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Healthcare-associated infections and antibiotic use in long-term care residents from two geographical regions in Switzerland

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SUMMARY

Background: The burden of healthcare-associated infections (HAIs) and antimicrobial use in Swiss long-term care facilities (LTCFs) is currently unknown. This study assessed the prevalence of HAIs and antibiotic use among LTCF residents in Switzerland.

Methods: A point-prevalence study was undertaken in LTCFs in eastern and western Switzerland from August to October 2019 according to the 'Healthcare-associated infections in long-term care facilities' (HALT) protocol. Characteristics of residents (age, sex, wounds, dementia, indwelling catheters) and institutions (specific factors, geographic region) were assessed. LTCF residents were screened for HAIs and current antibiotic treatment. Personal and institutional factors associated with HAIs were assessed.

Results: In total, 1185 residents from 16 LTCFs (eight per geographic region) were screened for HAIs and antibiotic treatment. Median age was 87 years (interquartile range 79–91) and 71% were female. The prevalence of HAIs was 4.2% (west 4.3% vs east 4.2%; P=0.93), with mucocutaneous skin infections (36%) and respiratory tract infections (30%) being the most common. Independent risk factors for the presence of HAIs were presence of a chronic wound [odds ratio (OR) 2.4, 95% confidence interval (CI) 1.1–5.0; P=0.02] and being immobile (OR 1.8, 95% CI 1.0–3.3; P=0.04). Antibiotics were given to 2.9% of residents (west 3.9% vs east 1.8%; P=0.05) on the day of the survey. The most commonly prescribed antibiotics were amoxicillin-clavulanic acid and quinolones.

Conclusions: The prevalence of HAIs in Swiss LTCFs is similar to that in other European countries, whereas antibiotic consumption is lower. Further point-prevalence surveys on a broader scale are recommended to improve understanding of the burden of HAIs and antibiotic consumption in this setting.

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Introduction

Healthcare-associated infections (HAIs) are a major concern in long-term care facilities (LTCFs) due to significant morbidity and mortality [1]. Antibiotic use is another concern as studies have reported that almost half of the antibiotics prescribed in LTCFs are inappropriate [2]. Furthermore, the use of antibiotics is an important driver of antimicrobial resistance and is associated with complications such as *Clostridiodes difficile* infection [3,4]. In 2008, the European Centre for Disease Prevention and Control (ECDC) initiated a surveillance programme for HAIs and antibiotic consumption in LTCFs within the framework of 'Healthcare-associated infections in long-term care facilities' (HALT) [5]. This programme monitors the extent of the problem in LTCFs, compares data across countries, and guides specialists and LTCF staff in the implementation of targeted interventions.

In Switzerland, LTCFs constitute a neglected setting when it comes to standardized and coordinated surveillance of HAIs and antibiotic use. In the canton of Vaud, a pilot study reported a prevalence of HAIs of 4.4%, which is similar to the results of other European countries [6]. Prior to the present study, no other data existed for a large cohort in Swiss LTCFs. Point-prevalence surveys (PPSs) are useful in LTCFs as these institutions have limited resources to perform continuous surveillance. In 2016, the Swiss Federal Office of Public Health (FOPH) developed the NOSO strategy which facilitates the creation of structures to prevent HAIs on a national level. One purpose was to enable systematic surveillance of HAIs in LTCFs, and subsequently encourage the implementation of measures to reduce the burden of HAIs [7].

The aim of this PPS was to assess HAIs and antibiotic use in LTCFs in two geographical regions in Switzerland. Another goal was to provide information on the burden of HAIs and the need for preventive programmes to reduce the use of antibiotics.

Methods

Selection of institutions and residents

This study was initiated by the infection control team of Cantonal Hospital in St. Gallen. St. Gallen is one of 26 cantons in Switzerland and is located in the east of the country. In order to include western Switzerland, the Cantonal Unit for Infection Control and Prevention of the canton of Vaud was invited to participate because of previous study experiences in LTCFs. Of the LTCFs with $\geq$40 residents, 40 of 75 LTCFs in St. Gallen and 20 of 160 LTCFs in Vaud were invited to participate. They were chosen purposely because of their geographic location. The first eight LTCFs of each canton to respond (representing 11% and 5% of all eligible LTCFs in St. Gallen and Vaud, respectively) were included in this study.

Every person residing in the institution as a long-term resident, who was present at 8 am on the day of the PPS, and who was not discharged during the day of the PPS was eligible for inclusion in this study. As a consequence, residents who were absent for any reason (e.g. family gatherings, hospital admissions) were excluded. All eligible residents were screened for the presence of HAIs and intake of antimicrobial substances. No informed consent was obtained because: (i) these data are of high interest to infection control specialists and public health authorities from a patient safety perspective; (ii) this part of the study was purely observational and did not involve any patient interaction; and (iii) these data were only analysed in aggregated form, which ensures absolute anonymity of residents. In 2017, there was a national PPS on HAI in acute care facilities for which no consent was required. As our survey has a similar methodology, no informed consent was required [8]. The study was approved by the ethics committees in charge of both geographic regions (#2019—00087).

Point-prevalence study

This study was performed between August and October 2019, which is in agreement with the HALT protocol that recommends avoiding the influenza season due to potential bias. During this period, every institution was visited by at least two members of the study team, and data were collected over 1—2 days per institution. All residents were screened for HAIs and antibiotic use based on the HALT protocol of ECDC [5]. Data were collected by trained teams which visited all the LTCFs (one team for St. Gallen and one team for Vaud).

Questionnaires

Questionnaires of the HALT protocol were adapted and used as case report forms. The first questionnaire was used to describe structural and functional characteristics of the institution, as well as information on antibiotic policies and infection control issues. The second questionnaire collected data on residents receiving antimicrobial agents and/or residents suffering from an infection on the day of the PPS (systemic antimicrobial treatment, infection site).

The indication for antibiotic use (treatment vs prophylaxis as reported in the file of the resident) and infections were defined according to the ECDC protocol [5]. Causative microorganisms/antibiotic substances were coded following the ECDC protocol. Microbiological data (bacteria identification) were based on clinical samples. Once completed, the data were entered manually into the secuTRIAL database by a trained member of staff.

Data analysis and statistics

Descriptive statistics were used for institutional- and resident-level characteristics, stratified by geographic region. Institutions with a high prevalence of infection (i.e. rate above the median) were compared with those with a low prevalence (i.e. below the median). The same analysis was performed for the prevalence of antibiotic use. Univariable and multivariable logistic regression were used to assess the predictors of HAI, and odds ratios (OR) and 95% confidence intervals (CI) were calculated. All variables that reached statistical significance in univariable analysis were included in the first multi-variable model (Model 1); antibiotic treatment (being a consequence rather than a predictor of HAI) was excluded in the second multi-variable model (Model 2). A sensitivity analysis was performed to adjust for random effects at institutional level using a generalized linear mixed model. Two-sided *P*-values $\leq$0.05 were considered to indicate significance, and statistical analyses were performed using R Version 3.5.2.

Table I
Nursing home characteristics by geographic region

	West (*N*=8)	East (*N*=8)	*P*-value
Ownership, *N* (%)			0.069
Not for profit	2 (25)	1 (12.5)	
Public	6 (75)	3 (37.5)	
Private	0	4 (50)	
Occupied beds at time of PPS, mean (SD)	73 (22)	75 (14)	0.854
Percentage of single room, mean (SD)	74 (25.2)	67 (23.4)	0.576
Full-time nurses per occupied bed, mean (SD)	0.27 (0.13)	0.64 (0.14)	**<0.001**
Percentage of full-time nursing assistants, mean (SD)	47.02 (10.63)	47.19 (13.22)	0.977
Physician in charge, *N* (%)			**0.026**
Employed by the facility alone	2 (25)	1 (12.5)	
Personal GP alone	0	5 (62.5)	
Both	6 (75)	2 (25)	
IPC-trained healthcare worker, *N* (%)	8 (100)	8 (100)	1.00
Hand hygiene training, *N* (%)	6 (75)	8 (100)	0.450
Hydroalcoholic solution consumption, L/bed (2018), mean (SD)	7.0 (6.0)	4.1 (2.1)	0.233
Therapeutic guidelines available, *N* (%)	8 (100)	1 (12.5)	**0.002**
Advisory pharmacist, *N* (%)	4 (50)	0 (0.0)	0.083

IPC, infection prevention and control; GP, general practitioner; PPS, point-prevalence study; SD, standard deviation.
Significant differences are highlighted in bold.

Results

LTCF characteristics

Sixteen LTCFs were included; eight from each geographic region (Table I). The LTCFs were of similar size, with mean bed occupancy of 73 in the west and 75 in the east. Although the percentage of full-time healthcare workers was similar, western LTCFs had significantly fewer full-time nursing positions per occupied bed than eastern LTCFs (0.27 vs 0.64, respectively; $P<0.001$). Most residents in eastern LTCFs are followed-up by a personal general practitioner (GP), whereas residents in western LTCFs are mainly served by both personal GPs and physicians that are employed by the LTCF ($P=0.026$). All western LTCFs had therapeutic guidelines, compared with one LTCF in the east ($P=0.002$). No differences in pharmacological consultation were found between western and eastern LTCFs ($P=0.083$).

Characteristics of the residents

In total, 1185 residents were included in this study: 585 in western LTCFs and 600 in eastern LTCFs (Table II). Median age was 87 years (interquartile range 79–91) and most were female (71%). Few residents had an indwelling catheter; <10% had a urinary catheter and <1% had an intravenous vascular line. Pressure sores were significantly more common in western LTCFs than eastern LTCFs (4.6% vs 2%; $P=0.02$). Disorientation and dementia were significantly more common in eastern LTCFs than western LTCFs (58.2% and 55% vs 47.7% and 36.8%, respectively; $P<0.001$).

Prevalence of HAIs and potential risk factors

Among the 1185 included residents, 50 (4.2%) had HAIs. At institutional level, prevalence ranged from 0% to 7.7% (Figure 1). No differences in institutional characteristics were found between LTCFs with high prevalence of HAIs and those with low prevalence of HAIs (Table S1, see online supplementary material). Mucocutanous infections (including candida stomatitis and fungal skin infections) were most common (36%, *N*=18), followed by respiratory tract infections (RTIs) (30%, *N*=15) and urinary tract infections (UTIs) (24%, *N*=12). Results of microbiological examination were only available for two bloodstream infections, both revealing the presence of *Staphylococcus epidermidis*. Predictors of HAIs were presence of a wound (OR 2.7, 95% CI 1.2–2.5; $P=0.01$), being immobile (OR 1.9, 95% CI 1.1–3.4; $P=0.02$), and use of antibiotics (OR 63, 95% CI 29–140). In Model 1, only antibiotic use remained significant (OR 60, 95% 28–138), whereas both presence of a wound (OR 2.4, 95% CI 1.1–5.0, $P=0.02$) and being immobile (OR 1.8, 95% CI 1.0–3.3, $P=0.04$) were

Table II
Characteristics of residents

	West (*N*=585)	East (*N*=600)	*P*-value
Age, median (IQR)	88 (80–92)	85 (78–90)	0.70
Sex female, *N* (%)	421 (72)	416 (69.3)	0.35
Urinary catheter, *N* (%)	51 (8.7)	60 (10.0)	0.51
Vascular catheter, *N* (%)	5 (0.9)	1 (0.2)	0.12
Pressure sore, *N* (%)	**27 (4.6)**	**12 (2.0)**	**0.02**
Other wound, *N* (%)	40 (6.8)	55 (9.2)	0.17
Surgery in previous 30 days, *N* (%)	3 (0.5)	8 (1.3)	0.24
Wheelchair/bedridden, *N* (%)	202 (34.5)	208 (34.7)	1.00
Urinary and/or faecal incontinence, *N* (%)	387 (66)	373 (62.2)	0.17
Disorientation	**279 (47.7)**	**349 (58.2)**	**<0.001**
Dementia	**215 (36.8)**	**330 (55.0)**	**<0.001**

IQR, interquartile range.
Significant differences are highlighted in bold.

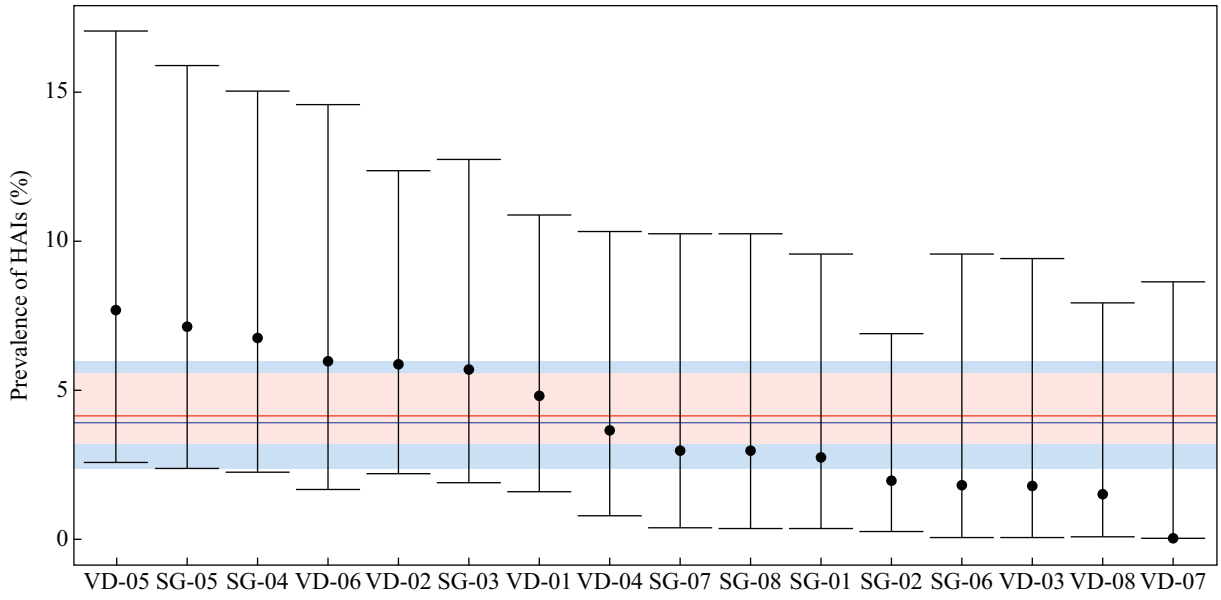

Figure 1. Caterpillar plot of the prevalence of healthcare-associated infections (HAIs) and 95% confidence intervals (CI) from 16 long-term care facilities (LTCFs). Dots, prevalence of HAIs (bars indicate 95% confidence intervals) among residents of each LTCF; red line, mean prevalence of HAIs among included Swiss LTCFs; blue line, mean prevalence of HAIs and 95% CI from European LTCFs [6].

significant in Model 2 (Table III). Estimates did not change significantly in the hierarchical model (i.e. sensitivity analysis). Of the 50 residents with HAIs, 21 (42%) were treated with antibiotics; untreated residents mainly suffered from skin infections (N=15), RTIs (N=7) and UTIs (N=6) (Table S2, see online supplementary material).

Antibiotic use

Among the 1185 residents, 34 (2.9%) were given an antibiotic on the day of the PPS, with higher prevalence among western LTCF residents (3.9%) compared with eastern LTCF residents (1.8%) (P=0.05) (Table IV). Prevalence rates ranged from 0% to 8% between institutions (Figure 2). A positive association was found between high antibiotic use and number of beds (Table S3, see online supplementary material). In western LTCFs, 18 residents received therapeutic antibiotics, of whom 17 (94%) fulfilled the criteria for HAI; in eastern LTCFs, four of eight (50%) residents treated with therapeutic intention fulfilled the criteria for HAI (data not shown). According to the patient charts, antibiotics were mainly given for the treatment of UTIs (32%, N=11), RTIs (26%, N=9) and for prophylaxis (21%, N=7). Amoxicillin/clavulanate (N=11) was the most commonly used antibiotic in both regions, followed by quinolones (N=6). Nitrofurantoin and fosfomycin were only used in western LTCFs, whereas trimethoprim/sulfamethoxazole was only used in eastern LTCFs (all for prophylaxis or treatment of UTIs) (Table IV). Eight residents received prophylactic antibiotics:

Table III
Predictors of infection among nursing home residents using logistic regression analysis

	Infection	No infection	Univariable			Model 1			Model 2		
	N=50	N=1135	OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value
Age [mean (SD)]	83.02 (12.3)	84.56 (24.7)	1.0	0.97–1.01	0.58						
Female, N (%)	36 (72.0)	801 (70.6)	1.1	0.6–2.1	0.83						
Western Switzerland, N (%)	25 (50.0)	560 (49.3)	1.0	0.6–1.8	0.93						
Urinary catheter, N (%)	8 (16.0)	103 (9.1)	1.9	0.8–4.0	0.11						
Urinary or faecal incontinence, N (%)	36 (72.0)	724 (63.8)	1.5	0.8–2.8	0.24						
Pressure sore, N (%)	1 (2.0)	38 (3.3)	0.6	0.1–2.8	0.61						
Other wound, N (%)	9 (18.0)	86 (7.6)	2.7	1.2–2.5	**0.01**	2.4	0.9–5.6	0.06	2.4	1.1–5.0	**0.02**
Disorientation, N (%)	26 (52.0)	602 (53.0)	0.9	0.5–1.7	0.89						
Dementia, N (%)	24 (48.0)	521 (45.9)	1.1	0.6–1.9	0.77						
Immobility, N (%)	25 (50.0)	750 (66.1)	1.9	1.1–3.4	**0.02**	1.7	0.9–3.3	0.12	1.8	1.0–3.3	**0.04**
Previous surgery, N (%)	1 (2.0)	10 (0.9)	2.3	0.1–12.3	0.43						
Antibiotics, N (%)	21 (42.0)	13 (1.1)	63.0	29–140	**<0.001**	60.0	28–138	**<0.001**			

Model 1, with antibiotic therapy; Model 2, without antibiotic therapy; SD, standard deviation; OR, odds ratio; CI, confidence interval.
Significant differences are highlighted in bold.

Table IV
Antibiotic substances prescribed in nursing home residents, by indication and by geographic region

	West *N*=585	East *N*=600	*P*-value
Any antibiotic	23 (3.9)	11 (1.8)	0.05
Therapeutic, *N* (%)	18 (78.2)	8 (72.7)	1.00
Amoxicillin/clavulanate, *N* (%)	8 (34.8)	3 (27.3)	0.17
Amoxicillin, *N* (%)	1 (4.3)	0	1.00
Cefuroxime, *N* (%)	2 (8.7)	0	1.00
Quinolones, *N* (%)	3 (13)	3 (27.3)	0.36
Nitrofurantoin and fosfomycin, *N* (%)	3 (13)	0	0.53
Trimethoprim/sulfamethoxazole, *N* (%)	0	2 (18.2)	0.12
Vancomycin, *N* (%)	1 (4.3)	0	1.00
Prophylactic, *N* (%)	5[a] (21.7)	3 (27.3)	1.00
Amoxicilline/clavulanate, *N* (%)	1 (4.3)	1 (9.1)	1.00
Macrolides, *N* (%)	3 (13)	0	0.53
Fosfomycin, *N* (%)	1 (4.3)	0	1.00
Trimethoprim/sulfamethoxazole, *N* (%)	0	2 (18.2)	0.12
No documented indication, *N* (%)	1 (4.3)	0	1.00
Doxycycline, *N* (%)	1 (4.3)	0	1.00

[a] One resident received two different prophylactic treatments.

three for RTI prophylaxis (macrolides), two for UTI prophylaxis (fosfomycin and amoxicillin/clavulanate), and one for skin infection prophylaxis (amoxicillin/clavulanate). No information was provided regarding the reason for trimethoprim/sulfamethoxazole prophylaxis (one resident).

Discussion

This multi-centre PPS of 1185 residents from 16 Swiss LTCFs revealed prevalence rates of HAIs and antibiotic use of 4.2% and 2.9%, respectively. Immobility and the presence of a wound were risk factors for HAI, whereas institutional factors were not associated with increased risk.

LTCF characteristics were similar between the two regions regarding infection prevention and control (IPC). Importantly, IPC training and hand hygiene training were available in most LTCFs. Indeed, as shown previously, IPC-trained healthcare workers are a cornerstone in the fight against HAIs [9,10]. Important differences between the two regions were the considerably lower nursing staff/resident ratio in the west compared with the east, and that residents in eastern LTCFs were more often treated by their individual GP compared with residents in western LTCFs.

The characteristics of the residents included in this study do not differ significantly compared with previous surveys in Europe [11,12]. The prevalence of disorientation and dementia

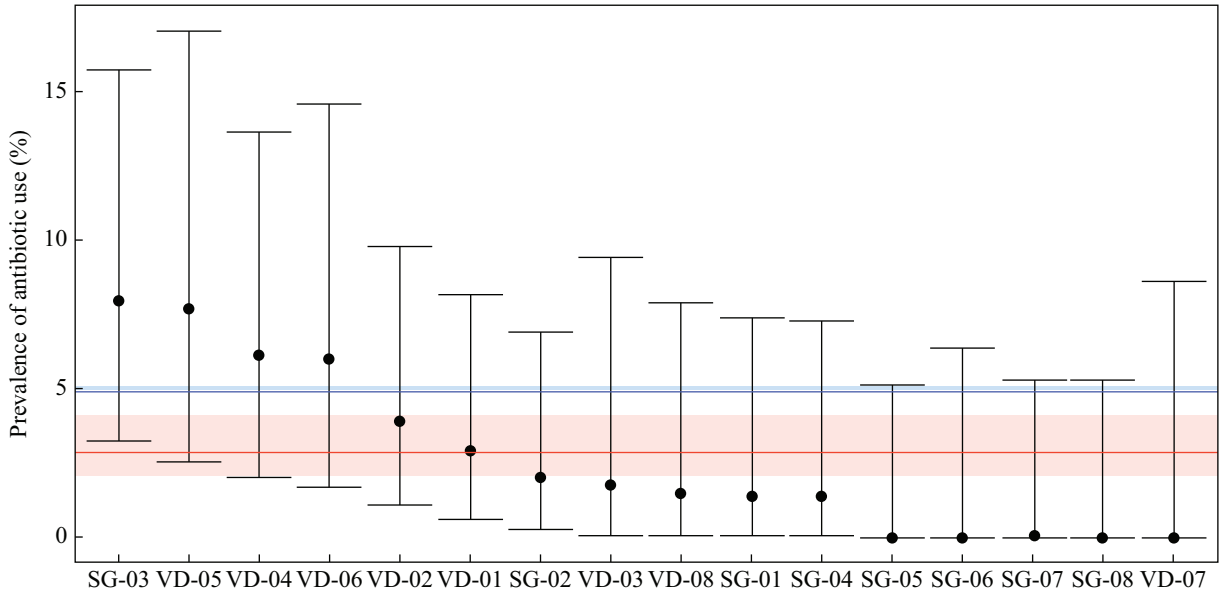

Figure 2. Caterpillar plot of antibiotic use and 95% confidence intervals (CI) from 16 long-term care facilities (LTCFs). Dots, prevalence of antibiotic use (bars indicate 95% CI) among residents of each LTCF; red line, mean prevalence of antibiotic use among included Swiss LTCFs; blue line, mean prevalence of antibiotic use and 95% CI from European LTCFs [17].

was significantly higher in the eastern LTCFs than the western LTCFs, but was similar to the 40% reported in a study from Slovenia [11]. The same study reported similar prevalence of wheelchair users and bedridden residents (28% and 27%, respectively). The present study found that <10% of the residents had an indwelling urinary catheter, which is in line with data reported in the most recent European study (7.3%) [6].

In this study, 4.2% of the residents suffered from an HAI at the time of the PPS. This prevalence is slightly higher than that found in the European survey (3.9%) [6]. However, this difference was not significant as the CIs overlap. Although there was large variation in the prevalence of HAIs between LTCFs, institutional factors were not associated with increased risk. Being immobile and the presence of a chronic wound were the only risk factors for HAI. Interestingly, 20% of all HAIs in western Switzerland occurred in one particular LTCF, with a high percentage of young residents with multiple disabilities and a high rate of indwelling catheters. Indeed, 71% of them needed a wheelchair or were bedridden, and 9% suffered from pressure sores. These results are congruent with previous data which identified these two factors – among others – as risk factors for HAI [13]. Skin infection was the prominent cause of HAIs (36%), followed by RTIs (30%) and UTIs (24%). This 'trio' is often found in the literature [6,14,15]. In an Irish PPS, for example, UTIs were the most common HAIs (40%), followed by RTIs (28%) and skin infections (20%) [14]. Of note, none of the carriers of urinary catheters (N=51) in LTCFs in western Switzerland had UTIs, compared with three of 60 (5%) in eastern Switzerland. This difference may be due to guidelines for the care of urinary catheters that are available online for IPC workers in the western LTCFs [16].

Only 2.9% of the residents in this survey received antibiotics on the day of the PPS, which is 1.9% points lower than in a recently published European survey [17]. In the European survey, 69.5% of the antibiotics were used for treatment and 29.4% for prophylaxis, which is similar to the findings of the present study (76.5% and 23.5%, respectively). The present result of 2.9% for prevalence of antibiotic use is also below the prevalence of antibiotic use found in a recent narrative review (3–11%) [18]. In Switzerland, cantons in the west and the south have been shown to have higher antibiotic consumption than cantons in the east, which is probably due to sociocultural factors [19]. Still, antibiotic use was also relatively low among western institutions in the present study. One reason for this may be that guidelines on antibacterial therapy, as well as regular physician–pharmacist–nurse quality circles were implemented in the west, which may have led to a significant decrease in antibiotic use between 2011 and 2016 [20]. Indeed, one recent review revealed that nearly half of the antibiotics that are prescribed in LTCFs are not necessary, and that antibiotic stewardship is key in LTCFs [9]. The purpose of the present survey was not to evaluate the appropriateness of the antibiotic treatment; this could be evaluated in further studies as data from the Netherlands show that antibiotic consumption could be reduced if appropriateness is improved, particularly for UTIs [21]. Nevertheless, given that the prevalence of HAIs was higher than the prevalence of antibiotic use, it is likely that most treatments were appropriate, at least in terms of the indication. Of note, most skin infections were treated with topical antifungals, which were not documented with the questionnaire.

Most antibiotics were penicillins and quinolones, which is also in line with European data [11,17]. Although antimicrobial use in the LTCFs in this study was lower than in other European countries, antibiotic prescription could be improved in terms of the prescribed group of antibiotics. Indeed, amoxicillin/clavulanate and fluoroquinolones may be problematic regarding antimicrobial resistance and the risk of *Clostridioides difficile* infection [22,23]. Although not significant, nitrofurantoin and fosfomycin were only used in western LTCFs; in eastern Switzerland, trimethoprim/sulfamethoxazole was used in four residents. As preventive and therapeutic guidelines for LTCFs are available in the west, whereas only general guidelines exist in the east, it is hypothesized that guidelines are followed more strictly in western LTCFs [24]. Another explanation could be that the resistance rate to trimethoprim/sulfamethoxazole in *Escherichia coli* had been lower in the east than in the west for a long time. In any case, the use of guidelines may have an impact on the prescription of antibiotics. Therefore, implementation of specific guidelines for antibiotic prescription in LTCFs should be encouraged [25].

Use of the ECDC framework and the inclusion of a large number of residents living in LTCFs of two regions of Switzerland are particular strengths of this study. Nevertheless, it has several limitations. First, despite the large number of included residents, the study only covered two regions of Switzerland and may not be representative for all regions, particularly not for those without IPC training, where the prevalence of HAIs may be higher. Indeed, recent data about the COVID-19 pandemic revealed the importance of IPC training in preventing HAIs [26]. Baseline characteristics of the LTCF residents were similar to studies from European countries (e.g. portion of immobile residents 28% and 27%; urinary catheter in <10% of residents), which suggests that the data reflect a realistic setting and are not influenced by possible selection bias as the institutions were included on a voluntary basis [6,11,12]. Second, the number of residents receiving antibiotic treatment was too low to assess risk factors, particularly at institutional level, for high antibiotic use. Third, the PPS only represents one moment in time, and the results should not be overstated.

In conclusion, this study found that the point prevalence of HAIs and antibiotic use in a selected number of LTCFs in two regions of Switzerland were similar or even lower compared with European data. Resident-level risk factors are more important than institutional-level factors for the development of HAIs. The relatively frequent use of penicillins and fluoroquinolones may be problematic, and should be further investigated and potentially optimized within antibiotic stewardship programmes. This first PPS study in Swiss LTCFs was embedded in the NOSO strategy built up by FOPH. A further PPS at national level would provide a more complete picture of the burden of HAIs and antibiotic use, which may help to implement targeted measures and reduce the burden of HAIs in LTCFs.

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Conflict of interest statement
None declared.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jhin.2021.08.018.

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