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Overuse of Antimicrobial Prophylaxis in Community Practice Urology

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Abstract

Purpose—We examined index urological surgeries to assess utilization patterns of antimicrobial prophylaxis in a large, community based population.

Materials and Methods—From the Premier Perspectives Database we identified patients who underwent inpatient urological surgeries that are considered index procedures by the ABU (American Board of Urology), including radical prostatectomy, partial or radical nephrectomy, radical cystectomy, ureteroscopy, shock wave lithotripsy, transurethral resection of the prostate, percutaneous nephrostolithotomy, transvaginal surgery, inflatable penile prosthesis, brachytherapy, transurethral resection of bladder tumor and cystoscopy. Procedures were identified based on ICD-9 procedure codes for 2007 to 2012. Antimicrobial administration, class and duration were abstracted from patient billing data. The class and duration of antimicrobials concordant with the 2008 AUA Best Practice Policy Statement was used to determine compliance.

Results—The overall compliance rate was 53%, ranging from 0.6% for radical cystectomy to 97% for shock wave lithotripsy. Antimicrobial use consistent with AUA Best Practices included the appropriate class in 67% of cases (range 34% to 80%) and the recommended duration in 78% (range 1.2% to 98%). Average prophylaxis duration for procedures for which it is recommended ranged from 1.1 days after brachytherapy to 10.3 days after radical cystectomy. The compliance rate increased from 46% overall in 2007 to 59% overall in 2012.

Conclusions—We documented considerable variation in antimicrobial prophylaxis for urological surgery. Compliance with AUA Best Practices increased with time but overall rates remain less than 60%. Efforts are needed to better understand the reasons for variation from recommended antimicrobial prophylaxis for common inpatient urological procedures to help decrease resultant complications and improve outcomes.

Keywords

urologic surgical procedures; antibiotic prophylaxis; physician's practice patterns; drug resistance; bacterial; quality of health care

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The use of properly timed perioperative prophylactic antimicrobials is associated with a decreased risk of surgical infection.^{1,2} However, there is substantial variation in the duration of antimicrobial administration and up to 60% of antimicrobials may be continued beyond 24 hours.³ Extended prophylactic antimicrobial use is common in urological cancer surgery and it has been linked to an increased risk of postoperative *Clostridium difficile* infection.⁴ Antimicrobial resistance, driven in part by improper administration of prophylactic antimicrobials for urological procedures, is associated with various negative consequences, including additional health care costs,⁵ a prolonged hospital stay,⁶ increasing resistance patterns^{7,8} and increased mortality.⁹ Moreover, the incidence of *C. difficile* infection is increasing¹⁰ with increasing *C. difficile* relapse rates.¹¹

In an effort to standardize antimicrobial regimens and decrease variability in 2008 the AUA developed a Best Practice Policy Statement.¹² We evaluated practice patterns in a cohort of urological patients spanning a study period before the release of the policy statement and through 4 years thereafter. Our data source, the Premier Perspectives Database (Premier, Charlotte, North Carolina), includes billing claims for care received at a large number of community hospitals and allows for ascertainment of community practices of care. We measured adherence to the policy statement recommendations for commonly performed hospital based urological procedures and identified factors associated with noncompliant antimicrobial administration. We believe that a better understanding of antimicrobial utilization patterns and sources of noncompliance may guide future efforts to decrease antimicrobial overuse and its resultant negative sequelae.

METHODS

Study Sample

We retrospectively reviewed the records of patient visits in the Premier Perspectives Database from January 1, 2007 through December 31, 2012. Premier is a large collaborative health care database that incorporates approximately a sixth of all hospitalizations annually in the United States. Premier extracts data from individual hospitals rather than partnered employers or payers and thus includes a wide range of patient ages and insurers.

Using ICD-9 procedural codes we identified patients who underwent certain ABU index inpatient urological procedures, including RP (ICD-9 code 60.5), RC (57.7, 57.71 and 57.79), Nephx (55.51, 55.52, 55.54, 55.4, 55.01, 55.24, 55.31, 55.39, 55.81, 55.89, 55.91, 59.02, 59.09 and 59.21), URS (56.0, 56.31, 56.35 and 56.39), SWL (98.5), TURP (60.2, 60.21 and 60.29), PCNL (55.03 and 55.04), TVS (70.51, 70.54, 59.4, 59.7, 59.71, 59.72 and 59.79), IPP (64.97), Bt (92.27) and TURBT (57.49 and 57.4). We also examined AMP use during outpatient cystoscopy (ICD-9 codes 57.31 and 57.33) for a primary diagnosis of hematuria (ICD-9 codes 599.7, 599.71, 599.72 and 791.2) to evaluate practice patterns for a simple urological procedure during which no AMP is recommended.

Our unit of analysis was a discrete admission since an individual patient may be included in the database more than once. For example, a patient with bilateral kidney cancer undergoing staged surgeries would count as 2 separate episodes for analysis. We further restricted the sample by including only surgical patients who were at least 18 years old, in whom the

procedure was performed by a urologist as coded by Premier and who underwent surgery at a facility where more than 1 urological procedure was done during the study period.

Other variables extracted from Premier data included age, gender, race/ethnicity, marital status, insurance type and procedure year. We abstracted hospital characteristics, including teaching status, location and procedural volume. Comorbidity was determined and tabulated according to the method of Elixhauser et al¹³ using secondary diagnosis ICD-9 codes for the index hospitalization. We calculated the length of stay from surgery date to the discharge date and classified a length of stay as prolonged beyond the 75th percentile in the patient respective surgery cohort.

Outcomes

Our main outcome of interest was the receipt of inappropriate AMP in the perioperative window, as defined by compliance with the 2008 AUA Best Practice Policy Statement on Urologic Surgery Antimicrobial Prophylaxis.¹² Recommendations for index urological procedures included the class and duration of the antimicrobial with no recommended duration exceeding 24 hours postoperatively. We identified patterns of AMP utilization from a review of a comprehensive list of cost information by patient episode. All antimicrobial pharmaceutical billing codes were included and parsed out to the generic name level. However, for the purpose of analysis doses and administration routes were not considered. Day of antimicrobial receipt was extracted from claims and categorized in relation to the day of the urological procedure. To distinguish between perioperative AMP and antimicrobial use for treatment or suspicion of infection (ie for cause antimicrobial use) we flagged and excluded from study 58,069 patients with a switch in antimicrobial class within 24 hours postoperatively. After removing patients whose antimicrobial course was determined to be for cause we classified appropriate AMP in 2 ways, including 1) if the patient received only the recommended AMP type or combination on the day of surgery and 2) if AMP did not extend into postoperative day 2. A compliant antimicrobial course (the main outcome) was defined as meeting the 2 definitions, ie a patient received the appropriate antimicrobial type or combination of antimicrobial types that did not extend into postoperative day 2. For SWL and cystoscopy any antimicrobial use was considered noncompliant.

Statistical Analysis

Descriptive statistics were calculated using the frequency and percent for categorical variables and the mean $\pm$ SD for continuous variables. Univariate associations between compliant AMP and patient characteristics were assessed by the chi-square tests for categorical variables and the independent sample t-test for continuous variables. Multivariate logistic regression models were constructed for each procedure type to identify factors independently associated with compliant AMP. All statistical procedures were done with SAS®, version 9. This study qualified for a waiver of institutional review board approval since the data are fully HIPAA (Health Insurance Portability and Accountability Act) compliant and completely de-identified.

RESULTS

We identified 53,450 patients with RP, 4,732 with RC, 44,130 with Nephx, 202,713 with URS, 137,310 with SWL, 91,270 with TURP, 21,469 with PCNL, 49,931 with TVS, 8,611 with IPP, 11,390 with Bt, 114,132 with TURBT and 22,179 with cystoscopy who met our study inclusion criteria (supplementary table 1, <http://jurology.com/>). Inpatient procedures with a shorter length of stay were associated with greater compliance with recommended AMP. Care at an urban facility was commonly associated with compliant AMP (RP, URS, TVS, IPP, Bt and TURBT $p < 0.05$) as was care at higher volume centers (RP, URS, TURP, TVS, Bt and TURBT $p < 0.05$). Regional variation was significant. Depending on the procedure residence in the Midwest (URS, TVS and TURBT $p < 0.05$), the Northeast (RP and SWL $p < 0.05$), the South (Nephx, IPP, Bt and cystoscopy $p < 0.05$) or the West (TURP and PCNL $p < 0.05$) was associated with AMP compliance. Patients who underwent an inpatient procedure more recently had significantly higher rates of compliant AMP except for RC, for which no time trend was identified. The figure shows cohorts with sources of noncompliance with AMP by procedure and the average number of days that antimicrobials were administered postoperatively.

Supplementary table 2 (<http://jurology.com/>) shows surgery specific multivariate models that identified factors independently associated with noncompliant AMP. Increased age was associated with increased odds of noncompliant AMP (RP, RC, Nephx, URS, TURP, TVS and TURBT $p < 0.05$). Female patients had higher odds of noncompliant AMP for URS, PCNL and TURBT but lower odds for SWL and cystoscopy. Compared to white patients the black and Hispanic patients undergoing RP had higher odds of noncompliant AMP. Hispanic patients and those of other race/ethnicity had higher odds than white patients for receiving AMP for cystoscopy. Medicaid and Medicare patients undergoing RP, URS and TVS had increased odds of noncompliant AMP. Increased comorbidity was associated with increased odds of noncompliant AMP (each cohort except RP and TURBT $p < 0.05$). A length of stay longer than the 75th percentile was associated with noncompliant AMP in all cohorts with all other variables held constant.

Patients who received care at teaching hospitals demonstrated significantly increased odds of noncompliant AMP in the URS, TURP, PCNL, TVS, TURBT and SWL cohorts, and significantly decreased odds of noncompliant AMP in the RC and cystoscopy cohorts compared with care at nonteaching hospitals. Surgical volume was associated with better antimicrobial practices. The highest volume providers showed increased odds of AMP compliance (RP, Nephx, TVS, IPP, Bt and TURBT $p < 0.05$). Compliance with the Best Practice Policy Statement¹² appears to be increasing with time.

DISCUSSION

We identified marked variation in compliance with the AUA Best Practice Policy Statement for peri-operative AMP.¹² The 2008 AUA Best Practice Policy Statement was intended to limit the sequelae of excessive antimicrobial administration through detailed recommendations for perioperative AMP. However, no procedure examined in this study was compliant in administration duration or antimicrobial class. In most cases, noncompliance

was due to an inappropriately long duration of antimicrobial administration. In 8 procedures examined prophylaxis extended beyond 24 hours postoperatively. For cystoscopy performed on an outpatient basis for a primary diagnosis of hematuria, a clinical situation in which no AMP is recommended, more than half of patients received antimicrobials. The average number of days of antimicrobial therapy delivered postoperatively ranged from less than a day for Bt to more than a week for RC. The procedures for which AMP showed a compliant duration are often performed as outpatient procedures.

AMP duration was most notably extended in patients undergoing RC, PCNL and Nephx. For all 3 procedures antimicrobial duration paralleled mean length of stay. Certainly providers must at times deviate from guidelines and rely on clinical acumen for AMP management.¹⁴ For example, a patient undergoing PCNL may have symptomatic bacteriuria preoperatively for which antimicrobials must necessarily be extended postoperatively. Nevertheless, these 3 procedures represent target surgeries for quality improvement initiatives aimed at decreasing excessive AMP.

Patients with increased comorbidities showed significantly increased odds of noncompliant AMP. Risk factors for postoperative infectious complications include poor nutritional status, immune deficiency, indwelling hardware or prosthetic devices, concomitant infected wounds, anatomical aberrations and advanced age.¹⁵ Similarly the preponderance of comorbidities correlates with a risk of postoperative complications, including acquired infections.^{16,17} The propensity to administer extended AMP in men and women with greater comorbidity may be driven in part by a desire to prevent infectious complications in more susceptible patients. Comorbidity is also associated with a higher risk of failing to rescue complications.¹⁸ Patients with multiple comorbidities may have less resilience to HAIs. A substantial number of noncompliance episodes was noted at academic teaching hospitals. However, since complex patients with increased comorbidity are often referred to academic centers for care, this trend may reflect an attempt to avoid infectious complications in these patients.

Extended AMP may lead to various complications, including HAIs. The adverse impact of HAIs is well recognized, including increased length of stay, cost and mortality.⁶ *C. difficile* colitis is a well recognized complication of antimicrobial overuse that is associated with substantial morbidity and mortality, and increased health care costs.^{4,10} Moreover, growing antimicrobial resistance patterns are emerging in humans⁸ and livestock,^{7,19} creating the challenge of treating infections in the context of a limited number of available antimicrobial agents.²⁰

Compliance with AMP guidelines is improving. This may relate to the dissemination and adoption of clinical guidelines, the implementation of clinical care pathways and the use of electronic health records, which provide automatic prompts to guide clinical decision making. Moreover, in the era of increased attention to health care costs physicians may be more likely to comply with guidelines and limit AMP.

We acknowledge a number of limitations of this study. 1) This is a retrospective study that may be subject to misclassification of data or inaccurate diagnosis reporting. 2) Clinical

situations may not always adhere to guidelines and in certain situations there is sound rationale to continue antimicrobial therapy beyond the immediate perioperative period, such as wound infection after RC or management of positive urine culture results before PCNL. 3) Judgment based on experience is often used in situations that demand deviation from the guidelines and clinical acumen may account for this deviation. 4) Data from Premier may not be generalizable, although Premier is not restricted by patient age, as are Medicare claims data, nor is it restricted by insurance status, as are commercial claims databases. However, a strength of Premier data is that it includes not only patient demographics, diagnostics and procedural codes but also itemized billing records (ie Chargemaster files) for costs associated with care, permitting analysis of billed inpatient medications. Also, although we used primary diagnosis codes, we may have been unable to differentiate clinical indications for surgery that would appropriately increase postoperative antimicrobial use. 5) We excluded patients in whom a second class of antibiotic was initiated within 24 hours as potentially representative of a changing clinical circumstance. However, it is possible that a similar class of antibiotic might also be used for this indication, although we believe that this is less commonly done in clinical practice. 6) Best practice policy statements often allow room for provider judgment. The AUA Best Practice Policy Statement¹² exemplifies that these documents are constantly in flux and understanding compliance may involve assessment of a moving target. For example, AMP use for Nephx is recommended in patients with risk factors rather than in all patients and yet according to our data nonAMP in this population is rare and overuse is commonplace. Therefore, our measurement of AMP adherence is a contemporary snapshot that should be reevaluated as recommendations are updated. 7) Lastly, our results do not consider the cost and availability of antimicrobials at each institution.

CONCLUSIONS

Despite these limitations we report that antimicrobial compliance rates vary according to the urological procedure examined. Prophylactic administration of antimicrobial therapy does not routinely adhere to guidelines. Most notably the duration of AMP is extended in patients who undergo a procedure with a longer length of stay, including RC, Nephx and PCNL. Efforts to improve antimicrobial stewardship may involve provider training or restriction of antimicrobial authorization (ie require approval from infectious disease).⁹ These efforts are intended to address preventable morbidity from HAIs, similar to efforts to remove the Foley catheter within 48 hours of surgery to prevent catheter associated urinary tract infection.²¹ Specialty specific quality improvement may further help improve adherence and limit resultant complications. In the future more study must be done to quantitate and define the precise relationship between poor antimicrobial stewardship in specific urological procedures and poor patient outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Abbreviations and Acronyms

AMP	antimicrobial prophylaxis
AUA	American Urological Association
Bt	brachytherapy
HAI	hospital acquired infection
IPP	inflatable penile prosthesis
Nephx	radical or partial nephrectomy
PCNL	percutaneous nephrostolithotomy
RC	radical cystectomy
RP	radical prostatectomy
SWL	shock wave lithotripsy
TURBT	transurethral bladder tumor resection
TURP	transurethral prostate resection
TVS	transvaginal surgery
URS	ureteroscopy

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Pie charts show noncompliance rates by procedure, including explication of noncompliance sources. Dark gray areas indicate incorrect class. Light gray areas indicate incorrect duration. Hatched areas indicate incorrect class and duration. Histograms show postoperative days of antibiotics by procedure. *Pct*, percent.