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Prophylactic Antibiotics and Postoperative Complications for Radical Cystectomy: a population-based analysis in the United States

Ross E Krasnow, MD, MS[1] – rkrasnow@partners.org
Matthew Mossanen, MD[1] – mmossanen@partners.org
Sophia Koo, MD[2] – skoo@partners.org
David W Kubiak, Pharm.D[2] – dwkubiak@partners.org
Mark A. Preston, MD, MPH[1] – mpreston@partners.org
Benjamin I. Chung, MD[3] – bichung@standford.edu
Adam S. Kibel, MD[1] – akibel@bwh.harvard.edu
Steven L Chang, MD, MS[1] - slchang@bwh.harvard.edu

[1]Division of Urology, Department of Surgery, Brigham and Women's Hospital, Harvard Medical School, Boston, MA

[2]Division of Infectious Diseases, Brigham and Women's Hospital, Harvard Medical School, Boston, MA

[3]Department of Urology, Stanford University, Stanford, CA

Corresponding Author:
Ross E Krasnow, MD, MS
Division of Urology
45 Francis Street
Boston, MA 02115
Phone 617-525-3117
Fax 617-525-6348
Email: rkrasnow@partners.org

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Abstract:

Purpose: Infectious, wound and soft tissue events contribute to the morbidity of radical cystectomy, but the association between these events and antibiotic prophylaxis is not clear. We sought to describe the contemporary use of antibiotic prophylaxis in radical cystectomy, adherence to published guidelines, and identify regimens with the lowest rates of infectious events.

Materials and Methods: Using a population-based, retrospective cohort study of patients who underwent radical cystectomy across the United States between 2003 and 2013, we identified the intraoperative antibiotic prophylaxis regimen. Multivariable regression was used to evaluate 90-day infectious events and length of stay.

Results: In a weighted cohort of 52,349 patients, there were 579 unique antibiotic prophylaxis regimens. Cefazolin was the most commonly utilized antibiotic (16%). The overall infectious event rate was 25%. Only 15% of patients received ABP based on guidelines. Of guideline-based antibiotic prophylaxis, ampicillin/sulbactam had the lowest odds of infectious events (OR 0.34, $p<0.001$). In 2.7% of patients, a penicillin-based regimen with a β-lactamase inhibitor was associated with a prominent reduction in the odds of infectious events (OR 0.45, $p=0.001$) and a reduced length of stay (-1.3 days, $p=0.016$).

Conclusions: Antibiotic prophylaxis practices are highly heterogeneous in radical cystectomy. There is a lack of adherence to published guidelines. We observed decreased infectious event rates and shorter length of stay with regimens that included broad coverage of common skin, genitourinary, and gastrointestinal flora. The ideal antibiotic regimen requires further study to optimize perioperative outcomes.

Introduction:

The treatment of bladder cancer with radical cystectomy (RC) is a morbid operation with a 90-day complication rate of 55-67%.[1,2] The infectious event rate is 8-61%, and the wound and soft tissue event rate is 12-15%.[1-4] Reducing the burden of infectious, wound and soft-tissue related complications (hereafter referred to as infectious events) would greatly decrease morbidity and costs.

The American Urological Association (AUA) and European Association of Urology (EAU) recommend antibiotic prophylaxis (ABP) for urologic surgery involving the intestine.[5,6] The AUA makes their recommendation based on general and colorectal surgery literature.[7-9] However, general and colorectal surgeries may not apply to RC given that the urinary tract is no longer isolated from the gastrointestinal tract. Currently, there is a paucity of data regarding appropriate ABP for RC and randomized trials are lacking.

Given these shortcoming, we sought to describe the variability in ABP for RC in the United States using a contemporary population-based cohort. These robust data permitted examination of the relationship between ABP regimen and infectious events.

Materials and Methods:

Data source:

The Premier Hospital Database (Premier, Inc., Charlotte, NC, USA) is an all-payer hospital discharge database developed for quality and utilization benchmarking in the United States.[10] A unique identifier for each patient permits longitudinal analysis. We received institutional review board exemption for this study.

Study cohort and covariates:

Using International Classification of Diseases, ninth revision (ICD-9) codes we identified adult (≥18 years old) patients who underwent RC (57.71, 57.79) between 2003 and 2013. The cohort was limited to patients with a diagnosis of bladder cancer (ICD 188.x) undergoing elective RC (defined by Premier and RC on admission day 1 or 2) who had an identifiable intravenous antibiotic administered on the day of surgery.

We captured the intravenous antibiotic name, class, and consecutive days of administration (Supplemental Table 1). Due to Premier's inability to capture oral antibiotics administered on an outpatient basis and the low likelihood of oral antibiotics to be used as ABP, oral antibiotic administration was not recorded. We defined antibiotics administered on post-operative day 0 or 1 to be within 24 hours of surgery, and administration beyond post-operative day 1 as an extended-duration.[11] We defined guideline-based ABP as regimens recommended by AUA or EAU.[5,6]

Patient characteristics included age (<60, 60–69, 70–79, ≥80), gender, race (white, black, Hispanic, other/unknown), marital status (unmarried, married), insurance status (Medicare, Medicaid, private, other/unknown), and Charlson Comorbidity Index.[12] Hospital characteristics included teaching status, hospital size (<400, 400–600, or >600 beds), location (urban or rural), and region (Northeast, Midwest, West, or South). Surgical characteristics included year, type of diversion (continent neobladder/pouch [57.87] versus ileal/colonic conduit [56.51,56.61,56.71]), pelvic lymphadenectomy (40.0, 40.3, 40.50, 40.53, 40.59, 40.0), operative time, and open versus robotic surgery.[13]

Outcomes:

We used ICD-9 codes to identify 90-day infectious events (Supplemental Table 2) from the inpatient stay, readmission or emergency room visits as defined by Health Care Cost and Utilization Project (HCUP) Clinical Classification Software (CCS).[14] Appropriate infectious events were categorized using CCS Level II or III designations by the authors (REK and SLC). For the specific complications of sepsis, wound dehiscence, and central venous catheter-related blood stream infections ICD-9 codes were based on the recommendations of the Agency for Healthcare Research and Quality (AHRQ) Patient Safety Indicators (PSI).[15]

We also assessed length of stay (LOS) and direct hospital costs, which were adjusted to 2013 US dollars using the medical component of the Consumer Price Index.[16]

Statistical analyses:

We summarized patient, hospital, and surgical characteristics with descriptive statistics. Categorical variables were compared using the chi-square test. A chi-square test for linear trend was used to assess temporal trends in the use of combination therapy, duration, and class.

Binary outcomes were evaluated using multivariable logistic regression. LOS was predicted using a negative binomial regression model, and costs were analyzed with a generalized linear model using a gamma distribution. These outcome models were adjusted for patient characteristics (age, gender, race, marital status, insurance status, Charlson score), hospital characteristics (teaching status, hospital size, location, region), and surgical characteristics (type of diversion, pelvic lymphadenectomy, operative time, transfusion, and open versus minimally invasive surgery). In the analysis of specific ABP regimens the reference was set to cefazolin given that it was the most commonly administered antibiotic. Goodness-of-fit was assessed using the method developed by Lemeshow and Hosmer.[17] As a sensitivity analysis, pairwise comparison of outcomes were adjusted for multiple testing using a Bonferroni correction.

The Premier database contains projection weights derived from the 1998 American Hospital Association Annual Survey, validated by the 1998 National Hospital Discharge Survey. Using these weights, we obtained nationally representative estimates for discharge data. Survey weighting and hospital clustering was used for all analyses. Tests were two-sided, and a p value <0.05 was considered statistically significant. Data extraction from the Premier Database was performed using SAS 9.3 (SAS Institute, Cary, NC, USA) and statistical analysis was performed using Stata 14.1 (StataCorp, College Station, TX, USA).

Results:

The study cohort consisted of 8,351 patients from 353 hospitals representing a survey weighted cohort of 52,349 individuals (Table 1). The mean age was 68.9 years (standard deviation [SD] 10.2). The majority of patients were male (81%), white (80%), and married (61%). A robotic approach was employed in 12% of patients, 75% underwent a lymphadenectomy, and 5% underwent a continent diversion. The mean operative time was 393.4 minutes (SD 117.5).

There were 579 unique antibiotic regimens given on the day of surgery, and 273 different combinations of classes. Combination ABP, defined as ≥2 antibiotics on the day of surgery, was used in 51% of patients. The majority of patients (71%) had their ABP stopped within 24 hours.

The use of combination ABP did not change over time (p=0.8), but more clinicians limited antibiotics to within 24 hours of surgery with a year to year estimated annual percent changes of 2.3% (95% Confidence Interval [95%CI] 2.8 to 1.7%, p<0.001, Figure 1A). Over the study period, there were significant increases in the use of 2nd/3rd generation (gen.) cephalosporins, lincosamides, carbapenems, and extended-spectrum penicillin/β-lactamase inhibitor combinations (Figure 1B). Conversely, there were significant decreases in the usage of aminoglycosides, penicillins, and quinolones.

The infectious, wound, or soft tissue related complication rate for the entire cohort was 25% (Table 2). The most common non-soft tissue infectious event was a urinary infection (12%) followed by sepsis (8.2%). The wound and soft tissue complication rate was 10%. The median LOS was 8 days (interquartile range [IQR] 7 to 12), and the median cost of admission was $27,414 [IQR $20,298 to 39,304]. On multivariable analysis, an infectious event increased the

LOS by 10.5 days (CI=10.3 to 10.7, p<0.001) and increased 90 day costs by $23,107 (CI=20,754 to 25,461, p<0.001).

Receipt of extended-duration ABP had no change in infectious event risk on crude (25% vs. 26%, p=0.4) or adjusted analysis (Odds ratio [OR]=1.01, 95%CI=0.88 to 1.17, p=0.9) (Table 3). With extended-duration ABP, 2.6% of patients developed *Clostridium difficile* infection compared to 2.0% in patients exposed to <24 hours of ABP (OR=1.51, 95%CI=1.05 to 2.17, p=0.028). Combination ABP had a lower infectious event rate of 23.5%, compared to 27.1% after single-agent therapy (OR=0.79, 95%CI=0.70 to 0.89, p<0.001). Similarly, there was a decrease in non-soft tissue infectious events, a decrease in wound and soft tissue complications, and a shorter hospital stay on adjusted analysis (Table 3).

Cefazolin as a single-agent was the most commonly administered antibiotic regimen, and a 2nd/3rd gen. cephalosporin as a single-agent was the most commonly used class. The top 25 antibiotic regimens and classes are shown in Supplemental Table 3. Using an adjusted model, we evaluated the infectious event risk of the top 25 actual antibiotic class regimens, setting cefazolin as the reference antibiotic (Supplemental Figure 1). The predicted probability of an infectious event with cefazolin was 27% (95%CI=23 to 30%). Many of the regimens did not perform significantly better or worse than cefazolin alone.

A minority of patients (28%) received ABP based on guidelines, and only 15% received guideline-based ABP that was discontinued within 24 hours of surgery (Table 4). Compared to cefazolin, the regimen of ampicillin/sulbactam was associated with the fewest infectious events (Table 3). There were no significant differences in infectious events and other outcomes between cefazolin and the other guideline-based regimens. Metronidazole was used in 19% of patient typically in combination with other antibiotics (99%) and was not found to have an appreciable change in the infectious event rate (p=0.6).

A regimen of a penicillin-based agents combined with β-lactamase inhibitors was administered as ABP in 2.7% of the patients; crude rate of infectious events was 18% compared to 27% in those who received cefazolin alone (p=0.001). On multivariable analysis, this regimen was associated with reduced odds of infectious events (compared to cefazolin), a decreased LOS, and a decrease in predicted probability of an infectious events (Table 3, Figure 2). Even after Bonferroni correction, penicillin-based agents combined with β-lactamase inhibition were superior to cefazolin, 2nd/3rd gen. cephalosporins, and other single-agent ABP (Supplemental Table 4).

Discussion:

In this population-based study of patients undergoing RC, we found considerable variability regarding ABP usage in RC leading to 579 unique antibiotic regimens given on the day of surgery. Despite AUA and EAU guidelines regarding ABP for urologic surgery involving bowel segments, only 14.9% of patients received a guideline-based regimens *and* had the antibiotics discontinued within 24 hours after surgery. Regardless, we found no clear difference in infectious events or other outcomes in patients who received a guideline-based ABP when compared to cefazolin except in the small percentage (1.8%) who received ampicillin/sulbactam. Combination antibiotic regimens were associated with fewer infectious events compared to single-agent regimens. Finally, we identified that an antibiotic regimen consisting of a penicillin-based agent in combination with a β-lactamase inhibitor (such as ampicillin/sulbactam, piperacillin/tazobactam, or ticarcillin/clavulanic acid) was associated with the lowest risk of infectious events in this cohort. These results suggest that patients have the best outcomes with the receipt of antimicrobials that are active against skin, genitourinary, and enteric flora given for less than 24 hours.

A key finding is the importance of Gram positive and Gram negative coverage in RC. Broad-spectrum regimens that also included a penicillin-based agent in combination with a β-lactamase inhibitor were associated with improved outcomes, potentially due to the enhanced coverage of skin flora compared to regimens directed at Gram negative organisms alone. A 2nd/3rd gen. cephalosporin, as recommend by the AUA and EAU guidelines, was the most commonly administered class. However, most 2nd/3rd gen. cephalosporins have less robust Gram positive coverage when compared to 1st gen. cephalosporins and penicillins.[18,19] Moreover, ampicillin/sulbactam is a unique penicillin with a β-lactamase inhibitor that demonstrates excellent Gram positive, Gram negative, and anaerobic coverage. Patients who received ampicillin/sulbactam had a 66% decrease in the odds of infectious events (Table 3). Extended spectrum penicillins with β-lactamase inhibition such as ticarcillin/clavulanate or piperacillin/tazobactam similarly have broad Gram positive, Gram negative, and anaerobic coverage, with more Gram positive activity than many $2^{nd}/3^{rd}$ gen. cephalosporins. Importantly, these agents also cover enterococci, which remain an important cause of post-operative infections.[4,20] Prophylaxis with ampicillin/sulbactam, piperacillin/tazobactam, or ticarcillin/clavulanate agents resulted in an adjusted absolute risk reduction of 12.5% (Figure 2). These results remained robust after Bonferroni correction.

The variability in ABP in RC alludes to deliberate efforts to avoid infectious complications in an area that lacks randomized trials. A recent systematic review of ABP in urologic surgery did not address ABP in urologic surgery involving the bowel likely due to a lack of studies.[21] The AUA guidelines extrapolate their recommendations from general (appendectomy and gastrostomy) and colorectal surgery systematic reviews.[5,7-9]

The current study is the largest investigation to date of ABP in RC. Calvert et al., demonstrated increased rates of *C. difficile* in patients undergoing extended duration ABP.[11] Mossanen et al, found high rates of non-compliance to guidelines in RC.[22] Hara et al. showed no difference in surgical site infections between patients who received 1-day or 3-days of ABP after RC.[23] Pariser et al. reported the 2 year outcomes at the University of Chicago after broadening ABP.[4] They changed their regimen from cefoxitin (386 patients) to ampicillin/sulbactam, gentamicin, and fluconazole (128 patients) after reviewing post-operative infection cultures. Their updated regimen reduced the risk of infection from 41% to 30% and remained significant on multivariable analysis (OR=0.58, 95%CI=0.35 to 0.99, p=0.044). Our data corroborate these findings, as we also found that ampicillin/sulbactam was associated with a low rate of infectious events. It remains unclear if the addition of gentamicin or antifungal agents decreases the rate of post-operative bacterial or mycotic infections. Moreover, there are important concerns using gentamicin in this patient population given the utilization of cisplatin-based neoadjuvant chemotherapy and potential for nephrotoxicity, especially when more than one dose is given.

Finally, future efforts should focus on antibiotic stewardship in RC. Antimicrobial stewardship includes targeted antibiotics for the shortest possible time to avoid resistance and adverse events.[24] In our study, only 14.9% of patients received a guideline-based regimen that was also discontinued with 24 hours of surgery. The Infectious Diseases Society of America (IDSA) recently published guidelines on implementation of an antibiotic stewardship program,[25] and RC patients may benefit from a targeted antibiotic stewardship program.

Limitations

This study has several limitations. First, the results of this study should be interpreted within the constraints of observational study design. The findings are hypothesis generating and require validation. We used a clustered analysis to limit sampling bias,[26] and we accounted for survey weight, similar to other population based studies.[27-29] Because we used administrative data, some complications may not have been captured leading to misclassification bias, and we cannot capture infectious events diagnosed and managed in an outpatient setting. Nonetheless, our rate of infectious events (32%), non-soft tissue events (30%), and wound and soft tissue complications (11%) is comparable to institutional series from high volume tertiary care centers.[1,3] There are unknown confounders such as smoking status, performance status, and the use of postoperative care pathways. Furthermore, extent of lymphadenectomy, tumor characteristics, and receipt of chemotherapy were not available. However, these unknown confounders would likely bias toward the null hypothesis. The ideal antibiotic regimen which is suited best at this moment (and place) may change in time due to changes in the specific microbial presence and/or resistance rates.

Conclusions:

This contemporary, population-based study of ABP in patients undergoing RC from 2003 to 2013 shows great heterogeneity in ABP administration across the United States. There is lack of adherence to AUA or EAU guideline-based regimens and duration. Despite this, there is not a marked difference in outcomes between cefazolin as a single-agent and many guideline-based regimens. While extended duration of antibiotics had no effect on outcomes, ABP regimens with penicillin-based agents in combination with β-lactamase inhibitors were associated with improved outcomes. Future efforts to improve antimicrobial stewardship in urologic oncology is warranted, and further study into the ideal ABP for RC is needed.

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Figures:

Figure 1: Trends in antibiotic duration, combination therapy (A), and usage of antibiotic classes (B) from 2003 until 2013 in the United States. *There has been a statistically significant increase in limiting the administration of antibiotic prophylaxis to the ≤24 hrs. There have been statistically significant increases in the use of $2^{nd}/3^{rd}$ gen. cephalosporins, extended spectrum penicillins with β-lactamase inhibition, carbapenems, and lincosamides. † There have been statistically significant decreases in the usage of aminoglycosides, quinolones, and penicillins.

Figure 2: The predicted probability of an infectious, soft tissue, and wound events between penicillin (PCN) agents with β-lactamase inhibitors, cefazolin, $2^{nd}/3^{rd}$ generation (gen) cephalosporins, other monotherapies, and other combination therapies.

Supplemental Figures:

Figure 1: Probability of infectious, soft tissue and would related complication in the top 25 antibiotic class regimens. (C1 = 1^{st} gen. cephalosporin [reference], C23 = 2^{nd}/3d gen. cephalosporin, AG = Aminoglycoside, PCN = Penicillin, PCN/BL = Penicillin with β-lactamase inhibitor, Q = Quinolone, AP = Anti-anaerobic agent, EPCN/BL = Extended spectrum penicillin with β-lactamase inhibitor, G=Glycopeptide, CP = Carbapenem, OTHER = Other antibiotic regimens). *$p<0.05$

Table 1: Patient characteristics

Total n	52,349
Median age, years (IQR)	70 (62-76)
Gender, no. (%)	
Male	42,622 (81.4%)
Female	9,727 (18.6%)
Race, no. (%)	
White	41,609 (79.5%)
Non-white	10,740 (20.5%)
Obese, no. (%)	3,250 (6.2%)
Married, no. (%)	31,742 (60.6%)
Payor, no. (%)	00 (0.0%)
Medicare	34,649 (66.2%)
Medicaid	1,617 (3.1%)
Private	13,663 (26.1%)
Other	2,420 (4.6%)
Charlson comorbidity index, no. (%)	
2	22,945 (43.8%)
3	14,712 (28.1%)
≥4	14,692 (28.1%)
Hospital beds, no. (%)	
<200	5,127 (9.8%)
200-400	19,361 (37.0%)
400-600	14,868 (28.4%)
>600	12,992 (24.8%)
Teaching Hospital, no. (%)	18,435 (35.2%)
Vicinity to city center, no. (%)	
Rural	2,059 (3.9%)
Urban	50,290 (96.1%)
Region, no. (%)	
Midwest	11,383 (21.7%)
Northeast	9,245 (17.7%)
South	19,872 (38.0%)
West	11,848 (22.6%)
Lymphadenectomy, no. (%)	39,450 (75.4%)
Continent diversion, no. (%)	2,704 (5.2%)
Robotic approach, no. (%)	6,138 (11.7%)
Operative time, no. (%)	
<4 hours	5,745 (11.0%)
4-6 hours	20,592 (39.3%)
6-8 hours	14,723 (28.1%)
≥8 hours	11,289 (21.6%)
PRBCs transfused on day of surgery, no. (%)	
0 unit	45,493 (86.9%)
1-2 units	4,577 (8.7%)
≥3 units	2,279 (4.4%)
Number of antibiotics, no (%)	
Single-agent therapy	25,917 (49.5%)
Combination therapy	26,432 (50.5%)
Antibiotic duration, no. (%)	
1-2 days	37,177 (71.0%)
3-4 days	15,172 (29.0%)
Antibiotic class, no. (%)	
1st gen. cephalosporin	22,093 (42.2%)

Table 2: Incidence of Infectious, Wound and Soft-tissue Events.

Complication	Number (%)
Infectious, Wound or Soft-Tissue Event	13,254 (25.3%)
Infectious Event	11,565 (22.1%)
Urinary infection	6,177 (11.8%)
Urinary Tract Infection	5,512 (10.5%)
Pyelonephritis	927 (1.8%)
Non-urinary infection	10,440 (19.9%)
Sepsis	4,305 (8.2%)
Unspecified Bacterial Infection	4,070 (7.8%)
Unspecified post-op infection	2,375 (4.5%)
Pneumonia	2,267 (4.3%)
Mycoses	2,122 (4.1%)
Fever of unknown origin	1,421 (2.7%)
Clostridium difficile	1,155 (2.2%)
Peritonitis	414 (0.8%)
Central venous line infection	393 (0.8%)
Cholecystitis	292 (0.6%)
Bronchitis	74 (0.1%)
Endocarditis	63 (0.1%)
Diverticulitis	60 (0.1%)
Appendicitis	49 (0.1%)
Unspecified respiratory infection	27 (0.1%)
Other enteritis	26 (0.0%)
Osteomyelitis	23 (0.0%)
Meningitis or Encephalitis	21 (0.0%)
Soft tissue or wound Event	5,242 (10.0%)
Wound dehiscence	2,395 (4.6%)
Abscess	2,120 (4.0%)
Cellulitis	879 (1.7%)
Wound infection	663 (1.3%)
Seroma	364 (0.7%)
Stoma complication	207 (0.4%)
Non-healing wound	98 (0.2%)

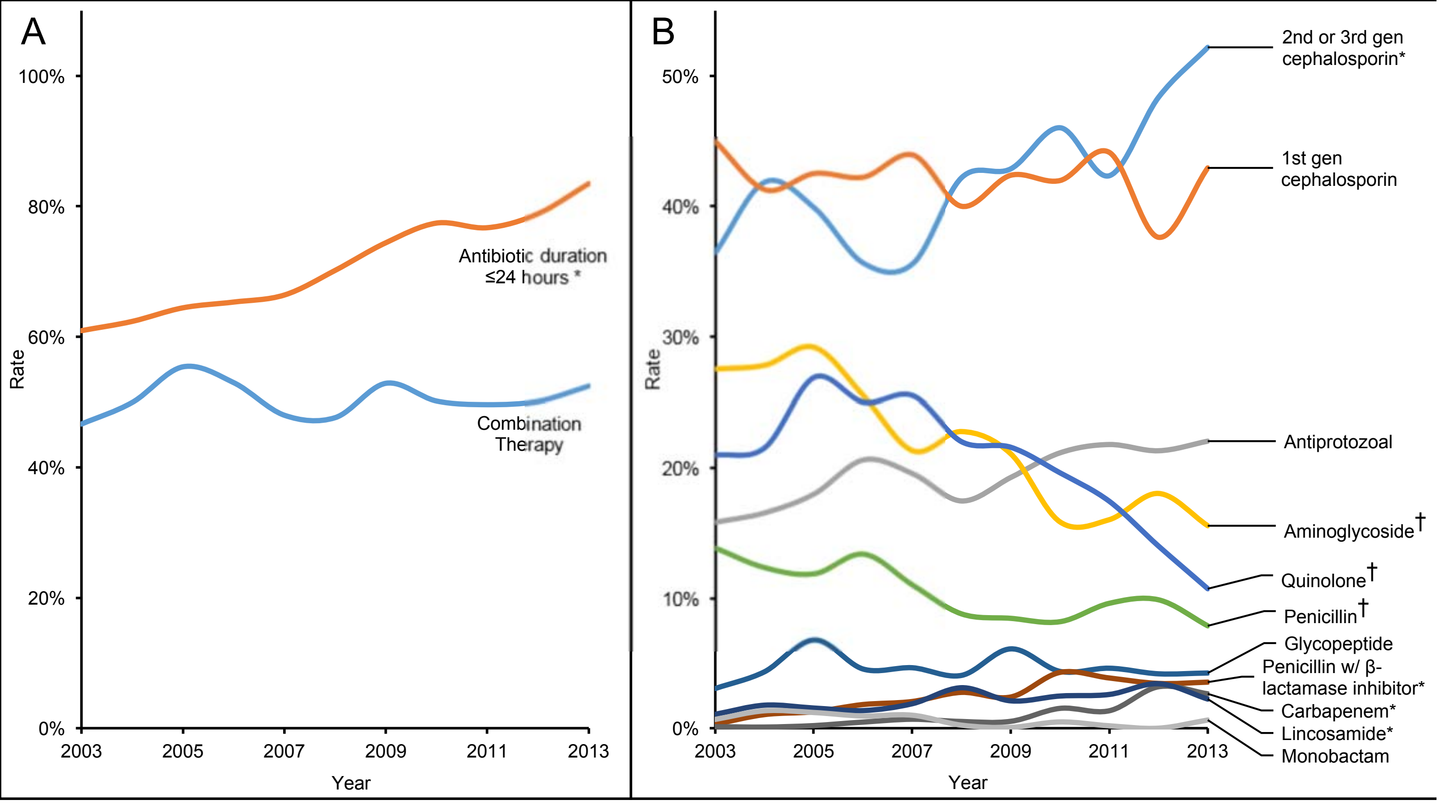
Table 3: Adjusted analyses for outcomes of different antibiotic regimens on (1) infectious, wound and soft tissue events (2) non-soft tissue infectious events (IE), (3) wound and soft tissue events, and (4) length of stay.

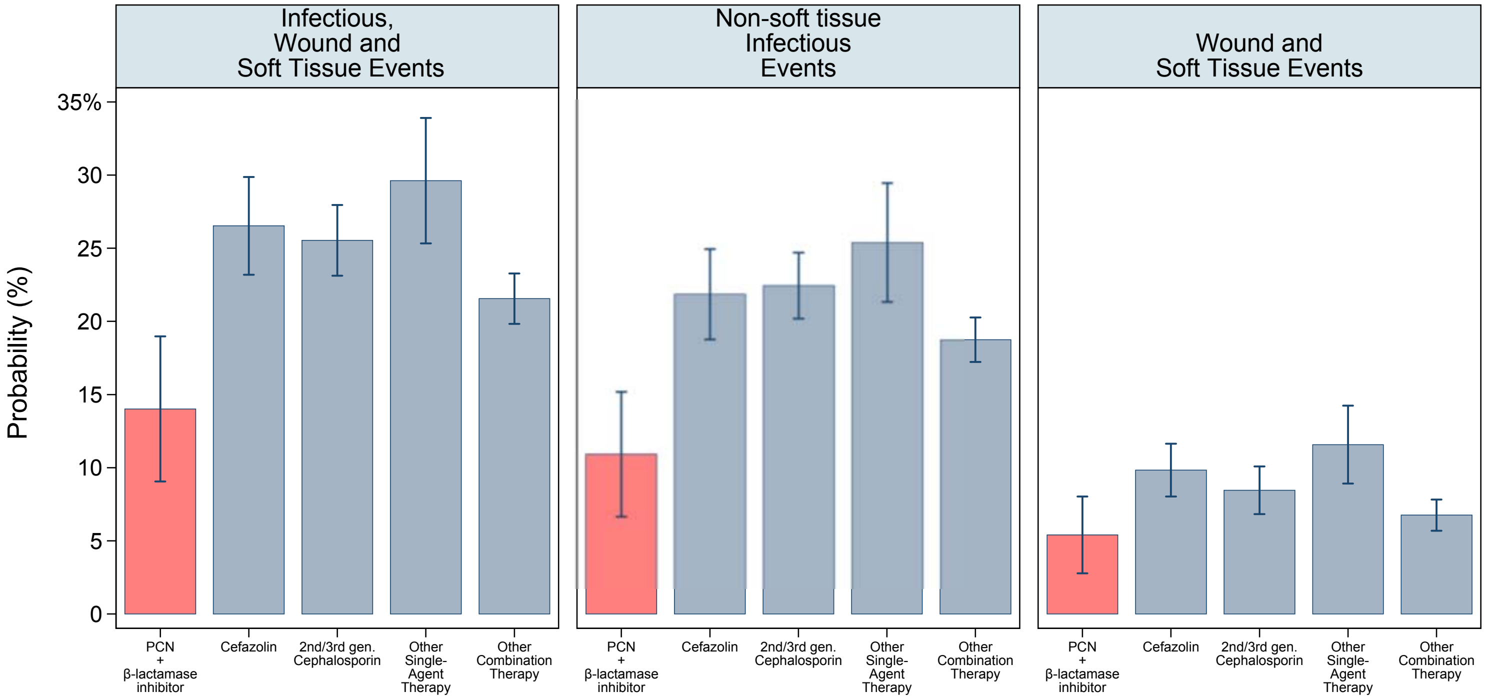
	Infectious, wound and soft-tissue events OR [95% CI]§	Non-soft tissue Infectious Events OR [95% CI]§	Wound and soft-tissue Complication OR [95% CI]§	Change in LOS (days) [95% CI]†
Extended Duration vs. 24 hours	1.01 [0.88-1.17]	1.00 [0.86-1.16]	1.12 [0.93-1.35]	-0.18 [-0.21,0.56]
Combination regimen vs. Single-Agent Therapy	0.79*** [0.70-0.89]	0.81*** [0.72-0.92]	0.72*** [0.60-0.86]	-0.40* [-0.73,-0.06]
Guidelines based therapy vs. all other regimens	1.16 [1.00-1.35]	1.15 [0.98-1.35]	1.08 [0.89-1.31]	0.06 [-0.35,0.46]
Guideline Regimens (Reference is cefazolin)				
AUA				
2nd/3rd gen. cephalosporin	0.95 [0.78-1.17]	1.04 [0.84-1.29]	0.85 [0.65-1.11]	0.19 [-0.40,0.78]
Aminoglycoside + Metronidazole or Clindamycin	1.06 [0.53-2.14]	1.19 [0.57-2.50]	1.19 [0.42-3.41]	0.53 [-1.55,2.61]
Ampicillin/sulbactam	0.34*** [0.19-0.60]	0.30*** [0.16-0.55]	0.46* [0.23-0.93]	-1.02 [-2.16,0.11]
Ticarcillin/clavulanate or Pipercillin/tazobactam	0.69 [0.40-1.18]	0.72 [0.41-1.26]	0.63 [0.29-1.37]	-1.67* [-3.27,-0.07]
EAU				
2nd/3rd gen. cephalosporin + Metronidazole	0.84 [0.58-1.23]	1.01 [0.68-1.48]	0.63 [0.38-1.04]	0.29 [-0.59,1.17]
Other non-guideline regimens	0.81* [0.67-0.97]	0.87 [0.71-1.05]	0.73** [0.58-0.93]	0.02 [-0.46,0.50]
Regimen associated with best outcomes (Reference is cefazolin)				
PCN + β-lactamase inhibitor	0.45*** [0.29-0.71]	0.44** [0.27-0.72]	0.52* [0.31-0.90]	-1.25* [-2.26,-0.24]
2nd/3rd gen. cephalosporin	0.95 [0.77-1.17]	1.03 [0.83-1.28]	0.85 [0.65-1.10]	0.18 [-0.41,0.78]
Other single-agent therapy	1.17 [0.89-1.52]	1.22 [0.92-1.62]	1.20 [0.88-1.64]	1.27** [0.49,2.05]
Other combination therapy	0.76** [0.63-0.92]	0.82 [0.68-1.00]	0.66*** [0.52-0.85]	-0.17 [-0.67,0.33]

OR=Odds ratio, CI=Confidence interval, LOS=Length of Stay
*p<0.05, **p<0.01, ***p<0.001
‡ This regimen consisted of cefazolin or ampicillin + gentamicin or a 2nd/3rd gen. cephalosporin
§ Survey-weighted logistic regression analyses clustered by hospital
†Performed using a negative binomial regression

Table 4: Adherence to AUA and EAU Antibiotic Prophylaxis Guidelines

Regimen	Duration ≤ 24 hrs N (%)	Any duration N (%)
Non-guideline Regimens	29,398 (56.2%)	37,635 (71.9%)
1st gen. Cephalosporin	4,780 (9.1%)	8,482 (16.2%)
Other regimens	24,617 (47.0%)	29,154 (55.7%)
Guideline Regimens	7,779 (14.9%)	14,713 (28.1%)
AUA		
2nd/3rd gen. Cephalosporin	6,117 (11.7%)	11,839 (22.6%)
Aminoglycoside + Metronidazole or Clindamycin	244 (0.5%)	244 (0.5%)
Ampicillin/Sulbactam	360 (0.7%)	925 (1.8%)
Ticarcillin/Clavulanate or Pipercillin/Tazobactam	205 (0.4%)	474 (0.9%)
EAU		
2nd/3rd gen. Cephalosporin + Metronidazole	853 (1.6%)	1,232 (2.4%)


A
100%
80%
60%
40%
20%
0%
Rate
Antibiotic duration ≤24 hours *
Combination Therapy
2003
2005
2007
2009
2011
2013
Year
B
50%
40%
30%
20%
10%
0%
Rate
2nd or 3rd gen cephalosporin*
1st gen cephalosporin
Antiprotozoal
Aminoglycoside†
Quinolone†
Penicillin†
Glycopeptide
Penicillin w/ β-lactamase inhibitor*
Carbapenem*
Lincosamide*
Monobactam
2003
2005
2007
2009
2011
2013
Year


Infectious, Wound and Soft Tissue Events
Non-soft tissue Infectious Events
Wound and Soft Tissue Events
Probability (%)
35%
30
25
20
15
10
5
0
PCN + β-lactamase inhibitor
Cefazolin
2nd/3rd gen. Cephalosporin
Other Single-Agent Therapy
Other Combination Therapy

Key:

ABP – Antibiotic Prophylaxis

RC – Radical Cystectomy

AUA – American Urological Association

EAU – European Association of Urology

ICD-9 - International Classification of Diseases, ninth revision

LOS - Length of Stay