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Monitoring healthcare-associated infections and antimicrobial use at regional level through repeated point prevalence surveys: what can be learnt?

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SUMMARY

Background: Healthcare-associated infections (HAIs) surveillance is an essential part of any infection prevention and control programme. Repeated point prevalence surveys (PPSs) according to European Centre for Disease Prevention and Control (ECDC) protocol have been implemented in all Friuli Venezia Giulia (FVG) region (Italy) acute hospitals to reduce and control HAIs.

Aim: Using the repeated PPSs within a regional-healthcare system (RHS) to promote and evaluate infection prevention and control (IPC) programmes.

Methods: The standard versions of the ECDC PPS protocols were used in all four surveys (2011, 2013, 2015, 2017). All RHS public and private accredited hospitals were involved within the 'safe care network' programme.

Findings: The numbers of surveyed patients in the four PPSs were 3172, 3253, 2969 and 3036, respectively. Prevalence of HAIs and antimicrobial use (AU) decreased significantly from 2011: HAIs ($P<0.05$) 7.1%, 6.3%, 5.5%, 5.8% and AU ($P<0.01$) 40.4%, 39.2%, 36.0%, 37.2%, respectively. The appropriateness of duration of surgical prophylaxis increased significantly (<24 h increased through surveys related to one in 2011: odds ratio (OR), 95% confidence interval (CI) 1.29, 0.92–1.81; 1.95, 1.31–2.91; 1.78, 1.20–2.64, respectively). The most frequently detected HAIs were: bloodstream, urinary tract, pneumonia and surgical site (more than the 70% of HAIs in each PPS).

Conclusion: The FVG regional approach to HAIs and AU surveillance was able to contribute to reduce prevalence over a 7-year period. Furthermore, it was able to keep hospital attention on HAIs and AU through the years and to guarantee a standardized and comparable evaluation of HAIs and AU burden in all RHS hospitals, as well as impacting on HAIs and AU regional programmes.

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Introduction

Healthcare-associated infections (HAIs) surveillance and sharing of its data remain key issues for infection prevention and control (IPC) programmes, as proved since 1985 by SENIC [1,2] and following studies such as KISS [3], and also confirmed by recent reviews [4,5]. At the same time the increasing relevance of multi-drug-resistant (MDR) pathogens [6–12] stressed the urgency for the appropriate use of antimicrobials worldwide [13]. These were included in the European Council recommendations 2009/C 151/01 of 9th June 2009 'on patient safety, including the prevention and control of healthcare-associated infections' [14] and antimicrobial stewardship (AMS) [15].

Within this framework the European Centre for Disease Prevention and Control (ECDC), within the 'Antimicrobial resistance and healthcare-associated infection' [16] programme, developed and implemented multiple surveillance networks including, starting from 2011–2012, the point prevalence survey (PPS) for the detection of HAIs and antimicrobial use (AU) in acute hospitals [17]. This PPS included only a sample of hospitals for each country in order to have comparable data.

HAIs prevalence studies have a long tradition, even though they periodically suffer from lack of emphasis. Since the 1980s they have been used to estimate the global burden of HAIs and, when used repeatedly, to evaluate at country level the impact of HAIs control programmes [18]. Compared to incidence studies that require many more resources, PPSs allow researchers to survey larger numbers of hospitals, even when human resources are limited. To partially control the existing gap with incidence studies, which remain a reference for HAIs description and understanding, they can be repeated at defined intervals [19].

Regional administrations, especially in larger European countries with decentralized healthcare systems, play a relevant role in running HAIs prevention and control programmes including surveillance activities [20]. Using the ECDC PPS in a repeated region-wide approach could be helpful to understand its possible impact on the IPC programmes.

The aim was to use the repeated PPS within the regional healthcare system (RHS) to sustain and evaluate IPC programmes; this paper reports the results of the four PPSs conducted every 2 years in the Friuli Venezia Giulia (FVG) hospitals.

Table I
Patients characteristics stratified by point prevalence survey year

Characteristics		2011 (patients *N*=3172)		2013 (patients *N*=3253)		2015 (patients *N*=2969)		2017 (patients *N*=3036)	
		N	%	*N*	%	*N*	%	*N*	%
Age	0–17	179	5.6%	191	5.9%	193	6.5%	161	5.3%
	18–64	983	31.0%	941	28.9%	874	29.4%	868	28.6%
	65 or more	2001	63.1%	2108	64.8%	1899	64.0%	1991	65.6%
	Missing/unknown	9	0.3%	13	0.4%	3	0.1%	16	0.5%
Gender	Female	1659	52.3%	1720	52.9%	1564	52.7%	1484	48.9%
	Male	1479	46.6%	1505	46.3%	1402	47.2%	1549	51.0%
	Missing/unknown	34	1.1%	28	0.9%	3	0.1%	3	0.1%
Type of hospital	Hub/specialized	2059	64.9%	2021	62.1%	1849	62.3%	1844	60.7%
	Spoke	1113	35.1%	1232	37.9%	1120	37.7%	1192	39.3%
Surgery during admission	None	2115	66.7%	2219	68.2%	2043	68.8%	2115	69.7%
	Non-NHSN	259	8.2%	261	8.0%	255	8.6%	232	7.6%
	NHSN	762	24.0%	751	23.1%	665	22.4%	674	22.2%
	Missing/unknown	36	1.1%	22	0.7%	6	0.2%	15	0.5%
McCabe score[a]	Non-fatal	2622	82.7%	2510	77.2%	2360	79.5%	2480	81.7%
	Fatal	345	10.9%	434	13.3%	382	12.9%	317	10.4%
	Progressively fatal	158	5.0%	265	8.1%	206	6.9%	196	6.5%
	Missing/unknown	47	1.5%	44	1.4%	21	0.7%	43	1.4%
Presence of CVC	No	2829	89.2%	2902	89.2%	2606	87.8%	2686	88.5%
	Yes	327	10.3%	341	10.5%	362	12.2%	342	11.3%
	Missing/unknown	16	0.5%	10	0.3%	1	0.0%	8	0.3%
Presence of PVC	No	1114	35.1%	1191	36.6%	1048	35.3%	1006	33.1%
	Yes	2039	64.3%	2049	63.0%	1919	64.6%	2027	66.8%
	Missing/unknown	19	0.6%	13	0.4%	2	0.1%	3	0.1%
Presence of UC	No	2467	77.8%	2547	78.3%	2345	79.0%	2457	80.9%
	Yes	689	21.7%	695	21.4%	620	20.9%	576	19.0%
	Missing/unknown	16	0.5%	11	0.3%	4	0.1%	3	0.1%
Presence of intubation	No	3084	97.2%	3176	97.6%	2882	97.1%	2975	98.0%
	Yes	64	2.0%	60	1.8%	85	2.9%	55	1.8%
	Missing/unknown	24	0.8%	17	0.5%	2	0.1%	6	0.2%

CVC, central venous catheter; NHSN, National Healthcare Safety Network; PVC, peripheral venous catheter; UC, urinary catheter.
[a] Classification of the severity of underlying medical conditions: non-fatal disease (expected survival at least five years), ultimately fatal disease (expected survival between one and five years), rapidly fatal disease (expected death within one year) [21,22].

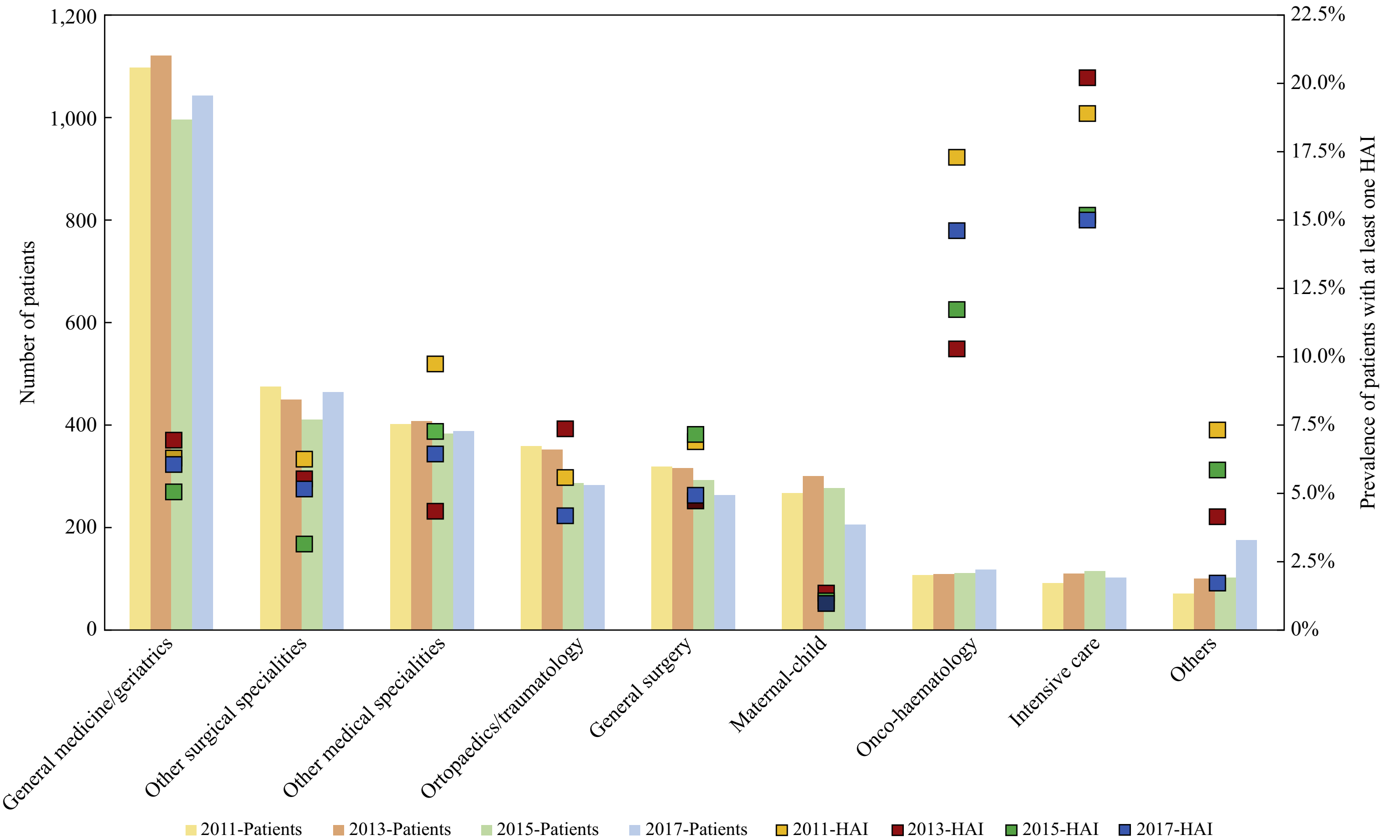

Figure 1. Number of involved patients stratified by clinical area and point prevalence survey year and related prevalence of patients with at least one healthcare-associated infection (HAI).

Methods

FVG RHS in 2011 decided to introduce a regional shared and time-structured approach for measuring and evaluating HAIs. Considering the necessity to apply a feasible and repeatable tool in all the regional hospitals, it was decided to adopt a prevalence methodology. In this context, this project was started in October 2011 adopting the protocol provided by ECDC for the first European survey [21], and the subsequent surveys were planned every 2 years for the same month in order to reduce seasonal bias.

All the definitions included in the PPS patient-based protocol provided by ECDC were used; the 4.3 version [21] was used in 2011, 2013 and 2015, while in 2017 the adopted version was the 5.3 [22] in accordance with the ECDC update.

All acute-care hospitals of FVG RHS were involved in the programme as part of the goals set up every year from the regional health authority: 14 public hospitals and five private accredited ones. Sixteen facilities (13 public and three private) carried out all the four PPSs. Two small private hospitals (about 190 total beds) that did not participate in all surveys and a small public hospital (80 beds) which in 2016 was reconverted into a long-term care facility were excluded. For the analysis the 16 hospitals were divided into two groups: hub/specialized, composed of three hubs (anchor hospitals which offer a full array of services), and two specialized structures (oncology and maternal—child care), and the spoke group, which is formed of the other 11 hospitals of the RHS network [23].

Each participating hospital identified a number of data collectors (nurses or physicians) actively engaged in IPC activities, who were specifically trained through a one-day course run one month before (September) each survey; about 100 professionals were included through the years. The standardized course included the explanation of the survey methodologies and the simulation of specific cases to better clarify the protocol criteria. A centralized coordinating team was constantly available (by e-mail and telephone) to support data collectors with any doubts; this team was also responsible for regional data validation and analysis. Surveyors received the ECDC protocol Italian version and the database designed in EpiInfo3™ (2011, 2013) and EpiInfo7™ (2015, 2017) format.

In accordance with with ECDC PPS protocols [21,22] each single ward evaluation was carried out in a single day, each hospital completed the database and then sent it to the regional team who checked and validated all data asking hospital teams for further details where needed.

All data were managed confidentiality, patient identifiers were anonymous at the level of database and analysis; the surveys were included in the yearly goals for hospital chief executive officers (CEOs) as a part of the RHS programme for IPC and AMS carried out by the 'safe-care network' regional team [24].

Statistical analysis included Chi-squared test, Shapiro—Wilk test, Kruskal—Wallis test and Chi-squared test for trend accepting a P-value <0.05. IBM© SPSS© version 20 was used for data analysis.

Results

The numbers of patients involved in the four PPSs were 3172, 3253, 2969 and 3036, respectively; in each survey the majority of them were hospitalized in a hub/specialized structure (64.9%, 62.1%, 62.3% and 60.7%).

Table I summarizes the main characteristics of the population stratified by survey. The mean age and SD in the four PPSs was 65.0±22.8, 65.7±23.2, 64.8±23.6 and 66.3±22.5, respectively. This characteristic for the whole population and for males changes significantly ($P<0.05$) in the surveys; on the contrary for females it remains homogeneous. The majority of the patients, almost two out of three, (over 60%) were 65 years or older.

About half of surveyed patients in each PPS were hospitalized in a medical ward and especially in general medicine/geriatrics (almost 35%, Figure 1). The length of stay in the four PPSs was 10.6±13.4, 11.3±12.9, 10.3±14.8 and 10.7±15.3, respectively, significantly higher ($P<0.05$) in 2013.

HAIs

Table II reports the prevalence of patients with at least one HAI; there was a decreasing trend ($P<0.05$) from 2011 (7.1%) to 2017 (5.8%), with a slight increase in 2017 with respect to 2015. In hub/specialized structures, the HAIs prevalence in the four surveys was 8.2% (168/2,059), 6.5% (132/2021), 5.9% (109/1,849) and 6.6% (121/1,844), respectively, while in spoke ones was always lower: 5.0% (56/1,113), 5.8% (72/1,232), 4.9% (55/1,120) and 4.5% (54/1,192). Figure 1 shows the biyearly HAI prevalence by clinical area and PPS year.

Table III shows the prevalence (standardized for 100 patients) of the HAI types in the four surveys and Figure 2 the main HAIs stratified for PPS and department: urinary tract infections (UTIs) decreased while bloodstream infections (BSIs) increased to become, in the last PPS, the most common cause of HAIs together with pneumonia. In particular, the 2017 BSI increase with respect to 2015 occurred mainly in hub/specialized hospitals (0.92 in 2015 and 1.63 × 100 patients in 2017) compared to spokes (0.54 and 0.76 × 100 patients, respectively). In the hub/specialized hospitals the presence of a venous catheter increased significantly over time since 2011 both for central venous catheter (CVC) (267/2046, 254/2015, 295/1848 and 277/1840 with $P<0.05$, odds ratio (OR), 95% confidence interval (CI) 0.96, 0.80–1.16; 1.27, 1.06–1.51; 1.18, 0.99–1.42 in 2013, 2015 and 2017, respectively) and for peripheral venous catheter (PVC) (1298/2043, 1260/2014, 1221/1847 and 1254/1842 with $P<0.01$, OR, 95% CI 0.96, 0.84–1.09; 1.12, 0.98–1.28; 1.22, 1.07–1.40 in 2013, 2015 and 2017, respectively). This trend was not found in spoke hospitals.

In 2011 most of the patients (93.0%, 227/244) had only one HAI, 5.3% (13/244) two and 1.7% (4/244) three: 92.6% (189/204) had one HAI and 7.4% (15/204) two in 2013, 95.7% (157/164) had one HAI and 4.3% (7/164) two in 2015 and 95.4% (167/175) had one HAI and 4.6% (8/175) two in 2017.

Concerning surgical site infections (SSIs), the majority of these were organ/space 43.0% (55/128) followed by deep 31.3% (40/128) and superficial 25.8% (33/128).

The number of microorganisms detected in the four surveys was 516 and were isolated from 444 HAIs. *Escherichia coli* was the most prevalent 21.3% (110/516; 23.0%: 43/187, 14.5%: 20/138, 32.6%: 30/92 and 17.2%: 17/99 in the four surveys, respectively) followed by: *Staphylococcus aureus* 10.5% (54/516), *Enterococcus faecalis* 9.9% (51/516), *Pseudomonas aeruginosa* 9.3% (48/516), *Staphylococcus epidermidis* 7.8% (40/516), *Klebsiella pneumoniae* 7.4% (38/516) and *Clostridium difficile* 5.2% (27/516).

AU

Table II shows the prevalence of patients who received at least one antimicrobial agent and the trend that showed a significant ($P<0.01$) decrease from 40.4% in 2011 to 37.2% 2017. In hub/specialized hospitals the AU prevalence was 42.2% (869/2,059), 39.6% (800/2,021), 37.9% (701/1,849) and 39.2% (723/1,844) in the four surveys, respectively, while in spoke hospitals it was 37.1% (413/1,113), 38.6% (476/1232), 32.9% (368/1,120) and 34.1% (406/1,192).

Table IV summarizes the antimicrobial indication for use, the most frequent reason in each of the four surveys was 'treatment of infection'. There was an improving trend ($P<0.01$) in the management of the duration of surgical prophylaxis: single dose and prophylaxis less than 24 h increased their prevalence in 2013, 2015 and 2017 related to 2011 (OR, 95% CI: 1.29, 0.92–1.81; 1.95, 1.31–2.91; 1.78, 1.20–2.64, respectively).

The most used antimicrobials for the treatment of infections are summarized in Table V. The prescription of piperacillin+tazobactam (OR, 95% CI: 1.40, 1.08–1.81; 1.53, 1.18–2.00; 2.09 1.63–2.67) and amoxicillin+clavulanate (OR, 95% CI: 1.05, 0.80–1.38; 1.16, 0.88–1.52; 1.57, 1.21–2.02) grew significantly ($P<0.01$) while use of levofloxacin ($P<0.01$; OR, 95% CI: 0.91, 0.72–1.15; 0.63, 0.49–0.82; 0.29, 0.21–0.39) and ciprofloxacin ($P<0.05$; OR, 95% CI: 0.98, 0.67–1.42; 1.03, 0.70–1.52; 0.55, 0.35–0.84) decreased significantly.

Table II
Prevalence of antimicrobial use and healthcare-associated infections in the four surveys

PPS	No. of patients	Antimicrobial use					Healthcare-associated infection				
		Yes		Chi-squared test for trend			Yes		Chi-squared test for trend		
		N	%	OR	95% CI		*N*	%	OR	95% CI	
2011	3172	1282	40.4%	1.00	—	$P<0.01$	224	7.1%	1.00	—	$P<0.05$
2013	3253	1276	39.2%	0.95	0.86–1.05		204	6.3%	0.88	0.72–1.07	
2015	2969	1069	36.0%	0.83	0.75–0.92		164	5.5%	0.77	0.63–0.95	
2017	3036	1129	37.2%	0.87	0.79–0.97		175	5.8%	0.81	0.66–0.99	

CI, confidence interval; OR, odds ratio.

Table III
Prevalence × 100 inpatients stratified by typology and point prevalence survey year

Type of infections	Point prevalence survey year							
	2011		2013		2015		2017	
	N	× 100 patients	*N*	× 100 patients	*N*	× 100 patients	*N*	× 100 patients
Urinary tract	59	1.9	52	1.6	36	1.2	28	0.9
Pneumonia	49	1.5	54	1.7	43	1.4	40	1.3
Surgical site	42	1.3	27	0.8	26	0.9	33	1.1
Bloodstream include CVC/PVC related	28	0.9	32	1.0	23	0.8	39	1.3
Gastrointestinal	15	0.5	15	0.5	12	0.4	10	0.3
Skin and soft tissue	14	0.4	2	0.1	6	0.2	2	0.1
Eye, ears, nose, throat	12	0.4	5	0.2	3	0.1	2	0.1
Treated unidentified severe infection	8	0.3	14	0.4	9	0.3	15	0.5
Cardiovascular	8	0.3	4	0.1	3	0.1	3	0.1
Vascular catheter (excluded bloodstream)	2	0.1	4	0.1	2	0.1	1	0.0
Lower respiratory tract	5	0.2	5	0.2	2	0.1	2	0.1
Bone and joint	1	0.0	3	0.1	3."	0.1	2	0.1
Reproductive tract	1	0.0	0	0.0	0	0.0	1	0.0
Central nervous system	1	0.0	1	0.0	0	0.0	0	0.0
Missing	0	0.0	1	0.0	3	0.1	5	0.2
Total	**245**	**7.7**	**219**	**6.7**	**171**	**5.8**	**183**	**6.0**

Discussion

Running a PPS every two years since 2011 guaranteed a general picture of HAIs and AU evolution in the FVG region; this approach reinforced the FVG RHS acute hospitals' attention to IPC and AU in a standardized way, as surveillance is one of the World Health Organization (WHO) -recommended core components of such programmes [5]. Furthermore, repeated PPSs complemented the yearly regional goals on IPC.

In addition, the training courses, repeated six times over the years and targeted at nurses and doctors (about 100 in the six events) engaged in IPC activities, could have contributed to

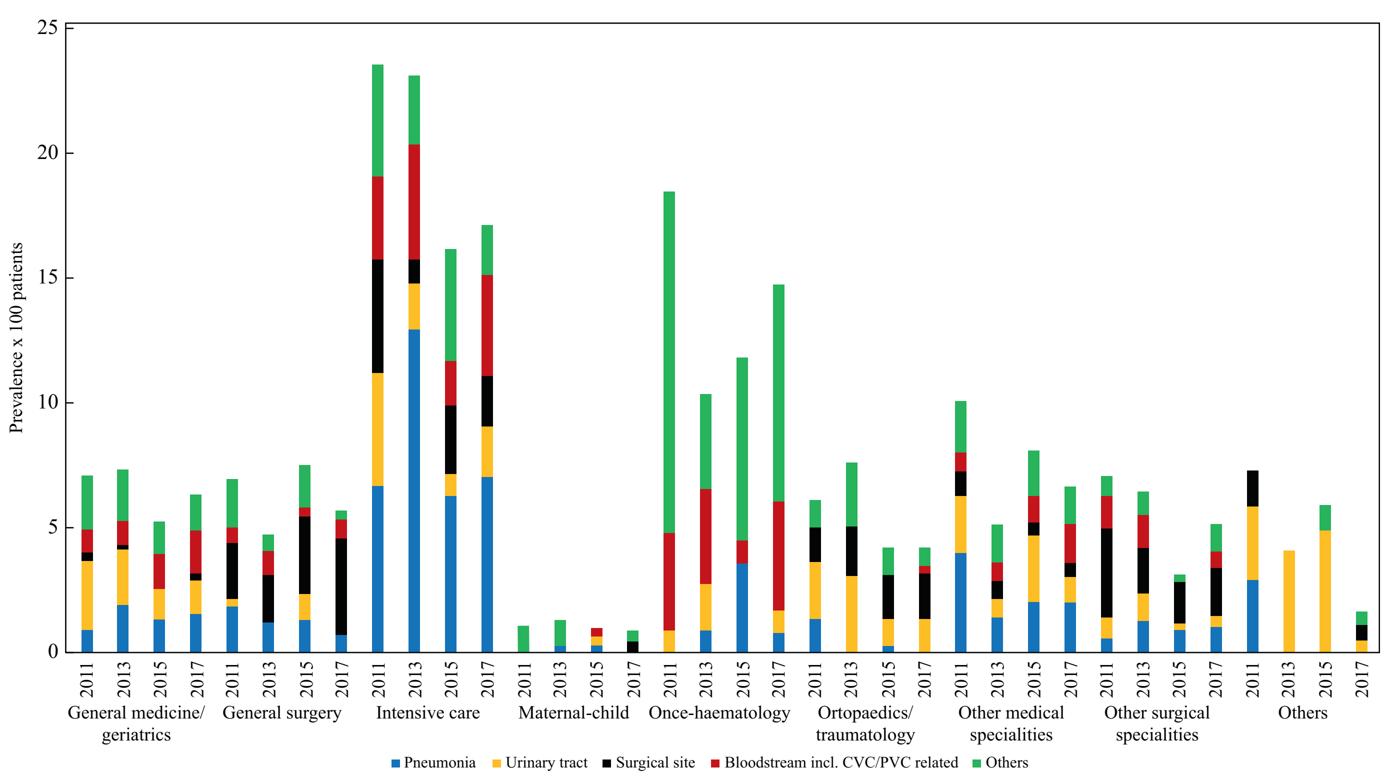

Figure 2. Prevalence per 100 patients for the main healthcare-associated infections, stratified for point prevalence survey years and department.

Table IV
Reasons for antimicrobial use in the four surveys (categories according to ECDC point prevalence survey protocol)

	Point prevalence survey year							
	2011		2013		2015		2017	
	N	%	*N*	%	*N*	%	*N*	%
Infection	**999**	**58.9%**	**1073**	**64.1%**	**903**	**64.7%**	**1034**	**68.4%**
Community	622	62.3%	704	65.6%	596	66.0%	699	67.6%
Hospital	332	33.2%	320	29.8%	268	29.7%	294	28.4%
Long term	45	4.5%	49	4.6%	39	4.3%	41	4.0%
Medical prophylaxis	**321**	**18.9%**	**228**	**13.6%**	**248**	**17.8%**	**188**	**12.4%**
Surgical prophylaxis	**298**	**17.6%**	**265**	**15.8%**	**178**	**12.8%**	**173**	**11.4%**
Single	142	47.7%	135	50.9%	106	59.6%	107	61.8%
≤24 h	25	8.4%	30	11.3%	21	11.8%	13	7.5%
>24 h	131	44.0%	100	37.7%	51	28.7%	53	30.6%
Not identified (Unknown reason, verified during PPS)	**9**	**0.5%**	**79**	**4.7%**	**29**	**2.1%**	**62**	**4.1%**
Missing	**19**	**1.1%**	**4**	**0.2%**	**9**	**0.6%**	**22**	**1.5%**
Other use	**49**	**2.9%**	**26**	**1.6%**	**28**	**2.0%**	**32**	**2.1%**
Total	**1695**	**100%**	**1675**	**100%**	**1395**	**100%**	**1511**	**100%**

sharing and refreshing of knowledge on HAIs surveillance as well as on IPC international standards and hopefully increased the sense of belonging to a regional community of practice.

The use of a European protocol (ECDC PPS) in all the RHS hospitals allowed us to provide a standardized benchmark both among regional hospitals and with Italian and European ones, as well as the possibility of showing trends within the same hospital. These are essential requirements for addressing HAIs and antimicrobial resistance: in fact, measuring and comparing outcomes are necessary steps to evaluate the impact of improvement activities [4].

This regional approach, which includes yearly HAIs and AU goals for CEOs, has allowed us to define priorities and to focus attention on specific topics; after each PPS all hospitals were requested to analyse, discuss and spread the results both at regional, hospital and single-ward levels. Furthermore, the PPSs aggregated data were made available in the regional website to all those interested [24].

Thus, based on data, both the regional team and hospital infection control teams evaluated the global impact of planned activities and set up further steps and interventions to improve hospital performance and to support specific awareness and knowledge among healthcare professionals. In particular, following the first survey, bundles for the prevention of some HAIs (insertion and management of venous and urinary catheters, SSI) were introduced and for 2018 it was decided to set up a surveillance for SSI in the general surgery wards to better evaluate the burden of this topic.

HAIs prevalence in FVG decreased compared to the starting value (2011) and in particular, in the last two surveys, never exceeded the European results (6%) of the 2011–12 ECDC survey [17]. The slight increase in the 2017 prevalence was sustained mainly by onco-haematology and surgical specialities; this data should be analysed in depth especially in the specialized surgical structure. In fact, while in the most common type of ward the rise was mainly related to BSI-prevalence (trend that was present in all the structures), the specialized surgeries showed an increase in all types of infections and a different trend compared to other surgical wards. Otherwise traditionally at-risk specialities kept the infection prevalence stable such as intensive care unit (ICU), general surgery, orthopaedics/traumatology. The number of patients with only one HAI increased through the years to more than 95% and this could be considered a positive trend as well.

AU decreased from 2011 (40.4%), especially in 2015 (36.0%) with a slight rebound in 2017 (37.2%). This positive trend could be related to the introduction in 2014 of the regional AMS programme [24]. This hypothesis could also be sustained by results of the yearly monitoring of defined daily dose (DDD) × 100 patients in FVG hospitals which decreased from 102.1 in 2012 to 99.4 [25] in 2017 and in particular for data about fluoroquinolones consumption which had been the subject of regional policies [26] to promote their decrease: their reduction was confirmed both in PPSs data and in DDD yearly monitoring (from 17.6 in 2012 to 12.9 in 2017) [27]. Comparing AU PPS results to the national one (44%) [17] FVG performed better, but when compared to European results (35%) [17] there is still room for improvement.

Prevalence of HAIs and AU, as reported in the literature [20], was in each PPS higher in hub/specialized hospitals than in spoke ones; this is probably related to the presence of high-risk wards in the hub/specialized hospitals as well as to their intrinsic function that often leads to admission of the most complicated cases.

The most prevalent HAIs were similar to European data: pneumonia, SSI, UTI and BSI together were responsible for more than 70% of cases [27]. HAIs were more prevalent in departments where patients are more fragile such as ICU and onco-haematology [20,28,29]. Furthermore, BSI in 2017 increased in almost all the clinical areas in hub/specialized hospitals where they almost doubled the 2015 results. This topic will have to be analysed in depth for the impact that these types of infections have on patients; an aspect from which to start should be the management of venous catheters, both CVC and PVC, that has demonstrated through the years an increase in the hub/specialized structures, in particular for PVC which was constantly higher than national

Table V
Most used antimicrobials for treatment of infections

Antibiotic	PPS year									
	2011 (*N*=999)		2013 (*N*=1073)		2015 (*N*=903)		2017 (*N*=1034)		Total (*N*=4009)	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%
Piperacillin + tazobactam	114	11.4	164	15.3	149	16.5	219	21.2	646	16.1
Amoxicillin + clavulanate	113	11.3	127	11.8	116	12.8	172	16.6	528	13.2
Levofloxacin	172	17.2	171	15.9	105	11.6	58	5.6	506	12.6
Ceftriaxone	62	6.2	75	7.0	66	7.3	84	8.1	287	7.2
Ciprofloxacin	57	5.7	60	5.6	53	5.9	33	3.2	203	5.1
Meropenem	41	4.1	40	3.7	47	5.2	54	5.2	182	4.5
Vancomycin	41	4.1	41	3.8	34	3.8	49	4.7	165	4.1
Clarithromycin	19	1.6	35	3.3	36	4.0	29	2.8	119	3.0
Cefotaxime	26	2.6	43	4.0	20	2.2	20	1.9	109	2.7
Ceftazidime	36	3.6	25	2.3	22	2.4	19	1.8	102	2.5

and European ones (FVG 66.8%, Italy 56.0%, Europe 46.7%) [17], while other devices were around half the level between the European (lower: CVC 7.6%, CU 17.2%, intubation 2.3%) and the Italian ones (higher: CVC 12.1%, CU 24.7%, intubation 3.0%) [17].

Although antibiotic prophylaxis showed an improvement over the years in terms of duration less than 24 h (from 56.1% in 2011 to 71.4% in 2017) there is still room for improvement: each regional hospital has a protocol for surgical prophylaxis and the compliance to it should be sustained and increased, also considering the importance for SSI prevention that this activity takes on [29,30].

The FVG regional approach has some limitations mainly due to prevalence methodology. The emerged 'pictures' could be influenced by concurrent outbreaks or epidemic events. Nevertheless, this approach based on bi-yearly surveys can guarantee a benchmark and give to the single hospital the opportunity to further investigate data that exceeded the expected prevalence. A further possible limitation is the number of surveyors involved in collecting data and the fact that they acted only within their own organization: this could increase the heterogeneity of protocol interpretation. Nevertheless, the repeated regional training courses, their constant engagement in IPC activities and presence of the regional team for PPS support could have contributed to minimizing this possible bias.

The application over seven years of PPS within a regional programme for patient safety has been shown to be able to significantly reduce HAIs and AU in all acute hospitals of FVG RHS.

These data potentially stress the relevance of the regional authorities' engagement in promoting IPC programmes and homogeneous patient safety standards, especially in those countries where healthcare is partially or totally decentralized.

Furthermore, this region-wide approach supported the provision to hospital managers and IPC professionals comparable data so that priorities and continuous improvement approaches could be implemented both at local and regional level.

Finally, the number of professionals engaged along such a span of time, despite giving possible bias, could guarantee a strong commitment to IPC programmes and possibly a sense of belonging.

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None declared.

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Appendix A

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