



H·CUP

HEALTHCARE COST AND UTILIZATION PROJECT

HCUP Projections

Clostridium Difficile Infection 2010 to 2011

Report #2011-01



Agency for Healthcare
Research and Quality



U.S. Department of Health and Human Services
Agency for Healthcare Research and Quality

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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 *Action Plan to Prevent Healthcare-Associated Infections*.¹ The response to this call to action has been seen at the Federal, State, and local level.

This report 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 CDI may also be acquired in the community.^{3,4} 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 CDI has been associated with excess lengths of stay and substantial increases in healthcare costs.⁵ 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 *C. difficile* 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 originated in another type of healthcare setting, such as a nursing home, or in the community prior to the hospital admission. CDI cases that were resolved without an inpatient stay are not captured in the trends. Timely information on the burden of CDI cases to the inpatient setting provides analysts and policy makers with baseline information and helps inform the need for quality improvement efforts.

Longitudinal inpatient discharge data from the Healthcare Cost and Utilization Project (HCUP) sponsored by AHRQ is used to project 2010 and 2011 rates of CDI. 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 growing percentage of hospital

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

² Information on preventing CDI is available on the Centers for Disease Control and Prevention Web site at <http://www.cdc.gov/Features/Clostridiumdifficile/> (Accessed September 13, 2011.)

³ Centers for Disease Control and Prevention. (2008). *MMWR weekly: Surveillance for Community-Associated Clostridium difficile --- Connecticut, 2006*.

<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5713a3.htm> (Accessed September 13, 2011.)

⁴ 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.

⁵ 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.

discharges nationwide. In fact, the 2009 HCUP State Inpatient Databases (SID) encompass more than 95 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 2001 to 2009 include about 295 million inpatient discharges from 44 States. Historical SID data with early 2010 data from 15 HCUP States are used to develop the quarterly projected rate of discharges for CDI in 2010 and 2011.

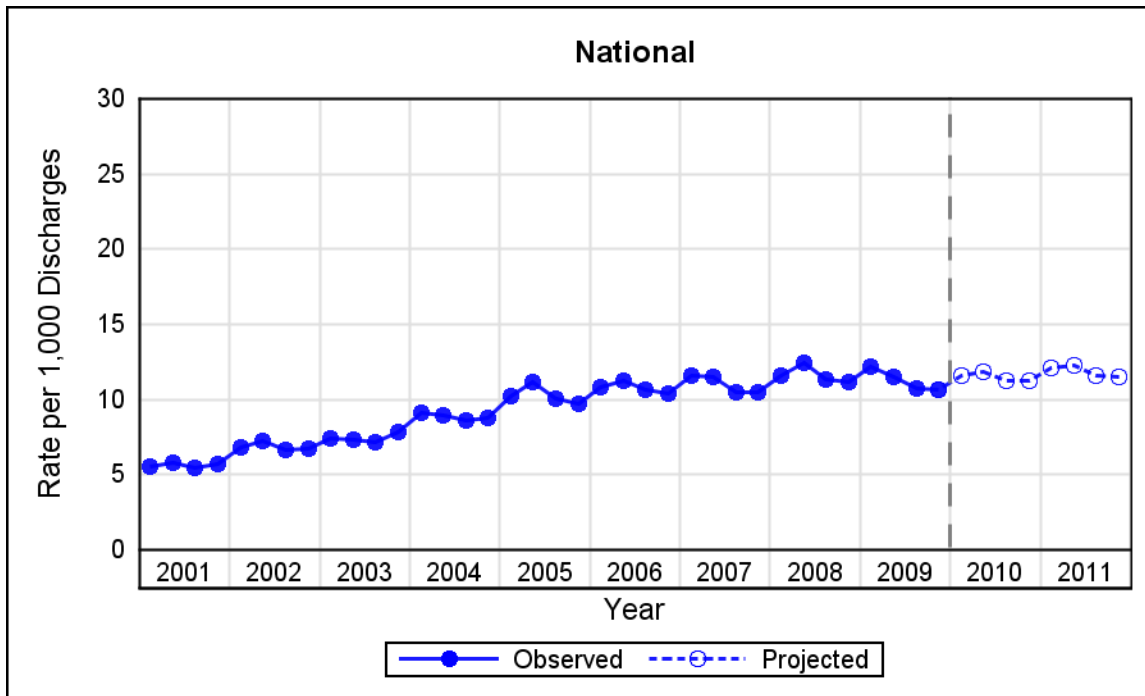
For this report, discharges with CDI are identified by the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code of intestinal infections due to *Clostridium difficile* (008.45), reported as either the principal or secondary diagnosis. An evaluation of surveillance for CDI in hospitals in 2006 found high sensitivity (78%) and specificity (99.7%) when using ICD-9-CM codes.⁶

Results are presented for the total United States and for each of the nine Census regional divisions. A list of States by Census division is included in Appendix II. Rates are calculated as the number of CDI discharges for adults per 1,000 non-maternal, adult discharges treated in community, non-rehabilitation hospitals. Rates are not risk-adjusted. A description of the projection methodology is available in Appendix III.

⁶ 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

As shown in the first figure, the national rate of discharges with CDI per 1,000 non-maternal, adult discharges increases from an average of 5.6 in 2001 to an average of 11.7 in 2008. By 2009, the rate averages 11.3 per 1,000 non-maternal, adult discharges and is projected to remain around 11.5 to 11.9 in 2010 and 2011. Within each year there is quarterly variation in the rate, with the third and fourth quarter often lower than the first and second quarter.



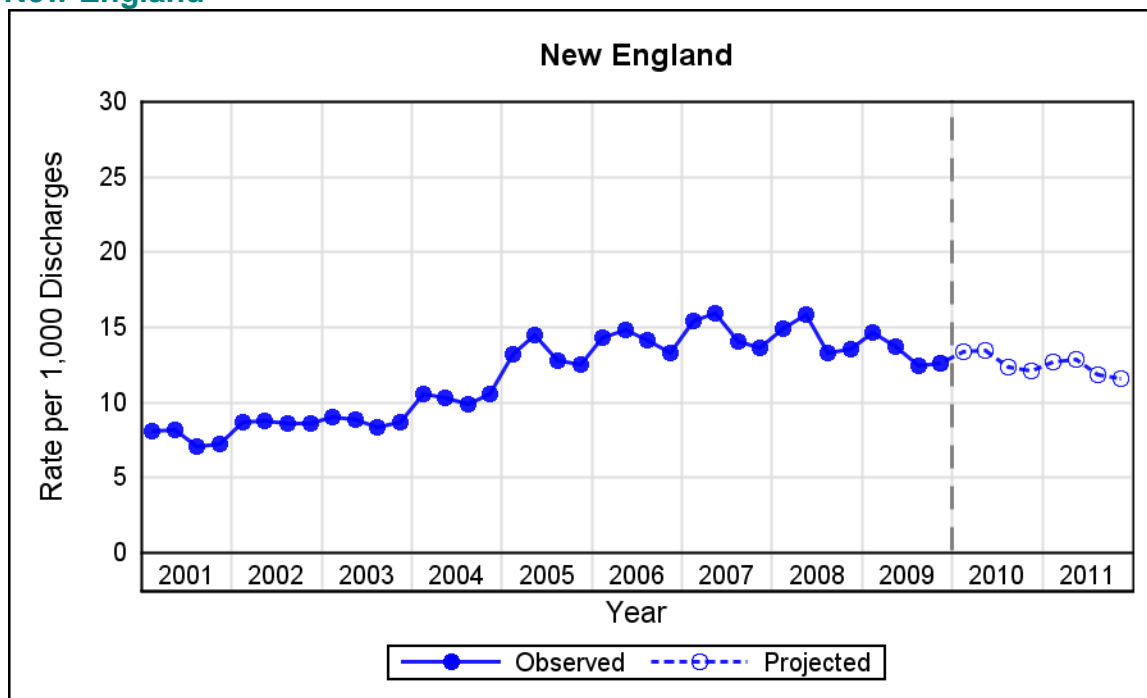
Source: Agency for Healthcare Research and Quality, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, State Inpatient Databases.

Projections by Census Division

The following nine figures depict the projections by Census divisions. New England has the highest rate of discharges with CDI per 1,000 non-maternal, adult discharges in 2001 (average of 7.7) and the highest rate in 2009 (average of 13.4). In contrast, the West South Central region has the lowest rate of discharges with CDI per 1,000 non-maternal, adult discharges in 2001 (average of 4.5) and the lowest rate in 2009 (average of 8.5).

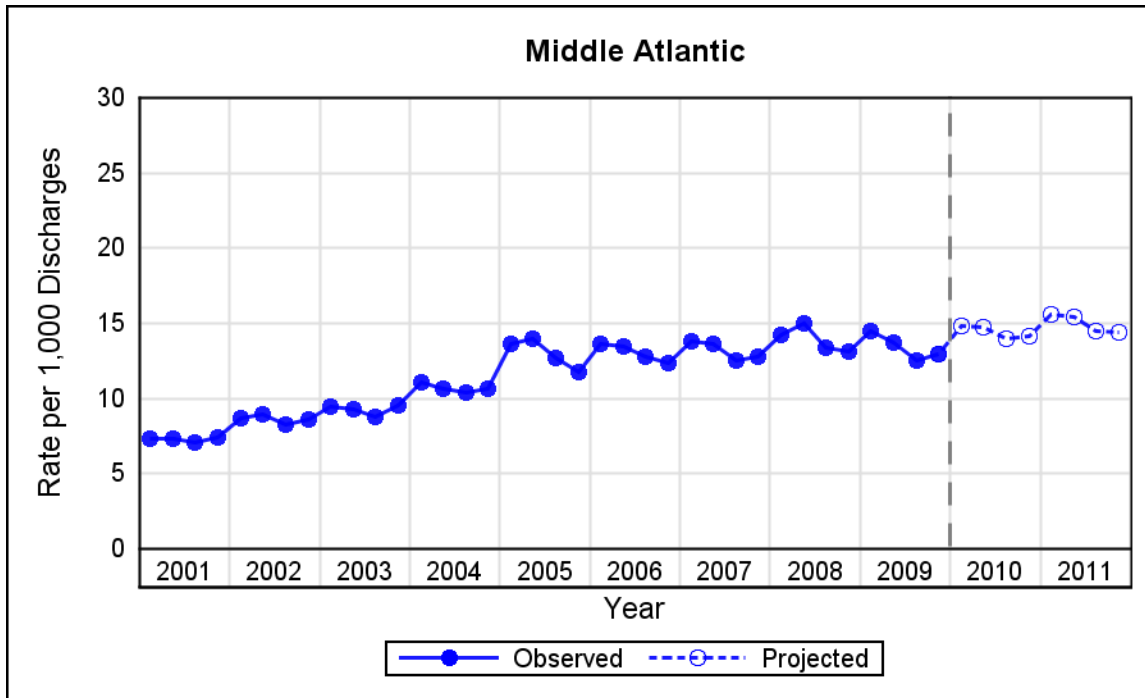
The rate of CDI across time varies across the nine Census divisions. The East South Central and Pacific divisions show rates of CDI treated in hospitals steadily increasing from 2001 to 2009, and are projected to continue increasing through 2011. Other Census divisions show a steady increase from 2001 to 2004/2005, level off at the higher rate through 2009, and are projected to continue at this level in 2010 and 2011. The exception is New England, which is projected to slightly decline beginning in 2009 through 2011, following a steady high rate from 2005 through 2008.

New England



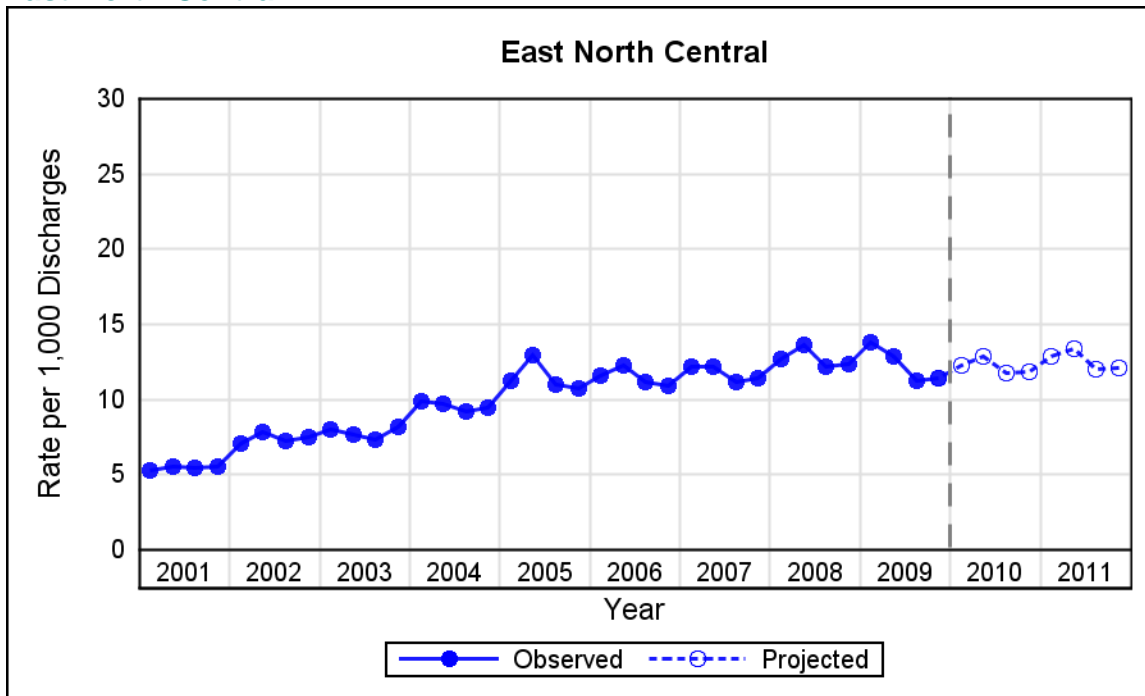
Source: Agency for Healthcare Research and Quality, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, State Inpatient Databases.

Middle Atlantic



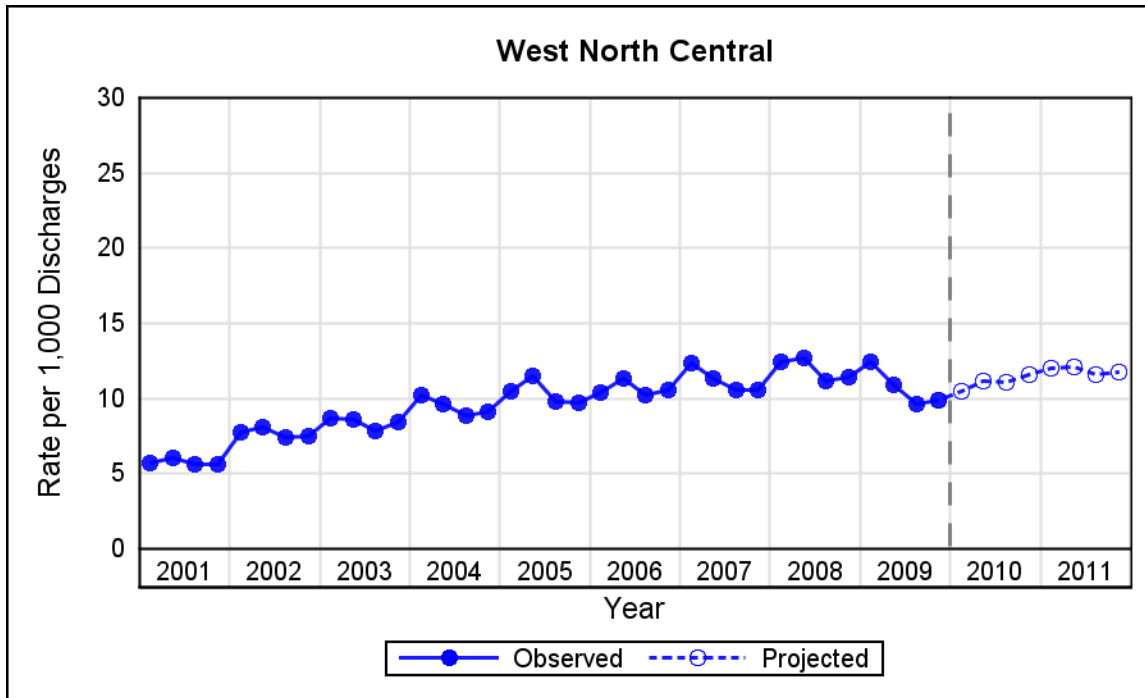
Source: Agency for Healthcare Research and Quality, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, State Inpatient Databases.

East North Central



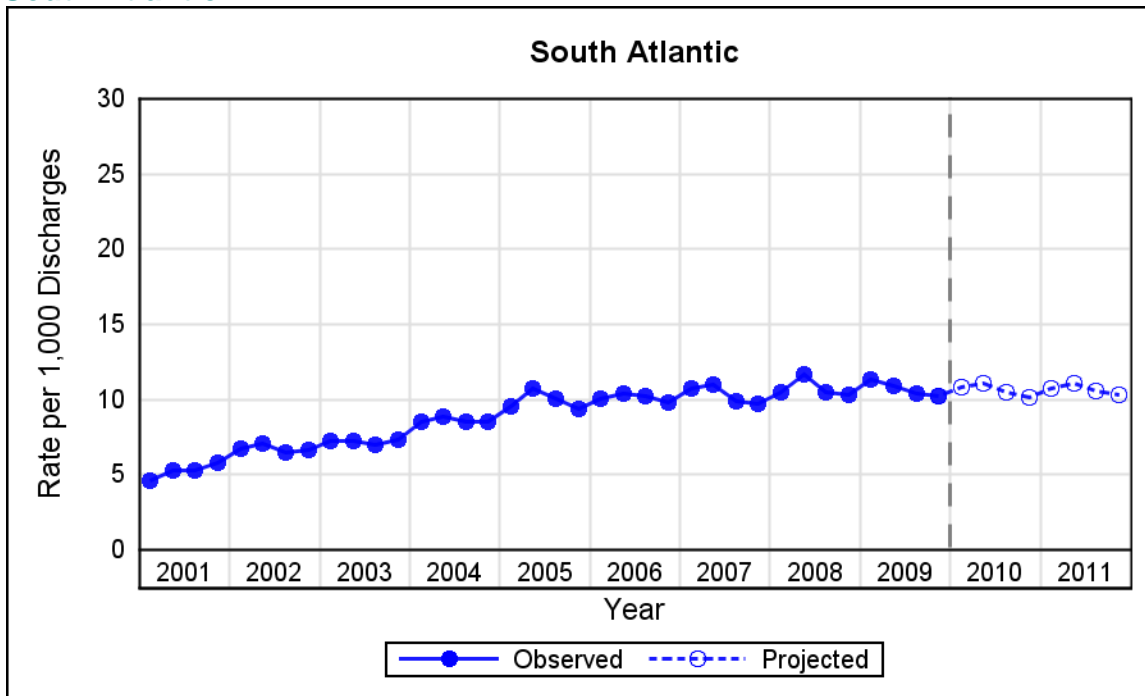
Source: Agency for Healthcare Research and Quality, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, State Inpatient Databases.

West North Central



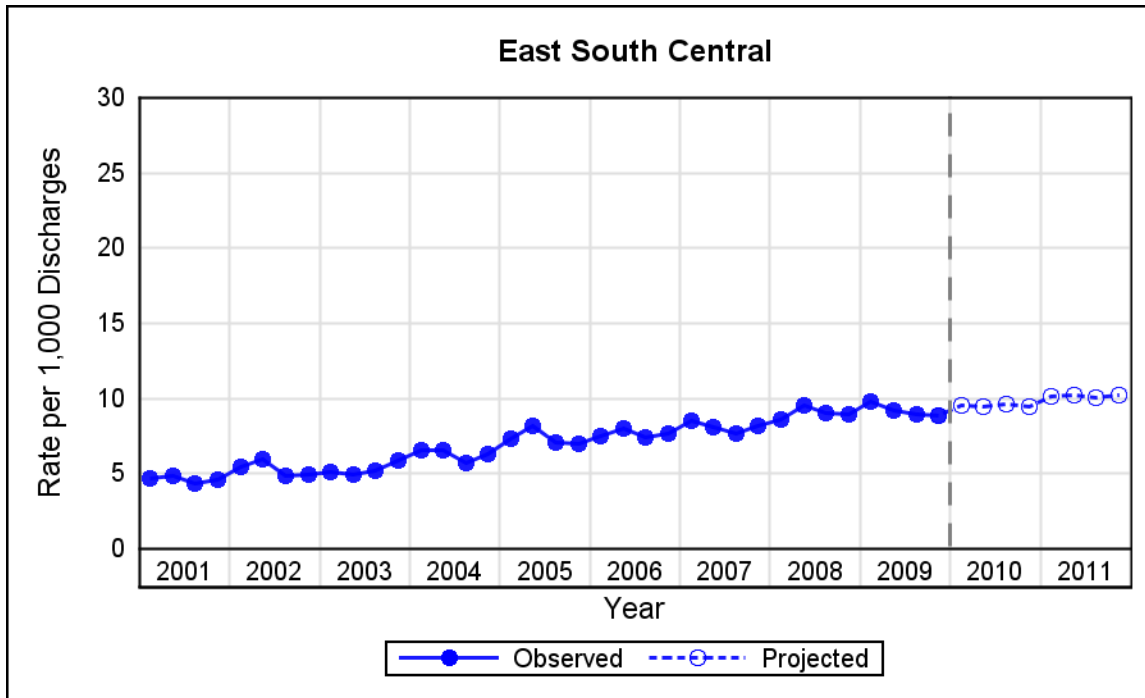
Source: Agency for Healthcare Research and Quality, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, State Inpatient Databases.

South Atlantic



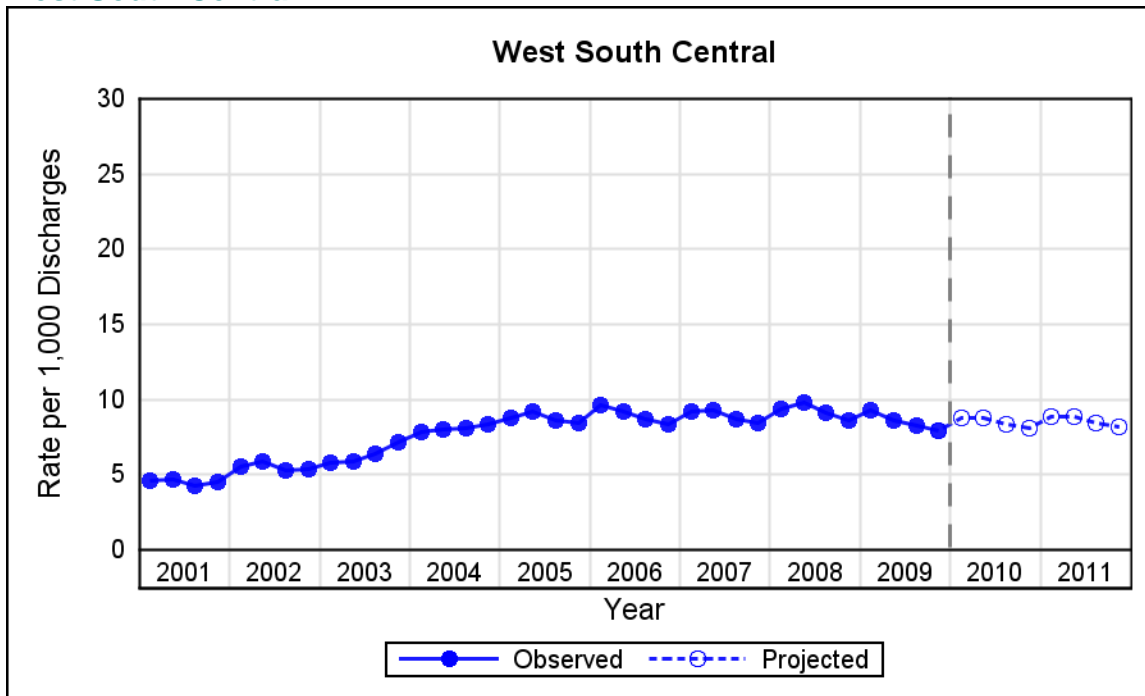
Source: Agency for Healthcare Research and Quality, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, State Inpatient Databases.

East South Central



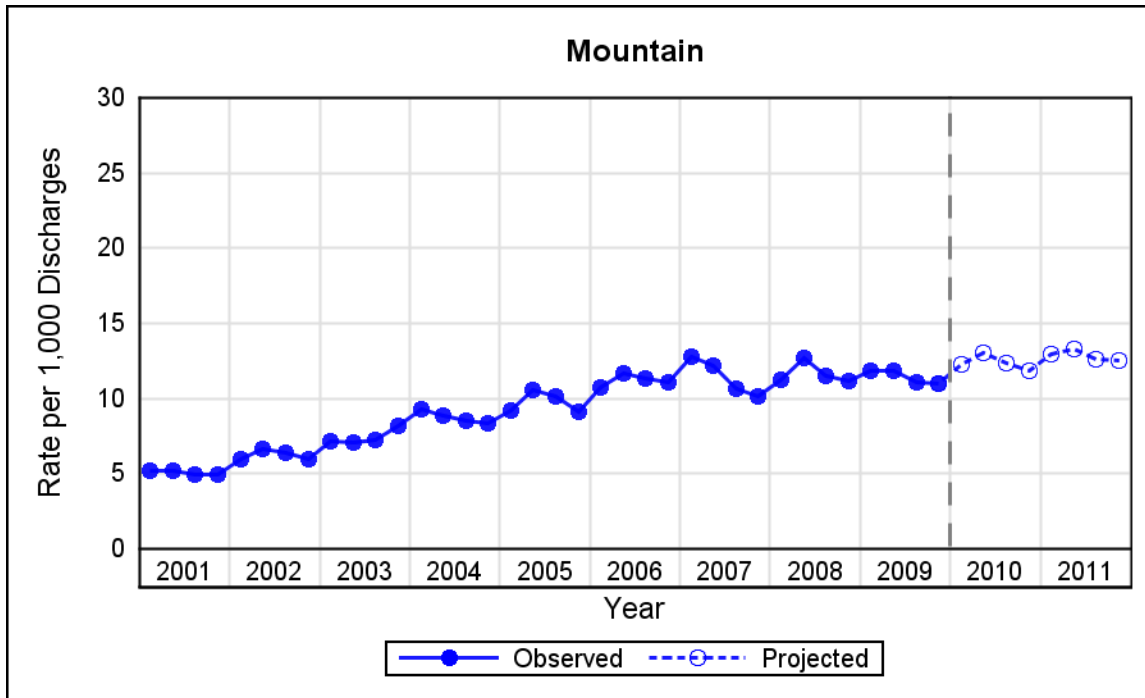
Source: Agency for Healthcare Research and Quality, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, State Inpatient Databases.

West South Central



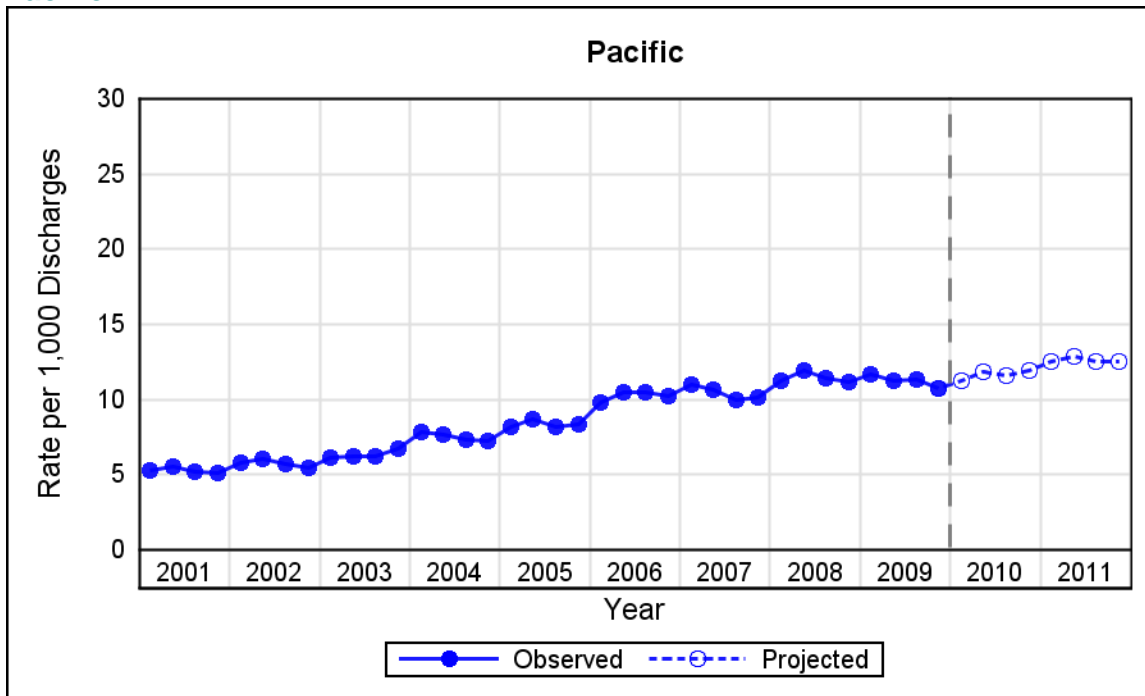
Source: Agency for Healthcare Research and Quality, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, State Inpatient Databases.

Mountain



Source: Agency for Healthcare Research and Quality, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, State Inpatient Databases.

Pacific



Source: Agency for Healthcare Research and Quality, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, State Inpatient Databases.

Appendix I: HCUP Partners

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

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 and Senior Services

New Mexico Health Policy Commission

New York State Department of Health

North Carolina Department of Health and Human Services

Ohio Hospital Association

Oklahoma State Department of Health

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: 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 a participating HCUP Partner State; therefore, data were not included in the analysis.

Appendix III: Methods

This section describes the method employed to project division-specific and national quarterly trends for the rate of discharges with *Clostridium difficile* infection (CDI) per 1,000 adult hospital discharges using the HCUP State Inpatient Databases (SID). Quarterly rate projections for 2010 and 2011 were generated for each of 44 States, based on each State's historical trend. Although trends are shown beginning in 2001, the statistical models employed data beginning in 2005.⁷

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 (ages 18 and older).

Projections were generated using the SAS Time Series Forecasting System™ (Version 9.2).⁸ 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 CDI rate was considered to be binomial, taking values between zero and one. Consequently, the time series model fit the trend in the $\text{logit}(\text{rate}) = \log[\text{rate} / (1 - \text{rate})]$.⁹ 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 2009 AHA Hospital Survey. These weights were used throughout the period 2001–2011. We had 2010 data for 15 States. The 2010 projections incorporated observed rates for these 15 States and incorporated rates estimated from time series models for the remaining States. For 2011, the projections were entirely based on rates estimated from time series models.

⁷ For CDI, the 2001-2004 trend differed substantially from the 2005-2009 trend. Therefore, the 2005-2009 data were selected as the basis of projections for 2010 and 2011.

⁸ *Large-Scale Automatic Forecasting Using Inputs and Calendar Events*. White Paper, SAS Institute Inc., 2009.

⁹ 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.