H·CUP

HEALTHCARE COST AND UTILIZATION PROJECT

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Research and Quality

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Introduction

Health care-associated infections are a threat to patient safety and have become the most common complication of modern health care. In 2009, the Department of Health and Human Services (HHS) identified key actions needed to achieve and sustain progress in protecting patients from the transmission of serious and, in some cases, deadly infections in the *National Action Plan to Prevent Health Care-Associated Infections: Road Map to Elimination.*[1] The response to this call to action has been seen at the Federal, State, and local levels.

The present report, funded by the Agency for Healthcare Research and Quality (AHRQ), focuses on the burden to hospitals of one type of health care-associated infection—*Clostridium difficile* infection (CDI). CDI may develop during the process of a patient's treatment for medical or surgical conditions in health care settings, including hospitals, clinics, nursing homes, and other health facilities.[2,3,4] CDI may also be acquired in the community.[5,6]

CDI includes a broad spectrum of illnesses, ranging from uncomplicated diarrhea in its mildest form to its most severe manifestation of fulminant sepsis. CDI is recognized as a main cause of diarrhea in health care facilities, where it has been associated with excess lengths of stay and substantial increases in health care costs.[7] CDI transmission occurs primarily via the hands of health care personnel or from a contaminated environment. A well-established risk factor for CDI is previous antimicrobial therapy, which may suppress the normal flora of the colon and allow growth of CDI after exposure occurs. Treatment of severe cases may require a colectomy and may result in death.

Timely information on the burden of CDI cases in the inpatient setting provides analysts and policymakers with baseline information and helps illustrate the need for quality

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[1] Details of the HHS Action Plan are available at http://www.hhs.gov/ash/initiatives/hai/actionplan/. Accessed November 14, 2014.

[2] Centers for Disease Control and Prevention. CDC Features. Vital Signs: Stop *C. difficile* Infections. March 6, 2012. http://www.cdc.gov/Features/VitalSigns/HAI/. Accessed November 14, 2014.

[3] Centers for Disease Control and Prevention. Vital Signs. Making Health Care Safer: Stopping *C. difficile* Infections. March 2012. http://www.cdc.gov/vitalsigns/hai/. Accessed November 14, 2014.

[4] Centers for Disease Control and Prevention. Vital signs: Preventing *Clostridium difficile* infections. Morbidity and Mortality Weekly Report (MMWR). 2012 Mar 9,61(09):157–62. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6109a3.htm?s_cid=mm6109a3_w. Accessed November 14, 2014.

[5] Centers for Disease Control and Prevention. Surveillance for community-associated *Clostridium difficile* --- Connecticut, 2006. Morbidity and Mortality Weekly Report (MMWR). 2008 Apr 4,57(13);340–3. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5713a3.htm. Accessed November 14, 2014.

[6] Kuntz JL, Chrischilles EA, Pendergast JF, Herwaldt LA, Polgreen PM. Incidence of and risk factors for community-associated Clostridium difficile infection: a nested case-control study. BMC Infect Dis. 2011 Jul 15;11:194.

[7] Dubberke ER, Reske KA, Olsen MA, McDonald LC, Fraser VJ. Short- and long-term attributable costs of Clostridium difficile-associated disease in nonsurgical inpatients. Clin Infect Dis. 2008 Feb 15;46(4):497–504.

improvement efforts. Therefore, information about national, regional, and State-level trends in the prevalence of adult inpatient discharges with CDI is presented in this report.

Longitudinal inpatient discharge data from the Healthcare Cost and Utilization Project (HCUP) sponsored by AHRQ were used to provide quarterly estimates of *C. difficile* hospitalization rates from 2003 through 2012 and to project 2013 and 2014 quarterly rates. HCUP includes the largest collection of longitudinal hospital care data in the United States, with all-payer, encounter-level information beginning in 1988. The number of HCUP Partners has expanded over the years to include a large percentage of nationwide hospital discharges. The 2012 HCUP State Inpatient Databases (SID) encompass about 97 percent of all U.S. community hospital discharges and are made possible by the data collection efforts of State data organizations, hospital associations, private data organizations, and the Federal government. The list of statewide data organizations that contribute to the HCUP databases is available in Appendix I.

The HCUP SID from 2003 to 2012 include about 340 million inpatient discharges from 47 States. In addition to the 2003 to 2012 historical SID, 2013 data from 17 States and 2014 data from one State were used to inform the projections for 2013 and 2014.

For this report, *C. difficile* hospitalizations were identified by the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code of intestinal infections due to *Clostridium difficile* (008.45), which were reported as either the principal or secondary diagnosis. An evaluation of surveillance for CDI in 2003 found high sensitivity (78%) and specificity (99.7%) when using ICD-9-CM codes.[8] This study was based on one hospital. Coding practices will vary across hospitals and States. It should be noted that the origin of the infection may not be the inpatient hospital. It is possible that the CDI infection originated in another type of health care setting, such as a nursing home, or in the community prior to the hospital admission. CDI cases that resolved without an inpatient stay are not captured in the trends.

Rates were calculated as the number of *C. difficile* hospitalizations for adults per 1,000 nonmaternal, adult discharges treated in community, nonrehabilitation hospitals. Rates were not risk adjusted. Additional details about the methods used for this report, including a description of the projection methodology, are contained in Appendix II. Results are presented for the nation and the nine Census divisions. A list of States by Census division is included in Appendix III.

General Trends

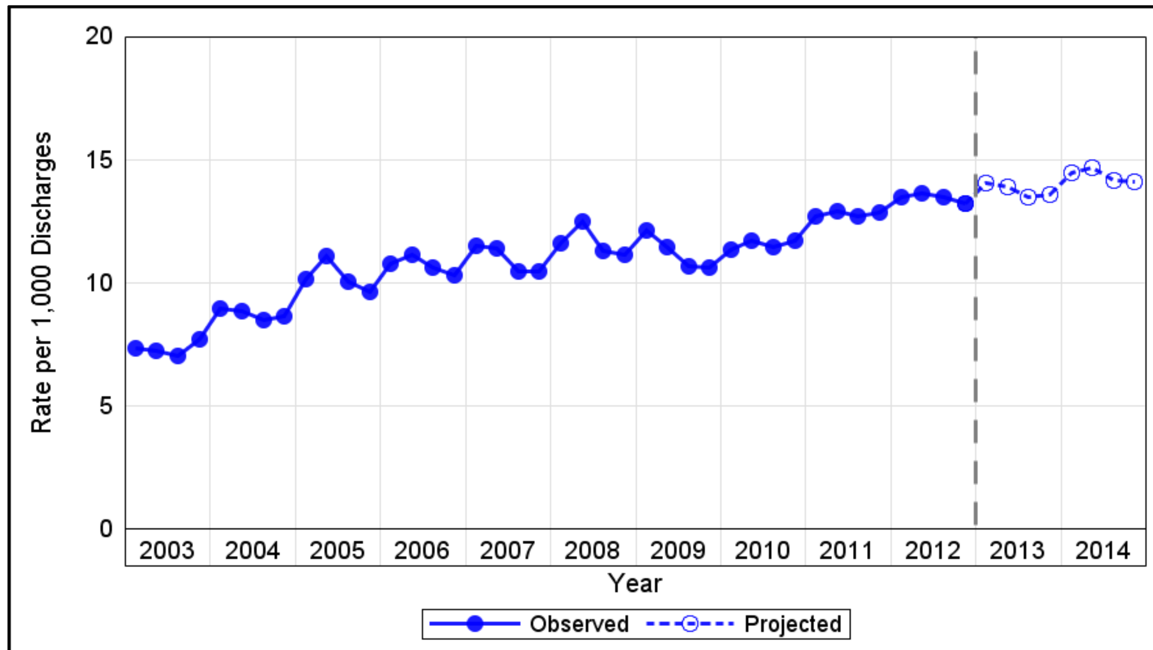
National and Census division trends showed quarterly variation and an increase in the rate of *C. difficile* hospitalizations from 2003 through 2012. Projections showed that *C. difficile* hospitalization rates were expected to continue to increase in 2013 and 2014,

[8] Dubberke ER, Reske KA, McDonald LC, Fraser VJ. ICD-9 codes and surveillance for *Clostridium difficile*-associated disease. Emerg Infect Dis. 2006 Oct;12(10):1576-9.

with the rate of growth moderately slowing in these years. Although this report showed an increase in the rate of *C. difficile* hospitalizations, it cannot be determined whether this reflected an increase in unique cases. That distinction is beyond the limits of the data used.

National Projections

The national rate of *C. difficile* hospitalizations per 1,000 nonmaternal, adult discharges increased from an average of 7.4 in 2003 to 13.5 in 2012. The rate was projected to continue to increase by about 2 percent a year to an average of 13.8 in 2013 and 14.4 in 2014. Within each year, there was quarterly variation in the rate; the third and fourth quarters were often lower than the first and second quarters.

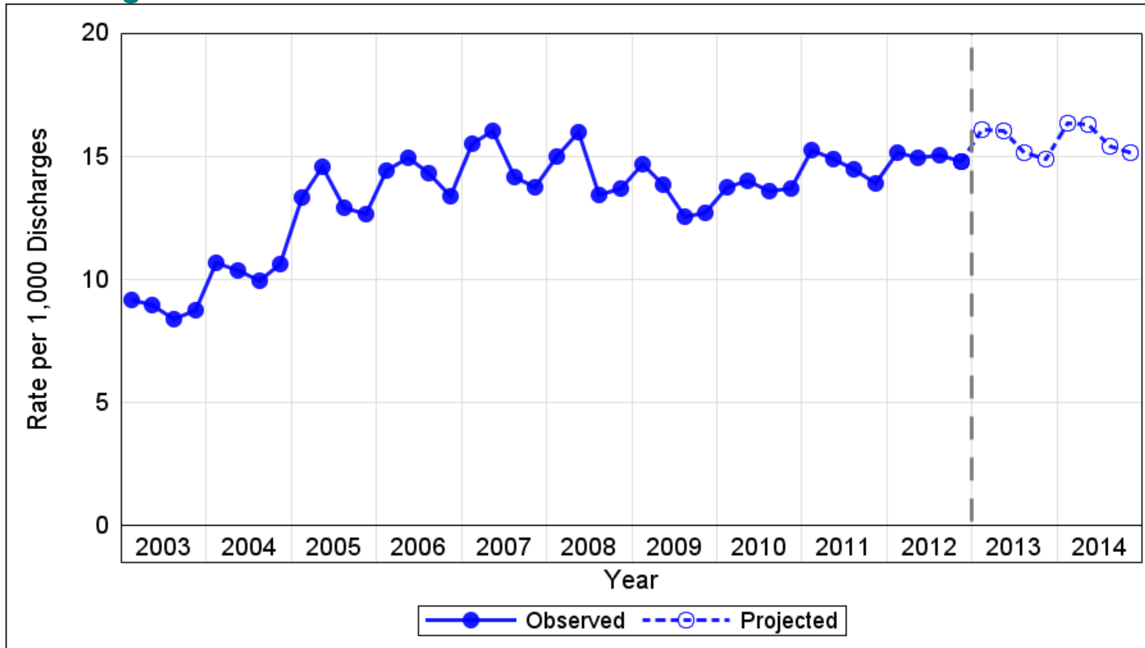


Projections by Census Divisions

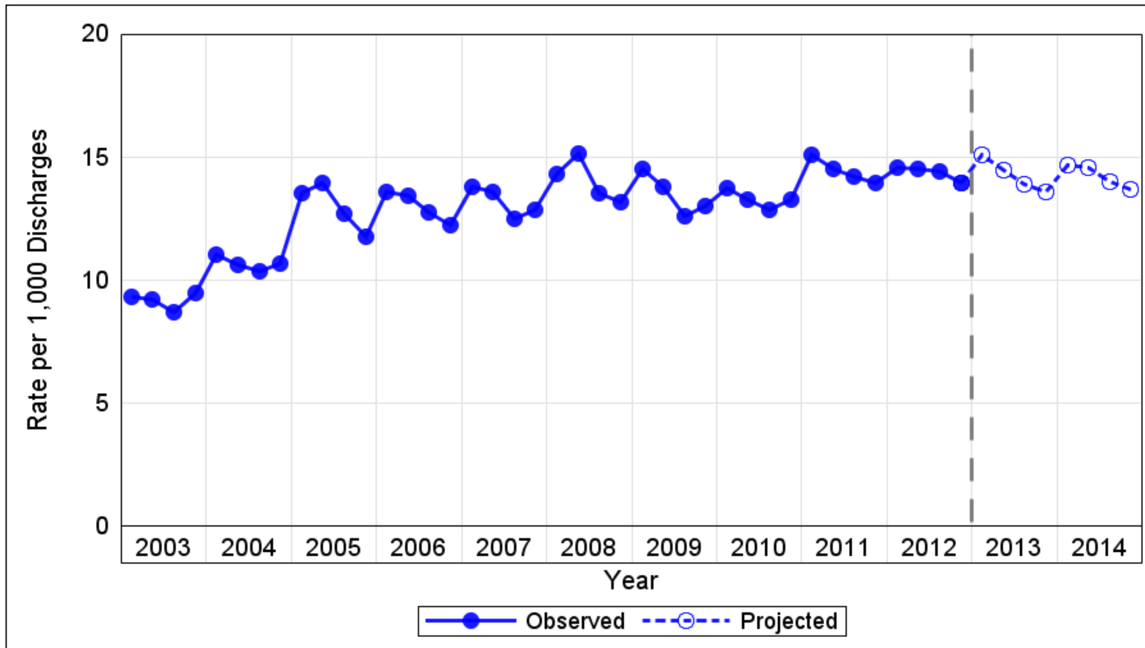
Across the nine Census divisions, New England and the Middle Atlantic divisions had the highest rates of *C. difficile* hospitalizations per 1,000 nonmaternal, adult discharges in 2003 (average of 8.8 and 9.2, respectively). New England had the highest rates in 2012 (average of 15.0) followed by the East North Central and Mountain divisions with an average of 14.7. In contrast, the East South Central and West South Central divisions had the lowest rates of *C. difficile* hospitalizations per 1,000 nonmaternal, adult discharges in 2003 (average of 5.2 and 6.1, respectively) and the lowest rates in 2012 (average of 11.1 and 11.0, respectively).

The rates of *C. difficile* hospitalizations varied across time and across the nine Census divisions. All of the divisions showed that rates of *C. difficile* infections treated in hospitals increased by at least 40 percent between 2003 and 2008. Between 2008 and 2009, there is a break in the upward trend. The average of the quarterly rates of *C. difficile* hospitalizations either stayed the same or decreased by less than 10 percent in all divisions between 2008 and 2009. The upward trend returned between 2009 and 2012 with the average of the quarterly rates of *C. difficile* hospitalizations increasing by at least 10 percent in all divisions except the Middle Atlantic (with only a 7 percent increase in rate). Rates of *C. difficile* hospitalizations were projected to increase by at least 5 percent between 2012 and 2014 in all divisions, with the exception of the Middle Atlantic. The Middle Atlantic division showed a small 2 percent decline in the rate of *C. difficile* hospitalizations between 2012 and 2014. The following figures show the rates of *C. difficile* hospitalizations per 1,000 discharges for the years 2003 through 2012 and the projected rates for 2013 and 2014 by Census division.

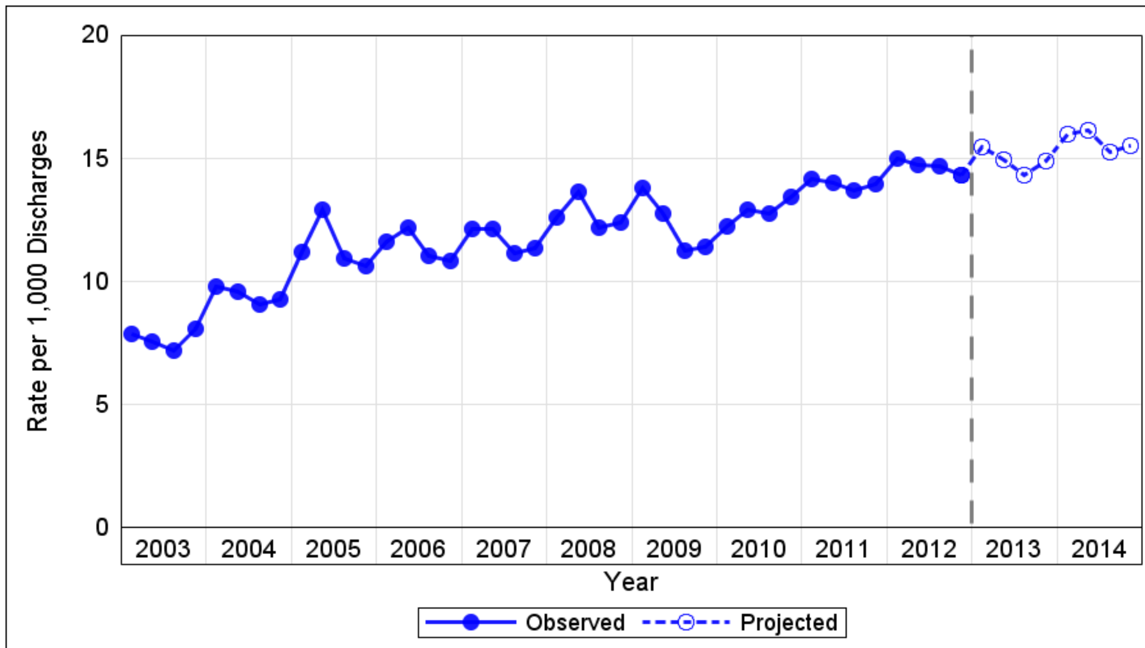
New England Division



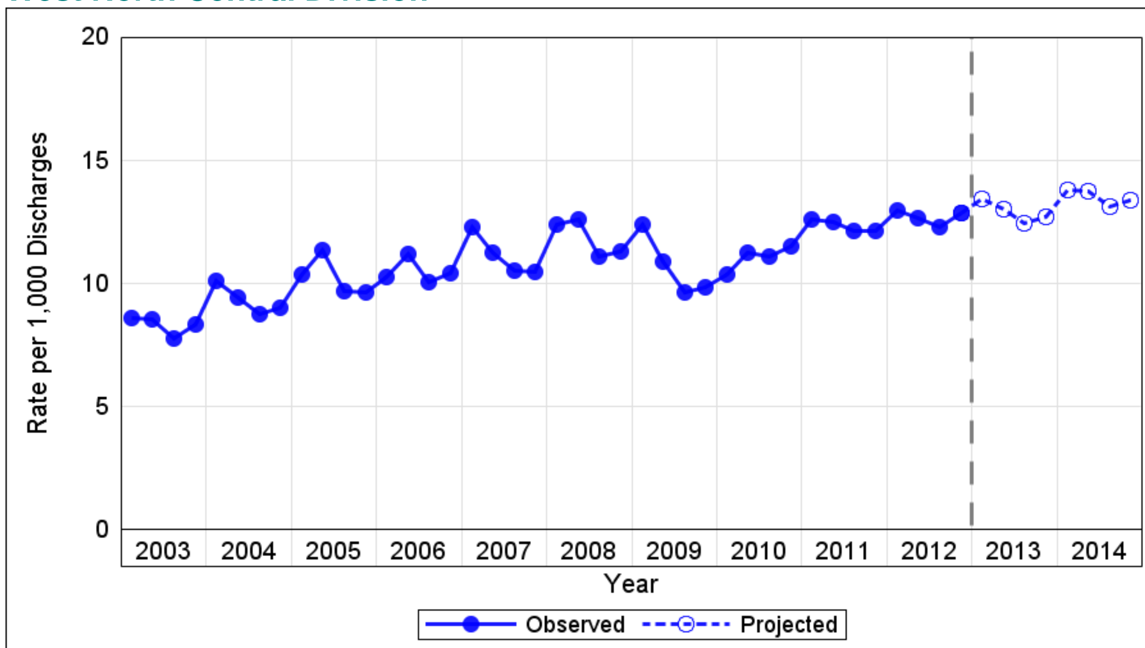
Middle Atlantic Division



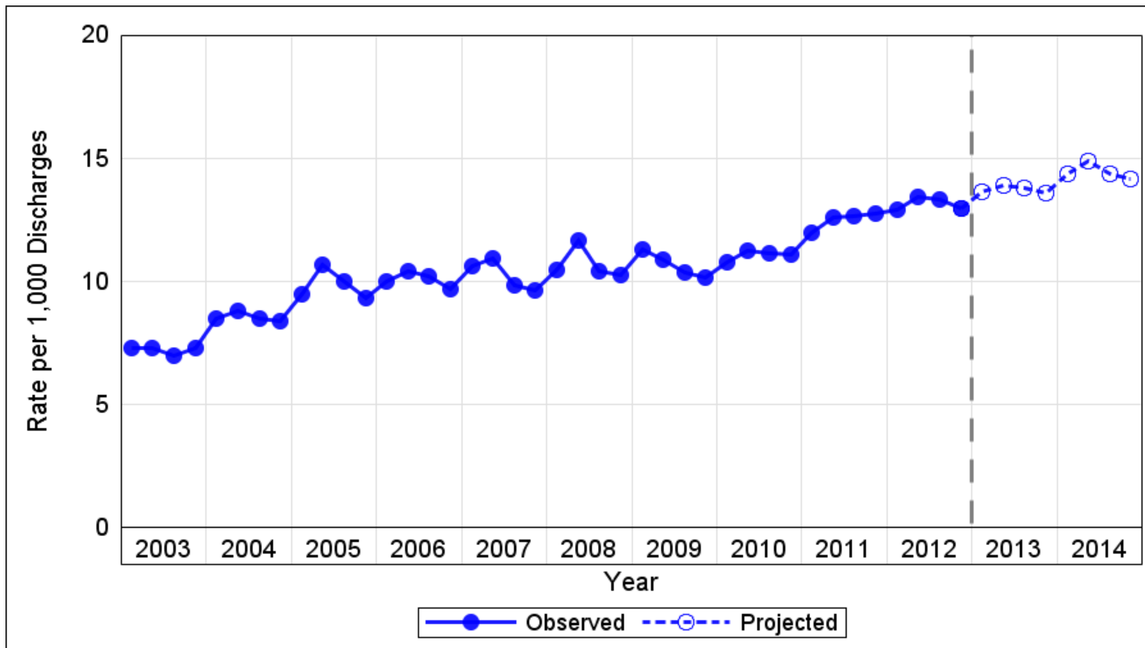
East North Central Division



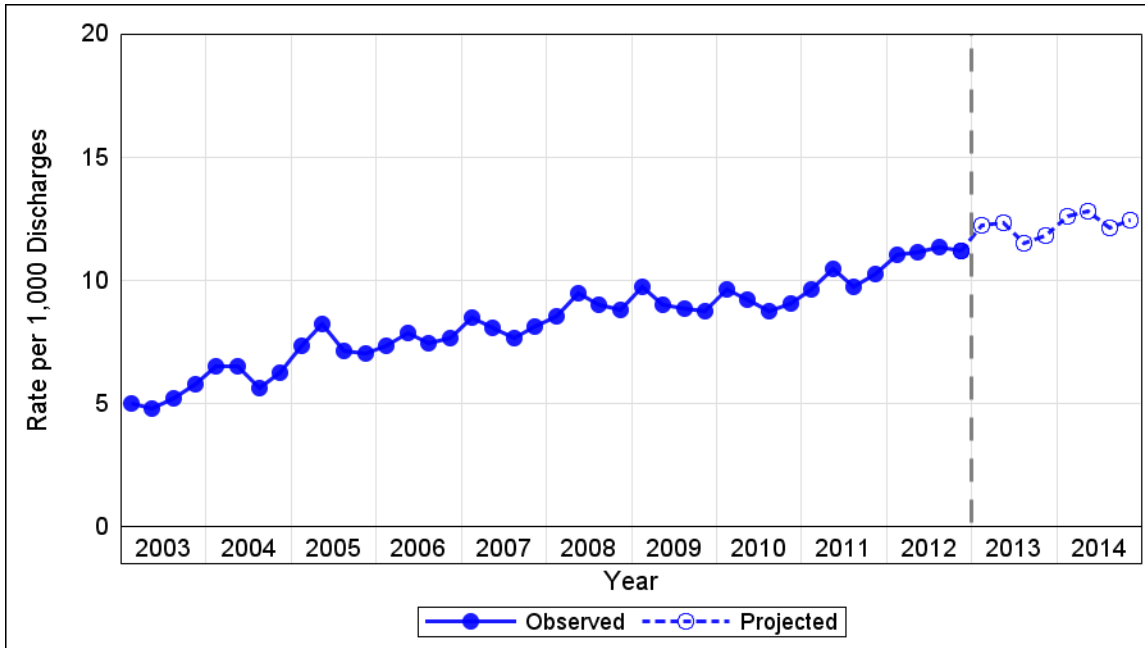
West North Central Division



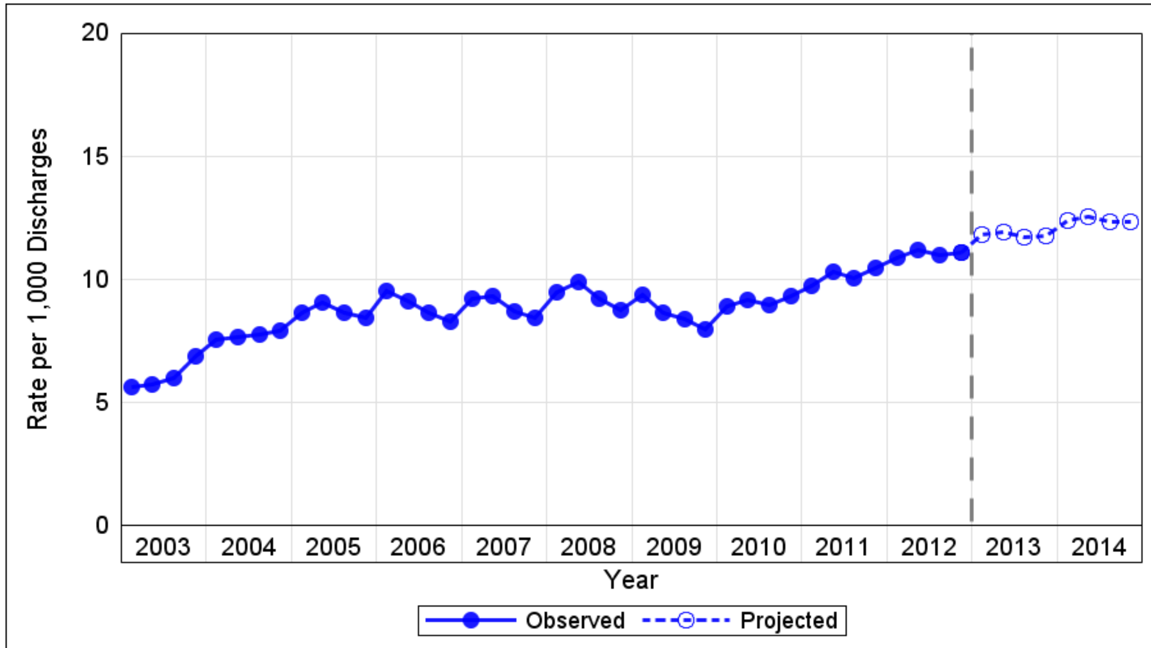
South Atlantic Division



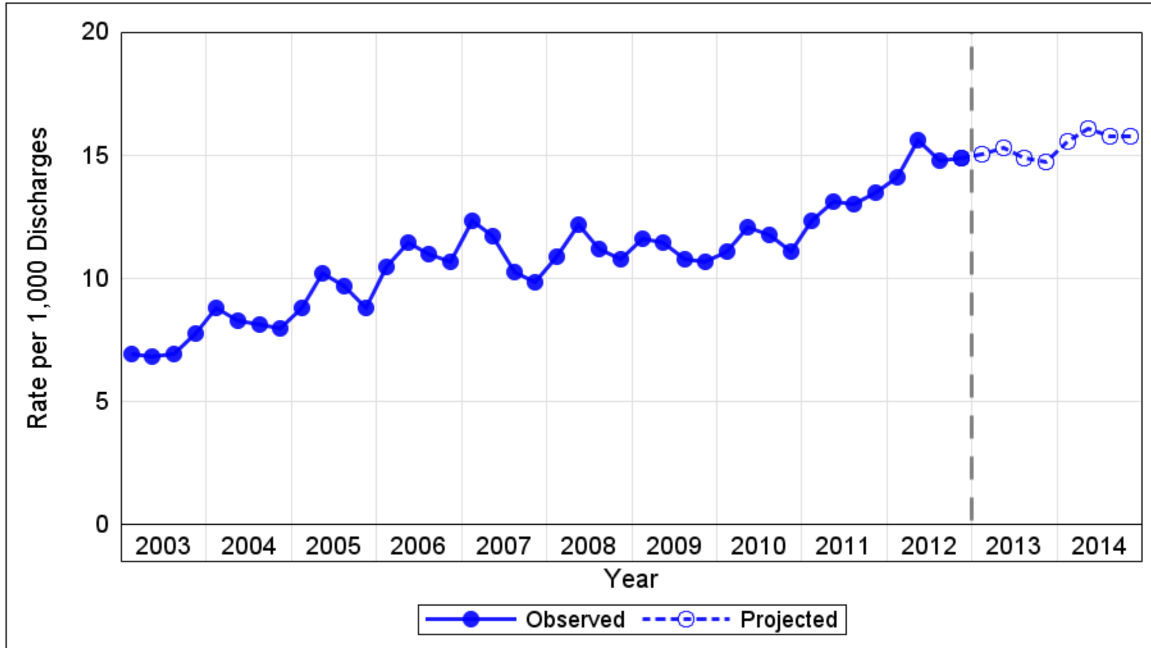
East South Central Division



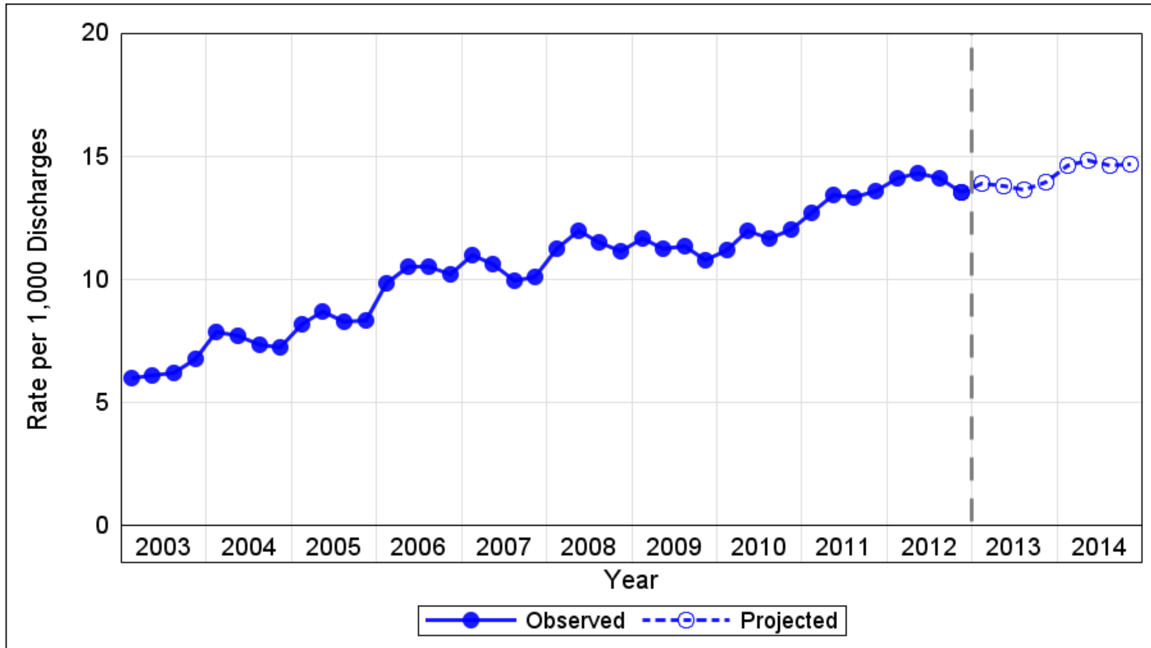
West South Central Division



Mountain Division



Pacific Division



Appendix I: HCUP Partners

Alaska State Hospital and Nursing Home Association

Arizona Department of Health Services

Arkansas Department of Health

California Office of Statewide Health Planning and Development

Colorado Hospital Association

Connecticut Hospital Association

Florida Agency for Health Care Administration

Georgia Hospital Association

Hawaii Health Information Corporation

Illinois Department of Public Health

Indiana Hospital Association

Iowa Hospital Association

Kansas Hospital Association

Kentucky Cabinet for Health and Family Services

Louisiana Department of Health and Hospitals

Maine Health Data Organization

Maryland Health Services Cost Review Commission

Massachusetts Center for Health Information and Analysis

Michigan Health & Hospital Association

Minnesota Hospital Association

Mississippi Department of Health

Missouri Hospital Industry Data Institute

Montana MHA - An Association of Montana Health Care Providers

Nebraska Hospital Association

Nevada Department of Health and Human Services

New Hampshire Department of Health & Human Services

New Jersey Department of Health

New Mexico Department of Health

New York State Department of Health

North Carolina Department of Health and Human Services

North Dakota (data provided by the Minnesota Hospital Association)

Ohio Hospital Association

Oklahoma State Department of Health

Oregon Association of Hospitals and Health Systems

Oregon Health Policy and Research

Pennsylvania Health Care Cost Containment Council

Rhode Island Department of Health

South Carolina Revenue and Fiscal Affairs Office

South Dakota Association of Healthcare Organizations

Tennessee Hospital Association

Texas Department of State Health Services

Utah Department of Health

Vermont Association of Hospitals and Health Systems

Virginia Health Information

Washington State Department of Health

West Virginia Health Care Authority

Wisconsin Department of Health Services

Wyoming Hospital Association

Appendix II: Methods

This section describes the methods employed to project division-specific and national quarterly trends for the rates of *C. difficile* hospitalizations per 1,000 adult hospitalizations using the Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases (SID). Quarterly rate projections for 2013 and 2014 were generated for HCUP States based on each State's historical trend. Although trends are shown beginning in 2003, the statistical models employed data beginning in 2005.[9]

Discharges were limited to those from hospitals that were open during any part of each calendar year and were designated as community hospitals by the American Hospital Association (AHA) Annual Survey of Hospitals, excluding rehabilitation hospitals. The definition of a community hospital was that used by the AHA: "all nonfederal short-term general and other specialty hospitals, excluding hospital units of institutions." The population at risk included only nonmaternal, adult discharges aged 18 years and older.

Projections were generated using the SAS Time Series Forecasting System™ (Version 9.3).[10] For each State, this software automatically selected the model with the lowest mean absolute percentage error (MAPE) for that State from among 40 different time-series models. The *C. difficile* hospitalization rate was considered to be a binomial rate, taking values between zero and one. Consequently, the time-series model fitted the trend in the logit(rate) = log[rate / (1 – rate)].[11] The estimated logits were then transformed back to the rate scale and multiplied by 1,000 for the final projections. This ensured that the final projections could not go below zero or above 1,000.

Division-level quarterly trends were calculated as a weighted average of the State-level quarterly trends within each division. Each State's weight was proportional to its total number of discharges (excluding newborns) as reported in the 2012 AHA Hospital Survey. These AHA-based weights were used throughout the period 2003–2014. We had 2013 data for 17 States and one quarter of 2014 data for one State. The 2013 and 2014 projections incorporated observed rates for States with available data and incorporated rates estimated from time-series models for the remaining States.

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[9] For *C. difficile* hospitalization rates, the 2003–2004 trend differed substantially from the trend starting in 2005. Therefore, the 2005–2012 data were selected as the basis of projections for 2013 and 2014.

[10] SAS Institute. Large-Scale Automatic Forecasting Using Inputs and Calendar Events. White Paper. 2009. Cary, NC; SAS Institute Inc. http://www.sas.com/reg/wp/ca/3478. Accessed November 14, 2014.

[11] Very rarely, an observed rate was equal to zero. In those cases, a rate of .0001 was substituted so that the logit would be defined and estimation could proceed.

Appendix III: HCUP Partner States Within Census Divisions

Region I: Northeast	
Division 1: New England	**Division 2: Middle Atlantic**
(6 States)	**(3 States)**
Connecticut	New Jersey
Maine	New York
Massachusetts	Pennsylvania
New Hampshire	
Rhode Island	
Vermont	

Region II: Midwest	
Division 3: East North Central	**Division 4: West North Central**
(5 States)	**(7 States)**
Illinois	Iowa
Indiana	Kansas
Michigan	Minnesota
Ohio	Missouri
Wisconsin	Nebraska
	North Dakota
	South Dakota

Region III: South		
Division 5: South Atlantic	**Division 6: East South Central**	**Division 7: West South Central**
(9 States)	**(4 States)**	**(4 States)**
Delaware*	Alabama*	Arkansas
Washington, D.C.*	Kentucky	Louisiana
Florida	Mississippi	Oklahoma
Georgia	Tennessee	Texas
Maryland		
North Carolina		
South Carolina		
Virginia		
West Virginia		

Region IV: West	
Division 8: Mountain	**Division 9:Pacific**
(8 States)	**(5 States)**
Arizona	Alaska
Colorado	California
Idaho*	Hawaii
Montana	Oregon
Nevada	Washington
New Mexico	
Utah	
Wyoming	

* Not an HCUP Partner State.