalence of 0.68%), and gastrointestinal infections (*N*=8, prevalence of 0.30%). A relevant device was in use on 69.04% (*N*=136) of patients with HAIs before infection onset. The average time between hospital admission and HAI onset was 15.73 ± 21.13 days (median: 9).

In total, 154 micro-organisms were isolated among 136 HAIs (65.38% of all HAIs), whereas in 34.62% a microbial result was not available. The most frequently isolated micro-organisms were *Escherichia coli* (*N*=24, 15.58%), *Pseudomonas aeruginosa* (*N*=15, 9.74%), *Acinetobacter baumannii* (*N*=12, 7.79%), and *Klebsiella pneumoniae* (*N*=12, 7.79%).

Table I highlights the results of the bivariate analyses. Diagnosis of HAI was associated with longer hospital stay, more severe McCabe score, presence of central vascular catheter, presence of urinary catheter, intubation, greater number of devices, antimicrobial therapy, hospital type, specialty, and hospital size.

The multilevel regression analysis (Table II) confirmed that people hospitalized for longer periods were more likely to have

Table I
Bivariate analysis: healthcare-associated infection (HAI)

Variable	No.	% with HAI (95% CI)	*P*
Sex			NS
Female	1332	8.1 (5.46–8.24)	
Male	1308	6.76 (6.68–9.71)	
Missing	13		–
Age (years)			NS
<15	190	3.16 (1.17–6.75)	
15–44	318	4.72 (2.66–7.66)	
45–64	504	7.74 (5.56–10.43)	
65–74	479	8.98 (6.57–11.90)	
75–84	631	7.77 (5.80–10.14)	
≥85	501	8.38 (6.11–11.16)	
Missing	30	10.00 (2.11–26.53)	–
Length of hospital stay (admission–HAI onset) (days)			0.000
<4	927	4.31 (3.10–5.83)	
4–7	684	4.68 (3.22–6.54)	
8–14	533	7.13 (5.09–9.65)	
>14	446	13.90 (10.83–17.46)	
Missing	63	36.68 (27.57–52.80)	–
McCabe score			0.000
Non-fatal disease	1782	5.22 (4.23–6.35)	
Ultimately fatal disease	473	11.63 (8.88–14.86)	
Rapidly fatal disease	132	23.48 (21.9–40.65)	
Unknown	266	6.77 (4.06–10.48)	
Surgery since admission			NS
No surgery	1919	6.72 (5.64–7.94)	
Minimally invasive/ non-NHSN surgery	170	8.82 (5.02–14.14)	
NHSN surgery	521	9.79 (7.38–12.67)	
Unknown	43	4.65 (0.57–15.81)	
Central vascular catheter			0.000
No	2069	4.64 (3.77–5.64)	
Yes	557	17.77 (14.69–21.21)	
Unknown	27	7.41 (0.91–24.29)	
Urinary catheter			0.000
No	1616	3.96 (3.06–5.03)	
Yes	1012	13.04 (11.03–15.28)	
Unknown	25	4.00 (0.10–20.35)	
Intubation			0.000
No	2526	6.65 (5.71–7.69)	
Yes	102	28.43 (19.94–38.22)	
Unknown	25	0.00	
No. of devices			0.000
0	1441	2.91 (2.11–3.92)	
1	834	8.99 (7.14–11.14)	
2	297	18.52 (14.27–23.41)	
3	81	30.86 (21.07–42.11)	
Antibiotic therapy			0.000
No	1394	0.79 (0.39–1.41)	
Yes	1255	14.82 (12.90–16:91)	
Missing	4	0.00	–
AST/hospital			0.000
AST 1	565	7.61 (5.56–10.11)	

Table I (*continued*)

Variable	No.	% with HAI (95% CI)	*P*
AST 2	395	4.30 (2.53–6.80)	
AST 3	328	6.71 (4.25–9.98)	
AST 4	200	0.50 (0.01–2.75)	
AST 5	352	6.82 (4.42–9.98)	
AOU delle Marche	681	11.01 (8.76–13.61)	
INRCA	132	11.36 (6.50–18.05)	
Alcohol hand-rub consumption (L/year)			NS
<10	144	6.25 (2.90–11.53)	
10–19	391	8.44 (5.88–11.65)	
>19	1750	8.46 (7.20–9.86)	
Missing	368	1.90 (0.77–3.88)	–
IPC personnel			NS
0	760	5.92 (4.35–7.84)	
>0 and <4.61	1545	8.61 (7.26–10.12)	
>4.61	180	7.22 (3.90–12.03)	
Missing	168	3.57 (1.32–7.61)	–
IPC plan			NS
Yes	2277	7.51 (6.46–8.67)	
No	208	9.62 (5.97–14.46)	
Missing	168	3.57 (1.32–7.61)	–
Hospital type			0.000
Primary	36	11.11 (3.11–26.06)	
Secondary	1804	5.71 (4.68–6.88)	
Tertiary	681	11.01 (8.76–13.61)	
Specialized	132	11.36 (6.50–18.05)	
Specialty			0.000
Medicine	1325	8.00 (6.60–9.59)	
Surgery	618	6.31 (4.53–8.53)	
Intensive care	172	21.51 (15.62–28.41)	
Paediatrics	115	0.87 (0.02–4.75)	
Psychiatry	108	0.00	
Obstetrics and gynaecology	155	1.29 (0.16–4.58)	
Long-term care	28	7.14 (0.88–23.50)	
Rehabilitation	43	9.30 (2.59–22.14)	
Geriatrics	79	7.59 (2.84–15.80)	
Missing	10	0.00	–
Hospital size (no. of beds)			0.000
<300	1382	6.08 (4.88–7.47)	
300–00	422	7.58 (5.24–10.54)	
>600	681	11.01 (8.76–13.61)	
Missing	168	3.57 (1.32–7.61)	–

CI, confidence interval; NS, non-significant; NHSN, National Health Surveillance Network; AST, Azienda Sanitaria Territoriale; AOU, Azienda Ospedaliero-Universitaria; INRCA, Istituto Nazionale Ricovero e Cura Anziani; IPC, infection prevention and control.

an HAI as well as those aged 15–44 years, patients with a rapidly fatal disease, intubated patients, and patients with one or two devices.

Antimicrobial use

Antimicrobial therapy was administered to 1255 patients (47.30%) and in 332 (12.51%) cases it consisted of more than one

Table II
Multilevel regression analysis: healthcare-associated infection

Variable	OR	95% CI	*P*
Sex			
Male	0.85	0.60–1.20	NS
Age (years)			
15–44	3.61	1.01–12.89	0.048
45–64	2.36	0.71–7.78	NS
65–74	2.15	0.65–7.18	NS
75–84	2.31	0.67–7.93	NS
≥85	2.17	0.60–7.81	NS
Length of hospital stay (admission–HAI onset) (days)			
4–7	0.77	0.46–1.29	NS
8–14	0.92	0.54–1.57	NS
>14	2.25	1.40–3.62	0.001
McCabe score			
Ultimately fatal disease	1.45	0.95–2.23	NS
Rapidly fatal disease	2.08	1.17–3.70	0.012
Unknown	1.41	0.67–2.98	NS
Surgery since admission			
Minimally invasive/ non-NHSN surgery	1.77	0.85–3.66	NS
NHSN surgery	1.61	0.92–2.85	NS
Unknown	0.89	0.09–9.06	NS
Central vascular catheter			
Yes	1.17	0.60–2.29	NS
Urinary catheter			
Yes	1.20	0.62–2.33	NS
Intubation			
Yes	3.56	1.28–9.86	0.015
No. of devices			
1	2.16	1.11–4.22	0.024
2	4.08	1.38–12.02	0.011
3	1.00		
Alcohol hand-rub consumption (L/year)			
10–19	1.24	0.18–8.53	NS
>19	0.76	0.10–5.81	NS
IPC personnel			
>0 and <4.61	1.34	0.67–2.67	NS
>4.61	1.27	0.21–7.78	NS
IPC plan			
Yes	1.25	0.36–4.28	NS
Hospital type			
Secondary	0.30	0.07–1.24	NS
Tertiary	0.61	0.14–2.60	NS
Specialized	1.00		
Specialty			
Surgery	0.69	0.37–1.27	NS
Intensive care	1.31	0.67–2.56	NS
Paediatrics	0.73	0.07–7.77	NS
Psychiatry	1.00		NS
Obstetrics and gynaecology	0.23	0.05–1.11	NS
Long-term care	0.58	0.12–2.93	NS
Rehabilitation	1.34	0.37–4.86	NS
Geriatrics	0.86	0.30–2.48	NS

(*continued on next page*)

Table II (*continued*)

Variable	OR	95% CI	*P*
Hospital size			
300–600	0.97	0.50–1.91	NS
>600	1.00		

OR, odds ratio; CI, confidence interval; NS, non-significant; HAI, healthcare-associated infection; NHSN, National Health Surveillance Network; IPC, infection prevention and control.

antimicrobial. Parenteral administration was by far the most common route to deliver antimicrobials and was chosen in 91.95% (*N*=1507) of therapies, whereas the oral route was used in 7.87% (*N*=129) of therapies.

Out of the 1639 administered antimicrobials, 677 (41.31%) were used to treat community-acquired infections, 319 (19.46%) for medical prophylaxis, 272 (16.60%) to treat HAIs, and 228 (13.91%) for surgical prophylaxis.

The five most administered antimicrobial classes were penicillins and enzyme combinations (*N*=338, 20.62%), third-generation cephalosporins (*N*=279, 17.02%), carbapenems (*N*=184, 11.23%), fluoroquinolones (*N*=147, 8.97%), and glycopeptides (*N*=117, 7.14%).

The bivariate analyses (Table III) showed a statistically significant difference in the prevalence of antimicrobial use associated with sex, age, length of hospital stay, McCabe score, presence of central vascular catheter, presence of urinary catheter, intubation, number of devices, presence of HAI, alcohol hand-rub consumption, IPC personnel, hospital type, specialty, and hospital size. Table IV shows the results of the multilevel regression analysis. Males, unknown McCabe scores, minimally invasive/non-NHSN surgery, patients with HAIs, hospitals with a higher alcohol hand-rub consumption, hospitals with a greater number of IPC personnel, geriatric wards, and patients in hospital with 300–600 beds were more likely to be under antimicrobial therapy.

Discussion

Our study aimed to estimate the point prevalence of HAIs and antimicrobial consumption in the context of the European Point Prevalence Survey 2023 protocol [21].

The point prevalence of HAIs was 7.43% (95% CI: 6.46–8.49), which is similar to the results of the European survey reporting a prevalence of 6.5%, as well as to the results of the Italian survey reporting an 8.0% prevalence, both estimated from the previous PPS of 2016–2017 [24].

Looking at regional data for the same year, the prevalence of HAIs remained stable, as it was 8.9% (95% CI: 7.7–10.2) in 2016–2017 (unpublished data). It is of note that the 2022 version of the protocol is slightly different from the previous. The main changes are the inclusion of healthcare-associated COVID-19 and related indicators, the simplification of the antimicrobial use data, the inclusion of indicators on automated HAI surveillance, and an alignment of the question regarding multimodal strategies for the implementation of IPC interventions with the question in the WHO Infection Prevention and Control Assessment Framework (IPCAF) tool [21,25].

Comparing the most frequently isolated micro-organisms with the results of the previous survey, it was found that *E. coli*

Table III
Bivariate analysis: antibiotics

Variable	No.	% with antibiotic	*P*
Sex			0.000
Female	1332	43.62 (40.93–46.33)	
Male	1308	51.30 (48.55–54.04)	
Missing	13		–
Age (years)			0.000
<15	190	31.58 (25.04–38.70)	
15–44	318	37.74 (32.39–43.32)	
45–64	504	46.03 (41.62–50.49)	
65–74	479	48.23 (43.67–52.80)	
75–84	631	48.02 (44.06–52.00)	
≥85	501	59.08 (54.63–63.42)	
Missing	30	43.33 (25.46–62.57)	–
Length of hospital stay (admission-survey) (days)			0.002
<4	897	43.92 (40.65–47.24)	
4–7	678	47.20 (43.39–51.03)	
8–14	543	54.33 (50.03–58.58)	
>14	495	45.45 (41.01–49.96)	
Missing	36	58.33 (40.76–74.49)	–
McCabe score			0.000
Non-fatal disease	1782	43.10 (40.78–45.43)	
Ultimately fatal disease	473	58.14 (53.55–62.63)	
Rapidly fatal disease	132	62.88 (54.04–71.12)	
Unknown	266	48.50 (42.35–54.68)	
Surgery since admission			NS
No surgery	1919	46.85 (44.59–49.11)	
Minimally invasive/non-NHSN surgery	170	52.94 (45.15–60.63)	
NHSN surgery	521	48.56 (44.19–52.95)	
Unknown	43	30.23 (17.18–46.13)	
Central vascular catheter			0.000
No	2069	42.63 (40.49–44.79)	
Yes	557	65.89 (61.79–69.82)	
Unknown	27	22.22 (8.62–42.26)	
Urinary catheter			0.000
No	1616	37.19 (34.83–39.60)	
Yes	1012	64.43 (61.39–67.38)	
Unknown	25	8.00 (0.98–26.03)	
Intubation			0.000
No	2526	46.56 (44.60–48.52)	
Yes	102	73.53 (63.87–81.78)	
Unknown	25	16.00 (4.54–36.08)	
No. of devices			0.000
0	1437	33.82 (31.37–36.33)	
1	834	60.43 (57.02–63.77)	
2	297	69.02 (63.43–74.24)	
3	81	74.07 (63.14–83.18)	
Antibiotic therapy		% of patients	
No	1394	52.54 (50.62–54.46)	
Yes	1255	47.30 (45.39–49.23)	
Missing	4	0.15 (0.04–0.39)	

Table III (*continued*)

Variable	No.	% with antibiotic	*P*
HAI			0.000
No	2449	43.60 (41.62–45.59)	
Yes	197	94.42 (90.23–97.18)	
Missing	7		–
AST//hospital			0.000
AST 1	565	59.12 (54.93–63.20)	
AST 2	395	42.28 (37.35–47.32)	
AST 3	328	44.21 (38.75–49.77)	
AST 4	200	47.50 (40.41–54.66)	
AST 5	352	48.01 (42.69–53.37)	
AOU delle Marche	681	41.85 (38.11–45.66)	
INRCA	132	46.21 (37.50–55.10)	
Alcohol hand-rub consumption		% with antibiotic	0.000
<10 L/year	144	31.25 (23.79–39.50)	
10–19 L/year	391	53.96 (48.88–58.99)	
>19 L/year	1750	48.00 (45.64–50.37)	
Missing	368	43.21 (38.08–48.44)	–
IPC personnel			0.001
0	760	47.76 (44.16–51.38)	
>0 and <4.61	1545	49.58 (47.06–52.10)	
>4.61	180	34.44 (27.53–41.88)	
Missing	168	38.10 (27.53–41.88)	–
IPC plan			NS
Yes	2277	47.96 (45.89–50.03)	
No	208	47.60 (40.65–54.62)	
Missing	168	38.10 (30.72–45.89)	–
Hospital type			0.006
Primary	36	47.22 (30.41–64.51)	
Secondary	1800	49.61 (47.28–51.95)	
Tertiary	681	41.70 (37.97–45.51)	
Specialized	132	46.21 (37.50–55.10)	
Specialty			0.000
Medicine	1325	53.36 (50.63–56.07)	
Surgery	618	46.76 (42.77–50.79)	
Intensive care	172	56.40 (48.64–63.93)	
Paediatrics	115	31.30 (22.98–40.62)	
Psychiatry	108	2.78 (0.58–7.90)	
Obstetrics and gynaecology	155	32.26 (24.98–40.23)	
Long term care	28	39.29 (21.50–59.42)	
Rehabilitation	43	11.63 (3.89–25.08)	
Geriatrics	79	65.82 (54.29–76.13)	
Missing	10	50.00 (18.71–81.29)	–
Hospital size			0.000
<300	1382	46.31 (43.65–48.98)	
300–600	422	63.27 (58.47–67.88)	
>600	681	41.70 (37.97–45.51)	
Missing	168	38.10 (30.72–45.89)	–

CI, confidence interval; NS, non-significant; NHSN, National Health Surveillance Network; AST, Azienda Sanitaria Territoriale; AOU, Azienda Ospedaliero-Universitaria; INRCA, Istituto Nazionale Ricovero e Cura Anziani; IPC, infection prevention and control.

is still the most represented micro-organism (11.7% in 2016 vs 15.58% in 2022); both *P. aeruginosa* and *K. pneumoniae* remained stable (9.4% in 2016 vs 9.74% in 2022 and 7.8% in 2016 vs 7.79% in 2022 respectively), *A. baumannii* experienced a substantial increase in circulation (1.6% in 2016 vs 7.79% in 2022).

Table IV
Multilevel regression analysis (antibiotics)

Variable	OR	95% CI	*P*
Male	1.41	1.16–1.72	0.001
Age (years)			
15–44	1.21	0.59–2.48	NS
45–64	1.01	0.52–1.94	NS
65–74	0.75	0.38–1.46	NS
75–84	0.82	0.42–1.59	NS
≥85	1.07	0.54–2.14	NS
Length of hospital stay (admission-survey)			
4–7	0.96	0.75–1.22	NS
8–14	0.95	0.72–1.25	NS
>14	0.38	0.28–0.53	0.000
McCabe score			
Ultimately fatal disease	1.08	0.83–1.41	NS
Rapidly fatal disease	0.94	0.59–1.49	NS
Unknown	2.04	1.27–3.27	0.003
Surgery since admission			
Minimally invasive/non-NHSN surgery	1.08	1.12–2.77	0.014
NHSN surgery	0.98	0.70–1.37	NS
Unknown	1.37	0.31–6.05	NS
Central vascular catheter			
Yes	1.63	0.82–3.21	NS
Urinary catheter			
Yes	1.52	0.77–3.02	NS
Intubation			
Yes	2.08	0.62–6.95	NS
Number of devices			
1	1.46	0.744–2.87	NS
2	1.23	0.34–4.42	NS
3	1.00		
HAI			
Yes	33.12	16.04–68.39	0.000
Alcohol hand rub consumption			
10–19 L/year	23.28	5.69–95.26	0.000
>19 L/year	12.75	3.00–54.14	0.001
IPC personnel			
>0 and <4.61	1.32	0.94–1.86	NS
>4.61	6.69	1.73–25.92	0.006
IPC plan			
Yes	1.02	0.57–1.83	NS
Hospital type			
Secondary	1.00	0.48–2.09	NS
Tertiary	0.73	0.34–1.57	NS
Specialized	1.00		
Specialty			
Surgery	0.89	0.64–1.24	NS
Intensive care	0.68	0.41–1.13	NS
Paediatrics	0.65	0.29–1.41	NS
Psychiatry	0.04	0.01–0.16	0.000
Obstetrics and gynaecology	0.75	0.42–1.31	NS
Long-term care	0.90	0.36–2.24	NS
Rehabilitation	0.06	0.01–0.26	0.000
Geriatrics	2.03	1.11–3.70	0.022

(*continued on next page*)

Table IV (*continued*)

Variable	OR	95% CI	*P*
Hospital size			
300–600	1.51	1.09–2.09	0.012
>600	1.00		

OR, odds ratio; CI, confidence interval; NS, non-significant; HAI, healthcare-associated infection; NHSN, National Health Surveillance Network; IPC, infection prevention and control.

The percentage of patients who were taking at least one antibiotic at the time of the survey was 47.30%, a finding that is in line with the regional data from the last study, which recorded 44.6% use (internal data); the most frequently used route of administration is confirmed to be parenteral.

Looking at European data, among all patients, 32.9% received at least one antimicrobial agent, most (72.8%) administered parenterally [26,27].

The two most frequently administered antimicrobial classes continue to be penicillins and enzyme combinations and third-generation cephalosporins, although fluoroquinolones, which were used in 16.1% of cases in 2016, have been replaced by carbapenems (11.23%).

Among all the antimicrobial prescriptions used for the treatment of HAIs, combination of penicillins with β-lactamase inhibitors was the antimicrobial agent most commonly used (19.8%) followed by carbapenems (9.9%) and fluoroquinolones (9.4%); for the treatment of community-acquired infections, the three antimicrobial agents most commonly prescribed were combinations of penicillins and β-lactamase inhibitors (23.2%) followed by third-generation cephalosporins (11.7%) and fluoroquinolones (11.1%) [25].

It is of note that some data were consistently missing; we should underline the data concerning alcohol hand rub – a critical item in Italy – due to the historically low level of hand hygiene utilization according to previous surveillance data and the efforts made to ameliorate it, and the possibility of an underestimation of alcohol hand-rub utilization in the Italian context due to the lack of accurate data [28,29]. This phenomenon may be clarified thanks to the introduction of a national alcohol hand-rub monitoring system, which is an ongoing effort by our National Institute of Health [30]. The need for standardization of alcohol hand-rub consumption is a recommendation based on the 2011–2012 ECDC PPS results [31]. On the other hand, more than 10% of McCabe scores were missing; despite its importance as a marker of comorbidity in HAI PPSs, the McCabe test is difficult to assess, as previously recorded [32].

The strengths of our study include being able to involve all acute care hospitals throughout the Marche region, making use of appropriately trained staff, often part of infection control teams, and using a codified ECDC protocol. On the other hand, we recognize the limitations of a prevalence study that may underestimate HAI prevalence compared to a longitudinal one. Moreover, defined daily dose or antibiotic days of therapy could not be calculated because no additional information on antibiotic therapy was collected according to the ECDC protocol, either regarding dose or duration.

In conclusion, this PPS provided valuable information on the prevalence of HAIs and antimicrobial consumption in acute care hospitals of the Marche Region. The high prevalence of HAIs in acute care hospitals, especially in intensive care units, highlights the need for improved infection control measures. Preventing and controlling HAIs and AMR will not only improve patient outcomes but it will also preserve the long-term effectiveness of antibiotics and protect our ability to treat infections in the future. Health professionals must strictly collaborate with policy-makers and institutions both at regional and national level, implementing a real one-health approach aimed to improve actions against HAIs and AMR.

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