



H·CUP

HEALTHCARE COST AND UTILIZATION PROJECT



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Introduction

Healthcare-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 (DHHS) 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 Healthcare-Associated Infections: Road Map to Elimination*.¹ The response to this call to action has been seen at the Federal, State, and local level.

This report funded by the Agency for Healthcare Research and Quality (AHRQ) focuses on the burden to hospitals of one type of healthcare-associated infection – *Clostridium difficile* infection (CDI). CDI may develop during the process of a patient's treatment for medical or surgical conditions in healthcare 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 fulminant sepsis, resulting in colectomy and even death, in its most severe manifestations. CDI is recognized as a main cause of diarrhea in healthcare facilities, where it has been associated with excess lengths of stay and substantial increases in healthcare costs.⁷ CDI transmission occurs primarily via the hands of healthcare personnel or from a contaminated environment. A well-established risk factor for CDI is previous antimicrobial therapy which may have suppressed the normal flora of the colon, allowing growth of CDI after exposure occurs.

Information about national and regional trends in the prevalence of adult inpatient discharges with CDI is presented in this report. The origin of the infection may not be the inpatient hospital. It is possible that the CDI infection originated in another type of healthcare 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. Timely information on the burden of CDI cases in the inpatient setting provides

¹ Details of the HHS Action Plan are available at <http://www.hhs.gov/ash/initiatives/hai/actionplan/>

² Centers for Disease Control and Prevention Feature, Vital Signs: Stop *C. difficile* Infections, March 6, 2012. Retrieved from <http://www.cdc.gov/Features/VitalSigns/HAI/>.

³ Centers for Disease Control and Prevention Vital Signs, Making Health Care Safer Stopping *C. difficile* Infections, March 2012. Retrieved from <http://www.cdc.gov/vitalsigns/hai/>.

⁴ Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report (*MMWR*), Vital Signs: Preventing *Clostridium difficile* Infections, March 9, 2012, 61(09);157-162. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6109a3.htm?s_cid=mm6109a3_w.

⁵ Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report (*MMWR*), Surveillance for Community-Associated *Clostridium difficile* --- Connecticut, 2006, April 4, 2008, 57(13);340-343. Retrieved from <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5713a3.htm>.

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. PubMed PMID:21762504; PubMed Central PMCID: PMC3154181.

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.

analysts and policy makers with baseline information and helps illustrate the need for quality improvement efforts.

Longitudinal inpatient discharge data from the Healthcare Cost and Utilization Project (HCUP) sponsored by AHRQ is used to provide quarterly estimates of *C. difficile* hospitalization rates from 2001 through 2010, and to project 2011 and 2012 quarterly rates. The HCUP SID from 2001 to 2010 include about 330 million inpatient discharges from 46 States. Historical SID data with early 2011 data from 10 HCUP States are used to develop the quarterly projected rate of *C. difficile* hospitalizations in 2011 and 2012. 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 an ever-larger percentage of hospital discharges nationwide. The 2010 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.

For this report, *C. difficile* hospitalizations are 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) 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. Rates are calculated as the number of *C. difficile* hospitalizations for adults per 1,000 non-maternal, adult discharges treated in community, non-rehabilitation hospitals. Rates are not risk adjusted.

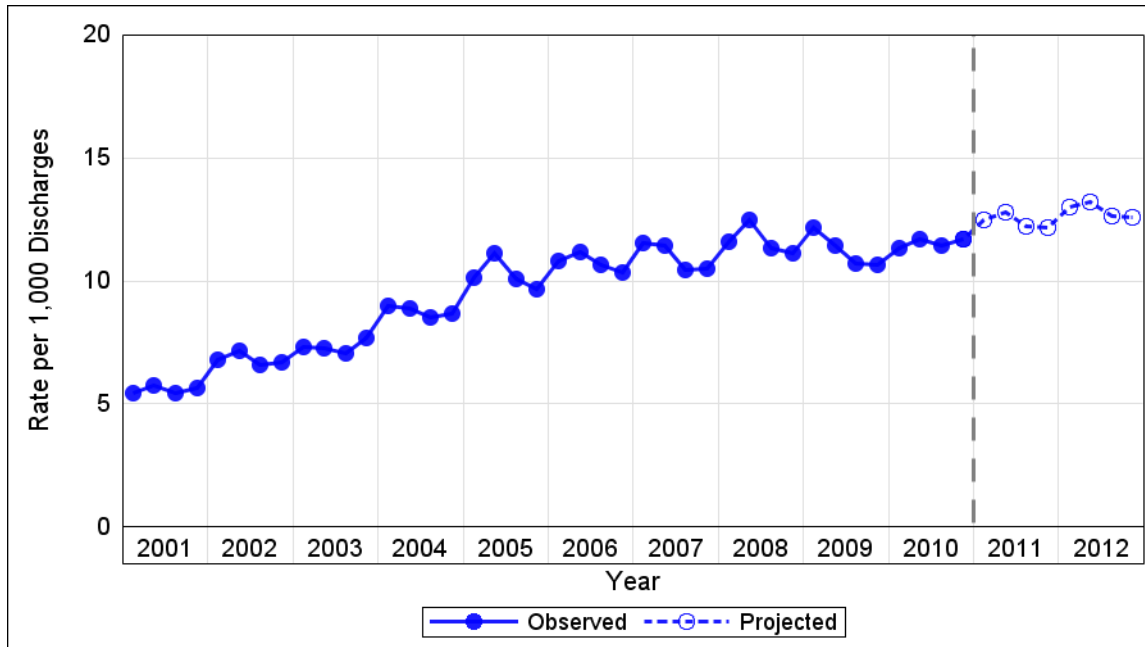
Results are presented for the nation and the nine Census divisions. A list of States by Census division is included in Appendix II. A description of the projection methodology is available in Appendix III.

National and Census division trends show quarterly variation and an increase in the rate of *C. difficile* hospitalizations from 2001 to 2011. Projections show that *C. difficile* hospitalization rates are expected to continue to increase in 2011 to 2012, with the rate of growth slowing in 2012. While this report shows an increase in the rate of *C. difficile* hospitalizations, it cannot be determined whether or not this means an increase in unique cases. That distinction is beyond the limitations of the data used.

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.

National Projections

The national rate of *C. difficile* hospitalizations per 1,000 non-maternal, adult discharges increases from about 5.6 in 2001 to 11.5 in 2010. The rate is projected to continue to increase to about 12.5 in 2011 and 12.8 in 2012. Within each year, there is quarterly variation in the rate with the third and fourth quarter often lower than the first and second quarter.

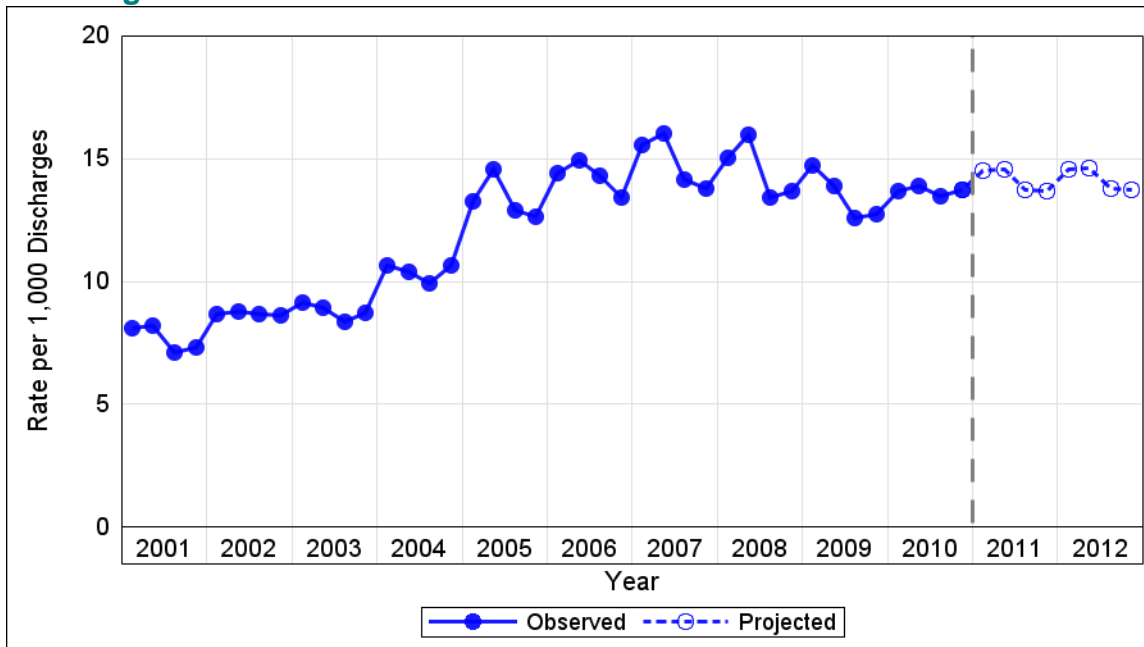


Projections by Census Division

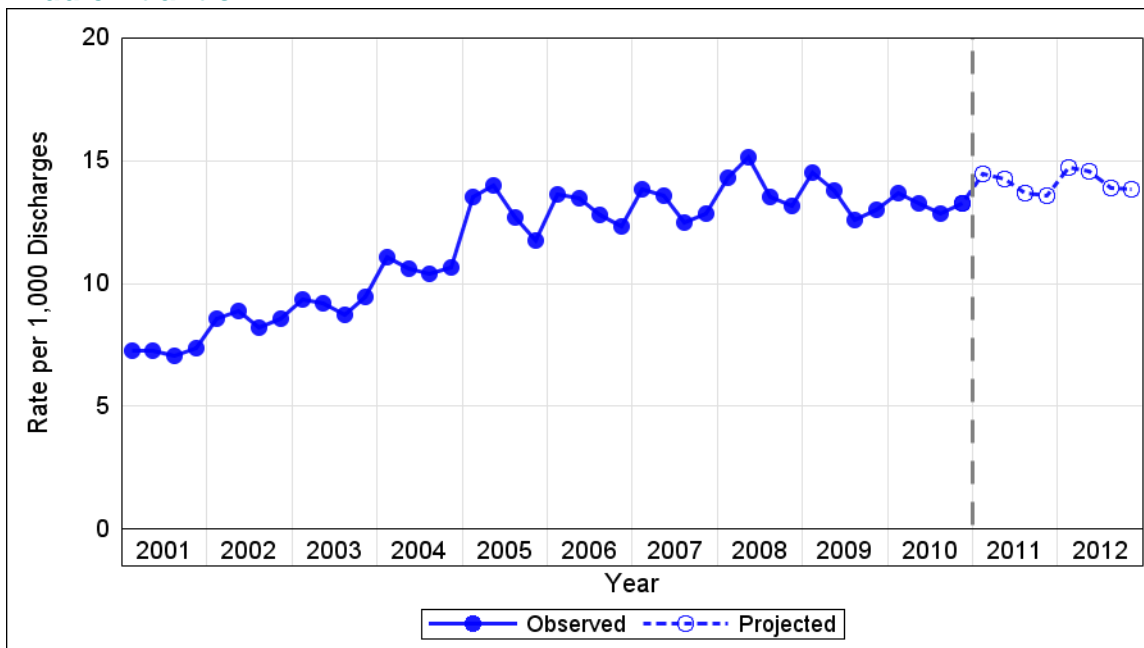
Across the nine Census divisions, New England has the highest rate of *C. difficile* hospitalizations per 1,000 non-maternal, adult discharges in 2001 (average of 7.7) and the highest rate in 2010 (average of 13.7). In contrast, the West South Central has the lowest rate of *C. difficile* hospitalizations per 1,000 non-maternal, adult discharges in 2001 (average of 4.5) and the lowest rate in 2010 (average of 9.1).

The rate of *C. difficile* hospitalizations across time varies across the nine Census divisions. Some of the divisions show rates of *C. difficile* hospitalizations treated in hospitals steadily increasing from 2001 to 2010 (East North Central, East South Central, Mountain, and Pacific). Other Census divisions show a steady increase from 2001 to 2004/2005 and then a slower rate of increase through 2010 (New England, Middle Atlantic, West North Central, South Atlantic, and West South Central). The rates of *C. difficile* hospitalizations in all divisions are projected to increase in 2011 and 2012, with the rate of growth slowing in 2012.

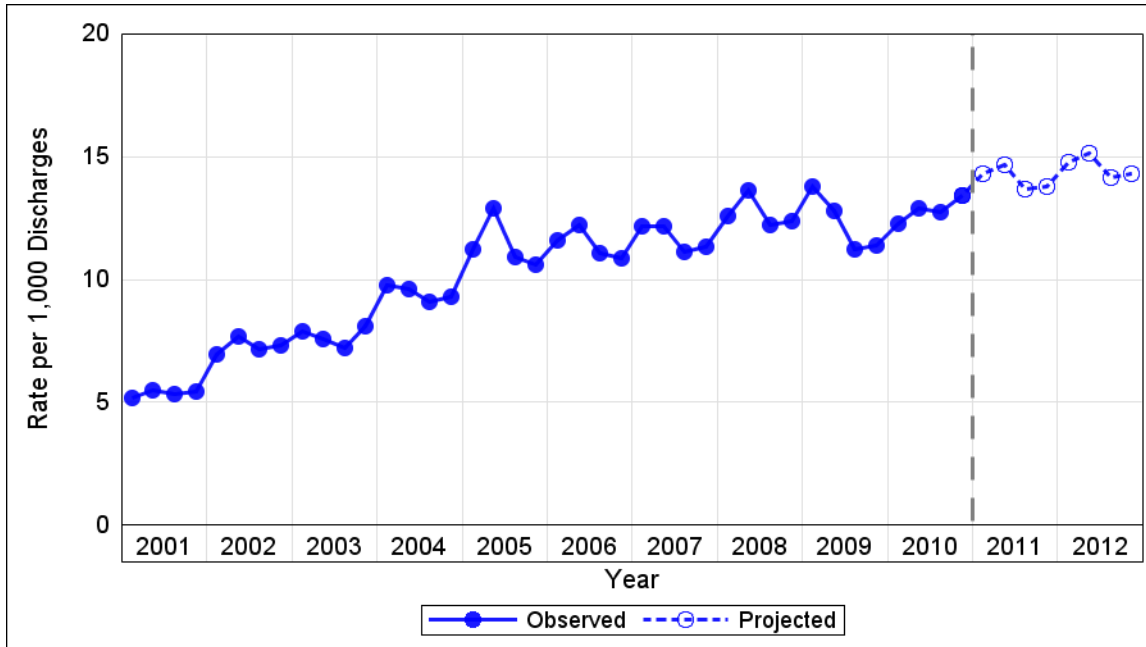
New England



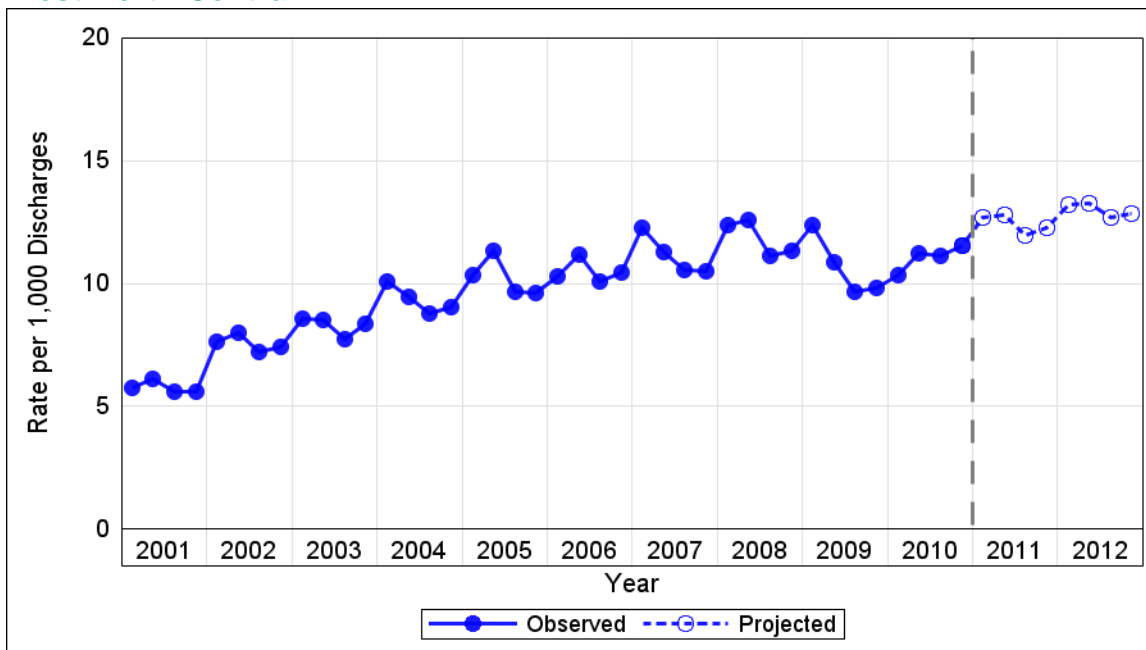
Middle Atlantic



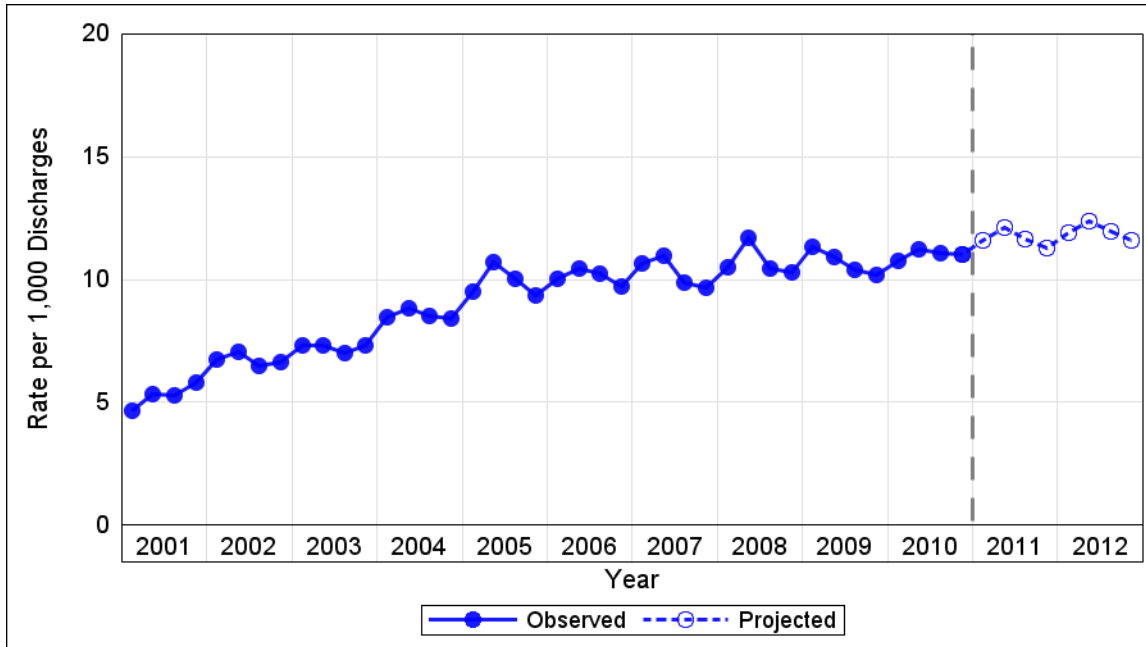
East North Central



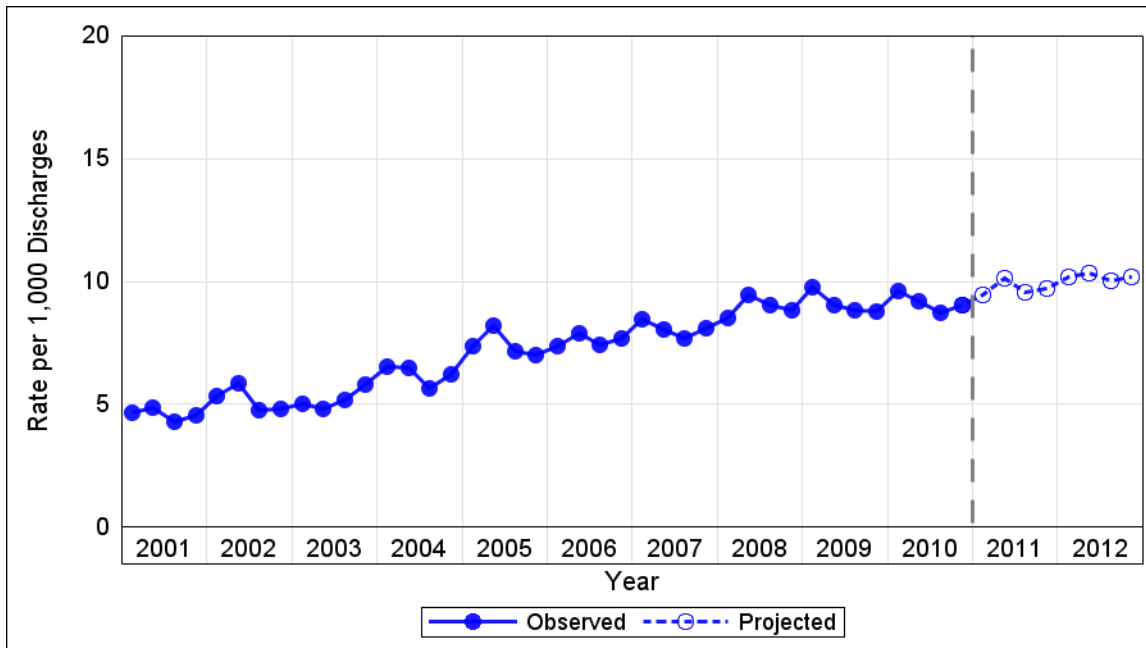
West North Central



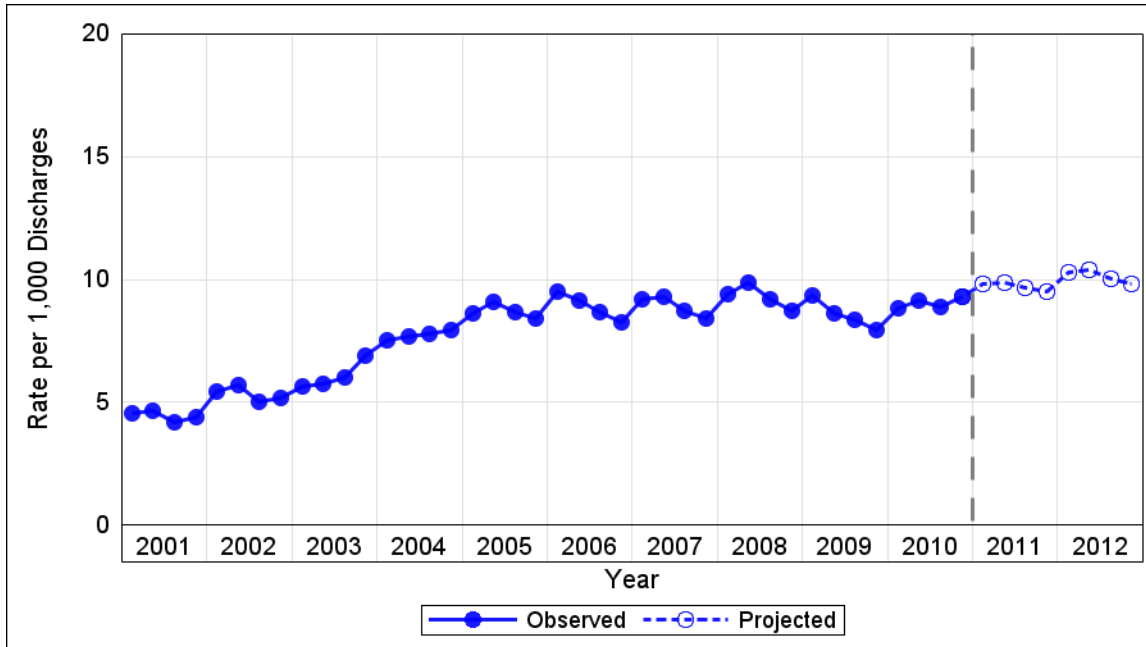
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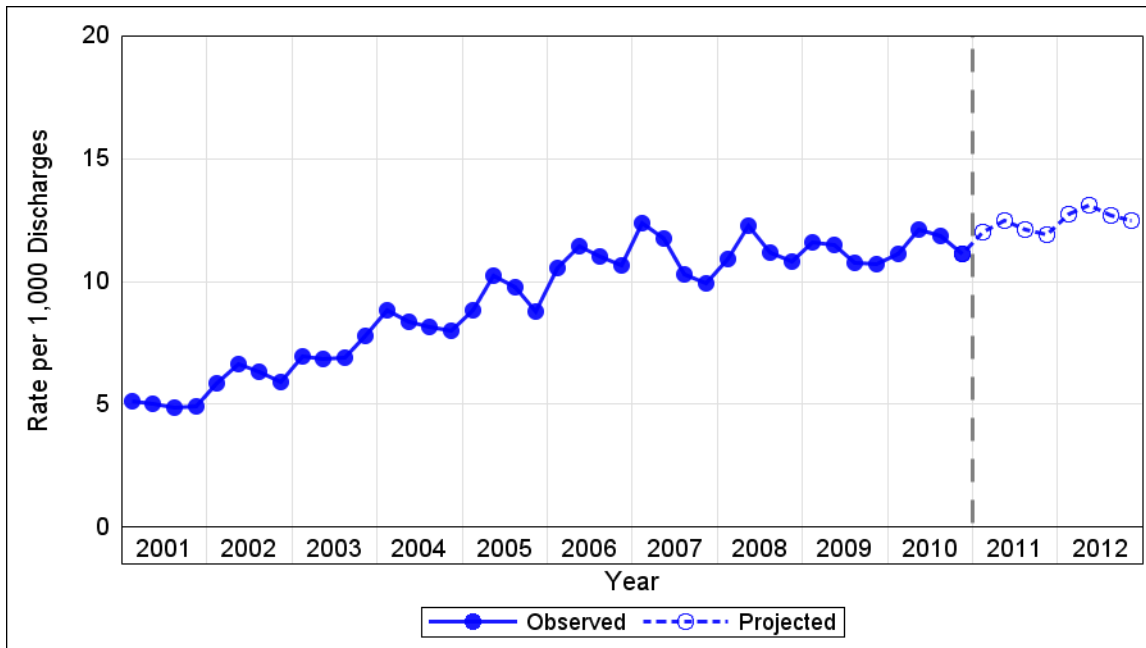
East South Central



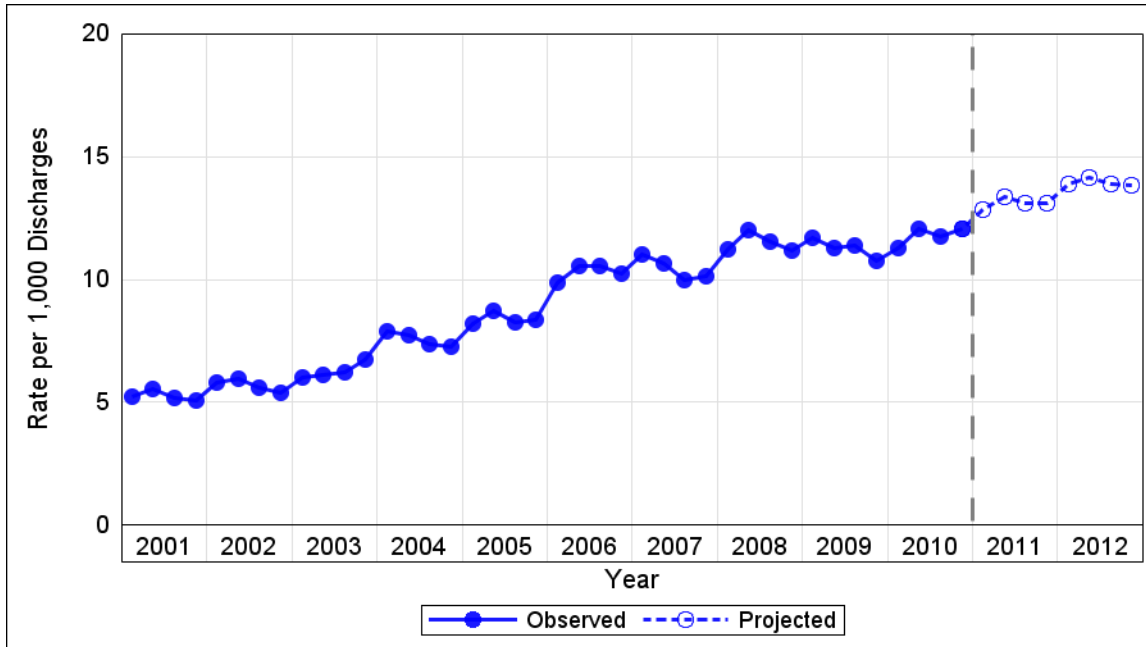
West South Central



Mountain



Pacific



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 Division of Health Care Finance and Policy

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

Ohio Hospital Association

Oklahoma State Department of Health

Oregon Health Policy and Research

Oregon Association of Hospitals and Health Systems

Pennsylvania Health Care Cost Containment Council

Rhode Island Department of Health

South Carolina State Budget & Control Board

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: 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.

Appendix III: Methods

This section describes the method employed to project division-specific and national quarterly trends for the rate of *C. difficile* hospitalizations per 1,000 adult hospitalizations using the HCUP State Inpatient Databases (SID). Quarterly rate projections for 2011 and 2012 were generated for HCUP States based on each State's historical trend. While trends are shown beginning in 2001, 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 non-maternal, adult discharges (age 18 and over).

Projections were generated using the SAS Time Series Forecasting System™ (Version 9.2).¹⁰ For each State, this software automatically selected from among 40 different time series models the model with the lowest mean absolute percentage error (MAPE) for that State. 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 $\text{logit}(\text{rate}) = \log[\text{rate} / (1 - \text{rate})]$.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 2010 AHA Hospital Survey. These weights were used throughout the period, 2001-2012. We had 2011 data for 10 States. The 2011 projections incorporated observed rates for these 10 States and incorporated rates estimated from time series models for the remaining States. For 2012, the projections were entirely based on rates estimated from time series models.

⁹ For *C. difficile* hospitalization rates, the 2001-2004 trend differed substantially from the 2005-2010 trend. Therefore, the 2005-2010 data were selected as the basis of projections for 2011 and 2012.

¹⁰ *Large-Scale Automatic Forecasting Using Inputs and Calendar Events*. White Paper, SAS Institute Inc., 2009.

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