Clostridium difficile Infection in Texas Hospitals, 2007-2011

We examined the epidemiology of *Clostridium difficile* infection (CDI) for hospitalizations in Texas and estimated the incremental impact of CDI on mortality, length of stay, and costs. For patients hospitalized for other conditions or procedures, CDI may result in higher mortality risk, additional costs, and longer lengths of stay. However, little is known about these incremental impacts from observational data. This study uses publicly available inpatient discharge data from Texas to estimate these impacts. Texas was selected for study owing to the large number of hospitals, geographic and demographic diversity of hospitalized patients, and recent population growth in Texas.

C. difficile is the leading cause of infectious diarrhea in hospitalized patients; the Centers for Disease Control and Prevention reported an almost 10-fold increase in deaths due to CDI between 1999 and 2008.[1] Documented infections have increased since 2001 as an epidemic strain of *C. difficile* (B1/NAP1) appeared; however, subsequent reports using a national sample of adult hospital discharges indicated the overall rate of CDI in hospitals leveled off between 2008 and 2010.[2] Although it can be acquired in the community, it has been a known cause of healthcare-associated (nosocomial) infection for approximately 30 years.[3] Associated with use of multiple antibiotics and longer hospital stays, CDI is more likely to impact individuals who are vulnerable to infection, such as older adults and patients transferred from other healthcare settings.[4,5] Because there is a need to treat other conditions with antibiotics, CDI is not always avoidable, and management often includes better antibiotic stewardship along with surveillance to allow for early identification and treatment of cases.

This observational cohort study included most inpatient discharges from Texas hospitals between 2007 and 2011 as reported through the Texas Health Care Information Collection Inpatient Public Use Data Files. The deidentified files contain discharge abstracts from Texas hospitals not exempt from reporting due to rural status, to staffing less than 100 beds, or to not soliciting payments from insurers or the government.[6] Other systematic exclusions from the public use data were to protect patient identity through suppression of demographic information, which accounted for approximately 5% of all discharges.[6] CDI cases were identified by an *International Statistical Classification of Disease, Ninth Revision, Clinical Modification* code of 008.45 (*C. difficile*) in any of the discharge diagnosis fields. CDI discharges were stratified by principal versus secondary diagnosis and those with secondary diagnosis were matched to controls (without CDI) using observed characteristics and one-to-one greedy propensity-score matching methods.[7] In-hospital mortality and length of stay were directly assessed from the discharge records; costs were estimated using facility-specific cost to charge ratios generated from the Centers for Medicare and Medicaid Services cost reports.[8] Mortality, mean/median length of stay, and mean/median cost outcomes were compared between CDI cases and matched controls. McNemar's test was used to assess statistically significant differences in mortality odds ratios because mortality is a dichotomous measure, whereas paired *t* tests and Wilcoxon signed-rank tests were used to assess statistical significance in differences in length of stay and cost outcomes, respectively.

This study identified 14,723,825 discharge records from Texas hospitals between 2007 and 2011. Of these records, 97,989 (0.67%) had a principal or secondary diagnosis of CDI. The CDI rate per 1,000 discharges across 5 years was 6.66, with a rate of 7.4 cases per 1,000 discharges in 2011, with higher rates for white patients not of Hispanic origin, adults aged 65 or older, and patients arriving from or discharged to other health facilities, including nursing homes (data not shown). For discharges with CDI as a secondary diagnosis, the most common principal diagnoses were septicemia, rehabilitation, acute respiratory failure, pneumonia, pneumonitis, acute renal failure, and pressure ulcer (data not shown).

Hospitalizations with a CDI as a secondary diagnosis had significantly higher in-hospital mortality, longer mean and median lengths of stay, and higher mean and median costs for each data year (see Table 1). Odds ratios for mortality ranged between 1.65 and 1.87 for the overall matched sample comparison of CDI cases compared with controls. CDI hospitalizations were at least 1 week longer, on average, compared with non-CDI hospitalizations; this difference decreased over the study time frame from 9.3 to 7.4 days. Longer median lengths of stay for CDI cases versus controls also decreased from 8 to 6 additional days over the studied years. Median hospitalization costs, which reflect the 50th percentile of discharges and minimize the impact of cost outliers, were approximately $8,000 to $8,350 higher for CDI discharges over the study time frame.

CDI was identified in a small percentage of hospital discharges in Texas, but the rate of CDI per 1,000 discharges increased from 6.02 in 2007 to 7.40 in 2011. Analyses according to year, demographic, geographic, facility, and diagnostic characteristics confirmed that CDI was an increasing problem in Texas hospitals between 2007 and 2011 with disproportionate impacts on older adults, patients in long-term care facilities, and non-Hispanic white patients (data not shown). Even after careful adjustment using propensity score matching, discharges with CDI as a secondary diagnosis had increased in-hospital mortality, longer lengths of stay, and higher costs. The noted decrease in in-hospital mortality rates for CDI hospitalizations over the study time frame was inconsistent with findings from a recent national study but may reflect differences in the underlying hospitalized population in Texas.[2] Nevertheless, reductions in avoidable CDI cases through improved infection control practices and antibiotic stewardship could improve quality and quantity of life for persons potentially impacted by this infection.

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TABLE 1. Estimated Differences in Mortality, Length of Stay, and Cost Between Inpatients With *Clostridium difficile* Infection (CDI) as a Secondary Diagnosis and Matched Inpatients Without CDI, 2007-2011

Variable	2007	2008	2009	2010	2011
Mortality					
Rate for CDI as secondary diagnosis[a]	115.1	128.9	111.9	110.1	102.4
Rate for no CDI diagnosis[a]	69.8	70.4	67.1	66.1	63.6
Adjusted odds ratio[b]	1.68	1.87	1.71	1.69	1.65
Mean length of stay, days					
CDI as secondary diagnosis	18.97	18.59	18.26	17.75	16.53
No CDI diagnosis	9.69	9.66	9.42	9.33	9.15
Difference[c]	9.28	8.93	8.84	8.42	7.38
Median length of stay, days					
CDI as secondary diagnosis	14	13	13	12	11
No CDI diagnosis	6	6	6	6	5
Difference	8	7	7	6	6
Mean costs, US$[d]					
CDI as secondary diagnosis	$26,346	$27,423	$28,995	$30,915	$31,273
No CDI diagnosis	$12,787	$13,648	$19,884	$15,883	$17,265
Difference[c]	$13,559	$13,775	$9,111	$15,032	$14,008
Median costs, US$					
CDI as secondary diagnosis	$15,108	$16,315	$16,750	$18,210	$18,210
No CDI diagnosis	$7,126	$8,085	$8,398	$9,920	$9,920
Difference	$7,982	$8,230	$8,352	$8,290	$8,290
Number of cases[e]					
Costs and length of stay	11,182	12,344	11,746	12,483	13,262
Mortality	11,182	12,344	11,747	12,485	13,263

NOTE. All odds ratios and differences are significant at $P < .001$ except for total charges in 2009, which was significant at $P < .025$. Controls were selected through propensity score logistic regression and one-to-one greedy match algorithms. The matching models evaluated included all available variables and combinations of the following interactions (including none): race and ethnicity, Major Diagnostic Category (MDC) and no. of comorbidities, and payer 1 and payer 2. The final model included all variables and significant interaction terms of payer 1 and payer 2, and MDC and no. of comorbidities. This model yielded the highest C-statistic, had the most complete matches, and had the fewest nonsignificant covariates in the matching model results.

[a]Rate is number of deaths per 1,000 patients.

[b]Odds ratios were calculated through use of the McNemar's odds ratio for one-to-one propensity score matching of cases to controls. Significance of differences were measured using McNemar's test.

[c]Mean length of stay and mean costs were calculated through the use of one-to-one propensity score matching of cases to controls. Significance of differences were measured with paired *t* test.

[d]Costs estimated from total charges using cost to charge ratios from the Centers for Medicare and Medicaid Services cost reports.

[e]Number of cases differ owing to missing total charges data.

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REFERENCES

1. Murphy SL, Xu J, Kochanek KD. Deaths: final data for 2010. *Natl Vital Stat Rep* 2013;61:1–117.
2. Reveles KR, Lee GC, Boyd NK, Frei CR. The rise in *Clostridium difficile* infection incidence among hospitalized adults in the United States: 2001-2010. *Am J Infect Control* 2014;42:1028–1032.

3. Kelly C, LaMont J. *Clostridium difficile*—more difficult than ever. *N Engl J Med* 2008;359:1932–1940.
4. Clabots CR, Johnson S, Olson MM, Peterson LR, Gerding DN. Acquisition of *Clostridium difficile* by hospitalized patients: evidence for colonized new admissions as a source of infection. *J Infect Dis* 1992;166:561–567.
5. Tartof SY, Rieg GK, Wei R, Tseng HF, Jacobsen SJ, Yu KC. A comprehensive assessment across the healthcare continuum: risk of hospital-associated *Clostridium difficile* infection due to outpatient and inpatient antibiotic exposure [published online September 21, 2015]. *Infect Control Hosp Epidemiol* 2015, http://journals.cambridge.org/abstract_S0899823X15002202. Accessed September 24, 2015.
6. User manual: Texas hospital inpatient discharge public use data file (PUDF). Texas Department of State Health Services website. http://www.dshs.state.tx.us. Published 2014. Accessed September 24, 2015.
7. Parsons L. Reducing bias in propensity score matched-pair sample using greedy matching techniques. SAS website. http://www2.sas.com/proceedings /sugi26/p214-26.pdf. Published 2001. Accessed September 28, 2015.
8. Cost reports by fiscal year. Centers for Medicare and Medicaid Services website. http://www.cms.gov/Research-Statistics-Data-and-Systems/Files-for-Order/CostReports/Cost-Reports-by-Fiscal-Year.html. Published 2014. Accessed June 20, 2015.

Antibiotic Prescribing for Urinary Tract Infections in the Emergency Department Based on Local Antibiotic Resistance Patterns: Implications for Antimicrobial Stewardship

Informing emergency medicine providers of the local resistance patterns for uropathogens may optimize empiric treatment of urinary tract infection. Recent emergency department–based studies have demonstrated that urinary isolates of *Escherichia coli* are often resistant to trimethoprim-sulfamethoxazole (TMP-SMX).[1,2] Low rates of resistance to nitrofurantoin have been reported for common uropathogens.[3,4] We evaluated changes in the antibiotic prescribing patterns for patients discharged from the emergency department after distribution of antibiotic resistance data specific to our emergency department patient population.

A quasi-experimental study design was used with retrospective chart review for all patients discharged from our emergency department with a diagnosis of urinary tract infection from October 1, 2014, to March 31, 2015. The primary outcome was to compare the prescribing patterns for uncomplicated urinary tract infection at baseline (October 1, 2014, through November 30, 2014) and after education regarding local uropathogen resistance (February 1, 2015, through March 31, 2015). Prescribing patterns were evaluated for all patients that received a prescription for suspected urinary tract infection at 3 sites in Providence, Rhode Island: Rhode Island Hospital, The Miriam Hospital, and Hasbro Children's Hospital. All sites are staffed by the same group of emergency medicine providers and together account for >200,000 patient visits per year.

Baseline antibiotic resistance was collected for each urine culture that grew >100,000 CFU/mL of a single microorganism. *E. coli* was identified in approximately 80% of urine cultures and therefore was chosen as the primary organism of interest for this intervention when isolated as a single pathogen. If patients with such urine culture results presented to the emergency department more than once, only the initial visit was used for the primary analysis. Urine isolates of *E. coli* had a lower likelihood of resistance to nitrofurantoin (5%) compared to fluoroquinolones or TMP-SMX (14% and 29%, respectively, $P < .001$) but not cefazolin (8%, $P = .2$). Antibiotic resistance data for *E. coli* were sent to all providers by email on December 3, 2014, and were posted in emergency department clinical treatment areas. The message included a recommendation to consider nitrofurantoin in the absence of contraindications due to low rate of resistance. Updated information was sent February 2, 2015, and March 23, 2015. The final update included further clarification of the use of nitrofurantoin in elderly patients; nitrofurantoin should only be used for short-term treatment of uncomplicated UTIs.

A total of 1,140 patients were discharged from the emergency department with a diagnosis of uncomplicated UTI and were prescribed antibiotics. There were fewer prescriptions for TMP-SMX (13% vs 7%, $P = .01$) and ciprofloxacin (39% vs 26%, $P < .001$) and more prescriptions for nitrofurantoin (20% vs 30%, $P = .003$) and cephalexin (21% vs 34%, $P < .001$) at the end of the study period (Table 1).

A total of 651 urine cultures were sent during the periods of comparison. There were 117 (18%) cultures with no growth and 217 (33%) with multiple organisms suggestive of contamination. *E. coli* was isolated in 267 of the 317 (84%) cultures with a single organism. During the first 2 months of the study, 11 of 144 patients (7.6%) with a urine culture positive for *E. coli* were prescribed antibiotics that were not effective against the isolated organism. Of these patients, 10 were prescribed ciprofloxacin and 1 patient was prescribed TMP-SMX. In the final 2 months of the study, 5 of 123 patients (4.1%) were prescribed ineffective antibiotics. Of these, 4 patients were prescribed ciprofloxacin and 1 patient was prescribed cephalexin. The reduction in prescribing ineffective antibiotics did not reach statistical significance (OR, 0.51; 95% CI, 0.17–1.52).

Information on urinary pathogen resistance patterns changed the prescribing practice of emergency medicine providers. Focusing empiric treatment on antibiotics with the lowest likelihood of resistance may decrease the likelihood that patients receive ineffective antibiotics, even though the subset of patients that had urine culture data available in this study was of inadequate size to show a statistically significant change.

Prior investigation demonstrated that only 57% of the elderly patients treated for UTI in the emergency department had a positive urine culture and that overtreatment of infections with broad-spectrum antibiotics is common in the emergency department.[5,6] Some degree of overdiagnosis remains because 18% of the patients treated for suspected UTI with culture

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