HEALTHCARE COST AND UTILIZATION PROJECT

Agency for Healthcare Research and Quality

STATISTICAL BRIEF #241

July 2018

Coronary Artery Disease, Acute Myocardial Infarction, and Ischemic Stroke Rates Among Inpatient Stays, 2001–2014

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Introduction

Atherosclerotic cardiovascular disease (ASCVD) refers to disease of the heart and blood vessels due to the accumulation of plaques. ASCVD can limit blood flow to the heart (coronary artery disease) and lead to dangerous cardiovascular events such as heart attacks (acute myocardial infarction). ASCVD in the blood vessels of the brain can decrease blood flow to the brain and result in ischemic strokes. Heart disease and stroke are among the top five leading causes of death.[1]

When these events do occur they often result in inpatient hospitalizations. Hospitalizations can put patients at greater risk for additional complications, such as hospital-associated infections and even death.[2,3,4]

ASCVD places a substantial burden on the U.S. health care system. The direct medical costs from coronary artery disease and stroke are currently estimated to be $126 billion per year and are expected to rise to $309 billion by 2035.[5]

This Healthcare Cost and Utilization Project (HCUP) Statistical Brief presents data on adult inpatient stays with a principal diagnosis of ASCVD, defined as one of three specific diagnoses: coronary artery disease (CAD), acute myocardial infarction (AMI), and ischemic stroke (referred to hereinafter as *stroke*). The rate of ASCVD stays among adults aged 18 years and older is provided along with the percentage of ASCVD stays with an in-hospital

[1] Murphy SL, Xu J, Kochanek KD, Curtin SC, Arias E. Deaths: final data for 2015. National Vital Statistics Reports. 2017;66(6):1–75.
[2] U.S. Department of Health and Human Services, Office of the Inspector General. Adverse Events in Hospitals: National Incidence Among Medicare Beneficiaries. November 2010. www.oig.hhs.gov/oei/reports/oei-06-09-00090.pdf. Accessed April 17, 2018.
[3] Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, et al. Multistate point-prevalence survey of health care–associated infections. New England Journal of Medicine. 2014;370:1198–1208.
[4] Covinsky KE, Pierluissi E, Johnston CB. Hospitalization-associated disability: "She was probably able to ambulate, but I'm not sure." JAMA. 2011;306(16):1782–93.
[5] American Heart Association. Cardiovascular Disease: A Costly Burden for America, Projections Through 2035. 2017. www.heart.org/idc/groups/heart-public/@wcm/@adv/documents/downloadable/ucm_491543.pdf. Accessed April 17, 2018.

Highlights

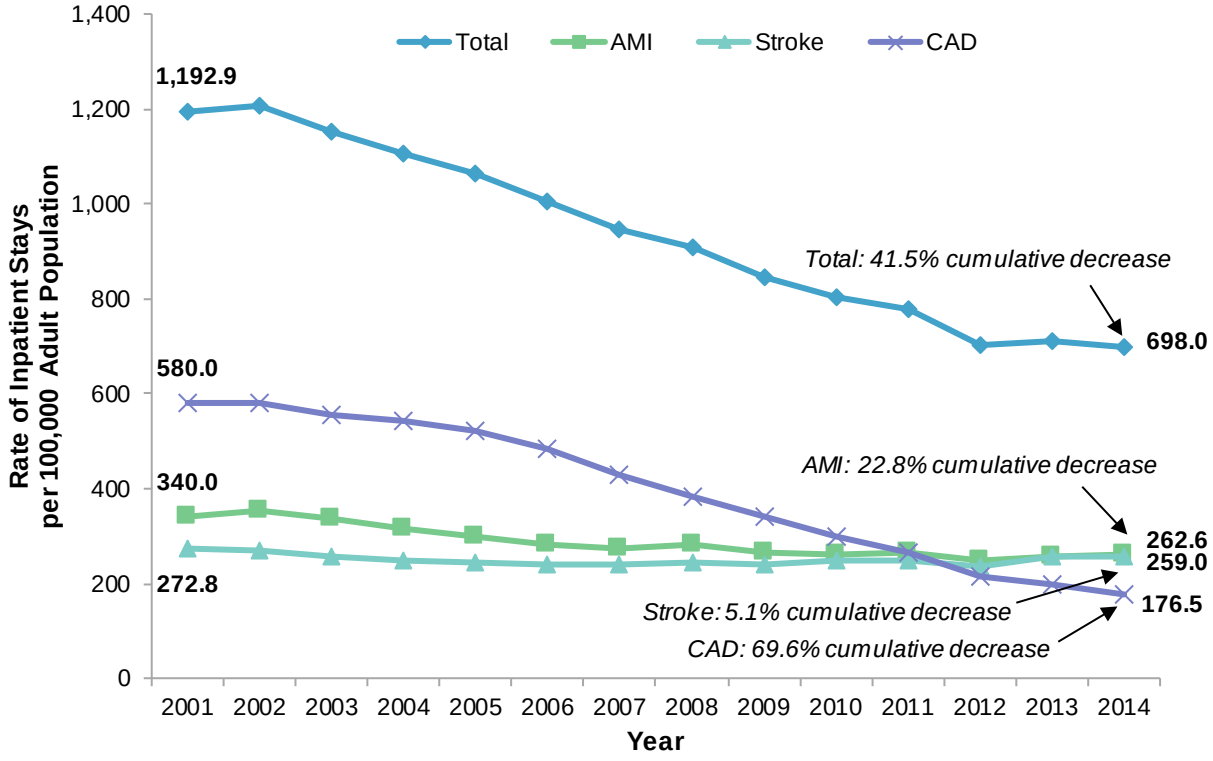
- From 2001 to 2014, the rate of atherosclerotic cardiovascular disease (ASCVD) inpatient stays among adults decreased 41.5 percent, from 1,192.9 to 698.0 stays per 100,000 adults. ASCVD is defined here as coronary artery disease (CAD), acute myocardial infarction (AMI), or ischemic stroke.
- The percentage of stays for ischemic stroke resulting in an in-hospital death decreased 38.1 percent from 2001 to 2014; in-hospital deaths also decreased 29.3 percent during this time among stays for AMI.
- In 2014, the rate of ASCVD stays per 100,000 adults was highest in low-income areas and progressively decreased as community-level income increased. Specifically, there were 855.8 stays per 100,000 adults in the lowest income areas compared with 536.1 stays per 100,000 adults in the wealthiest communities.
- The rate of stays for CAD was 69.3 percent higher in the lowest income areas than in the wealthiest areas in 2014 (222.0 vs. 131.2 stays per 100,000 adults).
- The rate of ASCVD stays among adults in 2014 was 31.2 percent lower in large metropolitan areas than in rural areas (667.7 vs. 969.8 stays per 100,000 adults).
- The rate of stays for AMI was 40.1 percent lower in large metropolitan areas than in rural areas in 2014 (239.8 vs. 400.1 stays per 100,000 adults).

death from 2001 to 2014, overall and for specific subgroups defined by diagnosis (AMI, stroke, CAD) and by procedure (percutaneous transluminal coronary angioplasty [PTCA] and coronary artery bypass graft [CABG]). The rate of adult ASCVD stays in 2014 is also presented by community-level income and by patient location. Differences greater than 10 percent between estimates are noted in the text.

Findings

Inpatient stays among adults with a principal diagnosis of ASCVD, 2001–2014
Figure 1 presents the rate of ASCVD inpatient stays per 100,000 adults from 2001 to 2014, overall and for each of the three specific ASCVD diagnoses—AMI, stroke, and CAD.

Figure 1. Inpatient stays for ASCVD among adults, 2001–2014



Abbreviations: AMI, acute myocardial infarction; ASCVD, atherosclerotic cardiovascular disease; CAD, coronary artery disease

Notes: Inpatient stays are based on principal diagnoses. Cumulative percent change is reported based on unrounded rates. ASCVD is defined here as a diagnosis of CAD, AMI, or ischemic stroke. Total refers to the sum of the three specific ASCVD diagnoses of CAD, AMI, and stroke.

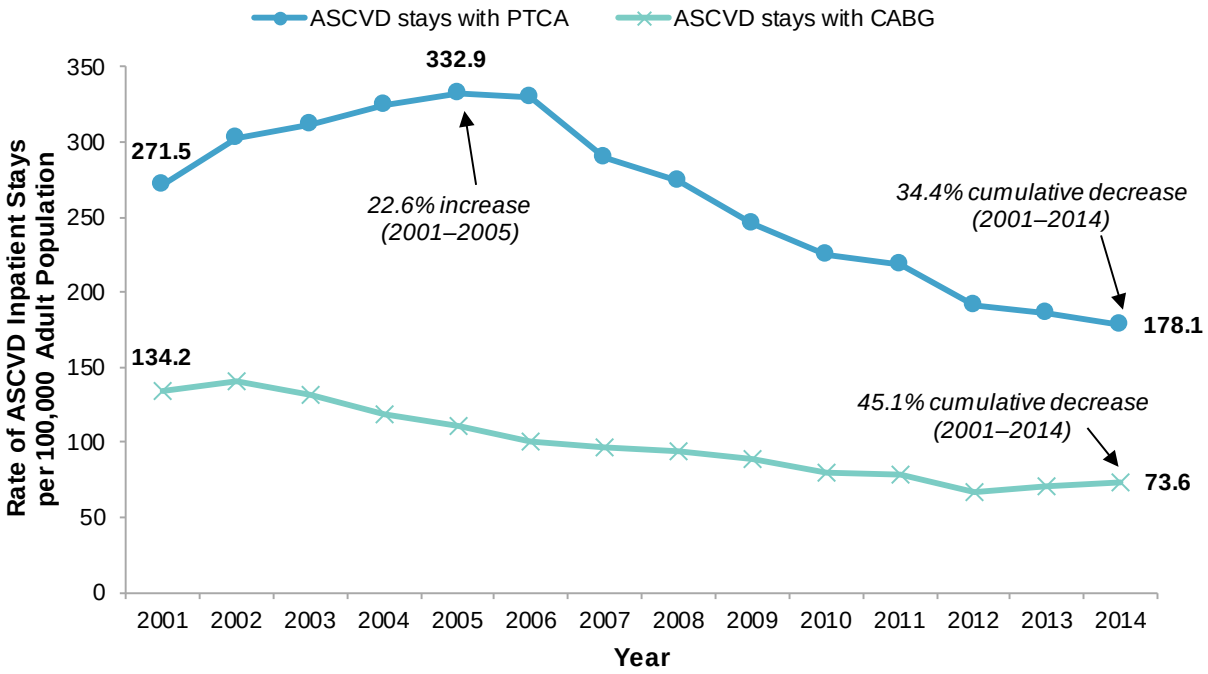
Source: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2001–2014, weighted to provide national estimates

- **The rate of inpatient ASCVD stays per 100,000 adults generally decreased from 2001 through 2014, for a total 41.5 percent cumulative decrease.**

  From 2001 to 2014, the rate of total ASCVD stays among adults decreased 41.5 percent, from 1,192.9 stays per 100,000 adults in 2001 to 698.0 stays per 100,000 adults in 2014. Among adult ASCVD stays, the rate of stays with a principal diagnosis of CAD decreased 69.6 percent from 2001 to 2014, from 580.0 to 176.5 stays per 100,000 adults. Stays with a principal diagnosis of AMI decreased 22.8 percent, from 340.0 to 262.6 stays per 100,000 adults. Stays with a principal diagnosis of stroke remained relatively stable at around 260–270 stays per 100,000 adults between 2001 and 2014.

Figure 2 presents the rate per 100,000 adults of ASCVD inpatient stays during which either of two common cardiovascular procedures—PTCA or CABG—were performed, from 2001 to 2014.

Figure 2. Adult ASCVD inpatient stays with common cardiovascular procedures, 2001–2014



Abbreviations: ASCVD, atherosclerotic cardiovascular disease; CABG, coronary artery bypass graft; PTCA, percutaneous transluminal coronary angioplasty

Notes: Inpatient stays are based on principal diagnoses and all-listed procedures. Cumulative percent change is reported based on unrounded rates. ASCVD is defined here as a diagnosis of coronary artery disease, acute myocardial infarction, or ischemic stroke.

Source: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2001–2014, weighted to provide national estimates

- **The rate of ASCVD stays involving PTCA increased from 2001 to 2005 and then decreased from 2005 to 2014.**

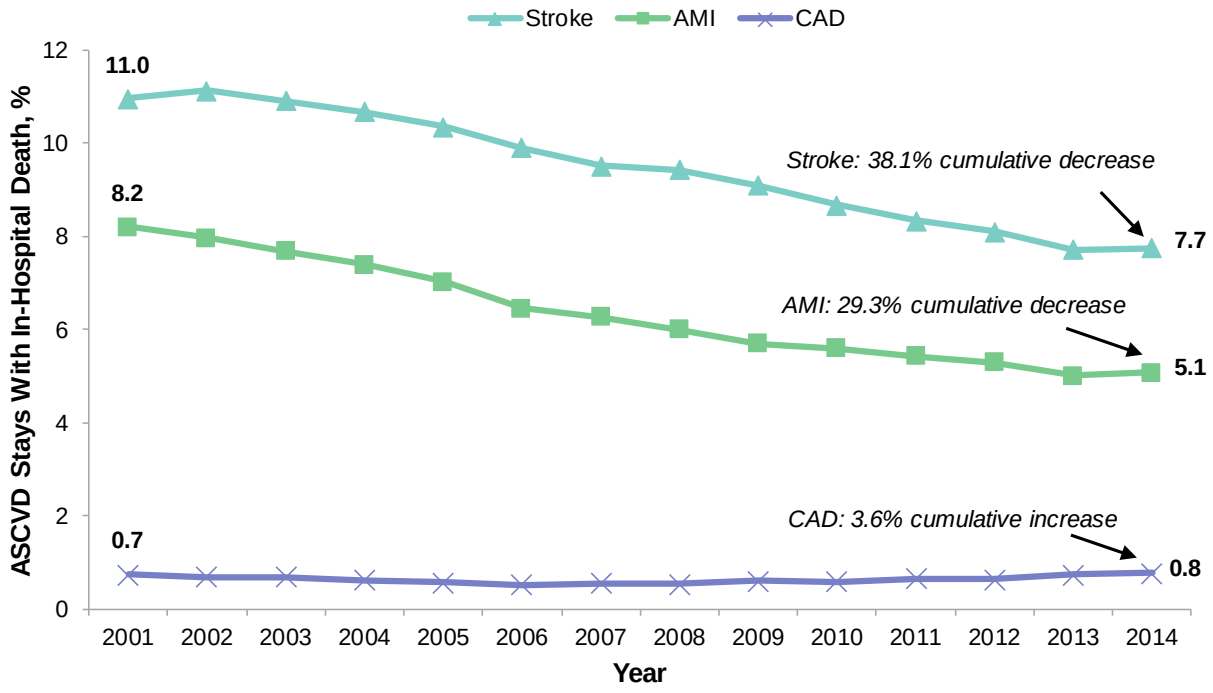
  The rate of ASCVD stays that involved PTCA increased 22.6 percent between 2001 and 2005, from 271.5 to 332.9 stays per 100,000 adults, and then decreased after 2005. Overall, from 2001 to 2014, the rate of adult ASCVD stays that involved PTCA decreased 34.4 percent, to 178.1 stays per 100,000 adults.

- **The rate of ASCVD stays involving CABG generally decreased from 2001 to 2014.**

  From 2001 to 2014, the rate of adult ASCVD stays that involved CABG decreased 45.1 percent, from 134.2 stays per 100,000 adults in 2001 to 73.6 stays per 100,000 adults in 2014.

In-hospital deaths among adult inpatient stays with a principal diagnosis of ASCVD, 2001–2014
Figure 3 presents the percentage of adult ASCVD stays that resulted in an in-hospital death from 2001 to 2014 for each of the three specific ASCVD diagnoses—AMI, stroke, and CAD.

Figure 3. In-hospital deaths among adult ASCVD inpatient stays, 2001–2014



Abbreviations: AMI, acute myocardial infarction; ASCVD, atherosclerotic cardiovascular disease; CAD, coronary artery disease

Notes: Inpatient stays are based on principal diagnosis. Cumulative percent change is reported based on unrounded rates. ASCVD is defined here as a diagnosis of CAD, AMI, or ischemic stroke.

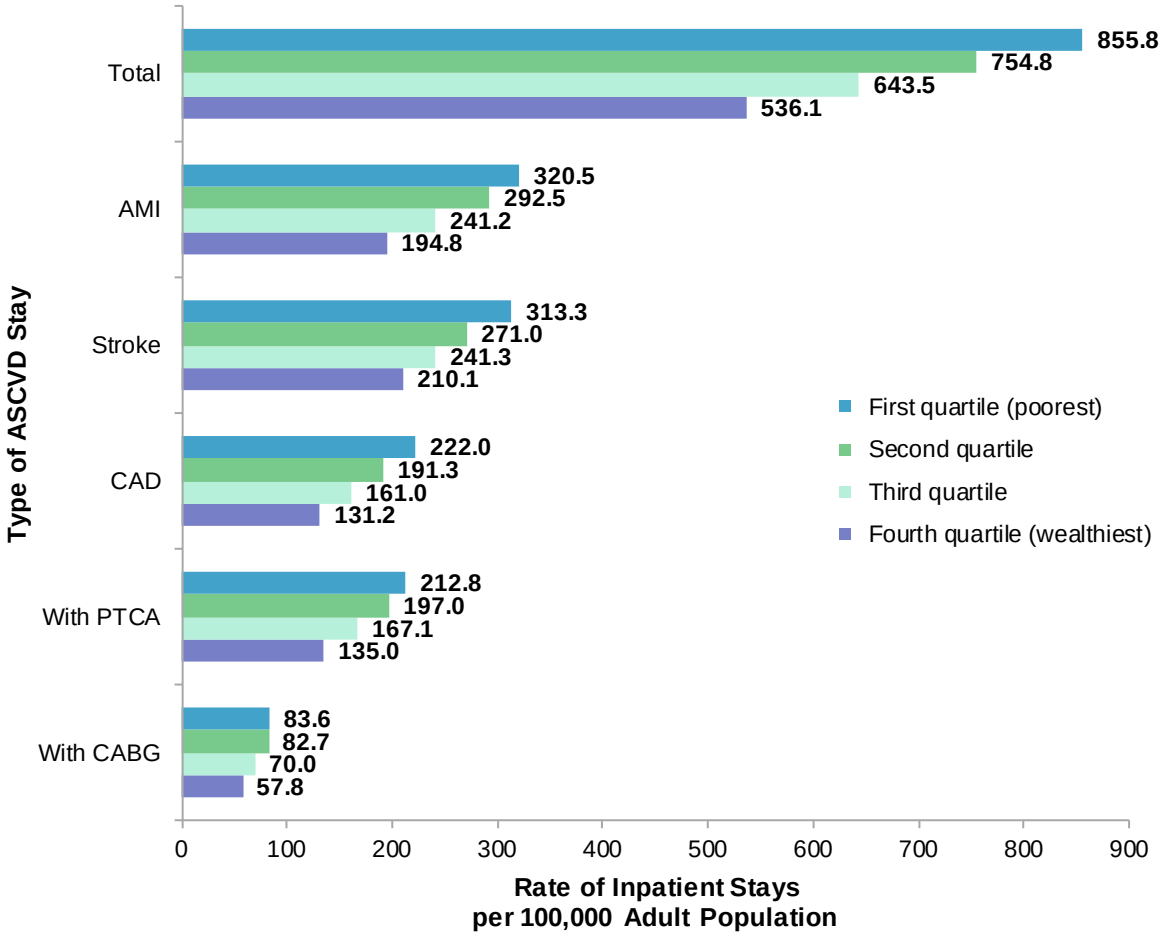
Source: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2001–2014, weighted to provide national estimates

- **From 2001 to 2014, the percentage of ASCVD stays with an in-hospital death decreased 38.1 percent among stays for stroke and decreased 29.3 percent among stays for AMI.**

  In-hospital deaths occurred during 11.0 percent of stays for stroke in 2001. By 2014, only 7.7 percent of stays for stroke resulted in an in-hospital death, a 38.1 percent decrease. During this same time period, in-hospital deaths among stays for AMI decreased 29.3 percent, from 8.2 to 5.1 percent of stays for AMI. Less than 1 percent of stays for CAD resulted in an in-hospital death between 2001 and 2014.

Rates of ASCVD inpatient stays per 100,000 adults by patient characteristics, 2014
Figure 4 presents the rate of ASCVD stays per 100,000 adults in 2014 by community-level income quartile, overall and for each of the three specific ASCVD diagnoses (AMI, stroke, and CAD) and procedures (PTCA and CABG).

Figure 4. Adult ASCVD inpatient stays by community-level income, 2014



Abbreviations: AMI, acute myocardial infarction; ASCVD, atherosclerotic cardiovascular disease; CABG, coronary artery bypass graft; CAD, coronary artery disease; PTCA, percutaneous transluminal coronary angioplasty

Notes: Inpatient stays are based on principal diagnoses and all-listed procedures. ASCVD is defined here as a diagnosis of CAD, AMI, or ischemic stroke. Total refers to the sum of the three specific ASCVD diagnoses of CAD, AMI, and stroke.

Source: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project (HCUP), 36 State Inpatient Databases (SID), 2014, weighted to provide national estimates

- **The rate of ASCVD stays per 100,000 adults was highest in low-income areas in 2014 and decreased as community-level income increased.**

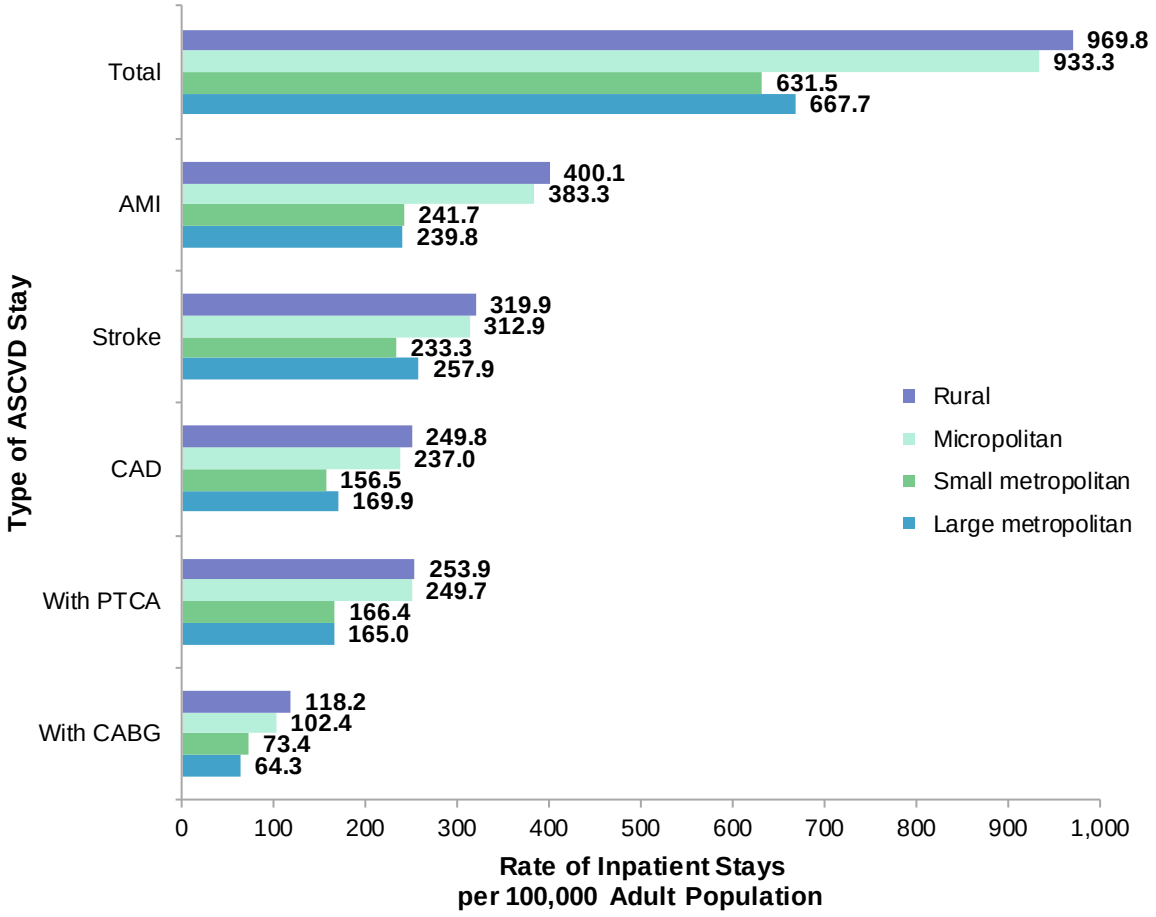
  In 2014, there were 855.8 total ASCVD stays per 100,000 adults residing in communities with the lowest income (i.e., the first quartile), which was 60 percent higher than the 536.1 stays per 100,000 adults in the wealthiest communities (i.e., the fourth quartile). The rate of total ASCVD stays per 100,000 adults was 754.8 in the second quartile and 643.5 in the third quartile of community-level income.

  In 2014, the rate of stays was highest in the first income quartile among stays with a principal diagnosis of AMI, stroke, or CAD (320.5, 313.3, and 222.0 stays per 100,000 adults, respectively). The rate of ASCVD stays per 100,000 adults also decreased as community-level income increased in 2014 across these three specific ASCVD diagnoses and across both cardiovascular procedures (i.e.,

PTCA and CABG). The greatest differential between the poorest and wealthiest communities was observed for adult ASCVD stays with a principal diagnosis of CAD (69.3 percent higher rate in the lowest vs. highest income communities: 222.0 vs. 131.2 per 100,000 adults) and stays with PTCA (57.7 percent higher rate in the lowest vs. highest income communities: 212.8 vs. 135.0 stays per 100,000 adults).

Figure 5 presents the rate of ASCVD inpatient stays per 100,000 adults in 2014 by location of patients' residence, overall and for specific ASCVD diagnoses (AMI, stroke, and CAD) and procedures (PTCA and CABG).

Figure 5. Adult ASCVD inpatient stays by location of patients' residence, 2014



Abbreviations: AMI, acute myocardial infarction; ASCVD, atherosclerotic cardiovascular disease; CABG, coronary artery bypass graft; CAD, coronary artery disease; PTCA, percutaneous transluminal coronary angioplasty

Notes: Inpatient stays are based on principal diagnoses and all-listed procedures. ASCVD is defined here as a diagnosis of CAD, AMI, or ischemic stroke. Total refers to the sum of the three specific ASCVD diagnoses of CAD, AMI, and stroke.

Source: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project (HCUP), 36 State Inpatient Databases (SID), 2014, weighted to provide national estimates

- **The rate of ASCVD stays per 100,000 adults was lowest in metropolitan areas (both large and small) in 2014.**

  In 2014, the rates of ASCVD stays per 100,000 adults were similar in small and large metropolitan areas and lower than the rates in rural and micropolitan areas, which also were similar. These patterns were observed across all three specific ASCVD diagnoses (AMI, stroke, and CAD) and both cardiovascular procedures (PTCA and CABG).

The rate of ASCVD stays in large metropolitan areas was 31.2 percent lower than in rural areas (667.7 vs. 969.8 stays per 100,000 adults). The largest variation across the three ASCVD diagnoses occurred among stays for AMI, with the rate in large metropolitan areas 40.1 percent lower than the rate in rural areas (239.8 vs. 400.1 stays per 100,000 adults). The rates of ASCVD stays for stroke and CAD were 19.4 and 32.0 percent lower in large metropolitan areas than in rural areas, respectively (257.9 vs. 319.9 and 169.9 vs. 249.8 stays per 100,000 adults). The largest variation between the two cardiovascular procedures occurred among ASCVD stays with CABG, with the rate in metropolitan areas 45.6 percent lower than the rate in rural areas (64.3 vs. 118.2 stays per 100,000 adults). The rate of ASCVD stays with PTCA was 35.0 percent lower in large metropolitan areas than in rural areas (165.0 vs. 253.9 stays per 100,000 adults).

About Statistical Briefs

Healthcare Cost and Utilization Project (HCUP) Statistical Briefs provide basic descriptive statistics on a variety of topics using HCUP administrative health care data. Topics include hospital inpatient, ambulatory surgery, and emergency department use and costs, quality of care, access to care, medical conditions, procedures, and patient populations, among other topics. The reports are intended to generate hypotheses that can be further explored in other research; the reports are not designed to answer in-depth research questions using multivariate methods.

Data Source

The estimates in this Statistical Brief are based upon data from the HCUP State Inpatient Databases (SID), 2001–2014, nationally weighted analysis files using a sampling and weighting strategy similar to that used in the 2011 Nationwide Inpatient Sample, but with a higher sampling rate of 40 percent of hospitals.[6] Because analyses in this Statistical Brief are based on a nationally representative analysis file, the values may differ from results reported from the HCUP National (Nationwide) Inpatient Sample (NIS). Supplemental sources included population denominator data for use with HCUP databases, derived from information available from Claritas, a vendor that compiles and adds value to data from the U.S. Census Bureau.[7]

Definitions

Diagnoses, procedures, and Clinical Classifications Software (CCS)
The *principal diagnosis* is that condition established after study to be chiefly responsible for the patient's admission to the hospital. *Secondary diagnoses* are concomitant conditions that coexist at the time of admission or develop during the stay. *All-listed diagnoses* include the principal diagnosis plus these additional secondary conditions.

All-listed procedures include all procedures performed during the hospital stay, whether for definitive treatment or for diagnostic or exploratory purposes. The *first-listed procedure* is the procedure that is listed first on the discharge record. Inpatient data define this as the *principal procedure*—the procedure that is performed for definitive treatment rather than for diagnostic or exploratory purposes (i.e., the procedure that was necessary to take care of a complication).

CCS categorizes ICD-9-CM diagnosis codes and procedure codes into a manageable number of clinically meaningful categories.[8] This clinical grouper makes it easier to quickly understand patterns of diagnoses and procedure use.

Case definition
For this report, the study population of adults aged 18 years and older who were hospitalized for atherosclerotic cardiovascular disease was defined using the following CCS principal diagnosis categories:

- 100: acute myocardial infarction (AMI)
- 101: coronary artery disease (CAD)
- 109: acute cerebrovascular disease (i.e., stroke)

Cardiovascular procedures CABG and PTCA were defined using the following all-listed CCS procedure categories:

[6] Barrett M, Coffey R, Houchens R, Heslin K, Moles E, Coenen N. Methods Applying AHRQ Quality Indicators to Heathcare Cost and Uitilization Project (HCUP) Data for the 2016 National Healthcare Quality and Disparities Report (QDR). HCUP Methods Series Report #2017-03. July 13, 2017. U.S. Agency for Healthcare Research and Quality. www.hcup-us.ahrq.gov/reports/methods/2017-03.pdf. Accessed February 19, 2018.
[7] Claritas. Claritas Demographic Profile by ZIP Code. https://claritas360.claritas.com/mybestsegments/. Accessed June 6, 2018.
[8] Agency for Healthcare Research and Quality. HCUP Clinical Classifications Software (CCS) for ICD-9-CM. Healthcare Cost and Utilization Project (HCUP). Agency for Healthcare Research and Quality. Updated March 2017. www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp. Accessed January 18, 2018.

- 44: coronary artery bypass graft (CABG)
- 45: percutaneous transluminal coronary angioplasty (PTCA)

Types of hospitals included in HCUP State Inpatient Databases
This analysis used State Inpatient Databases (SID) limited to data from community hospitals, which are defined as short-term, non-Federal, general, and other hospitals, excluding hospital units of other institutions (e.g., prisons). Community hospitals include obstetrics and gynecology, otolaryngology, orthopedic, cancer, pediatric, public, and academic medical hospitals. Excluded for this analysis are long-term care facilities such as rehabilitation, psychiatric, and alcoholism and chemical dependency hospitals. However, if a patient received long-term care, rehabilitation, or treatment for a psychiatric or chemical dependency condition in a community hospital, the discharge record for that stay was included in the analysis.

Unit of analysis
The unit of analysis is the hospital discharge (i.e., the hospital stay), not a person or patient. This means that a person who is admitted to the hospital multiple times in 1 year will be counted each time as a separate discharge from the hospital.

Location of patients' residence
Place of residence is based on a simplified adaptation of the Urban Influence Codes (UIC) developed by the United States Department of Agriculture Economic Research Service. The county-level designation is based on the 2013 version of the UIC. The 12 categories of the UIC are combined into 4 broader categories that differentiate between large metropolitan counties (include one or more urbanized areas with at least one million residents), small metropolitan counties (include one or more urbanized areas with 50,000–999,999 residents), micropolitan counties (include at least one urbanized area with 10,000–49,999 residents), and nonurban residual counties (rural). The location of patients' residence is set to large metropolitan for patients who are homeless. Foreign patients could not be classified and were excluded from results by location of patients' residence.

Community-level income
Community-level income is based on the median household income of the patient's ZIP Code of residence. Quartiles are defined so that the total U.S. population is evenly distributed. Cut-offs for the quartiles are determined annually using ZIP Code demographic data obtained from Claritas, a vendor that adds value to data from the U.S. Census Bureau.[9] The value ranges for the income quartiles vary by year. The income quartile is set to the lowest category (i.e., the first quartile) for patients who are homeless.

About HCUP

The Healthcare Cost and Utilization Project (HCUP, pronounced "H-Cup") is a family of health care databases and related software tools and products developed through a Federal-State-Industry partnership and sponsored by the Agency for Healthcare Research and Quality (AHRQ). HCUP databases bring together the data collection efforts of State data organizations, hospital associations, and private data organizations (HCUP Partners) and the Federal government to create a national information resource of encounter-level health care data. HCUP includes the largest collection of longitudinal hospital care data in the United States, with all-payer, encounter-level information beginning in 1988. These databases enable research on a broad range of health policy issues, including cost and quality of health services, medical practice patterns, access to health care programs, and outcomes of treatments at the national, State, and local market levels.

HCUP would not be possible without the contributions of the following data collection Partners from across the United States:

Alaska Department of Health and Social Services
Alaska State Hospital and Nursing Home Association

[9] Claritas. Claritas Demographic Profile by ZIP Code. https://claritas360.claritas.com/mybestsegments/. Accessed June 6, 2018.

Arizona Department of Health Services
Arkansas Department of Health
California Office of Statewide Health Planning and Development
Colorado Hospital Association
Connecticut Hospital Association
District of Columbia 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
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 State Department of Health
Missouri Hospital Industry Data Institute
Montana Hospital Association
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 Office of Health Analytics
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 Department of Health and Human Resources, West Virginia Health Care Authority
Wisconsin Department of Health Services
Wyoming Hospital Association

About the SID

The HCUP State Inpatient Databases (SID) are hospital inpatient databases from data organizations participating in HCUP. The SID contain the universe of the inpatient discharge abstracts in the participating HCUP States, translated into a uniform format to facilitate multistate comparisons and analyses. Together, the SID encompass more than 97 percent of all U.S. community hospital discharges. The SID can be used to investigate questions unique to one State, to compare data from two or more States, to conduct market-area variation analyses, and to identify State-specific trends in inpatient care utilization, access, charges, and outcomes.

For More Information

For other information on heart and circulatory conditions, refer to the HCUP Statistical Briefs located at www.hcup-us.ahrq.gov/reports/statbriefs/sb_heart.jsp.

For additional HCUP statistics, visit:

- HCUP Fast Stats at www.hcup-us.ahrq.gov/faststats/landing.jsp for easy access to the latest HCUP-based statistics for health information topics
- HCUPnet, HCUP's interactive query system, at www.hcupnet.ahrq.gov/

For more information about HCUP, visit www.hcup-us.ahrq.gov/.

For a detailed description of HCUP and more information on the design of the State Inpatient Databases (SID) please refer to the following database documentation:

Agency for Healthcare Research and Quality. Overview of the State Inpatient Databases (SID). Healthcare Cost and Utilization Project (HCUP). Rockville, MD: Agency for Healthcare Research and Quality. Updated April 2017. www.hcup-us.ahrq.gov/sidoverview.jsp. Accessed January 18, 2018.

Suggested Citation

Ngo-Metzger Q (AHRQ), Bierman AS (AHRQ), Borsky A (AHRQ), Heslin KC (AHRQ), Moore BJ (IBM Watson Health), Barrett ML (M.L. Barrett, Inc.). Coronary Artery Disease, Acute Myocardial Infarction, and Ischemic Stroke Rates Among Inpatient Stays, 2001–2014. HCUP Statistical Brief #241. July 2018. Agency for Healthcare Research and Quality, Rockville, MD. www.hcup-us.ahrq.gov/reports/statbriefs/sb241-Coronary-Artery-AMI-Stroke-Hospital-Stays-2001-2014.pdf .

Acknowledgments

The authors would like to acknowledge the contributions of Minya Sheng of IBM Watson Health.

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AHRQ welcomes questions and comments from readers of this publication who are interested in obtaining more information about access, cost, use, financing, and quality of health care in the United States. We also invite you to tell us how you are using this Statistical Brief and other HCUP data and tools, and to share suggestions on how HCUP products might be enhanced to further meet your needs. Please e-mail us at hcup@ahrq.gov or send a letter to the address below:

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This Statistical Brief was posted online on July 24, 2018.