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Healthcare-associated infections point prevalence survey and antimicrobials use in acute care hospitals (PPS 2016–2017) and long-term care facilities (HALT-3): a comprehensive report of the first experience in Molise Region, Central Italy, and targeted intervention strategies

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ABSTRACT

Background: Healthcare associated infections (HAIs) are a major public health concern both in acute hospitals and long-term care facilities (LTCFs), considering the clinical presentations and related costs. The study describes the first regional experience on HAIs and antimicrobials consumption obtained through point prevalence survey (PPS) 2016–2017 in the "Antonio Cardarelli" acute hospital, and in the LTCF of Larino municipality (Healthcare-associated infections and Antimicrobial use in European Long-Term care facilities, HALT-3) of Molise Region, Central Italy, both coordinated by the European Center for Disease Control (ECDC).

Methods: PPS was carried out during 24–26 November 2016, while HALT-3 on 29 June 2017. Standardized protocols and software provided by ECDC were used to collect facilities information, patients/residents, HAIs and antibiotic consumption data.

Results: An active HAI was found in 16 (7.1%) of 224 admitted patients in the acute hospital, and 50% occurred in a clinical specialty ward. Bundles, checklist for HAIs prevention and antimicrobial stewardship were lacking. Among 29 LTCF residents the HAIs prevalence was 3.4%. Surveillance programs for HAIs and antimicrobial stewardship strategy were not available.

Conclusion: The overall results identified the need and types of interventions to be implemented in both settings, either at organizational or individual level, to improve antibiotic prescription practice and limit risk factors involved in potentially preventable infections.

Introduction

Multiple risk factors for healthcare-associated infections (HAIs) have been reported, such as patient's age >65 years; intensive care unit (ICU) and emergency admission; hospital stay longer than seven days; placement of central venous catheter; indwelling urinary catheter and endotracheal tube [1,2]. Nowadays, HAIs represent one of the foremost public health concern globally, requiring specific interventions. Hence, understanding their burden is essential to develop proper control strategies, and the introduction of a national surveillance plan to reduce their incidence.

In Europe, about four million HAI cases and 37,000 related deaths occur annually, a proportion comparable to the victims who die each year in road traffic accidents [2,3]. Preventing HAIs does not only allow saving of medical costs [1,2], but can also reduce disability-adjusted life years.

Since 2008, the European Centre for Disease Prevention and Control (ECDC) has established the Healthcare-associated Infections Network for HAIs surveillance to coordinate Point Prevalence Surveys (PPSs) [3]. During 2011–2012, the first PPS has been carried out on HAIs and antimicrobial use in European acute care hospi-

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tals, and 15,000 HAIs were reported, with an estimated prevalence of 6.0% (6.3% in Italy). The second PPS in European acute hospitals, including for the first time the Molise Region, Central Italy, was completed in November 2017, and results divulgation is ongoing.

In European countries, elderly population is rapidly growing due to the combination of fertility declining and/or life expectancy rising [4]. Therefore, a greater proportion of population will be affected of chronic diseases, comorbidities and adverse events due to polytherapy [4]. In Italy, there is a similar trend, having the largest proportion of elderly population in Europe, a low fertility rates due to delay in transition to adulthood and difficult reconciliation of work and maternity for women [5]. Thus, considering the rise of non-self-sufficiency, residential care facilities play a crucial role in taking care of elderly patients.

Following the point prevalence survey on Healthcare-associated infections and Antimicrobial use in European Long-Term care facilities (HALT-1) in 2008, ECDC promoted a second survey (HALT-2) during April–May 2013 collecting data from 1,181 long-term care facilities (LTCFs) [6]. Italy participated to HALT-2 with 235 LTCFs, and HAIs prevalence and antibiotic use were of 3% and 4%, respectively [6]. On May 2015, ECDC launched the third project HALT-3 updating tools for the survey, and Italy participated during April–June 2017, including for the first time the Molise Region.

Hence, the main aim of this study is to describe results of the first regional experience obtained through PPS 2016–2017 and HALT-3, useful to complete the national and international epidemiological framework of HAIs and the antimicrobials consumption. The study further aims to identify the main critical areas in acute and long-term settings to design and address effective interventions on HAIs and antimicrobials prescription.

Methods

PPS and HALT-3 setting

For PPS 2016–2017, the ECDC developed the protocol Version 5.3 to standardize the survey among European countries. Molise Region, which is the second smallest Region in Italy [7], was included with the "Antonio Cardarelli" hospital. The survey was conducted between 24th and 26th November 2016.

For HALT-3, ECDC developed the Version 2.1 protocol to standardize the surveys and make results comparable in LTCFs. Data were collected in one day on 29th June 2017, with the inclusion of the biggest public nursing home located in Larino municipality.

The Italian versions of PPS 2016–2017 and HALT-3 protocols have been commissioned and authorized by ECDC, and have been provided by Department of Public Health and Pediatrics, University of Turin, which has coordinated both the surveys in Italy.

PPS 2016–2017 and HALT-3 participants

For PPS, all the hospital wards, excluding the emergency and those where patients were monitored for less than 24 h, were included. Patients admitted in a ward before or at 8.00 a.m. and not discharged at the time of detection were enrolled, as well as patients transferred to another ward and returned to the initial one.

For HALT-3, all LTCF residents who were present at 8.00 on the day of detection and for at least 24 h were eligible.

Variables

The ECDC protocol Version 5.3 for PPS 2016–2017 provided definition of variables in a standardized questionnaire [8], divided into different sections for collecting hospital characteristics and indicators, wards, patients, HAIs, and antimicrobial use. All data were recorded in HelicsWin.Net software version 2.3, provided along with the protocol.

For HALT-3 survey, data were recorded on HALT-Application for LTCF software provided by ECDC.

On the basis of ECDC PPS 2016–2017 protocol for acute care hospitals, HAI was considered active when signs and symptoms of the infection were present on the survey date, or signs and symptoms were present in the past and the patient is (still) receiving treatment for that infection on the survey date, and the onset of symptoms was on day 3 or later (day of admission = day 1) of the current admission or the patient presents with an infection but has been readmitted less than 48 h after a previous admission to an acute care hospital; or the patient has been admitted (or develops symptoms within two days) with an infection that meets the case definition of an active surgical site infection, and the patient either has symptoms that meet the case definition and/or is on antimicrobial treatment for that infection; or the patient has been admitted (or develops symptoms within two days) with *Clostridium difficile* infection less than 28 days after a previous discharge from an acute care hospital; or an invasive device was placed on day 1 or day 2, resulting in an HAI before day 3.

Based on HALT-3 protocol, a HAI was defined active when signs/symptoms of the infection were present on the survey date and are new or acutely worse, or were present in the two weeks (14 days) prior to the survey and were new or acutely worse, and the resident is (still) receiving treatment for that infection on the survey date, and the onset of symptoms occurred more than 48 h after the resident was (re-)admitted to the current LTCF or less than 48 h (*i.e.* present on admission, on day of admission, or on day 2) after the resident was (re-)admitted to the current LTCF from another healthcare facility, or deep and organ/space surgical site infections occurring less than 90 days after implant surgery; or other surgical site infections occurring less than 30 days after an operation; or *C. difficile* infections occurring less than 28 days after discharge from a healthcare facility.

Data on antimicrobial use were collected for patients/residents receiving an antimicrobial agent.

Bias

A single multidisciplinary team collected data for both acute care and long-term surveys. To minimize individual variability and standardize data collection, the working group participated to a theoretical-practical *in place* training focused on the protocol and use of HelicsWin.Net software version 2.3 for PPS 2016–2017, and to a specific webinar for HALT-3 study. The national coordinator managed both training courses.

Statistics

A descriptive analysis of hospital/wards data and public nursing home, patients' and resident characteristics, HAIs occurrence and antimicrobials use, was carried out using the Statistical Package for the Social Sciences (SPSS®) software Version 23.0. Results were reported as absolute and relative frequencies for qualitative variables, while mean, median and interquartile range were calculated for quantitative ones. Point prevalence of HAIs with 95% confidence interval (95%CI) and antimicrobial use were further evaluated.

Results

PPS 2016-2017 in the "A. Cardarelli" hospital for acute

Hospital characteristics and ward indicators

Hospital and wards data were collected at a directorate level and were related to 2016 or to the most recent available data. The survey

Table 1
In place strategies for HAIs prevention and antimicrobials management in ICU and non-ICU wards.

	Guidelines	Training	Checklist	Audit	Surveillance	Feedback	Care bundle
Pneumonia (PN)	Yes	Yes	No	No	No	No	No
Bloodstream infections (BSIs)	Yes	Yes	No	No	No	No	No
Urinary tract infections (UTIs)	Yes	Yes	No	No	No	No	No
Surgical site infections (SSIs)[a]	No	No	No	No	No	No	No
Antimicrobial use/stewardship	No	No	No	No	No	No	No

[a] It is related only to non-ICU wards.

included all 19 hospital wards; ten (52.6%) wards were of medicine and surgery specialties, four (21.0%) of pediatrics and two (10.5%) of ICU specialties, followed by single wards of gynecology/obstetrics, geriatrics, psychiatry, rehabilitation, and mixed specialties.

At time of the survey, there were 336 total beds, 320 for acute care and 16 for ICU. The number of beds occupied at 00:01 on the first PPS day was 227 (67.6% bed occupancy rate). The majority (n = 103; 35.0%) of beds were in surgical unit specialty, followed by medical (n = 91; 31.0%), gynecology/obstetrics (n = 25; 9.0%), ICU (n = 23; 7.9%), geriatrics (18; 6.0%), pediatrics (n = 13; 4.0%), mixed (n = 8; 2.7%), rehabilitation (n = 7; 2.4%), and psychiatrics (n = 6; 2.0%).

About workload/staffing, there were 76.3/100 beds (106.9/100 ICU beds) and 16.1/100 beds (5.6/100) of full-time equivalent (FTE) registered nurses and FTE nursing assistants, respectively.

During 2015, 15,000 discharges/admissions were recorded, with 96,320 patient-days-year and 6.4 days mean length of stay. The hospital had 110 patient rooms; 9.1% (n = 10) and 5.5% (n = 6) were single patient rooms and with toilet and shower, respectively, and 2.7% (n = 3) for airborne infection isolation.

Concerning infection prevention and control (IPC) programs in 2016, neither FTE infection control nurses, nor FTE antimicrobial stewardship consultants were available. A formal procedure to review antimicrobial (post-prescription review) was also not present. An annual IPC plan or report approved by the hospital Chief Executive Officer (CEO, managing director) was not undertaken. Furthermore, the hospital did not participate to surveillance networks for surgical site infections (SSIs), *C. difficile* infections (CDIs) and antimicrobial resistance. About microbiology/diagnostic performance, the hospital laboratory received and incubated 2,632 blood culture sets/year (27.3/1,000 patients-days), and 83 stool tests for CDI/year (0.9/1,000 patients-days). During the weekend, clinicians can request routine microbiological tests, and receive results within the standard turnaround time usually for clinical tests.

On multimodal strategies and components in ICU and non-ICU wards, the hospital had developed *in place* guidelines and training to prevent HAIs, addressed for pneumonia, bloodstream (BSIs) and urinary tract infections (UTIs) (Table 1), but a strategy for antimicrobial use was not available, as well as a plan for SSIs in non-ICU wards.

Concerning hand hygiene, consumption of alcohol hand rub (AHR) was of 690 L at ward level that, considering 88,983 patients-year, corresponded to 7.8 L/1,000 patient-days. AHR consumption was different by unit specialty ranging between 1.5 and 69.4 L/1,000 patient-days, with highest consumption observed in ICU, followed by mixed/brief observation (43.6 L/1,000 patient-days) and pediatrics (36.7 L/1,000 patient-days). AHR dispensers were not available at point of care, but there were corridors wall dispensers.

Patient characteristics

A total of 224 patients (54.0% female; mean age 66.3 ± 20.0 years, median 72 years) were included in the PPS, with average length of stay of 9.7 ± 12.7 days (median 6 days, range 7.6–10.9 days). The largest number of patients were in surgical (n = 82; 36.6%) and medical (n = 81; 36.1%) unit specialty, followed by psychiatrics (n = 16; 7.1%) and gynecology/obstetrics (n = 13; 5.8%).

Most patients (n = 155, 69.2%) did not undergo surgery, whereas a surgery defined according to the National Healthcare Safety Network (NHSN operative procedure category mappings to ICD-9-CM codes, 2010), and non-NHSN surgery was executed on 39 (17.4%) and 29 (12.9%) patients, respectively.

Based on NHSN surgery type, the majority (n = 8, 3.6%) underwent open reduction of fracture, followed by cesarean section (n = 5, 2.2%), hip prosthesis or laminectomy or kidney or small bowel surgery (n = 3 each, 1.3%). The analysis of the McCabe score, allowing to classify patients on underlying medical conditions, showed that 77.7% (n = 174) patients had non-fatal disease, while 13.8% (n = 31) and 3.6% had ultimately (expected survival 1–5 years) and rapidly fatal diseases (survival within 1 year), respectively.

On survey date, 70.1% of patients (n = 157) had a peripheral vascular catheter, followed by 35.3% (n = 79) and 7.6% (n = 17) with urinary and central vascular catheter, respectively. Only three patients were in intubation.

HAIs point prevalence

HAIs prevalence was of 7.1% (n = 16, 95%CI 4.1–11.3), and were mostly reported in medicine specialty (n = 8, 50.0%), followed by 25.0% (n = 4) in surgery, 12.5% (n = 2) in intensive care, and one case (6.25%) in each of geriatrics and rehabilitation (Table 2). Most (n = 11, 68.8%) HAIs occurred during current hospitalization, while signs and symptoms were present at admission in three (18.8%) patients and were from healthcare structures other than "A. Cardarelli" hospital. HAIs were frequently (n = 12, 75.0%) associated to the current ward, but data for two patients were not available. UTIs and SSIs were the most frequent, with four cases each, followed by three and two cases of systemic infections and BSIs. A urinary catheter within 7 days before onset was present in all patients with UTIs, as well as a vascular catheter within 48 h before onset of BSIs, whilst intubation occurred for pneumonia within 48 h before onset.

Information on isolated microorganisms were available only for three patients, and *Staphylococcus aureus* (n = 2 strains), *Acinetobacter* spp. and *Acinetobacter baumannii* (n = 1 each), and Candida were identified. Of these, *A. baumanni* strain and one *S. aureus* were resistant to carbapenem and oxacillin, respectively.

Antimicrobials use

Ninety (40.2%; 95%CI 33.7–46.9) patients received at least one antimicrobial, and 25.6% (n = 23) received more than one (n = 19, 21.1% and n = 4, 4.5% two and three or more antimicrobials, respectively).

Overall, 118 antimicrobials were administered: 38.1% (n = 45) were indicated for treatment intention, followed by 33.1% (n = 39) and 14.4% (n = 17) for medical and surgical (n = 15, 6.7%) prophylaxis (Table 3). Unknown or missing indication was reported for 4.2% (n = 5) and 10.2% (n = 12) antimicrobials, respectively. The route of antimicrobials administration was mostly parenteral (n = 105, 89.0%), followed by oral route (n = 13, 11.0%).

Table 2
Description of active HAIs diagnosed at the time of PPS.

Specialty	Ward	HAI definition	Device *in situ*	HAI at admission	Date of onset
Medicine	Neurology	Skin/soft tissue infection, not specified/unknown category	No	No	24/11/2016
Surgery	General surgery	Treated unidentified severe infection in adults and children	Yes	No	16/11/2016
Surgery	Orthopedics	Surgical site infection, deep incisional	Not available	Unknown	07/11/2016
Surgery	Orthopedics	Surgical site infection, deep incisional	Not available	Unknown	27/10/2016
Medicine	Internal medicine	Pneumonia	Yes	Yes	Not available
Medicine	Internal medicine	Surgical site infection, deep incisional	Yes	No	24/11/2016
Medicine	Internal medicine	Bloodstream infection laboratory-confirmed, other than catheter-related infection with positive blood culture	Yes	No	19/11/2016
Medicine	Internal medicine	Symptomatic urinary tract infection not microbiologically confirmed	Yes	No	21/11/2016
Intensive care	Neonatal ICU	Gastrointestinal tract (esophagus, stomach, small and large bowel, and rectum), excluding gastroenteritis	Yes	No	12/11/2016
Intensive care	Neonatal ICU	Laboratory-confirmed bloodstream infection with coagulase-negative staphylococci in neonates	Yes	No	31/10/2016
Medicine	Oncology	Disseminated infection, not specified/unknown category	Yes	No	23/11/2016
Medicine	Oncology	Surgical site infection, deep incisional	No	No	23/11/2016
Other specialties	Brief observation	Symptomatic urinary tract infection microbiologically confirmed	Yes	No	21/11/2016
Other specialties	Rehabilitation	Symptomatic urinary tract infection not microbiologically confirmed	Yes	No	13/11/2016
Medicine	Cardiology	Disseminated infection	No	Yes	Not available
Geriatrics	Geriatrics	Symptomatic urinary tract infection microbiologically confirmed	Yes	Yes	Not available

Table 3
Antimicrobial agents (ATC codes, 2016) by indication.

Antimicrobial agents	ATC code	Treatment intention N (%)	Surgical prophylaxis N (%)	Medical Prophylaxis N (%)	Total N (%)
Tetracyclines	J01AA	1 (2.2)		1 (2.6)	2 (1.7)
Penicillins, extended spectrum without anti-pseudomonal activity	J01CA				1 (0.8)
Combinations of penicillins, including beta-lactamase inhibitors	J01CR	6 (13.3)		12 (30.8)	23 (19.5)
Second-generation cephalosporins	J01DC		4 (23.5)		5 (4.2)
Third-generation cephalosporins	J01DD	4 (8.9)	7 (41.2)	8 (20.5)	25 (21.2)
Carbapenems	J01DH	5 (11.1)		1 (2.6)	6 (5.1)
Macrolides	J01FA	3 (6.7)		1 (2.6)	4 (3.4)
Lincosamides	J01FF	3 (6.7)		1 (2.6)	4 (3.4)
Aminoglycosides	J01GB	1 (2.2)		1 (2.6)	2 (1.7)
Fluoroquinolones	J01MA	12 (26.7)	2 (11.8)	11 (28.2)	26 (22.0)
Glycopeptide antibacterials	J01XA	3 (6.7)	4 (23.5)		7 (5.9)
Polymyxins	J01XB	1 (2.2)			1 (0.8)
Imidazole derivatives	J01XD	1 (2.2)		1 (2.6)	5 (4.2)
Other antibacterials	J01XX	2 (4.4)		1 (2.6)	3 (2.5)
Antimycotics, antibiotics	J02AA	2 (4.4)			2 (1.7)
Triazole derivatives	J02AC	1 (2.2)			1 (0.8)
Other antimycotics for systemic use	J02AX			1 (2.6)	1 (0.8)
Total		45 (38.1)	17 (14.4)	39 (33.0)	

For 91.1% (n = 82) patients the antimicrobial agent did not change, whereas de-escalation occurred in three (3.3%) patients. Fluoroquinolones resulted the most frequently (n = 26, 22.0%) administered antimicrobials, followed by third-generation cephalosporins and combinations of penicillins, including beta-lactamase inhibitors (Table 3).

HALT-3 in the LTCF of Larino municipality

General information of the facility

The LTCF had 40 beds located in 17 resident rooms, of which three were single rooms with individual toilet. There were 13 FTE registered nurses and 16.5 FTE registered assistants.

Both employed medical doctors and general practitioners visiting residents in the LTCF were authorized for antimicrobial prescribing, and one internal medical doctor supervised the medical activities.

Infection control practices

There were no operators with training in infection control or prevention available from the staff, as well as an internal infection control committee. However, there was an offer system of annual flu immunization for all residents, and the LTCF can require help and expertise from an external infection control team on a formal basis. No protocols were available for the management of methicillin-resistant *S. aureus* (MRSA), hand hygiene, management of urinary catheters and venous catheters/lines, as well as of enteral feeding. A surveillance program of HAIs with annual reports was also not realized. A liquid soap was available for hand hygiene, but AHR solutions, wipes or bar soaps in clinical area were not found. Hand hygiene with water and non-antiseptic soap was the most frequently method used by operators. No training session on hand hygiene issues was organized for care professionals in the previous year.

Antimicrobials policy in the LTCF

Prescription of third generation cephalosporines and intravenously administered antibiotics required the permission of a designated medical doctor. An annual training on appropriate antimicrobial prescription, and guidelines for antimicrobial use appropriateness were not available. Urine dipsticks test for detection of UTIs were not available, as well as a program for surveillance

of antimicrobial consumption or resistant microorganisms. The antimicrobials were provided by more than one pharmacy, and the "A. Cardarelli" Clinical Laboratory performed the microbiological samples analysis required by the facility.

Residents' characteristics

There were 29 patients (n = 4, 13.8% male; mean age 82.8 ± 17.4 years, median 88 years); more than half (n = 18; 55.1%) had a length of stay of at least one year. Among residents, 25 (86.2%) were on wheelchair or bedridden, and 24 (82.7%) had urinary or fecal incontinence. Furthermore, 44.8% (n = 13) had spatial-temporal disorientation, six (20.7%) and one patient had urinary and vascular catheter, respectively. No resident had a surgery 30 days before the survey.

HAIs and antimicrobial use among LTCF residents

One patient (point prevalence 3.4%) had active HAI, which was a skin infection not present at the time of admission. Microorganism isolation and antibiotic resistance tests were not required by the staff. Furthermore, no resident was receiving an antimicrobial therapy at time of survey.

Discussion

HAIs and antimicrobial use in the acute care hospital

Point prevalence surveys are considered as one of the main efforts by the ECDC for HAIs prevention and control, and for enhancing the prudent use of antimicrobials in healthcare settings, enabling comparisons between countries and hospitals. The Molise Region participated with one hospital for the first time in the PPS 2016–2017.

This first experience provided data useful to complete the epidemiological framework on HAIs and antimicrobial use and highlighted critical issues to be solved.

The hospital partially complied with infection prevention practices, because only guidelines and training programs for few healthcare workers (HCWs) were available. Despite the clinical benefits widely reported [9], audit, surveillance programs and bundles were not available in the hospital. These strategies must be implemented in addition to those already existing and tailored for the local setting: for example, bundles and checklists demonstrated their efficacy in HAI prevention in ICU [10], while audit and feedback can lead to significant improvements for clinical outcomes, reducing length of stay of patients and costs [11].

Significant concerns rely on the lack of antimicrobial stewardship and infection control practice (ICP) FTEs, since their presence can mainly lead to reduce inappropriate antimicrobials use, drug-related costs, *C. difficile* associated disease, and antimicrobial resistance emergence [12]. A comprehensive stewardship program includes monitoring, promotion of appropriate antimicrobial use, and collaboration with an effective infection control program. Although the constraints related to human resources and costs, evidence suggested that a pharmacist FTE investment of 1.0 per 100 occupied beds would be needed to implement a robust antimicrobial stewardship [13]. Recently, Italy adopted its first National Action Plan against Antimicrobial Resistance (PNCAR) 2017–2020 for reducing the occurrence of infections caused by antibiotic-resistant microorganisms [14]. This Plan represents the tool for implementing the strategy for the appropriate use of antibiotics in humans and animals, considering good practices and promoting their dissemination at national level.

Therefore, to reduce HAIs occurrence, an operative infection prevention and control program requires adequate staffing. Current evidences suggest that 1 ICP FTE per 100 occupied beds may be required to achieve these goals in hospitals for acute [15], while 1 ICP FTE/150–250 beds in LTCFs [16].

At time of PPS, prevalence of HAIs in "A. Cardarelli" hospital was 7.1%, which was slightly higher to that estimated (6.5% adjusted prevalence of patients with at least one HAI) within the overall ECDC PPS conducted between 2016 and 2017 in 1,209 acute care hospitals from 28 European countries [17]. Prevalence was also higher than that resulted from PPS 2011–2012 including 1,149 European hospitals (5.7%) [17], and considering that observed (6.3%) in 49 Italian hospitals included in the survey [18]. Anyway, it was lower than that found in other Italian studies (9.6% in Ferrara University hospital, and 10.3% in public hospitals of Liguria) [19,20].

Depending on specialties wards and available beds, hospitals can be classified as primary, secondary and tertiary level [21]. The "A. Cardarelli" hospital is a tertiary hospital, hence tends to produce more precise estimates compared to primary and secondary ones [22]; indeed our data might be partially explained considering the nosocomial characteristics and patients case-mix, as well as the period when the study was undertaken. Since PPS in Molise Region was conducted on November 2016, it may be possible that winter pressure could have increased the number of admissions due to seasonal respiratory conditions [23], thus potentially raising the estimation of HAIs.

In our setting, a high proportion (87.5%) of HAI patients was found in non-ICU wards. In Italy, several studies have reported higher rates in ICU wards [19,20,24], while data from other European countries were in line with our results [25–27]. These findings could be partially explained as consequence of a program implemented after an outbreak of *Klebsiella pneumoniae* carbapenemase-producing (KPC) occurred in the ICU of "A. Cardarelli" hospital [28]. By the improvement of internal procedures, the outbreak was effectively controlled. Afterward, the procedures have been strongly revised in the ICU, and results of these activities were included within a "good practices" document, reported as "Infection Control of KPC's-Actions to be taken in case of suspected epidemic or epidemic cluster from *Enterobacteriaceae* resistant to carbapenems" by the National Agency for Regional Health Services [29]. Although ICU admitted patients are susceptible to multiple HAI risk factors and prevalence is typically higher than any other wards, the significant occurrence in non-ICU patients may be related to the differences found in the implementation of prevention programs.

The inappropriate application of standard precautions among HCWs might also have raised the overall HAIs occurrence, as revealed in our recently published study related to the hospital included in the PPS survey [28]. In particular, in that study, the occurrence of *K. pneumoniae* outbreak in ICU during Christmas holidays was reported, related mostly to reduced personnel, but perhaps also to a poor compliance to standard hygiene measures. Anyway, it is not possible to speculate about a general compliance problem in the hospital, although the results obtained from this study suggested a revision of some procedures in the ward interested.

In addition to the lack of dispensers at point of care, it was observed that none HCW carried AHR dispensers in their pocket uniform, thus limiting the hand hygiene opportunities. Limited compliance to these practices among HCWs have been related to insufficient time, work overload, inadequate knowledge, inconvenient locations for sinks and soap dispensers [30]. Educational intervention at hospital level and availability of individual AHR dispensers can significantly increase hand hygiene among HCWs [30], but these interventions were not found.

Considering HAIs, UTIs and SSIs were the most frequent, both accounting for 50% of all cases, in line with several Italian [19,20,22] and European [25–27] studies. SSIs might be related to high

number of admitted patients with comorbidities and duration of intervention [31]. On the other hand, the urinary catheter is a well-recognized risk factor for developing UTIs [22,32], as found for all patients with these infections. Although guidelines and training to prevent UTIs were available in either ICU or non-ICU wards, an over exposure of *in-situ* devices could have raised the risk of infections.

Although the limited number of microbial isolations hampers a good comparison, *S. aureus* and Gram-negative non-*Enterobacteriaceae* were the most frequent HAIs responsible bacteria, in contrast with other studies in Italy, where a high prevalence of *Enterobacteriaceae* was reported [19,20,22,24].

Concerning the antimicrobial use, prevalence (40.2%) was higher than the overall weighted estimates of 30.5% in the EU/EEA acute care hospitals included in the ECDC PPS 2016–2017 [33], but lower than that reported in the PPS 2011–2012 (44%) for Italian hospitals [18], and in other studies ranging between 46% [20] and 53.9% [34].

The most frequently prescribed antimicrobials were third-generation cephalosporines and fluoroquinolones, in line with other reports [19,24].

Nevertheless, data on antimicrobial use indications were not available for all patients, as well as prescribing information. Hence, it is reasonable that some patients could have received antibiotics with no details about diagnosis and dosage. Antimicrobial stewardship programs were also not found. Consistent evidences indicate that their implementation extremely improves the quality of antimicrobial use in hospitals in relation to clinical outcomes, adverse events, costs, and resistance rates [35]. Recently, an internal procedure for the laboratory reporting of Alert Organisms has been introduced in the hospital, including the need to indicate specific suggestions related to antimicrobial use and prescription in the medical diagnostic report, and the need to ask for support by an infectious diseases specialist. This is generally considered as one of the first step useful for implementation of an antimicrobial stewardship program. In addition, educational interventions for HCWs need to be addressed leading to appropriate indications and prescriptions [36].

HAIs and antimicrobial use in in LTCF of Larino municipality

Molise Region is still undertaking a plan to reduce economic expenditure for healthcare [37]. Among the objectives, de-hospitalization was favored to optimize the economic resources allocation, with the aim of the reinforcement of the territorial healthcare assistance network. In 2010, with a regional decree, LTCFs were established to admit patients that do not require admission to hospitals for acute [38].

HAIs occurrence results in the LTCF of Larino municipality were in line with the overall prevalence estimated in the HALT-3 survey from 2,221 LTCFs in 23 European countries [17], and with those obtained in the HALT-2 project at national level, where approximately one of 30 residents in LTCFs had an active HAI, although respiratory infections were most frequently reported [39].

Even though our results are limited and could not be properly compared with other studies, some considerations could be stated. It may be possible an underestimation of HAIs due to summer season and the low clinical complexity of the residents; a 3-years study with six repeated prevalence surveys found that case-mix index and seasonality in LTCFs are associated with the occurrence of infections, leading to potential sources of confounding HAIs prevalence [40,41].

Several considerations further regard the results of infection control practices in the LTCF. Studies reported that hand hygiene adherence is lower in LTCFs compared to acute hospitals, even performing high-risk procedures [42,43]. Considering that AHR point solutions and annual training sessions were not found, it could be presumed that hand hygiene would be performed with low guidelines adherence. Thus, both individual AHR solutions and training should be provided to HCWs.

Further concerns regard *C. difficile* infection control policies, considering that LTCF residents are at elevated risk due to age, comorbidities and high antibiotic exposure. In Italy, *C. difficile* ICPs are available only for acute-care settings [44], while it has been underlined the need of international harmonization on the evidence for best practices, to be tailored in relation to the healthcare settings [45].

HAIs prevention and control networks should be also established. The experience of Japan, a country with ageing population trends similar to Italy, could be considered as reference. Through a national plan, in which healthcare institutions were recommended to work together for HAIs prevention and control, LTCFs, hospitals and public health centers are collaborating to review infection control activities and tailor infection control programs among different healthcare scenarios [46].

Finally, optimizing the use of antimicrobials could be a challenge in the LTCF setting, because of several determinants, such as difficult diagnoses, presence of several prescribers and concurrent use of multiple medications by a patient (polypharmacy) [47], potentially leading to inappropriate prescriptions. The reinforcement of HCWs education represents the most significant intervention for improving the careful use of antibiotics among LTCF residents [39,47].

Conclusion

Although the results of PPS 2016–2017 regard the Molise Region and could not be representative and generalizable to other Italian hospitals, this work describes hitherto invaluable information concerning an area never investigated in previous ECDC surveys. Similarly, despite the limited information of HALT-3 in our Region, the survey conducted in the LTCF of Larino municipality allows to underline the areas needing of critical interventions, related to infection control policies and antimicrobial stewardship implementation.

The study findings present strengths in identifying the need of specific interventions to be undertaken at organizational and individual level, and to improve the prescription practice, for reducing the risk factors involved in potentially preventable infections and antimicrobials resistance emergence. A comprehensive prevention-based culture for HAIs needs to be promoted in our hospital and long-term facilities settings, including the effectiveness of bundles and antimicrobial stewardship. Further PPS studies are considered essential to timely monitor the prevalence of HAIs and antimicrobial use.

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Competing interests

None declared.

Ethical approval

Not required.

Appendix A

Collaborators (9)

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References

[1] Douglas Scott II R. The direct medical costs of healthcare-associated infections in U.S. hospitals and the benefits of prevention; 2009. https://www.cdc.gov/HAI/pdfs/hai/Scott_CostPaper.pdf. [Accessed 26 April 2018].

[2] Zimlichman E, Henderson D, Tamir O, Franz C, Song P, Yamin CK, et al. Health care-associated infections: a meta-analysis of costs and financial impact on the US health care system. JAMA Intern Med 2013;173(22):2039–46.

[3] Healthcare-associated Infections Surveillance Network (HAI-Net). European Centre for Disease Prevention and Control. About the network. https://ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/hai-net. [Accessed 26 April 2018].

[4] Rechel B, Grundy E, Robine JM, Cylus J, Mackenbach JP, Knai C, et al. Ageing in the European Union. Lancet 2013;381(9874):1312–22.

[5] Rosina A, Caltabiano M. Where, in which way and to what extent can Italian fertility grow in the next 15 years? J Matern Fetal Neonatal Med 2012;25(4):45–7.

[6] European Centre for Disease Prevention and Control. Point prevalence survey of healthcare associated infections and antimicrobial use in European long-term care facilities. Stockholm: ECDC; 2014. April–May 2013.

[7] Istituto Nazionale di Statistica. Popolazione residente per età, sesso e stato civile al 1; 2017, gennaio. http://demo.istat.it/pop2017/index.html. [Accessed 26 April 2018].

[8] European Centre for Disease Prevention and Control. Point prevalence survey of healthcare-associated infections and antimicrobial use in European acute care hospitals — protocol version 5.3. Stockholm: ECDC; 2016. https://ecdc.europa.eu/sites/portal/files/media/en/publications/Publications/PPS-HAI-antimicrobial-use-EU-acute-care-hospitals-V5-3.pdf. [Accessed 26 April 2018].

[9] International Federation of Infection Control (IFIC). Basic concepts of infection control. 3rd ed; 2016.

[10] Yazici G, Bulut H. Efficacy of a care bundle to prevent multiple infections in the intensive care unit: a quasi-experimental pretest-posttest design study. Appl Nurs Res 2018;39:4–10.

[11] Carling P, Fung T, Killion A, Terrin N, Barza M. Favorable impact of a multidisciplinary antibiotic management program conducted during 7 years. Infect Control Hosp Epidemiol 2003;24(9):699–706.

[12] Ohl CA, Luther VP. Antimicrobial stewardship for inpatient facilities. J Hosp Med 2011;6(1):S4–15.

[13] Echevarria K, Groppi J, Kelly AA, Morreale AP, Neuhauser MM, Roselle GA. Development and application of an objective staffing calculator for antimicrobial stewardship programs in the Veterans Health Administration. Am J Health Syst Pharm 2017;74(21):1785–90.

[14] Ministero della Salute. Piano Nazionale di Contrasto dell'Antimicrobico-Resistenza (PNCAR) 2017–2020. http://www.salute.gov.it/imgs/C_17_pubblicazioni_2660_allegato.pdf. [Accessed 13 June 2018].

[15] O'Boyle C, Jackson M, Henly SJ. Staffing requirements for infection control programs in US health care facilities: Delphi project. Am J Infect Control 2002;30(6):321–33.

[16] Morrison J, Health Canada, Nosocomial and Occupational Infections Section. Development of a resource model for infection prevention and control programs in acute, long term, and home care settings: conference proceedings of the Infection Prevention and Control Alliance. Am J Infect Control 2004;32(1):2–6.

[17] Suetens C, Latour K, Kärki T, Ricchizzi E, Kinross P, Moro ML, et al. Prevalence of healthcare-associated infections, estimated incidence and composite antimicrobial resistance index in acute care hospitals and long-term care facilities: results from two European point prevalence surveys, 2016 to 2017. Euro Surveill 2018;23(46), http://dx.doi.org/10.2807/1560-7917.ES.2018.23.46.1800516.

[18] Ricchizzi E, Morsillo F, Buttazzi R. Studio di prevalenza europeo su infezioni correlate all'assistenza e uso di antibiotici negli ospedali per acuti. Rapporto nazionale; 2013. http://assr.regione.emilia-romagna.it/it/servizi/pubblicazioni/rapporti-documenti/studio-prevalenza-europeo-ICA-ospedali-acuti. [Accessed 26 April 2018].

[19] Antonioli P, Manzalini MC, Stefanati A, Bonato B, Verzola A, Formaglio A, et al. Temporal trends of healthcare associated infections and antimicrobial use in 2011-2013, observed with annual point prevalence surveys in Ferrara University Hospital, Italy. J Prev Med Hyg 2016;57(3):E135–41.

[20] Sticchi C, Alberti M, Artioli S, Assensi M, Baldelli I, Battistini A, et al. Regional point prevalence study of healthcare-associated infections and antimicrobial use in acute care hospitals in Liguria, Italy. J Hosp Infect 2018;99(1):8–16.

[21] World Health Organization. Management for health services delivery, management of health facilities: referral systems, http://www.who.int/management/referralhospitals.pdf. [Accessed 7 June 2018].

[22] Charrier L, Argentero PA, Farina EC, Serra R, Mana F, Zotti CM. Surveillance of healthcare-associated infections in Piemonte, Italy: results from a second regional prevalence study. BMC Public Health 2014;14:558.

[23] British Lung Foundation (BLF). Out in the cold: lung disease, the hidden driver of NHS winter pressure; 2017. December. https://cdn.shopify.com/s/files/1/0221/4446/files/Out_in_the_cold_Dec_2017.pdf?15282568839826487629. [Accessed 26 April 2018].

[24] Sinatra I, Carubia L, Marchese V, Aprea L, D'Alessandro N, Mammina C, et al. Prevalence survey of healthcare-associated infections and antimicrobial use at the University Hospital "Paolo Giaccone", Palermo, Italy. J Prev Med Hyg 2013;54(4):200–4.

[25] The French Prevalence Survey Study Group. Prevalence of nosocomial infections in France: results of the nationwide survey in 1996. J Hosp Infect 2000;46(3):186–93.

[26] Hopmans TE, Blok HE, Troelstra A, Bonten MJ. Prevalence of hospital-acquired infections during successive surveillance surveys conducted at a university hospital in the Netherlands. Infect Control Hosp Epidemiol 2007;28(4):459–65.

[27] Gordts B, Vrijens F, Hulstaert F, Devriese S, Van de Sande S. The 2007 Belgian national prevalence survey for hospital-acquired infections. J Hosp Infect 2010;75(3):163–7.

[28] Ripabelli G, Tamburro M, Guerrizio G, Fanelli I, Flocco R, Scutellà M, et al. Tracking multidrug-resistant Klebsiella pneumoniae from an Italian Hospital: molecular epidemiology and surveillance by PFGE, RAPD and PCR-based resistance genes prevalence. Curr Microbiol 2018;75(8):977–87.

[29] Agenzia Nazionale per i Servizi Sanitari (AGENAS). Osservatorio Buone Pratiche, Il database delle buone pratiche, http://buonepratiche.agenas.it/questionnaire.aspx?id=5328. [Accessed 13 June 2018].

[30] Marra AR, Edmond MB. New technologies to monitor healthcare worker hand hygiene. Clin Microbiol Infect 2014;20(1):29–33.

[31] Malone DL, Genuit T, Tracy JK, Gannon C, Napolitano LM. Surgical site infections: reanalysis of risk factors. J Surg Res 2002;103(1):89–95.

[32] Saint S, Kaufman SR, Rogers MA, Baker PD, Boyko EJ, Lipsky BA. Risk factors for nosocomial urinary tract-related bacteremia: a case-control study. Am J Infect Control 2006;34(7):401–7.

[33] Plachouras D, Kärki T, Hansen S, Hopkins S, Lyytikäinen O, Moro ML, et al. Antimicrobial use in European acute care hospitals: results from the second point prevalence survey (PPS) of healthcare-associated infections and antimicrobial use, 2016 to 2017. Euro Surveill 2018;23(46), http://dx.doi.org/10.2807/1560-7917.ES.23.46.1800393.

[34] Marani A, Napoli C, Berdini S, Montesano M, Ferretti F, Di Ninno F, et al. Point prevalence surveys on healthcare acquired infections in medical and surgical wards of a teaching hospital in Rome. Ann Ig 2016;28(4):274–81.

[35] Schuts EC, Hulscher MEJL, Mouton JW, Verduin CM, Stuart JWTC, Overdiek HWPM, et al. Current evidence on hospital antimicrobial stewardship objectives: a systematic review and meta-analysis. Lancet Infect Dis 2016;16(7):847–56.

[36] Davey P, Marwick CA, Scott CL, Charani E, McNeil K, Brown E, et al. Interventions to improve antibiotic prescribing practices for hospital inpatients. Cochrane Database Syst Rev 2017;2:CD003543.

[37] Regione Molise, Servizio Sanitario Regionale, Programma Operativo Triennio 2007-2009, Accordo ai sensi dell'articolo 1 comma 180 della legge 311/2004, D.L.vo 14 maggio 2005, n. 80. http://www.salute.gov.it/imgs/C_17_pubblicazioni_1229_allegato.pdf. [Accessed 7 June 2018].

[38] Regione Molise Istituzione delle residenze sanitarie assistenziali ASReM presso gli Stabilimenti ospedalieri di Agnone, Larino e Venafro (D.C.A. 79 del 17 nov. 2010). http://www3.regione.molise.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/2386. [Accessed 7 June 2018].

[39] Moro ML, Ricchizzi E, Morsillo F, Marchi M, Puro V, Zotti CM, et al. Infections and antimicrobial resistance in long term care facilities: a national prevalence study. Ann Ig 2013;25(2):109–18.

[40] Marchi M, Grilli E, Mongardi M, Bedosti C, Nobilio L, Moro ML. Prevalence of infections in long-term care facilities: how to read it? Infection 2012;40(5):493–500.

[41] Stillo M, Scoffone S, Passi S, Zotti CM. Point prevalence survey of health care associated infections and antimicrobial use in Piedmont Region long-term care facilities according to ECDC protocol. Epidemiol Prev 2014;38(6):93–7.

[42] Pan A, Domenighini F, Signorini L, Assini R, Catenazzi P, Lorenzotti S, et al. Adherence to hand hygiene in an Italian long-term care facility. Am J Infect Control 2008;36(7):495–7.

[43] Smith A, Carusone SC, Loeb M. Hand hygiene practices of health care workers in long-term care facilities. Am J Infect Control 2008;36(7):492–4.

[44] Società Italiana Multidisciplinare per la Prevenzione delle Infezioni nelle Organizzazioni Sanitarie. Prevention and control of infections from *Clostridium difficile*; 2011. http://www.simpios.eu/wp-content/uploads/2016/12/GimpiosS01_CDiff2011.pdf. [Accessed 7 June 2018].

[45] Balsells E, Filipescu T, Kyaw MH, Wiuff C, Campbell H, Nair H, et al. Infection prevention and control of *Clostridium difficile*: a global review of guidelines, strategies, and recommendations. J Glob Health 2016;6(2):020410.

[46] Kariya N, Sakon N, Komano J, Tomono K, Iso H. Current prevention and control of health care-associated infections in long-term care facilities for the elderly in Japan. J Infect Chemother 2018;24(5):347–52.

[47] Dyar OJ, Pagani L, Pulcini C. Strategies and challenges of antimicrobial stewardship in long-term care facilities. Clin Microbiol Infect 2015;21(1):10–9.