A European perspective on nosocomial urinary tract infections II. Report on incidence, clinical characteristics and outcome (ESGNI–004 study)

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Objectives To estimate the incidence of nosocomially acquired urinary tract infections (NAUTI) in Europe and provide information on the clinical characteristics, underlying conditions, etiology, management and outcome of patients.

Materials and methods We collected clinical information from NAUTI patients with a microbiology report on the named study day.

Results A total of 141 hospitals from 25 European countries participated in the study. Written institutional bladder catheter guidelines were in place in 90.3% of EU hospitals and 55% of non-EU hospitals ($P < 0.05$). The total number of new NAUTI episodes on the day of the study was 298, representing an incidence of 3.55 episodes/1000 patient-days and an estimated prevalence of 10.65/1000. The five most commonly isolated micro-organisms were *Escherichia coli*, *Enterococcus* sp., *Candida* sp., *Klebsiella* sp. and *Pseudomonas aeruginosa*. Patients from non-EU countries were younger, with more severe underlying diseases with a higher incidence of obstructive uropathy/lithiasis. Overall, 22.8% of patients had no 'classic' UTI-predisposing factors. Catheter-associated UTI (CAUTI) was present in 187 patients (62.8%). A closed drainage system was used in only 78.5% of catheterised patients. The indication for bladder catheterisation was not considered adequate in 7.6% of cases and continuation of bladder catheterisation was considered unnecessary in 31.3%. Opening of the closed drainage system was the most frequent major error in catheter management (16.8%). Antimicrobial treatment was not considered adequate in 19.8% of all cases.

Conclusions The incidence of NAUTI in a large European population is 3.55/1000 patient-days. There is clearly room for improvement in the area of bladder catheterisation, catheter care and medical management of NAUTI. We recommend that European authorities draw up and implement practical and specific guidelines to reduce the incidence of this infection.

Keywords Urinary tract infection, nosocomial infections, Europe

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INTRODUCTION

In a preceding study [European Study Group on Nosocomial Infections 003 (ESGNI-003)], we assessed the microbiology workload, diagnostic criteria, etiology and antimicrobial susceptibility caused by urinary tract infection (UTI) in patients hospitalised in 228 European institutions [1]. The aim of the present study (ESGNI-004) was to collect bedside information from patients with nosocomially acquired urinary tract infections (NAUTI), and to compare the situation between countries of the European Union (EU) and countries outside the EU (non-EU). We obtained information from 141 hospitals in 25 European countries. Our aim was to obtain baseline data on a broad basis and to establish opportunities for intervention and improvement.

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MATERIALS AND METHODS

ESGNI-004 was a 1-day (29 February 2000) incidence study linked to ESGNI-003. Cases with microbiologically proven NAUTI on the study day had a bedside evaluation and follow-up for a maximum of 1 month. Data collected from each patient with significant bacteriuria or funguria included: age, sex, weighted index of co-morbidity, classification of the underlying disease according to the McCabe and Jackson groups, etiology of the episode, presence of fever, severity of illness according to the sepsis score, and predisposing conditions for infection. In patients with a urinary catheter (UC), we requested the following information: type of catheter, length of time the catheter had been in place on the study day, catheter indication, use of closed drainage systems, use of urinometer or silver-coated catheter, and indication, insertion and care adequacy according

to the physician's opinion and institutional guidelines. Antimicrobial treatment was classified as adequate or inadequate, we registered the number of days of antimicrobial administration for the NAUTI episode and finally, patients were followed up for 1 month until discharge. Deaths were classified by the observer as attributable or not attributable to the UTI.

Definitions used

UTI episode. Episodes of significant bacteriuria [$\geq 10^5$ colony-forming units (CFU)/mL] or funguria ($\geq 10^3$ CFU/mL).

Nosocomially acquired UTI. A nosocomial episode is considered to be any UTI infection beginning at least 48 h after admission.

Polymicrobial UTI. Polymicrobial UTI is defined as isolation of two micro-organisms during a single UTI episode.

Associated bacteremia. Presence of positive blood cultures and micro-organism isolated not more than 3 days apart from the urinary isolate with the same micro-organism.

Severity of illness [2].
Sepsis: Systemic response manifested by two or more of the following conditions as a result of infection: (a) temperature $>38\,^{\circ}C$ or $<36\,^{\circ}C$; (b) heart rate >90 beats/min; (c) respiratory rate >20 breaths/min or P_aCO_2 <32 mmHg; (d) white blood cell count $>12\,000$ cells/mm^3, <4000 cells/mm^3, or $>10\%$ immature (band) forms.
Severe sepsis: Sepsis associated with organ dysfunction, hypoperfusion, or hypotension. Hypoperfusion and perfusion abnormalities may include, but are not limited to, lactic acidosis, oliguria, or an acute alteration in mental status.
Septic shock: Sepsis with hypotension, despite adequate fluid resuscitation, along with the presence of perfusion abnormalities that may include, but are not limited to, lactic acidosis, oliguria, or an acute alteration in mental status. Patients who are on inotropic or vasopressor agents may not be hypotensive at the time perfusion abnormalities are measured.
Multiorgan failure: Failure of three or more organ systems during at least a 24-h period, as a consequence of NAUTI.

UTI-associated factors. (a) Urinary catheter, intravenous catheter, if present at the time of infection; (b) Presence of obstructive uropathy/lithiasis; (c) Urinary tract anatomic abnormalities; (d) Previous UTI; (e) Renal transplantation; (f) Fecal incontinence; (g) Pregnancy; (h) Uterine prolapse; (i) Surgery if it was during hospital admittance; (j) Corticosteroids if taken at a dose of 20 mg or more of prednisone daily (or equivalent) for at least 2 weeks, or 30 mg or more of prednisone daily for at least 1 week, before the urine culture; (k) Previous antimicrobials if the patient received any oral or parenteral antibiotic in the 15 days previous to the UTI episode; (l) Urological intervention, including prostatectomy if performed during the week previous to the UTI episode, and; (m) Other invasive procedures

Adequacy of treatment. Treatment was considered adequate if the patient received one or more antibiotics active in vitro against the micro-organisms isolated, when indicated.

Days of treatment. Only the number of days of adequate treatment have been considered.

Death attributable to UTI. Death is considered as attributable to NAUTI if it occurs during the phase of active infection or while the patient is undergoing antibiotic treatment.

McCabe and Jackson groups [3], and the Charlson weighted index [4] were used as comorbidity indexes.

Data analysis

We expressed continuous variables as the mean and standard deviation (SD) when normally distributed, or as the median and interquartile range (IQR) if their distribution was skewed, and discrete variables as percentages. We used Student's unpaired *t*-test to compare continuous variables, the Mann–Whitney *U*-test to compare continuous variables not normally distributed, and the χ^2 or Fisher exact test to compare proportions. All statistical tests were two-tailed.

RESULTS

A total of 141 hospitals from 25 countries (12 EU countries and 13 non-EU countries) participated in the ESGNI-004 study. (Table 1).

Table 1 Participating hospitals

Country	No. of hospitals participating (%)	Country	No. of hospitals participating (%)
Austria	4 (2.8)	Lithuania	1 (0.7)
Belgium	10 (7.1)	Netherlands	2 (1.4)
Croatia	3 (2.1)	Poland	6 (4.3)
Czech Republic	6 (4.3)	Portugal	4 (2.8)
Denmark	1 (0.7)	Romania	2 (1.4)
Finland	1 (0.7)	Russia	2 (1.4)
France	11 (7.8)	Slovak Republic	3 (2.1)
Germany	10 (7.1)	Slovenia	4 (2.8)
Greece	8 (5.7)	Spain	34 (24.1)
Hungary	1 (0.7)	Switzerland	5 (3.5)
Israel	1 (0.7)	Turkey	8 (5.7)
Italy	11 (7.8)	United Kingdom	2 (1.4)
Latvia	1 (0.7)		
TOTAL	141		

Table 2 Micro-organisms isolated in urine (>1%)

EU countries ($n=224$)		Non-EU countries ($n=116$)		Total ($n=340$)	
*Escherichia coli**	79 (35.3%)	*Escherichia coli**	25 (21.6%)	*Escherichia coli*	104 (30.6%)
Enterococcus sp.	34 (15.2%)	*Pseudomonas aeruginosa**	16 (13.8%)	*Enterococcus sp.*	48 (14.1%)
Candida sp.	29 (12.9%)	*Candida sp.*	15 (12.9%)	*Candida sp.*	44 (12.9%)
Klebsiella sp.	22 (9.8%)	*Enterococcus sp.*	14 (12.1%)	*Klebsiella sp.*	34 (10%)
Proteus sp.	15 (6.7%)	*Klebsiella sp.*	12 (10.3%)	*Pseudomonas aeruginosa*	28 (8.2%)
*Pseudomonas aeruginosa**	12 (5.4%)	*Proteus sp.*	10 (8.6%)	*Proteus sp.*	25 (7.4%)
Enterobacter sp.	10 (4.5%)	*Staphylococcus aureus*	5 (4.3%)	*Enterobacter sp.*	14 (4.1%)
Staphylococcus aureus	7 (3.1%)	*Enterobacter sp.*	4 (3.4%)	*Staphylococcus aureus*	12 (3.5%)
Citrobacter sp.	6 (2.7%)	CNS	4 (3.4%)	CNS	7 (2.1%)
Morganella sp.	3 (1.3%)	*Acinetobacter sp.*	3 (2.6%)	*Citrobacter sp.*	9 (2.6%)
CNS	3 (1.3%)	*Citrobacter sp.*	3 (2.6%)		

*$P<0.05$.
CNS, coagulase-negative staphylococci.

Characteristics of participating institutions

We obtained this information from 141 hospitals of different sizes serving an estimated population of 99 759 000 (41.4% had <500 beds, 33.6% had 501–1000 beds, and 25% >1000 beds), 98 from EU countries and 43 from non-EU countries. Overall, the total number of estimated admissions in these institutions during 1999 was 4 410 500. With regard to administration and activity, 70.7% were teaching hospitals, 83.7% were public, 5.9% private and 10.4% both public and private. No statistically significant differences were noted between EU and non-EU institutions except for the percentage of hospitals with written institutional bladder catheter guidelines, 79.7% overall, 90.3% in EU hospitals and 55% in non-EU hospitals ($P<0.0001$). On the study day, 83 962 beds were occupied (80% occupancy).

Incidence and estimated prevalence

The total number of NAUTI episodes confirmed by the microbiology laboratory on the study day was 298 (198 from EU countries, 100 from non-EU countries), giving an incidence of 3.55 episodes/1000 patient-days (3.43 in EU countries, 3.82 in non-EU countries; $P>0.05$). Theoretically, a prevalence rate can be estimated from the incidence density value, which is proportional to the mean duration of the measured disease [5]. An accurate method for estimating prevalence rate from incidence rate has been revised recently [6], but depends on data that we cannot obtain from this study, such as the mean length of hospitalisation of patients who acquire one or more nosocomial infections (NI), the mean length of hospitalisation for all patients and the mean interval between admission and the onset of the first NI. Thus, if we estimate a duration of 3 days of UTI symptoms [7] we obtain a rough equivalent NAUTI prevalence value of 10.65 episodes/1000.

Etiology

The number of micro-organisms isolated from NAUTI episodes was 340. The etiology of the episodes is summarised in Table 2. Gram-positive bacteria represented 21.2% of all isolates, whereas Gram-negative bacteria were 65.9%. Yeasts were 12.9%. The five most commonly isolated micro-organisms were *Escherichia coli*, *Enterococcus* sp., *Candida* sp., *Klebsiella* sp. and *Pseudomonas aeruginosa*. *Staphylococcus aureus* represented 3.5% of all isolates, an even higher rate than coagulase-negative staphylococci. Overall, 14.1% of the episodes were polymicrobial (13.1% in EU countries versus 16% in non-EU countries; $P>0.05$). The type of micro-organism was comparable between both groups of hospitals (EU and non-EU) with the single exception of *P. aeruginosa*, which was isolated more frequently in non-EU countries ($P<0.05$), and *E. coli*, which represents only 21.6% in non-EU countries (35.3% in EU countries, $P<0.05$).

Age, sex and underlying conditions

We obtained complete clinical information from the protocol on 298 individuals with nosocomially acquired UTI which was active on the study day (Table 3). There were 135 males (45.3%) and 163 females (54.7%), with more females in EU countries (60.2% versus 44%, $P<0.05$). Mean age was 62.71 (SD 25), and patients from non-EU countries were significantly younger (mean 52.54 versus 67.95, $P<0.05$).

According to the McCabe and Jackson classification, 10% of the patients had rapidly fatal diseases (16.7% non-EU countries, 6.6% in EU countries, $P<0.05$), 35.5% had ultimately fatal diseases and 54.5% had diseases considered as non-fatal. Comorbidity was rated according to Charlson's criteria and the mean index was 3.1 (SD 2.8).

Table 4 shows the distribution of underlying diseases and the potential predisposing factors in the nosocomial UTI population.

Table 3 Patient characteristics

	EU countries ($n=198$)	Non-EU countries ($n=100$)	Total ($n=298$)
Age (SD)*	67.95 (20.6)	52.54 (29.4)	62.71 (25)
Sex*			
Female	118 (60.2%)	44 (44%)	162 (54.7%)
Male	78 (39.8%)	56 (56%)	134 (45.3%)
Charlson index (SD)	3.21 (2.7)	2.89 (2.9)	3.1 (2.8)
McCabe and Jackson groups			
1 (Nonfatal)	54.1%	55.2%	54.5%
2 (Ultimately fatal)	39.3%	28.1%	35.5%
3 (Rapidly fatal)*	6.6%	16.7%	10%

*$P < 0.05$.

Table 4 Global considered related factors

	Total		Non-EU countries		EU countries	
	n	%	*n*	%	*n*	%
No 'classic'[a] UTI-predisposing factors	68	22.8%	17	17%	51	25.8
Urinary catheter	187	62.8%	68	68%	119	60.1%
Obstructive uropathy/lithiasis*	55	18.5%	28	28%	27	13.6%
Obstructive uropathy/lithiasis[*b]*	*15*	*5%*	*11*	*11%*	*4*	*2%*
Urinary tract anatomic abnormalities	19	6.4%	9	9%	10	5.1%
Urinary tract anatomic abnormalities[b]	*5*	*1.7%*	0	*0*	*5*	*2.5%*
Recent urological intervention	19	6.4%	10	10%	9	4.5%
Recent urological intervention[b]	*2*	*0.7%*	0	*0%*	*2*	*1%*
Previous urinary tract infections	75	25.2%	22	22%	53	26.8%
Previous urinary tract infections[b]	*16*	*5.4%*	*4*	*4%*	*12*	*6.1%*
Renal transplantation	2	0.7%	1	1%	1	0.5%
Previous antimicrobials	117	39.3%	42	42%	75	37.9%
Fecal incontinence	44	14.8%	14	14%	30	15.2%
Pregnancy	6	2%	0	0%	6	3%
Uterine prolapse	4	1.3%	0	0%	4	2%
IV catheter	144	48.3%	51	51%	93	47%
Corticosteroid treatment	35	11.7%	7	7%	28	14.1%
Surgery during admission	60	21%	16	16%	44	22.2%
Other invasive procedures	17	5.7%	7	7%	10	5.1%

[a]Obstructive uropathy, anatomic abnormalities, urinary device, urinary manipulation.
[b]As only predisposing factor (without urinary catheter).
*$P < 0.05$.

Overall, 22.8% of patients had no 'classic' UTI-predisposing factors and 62.8% had a urinary catheter (UC). When EU and non-EU countries were compared, there were significant differences in the overall presence of obstructive uropathy/lithiasis (either associated or as a single condition); this finding was more frequent in non-EU patients ($P < 0.05$).

Fever and sepsis

Of all patients with NAUTI, 51.5% were febrile on the study day, either due to UTI or to other causes (59% in non-EU countries, 44.7% in EU countries; $P < 0.05$). Of the whole population with NAUTI, and throughout the observation period, 2% went on to develop severe sepsis, 0.3% septic shock and 1.7% multiorgan failure, always according to the assignment to this category made by the observing physician (Table 5). In 2.7% of all patients with NAUTI the micro-organism recovered from the urine was also isolated from blood.

Catheter-associated UTI

Catheter-associated UTI (CAUTI) was present in 187 patients (62.8%) (Table 6). A bladder catheter was the most commonly used type (92.4%), and 90.8% were short-term catheterisations

Table 5 Clinical data

Clinical data	Global		Non-EU countries		EU countries	
	n	%	*n*	%	*n*	%
Fever*	153	51.5	59	59	94	44.7
Same micro-organism isolated in blood and urine	10	2.7	5	4	5	2
Presence of sepsis	107	35.9	38	38	69	34.8
Severity of sepsis						
Plain sepsis	95	31.9	30	30	65	32.8
Severe sepsis	6	2	3	3	3	1.5
Septic shock	1	0.3	1	1	0	0
Multiorgan failure	5	1.7	4	4	1	0.5

*$P < 0.05$.

Table 6 Urinary catheter data

	Total		Non-EU countries		EU countries	
	n	%	*n*	%	*n*	%
Type of urinary catheter						
Bladder catheter	171	92.4	59	88.1	112	94.9
Suprapubic catheter	9	4.9	5	7.5	4	3.4
Nephrostomy	4	2.1	3	4.5	1	0.8
Total	184	100	67	100	117	100
Days of catheterisation						
1–7	78	44.8	35	53.8	43	39.4
8–30	80	46	24	36.9	56	51.4
More than 30	16	9.2	6	9.2	10	9.2
Total	174	100	65	100	109	100
Global catheter indication						
Surgery	33	19.5	12	20	21	19.3
Output measurement	30	17.8	9	15	21	19.3
Obstruction	34	20.1	12	20	22	20.2
Incontinence	60	35.5	22	36.7	38	34.9
Other	12	7.1	5	8.3	7	6.4
Catheter indication not adequate	13	7.6	4	6.5	9	8.2
No catheter indication on study day	56	31.3	20	29.4	36	32.4
No initial or later indication	62	36.7	23	36.5	39	36.8
Closed drainage system	142	78.5	55	82.1	87	76.3
Silver-coated catheter used	4	2.2	0	0	4	3.5
Urinometer used	43	23.9	13	19.7	30	26.3
Errors in catheter management						
Catheter insertion	3	1.7	0	0	3	2.6
Catheter care	10	5.5	7	10.4	3	2.6
Drainage system opened	31	16.8	14	20.6	17	14.7
Open drain or violated closed drain	68	36.8	27	39.1	41	35.3
Global preventable errors*	93	53.1	39	58.2	54	50

Differences were statistically insignificant (i.e. $P > 0.05$).

*Either in indication or management.

(<30 days): in 44.8% 1–7 days and in 46% 8–30 days. The main indication was incontinence (35.5%), followed by obstruction (20.1%), perioperative monitoring (19.5%) and non-surgical output measurement (17.8%). The indication for bladder catheterisation was not considered adequate in 7.6% of cases at the time of the first visit, and continuation of bladder catheterisation was considered unnecessary in 31.3% of patients from then on. A closed drainage system was used in only 78.5% of catheterised patients, a silver-coated catheter in 2.2% and a urinometer in 23.9%. Major errors in catheter management

Table 7 Treatment and outcome

	Total		Non-EU countries		EU countries	
	n	%	*n*	%	*n*	%
Antimicrobial treatment	222	75.5	78	78	144	74.2
Antimicrobial treatment adequacy	178	80.2	62	79.5	116	80.6
Patients with urinary catheter						
Change of catheter	75	44.4	27	46.6	48	43.2
Adequate antimicrobials + catheter change	52	32.7	18	31.6	34	33.3
Global mortality	35	11.7	13	13	22	11.1
Attributable mortality	5	1.7	3	3	2	1

were observed in 24% of these patients. Opening of the drainage system was the most frequent (16.8%). An opened drainage system or a violated closed system was observed in 36.8% of catheterised patients. We estimated that in 53.1% of CAUTI patients an obvious preventable mistake had been made, either in the indication of catheter use or in its management. No significant differences were found between EU and non-EU patients in the UC data.

Antimicrobial therapy and outcome

At the time of the first visit, 75.5% of patients with NAUTI were receiving one or more antimicrobial agents. Antimicrobial treatment was not considered adequate in 19.8% of all cases. The median number of days of planned treatment was 7 days (IQR 7 days; range 0–21). The mean number of days of planned treatment in non-EU patients was significantly higher than in EU patients (10.85 verss 6.83; $P < 0.05$). Urinary catheters were changed or withdrawn in 44.4% of cases during the observation period. The mortality rate of the study population was 11.7%, with 1.8% considered as attributable to UTI according the observer's own opinion (Table 8). In these areas there were no significant differences between EU and non-EU countries (Table 7) .

Comparison of patients with or without catheter

Tables 8 and 9 compare patients with and without UC. Patients without UC were significantly younger with less severe underlying diseases ($P < 0.05$). The presence of obstructive uropathy, urological intervention, previous antimicrobial use and fecal incontinence were significantly more frequent in patients with UC ($P < 0.05$). Fever was more frequent in catheterised patients ($P < 0.05$), although the incidence of sepsis was similar in both groups.

Etiological differences between the two groups are described in Table 10. Polymicrobial infection was more frequent in the CAUTI group and slightly over the boundary of statistical significance (17.1% versus 9%, $P = 0.06$). *Escherichia coli* was clearly more frequent in patients without urinary devices

Table 8 Global related factors (urinary catheter excluded)

	Total		Without UC		With UC	
	n	%	*n*	%	*n*	%
Obstructive uropathy/lithiasis*	55	18.5%	18	14.3%	42	20.8%
Urinary tract anatomic abnormalities	19	6.4%	5	4.5%	14	7.5%
Urological intervention*	19	6.4%	2	1.8%	17	9.1%
Previous urinary tract infections	75	25.2%	25	22.5%	50	26.7%
Renal transplantation	2	0.7%	1	0.9%	1	0.5%
Previous antimicrobials*	117	39.3%	35	31.5%	82	43.9%
Fecal incontinence	44	14.8%	6	5.4%	38	20.3%
Pregnancy	6	2%	4	3.6%	2	1.1%
Uterine prolapse	4	1.3%	1	0.9%	3	1.6%
IV catheter*	144	48.3%	37	33.3%	107	57.2%
Treatment with corticosteroids	35	11.7%	18	16.2%	17	9.1%
Surgery on admission	60	21%	18	16.2%	42	22.5%
Other invasive procedures	17	5.7%	5	4.5%	12	6.4%

*$P < 0.05$.

Table 9 Comparison with/without catheter

		Total (*n* = 298)		**Without UC (*n* = 111)**		**With UC (*n* = 187)**	
Age* (SD)		62.71 (25)		56.62 (28.4)			66.24 (22.1)
Charlson index mean (SD)		62.71 (25)		2.75 (3)		3.31 (2.6)	
		n	%	*n*	%	*n*	%
Sex	Female	162	54.7	66	60	96	51.6
	Male	134	45.3	44	40	90	48.4
McCabe and Jackson groups*							
	1* (Non-fatal)	152	54.5	66	62.9	86	49.4
	2 (Ultimately fatal)	99	35.5	32	30.5	67	38.5
	3 (Rapidly fatal)	28	10	7	6.7	21	12.1
Fever*		153	51.5	47	42.3	106	57
Presence of sepsis		107	35.9	33	29.7	74	39.6
Severity of sepsis	Plain sepsis	95	31.9	32	28.8	63	33.7
	Severe sepsis	6	2	0	0	6	3.2
	Septic shock	1	0.3	1	0.9	0	0
	Multiorgan failure	5	1.7	0	0	5	2.7
Distribution of micro-organisms*							
	Gram negatives	224	65.9	83	68.6	141	64.4
	Gram positives	72	21.2	30	24.8	42	19.2
	*Candida**	44	12.9	8	6.6	36	16.4
Polymicrobial UTI (two isolates)		42	14.1	10	9	32	17.1
Same micro-organism isolated in blood and urine		10	2.7	2	1.5	8	3.4
Antimicrobial treatment given		222	75.5	76	69.7	146	78.9
Antimicrobial treatment adequacy		193	72.3	73	73	120	71.9
Global mortality*		35	11.7	3	2.7	32	17.1
Attributable mortality[a]		5	1.7	0	0	5	2.7

*$P < 0.05$.

[a]Exclusively according to the observer's own criteria.

Table 10 Micro-organisms isolated in urine (>1%)

With UC (*n* = 219)		**Without UC (*n* = 121)**		**Total (*n* = 340)**	
*Escherichia coli**	55 (25.1%)	*Escherichia coli**	49 (40.5%)	*Escherichia coli*	104 (30.6%)
*Candida sp.**	36 (16.4%)	*Enterococcus sp.*	19 (15.7%)	*Enterococcus sp.*	48 (14.1%)
Enterococcus sp.	29 (13.2%)	*Klebsiella sp.*	12 (9.9%)	*Candida sp.*	44 (12.9%)
*Pseudomonas aeruginosa**	23 (10.5%)	*Proteus sp.*	9 (7.4%)	*Klebsiella sp.*	34 (10%)
Klebsiella sp.	22 (10%)	*Candida sp.**	8 (6.6%)	*Pseudomonas aeruginosa*	28 (8.2%)
Proteus sp.	16 (7.3%)	*Pseudomonas aeruginosa**	5 (4.1%)	*Proteus sp.*	25 (7.4%)
Enterobacter sp.	11 (5%)	*Staphylococcus aureus*	4 (3.3%)	*Enterobacter sp.*	14 (4.1%)
Staphylococcus aureus	8 (3.7%)	CNS	4 (3.4%)	*Staphylococcus aureus*	12 (3.5%)
Citrobacter sp.	6 (2.7%)	*Enterobacter sp.*	3 (2.5%)	*Citrobacter sp.*	9 (2.6%)
CNS[a]	4 (1.8%)	*Citrobacter sp.*	3 (2.5%)	CNS	7 (2.1%)
Acinetobacter sp.	3 (1.4%)	*Streptococcus agalactiae*	3 (2.5%)	*Morganella sp.*	4 (1.2%)

*$P < 0.05$.

[a]CNS, coagulase-negative staphylococci.

Table 11 Catheter-adjusted etiological differences between EU and non-EU countries

	With UC ($n=219$)		Without UC ($n=121$)	
Micro-organisms	**EU countries**	**Non-EU countries**	**EU countries**	**Non-EU countries**
Escherichia coli	37 (27.2%)	18 (21.7%)	42 (47.7%)*	7 (21.2%)*
Pseudomonas	12 (8.8%)	11 (13.3%)	0 (0%)*	5 (15.2%)*
Candida	25 (18.4%)	11 (13.3%)	4 (4.5%)	4 (12.1%)

*$P < 0.05$.

(40.5% versus 25.1%; $P < 0.05$) whereas *Candida* and *Pseudomonas* were more frequently isolated in catheterised patients (16.4% versus 6.6% and 10.5% versus 4.1%, respectively; $P < 0.05$). The significant differences observed in *Pseudomonas* and *E. coli* were only seen in the group of patients without a urinary device (Table 11). No significant differences were found in the incidence of bacteremic UTI, which was more frequent in the UC group (3.4% versus 1.5%). Catheterised patients presented a higher rate of global mortality ($P < 0.05$).

DISCUSSION

The incidence density of NAUTI in Europe obtained in our study was 3.55 per 1000 hospitalised patient-days. We made a rough estimate of an equivalent prevalence rate of 10.65 episodes per 1000, exclusively in order to compare this data with other European figures. Although the mean time of nosocomial infection duration used in this estimation should ideally have been derived from a more complex method recently revised by Gastmeier et al. [6], we did not have the necessary data to perform it. European information regarding this topic is generally fragmentary, covering different populations and areas and difficult to compare with our data [8,9]. The most recently reported prevalence figures that cover a more general population range from 0.5 per 1000 to 24 per 1000, with most around 20 per 1000 [10–15].

The clinical condition of patients with NAUTI showed significant differences between EU and non-EU patients. Non-EU patients were significantly younger, had more severe underlying diseases, and presented more frequently with obstructive uropathy as a predisposing factor for UTI. These facts may reflect different admission criteria and management of obstructive uropathy between EU and non-EU institutions.

With regard to etiology, this study is largely confirmatory of data obtained in ESGNI-003 [1]. It shows important shifts in the etiological agents of NAUTI, with an increase in yeasts and Gram-positive bacteria, such as *Enterococcus*, which has been described in other studies [16–18].

The majority of NAUTI studies and major references in infectious diseases identify NAUTI with CAUTI [19–25]. To our surprise, a high proportion of NAUTI in the present study (37%) were not related to an indwelling urinary catheter. In fact, 22.8% of patients were not associated with any 'classic' UTI-predisposing factor. Patients with NAUTI not associated with urinary catheter are younger, less compromised, have less frequent urological interventions and have a better outcome than those with CAUTI. They clearly deserve greater attention [25–27]. Most NAUTI (63%) are urinary catheter-related, although in a lower proportion than in other global NAUTI series [22,28]. In general, these patients are elderly, with severe underlying diseases and with high global mortality rates (over 17%). We found a higher incidence of fever than expected for CAUTI [29,30]. Otherwise, bacteremic NAUTI occurred in 2.7% of cases in our study, a figure similar to that previously reported [31,32].

The information revealed in our study gives cause for concern throughout Europe. Overall, 20% of European institutions surveyed do not have specific written guidelines for management and care of urinary catheters (45% of non-EU hospitals). The UC was not indicated in 37% of patients, either initially or at the moment of the NAUTI diagnosis. This is important in terms of primary prevention [28,33]. Although a closed system for urine drainage is now widely recommended [19,34,35], we found 21.5% of catheterised patients with open systems, confirming similar recent surprising data from other European studies [36]. Violation (opening) of closed systems is also a major error [37], and occurred in 17% of our cases.

It is also alarming that antimicrobial therapy was considered inadequate in almost one of every five patients treated for UTI, and that the catheter was changed in fewer than 50% of the patients with infection. The overall mortality of 1.8% (six patients) was considered attributable to NAUTI according to the observers' own criteria. All these patients had an indwelling urinary catheter and represented 3% of all catheterised patients. The contribution of CAUTI to mortality is unclear [29,38,39], so further directed studies should be performed in order to evaluate it.

The results of our study provide a panoramic view of nosocomial UTI in Europe, obtained with limited resources and with the efforts of many. Our figures must be confirmed by other studies, but the dimension of the problem is obvious.

There is clearly room for improvement in the indication for bladder catheterisation, catheter care and medical management of NAUTI. Hence, specific guidelines must be implemented practically by European scientific societies.

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