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European Association of Urology

Infections

Antibiotic Prophylaxis in Urology Departments, 2005–2010

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Article info

Article history:
Accepted September 14, 2012
Published online ahead of print on September 25, 2012

Keywords:
Healthcare-associated urinary tract infections (HAUTI)
Antimicrobial prophylaxis
EAU Guidelines

Abstract

Background: Antibiotic prophylaxis (AP) is an important measure in preventing health care–associated urinary tract infections (HAUTIs). Despite regional variations in the bacterial spectrum and antibiotic susceptibility patterns, guideline recommendations are usually given on an international level.
Objective: To describe the use of AP in urology departments and relate this to relevant parameters such as country, type of hospital, and European Association of Urology guideline recommendations.
Design, setting, and participants: Data from the Global Prevalence Study on Infections in Urology for the period 2005–2010 were analysed to evaluate the use of antibiotics in general and AP for urologic procedures. Of the 13 723 patients enrolled, 8178 received antibiotics on the study days.
Outcome measurements and statistical analysis: Study data were imported from the Web-based survey into Microsoft Access and exported into SPSS v.17.0. The data were then coded and analysed. The Pearson chi-Square test was used to compare categorical data and a probability level of 5% was considered significant. Multiple logistic regression analysis was used to define significantly different variables in multiple set categories.
Results and limitations: Questions on AP were answered on 8370 forms and 6306 (75.3%) investigators reported their routine application of AP. Routine AP was highest in Latin America (n = 337; 84%), followed by Asia (n = 1338; 86%), Africa (n = 234; 85%), and Europe (n = 4116; 67%). The antibiotics most frequently used for AP were second-generation cephalosporins, ciprofloxacin, cefotaxime, and amoxicillin plus beta-lactamase inhibitor.
Conclusions: There were significant differences between countries/regions and types of hospitals, both in using AP for clean procedures and in the types of antibiotics used. AP was not always consistent with recommended guidelines.

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1. Introduction

Health care–associated infections are universal, complicate patient care, and have a daily prevalence of 1.4 million patients worldwide [1]. The most frequent are health care–associated urinary tract infections (HAUTIs). Resistant microorganisms causing HAUTIs and the consequent high level of antibiotic use are major concerns [2].

Preoperative antibiotic prophylaxis (AP) is widely used in urology to prevent infection complications. Despite regional

0302-2838/$ – see back matter
http://dx.doi.org/10.1016/j.eururo.2012.09.038

variations in the bacterial spectrum and susceptibility patterns, guideline recommendations are usually given on an international level [3]. We aimed to describe the use of AP for various procedures in urology departments around the world and to correlate our findings to country/region, type of hospital, general use of antibiotics, and adherence to European Association of Urology (EAU) guidelines [3].

2. Materials and methods

2.1. Hospitals and patients

Data collected during 2005–2010 from the Global Prevalence Study on Infections in Urology (GPIU) were reviewed to determine the use of antibiotics in urology departments and the susceptibility of uropathogens causing HAUTIs. The study was announced by the EAU by various methods and carried out electronically on Uroweb, the Internet portal of the EAU. The protocol, organisation, data application, and processing of the GPIU studies have been described earlier [4,5].

2.2. Questionnaire on prophylaxis

Starting in 2005, a special Internet-based questionnaire was used to ascertain the administration of AP for urologic procedures in different risk and contamination categories. Investigators were asked to tick buttons in a preselected menu of antibiotics. The menu, presenting the antibiotics most commonly used in urology, was selected by the GPIU study group. A total of 536 questionnaires were subjected to analysis. Antibiotics selected for routine cases and cases with high risk for HAUTI were evaluated for each procedure. The frequency of antibiotic use and the three most frequently preferred antibiotics for each procedure were evaluated.

2.3. Antibiotic use

Antibiotics were prescribed for four different indications: (1) microbiologically proven UTI, (2) clinically suspected UTI without microbiologic proof, (3) infections outside the urinary tract, and (4) prophylaxis. The types of antibiotics and rate of antibiotic administration were calculated for each group.

Patients developing HAUTI were classified according to the urologic intervention they underwent: diagnostic, endoscopic, or open or laparoscopic surgery. Contamination status of the procedures was also recorded as clean, clean-contaminated, and contaminated, where transrectal ultrasound-guided biopsy (TRUSBx) of the prostate was recorded as a contaminated procedure [3]. A detailed description of interventions in each group and the antibiotics prescribed were also requested to ensure that groups of countries were comparable. HAUTI was defined according to US Centres for Disease Control and Prevention criteria [6].

2.4. Antibiotic susceptibility of pathogens causing health care–associated urinary tract infection

All cultures were analysed in local laboratories and the standard used for susceptibility testing was recorded (eg, the Clinical and Laboratory Standards Institute [CLSI], Deutsches Institut fuer Normung [the German Institute for Standardisation; DIN], the European Committee on Antimicrobial Susceptibility Testing [EUCAST]). The distribution of causative pathogens was analysed for all regions and only the antibiotic susceptibility data for *Escherichia coli*, the most common causative pathogen, were included as a marker for the overall resistance patterns in this study. Evaluation of resistance in various regions is beyond the scope of this manuscript and is published elsewhere [7].

2.5. Data analysis

Study data were imported from the Web-based survey into Microsoft Access (Microsoft Corp.; Seattle, WA, USA) and exported into SPSS v.17.0 (IBM Corp., Armonk, NY, USA). The data were then coded and analysed.

The Pearson chi-square test was used to compare categorical data and a probability level of 5% was considered significant. Multiple logistic regression analysis was used to define significantly different variables in multiple set categories.

3. Results

Patients (n = 13 723) were reviewed on study days from 536 hospital entries from 60 countries on four continents (regions).

3.1. Features of groups

3.1.1. Countries and regions

The majority of participating centres were from Europe (n = 389; 72.5%), followed by Asia (n = 103; 19.2%), Latin America (n = 25; 4.7%), and Africa (n = 19; 3.5%). The four countries with the highest number of patients screened were Germany (n = 2899; 21.5%), Hungary (n = 2045; 15.1%), Russia (n = 1078; 8.0%), and Turkey (n = 981; 7.3%).

3.1.2. Hospitals

Hospitals (n = 536) were classified as university (n = 245; 45.7%), teaching (n = 150; 28%), district (n = 114; 21.3%), and *others* (n = 27; 5.0%). The mean number of beds in these hospitals was 682 (range: 14–2429), with a mean of 33.2 (range: 2–240) urology beds. Hospitals were given new registration numbers if they registered in >1 yr.

3.1.3. Patients

Patients (3793 [27.6%] female, 9930 [72.4%] male) were screened for HAUTI on the study days. Only 300 (2.2%) of these patients were aged ≤15 yr; 5826 (42.5%) were aged 16–60 yr and 7597 (55.2%) were >60 yr old.

3.1.4. Urologic interventions

During the study period, 9752 (71%) patients underwent a urologic intervention: open surgery (n = 4002; 41.0%), endoscopic procedures (n = 3389; 34.8%), laparoscopy (n = 1280; 13.1%), and TRUSBx of the prostate (n = 1081; 11.1%).

3.1.5. Prevalence of health care–associated urinary tract infections

Overall prevalence of HAUTI was 10.5% (1143 of 13 725 patients). The prevalence varied among the continents (Europe: 9.9%; Asia: 13.0%; South America: 6.7%; and Africa: 11.6%) and hospital types (university: 11.0%; teaching: 9.9%; district: 12.7%; and others: 5.1%).

3.1.6. Pathogens and susceptibility

E. coli was the most frequent pathogen found associated with HAUTI (452 of 1117 patients; 40.9%), followed by *Enterococcus*, *Klebsiella*, and *Pseudomonas* species, and others (Fig. 1). The standard used for susceptibility testing

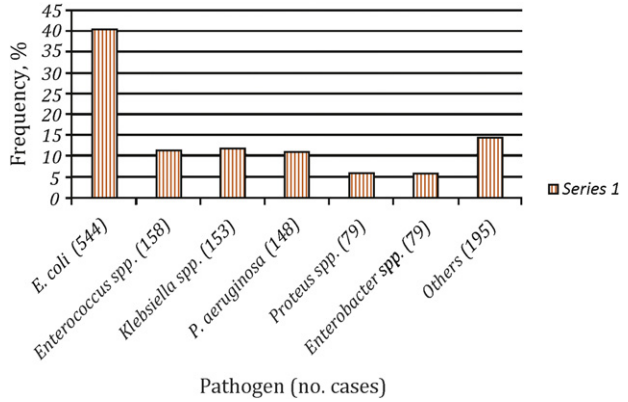

Fig. 1 – Distribution of pathogens in all regions. *E. coli* = *Escherichia coli*; *P. aeruginosa* = *Pseudomonas aeruginosa*.

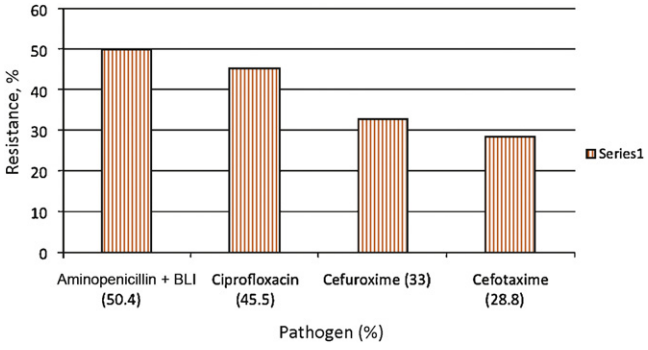

Fig. 2 – Resistance rate of *Escherichia coli* in all regions. BLI = beta-lactamase inhibitor.

was provided for 1003 cases: CLSI, 71%; DIN, 14%; EUCAST, 6%; and others, 9%. The overall susceptibility rate of *E. coli* to the four most commonly used antibiotics are shown in Fig. 2.

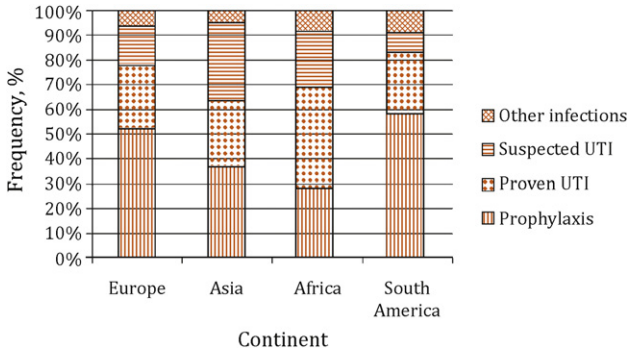

Fig. 3 – Indications for antibiotic usage in different regions.

3.2. *Use of antibiotics for treatment and antibiotic prophylaxis*

On the study day, 8178 patients (59.6%) received antibiotics; of these, 3898 patients (47.7%) received antibiotics for prophylaxis. The rest were treated either for proven UTI ($n = 2174$; 26.5%), suspected UTI ($n = 1619$; 19.8%), or other infections ($n = 487$; 6.0%) (Fig. 3).

The practice of AP in different regions and types of hospital is listed in Tables 1 and 2. The rate of routine administration of prophylactic antibiotics varied between 46.4% (cystoscopy) and 96.9% (contaminated procedures).

3.2.1. *Importance of regions and types of hospitals*

The rate of AP was the highest in Asia ($n = 1338$; 86%), followed by Africa ($n = 234$; 85%), Latin America ($n = 337$; 84%), and Europe ($n = 4116$; 67%). This difference is statistically significant ($p < 0.0001$). The lowest rates of AP were in Europe for cystoscopy ($n = 153$; 40.5%), diagnostic ureteroscopy (URS) ($n = 255$; 73.5%), transurethral resection of the prostate (TURP) ($n = 275$; 77.2%), transurethral resection of bladder tumour (TURBT) ($n = 275$; 77.2%,), clean open or laparoscopic surgery ($n = 1235$; 56.6%,), and clean-contaminated open or

Table 1 – Routine antibiotic prophylaxis practice in different world regions

	Europe	Asia	Africa	Latin America	Global	*p* value
Procedure			Diagnostic procedures			
Cystoscopy	153/378 (40.5)	62/93 (66.7)†	9/17 (52.9)	14/25 (56.0)	238/513 (46.4)	<0.05
URS	255/342 (73.5)	76/88 (86.4)	13/16 (81.3)†	20/22 (90.9)	364/473 (77.0)	<0.05
Prostate biopsy	315/340 (92.6)	73/89 (82)	13/14 (92.9)	23/24 (95.8)	424/467 (90.8)	NS
			Endoscopic surgery			
URS for uncomplicated stone treatment	298/363 (82.1)	84/91 (92.3)	11/14 (78.6)	17/18 (94.4)	410/486 (84.4)	NS
TURP	275/356 (77.2)†	89/96 (92.7)	13/16 (81.3)	23/25 (92)	400/493 (81.1)	<0.05
TURBT	275/356 (77.2)†	89/96 (92.7)	13/16 (81.3)	23/25 (92)	400/493 (81.1)	<0.05
PCNL	270/333 (81.1)	62/71 (87.3)	14/16 (87.5)	12/15 (80)	358/435 (82.3)	NS
			Open or laparoscopic urologic surgery according to contamination status			
Clean	1235/2182 (56.6)†	461/564 (81.7)	78/106 (73.6)	109/146 (74.7)	1883/2998 (62.8)	<0.05
Clean-contaminated	809/941 (86)	220/243 (90.5)	44/47 (93.6)†	57/63 (90.5)	1130/1294 (87.3)	<0.05
Contaminated	509/522 (97.5)	122/128 (95.3)	26/28 (92.9)	39/40 (97.5)	696/718 (96.9)	NS

URS = ureteroscopy; NS = not significant; TURP = transurethral resection of the prostate; TURBT = transurethral resection of bladder tumor; PCNL = percutaneous nephrolithotomy.
Data given as number of centers practicing antibiotic prophylaxis divided by total number of responding centers (percentage) unless otherwise indicated.
† Statistically significant difference according to multiple logistic regression analysis.

Table 2 – Routine antibiotic prophylaxis practice according to different institution settings

	University	Teaching	District	Other	Global	*p* value
Procedure			Diagnostic procedures			
Cystoscopy	129/237 (54.4)†	54/143 (37.8)	43/106 (40.6)	11/26 (42.3)	237/512 (46.3)	<0.05
URS	178/222 (80.2)	96/133 (72.2)	74/97 (76.3)	16/21 (76.2)	364/473 (77)	NS
Prostate biopsy	02/223 (90.6)	120/131 (91.6)	87/97 (89.7)	15/16 (93.8)	424/467 (90.8)	NS
			Endoscopic surgery			
URS for uncomplicated stone treatment	208/227 (91.6)†	106/142 (74.6)	77/98 (78.6)	19/19 (100)	410/486 (84.4)	<0.05
TURP	190/225 (84.4)	108/145 (74.7)	83/103 (80.6)	19/20 (95)	400/493 (81.2)	NS
TURBT	175/225 (77.7)†	97/145 (66.9)†	74/103 (71.8)	20/20 (100)	365/493 (74.1)	<0.05
PCNL	180/209 (86.1)†	102/129 (79.1)	61/81 (75.3)	15/16 (93.8)	358/435 (82.3)	<0.05
			Open or laparoscopic urologic surgery according to contamination status			
Clean	1008/1430 (70.5)†	496/885 (56)	292/562 (52)	87/121 (71.9)	1883/2998 (62.8)	<0.05
Clean-contaminated	581/629 (92.4)	302/372 (81.2)†	199/241 (82.6)†	48/52 (92.3)	1130/1294 (87.3)	<0.05
Contaminated	356/368 (96.5)	202/210 (95.2)	111/113 (98.2)	27/27 (100)	696/718 (96.9)	NS

URS = ureteroscopy; NS = not significant; TURP = transurethral resection of the prostate; TURBT = transurethral resection of bladder tumor; PCNL = percutaneous nephrolithotomy.
Data given as number of centers practicing antibiotic prophylaxis divided by total number of responding centers (percentage) unless otherwise indicated.
† Statistically significant difference according to multiple logistic regression analysis.

laparoscopic surgery ($n = 809$; 86.0%,). The lowest rate of AP for TRUSBx of the prostate was in Asia ($n = 73$; 82.0%,) while Africa had the lowest rates for URS for uncomplicated stone treatment ($n = 11$; 78.6%,) and clean-contaminated open surgery ($n = 25$; 92.9%), and Latin America had the lowest rates for percutaneous nephrolithotomy (PCNL) ($n = 12$; 80.0%,). The region with the highest use of AP differed for each procedure (Table 1).

AP use according to hospital types are listed in Table 2. Further evaluation showed that AP for open surgery was used in 64.6% of the patients in university hospitals, 51.8% in teaching hospitals, 47.0% in district hospitals, and 51.5% in other hospitals. Similar differences were observed for endoscopic and laparoscopic surgery, while AP was more or less consistent for TRUSBx of the prostate (89.7–93.8%; $p > 0.05$) (Table 2).

3.2.2. *Importance of contamination categories and procedures*

Average rates of AP for the different levels of contamination were as follows: 62.8% for clean, 87.3% for clean-contaminated, and 96.9% for contaminated.

Procedures showing significant differences were cystoscopy, URS, TURP, TURBT, clean surgeries, and clean-contaminated surgeries.

The highest rate of AP was seen in Asia for most of the procedures other than clean-contaminated surgery and TRUSBx of the prostate. Europe and Africa had the lowest rates for most of the procedures. University hospitals had the highest rate of routine prophylaxis; the lowest rate was seen in teaching hospitals.

3.2.3. *Choice of antibiotics for prophylaxis*

The most frequently used prophylactic antibiotics for various urologic interventions in different regions and different hospital settings are shown in Tables 3 and 4. These were ciprofloxacin, second-generation cephalosporins, ceftazidime, and cefotaxime. However, practice varied according to region, hospital setting, contamination, and risk category.

Ciprofloxacin was the first choice for all endoscopic procedures, except PCNL and affected stone treatment with URS; cephalosporins were the first choice for laparoscopic and open surgical procedures.

Second-generation cephalosporins were most frequently used for open and laparoscopic surgery ($n = 584$; 21% in both), and ciprofloxacin was most frequently used for TRUSBx of the prostate ($n = 223$, 36%), TURP ($n = 125$; 20%), and TURBT ($n = 103$; 19%,).

Ciprofloxacin was the first choice for diagnostic procedures in all regions except South America, where ceftazidime was preferred most frequently. The first choice for endoscopic surgery was ciprofloxacin in Europe, cefotaxime in Asia, and second-generation cephalosporins in Latin America and Africa.

3.2.4. *Importance of hospitals*

Hospital-based differences were only shown for contaminated surgeries. Choices of prophylactic antibiotics for all other procedures were similar in different hospital settings. The antibiotics used most often were ciprofloxacin, second-generation cephalosporins, cefotaxime, nitrofurantoin, and trimethoprim-sulphamethoxazole.

Ciprofloxacin was mostly preferred for endoscopic procedures and TRUSBx of the prostate. However, it was not often used for open/laparoscopic surgeries. Instead, cephalosporins were the most frequent choice for these procedures.

3.3. *Overall evaluation*

Ciprofloxacin and cephalosporins are the antibiotics most often preferred for AP. Choices of prophylactic antibiotics did not show significant variations for most of the

Table 3 – The three most preferred antibiotics in routine antibiotic prophylaxis according to regions

	Europe	Asia	Latin America	Africa	Global
Procedure			Diagnostic procedure		
Cystoscopy	1. Ciprofloxacin (37/180; 21)	1. Ciprofloxacin (20/118; 17)	1. Ceftazidime (4/22; 27)	1. Ciprofloxacin (8/20; 40)	1. Ciprofloxacin (67/340; 20)
	2. Cefotaxime (22/180; 12)	2. Cefotaxime (12/118; 10)	2. 2G cephalosporins (3/22; 20)	2. Nitrofurantoin (6/20; 30)	2. 2G cephalosporins (35/340; 10)
	3. TMP–SMX (20/180; 11)	3. 2G cephalosporins (12/118; 10)	3. Ciprofloxacin (2/22; 13)	3. Fosfomycin (3/20; 15)	3. Cefotaxime (35/340; 10)
URS	1. Ciprofloxacin (70/359; 19)	1. Ciprofloxacin (25/139; 18)	1. Ciprofloxacin (7/26; 26)	1. 2G cephalosporins (6/16; 37)	1. Ciprofloxacin (102/540; 19)
	2. Cefotaxime (49/359; 14)	2. Cefotaxime (22/139; 16)	2. 2G cephalosporins (5/26; 20)	2. Gentamicin (3/16; 19)	2. 2G cephalosporins (85/540; 16)
	3. TMP–SMX (40/359; 11)	3. 2G cephalosporins (19/139; 14)	3. Amoxicillin + BLI (4/26; 15)	3. Ceftazidime (2/16; 13)	3. Cefotaxime (72/540; 13)
Prostate biopsy	1. Ciprofloxacin (171/452; 38)	1. Ciprofloxacin (36/120; 30)	1. Ciprofloxacin (12/32; 38)	1. Ciprofloxacin (4/16; 25)	1. Ciprofloxacin (223/620; 36)
	2. Nitrofurantoin (79/452; 17)	2. Ceftazidime (14/120; 12)	2. Amicasin (8/32; 25)	2. 2G cephalosporins (3/16; 19)	2. Nitrofurantoin (98/620; 31)
	3. TMP–SMX (46/452; 10)	3. Nitrofurantoin (12/120; 10)	3. Nitrofurantoin (6/32; 19)	3. Ceftazidime (2/16; 13)	3. TMP–SMX (55/620; 9)
			Endoscopic surgery		
URS for uncomplicated stones	1. Ciprofloxacin (84/415; 20)	1. Cefotaxime (35/154; 23)	1. 2G cephalosporins (8/26; 31)	1. 2G cephalosporins (5/15; 33)	1. Cefotaxime (117/540 -22)
	2. Cefotaxime (78/415; 19)	2. 2G cephalosporins (27/154; 18)	2. Ciprofloxacin (7/26; 27)	2. Ceftazidime (3/15; 20)	2. Ciprofloxacin (114/540; 21)
	3. 2G cephalosporins (48/415; 12)	3. Ciprofloxacin (22/154; 14)	3. Cefotaxime (3/26; 12)	3. Cefotaxime (3/15; 20)	3. 2G cephalosporins (76/540; 14)
TURP	1. Ciprofloxacin (90/397; 23)	1. Ciprofloxacin (29/165; 18)	1. 2G cephalosporins (9/29; 31)	1. 2G cephalosporins(6/20; 30)	1. Ciprofloxacin (125/611; 20)
	2. 2G cephalosporins (60/397; 15)	2. Cefotaxime (29/165; 18)	2. Amoxicillin + BLI (5/29; 17)	2. Gentamicin (3/20; 15)	2. 2G cephalosporins (92/611; 15)
	3. TMP–SMX (46/397; 12)	3. Ceftazidime (20/165; 12)	3. Ciprofloxacin (4/29; 14)	3. Amoxicillin + BLI (3/20; 15)	3. TMP–SMX (74/611; 12)
TURBT	1. Ciprofloxacin (75/349; 21)	1. Cefotaxime (29/140; 21)	1. 2G cephalosporins (8/25; 32)	1. 2G cephalosporins (6/18; 3)	1. Ciprofloxacin (103/532; 19)
	2. 2G cephalosporins (49/349; 14)	2. Ciprofloxacin (22/140; 16)	2. Ciprofloxacin (5/25; 20)	2. Amoxicillin + BLI (3/18; 17)	2. Cefotaxime (78/532; 15)
	3. TMP–SMX (45/349; 13)	3. Ceftazidime (20/140; 14)	3. Cefotaxime (4/25; 16)	3. Ceftazidime (2/18; 11)	3. 2G cephalosporins (77/532; 14)
PCNL/URS for impacted or proximal stone	1. Cefotaxime (76/370; 21)	1. Cefotaxime (27/100; 27)	1. Ciprofloxacin (4/15; 27)	1. 2G cephalosporins (5/19; 26)	1. Cefotaxime (108/504; 21)
	2. 2G cephalosporins (70/370; 19)	2. 2G cephalosporins (16/100; 16)	2. Nitrofurantoin (3/15; 20)	2. Cefotaxime (4/19; 21)	2. 2G cephalosporins (93/504; 18)
	3. Ciprofloxacin (66/370; 18)	3. Ceftazidime (14/100; 14)	3. 2G cephalosporins (2/15; 13)	3. Ceftazidime (4/19; 21)	3. Ciprofloxacin (81/504; 16)
			Open or laparoscopic urologic surgery according to contamination status		
Clean	1. Cefotaxime (385/1738; 22)	1. Cefotaxime (170/799; 21)	1. 2G cephalosporins (45/129; 35)	1. 2G cephalosporins (34/113; 30)	1. Cefotaxime (584/2817; 21)
	2. 2G cephalosporins (383/1738; 22)	2. Ceftazidime (112/799; 14)	2. Cefotaxime (18/129; 14)	2. Ceftazidime (17/113; 15)	2. 2G cephalosporins (573/2817; 20)
	3. Ciprofloxacin (162/1783; 9)	3. 2G cephalosporins (111/799; 14)	3. Ciprofloxacin (16/129; 12)	3. Cefotaxime (11/113; 10)	3. Ceftazidime (266/2817; 10)
Clean-contaminated	1. 2G cephalosporins (257/1154; 22)	1. Cefotaxime (98/422; 23)	1. 2G cephalosporins (21/70; 30)	1. 2G cephalosporins (15/64; 23)	1. Cefotaxime (366/1710; 21)
	2. Cefotaxime (247/1154; 21)	2. 2G cephalosporins (59/422; 14)	2. Cefotaxime (13/70; 19)	2. Ceftazidime (10/64; 16)	2. 2G cephalosporins (352/1710; 21)
	3. Ciprofloxacin (161/1154; 14)	3. Ceftazidime (55/422; 13)	3. Ciprofloxacin (9/70; 13)	3. Cefotaxime (8/64; 13)	3. Ciprofloxacin (208/1710; 12)
Contaminated	1. Cefotaxime (177/959; 18)	1. Cefotaxime (56/269; 21)	1. 2G cephalosporins (12/58; 21)	1. 2G cephalosporins (9/44; 20)	1. Cefotaxime (243/1330; 18)
	2. 2G cephalosporins (129/959; 13)	2. Ceftazidime (38/269; 14)	2. Cefotaxime (8/58; 14)	2. Ceftazidime (8/44; 18)	2. 2G cephalosporins (178/1330; 13)
	3. Amoxicillin + BLI (74/959; 8)	3. 2G cephalosporins (28/269; 10)	3. Ciprofloxacin (7/58; 12)	3. Amoxicillin + BLI (7/44; 16)	3. Ceftazidime (99/1330; 7)

TMP–SMX = trimethoprim plus sulphamethoxazole (co-trimoxazole); BLI = beta-lactamase inhibitor; 2G = second generation; URS = ureteroscopy; TURP = transurethral resection of the prostate; TURBT = transurethral resection of bladder tumor; PCNL = percutaneous nephrolithotomy.
Data given as number of preferring centers divided by total number of centers (percentage). Antibiotics are numbered 1, 2, or 3 in order of preference.

Table 4 – The three most preferred types of antibiotic prophylaxis according to hospital type

	University hospital	Teaching hospital	District hospital	Others	Global
Procedure			Diagnostic procedure		
Cystoscopy	1. Ciprofloxacin (37/205; 18)	1. Ciprofloxacin (14/67; 21)	1. Ciprofloxacin (13/64; 20)	1. Nitrofurantoin (8/15; 53)	1. Ciprofloxacin (67/340; 20)
	2. Cefotaxime (22/205; 11)	2. Cefotaxime (9/67; 13)	2. Nitrofurantoin (11/64; 17)	2. Ciprofloxacin (3/15; 20)	2. 2G cephalosporins (35/340; 10)
	3. TMP–SMX (20/205; 10)	3. 2G cephalosporins (9/67; 13)	3. 2G cephalosporins (6/64; 9)	3. Ceftazidime (3/15; 20)	3. Cefotaxime (35/340)
URS	1. Ciprofloxacin (45/288; 16)	1. Ciprofloxacin (32/136; 24)	1. Ciprofloxacin (21/100; 21)	1. Ceftazidime (5/16; 31)	1. Ciprofloxacin (102/540; 19)
	2. Cefotaxime (43/288; 15)	2. Cefotaxime (22/136; 16)	2. 2G cephalosporins (17/100; 17)	2. Ciprofloxacin (4/16; 25)	2. 2G cephalosporins (85/540; 16)
	3. 2G cephalosporins (43/288; 15)	3. 2G cephalosporins (17/136; 13)	3. Gentamicin (16/100; 16)	3. Nitrofurantoin (4/16; 25)	3. Cefotaxime (72/540; 13)
Prostate biopsy	1. Ciprofloxacin (110/304; 36)	1. Ciprofloxacin (55/173; 32)	1. Ciprofloxacin (55/118; 42)	1. Ciprofloxacin (8/25; 32)	1. Ciprofloxacin (223/620; 36)
	2. Nitrofurantoin (41/304; 13)	2. Nitrofurantoin (27/173; 10)	2. Nitrofurantoin (24/118; 20)	2. Nitrofurantoin (6/25; 24)	2. Nitrofurantoin (98/620; 31)
	3. Cefotaxime (20/304; 7)	3. TMP–SMX (21/173; 12)	3. TMP–SMX (14/118; 12)	3. Ceftazidime (3/25; 12)	3. TMP-SMX (55/620; 9)
			Endoscopic surgery		
URS for uncomplicated stones	1.Cefotaxim (67/330; 20)	1. Ciprofloxacin (39/155; 25)	1. Cefotaxime (20/99; 20)	1. Ciprofloxacin (8/26; 31)	1. Cefotaxime (117/540; 22)
	2. Ciprofloxacin (47/330; 14)	2. Cefotaxime (29/155; 19)	2. Ciprofloxacin (18/99; 18)	2. Ceftazidime (5/26; 19)	2. Ciprofloxacin (114/540; 21)
	3. 2G cephalosporins (43/330; 13)	3. 2G cephalosporins (19/155; 12)	3. Gentamicin (14/99; 14)	3. Nitrofurantoin (5/26; 19)	3. 2G cephalosporins (76/540; 14)
TURP	1. Ciprofloxacin (49/311; 16)	1. Ciprofloxacin (43/159; 27)	1. Ciprofloxacin (26/120; 22)	1. Ciprofloxacin (7/21; 33)	1. Ciprofloxacin (125/611; 20)
	2. 2G cephalosporins (46/311; 15)	2. 2G cephalosporins (24/159; 15)	2. 2G cephalosporins (20/120; 17)	2. Nitrofurantoin (5/21; 24)	2. 2G cephalosporins (92/611; 15)
	3. Cefotaxime (41/311; 13)	3. TMP–SMX (18/159; 11)	3. Cefotaxime (15/120; 13)	3. Ceftazidime (4/21; 19)	3. TMP-SMX (74/611; 12)
TURBT	1. Ciprofloxacin (44/273; 16)	1. Ciprofloxacin (31/137; 23)	1. Ciprofloxacin (21/98; 21)	1. Ciprofloxacin (7/24; 29)	1. Ciprofloxacin (103/532; 19)
	2. TMP–SMX (42/273; 15)	2. TMP–SMX (21/137; 15)	2. 2G cephalosporins (15/98; 15)	2. Nitrofurantoin (6/24; 25)	2. Cefotaxime (78/532; 15)
	3. 2G cephalosporins (40/273; 15)	3. Cefotaxime (20/137; 15)	3. Cefotaxime (14/98; 14)	3. Ceftazidime (4/24; 17)	3. 2G cephalosporins (77/532; 14)
PCNL/URS for impacted or proximal stone	1. Cefotaxime (68/264; 26)	1. Ciprofloxacin (32/148; 22)	1. 2G cephalosporins (16/75; 21)	1. Ceftazidime (5/15; 33)	1. Cefotaxime (108/504; 21)
	3. Ciprofloxacin (51/264; 19)	2. Cefotaxime (27/148; 18)	2. Ciprofloxacin (16/75; 21)	2. Cefotaxime (3/15; 20)	2. 2G cephalosporins (93/504; 18)
	3. 2G cephalosporins (32/264; 12)	3. 2G cephalosporins (23/148; 16)	3. Nitrofurantoin (10/75; 13)	3. 2G cephalosporins (3/15; 20)	3. Ciprofloxacin (81/504; 16)
			Open or laparoscopic urologic surgery according to contamination status		
Clean	1. Cefotaxime (322/1599; 21)	1. Cefotaxime (169/729; 23)	1. Cefotaxime (104/427; 24)	1. Ceftazidime (36/102; 35)	1. Cefotaxime (584/2817; 21)
	2. 2G cephalosporins (304/1599; 19)	2. 2G cephalosporins (162/729; 22)	2. 2G cephalosporins (78/427; 18)	2. Cefotaxime (15/102; 15)	2. 2G cephalosporins (573/2817; 20)
	3. Ceftazidime (148/1599; 9)	2. Ciprofloxacin (63/729; 9)	3. Ciprofloxacin (37/427; 9)	3. Amoxicillin + BLI (9/102; 9)	3. Ceftazidime (266/2817; 10)
Clean-contaminated	1. Cefotaxime (190/930; 20)	1. Cefotaxime (113/432; 26)	1. 2G cephalosporins (66/277; 24)	1. Ceftazidime (18/71; 25)	1. Cefotaxime (366/1710; 21)
	2. 2G cephalosporins (184/930; 20)	2. 2G cephalosporins (98/432; 23)	2. Cefotaxime (57/277; 21)	2. Ciprofloxacin (16/71; 23)	2. 2G cephalosporins (352/1710; 21)
	3. Ciprofloxacin (48/930; 5)	3. Ciprofloxacin (48/432; 11)	3. Ciprofloxacin (49/277; 18)	3. Cefotaxime (6/71; 8)	3. Ciprofloxacin (208/1710; 12)
Contaminated	1. Cefotaxime (126/703; 18)	1. Cefotaxime (74/355; 21)	1. 2G cephalosporins (37/224; 17)	1. Ceftazidime (11/48; 23)	1. Cefotaxime (243/1330; 18)
	2. Amoxicillin + BLI (56/703; 8)	2. 2G cephalosporins (56/355; 16)	2. Cefotaxime (36/224; 16)	2. Cefotaxime (7/48; 15)	2. 2G cephalosporins (178/1330; 13)
	3. Ceftazidime (53/703; 8)	3. Amoxicillin + BLI (23/355; 6)	3. Ciprofloxacin (15/224; 7)	3. Ciprofloxacin (7/48; 15)	3. Ceftazidime (99/1330; 7)

TMP–SMX = trimethoprim plus sulphamethoxazole (co-trimoxazole); BLI = beta-lactamase inhibitor; 2G = second generation; URS = ureteroscopy; TURP = transurethral resection of the prostate; TURBT = transurethral resection of bladder tumor; PCNL = percutaneous nephrolithotomy.
Data given as number of preferring centers divided by total number of centers (percentage).

procedures. However, no standard practice for contaminated surgical procedures was seen.

4. Discussion

4.1. General perspectives and limitations

HAUTIs are frequent after urologic interventions, causing not only individual health problems, but also contributing significantly to antibiotic consumption and emergence of antimicrobial bacterial resistance. Although AP is only one of several factors affecting urologic infections [8], modern urologic surgery depends on effective AP. Our study delivers data on AP practice in urology clinics between 2005 and 2010 in 60 countries.

Antibiotic resistance is a global problem, causing increased morbidity, mortality, and costs of health care [9]. A relation between consumption and resistance has been documented for certain classes of antibiotics in several studies [10–13]. However, the design and setting of our survey does not allow us to draw any conclusions on this matter.

Guidelines on AP are based on four main concerns: (1) antimicrobial susceptibility of the most likely pathogens, (2) favourable antibiotic distribution to the tissues involved, (3) minimal collateral damage, and (4) reservation of the most potent antibiotics for treatment. The first concern depends on local conditions, while the others are general concerns. Evidence-based guidelines assist clinicians to find the delicate balance between desired effects and unwanted collateral side effects of AP. Our data indicate that antibiotic usage often differs widely from recommended guidelines, particularly for open, clean procedures (Table 5).

4.2. Methodology

Since many surveillance studies are carried out by large hospitals [14], very few data are available from smaller hospitals. In contrast, GPIU studies include a wide variety of centres. However, registration was on a voluntary basis and despite the relatively high number of hospitals registered, it remains undecided whether the results are representative for a whole region. It is reasonable, though, to accept that investigators who are more concerned about HAUTI were involved in the studies and hence contributed reliable data. Europe was the best-represented continent with 27 countries, followed by Asia (7 countries), Latin American (6 countries), and Africa (5 countries). University hospitals and teaching hospitals composed the majority types of hospitals in the study, presumably due to the higher scientific interest of investigators. A considerable number of patients were treated in district hospitals and in hospitals categorised as *other* in this survey.

4.3. Main findings

We found that 59.5% of inpatients (8178 of 13 723) received antibiotics on the study days throughout the study period. About 50% of antibiotics were prescribed for prophylaxis, 25% for suspected UTI, and 25% for treatment of infections with identified pathogens and known susceptibility. Thus, about 75% of all antibiotics administered in urology departments were given empirically.

There was significant difference in AP, especially for clean procedures. Similar findings were reported by Bjerklund Johansen et al. in 2006 [4]. A higher rate of AP for these procedures was seen in university hospitals and Asian countries. One possible reason for the differences may be because there was moderate to high level of evidence in favour of AP for TURP and prostate biopsy only [15]. For many other urologic interventions and operations, clinical study data are missing, leaving the clinician without a clear opinion on the value of AP. Not surprisingly, compliance with the American Urological Association guidelines for AP was reported to be only 40% [16].

Currently, routine AP for TRUSBx of the prostate includes fluoroquinolones in 64% to 98.2% of patients [17,18]. However, up to 22.0% of these patients may harbour fluoroquinolone-resistant *E. coli* strains, which pose a risk for infection complications [19]. In a series of 5798 patients undergoing TRUSBx of the prostate, 22 of 42 (52%) patients having sepsis were infected by pathogens resistant to ciprofloxacin [20]. In their review of infection complications of prostate biopsy, Loeb and co-workers recently reported that of positive urine and blood cultures, 78.9% and 94.1%, respectively, were resistant to at least one of the eight most common antimicrobial agents tested [21]. As AP is also frequently used for clean operations and simple diagnostic procedures, the risk for selection of pathogenic bacteria may be high within the urologic patient population. Therefore, carefully reviewing a patient's history is of utmost importance.

4.4. Importance of results and perspectives

The findings of GPIU studies show differences among countries and regions in the practice of AP in urology. While second-generation cephalosporins were the first choice in open surgery in Europe, Africa, and South America, cefotaxime was the most preferred antibiotic in Asia (Table 3). The first choice in endoscopic surgery was ciprofloxacin in Europe, cefotaxime in Asia, and second-generation cephalosporins in Africa and South America. Ciprofloxacin was unanimously preferred for prophylaxis in TRUSBx of the prostate, but preferences in laparoscopic surgery again differed, with second-generation cephalosporins being the antibiotics of first choice in Europe and South America, cefotaxime the first choice in Asia, and amoxicillin plus beta-lactamase inhibitor in Africa.

Routine AP before clean-contaminated surgical procedures varied among continents (Table 1) and various hospital settings (Table 2) despite any evidence-based reason.

Our findings underline the need for reducing AP in clean procedures. The high use of AP for cystoscopy, which is opposed in the EAU guidelines, is of concern (Table 5). Local monitoring of HAUTI and causative pathogens is crucial for tailored prophylaxis and avoidance of collateral damage of the environment. Unfortunately, the resistance rates of

Table 5 – European Association of Urology guidelines and current practice of antibiotic prophylaxis according to the Global Prevalence Study on Infections in Urology, 2005–2010

	EAU guidelines		AP in GPIU studies 2005–2010, %			First three antibiotics for routine AP Antibiotic
	Routine AP	Recommended antibiotic	In high-risk cases only	Routinely	Not routinely	
Procedure			Diagnostic procedure			
Cystoscopy	No	TMP–SMX 2G cephalosporins	20	46	34	Ciprofloxacin 2G cephalosporins Cefotaxime
URS	No	TMP–SMX 2G cephalosporins	14.4	77	8.7	Ciprofloxacin 2G cephalosporins Cefotaxime
TRUS biopsy	All patients	Fluoroquinolones TMP–SMX Metronidazole	5.1	90	4.1	Ciprofloxacin Nitrofurantoin TMP–SMX
			Endoscopic surgery			
URS for uncomplicated stone treatment	No	TMP–SMX 2G or 3G Cephalosporins Aminopenicillin + BLI Fluoroquinolones	11.3	84.4	4.3	Cefotaxime Ciprofloxacin 2G cephalosporins
TURP	All patients	TMP–SMX 2G or 3G cephalosporins Aminopenicillin + BLI	13	81.2	5.9	Ciprofloxacin 2G cephalosporins TMP–SMX
TURBT	No	TMP–SMX 2G or 3G cephalosporins Aminopenicillin + BLI	11.7	74.1	14.1	Ciprofloxacin Cefotaxime 2G cephalosporins
PCNL/URS for impacted or proximal stone	All patients	TMP–SMX 2G or 3G cephalosporins Aminopenicillin + BLI Fluoroquinolones	11.5	82.3	6.2	Cefotaxime 2G cephalosporins Ciprofloxacin
			Open or laparoscopic urologic surgery according to contamination status			
Clean	No		9.4	62.8	27.8	Cefotaxime 2G cephalosporins Ceftazidime
Clean-contaminated	Recommended	TMP–SMX 2G or 3G cephalosporins Aminopenicillin/BLI	7.2	87.3	5.5	Cefotaxime 2G cephalosporins Ciprofloxacin
Contaminated	All patients	2G or 3G cephalosporins Metronidazole	3.1	96.9	0	Cefotaxime 2G cephalosporins Ceftazidime

AP = antibiotic prophylaxis; GPIU = Global Prevalence Study on Infections in Urology; TMP–SMX = trimethoprim alone or in combination with sulphamethoxazole (co-trimoxazole); URS = ureteroscopy; BLI = beta-lactamase inhibitor; TRUS = transrectal ultrasound; 2G = second generation; 3G = third generation; TURP = transurethral resection of the prostate; TURBT = transurethral resection of bladder tumor.

E. coli, the most frequent pathogen causing HAUTI against the four most frequently used antibiotics for AP, is already alarmingly high at about 30% to 50%. Participation in surveillance studies, where local practice can be compared to centres of excellence, is highly recommended. Governments should consider making this a prerequisite for reimbursement of treatment costs.

Implementation of guidelines is important; however, further research is required to deliver good-quality data supporting the recommendations of guidelines.

5. Conclusions

There are significant differences among countries/regions and types of hospitals in the use of AP, both in terms of using antibiotics for clean procedures and in the type of antibiotic used. AP is not always consistent with evidence-based guidelines.

Author contributions: Mete Çek had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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Obtaining funding: None.
Administrative, technical, or material support: Van Oostrum, Bjerklund Johansen.
Supervision: Bjerklund Johansen, Naber.
Other (specify): None.

Financial disclosures: Mete Çek certifies that all conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject matter or materials discussed in the manuscript (eg, employment/affiliation, grants or funding, consultancies, honoraria,

stock ownership or options, expert testimony, royalties, or patents filed, received, or pending), are the following: None.

Funding/Support and role of the sponsor: European Association of Urology.

Acknowledgment statement: We acknowledge all investigators who participated in GPIU between 2005 and 2010.

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