Rhode Island *Clostridium difficile* Infection Trends and Laboratory ID Events Ranking

YONGWEN JIANG, PhD; ROSA BAIER, MPH; BLAKE MORPHIS, BS, CPEHR; LEONARD A. MERMEL, DO, SCM; SAMARA VINER-BROWN, MS

In January 2013, the Centers for Medicare & Medicaid Services (CMS) began requiring acute-care hospitals to submit any laboratory-identified ("LabID") *Clostridium difficile* cases to the Centers for Disease Control and Prevention's surveillance system, the National Healthcare Safety Network (NHSN).[1] By collecting data from acute-care hospitals across the nation, Medicare was able, for the first time, to systematically assess the burden of *C. difficile* nationwide and to publicly report LabID incidence on Hospital Compare.[2]

CMS's requirement to collect *C. difficile* surveillance data reflects the fact that *C. difficile* infection (CDI) is a high public health priority—both because of the impact on patients, who suffer diarrhea due to mucosal inflammation and damage[3] and because it is the most common healthcare-associated infection (HAI).[1,4,5] In 2011, there were 383,498 cases of CDI at hospital discharge in just 36 states with available data.[6] The cost of an inpatient CDI is more than $35,000 and estimates of annual medical costs exceed $3 billion nationally.[1]

The recent inclusion of CDI LabID data in Hospital Compare provides an opportunity to assess Rhode Island's performance. The objectives of this analysis were to: (1) describe RI's longitudinal trends in CDI using available historical data, and (2) compare RI's performance to neighboring states and the nation, using the newly-available LabID events data.

METHODS

Data sources

We used two data sources: (1) Healthcare Cost and Utilization Project (HCUP) data from 2002 to 2012, which includes CDI, and (2) Hospital Compare data for the first quarter of 2013, which includes LabID events. Of note, these two data sources use different measures of *C. difficile:* CDI is based on clinical diagnosis, whereas LabID events do not distinguish between *C. difficile* colonization and infection. As a result, LabID events overestimate the true CDI infection rate.[7]

HCUP databases are sponsored by the Agency for Healthcare Research and Quality and include longitudinal administrative data (inpatient, ambulatory surgery, and emergency department) for all patients, regardless of payer.[8]

Hospital Compare includes data on care processes and outcomes for selected conditions, and patient experience with care.[2] CMS requires the acute-care hospitals that participate in the Inpatient Prospective Payment System (IPPS) to submit select data, including *C. difficile* LabID event, and penalizes facilities that fail to comply. We downloaded the most recently available data (Q1 2013), which includes standardized infection ratios (SIRs)[2] comparing each hospital's and state's observed number of infections to the predicted number of infections, estimated using regression models based on data from 2010-2011.[9] SIRs are summary measures used to track and compare HAIs at the facility, state and national levels. If the upper limit of the SIR 95% confidence interval (CI) is less than 1.0, the infection rate is better than predicted; if the 95% CI includes 1.0, it is the same as predicted; if the lower limit of the 95% CI is greater than 1.0, it is worse than predicted.

Statistical Analyses

We used HCUP to query the number of CDIs by primary or secondary *C. difficile* diagnosis (ICD-9-CM code 008.45) and the number of hospital discharges. We calculated CDI rates (the number of infections per 1,000 hospital discharges) from 2002-2012 for Rhode Island, the two neighboring states with available data (Massachusetts and Vermont) and the U.S. as a whole, and then graphed these results. We also downloaded *C. difficile* LabID event SIRs from Hospital Compare and used Geographic Information System 10.2 (Environmental Systems Research Institute, Inc., Redlands, CA) software both to rank the 50 states and D.C. and to map the rankings.

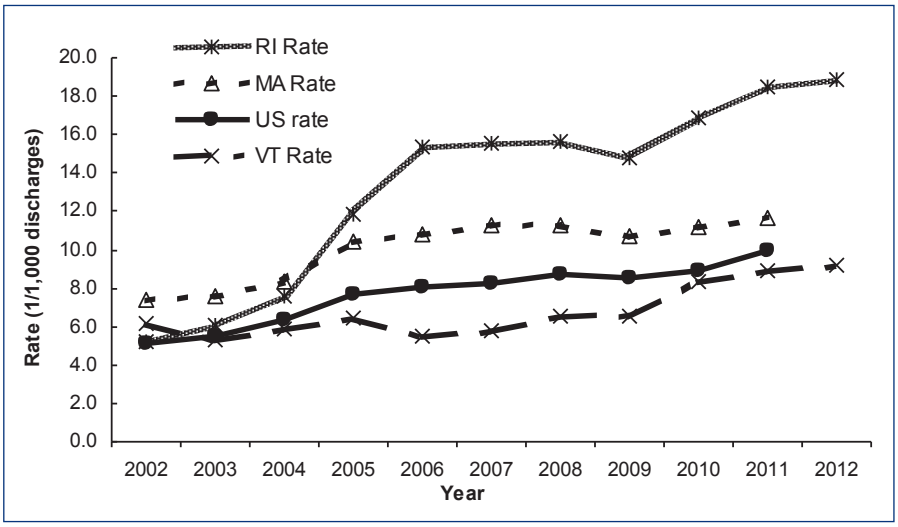
RESULTS

HCUP data reveal that the rate of CDI (listed as any diagnosis in administrative data) in Rhode Island increased more than three-fold over the past decade (5.21 per 1,000 discharges in 2002 vs. 18.87 per 1,000 in 2012), outpacing national trends and neighboring states (**Figure 1**). In comparison, CDI slightly increased in Massachusetts, Vermont, and U.S. between 2002 and 2011.

In the first quarter of 2013, RI ranked 51st among the 50 States and Washington, D.C., for *C. difficile* LabID SIRs (Figure 2). There were 19 states with upper limits of 95% CI of the SIR below 1.0 (i.e., better than the U.S. average); 22 states with 95% CI of the SIR crossing 1.0 (i.e., same as U.S. average); and 10 states, RI, AZ, NM, MD, NV, NJ, VA, NY, CA, and MA with lower limits of 95% CI of the SIR above 1.0 (i.e., worse than U.S. average).

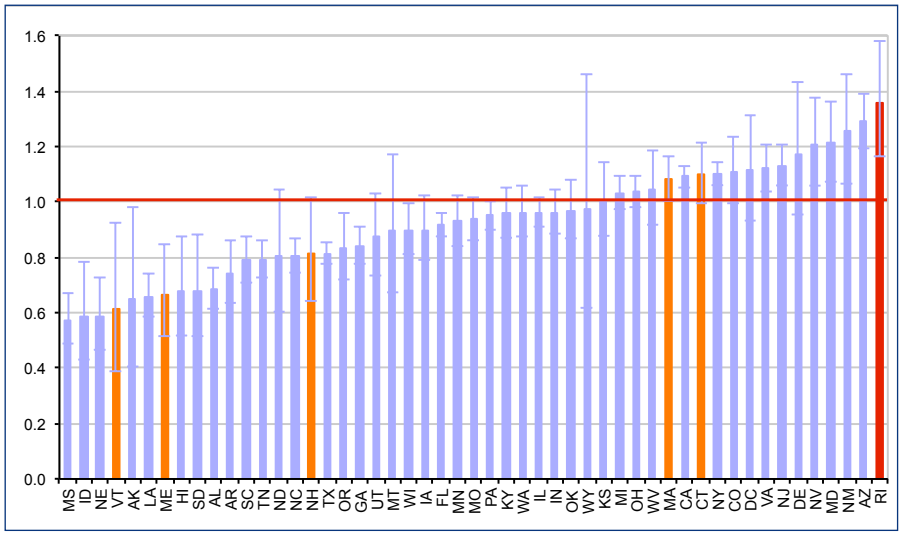
The SIRs display some region clustering, with the highest (worst) SIRs in the Northeast (VA, MD, D.C., DE, NJ, NY, RI) and West (NV, AZ, NM, CO) (Figure 3). The states with the 10 lowest (best) rankings were more widespread and included states in the Midwest (ID, SD, NE), South (LA, MS, AL) and elsewhere (VT, ME, AK, HI). In New England, VT and ME were better than the U.S. as a whole; NH and CT were same as U.S.; and MA and RI were worse than U.S. (**Table 1**), first quarter of 2013.

Figure 1. *Clostridium difficle* Infection Rate, New England Area and U.S. 2002–2012



Note: Data from Healthcare Cost and Utilization Project (HCUP) (http://www.hcup-us.ahrq.gov/)

Figure 2. States Ranked by Standardized Incidence Ratio (SIR) of *Clostridium difficile* LabID Events, First Quarter of 2013



Note: Data from Hospital Compare Website (https://data.medicare.gov/)

DISCUSSION

Between 2002 and 2012, CDI increased throughout the U.S., but the increase was greater in RI compared to other New England states (MA and VT) and the U.S. as a whole. In the first quarter of 2013, RI ranked 51st among the 50 States and D.C. for *C. difficile* LabID SIRs. The highest (worst) *C. difficile* LabID SIRs are in the Northeast and West.

CDI is spread by the fecal-oral route[3] and is strongly associated with antibiotic overuse; widespread use of broad-spectrum antibiotics is a likely contributor.[1,3] A resistant strain of *C. difficile* (BI/NAP1/027) appeared in 2004. This strain is associated with more severe clinical outcomes and may be contributing to the rapid global spread of CDI[1,3,4,8,10] and the increasing trends we noted between 2002 and 2012. Robust antibiotic stewardship programs can reduce CDI risk.[3] Although all RI hospitals have antibiotic stewardship programs in an effort to reduce targeted antibiotic use, none have a full-time physician or infectious diseases-trained pharmacist whose sole responsibility is to manage an antibiotic stewardship program, as is done in some hospitals around the country.[11] It may be that the thin profit margin of hospitals in RI compared to other states has limited the resources needed to further control CDI.

Elderly patients and those with comorbidities are the most affected by CDI.[10] Over two-thirds of patients with CDI are 65 years of age or older[1,8] and nearly 90% of CDI deaths are in elderly persons.[4] This may partially explain the regional trends we noted because the Northeast has the highest proportion of the population at least 65 years of age (14.1%) and at least 85 years of age (2.2%) in the U.S. based on 2010 census data.[12] More specifically, RI has a higher proportion of the population 65 years of age and older (14.4% in RI vs. 13.0% on average in the U.S.); and a higher proportion of those 85 years of age and older (2.5% in RI vs. 1.8% on average in the U.S.).[12]

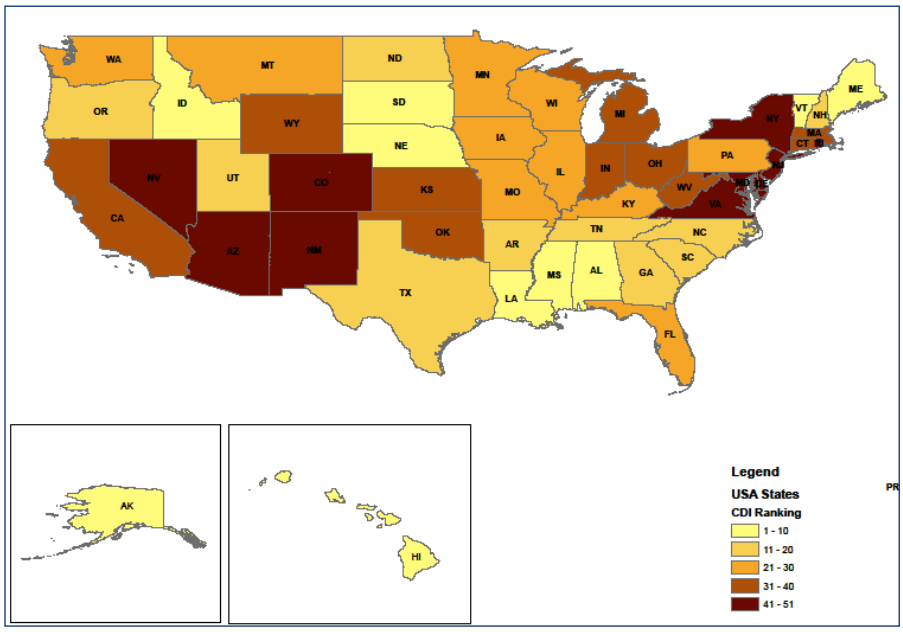
Although the CDC uses a regression model to risk-adjust the Hospital Compare data based on numerous factors, including hospital bed size, medical school affiliation, admission prevalence rate of community-onset *C. difficile* LabID events, and the test type used to detect *C. difficile* in stool,[9] HCUP does not adjust for the diagnostic test type and it is important to note that the various tests have differing sensitivities. Possibly unlike any other states, 100%

of RI hospitals currently use the most sensitive CDI diagnostic testing method, nucleic acid amplification test (NAAT) testing.[13] Ten of 11 hospitals in RI switched to NAAT from other test types over the past few years and, if these changes occurred more rapidly and uniformly than in other states, this may partially account for some of the difference in rates of CDI or *C. difficile* LabID events in RI compared to other states or national benchmark data. Although the CDC risk adjusts for diagnostic test method used, it is unclear if this is robust enough to address what is likely a statewide difference from other states or to account for facilities' changes in tests over time.

We note several additional limitations. First, HCUP uses administrative data that is collected for billing purposes and may not accurately measure HAIs.[14] Second, HCUP data cannot distinguish community-onset CDI from hospital-onset CDI, so we are unable to attribute infections to hospital care. Third, HCUP data for CDI are limited to 37 states and some states are missing data for one or more years. There is no CDI data for CT, precluding us from comparing RI against both adjacent states (MA and CT); ME does not have data for 2004 and 2005; and NH does not have data for 2002 and 2010-2012. Finally, we have only a single quarter of Hospital Compare data (Q1 2013) and are therefore unable to assess longitudinal trends or to compare CDI and *C. difficile* LabID estimates for the same time period.

These findings highlight the need to focus additional financial and human resources on reducing CDI. Although wearing gowns and gloves when entering the room of a patient with CDI and rigorous environmental cleaning of their room can decrease *C. difficile* transmission by 20%,[4] such interventions require sufficient staffing (e.g., to perform rigorous daily and discharging cleaning) and, in some cases, costly adjunctive measures (e.g., the use of portable robotic ultraviolet lights and hydrogen peroxide vapor to disinfect rooms when terminally cleaned). In RI hospitals, infection preventionists are now responsible not only for providing education and leading multi-disciplinary interventions across the hospital, but also for conducting surveillance and reporting results to the CDC and elsewhere. Additional resources may help to improve our state's *C. difficile* performance relative to past trends and our peers.

Figure 3. States Ranked by Standardized Incidence Ratio (SIR) of *Clostridium difficile* LabID Events, First Quarter of 2013.



Note: Data from Hospital Compare Website (https://data.medicare.gov/)

Table 1. Hospital *Clostridium difficile* LabID Events in New England States, First Quarter of 2013

State	Observed Cases	Predicted Cases	SIR	95% CI	Rank
Vermont	23	37.4	0.614	0.389-0.922	4
Maine	65	97.8	0.665	0.513-0.847	7
New Hampshire	77	94.6	0.814	0.642-1.017	16
Massachusetts	693	640.0	1.083	1.004-1.167	38
Connecticut	397	356.9	1.100	0.994-1.213	40
Rhode Island	170	125.2	1.358	1.162-1.578	51

SIR, standardized incidence ratio; CI, confidence interval.
Note: Data from Hospital Compare Website (https://data.medicare.gov/)

Acknowledgements

We would like to express our particular thanks to Steve Sawyer, Rhode Island Department of Health, for his GIS technical assistance.

References

1. Association for Professionals in Infection Control and Epidemiology (APIC). Guide to Preventing *Clostridium difficile* Infections (2013). *APIC Implementation Guides* 2013; http://apic.org/Professional-Practice/Implementation-guides. Accessed March 7, 2014.
2. Centers for Medicare & Medicaid Services. Hospital Compare Database. 2014; https://data.medicare.gov/ Accessed March 14, 2014.
3. Vital signs: preventing *Clostridium difficile* infections. *MMWR Morb Mortal Wkly Rep.* 2012;61(9):157-162.
4. Centers for Disease Control and Preventions. Information about the Current Strain of *Clostridium difficile*. *Healthcare-associated Infections (HAIs)* 2011; http://www.cdc.gov/HAI/organisms/cdiff/Cdiff-current-strain.html#a1. Accessed March 10, 2014.
5. Magill SS, Edwards JR, Bamberg W, et al. Multistate point-prev-

alence survey of health care-associated infections. *N Engl J Med.* 2014;370(13):1198-1208.

6. Agency for Healthcare Research and Quality. Welcome to HCUPnet. 2014; http://hcupnet.ahrq.gov/HCUPnet.app/. Accessed March 10, 2014.
7. Baier R, Morphis B, Marsella M, Mermel LA. *Clostridium difficile* surveillance: a multicenter comparison of LabID events and use of standard definitions. *Infect Control Hosp Epidemiol.* 2013;34(6):653-655.
8. Lucado J, Gould C, Elixhauser A. *Clostridium difficile* Infections (CDI) in Hospital Stays, 2009. *HCUP STATISTICAL BRIEF #124.* 2012. http://www.hcup-us.ahrq.gov/reports/statbriefs/sb124.jsp. Accessed March 10, 2014.
9. Dudeck MA, Weiner LM, Malpiedi PJ, Edwards JR, Peterson KD, Sievert DM. Risk Adjustment for Healthcare Facility-Onset C. difficile and MRSA Bacteremia Laboratory-identified Event Reporting in NHSN. 2013:9. http://www.cdc.gov/nhsn/PDFs/mrsa-cdi/RiskAdjustment-MRSA-CDI.pdf.
10. Williamson DA, Basu I, Freeman J, Swager T, Roberts SA. Improved detection of toxigenic *Clostridium difficile* using the Cepheid Xpert C difficile assay and impact on *C difficile* infection rates in a tertiary hospital: A double-edged sword. *Am J Infect Control.* 2013;41(3):270-272.
11. Dellit TH, Owens RC, McGowan JE, Jr., 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(2):159-177.
12. U.S. Census Bureau. The Older Population: 2010. *2010 Census Briefs.* 2011. https://www.census.gov/prod/cen2010/briefs/c2010br-09.pdf.
13. Baron EJ, Miller JM, Weinstein MP, et al. A guide to utilization of the microbiology laboratory for diagnosis of infectious diseases: 2013 recommendations by the Infectious Diseases Society of America (IDSA) and the American Society for Microbiology (ASM)(a). *Clin Infect Dis.* 2013;57(4):e22-e121.
14. Goto M, Ohl ME, Schweizer ML, Perencevich EN. Accuracy of administrative code data for the surveillance of healthcare-associated infections: a systematic review and meta-analysis. *Clin Infect Dis.* 2014;58(5):688-696.

Authors

Yongwen Jiang, PhD, is a Senior Public Health Epidemiologist in the Center for Health Data and Analysis at the Rhode Island Department of Health, and Clinical Assistant Professor in the Department of Epidemiology, Warren Alpert Medical School of Brown University.

Rosa Baier, MPH, is Senior Scientist at the Healthcentric Advisors, Teaching Associate in the Department of Health Services, Policy, and Practice, Brown University School of Public Health.

Blake Morphis, BS, CPEHR, is Senior Health Information Analyst at Healthcentric Advisors.

Leonard Mermel, DO, ScM, AM (Hon), FSHEA, FIDSA, FACP, is a Professor of Medicine, Warren Alpert Medical School of Brown University and the Medical Director, Department of Epidemiology & Infection Control, Rhode Island Hospital.

Samara Viner-Brown, MS, is Chief of the Center for Health Data and Analysis at the Rhode Island Department of Health.

Disclosure

The authors have no financial interests to disclose.

Correspondence

Yongwen Jiang, PhD
Rhode Island Department of Health
3 Capitol Hill
Providence RI 02908-5097
yongwen.jiang@health.ri.gov