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Original article

Prevalence of healthcare-associated urinary tract infections in Catalonia

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ABSTRACT

Introduction: Healthcare-associated urinary tract infections (HCA-UTIs) account for an important number of infections in acute care hospitals (ACH) and long-term care facilities (LTCF). Our objective was to evaluate the prevalence of HCA-UTIs in Catalonia.
Methods: Descriptive observational study in which we analyzed the prevalence of HCA-UTIs, including catheter-associated UTIs (CAUTIs) and non-CAUTIs, from point prevalence surveys conducted in 55 ACH (44,734 patients) and 97 LTCF (116,882 residents) between 2013 and 2022 as part of the VINCat program. Prevalence time trends were also assessed by using a Spearman correlation.
Results: In ACH, the overall prevalence of HCA-UTI was 1.6%. The prevalence of CAUTI was 3.9%, while the prevalence of non-CAUTI was 1%, with no significant changes over time. CAUTIs were more prevalent in large size and specialty hospitals. Among the 695 HCA-UTIs, 325 (46.8%) were CAUTIs and 370 (53.2%) non-CAUTIs. The overall prevalence of HCA-UTI in LTCF was 3.6%. The prevalence of CAUTI and non-CAUTI was 11% and 2.8%, respectively, with no significant changes over time. Among the 4190 HCA-UTIs, 1200 (28.6%) were CAUTIs and 2990 (71.4%) non-CAUTIs.
Conclusion: Most HCA-UTIs, in ACH and LTCF, were non-CAUTIs although patients with a urinary catheter had a higher risk of HCA-UTIs. HCA-UTIs surveillance programs are essential for identifying at risk patients and developing preventive strategies.

Prevalencia de las infecciones del tracto urinario relacionadas con la atención sanitaria en Cataluña

Palabras clave:
Infecciones del tracto urinario relacionadas con la atención sanitaria
Sonda urinaria
Hospitales de agudos
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RESUMEN

Introducción: Las infecciones del tracto urinario relacionadas con la atención sanitaria (ITU-AS) causan un importante número de infecciones en hospitales de agudos (HA) y centros sociosanitarios (CSS). Nuestro objetivo fue evaluar la prevalencia de las ITU-AS en Cataluña.
Métodos: Estudio descriptivo observacional en el que se analizó la prevalencia de las ITU-AS, incluyendo las asociadas a sonda urinaria (SU) (ITU-SU) y las no asociadas a SU (ITU-NSU), a partir de estudios de

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prevalencia realizados en 55 HA (44.734 pacientes) y 97 CSS (116.882 residentes) entre 2013 y 2022 como parte del programa VINCat. También se evaluaron las tendencias temporales de la prevalencia mediante una correlación de Spearman.

Resultados: En HA, la prevalencia global de ITU-AS fue del 1,6%. La prevalencia de ITU-SU fue del 3,9% y la de UTI-NSU del 1%, sin evidenciarse cambios temporales. Las ITU-SU fueron más prevalentes en hospitales grandes y aquellos especializados. Entre las 695 ITU-AS, 325 (46,8%) fueron ITU-SU y 370 (53,2%) ITU-NSU. En CSS, la prevalencia global de ITU-AS fue del 3,6%. La prevalencia de ITU-SU y de ITU-NSU fue del 11 y el 2,8%, respectivamente, sin objetivar cambios en el tiempo. Entre las 4.190 ITU-AS, 1.200 (28,6%) fueron ITU-SU y 2.990 (71,4%) ITU-NSU.

Conclusión: La mayoría de las ITU-AS en HA y CSS, fueron ITU-NSU, aunque los pacientes con SU presentaron un mayor riesgo de ITU-AS. Los programas de vigilancia de las ITU-AS son esenciales para identificar a los pacientes de riesgo y desarrollar estrategias preventivas.

Introduction

Urinary tract infections (UTIs) represent one of the most frequent healthcare-associated infections (HAIs) in acute care hospitals (ACH) and long-term care facilities (LTCF). Healthcare-associated UTIs (HCA-UTIs) accounted for 20.6% of all hospital-acquired infections, according to the 2023 report on the prevalence of HAIs in hospitalized patients in Spain, which is slightly higher than the frequencies found in a previous European point prevalence survey (PPS).[1,2] In the case of LTCF, the same European study revealed that HCA-UTIs were responsible for 32% of all HAIs in LTCF.[2]

It has been estimated that approximately 70% of all hospital-acquired UTIs occur in patients with indwelling urinary catheters (IUCs).[3] This is particularly relevant if we consider that between 21% and 55% of patients have an inappropriate indication for urethral catheterization, and thus catheter-associated UTIs (CAUTIs) are a potentially preventable complication.[4] IUCs are placed in approximately 20% of patients admitted to ACH and in 5–10% of residents in LTCF.[1,2,5] CAUTIs are the main complication derived from the use of IUCs, being the risk directly proportional to the catheterization time.[6] The probability of asymptomatic bacteriuria increases by 3–8% per day of urinary catheterization, although less than 25% will develop a symptomatic UTI.[7] In addition, CAUTIs are a common cause of secondary bloodstream infection in patients admitted to ACH and in residents from LTCF.[6]

Although morbidity, mortality, and healthcare costs of HCA-UTIs are lower than those of other HAIs, their high frequency and preventability make HCA-UTIs a public health priority.[8] Despite their high frequency, UTIs are frequently overdiagnosed due to the high prevalence of asymptomatic bacteriuria in older people, which may lead to an incorrect diagnosis and unnecessary antimicrobial treatment when nonspecific urinary symptoms are present.[5,9] An overuse of antimicrobials can cause adverse drug events, and by applying selective pressure, increase the risk of *Clostridioides difficile* and multidrug-resistant organisms infections which can have an impact not only on the person taking antibiotics but also on those around them.[10]

Therefore, HCA-UTIs must be monitored in any given HAIs surveillance program and be the target of quality programs. The objective of this study was to evaluate the prevalence of HCA-UTIs in ACH and LTCF in the VINCat program and analyze their time trends over a 10-year period.

Methods

This was a descriptive observational study that examined the prevalence of HCA-UTIs from PPS in ACH and LTCF, in Catalonia between 2013 and 2022 as part of the VINCat program. The program provides a unified surveillance system for HAIs in health care centres in Catalonia. The PPS methodology in ACH and LTCF has been described in the specific articles included in this monographic review and in the VINCat manual.[11] In ACH and LTCF, two PPS (in May and November) are conducted annually. In the case of ACH, only data on the PPS performed in May were included, as all size hospitals participated in the study. The study included 55 ACH (44,734 patients) and 97 LTCF (116,882 residents).

Variables collected from patients in PPS from ACH included age, gender, presence of an IUC, admission ward (medical or surgical specialty or intensive care unit (ICU)), recent surgery (within the previous 30 days), antimicrobial therapy at the time of the study, and whether the patient had an HCA-UTI including number of days from admission to infection. In the case of residents from LTCF, additional specific variables collected included type of admission (convalescent, long-term care, or subacute unit), resident status, including the Barthel index score, global deterioration scale, Charlson comorbidity index, and existence of temporal and spatial disorientation, severe dependency, dysphagia, and fecal or urinary incontinence.

The overall prevalence of HCA-UTI was calculated by dividing the number of patients with a HCA-UTI by the number of patients included in the study. The prevalence of CAUTI and non-catheter-associated UTI (non-CAUTI) were defined as the number of patients with the infection divided by the number of patients with or without a urinary catheter, respectively.

Only symptomatic UTIs were considered, and thus patients with asymptomatic bacteriuria were not included. The European Centre for Disease Prevention and Control case definitions were applied to patients with suspected UTI without IUC and can be reviewed in the VINCat manual.[11,12] The VINCat program has grown steadily since its inception, and it now has 10 objectives. Objective number 10, which is focused on HCA-UTIs surveillance, primarily in patients with IUCs, was the last to be included in 2022. The diagnostic criteria for CAUTIs were those established by the Infectious Diseases Society of America in 2009.[7] Prior to 2022, for the purposes of this study, we assumed that a patient had a CAUTI if, they had a UTI and an IUC in place on the day of the PPS.

Urine samples were collected from clean-catch midstream urine. Following the recommendations issued by the Infectious Diseases Society of America and the Spanish Society of Infectious Diseases and Clinical Microbiology, urine collection in patients with short-term IUCs were obtained by sterile puncture-aspiration through the sampling port. In cases of long-term IUCs, urine samples were collected from a newly inserted catheter. If catheter use was no longer necessary, a urine sample could be obtained by spontaneous micturition.[7,13] Urine samples were cultured according to

Table 1
Patients included in the study.

Characteristics	Overall	Period 1	Period 2	*p*-Value[a]
Acute care hospitals				
Number of patients, n	44,734	19,927	24,807	
IUC wearer prevalence				
No	36,414 (81.4)	16,215 (81.4)	20,199 (81.4)	0.897
Yes	8,320 (18.6)	3,712 (18.6)	4,608 (18.6)	–
IUC wearer prevalence by ward				
ICU	1,487 (69.6)	657 (71.8)	830 (67.9)	0.056
Medical	3,338 (13.4)	1,444 (12.9)	1,894 (13.8)	0.035
Surgical	3,495 (19.8)	1,611 (20.6)	1,884 (19.1)	0.011
HCA-UTI prevalence, n (%)	695 (1.6)	305 (1.5)	390 (1.6)	0.753
Long-term care facilities				
Number of patients, n	116,822	50,686	66,136	
IUC wearer prevalence				
No	105,944 (90.7)	46,106 (91)	59,838 (90.5)	0.005
Yes	10,878 (9.3)	4,580 (9)	6,298 (9.5)	–
IUC wearer prevalence by ward				
Convalescent unit	3,209 (8.6)	1,299 (8.6)	1,910 (8.5)	0.893
Long-term care unit	4,715 (8.6)	2,032 (8.3)	2,683 (8.7)	0.111
Subacute unit	974 (18.3)	362 (18.7)	612 (18.1)	0.603
HCA-UTI prevalence, n (%)	4,190 (3.6)	1,810 (3.6)	2,380 (3.6)	0.814

IUC: indwelling urinary catheter; ICU: intensive care unit; HCA-UTI: healthcare-associated urinary tract infection.
[a] Pearson Chi-squared test.

standard methods. Each center's reference microbiological laboratory performed microbiological identification and antimicrobial susceptibility testing.

Statistical analysis

Data were summarised as frequencies and proportions for categorical variables. For continuous variables, we presented medians and interquartile ranges or means and standard deviations, depending on the distribution. To assess differences in percentages, we conducted Chi-squared tests or Fisher's tests, as deemed suitable. For continuous variables, comparisons were performed using the Student's *t*-test or the Wilcoxon–Mann–Whitney test, as appropriate. Analyses were stratified into two 5-year periods, with Period 1 covering from 2013 to 2017 and Period 2 spanning from 2018 to 2022. To assess the strength and direction of the monotonic relationship between urinary infection prevalence across the years, we conducted a Spearman correlation (rho). A significance level of 0.05 was applied to all statistical tests. In addition, LOESS smoothing was applied to the graphs to provide a clearer depiction of data trends. Results were analysed using the statistical bundle R v4.2.2, The R Foundation, Vienna, Austria.

Results

The overall HCA-UTI prevalence in ACH was 1.6%, while the prevalence of patients with an IUC was 18.6% (Table 1). CAUTIs were found in 325 of the 8320 catheterized patients, giving a prevalence rate of 3.9%, which was higher than the non- CAUTI prevalence (Table 2). There was no discernible temporal trend in the prevalence of CAUTIs and non-CAUTIs in ACH (Fig. 1). When compared to medium and small hospitals, the prevalence of CAUTIs was higher in large and specialty hospitals, though there was a significant increase in the prevalence of CAUTIs in small size hospitals during the two study periods (Table 2).

The characteristics of patients with HCA-UTIs in ACH are shown in Table 3. Among the 695 HCA-UTIs episodes, 325 (46.8%) were CAUTIs and 370 (53.2%) non-CAUTIs. Overall, patients who developed a CAUTI had a similar age as patients with a non-CAUTI. There was a trend toward a lower percentage of females in patients with a CAUTI. Patients admitted to the medical wards had the highest overall rates of HCA-UTIs, regardless of the presence of an IUC, followed by those in the surgical wards, while patients in the ICUs had the lowest rates. The prevalence of CAUTIs was 4.7% in the medical wards, 3.5% in the surgical wards, and 3.02% in the ICU. A closer examination revealed that the overall percentage of non-CAUTIs was higher in the medical wards when compared to the rates of CAUTIs (62.4% versus 48.6%), while the percentage of CAUTIs was higher in the ICUs (13.8% versus 1.4%). There were no significant differences between CAUTIs and non-CAUTIs in terms of recent surgery, antimicrobial use, or days from admission to UTI. No significant changes in the prevalence of CAUTIs and non-CAUTIs was observed over time (Fig. 1).

In LTCF, the prevalence of HCA-UTIs remained constant between periods 1 and 2, with an overall frequency of 3.6%. In the examined periods, the prevalence of patients with an IUC, increased from 9% to 9.5%, with a global prevalence of 9.3% (Table 1). CAUTIs were reported in 1200 out of 10,878 catheterized patients, resulting in an 11% prevalence rate, which was higher than the prevalence of non-CAUTIs (Table 2).

There was a non significant trend towards a decrease in the prevalence of CAUTIs in LTCF (Fig. 2). This tendency was observed mainly in convalescent and subacute units. Convalescent unit residents had a higher overall prevalence of CAUTI (Table 2).

Table 4 shows the main characteristics of patients with HCA-UTIs in LTCF. One thousand two hundred (28.6%) of the 4190 episodes of HCA-UTIs were CAUTIs and 2990 (71.4%) non-CAUTIs. Overall, residents who acquired a CAUTI were younger, with a lower percentage of females than those with non-CAUTI. In terms of the patient's conditions, those with a CAUTI had lower Barthel scales as well as higher Charlson comorbidity scores and an increased degree of disorientation, severe dependency, dysphagia, pressure ulcers and fecal or urinary incontinence.

Table 5 shows the uropathogens isolated in HCA-UTIs in both ACH and LTCF. Gram-negative bacteria, primarily *Escherichia coli*, were the most common pathogens causing CAUTIs and non-CAUTIs

Table 2
Prevalence of urinary tract infections among catheterized and non-catheterized patients, by hospital size or unit type.

Hospital size or unit type	Participating centers			Non-CAUTI				CAUTI			
	OP	P1	P2	OP	P1	P2	*p*-Value[a]	OP	P1	P2	*p*-Value[a]
Acute care hospitals											
Large	5	4	5	132/10,338 (1.3)	68/5,488 (1.2)	64/4,850 (1.3)	0.786	133/2,818 (4.7)	67/1,434 (4.7)	66/1,384 (4.8)	0.979
Medium	14	8	14	145/15,075 (1)	59/6,563 (0.9)	86/8,512 (1)	0.546	104/3,128 (3.3)	44/1,342 (3.3)	60/1,786 (3.4)	0.984
Small	31	19	30	60/8,792 (0.7)	27/2,928 (0.9)	33/5,864 (0.6)	0.075	58/1,724 (3.4)	10/546 (1.8)	48/1,178 (4.1)	0.029
Specialty hospital	5	3	5	33/2,209 (1.5)	13/1,236 (1.1)	20/973 (2.1)	0.085	30/650 (4.6)	17/390 (4.4)	13/260 (5)	0.862
Total	55	34	54	370/36,414 (1)	167/16,215 (1)	203/20,199 (1)	0.857	325/8,320 (3.9)	138/3,712 (3.7)	187/4,608 (4.1)	0.478
Long-term care facilities											
Convalescent unit	87	70	82	1,047/34,315 (3.1)	452/13,843 (3.3)	595/20,472 (2.9)	0.071	417/3,209 (13)	173/1,299 (13.3)	244/1,910 (12.8)	0.733
Long-term care unit	86	76	83	1,313/50,397 (2.6)	550/22,333 (2.5)	763/28,064 (2.7)	0.086	502/4,715 (10.6)	218/2,032 (10.7)	284/2,683 (10.6)	0.925
Subacute unit	50	35	48	163/4,335 (3.8)	56/1,570 (3.6)	107/2,765 (3.9)	0.687	92/974 (9.4)	35/362 (9.7)	57/612 (9.3)	0.957
Total	97	86	96	2,990/105,944 (2.8)	1,286/46,106 (2.8)	1,704/59,838 (2.8)	0.593	1,200/10,878 (11)	524/4,580 (11.4)	676/6,298 (10.7)	0.313

OP: overall period (2013–2022); P1: Period 1 (2013–2017); P2: Period 2 (2018–2022); UTI: urinary tract infection; CAUTI: catheter-associated UTI.
Large: hospitals with >500 beds; medium: hospitals with 200–500 beds; small: hospitals with <200 beds. Prevalence results are expressed as patients with UTI/total patients per group (%).

[a] Pearson Chi-squared test.

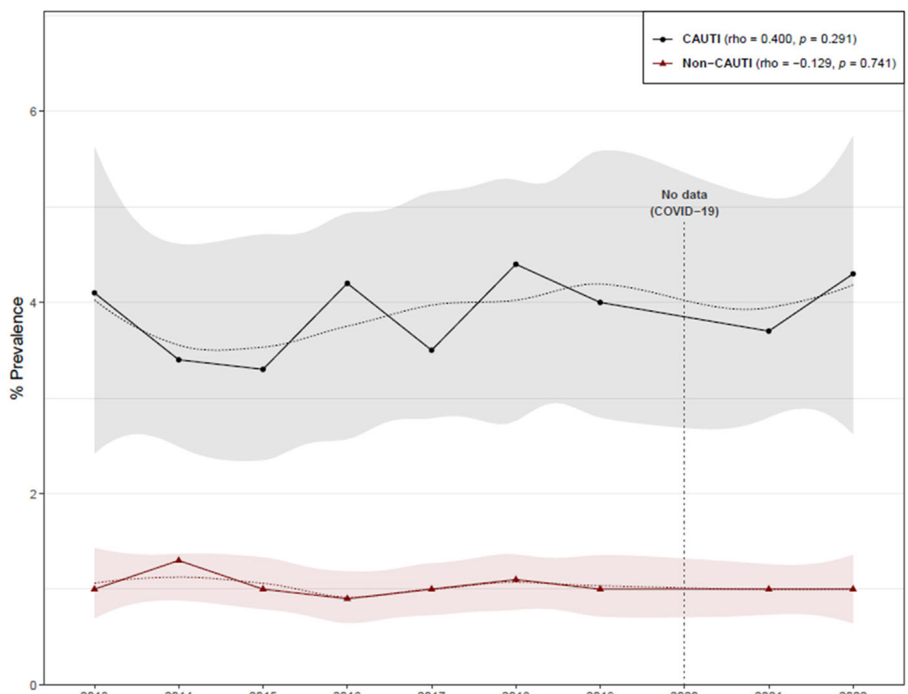

Fig. 1. Evolution of CAUTI and non-CAUTI prevalence in acute care hospitals. CAUTI: catheter-associated urinary tract infection.

episodes in ACH and LTCF, though they were isolated less frequently in LTCF. *Pseudomonas aeruginosa* and *Enterococcus* spp. were more common in CAUTIs isolates from ACH patients than in those from LTCF. In LTCF, the proportion of patients who did not have a urine culture collected was significantly higher. Polymicrobial growth was observed in a comparable number of CAUTIs in ACH and LTCF.

Discussion

This study provides important insights regarding the prevalence of HCA-UTIs in a large number of patients from ACH and LTCF. According to the VINCat PPS data included in this monographic issue, HCA-UTIs were the second most frequent HAIs in ACH after surgical site infections and the main cause of HAIs in LTCF. These findings differ from those reported in the European Centre for Disease Prevention and Control latest PPS.[2] First, the HAIs prevalence was lower than the VINCat rates both in ACH (5.9% versus 7.1%) and LTCF (3.7% versus 8.8%). Second, in the European PPS, HCA-UTIs were the second most frequent HAIs after respiratory infections in all clinical settings. The frequencies of HCA-UTIs in the European PPS were lower when compared to the overall prevalence reported by the VINCat in ACH (18.9% versus 25% of all reported infections) and LTCF (32% versus 41.2% of all reported infections).

According to our findings, the majority of HCA-UTIs were non-CAUTIs, though patients with an IUC were at higher risk of developing a HCA-UTI. As we used CAUTI and non-CAUTI prevalence rates, it is was difficult to compare our results to those of

Table 3
Characteristics of patients with urinary tract infections in acute care hospitals.

Characteristics	Overall (n = 695)			Period 1 (n = 305)			Period 2 (n = 390)		
	Non-CAUTI 370 (53.2%)	CAUTI 325 (46.8%)	p-Value[a]	Non-CAUTI 167 (54.8%)	CAUTI 138 (46.2%)	p-Value[a]	Non-CAUTI 203 (52.1%)	CAUTI 187 (47.9%)	p-Value[a]
Patient details									
Age, median (Q1–Q3)	75.2 (62.7–83.3)	74.8 (62.6–83.8)	0.746	72.4 (60.8–81.9)	73.9 (62.3–83.2)	0.699	76.2 (65.5–84.2)	75.3 (63.1–84.7)	0.962
Female sex, n (%)	188 (50.8)	141 (43.4)	0.060	88 (52.7)	61 (44.2)	0.173	100 (49.3)	80 (42.8)	0.238
Wards									
Intensive care	5 (1.4)	45 (13.8)	<0.001	1 (0.6)	21 (15.2)	<0.001	4 (2)	24 (12.8)	<0.001
Medical specialties	231 (62.4)	158 (48.6)	–	107 (64.1)	61 (44.2)	–	124 (61.1)	97 (51.9)	–
Surgical specialties	134 (36.2)	122 (37.5)	–	59 (35.3)	56 (40.6)	–	75 (36.9)	66 (35.3)	–
Medical cares									
Surgery (in the previous 30 days), n (%)	117 (31.6)	113 (34.8)	0.647	54 (32.3)	61 (44.2)	0.070	63 (31)	52 (27.8)	0.741
Antibiotic usage, n (%)	351 (94.9)	315 (96.9)	0.244	158 (94.6)	134 (97.1)	0.431	193 (95.1)	181 (96.8)	0.549
Days from admission to UTI, median (Q1–Q3)	8 (4–21)	10 (4–22)	0.590	8 (4–19)	11 (4–21)	0.246	8 (4–21)	9 (4–23)	0.747

Q1: 1st quartile or 25th percentile; Q3: 3rt quartile or 75th percentile; SD: standard deviation; UTI: urinary tract infection; CAUTI: catheter-associated UTI.
[a] Two-sample t-test or Wilcoxon rank-sum test; Pearson Chi-squared test or Fisher exact test.

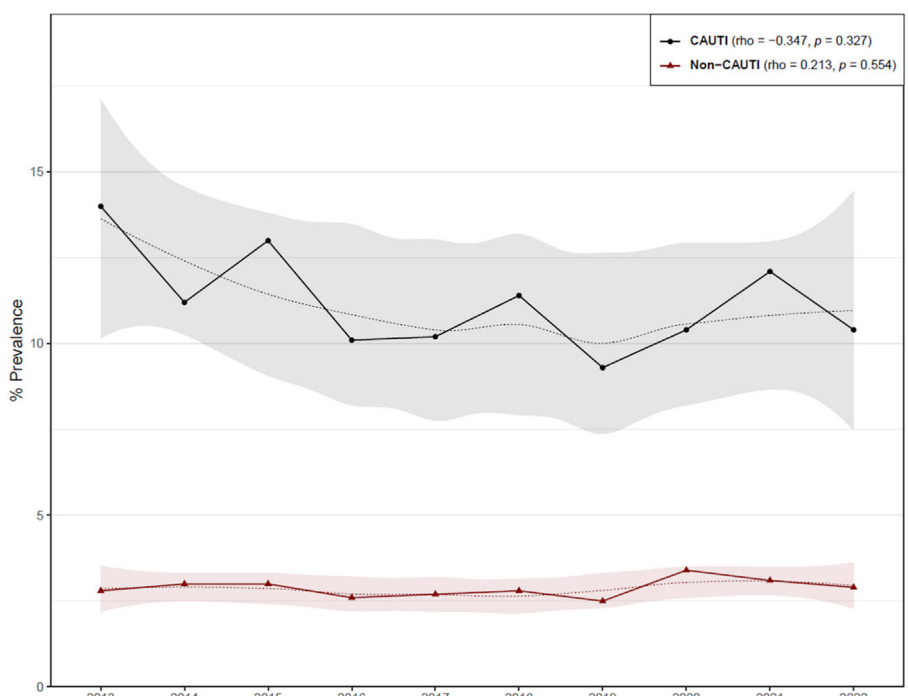

Fig. 2. Evolution of CAUTI and non-CAUTI prevalence in long-term care facilities. CAUTI: catheter-associated urinary tract infection.

previous studies. The most commonly reported metric is CAUTI incidence rates, which is the number of infections per 1000 catheter-days. This rate, however, is difficult to obtain in most ACH, with the exception of services such as the ICUs, and especially in LTCF. We found an overall CAUTI prevalence of 3.9% in ACH, which is lower than the prevalence reported in Italy (6.2%) and higher than the rates observed in the United States (1.4%).[14,15] Data on CAUTI prevalence in LTCF are even more limited. The prevalence of HCA-UTIs is reported in PPS on HAIs in LTCF, but no information on the prevalence of CAUTIs is usually given.[2] CAUTI incidence rates are occasionally provided, normally in the context of interventions to prevent CAUTIs.[16] As a result, we were unable to compare our 11% overall CAUTI prevalence in LTCF to rates reported in previous studies.

The most important risk factor for HCA-UTIs is urinary catheters exposure, which is widely accepted and supported by our data. In addition to increasing the risk of CAUTIs, IUC use has been linked to other negative outcomes.[17] Various strategies aimed at reducing CAUTIs frequency have been developed. An educational intervention promoting adherence to appropriate urinary catheter indication decreased catheter utilization from 18.1% to 13.8% and improved adequate indication from 44.3% to 57.6%.[18] In another initiative to improve safety in patients requiring IUCs, CAUTI rates were reduced from 2.4 to 0.8 episodes per 1000 catheter-days.[19] A

Table 4
Characteristics of patients with urinary tract infections in long-term care facilities.

Characteristics	Overall (n = 4,190)			Period 1 (n = 1,810)			Period 2 (n = 2,380)		
	Non-CAUTI 2,990 (71.4)	CAUTI 1,200 (28.6)	p-Value[a]	Non-CAUTI 1,286 (71)	CAUTI 524 (29)	p-Value[a]	Non-CAUTI 1,704 (71.6)	CAUTI 676 (28.4)	p-Value[a]
Patient details									
Age, median (Q1–Q3)	84.1 (77–89.1)	83.3 (75–88.5)	0.006	83.8 (77.1–88.6)	83 (74.9–87.7)	0.013	84.3 (76.9–89.3)	83.5 (75.1–89)	0.137
Female sex, n (%)	2,010 (67.2)	523 (43.6)	<0.001	854 (66.4)	213 (40.6)	<0.001	1,156 (67.8)	310 (45.9)	<0.001
Ward									
Convalescent unit	1,047 (35)	417 (34.8)	<0.001	452 (35.1)	173 (33)	<0.001	595 (34.9)	244 (36.1)	0.005
Long-term care unit	1,313 (43.9)	502 (41.8)	–	550 (42.8)	218 (41.6)	–	763 (44.8)	284 (42)	–
Subacute unit	163 (5.5)	92 (7.7)	–	56 (4.4)	35 (6.7)	–	107 (6.3)	57 (8.4)	–
Patient situation									
Barthel scale, mean (SD)	34.8 (26.2)	23.7 (22.9)	<0.001	34.7 (26.3)	23.5 (23.4)	<0.001	34.8 (26.1)	23.9 (22.5)	<0.001
GDS, mean (SD)	3.8 (2.1)	3.9 (2.1)	0.479	3.6 (2.2)	3.7 (2.2)	0.510	3.9 (2.1)	4 (2.1)	0.561
Charlson scale, mean (SD)	3.9 (3.2)	4.2 (3.1)	0.019	3.5 (3.3)	4 (3.6)	0.059	4.1 (3.1)	4.4 (2.8)	0.057
Temporal and spatial disorientation, n (%)	1,578 (52.8)	690 (57.5)	0.006	655 (50.9)	303 (57.8)	0.009	923 (54.2)	387 (57.2)	0.188
Severe dependency, n (%)	1,566 (52.4)	850 (70.8)	<0.001	672 (52.3)	370 (70.6)	<0.001	894 (52.5)	480 (71)	<0.001
Dysphagia, n (%)	781 (26.1)	448 (37.3)	<0.001	327 (25.4)	182 (34.7)	<0.001	454 (26.6)	266 (39.3)	<0.001
Pressure ulcers, n (%)	515 (17.2)	348 (29)	<0.001	204 (15.9)	139 (26.5)	<0.001	311 (18.3)	209 (30.9)	<0.001
Fecal/urinary incontinence, n (%)	2,087 (69.8)	992 (82.7)	<0.001	843 (65.6)	426 (81.3)	<0.001	1,244 (73)	566 (83.7)	<0.001
Medical cares									
Surgery (in the previous 30 days), n (%)	348 (11.6)	131 (10.9)	0.542	166 (12.9)	68 (13)	1.000	182 (10.7)	63 (9.3)	0.362
Antibiotic usage, n (%)	2,949 (97.9)	1,192 (97.9)	1.000	1,265 (97.6)	514 (97.2)	0.701	1,684 (98.1)	678 (98.4)	0.780
Days from admission to UTI, median (Q1–Q3)	22 (8–54)	22 (9–52)	0.974	22 (8–53)	20 (8–54)	0.461	22 (8–55)	24 (10–51)	0.544

Q1: 1st quartile or 25th percentile; Q3: 3rt quartile or 75th percentile; SD: standard deviation; UTI: urinary tract infection; CAUTI: catheter-associated UTI; GDS: global deterioration scale.

[a] Two-sample *t*-test or Wilcoxon rank-sum test; Pearson Chi-squared test or Fisher exact test.

recent intervention that included replacing any IUC that had been in place for more than 14 days and sending a urine culture only if urinalysis and clinical evaluation suggested a UTI, reduced CAUTIs from 3 to 0.94 infections/1000 catheter-days.[20]

Similar studies in LTCF have shown a significant reduction in CAUTI rates. In a large prospective project in nursing homes based on the C (catheter removal), A (aseptic insertion), U (use regular assessments), T (training for catheter care), I (incontinence care planning) bundle, CAUTI rates fell from 6.7 to 2.6 infections per 1000 catheter-days.[16] Once an IUC has been inserted, its presence is usually forgotten. It has been demonstrated that IUC reminders and/or withdrawals orders are effective in lowering the rate of CAUTIs.[4]

The prevalence of CAUTIs in ACH was higher in large hospitals, particularly in medical wards, despite having lower rates of urinary catheterization than ICUs. The implementation of the CAUTI-ZERO program may have contributed to the lower prevalence of CAUTIs in ICUs.[21] Regarding LTCF, despite lower rates of urinary catheterization than in subacute units, CAUTI prevalence was higher in convalescent units. HCA-UTIs were the most frequent HAIs in LTCF, but due to the high prevalence of AB in older patients, it was most likely overdiagnosed.

It is accepted that CAUTIs account for 70% of HCA-UTIs, although this conclusion is based on older studies conducted prior to the implementation of CAUTI prevention programs.[3,22] In our study, 46.8% of all HCA-UTIs in ACH and 28.6% in LTCF were CAUTIs. Therefore, most HCA-UTIs were in fact non-CAUTIs. Similar findings have previously been reported.[23,24] A limited number of studies have evaluated risk factors for non-CAUTIs. Comorbidity has been identified as a risk factor for non-CAUTIs in ACH.[25] In nursing homes, non-CAUTIs were more prevalent among women, residents over the age of 65, and those with falls, walking dependence, restraint use, treatment with antipsychotic or anti-anxiety medications, or with pressure ulcers.[24] Additional studies are required to fully identify risk factors for non-CAUTIs in ACH and LTCF.

Interventions have been developed to prevent non-CAUTIs. A care bundle based on close monitoring of hand hygiene compliance, routine checking of hydration status, effective incontinence and perineal care, and monitoring of antimicrobial use in urinary infection reduced HCA-UTIs from 4.2% to 0.9% in nursing residents without an IUC.[26] HCA-UTIs and antimicrobial use were reduced in nursing homes by a simple measure such as adequate hydration.[27]

In line with previous studies, in ACH, Gram-negative bacteria, particularly *E. coli*, were the most common pathogens isolated in HCA-UTIs, followed by *Klebsiella pneumoniae* in non-CAUTIs and *P. aeruginosa* in CAUTIs.[28] In a retrospective cohort study of ACH patients, CAUTIs had a higher frequency of polymicrobial infections and infections caused by *P. aeruginosa* or *Enterococcus* spp. than other complicated UTIs.[29] There were a number of *Candida* spp. isolates in ACH and LTCF, which seldom cause of HCA-UTIs. This might reflect the need for educational interventions in order to adhere to standard UTI definitions. A high percentage of HCA-UTIs in LTCF were diagnosed without a urine culture limiting antimicrobial stewardship interventions. The presence of polymicrobial growth in urine cultures from HCA-UTIs in ACH and LTCF, was most likely caused by contamination from inadequate urine sample collection. A Six Sigma project based on staff education to properly

Table 5
Aetiology of urinary tract infections among catheterized and non-catheterized patients.

Family/microorganism	Overall			Period 1			Period 2		
	Non-CAUTI	CAUTI	*p*-Value[a]	Non-CAUTI	CAUTI	*p*-Value[a]	Non-CAUTI	CAUTI	*p*-Value[a]
Acute care hospitals									
Number of UTI	370	325		167	138		203	187	
Gram-positive bacteria	33 (8.9)	35 (10.8)	0.489	14 (8.4)	13 (9.4)	0.909	19 (9.4)	22 (11.8)	0.543
Enterococcus spp.	28 (7.6)	31 (9.5)	0.427	11 (6.6)	12 (8.7)	0.634	17 (8.4)	19 (10.2)	0.665
Other GPB	5 (1.4)	4 (1.2)	0.467	3 (1.8)	1 (0.7)	1.000	2 (1)	3 (1.6)	0.674
Gram-negative bacteria	216 (58.4)	184 (56.6)	0.695	97 (58.1)	79 (57.2)	0.975	119 (58.6)	105 (56.1)	0.696
Escherichia coli	109 (29.5)	84 (25.8)	0.329	47 (28.1)	43 (31.2)	0.654	62 (30.5)	41 (21.9)	0.070
Pseudomonas aeruginosa	23 (6.2)	33 (10.2)	0.078	9 (5.4)	12 (8.7)	0.364	14 (6.9)	21 (11.2)	0.187
Klebsiella pneumoniae	33 (8.9)	31 (9.5)	0.88	17 (10.2)	11 (8)	0.641	16 (7.9)	20 (10.7)	0.433
Other GNB	33 (8.9)	23 (6.9)	0.070	15 (9)	8 (5.7)	0.421	18 (9)	15 (8.1)	0.275
Proteus mirabilis	18 (4.9)	13 (4)	0.714	9 (5.4)	5 (3.6)	0.646	9 (4.4)	8 (4.3)	1.000
Yeasts	11 (3)	12 (3.7)	0.752	6 (3.6)	6 (4.3)	0.967	5 (2.5)	6 (3.2)	0.89
Candida spp.	2 (0.5)	10 (3.1)	0.016	1 (0.6)	5 (3.6)	0.095	1 (0.5)	5 (2.7)	0.109
Candida albicans	9 (2.4)	2 (0.6)	0.069	5 (3)	1 (0.7)	0.227	4 (2)	1 (0.5)	0.374
Negative cultures	6 (1.6)	6 (1.8)	1.000	5 (3)	1 (0.7)	0.227	1 (0.5)	5 (2.7)	0.109
Samples not taken	46 (12.4)	37 (11.4)	0.758	20 (12)	21 (15.2)	0.511	26 (12.8)	16 (8.6)	0.234
Polymicrobial	54 (14.6)	44 (13.5)	0.772	23 (13.8)	17 (12.3)	0.838	31 (15.3)	27 (14.4)	0.930
Others	4 (1.1)	7 (2.2)	0.363	2 (1.2)	1 (0.7)	1.000	2 (1)	6 (3.2)	0.160
Long-term care facilities									
Number of UTI	2,990	1,200		1,286	524		1,704	676	
Gram-positive bacteria	104 (3.5)	67 (5.6)	0.002	39 (3)	30 (5.7)	0.01	65 (3.8)	37 (5.5)	0.091
Enterococcus spp.	79 (2.6)	48 (4)	0.027	25 (1.9)	20 (3.8)	0.031	54 (3.2)	28 (4.1)	0.294
S. aureus	10 (0.3)	11 (0.9)	0.030	6 (0.5)	5 (1)	0.380	4 (0.2)	6 (0.9)	0.036
CoNS	9 (0.3)	5 (0.4)	0.771	5 (0.4)	3 (0.6)	0.698	4 (0.2)	2 (0.3)	0.679
Other GPB	6 (0.2)	3 (0.3)	0.740	3 (0.2)	2 (0.4)	1.000	3 (0.2)	1 (0.1)	1.000
Gram-negative bacteria	1,315 (44)	483 (40.2)	0.030	527 (41)	195 (37.2)	0.152	788 (46.2)	288 (42.6)	0.118
Escherichia coli	752 (25.2)	228 (19)	<0.001	299 (23.3)	96 (18.3)	0.025	453 (26.6)	132 (19.5)	<0.001
Klebsiella pneumoniae	230 (7.7)	86 (7.2)	0.605	90 (7)	31 (5.9)	0.464	140 (8.2)	55 (8.1)	1.000
Pseudomonas aeruginosa	79 (2.6)	63 (5.2)	<0.001	39 (3)	27 (5.2)	0.041	40 (2.3)	36 (5.3)	<0.001
Proteus mirabilis	127 (4.2)	44 (3.7)	0.440	44 (3.4)	18 (3.4)	1.000	83 (4.9)	26 (3.8)	0.332
Other GNB	63 (2.2)	17 (1.4)	0.180	27 (2.2)	11 (2.2)	0.735	36 (2.1)	6 (0.7)	0.191
Klebsiella spp.	20 (0.7)	14 (1.2)	0.152	7 (0.5)	1 (0.2)	0.451	13 (0.8)	13 (1.9)	0.025
Enterobacter cloacae	13 (0.4)	11 (0.9)	0.101	7 (0.5)	3 (0.6)	1.000	6 (0.4)	8 (1.2)	0.036
Klebsiella oxytoca	12 (0.4)	10 (0.8)	0.130	5 (0.4)	4 (0.8)	0.292	7 (0.4)	6 (0.9)	0.265
Pseudomonas spp.	5 (0.2)	5 (0.4)	0.252	2 (0.2)	2 (0.4)	0.330	3 (0.2)	3 (0.4)	0.361
Morganella morganii	14 (0.5)	5 (0.4)	1.000	7 (0.5)	2 (0.4)	1.000	7 (0.4)	3 (0.4)	1.000
Yeasts	21 (0.7)	16 (1.3)	0.073	8 (0.6)	9 (1.7)	0.055	13 (0.8)	7 (1)	0.683
Candida albicans	16 (0.5)	10 (0.8)	0.371	7 (0.5)	6 (1.1)	0.287	9 (0.5)	4 (0.6)	0.768
Candida spp.	5 (0.2)	6 (0.5)	0.117	1 (0.1)	3 (0.6)	0.076	4 (0.2)	3 (0.4)	0.413
Negative cultures	52 (1.7)	22 (1.8)	0.937	18 (1.4)	5 (1)	0.592	34 (2)	17 (2.5)	0.527
Samples not taken	1,272 (42.5)	432 (36)	<0.001	589 (45.8)	218 (41.6)	0.115	683 (40.1)	214 (31.7)	<0.001
Polymicrobial	152 (5.1)	151 (12.6)	<0.001	74 (5.8)	54 (10.3)	<0.001	78 (4.6)	97 (14.3)	<0.001
Others	74 (2.5)	28 (2.3)	1.000	31 (2.4)	13 (2.5)	1.000	43 (2.5)	16 (2.3)	0.903

UTI: urinary tract infection; CAUTI: catheter-associated UTI; GNB: Gram-negative bacteria; GPB: Gram-positive bacteria; CoNS: coagulase-negative Staphylococci.
[a] Pearson Chi-squared test or Fisher exact test.

collect urine samples significantly reduced the number of contaminated specimens.[30]

This study has some limitations that should be considered. To begin, we assumed that a patient had a CAUTI if they had both an HCA-UTI and an IUC on the day of the study. In addition, we estimated the frequency of HCA-UTI using CAUTI and non-CAUTI prevalence rather than incidence rates, which is the preferred metric and a more accurate measure to evaluate the quality of care. Finally, a large proportion of HCA-UTIs from LTCF did not have a urine culture collected.

Despite limitations, this study included a large number of ACH and LTCF patients with a HCA-UTI. Although the presence of an IUC was a risk factor for developing a HCA-UTI, non-CAUTIs accounted for the vast majority of infections in ACH and LTCF. With an aging population, HCA-UTIs are expected to rise due to age-related factors. The VINCat surveillance program provides important information about the frequency and risk factors for HCA-UTIs in different sizes and hospital wards, as well as in LTCF units, which will be critical in developing safety and preventive quality programs in Catalonia.

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Conflicts of interest

All authors declare no conflict of interest relevant to this article.

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Appendix A.

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