Journal of Microbiology, Immunology and Infection (2015) 48, 517—524

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.e-jmii.com

ORIGINAL ARTICLE

Demography and burden of care associated with patients readmitted for urinary tract infection☆

Shawn H. MacVane [a], Lindsay O. Tuttle [b], David P. Nicolau [a,c,*]

[a] *Center for Anti-Infective Research and Development, Hartford Hospital, Hartford, CT, USA*
[b] *Saint Francis Hospital — Research Department, Saint Francis Hospital, Hartford, CT, USA*
[c] *Division of Infectious Diseases, Hartford Hospital, Hartford, CT, USA*

Received 12 March 2014; received in revised form 2 April 2014; accepted 3 April 2014
Available online 23 May 2014

KEYWORDS
demography;
economics;
readmission;
urinary tract infection

Background: Urinary tract infection (UTI) is one of the most prevalent admission diagnoses in hospital-based clinical practice. Despite its frequency, few data are available regarding its demographics and economic implications.
Purpose: To describe the demography, epidemiology, and burden of care of patients admitted to hospital with UTI and compare these characteristics depending on admission status.
Methods: A retrospective cohort study using an administrative database of patients admitted to Hartford Hospital (September 2011—August 2012) with UTI. Patient demographics, hospital characteristics, and total costs of care were examined.
Results: A total of 2345 unique patients were included. The mean age of the patients was 78 years and 71% were female. Median length of stay and total cost were 5 days and $8326 (interquartile range $5388—$14,179), respectively. A total of 359 patients (16.4%) were readmitted within 30 days, of which 111 patients (5.1%) had UTI on readmission. Only 16.3% of readmitted patients were infected with the same causative pathogen. A significant increase in the incidence of *Enterococcus faecalis* (1.2% vs. 9.3%; $p = 0.046$) occurred upon readmission, whereas occurrence of Enterobacteriaceae infection decreased in the readmission group (50.0% vs. 25.6%; $p = 0.006$), including a lower proportion of *Escherichia coli* (32.5% vs. 11.6%; $p < 0.001$). A higher proportion of readmission pathogens were nonsusceptible, including significant changes to cefazolin (24.4% vs. 63.6%; $p = 0.004$) and cefepime (8.7% vs. 27.6; $p = 0.05$).

☆ These data were presented in part at the *53rd Interscience Conference on Antimicrobial Agents and Chemotherapy* held in Denver, CO, USA (September 10—13, 2013).

* Corresponding author. Center for Anti-Infective Research and Development, Hartford Hospital, 80 Seymour Street, Hartford, CT 06102, USA.
E-mail address: david.nicolau@hhchealth.org (D.P. Nicolau).

http://dx.doi.org/10.1016/j.jmii.2014.04.002

Conclusion: UTI is highly prevalent and is associated with significant utilization of health-care resources among hospitalized patients. These findings, coupled with considerable rates of 30-day readmission, stress the importance of proper diagnosis and treatment.

Introduction

Urinary tract infection (UTI) is one of the most common diagnoses in patients admitted to hospitals. UTI accounts for nearly 1 million emergency department visits and over 100,000 hospital admissions annually in the United States.[1] In addition, UTI is estimated to cost $3.5 billion to the health-care system, a significant financial burden.[2] Despite the sizeable prevalence, data on the demography, uropathogen distribution, and burden of care of patients hospitalized with UTI are scarce. Because of the array of potential causative organisms, hospitalized patients often require use of broad-spectrum antibiotics empirically, generating higher rates of antimicrobial resistance.[3] Furthermore, due to UTI frequency and the aging population, readmissions to hospital are plentiful. Given the evolving health-care reimbursement process linking quality of care to payment in many disease states, it appears paramount to gain an appreciation for the consequences of this resource-demanding infection.

Hospital readmissions in the UTI population may be related to a number of factors, including failure of antimicrobial therapy, reoccurrence of infection, or unplanned or unrelated issues, among others. Because of this complexity, we sought to identify trends and relationships between demographics, epidemiology, and treatment, across admissions of patients readmitted to hospital with UTI. Through the identification of areas of potential improvement and future study in the management of patients with UTI, quality of care and consistency can ultimately be improved.

Methods

Study patients and design

We retrospectively studied the demographic, microbiologic, and economic attributes of patients admitted to Hartford Hospital (CT, USA) with a diagnosis of UTI on admission (≤48 hours). The study included adult patients (aged >18 years) identified from an administrative database using International Classification of Diseases 9th Edition Clinical Modification code (ICD-9-CM) 599.0 in the primary or secondary diagnosis field from September 1, 2011 to August 30, 2012. Patients were included in the primary analysis only on their first admission (index admission) during the study period, and any future admissions were excluded from the primary analysis. Patients who died while hospitalized or those who were placed on inpatient hospice care were excluded from the readmission analysis as they were inevitably not at risk for readmission.

The study was approved by the Institutional Review Board of Hartford Hospital. An informed consent waiver was granted as all data were currently in existence and no patient-specific interventions were conducted for the retrospective study. The collection of data was in compliance with the Health Insurance Portability and Accountability Act of 1996.

Data collection

Data collected from the administrative database included patient demographics, and hospital and discharge characteristics. Cost of overall hospitalization and payor mix were retrieved for the economic analysis.

In addition to the administrative data, the medical records (index and readmission visits) of all qualified patients with a UTI-related readmission within 30 days of discharge were assessed for the following key information: comorbid conditions, recent hospitalization, recent antibiotic therapy, causative urinary pathogen, and antibiotic therapy. For purposes of evaluating the potential development of resistance across admissions, we ascertained the causative organism and susceptibility of readmitted patient's UTI on each hospital visit.

End points and definitions

UTI was defined by the presence of either primary or secondary ICD-9-CM code 599.0. The 599.0 code was purposely chosen to be broad, to identify all patients with UTI (regardless of site specificity), because the standards used by coders and billers when deciding to apply a UTI diagnosis are inexact and general in nature. Likewise, in clinical settings, providers may diagnose and treat patients in the absence of classic signs and symptoms of UTI or without knowledge of the site and type of infection.[4] This allowed us to capture those patients billed for UTI to better understand the extent of the demographic and economic implications of the diagnosis on the health-care system.

Hospital readmission was defined as a pair of consecutive hospital admissions to Hartford Hospital, where the time between discharge from the first hospitalization and admission for the second hospitalization was less than or equal to 30 days. No distinction was made in terms of type of readmission, that is, planned versus unplanned.

An initial antibiotic treatment was a course of therapy initiated empirically (before availability of *in vitro* susceptibility reports). We considered an empiric antibiotic to be appropriate if it ultimately possessed *in vitro* activity against the isolated pathogen. At our institution, the preferred empiric antimicrobial agents for community-acquired and health-care-associated UTI are ceftriaxone and cefepime (±vancomycin), respectively. Time to appropriate antibiotics was defined as the elapsed time (hours) between the index culture collection and the initial dose of appropriate antibiotic therapy.

Hospital costs were calculated as the direct plus indirect hospitalization costs for each patient. Billing and financial information were retrieved from the hospital's accounting system. All economic values were reported in U.S. dollars.

Statistical analysis

Continuous variables were compared using Student *t* test, paired *t* test or the Wilcoxon signed rank test, as appropriate. Categorical variables were compared using the Chi-square test, Fisher's exact test, or McNemar's test, as appropriate. A p value ≤ 0.05 was considered statistically significant. All statistical analyses were performed using SigmaPlot, version 12 (Systat Software, Inc., San Jose, CA, USA).

Results

Administrative database

Patient population

A total of 2345 patients were admitted to Hartford Hospital with UTI. Among these patients, 493 (21%) patients had a primary discharge diagnosis and 1852 (79%) had a secondary diagnosis. A total of 2193 (93.5%) patients were evaluable for readmission. A flowchart of the inclusion and exclusion criteria for each study cohort is depicted in Fig. 1. Patients with a primary diagnosis of UTI were older than patients with a secondary diagnosis. Other demographics were comparable between diagnoses type.

A total of 359 (16.4%) patients were readmitted to hospital within 30 days of discharge. There was no difference in 30-day readmission rates between patients with a primary or secondary diagnosis (14.4% vs. 15.6%; $p = 0.557$). Male patients were more likely to be readmitted within 30 days than females (19.0% vs.13.7%; $p = 0.002$). No other demographics were more likely among readmitted patients.

Economic outcomes

Economic outcomes of the administrative database are presented in Table 1. A secondary diagnosis was associated with increased costs, longer length of stay, greater mortality, and increased admission to the intensive care unit (ICU; all $p < 0.001$). A significantly higher proportion of patients with primary diagnoses were receiving Medicare (a U.S. federal insurance program for adults $\geq$65 years; $p < 0.001$).

Readmission database

UTI-related readmission

There were no differences in the demographics, length of stay, or costs between those readmitted with and without

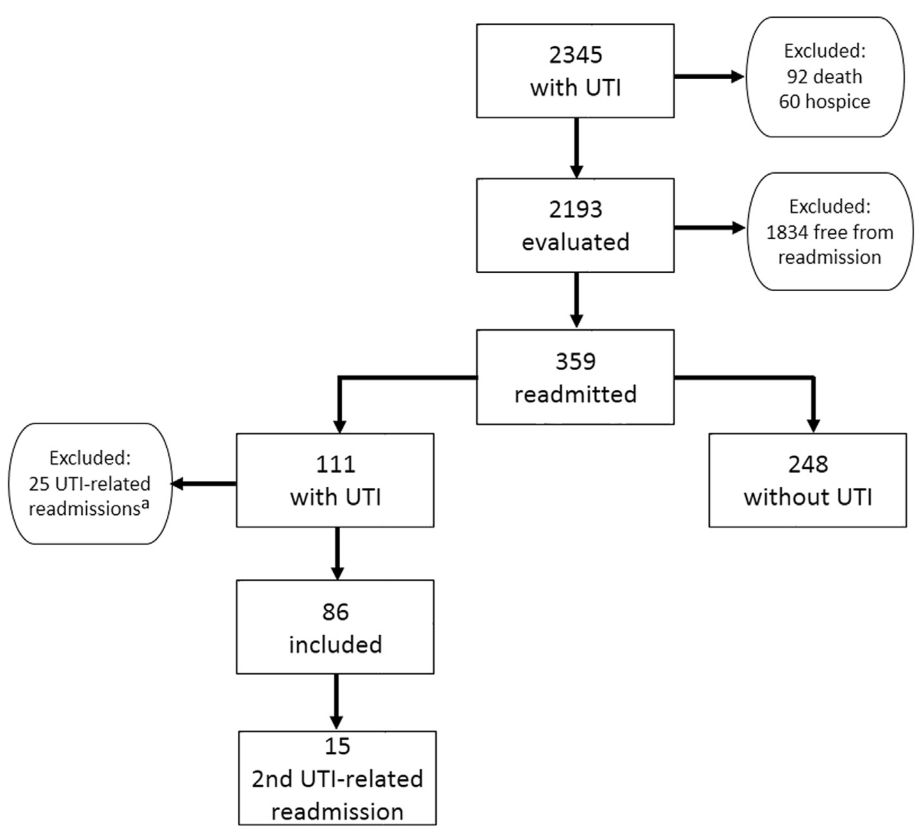

Figure 1. Inclusion and exclusion criteria flowchart of patients in each study cohort. [a]Excluded for the following reasons: eight with no urinary tract infection (UTI) on readmission, five with colonization (not treated with antibiotics), four with diagnosis before admission, four with psychiatry admission, two with extended non-UTI-related admission, and two with no UTI on index admission.

Table 1 Comparison of patient and hospital characteristics by diagnosis sequence (primary vs. secondary)

	UTI ($n = 2345$)	Primary ($n = 493$)	Secondary ($n = 1852$)	p
Demographics				
Age, y, median (IQR)	78 (64–86)	81 (71–87)	77 (62–86)	<0.001
Female	1674 (71.4)	368 (75.0)	1306 (70.5)	0.081
White	1798 (76.7)	374 (75.9)	1423 (76.8)	0.693
Black	207 (8.8)	43 (8.7)	164 (8.9)	0.997
Hispanic/Latino	267 (11.4)	60 (12.2)	207 (11.2)	0.591
Other	173 (3.1)	16 (3.2)	58 (3.1)	0.987
Clinical features				
LOS, days, median (IQR)	5.0 (3.0–8.0)	4.0 (3.0–5.0)	5.0 (3.0–8.5)	<0.001
ICU admission	306 (13)	7 (1.4)	299 (16)	<0.001
30-day all-cause readmission	359 (15.3)	71 (14.4)	288 (15.6)	0.557
Readmitted with primary UTI	32 (8.9)	14 (19.7)	18 (6.3)	0.005
Mortality	92 (3.9)	4 (0.8)	88 (4.8)	<0.001
Economic features				
Total costs, dollars, median (IQR)	8326 (5388–14,179)	5774 (4227–8219)	9393 (5951–16,211)	<0.001
Bed costs, dollars, median, (IQR)	5065 (3055–8744)	3715 (2634–5491)	5666 (3526–9807)	<0.001
Payor mix				
Medicare (%)	68	74	67	0.002
Medicaid (%)	10	6	11	0.002
Private insurance (%)	8	8	9	0.191
Managed care (%)	12	11	11	0.947

Data are number (%) of patients unless specified otherwise.
ICU = intensive care unit; IQR = interquartile range; LOS = length of stay; UTI = urinary tract infection.

UTI. Days to readmission were significantly shorter in patients readmitted with UTI [median (interquartile range, IQR), 15.0 (7.8–22)] compared with those readmitted without UTI [median (IQR), 19.0 (12–28); $p < 0.001$].

Based on coding, 111 patients (5.1%) had UTI at the time of readmission. However, 86 patients were evaluable, 25 patients were excluded from the readmission analysis (Fig. 1). A comparison between index and UTI-related readmission visits is shown in Table 2. Nearly 60% of readmissions came from a health-care (skilled nursing, long-term or acute care) facility, approximately two times as likely as their index admission (33%). With respect to clinical attributes, the rates of primary diagnoses, ICU admission, and development of bacteremia were similar between index and readmission visits.

Pathogen distribution

The distribution of causative organisms varied among patients (Table 2). Gram-negative organisms predominated, with *Escherichia coli* being the most commonly isolated pathogen. However, the occurrence of each pathogen changed considerably depending on hospital visit. There were 16.3% of patients ($n = 14$) infected with the same causative pathogen on index and readmission visits. The occurrence of Gram-positive organisms increased upon readmission, including a significant increase in the incidence of *Enterococcus faecalis* (1.2 vs. 9.3%; $p = 0.046$). With respect to Gram-negative organisms, the occurrence of Enterobacteriaceae infection remained most prominent, but were reduced by nearly half in the readmitted cases ($p = 0.006$). The proportion of infection with *E. coli* was significantly lower for the readmitted cases ($p < 0.001$).

Susceptibility profile

In vitro susceptibility test results of isolated pathogens from readmitted patients by visit are summarized in Table 3. No statistically significant difference was detected between the two admissions for the incidence of extended-spectrum beta-lactamases or vancomycin-resistant enterococci. Among tested isolates, susceptibility profiles were similar between admissions for ampicillin, ceftriaxone, ciprofloxacin, levofloxacin, trimethoprim–sulfamethoxazole, and vancomycin. By contrast, a higher proportion of readmission pathogens were nonsusceptible to cefazolin ($p = 0.004$) and cefepime ($p = 0.05$). There were increased rates of nonsusceptibility among urinary isolates between index, first, and second UTI-related readmission (not shown) visits to the most commonly used Gram-positive (vancomycin) and Gram-negative (ceftriaxone) antibacterial therapy. We noted a trend between vancomycin/ceftriaxone nonsusceptibility, rates of appropriate empiric therapy, and time to appropriate therapy, as depicted in Fig. 2.

Initial antibiotic therapy was similar between visits. Noncarbapenem beta-lactams were primarily used. In both admissions, ceftriaxone and vancomycin were the most used agents for Gram-negative and Gram-positive coverage, respectively. In-house days of antibiotics were similar between admissions ($p = 0.398$). However, median days of inappropriate antibiotics were prolonged in the readmission visit ($p = 0.005$).

Outcomes

Outcomes for readmitted patients by visit are shown in Table 3. Readmitted patients were less likely to receive

Table 2 Comparison of index versus readmission visits for patients readmitted with UTI within 30 days

Characteristics	Index admission ($n = 86$)	Readmission ($n = 86$)	p
Primary diagnosis	25 (29.1)	27 (31.4)	0.850
ICD-9-CM sequence, median (IQR)	3.0 (1.0—4.0)	2.5 (1.0—4.0)	0.976
Transfer from another health-care facility	33 (38.4)	51 (59.3)	0.010
Clinical features			
ICU admission	10 (11.6)	14 (16.3)	0.453
Bacteremia	6 (7.0)	4 (4.7)	0.752
Infectious diseases consultation	22 (25.6)	10 (11.9)	0.031
Empiric beta-lactam (noncarbapenem)	67 (77.9)	69 (80.2)	1.000
Discharge to SNF/LTC	51 (58.1)	49 (57.0)	1.000
Epidemiology by admission			
Urine culture positive	74 (86.0)	69 (80.2)	0.424
Same pathogen[a]	—	14 (16.3)	—
Different pathogen	—	19 (22.1)	—
Multiple bacterial morphologies	18 (20.9)	11 (12.8)	0.211
Gram-positive pathogen	8 (9.3)	14 (16.3)	0.121
Enterococcus faecalis	1 (1.2)	8 (9.3)	0.046
Enterococcus faecium	1 (1.2)	4 (4.7)	0.248
Staphylococcus sp. (except *S. aureus*)	3 (3.5)	1 (1.2)	0.480
Gram-positive (Gram stain only)	2 (2.3)	1 (1.2)	1.000
Gram-negative pathogen	49 (57.0)	38 (45.3)	0.289
Enterobacteriaceae	43 (50.0)	22 (25.6)	0.006
Escherichia coli	28 (32.5)	10 (11.6)	<0.001
Klebsiella pneumoniae	7 (8.1)	4 (4.7)	0.450
Proteus mirabilis	4 (4.7)	1 (1.2)	0.617
Pseudomonas aeruginosa	5 (5.8)	6 (7.0)	0.617
Lactose-fermenting GNR	1 (1.2)	5 (7.2)	0.221
Nonlactose-fermenting GNR	0	4 (5.8)	0.129
Other (1 patient each)	4 (4.7)	8 (9.3)	—

[a] Patients without positive cultures and those with multiple bacterial morphologies were not evaluable for determination of the same isolated pathogen.
Data are number (%) of patients unless specified otherwise.
GNR = Gram-negative rod; ICD-9-CM = International Classification of Diseases 9th Edition Clinical Modification code; ICU = intensive care unit; IQR = interquartile range; LTC = long-term care; SNF = skilled nursing facility; UTI = urinary tract infection.

appropriate empiric therapy on readmission ($p = 0.009$). As a result, time to appropriate therapy was delayed ($p = 0.045$). The length of stay and total hospital costs were similar between admissions.

The 15 patients (20%) readmitted with UTI on third admission experienced high rates of inappropriate empiric therapy and delays in time to appropriate therapy [median (IQR) 49 hours (5.5–74.0)], despite similar length of stay (median 5 days, $p = 0.118$) and costs (median $9677, $p = 0.168$; data not shown).

Discussion

In this study, we evaluated the demography and burden of care of patients admitted with UTI to our institution, with a particular emphasis on those readmitted within 30 days. In general, we found the impact of this infection on the health-care system to be extensive. The total cost of hospitalization is $8326/patient and driven by length of stay (median 5 days). Previous reports have focused on community- or hospital-acquired populations with limited data on the implications of those presenting to hospital with UTI.[1,2,5,6] Our approach complements the available literature by establishing a benchmark measurement of the demography and burden of care for patients admitted to hospital with UTI to track progress in the efforts to prevent and lower readmission rates over time.

Beyond the initial presentation, herein, we describe the characteristics and economic implications of this omnipresent condition, as well as a striking alteration in the epidemiology and resistance profile, between admissions for readmitted patients. Of late, readmissions have been an area of heavy scrutiny, and are considered a quality of care measure and that hospitals are being penalized for "excessive readmissions" in certain conditions.[7] Recent surveillance data report readmission rates varying from 13% to 25% for common conditions in the Medicare population.[8–10] Although urinary traction infection is not currently a penalized event by the Centers for Medicare and Medicaid (U.S. health program families and individuals with low income and resources) Services, given the high frequency and resource utilization of this common geriatric infection, it will likely be a forthcoming focus. We observed a readmission rate of 16.4% for patients with UTI. A single ICD-9-CM code was chosen to identify patients, as this is

Table 3 Comparison of index versus readmission nonsusceptibility, initial antibiotics, and outcomes

	Index admission (n = 86)	Readmission (n = 86)	p
Nonsusceptibility			
ESBL	4 (4.7)	6 (5.8)	0.716
VRE	1 (1.2)	4 (4.7)	0.364
Ampicillin	23/43 (53.5)	18/29 (62.1)	0.632
Cefazolin	11/45 (24.4)	14/22 (63.6)	0.004
Cefepime	4/46 (8.7)	8/29 (27.6)	0.050
Ceftriaxone	5/43 (11.6)	7/22 (31.8)	0.087
Ciprofloxacin	13/46 (28.3)	10/27 (37.0)	0.604
Levofloxacin	13/45 (28.9)	10/36 (27.8)	0.499
Trimethoprim—sulfamethoxazole	8/43 (18.6)	8/23 (34.8)	0.246
Vancomycin	1/3 (33.3)	4/5 (80.0)	0.464
Initial antibiotic therapy			
Ceftriaxone	46 (53.5)	45 (52.3)	1.000
Vancomycin	15 (17.4)	24 (27.9)	0.095
Cefepime	13 (15.1)	15 (17.4)	0.814
Levofloxacin	8 (9.3)	7 (8.1)	1.000
Ciprofloxacin	6 (7.0)	6 (7.0)	1.000
Piperacillin—tazobactam	5 (5.8)	5 (5.8)	1.000
Cefazolin	3 (3.5)	2 (2.3)	1.000
Trimethoprim—sulfamethoxazole	1 (1.2)	1 (1.2)	1.000
Ertapenem	1 (1.2)	1 (1.2)	1.000
Outcomes			
In-house days of antibiotics, median (IQR)	5.0 (3.0—7.0)	4.0 (3.0—6.0)	0.398
In-house days of inappropriate antibiotics, median (IQR)	0.0 (0.0—0.25)	1.5 (0.0—3.0)	0.005
Discharged on antibiotics	26 (30.2)	20 (25.0)	0.327
Length of hospital stay, days, median (IQR)	5.5 (4.0—8.0)	5.0 (3.0—8.0)	0.515
Total hospital costs, dollars, median (IQR)	9119 (5593—13,582)	8184 (5725—13,446)	0.544
Time to appropriate antibiotics, hours, median (IQR)	4 (1.5—19.0)	17.25 (2.6—50.75)	0.045
Patients who never received appropriate antibiotics	2 (2.3)	7 (8.1)	0.008
Appropriate empiric antibiotics	45/54 (83.3)	28/50 (56.0)	0.009

Data are number (%) of patients unless specified otherwise.
ESBL = extended-spectrum beta-lactamase; IQR = interquartile range; VRE = vancomycin-resistance enterococci.

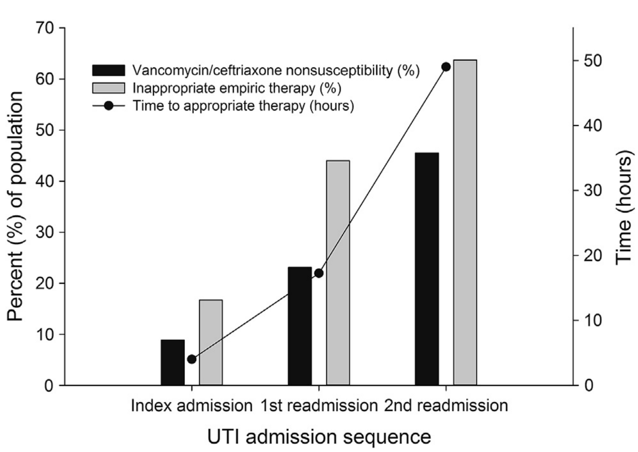

Figure 2. Association between vancomycin/ceftriaxone nonsusceptibility and appropriate antibacterial therapy. Vancomycin/ceftriaxone nonsusceptibility was determined for patients with positive urine cultures (based on isolated pathogens and/or Gram stains). Patients with multiple bacterial morphologies and no growth on urine culture were not included in the determination of vancomycin/ceftriaxone nonsusceptibility. UTI = urinary tract infection.

most commonly used billing code for UTI at our institution. However, it is possible that additional patients were readmitted with UTI and billed under an alternative code. Furthermore, the inclusion of patients receiving private insurance may have lowered our observed rate of readmission, as this population has been shown to experience a lower frequency of readmission, likely a result of overall better health (fewer comorbid conditions), higher incomes, and fewer risk factors for recurrent infections when compared with Medicare beneficiaries.[11—13] Despite this, the high frequency of UTI in the hospital setting translates into a significant total number of readmissions, regardless of the exact incidence.

Our comparison of index and readmission visits, for patients rehospitalized within 30 days, attests to the notion of antibiotic use leading to the emergence and development of resistance. While this correlation may seem obvious, previous investigations have generally relied on surveillance data to demonstrate the relationship.[14] In this study, the changing epidemiology and rise in resistance after treatment occurred in the same exposed patient population. The most alarming difference was the decline in the incidence of tradition uropathogens. On index admission, one-half of UTI episodes were due to Enterobacteriaceae infection, with *E. coli* being the most common occurrence. On readmission, rates of infection showed a numerical shift from Gram-negative to Gram-positive, including a significant reduction in the incidence of Enterobacteriaceae infection (50% vs. 25.6%, $p = 0.006$). Because many patients received appropriate initial therapy and a limited percentage (1 of 6 patients) were readmitted with the same isolated pathogen, the main causes of readmission in the study are likely a combination of reinfection, poorly managed follow up, failure to correct underlying causes, or unrelated admissions. Accordingly, the shifting landscape of uropathogens challenged the ability to provide sufficient antibiotic coverage on subsequent admissions. Furthermore, susceptibility test results were adversely affected between visits. There were dramatic increases in the rates of resistance to conventional urinary antibiotics (Table 3), including significantly higher rates of nonsusceptibility to cefepime and cefazolin. Applying the rates of nonsusceptibility to the most commonly used antibiotics for Gram-positive (vancomycin) and Gram-negative (ceftriaxone) coverage at our institution substantially diminished the adequacy of empiric therapy, potentially accounting for the delay in time to appropriate therapy observed in our cohort. Although not all readmissions are avoidable, these observations highlight the importance of appropriate treatment, correction of modifiable risk factors (i.e., indwelling catheter), and follow-up care for nonresponders as proposed strategies to reduce preventable rehospitalizations related to the initial hospital presentation.

Interestingly, although there were notable differences in the infectious etiology between hospital visits, we saw comparable length of stay and costs of hospitalization between admissions for the readmitted patients. However, subsequent admissions (first and second readmission) required the use of broader spectrum agents to effectively treat the more resistant organisms seen in these infections. In turn, there are potential downstream environmental and collateral consequences that may not have been captured in the scope of this study.[15–17]

As with other studies limitations exist with our current methodology. First, these data were obtained from a single hospital. Although data from multiple centers would be of interest, we used minimal exclusionary criterion yielding a diverse population that is likely representative of patients at other hospitals. Second, we evaluated patients based on the presence of a diagnostic billing code, rather than a clinical diagnosis, which potentially may have misclassified or failed to capture the frequency of UTI.[18] Third, we considered readmission to our institution only, and may not have detected readmitted patients who presented to an outside institution. Fourth, the study design was retrospective in nature and therefore inherently introduces certain levels of bias.

In conclusion, the burden of disease for patients admitted to hospital with UTI is high. A majority of patients with UTI requiring admission to hospital are frequently those aged $\geq$65. A considerable portion of their cost can be attributed to length of stay. Importantly, subsequent visits with UTI, where the burden is comparable with that of index admissions, are associated with changing epidemiology and complexity of managing their infection. This understanding is of critical importance to health systems globally, given the likely impending payment pressures on hospitals to reduce *unnecessary* readmissions, as currently seen in the United States. Further studies with an emphasis of understanding UTI management processes should be of heightened interest.

Conflicts of interest

D.P.N., S.H.M., and L.O.T report no conflicts of interest relevant to this article.

Financial support

This work was supported internally by our department.

Acknowledgments

We thank Gil Fortunado for his assistance with data retrieval. S.H.M. had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

References

1. Foxman B. Epidemiology of urinary tract infections: incidence, morbidity, and economic costs. *Am J Med* 2002;**113**:5S–13S.
2. Litwin MS, Saigal CS, Yano EM, Avila C, Geschwind SA, Hanley JM, et al. Urologic diseases in America Project: analytical methods and principal findings. *J Urol* 2005;**173**:933–7.
3. Gandhi T, Flanders SA, Markovitz E, Saint S, Kaul DR. Importance of urinary tract infection to antibiotic use among hospitalized patients. *Infect Control Hosp Epidemiol* 2009;**30**:193–5.
4. Meddings J, Saint S, McMahon Jr LF. Hospital-acquired catheter-associated urinary tract infection: documentation and coding issues may reduce financial impact of Medicare's new payment policy. *Infect Control Hosp Epidemiol* 2010;**31**:627–33.
5. Tambyah PA, Knasinski V, Maki DG. The direct costs of nosocomial catheter-associated urinary tract infection in the era of managed care. *Infect Control Hosp Epidemiol* 2002;**23**:27–31.
6. Kennedy EH, Greene MT, Saint S. Estimating hospital costs of catheter-associated urinary tract infection. *J Hosp Med* 2013;**8**:519–22.
7. Public Law 111-148, Patient Protection and Affordable Care Act 2010: Part III, Section 3025. Enacted date March 23, 2010. Washington, DC: U.S. Government Printing Office.
8. Lindenauer PK, Normand SL, Drye EE, Lin Z, Goodrich K, Desai MM, et al. Development, validation, and results of a measure of 30-day readmission following hospitalization for pneumonia. *J Hosp Med* 2011;**6**:142–50.
9. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. *N Engl J Med* 2009;**360**:1418–28.
10. Joynt KE, Orav EJ, Jha AK. Thirty-day readmission rates for Medicare beneficiaries by race and site of care. *JAMA* 2011;**301**:675–81.
11. Weiss AJ, Elixhauser A, Steiner C. Readmissions to U.S. hospitals by procedure, 2010: statistical brief #154. In: *Healthcare Cost and Utilization Project (HCUP) statistical briefs*. Rockville, MD: Agency for Health Care Policy and Research (US); 2006 Feb.

12. Davis K, Schoen C, Doty M, Tenney K. Medicare versus private insurance: rhetoric and reality. *Health Aff (Millwood)*; 2002: W311—24.
13. Hooton TM. Recurrent urinary tract infection in women. *Int J Antimicrob Agents* 2001;**17**:259—68.
14. Turnidge J, Christiansen K. Antibiotic use and resistance—proving the obvious. *Lancet* 2005;**365**:548—9.
15. Dellit TH, Owens RC, McGowan Jr JE, Gerding DN, Weinstein RA, Burke JP, et al. Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. *Clin Infect Dis* 2007;**44**: 159—77.
16. Spellberg B, Guidos R, Gilbert D, Bradley J, Boucher HW, Scheld WM, et al. The epidemic of antibiotic-resistant infections: a call to action for the medical community from the Infectious Diseases Society of America. *Clin Infect Dis* 2008;**46**: 155—64.
17. Boucher HW, Talbot GH, Bradley JS, Edwards JE, Gilbert D, Rice LB, et al. Bad bugs, no drugs: no ESKAPE! An update from the Infectious Diseases Society of America. *Clin Infect Dis* 2009;**48**:1—12.
18. Tieder JS, Hall M, Auger KA, Hain PD, Jerardi KE, Myers AL, et al. Accuracy of administrative billing codes to detect urinary tract infection hospitalizations. *Pediatrics* 2011;**128**: 323—30.