Medicare Quality Monitoring System (MQMS) Report: Outcomes of Vascular and Cardiac Surgeries

Final Report

November 2003

Eric Schone, Ph.D.

Submitted to: Centers for Medicare & Medicaid Services
Center for Beneficiary Choices/
Quality Measurement and Health Assessment Group
South Bldg., S3-24-05
7500 Security Blvd.
Mail Stop S3-02-01
Baltimore, MD 21244-1850

600 Maryland Ave. S.W., Suite 550
Washington, DC 20024-2512
Telephone: (202) 484-9220
Facsimile: (202) 863-1763

Project Officer: Lein Han
Project Director: Angela Merrill
# Contents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>x</td>
</tr>
<tr>
<td>I NATIONAL RESULTS</td>
<td>4</td>
</tr>
<tr>
<td>A. DISCHARGE RATES</td>
<td>4</td>
</tr>
<tr>
<td>B. MORTALITY RATES</td>
<td>5</td>
</tr>
<tr>
<td>C. READMISSION</td>
<td>6</td>
</tr>
<tr>
<td>II MEDICARE ELIGIBILITY RESULTS</td>
<td>7</td>
</tr>
<tr>
<td>A. DISCHARGE RATES</td>
<td>7</td>
</tr>
<tr>
<td>B. MORTALITY RATES</td>
<td>8</td>
</tr>
<tr>
<td>C. READMISSION RATES</td>
<td>10</td>
</tr>
<tr>
<td>III RESULTS BY RACE</td>
<td>11</td>
</tr>
<tr>
<td>A. DISCHARGE RATES</td>
<td>11</td>
</tr>
<tr>
<td>B. MORTALITY RATES</td>
<td>13</td>
</tr>
<tr>
<td>C. READMISSION RATES</td>
<td>15</td>
</tr>
<tr>
<td>Chapter</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>IV RESULTS BY MEDICAID ELIGIBILITY</td>
<td>17</td>
</tr>
<tr>
<td>A. DISCHARGE RATES</td>
<td>17</td>
</tr>
<tr>
<td>B. MORTALITY RATES</td>
<td>18</td>
</tr>
<tr>
<td>V RATES BY AGE</td>
<td>21</td>
</tr>
<tr>
<td>A. DISCHARGE RATES</td>
<td>21</td>
</tr>
<tr>
<td>VI RATES BY GENDER</td>
<td>23</td>
</tr>
<tr>
<td>A. DISCHARGE RATES</td>
<td>23</td>
</tr>
<tr>
<td>B. MORTALITY RATES</td>
<td>24</td>
</tr>
<tr>
<td>C. READMISSION RATES</td>
<td>24</td>
</tr>
<tr>
<td>VII REGIONAL RESULTS</td>
<td>26</td>
</tr>
<tr>
<td>A. DISCHARGE RATES</td>
<td>26</td>
</tr>
<tr>
<td>B. MORTALITY RATES</td>
<td>27</td>
</tr>
<tr>
<td>C. READMISSION RATES</td>
<td>29</td>
</tr>
<tr>
<td>VIII RESULTS FOR URBAN AND RURAL AREAS</td>
<td>30</td>
</tr>
<tr>
<td>A. DISCHARGE RATES</td>
<td>30</td>
</tr>
<tr>
<td>B. MORTALITY RATES</td>
<td>31</td>
</tr>
<tr>
<td>C. READMISSION RATES</td>
<td>31</td>
</tr>
<tr>
<td>IX DISCUSSION</td>
<td>33</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>35</td>
</tr>
<tr>
<td>APPENDIX A: MEASURE SPECIFICATIONS</td>
<td>A-1</td>
</tr>
</tbody>
</table>
FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.1</td>
<td>Cardiovascular Procedures: Three-Year Average Discharge Rate per 1,000 Beneficiaries</td>
<td>4</td>
</tr>
<tr>
<td>I.2</td>
<td>Cardiovascular Procedures: Three-Year Average 30-Day Mortality per 1,000 Beneficiaries</td>
<td>5</td>
</tr>
<tr>
<td>I.3</td>
<td>Cardiovascular Procedures: Three-Year Average 30-Day Readmits per 1,000 Beneficiaries with Surgery</td>
<td>6</td>
</tr>
<tr>
<td>II.1</td>
<td>2001 Cardiovascular Surgery Rates by Medicare Eligibility Status</td>
<td>7</td>
</tr>
<tr>
<td>II.2</td>
<td>Change in Cardiovascular Surgery Rates, 1994-2001, by Medicare Eligibility</td>
<td>8</td>
</tr>
<tr>
<td>II.3</td>
<td>2001 Cardiovascular Surgery 30-Day Mortality by Medicare Eligibility Status</td>
<td>8</td>
</tr>
<tr>
<td>II.4</td>
<td>Change in Cardiovascular Surgery Mortality, 1994-2001, by Medicare Eligibility</td>
<td>9</td>
</tr>
<tr>
<td>II.5</td>
<td>2001 Cardiovascular Surgery 30-Day Readmits by Medicare Eligibility Status</td>
<td>10</td>
</tr>
<tr>
<td>II.6</td>
<td>Change in Cardiovascular Surgery Readmits, 1994-2001, by Medicare Eligibility Status</td>
<td>10</td>
</tr>
<tr>
<td>III.1</td>
<td>2001 Cardiovascular Surgery Rates by Race</td>
<td>11</td>
</tr>
<tr>
<td>III.2</td>
<td>Change in Cardiovascular Surgery Rates, 1994-2001, by Race</td>
<td>11</td>
</tr>
<tr>
<td>III.3</td>
<td>CEA Procedures: Discharge Rate by Race</td>
<td>12</td>
</tr>
<tr>
<td>III.4</td>
<td>2001 Cardiovascular Surgery 30-Day Mortality by Race</td>
<td>13</td>
</tr>
<tr>
<td>III.5</td>
<td>Change in Cardiovascular Surgery Mortality, 1994-2001, by Race</td>
<td>13</td>
</tr>
<tr>
<td>III.6</td>
<td>CEA Procedures: 30-Day Mortality by Race</td>
<td>14</td>
</tr>
<tr>
<td>Figure</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>III.7</td>
<td>CABG Procedures: 30-Day Mortality by Race</td>
<td>14</td>
</tr>
<tr>
<td>III.8</td>
<td>2001 Cardiovascular Surgery 30-Day Readmits by Race</td>
<td>15</td>
</tr>
<tr>
<td>III.9</td>
<td>Change in Cardiovascular Surgery Readmits, 1994-2001, by Race</td>
<td>16</td>
</tr>
<tr>
<td>IV.1</td>
<td>Ratio of Cardiovascular Surgery Discharge Rates by Medicaid Status:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-Dual/Dual</td>
<td>17</td>
</tr>
<tr>
<td>IV.2</td>
<td>CABG Procedures: Discharge Rate by Medicaid Eligibility Group</td>
<td>18</td>
</tr>
<tr>
<td>IV.3</td>
<td>Ratio of Cardiovascular Surgery Mortality Rates by Medicaid Status:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-Dual/Dual</td>
<td>18</td>
</tr>
<tr>
<td>IV.4</td>
<td>CABG Procedures: 30-Day Mortality by Medicaid Eligibility</td>
<td>19</td>
</tr>
<tr>
<td>IV.5</td>
<td>LEBY Procedures: 30-Day Mortality by Medicaid Eligibility</td>
<td>20</td>
</tr>
<tr>
<td>V.1</td>
<td>2001 Cardiovascular Surgery Discharge Rates by Age</td>
<td>21</td>
</tr>
<tr>
<td>V.2</td>
<td>Growth in Cardiovascular Surgery Discharge Rates by Age</td>
<td>21</td>
</tr>
<tr>
<td>VI.1</td>
<td>Differences in Cardiovascular Surgery Discharge Rates by Gender:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Male/Female</td>
<td>23</td>
</tr>
<tr>
<td>VI.2</td>
<td>Differences in Cardiovascular Surgery Mortality by Gender:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Male/Female</td>
<td>24</td>
</tr>
<tr>
<td>VI.3</td>
<td>Differences in Cardiovascular Surgery Readmits by Gender:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Male/Female</td>
<td>24</td>
</tr>
<tr>
<td>VII.1</td>
<td>2001 Cardiovascular Surgery Rates by Geographic Region</td>
<td>26</td>
</tr>
<tr>
<td>VII.2</td>
<td>Change in Cardiovascular Surgery Rates, 1994-2001, by Geographic Region</td>
<td>27</td>
</tr>
<tr>
<td>VII.3</td>
<td>2001 Cardiovascular Surgery Mortality by Geographic Region</td>
<td>27</td>
</tr>
<tr>
<td>VII.4</td>
<td>Change in Cardiovascular Surgery Mortality, 1994-2001, by Geographic Region</td>
<td>28</td>
</tr>
<tr>
<td>VII.5</td>
<td>2001 Cardiovascular Surgery Readmits by Geographic Region</td>
<td>29</td>
</tr>
<tr>
<td>VII.6</td>
<td>Change in Cardiovascular Surgery Readmits, 1994-2001, by Geographic Region</td>
<td>29</td>
</tr>
<tr>
<td>VIII.1</td>
<td>Differences in Cardiovascular Surgery Discharge Rates: Rural/Urban</td>
<td>30</td>
</tr>
<tr>
<td>VIII.2</td>
<td>Differences in Cardiovascular Surgery Mortality: Rural/Urban</td>
<td>31</td>
</tr>
<tr>
<td>VIII.3</td>
<td>Differences in Cardiovascular Surgery Readmits: Rural/Urban</td>
<td>31</td>
</tr>
</tbody>
</table>
Acknowledgments and Disclaimer

Mathematica Policy Research, Inc. (MPR) prepared this report under contract GS-10F-0050L, task order CMS-02-01175, with the Centers for Medicare & Medicaid Services. MPR would like to acknowledge the contribution of RTI International, which prepared the databases, draft Appendix B tables, and draft data processing documentation. We would also like to acknowledge the direction and comments of Lein Han, Neil Gittings, and Aaron Goldfarb of CMS. The report was prepared by Robert Schmitz, Angela Merrill, Amy Quinn, Randall Brown, Daryl Hall, and Alfreda Holmes of MPR and by Christina Park of Anasys, Inc.

Opinions and interpretations expressed herein are not necessarily the position of CMS or any other federal agency.
BACKGROUND

The Medicare Quality Monitoring System (MQMS) is an ongoing system that processes, analyzes, interprets and disseminates health related data to monitor the quality of care delivered to Medicare fee-for-service beneficiaries. The MQMS was initiated to provide useful information to the CMS PROs (Peer Review Organizations, currently renamed as Quality Improvement Organizations) program and has been evolved to address growing public concerns over quality of care, patient safety, provider accountability and patient choice. It is directed by the Centers for Medicare & Medicaid Services (CMS) with assistance from its contractors. MQMS development and production involves a diverse group of CMS staff, including program managers, clinical area team leaders (clinicians), epidemiologists, statisticians, and data analysts in the central and regional offices. CMS also consulted with leading experts in other federal agencies—such as the Agency for Health Care Research and Quality, the Centers for Disease Control—and in quality improvement organizations and academia.

INTENDED USE OF THE MQMS DATA

The MQMS is designed with the intention to support data-driven decision-making regarding quality improvement and payment/coverage policymaking. Development and production of the 2003 MQMS measures and respective methodologies were primarily aiming at providing input for broad and high-level policy making and program planning within CMS.

The 2003 MQMS describes trends, patterns, and variations in health status, disease- and procedure-specific utilization, outcomes and process of care at the national and state level that are related to CMS quality improvement program and initiatives, patient safety and payment/coverage policies. Without further analysis and manipulation of the data, the 2003 MQMS data are inadequate to explain the specific causes of the trends, patterns, and variations.

In addition to CMS internal use, MQMS provides data on Medicare quality of care for the AHRQ National Healthcare Quality Report (NHQR) and National Healthcare Disparities Report (NHDR).
Specifically the MQMS data are to be used for:

- Identifying potential quality problems
- Tracking program implementation
- Suggesting project ideas for quality improvement program
- Targeting interventions
- Prioritizing activities & allocation of resources
- Focusing on a particular problem
- Raising research questions/hypothesis for further investigation

Further well-deliberated multivariate analysis is required for the MQMS data to be meaningful and useful for:

- Drawing conclusions on cause-effect association between the QIOs process of care measures with the MQMS outcome measures
- Evaluating individual QIO, providers in a state or state performance
- Evaluating directly the effectiveness of the QIO program and other CMS quality improvement initiatives and payment/coverage policies

**POPULATION AND HEALTH ISSUES EXAMINED**

The population under study consists of Medicare fee-for-service (FFS) beneficiaries. MQMS is limited to FFS beneficiaries because of the current unavailability of encounter data from Medicare managed care plans. The MQMS 2003 edition monitors the following types of quality measures:

- Mortality and readmission rates, length of stay, and cost of hospitalizations for three conditions —acute myocardial infarction (AMI), heart failure and stroke
- Process of care and progression of diseases for diabetes
- Mortality and readmission rates following cancer-related and cardiac-related high-risk surgical procedures
- Patient safety
- Preventable hospitalization

**METHODS**

The 2003 MQMS analysis is limited to the national and/or state level, presenting longitudinal and/or cross-sectional descriptive statistics for various demographic and geographic subgroups. The results of MQMS 2003 edition are age-sex adjusted and not
risk adjusted. The age-sex adjustment eliminates state-to-state and year-to-year variations in the age and sex composition but not the comorbidities or severity of illness of the population. The age-sex adjusted data preclude interpretation alluding to state or provider performance.

MQMS results are based on data from all fee-for-service beneficiaries and claims, rather than a sample of such beneficiaries and claims. This means that the rates presented in MQMS reports do not contain sampling error. MQMS rates are not presented with confidence intervals or significance testing, since these intervals and tests are based on properties of sampling error. This approach implies that the FFS population is not interpreted as a sample drawn from a super-population, such as all Medicare beneficiaries or FFS beneficiaries from another time period. The one exception is the MQMS diabetes results, which are based on a five percent sample of full-year fee-for-service Medicare beneficiaries. Thus, rates presented in the MQMS diabetes reports are subject to sampling error, and confidence intervals or significance testing are presented.

MQMS results are subject to measurement error in the CMS Denominator File and MedPAR database, as well as to modeling error resulting from the age-sex adjustment. CMS continues to investigate the magnitude of these errors.

PRODUCTS

The MQMS products are a series of reports on quality measures, a set of tables on CMS’ web site, plus the data files at the person and aggregate level used to generate the reports and documentation of the methodology and data processing. The reports are available on the CMS website; the data files and documentation reside on the CMS mainframe. To facilitate the use of the data and replication of the analysis, CMS makes available SAS programs and data processing documentation. Access to the data can be granted to CMS analysts on request. Other federal agencies and CMS contractors may obtain the data through a formal data request process.

MQMS 2003 reports include:


About MQMS
• MQMS Report: Diabetes, 1992-2001
EXECUTIVE SUMMARY

This report presents discharge rates, mortality rates and readmission rates for six surgical procedures on the heart and circulatory system. The procedures are abdominal aortic aneurysm (AAA) repair, carotid endarterectomy (CEA), coronary artery bypass graft (CABG), lower extremity vascular bypass (LEBY), aortic valve replacement and mitral valve replacement. The procedures are identified from discharge records for Medicare beneficiaries discharged from tertiary care hospitals between the years 1992 and 2001.

These procedures were selected for presentation in the MQMS because they are common, they are intended to cure disease or prolong life and there is a substantial risk of dying after the procedure. These characteristics make mortality following the procedure a useful measure of quality.

We track three measures for each of the surgeries. The measures are the rate at which beneficiaries receive the procedure, the rate at which procedures result in death within 30 days following the procedure, and the rate at which discharge is followed by readmission to the hospital within 30 days of discharge. Besides national, state, and regional rates, the report presents the following demographic subgroups:

- Medicare eligibility status
- Race
- Medicaid eligibility (dual eligibility)
- Age
- Gender
- Rural and urban residence

Though the procedures are performed often, we wish to be able to detect trends and long-term differences in the 3 measures rather than temporary fluctuations. For that reason, we follow 3-year moving averages of the measures. We use the average of the rate for the index year and the 2 preceding years as measures. We also adjust all rates for the age and sex composition of the denominator. National rates and rates for national subgroups are adjusted by the direct method. State rates are adjusted by the indirect method.
National Results

The rates of four procedures, CEA, AAA repair, CABG and LEBY all peak in the late 1990’s before declining into the 2000’s. CABG was the most common of these procedures in 2001, with a volume of 4.8 per thousand in our population. Aortic and mitral valve procedures were the least common.

Death rates for these procedures ranged from 18 per thousand for CEA to 158 per thousand for mitral valve repairs in 2001. The two heart valve procedures are most risky, aortic valve replacement was responsible for 96 and mitral valve replacement for 158 deaths per thousand. Mortality for all procedures fell from the beginning to the end of the study period. The greatest proportional declines affected CABG, CEA and mitral valve replacement, decreasing between 10 and 15 percent.

By contrast with mortality, readmission rates have been increasing throughout the nineties for all procedures but CEA. The change may reflect changing management strategy as length of stay is shortened and recovery is pursued at home. As with their mortality risk, valve replacements had the highest risk of 30-day readmission.

Medicare Eligibility Results

Except for LEBY, discharge rates for all surgeries were substantially higher for ESRD than for aged and disabled. ESRD discharge rates exceeded aged by 60 percent (CEA) to 250 percent (mitral valve replacement). In 2001, aged rates exceeded disabled by 100 percent (CABG and mitral valve replacement) to 300 percent (AAA repair). CEA and aortic valve and mitral valve replacement rates increased by more than 50 percent between 1994 and 2001.

CABG rates for beneficiaries with ESRD exceeded aged rates by more than 2 to 1. Twelve per thousand with ESRD received CABG in 2001, more than one percent of all ESRD beneficiaries. CABG rates for Medicare beneficiaries with ESRD increased by nearly 25 percent between 1994 and 2001, from 9.6 to 12.0 per thousand, while aged rates increased from 5.1 to 5.5, and disabled rates decreased from 3.0 to 2.7. ESRD patients’ discharge rates increased most of all eligibility groups, for CEA, CABG and aortic and mitral valve replacement.

Risk of death was uniformly highest for beneficiaries with ESRD who received one of these surgeries. Mortality rates for ESRD exceeded aged rates by 50 to 100 percent for most procedures (except AAA repair). Disabled mortality was the lowest of all eligibility groups for all procedures.

While mortality for aged and disabled decreased, ESRD mortality for AAA repair, CEA, and CABG increased more than 20 percent between 1994 and 2001. Mortality rates for valve replacements improved least for the disabled compared to other eligibility groups.
Except for CEA, with a readmission rate of 300 per thousand, and LEBY, which is too rarely performed on patients with ESRD to report mortality, between one third and one half of ESRD undergoing any of these procedures in 2001 returned to the hospital within 30 days.

Results by Race

Black discharge rates were lowest of all races for all of the surgeries we monitored, except LEBY. In 2001, whites’ discharge rates exceeded blacks’ by factors ranging from 70 percent for mitral valve replacement and CABG to 175 percent for CEA.

Racial disparities in discharge rates decreased during the 1990s for all of the procedures that favor whites. Between 1994 and 2001, white CABG rates increased by less than 10 percent, from 4.6 to 5.1, while black rates increased from 1.9 to 2.7.

Both black and white discharge rates for CEA increased during the 1990’s. White rates peaked in 1997 and began to decline, while black rates continued to climb. The ratio of white to black CEA rates declined only slightly from a ratio slightly above 3 to 1 to its current level.

White discharge rates for AAA repair fell from 0.8 to 0.7, while black rates remained approximately the same, at 0.3.

Blacks’ mortality rates in 2001 exceeded whites’ for all procedures but LEBY, and were the highest of all racial groups for AAA repair, CEA and aortic valve repair.

CEA mortality for all racial groups declined during the 1990s. The fall in black mortality exceeded the fall in white mortality, dropping from 29 to 24 per thousand, while white mortality fell from 20 to 17.

White mortality rates fell for all procedures between 1994 and 2001, while black rates increased for aortic valve replacement, LEBY and CABG. White CABG mortality fell from 63 to 54 per thousand, while black mortality remained approximately the same, 59 in 1994, and 60 in 2001. The similarity of black CABG mortality in 1994 and 2001 is deceptive because the rate in 1994 was anomalously low. In 1996, the black rate was 68, and it exceeded the white rate in every year after 1994.

Black readmission rates exceeded white rates for all surgeries except mitral valve replacement in both 1994 and 2001. The disparity in black and white readmission rates increased for LEBY, AAA repair and CABG. While white readmission rates for these procedures increased about 10 percent, black rates increased 20 percent or more.

Results by Medicaid Eligibility

Except for LEBY, surgical discharge rates for the non-dually eligible were 15 to 45 percent higher than rates for duals from 1994 to 2001. Dual and non-dual discharge rates
for mitral valve replacement, AAA repair, CEA and CABG converged during the 1990s. CABG discharge rates for duals increased over 25 percent, from 3.4 to 4.4, while non-dual discharge rates increased from 4.4 to 4.8.

Mortality rates for non-duals receiving CABG declined by nearly 20 percent, from 64 to 54, while dual mortality decreased much less, from 61 to 59. Between 1994 and 2001, LEBY mortality for non-duals fell over 10 percent, from 53 to 47, while mortality of duals remained at 45.

AAA mortality rates were substantially higher for duals than for non-duals in both 1994 and 2001. During those years, non-dual mortality fell from 64 to 42 per thousand, while dual mortality decreased less, from 81 to 74.

Rates by Age

In 2001, CABG was the most frequently performed procedure for beneficiaries under age 85. Over age 85, CEA and LEBY were more frequently performed than was CABG.

All six surgeries were performed on an older mix of beneficiaries in 2001 than in 1994. Discharge rates for four surgeries, CABG, CEA and aortic and mitral valve replacements increased by 50 percent among beneficiaries age 80 to 84 and by 150 percent among beneficiaries who were 90 to 94.

Rates by Gender

Except for mitral valve replacement, males’ discharge rates were substantially greater than females’ rates. Males’ 2001 AAA repair rate was over 300 percent higher than females’. Disparities between males and females in AAA repair, CABG and CEA decreased during the 1990s. The male discharge rate for AAA fell from 1.3 to 1.1 per thousand, while the female rate remained at 0.3.

Mortality rates for four surgeries, AAA repair, CABG and aortic and mitral valve replacement, were 15 to 33 percent lower for males than females during the 1990s. LEBY mortality rates of males exceeded female rates.

For these same four surgeries (AAA repair, CABG and aortic and mitral valve replacement), readmission rates for males were 10 to 20 percent lower than for females. Only CEA readmission rates were higher for males than for females.

Regional Results

Among U.S. regions in 2001, discharge rates for AAA repair, CABG, CEA and LEBY were lowest in the West. From 1994 to 2001, regional discharge rates for these surgeries were lowest in the West in every year, except 1994, when the western CEA rate exceeded the northeastern rate. Regional discharge rates for both CEA and CABG were highest in the South during the period from 1994 to 2001.
Between 1994 and 2001, CEA discharges increased by 40 percent or more in all regions except the West, where they increased by 17 percent. AAA and LEBY discharge rates decreased in all regions. Decreases in AAA repair ranged from 6 percent in the Midwest to 25 percent in the West. Other procedures’ discharge rates increased in all regions.

In 2001, regional aortic and mitral valve replacement mortality rates were highest in the South. CABG mortality varied substantially among U.S. regions in that year, ranging from 42 per thousand in the Northeast to 62 in the West. Between 1994 and 2001, CABG mortality decreased by over 30 percent in the Northeast, from 62 to 42 per thousand, more than twice the decline in any other region.

Readmission rates increased in all regions from 1994 to 2001, for all procedures except CEA.

Results for Rural and Urban Areas

In 2001, discharge rates for rural residents exceeded urban rates by 10 percent or more for AAA repair, CEA and CABG. Urban mitral valve replacement and LEBY rates were higher than rural. From 1994 to 2001, rural discharge rates increased relative to urban rates for all procedures.

In 2001, urban mortality rates for LEBY exceeded rural rates by 10 percent. Mortality rates for other procedures differed little between rural and urban residents.

Except for mitral valve replacement, for which rural readmission rates were 10 to 20 percent higher than urban, readmission rates differed little between rural and urban residents during the 1990s. Readmissions increased at similar rates for both rural and urban residents.
MEDICARE QUALITY MONITORING SYSTEM (MQMS) REPORT:

OUTCOMES OF VASCULAR AND CARDIAC SURGERIES

This report presents discharge rates, mortality rates and readmission rates for six surgical procedures on the heart and circulatory system. The procedures are abdominal aortic aneurysm (AAA) repair, carotid endarterectomy (CEA), coronary artery bypass graft (CABG), lower extremity vascular bypass (LEBY), aortic valve replacement and mitral valve replacement. The procedures are identified from discharge records for Medicare beneficiaries discharged from tertiary care hospitals between the years 1992 and 2001. The criteria used to identify the procedures and the subject population are shown in Appendix A.

These surgical procedures are responsible for about 4 percent of the discharges and 10 percent of the costs incurred by Medicare, so that their effectiveness is an important indicator of the effectiveness of that program’s investment in health care. They are procedures that are often performed for non-emergency admissions, so that the hospital where they are performed is determined not only by geography but by choice, of the patient or their physician. They are also procedures for which researchers have found volume and mortality to be inversely related. The implication of the volume-mortality relationship is that choosing the correct provider can increase the patient’s odds of survival. That makes the outcomes of these procedures candidates for public reporting at the hospital level.

These procedures were selected for presentation in the MQMS because they are common, they are intended to cure disease or prolong life and there is a substantial risk of dying after the procedure. These characteristics make mortality following the procedure a useful measure of quality.

We track three measures for each of the surgeries. The measures are the rate at which beneficiaries receive the procedure, the rate at which procedures result in death within 30 days following the procedure, and the rate at which discharge is followed by readmission to the hospital within 30 days of discharge. Discharge rates are useful because they tell us how many of the procedures are being performed and their overall impact on the system. They also tell us who is getting the procedures, and thus possibly
whether there are access barriers or overuse in some population subgroups. Mortality within 30 days is an indication that the procedure has not achieved its objective. National mortality rates tell us the overall effectiveness or riskiness of the procedure while the mortality rates of subgroups alert us to variations in the effectiveness with which treatment is provided. Readmission rates are important indicators of the resource cost of the procedure and may be indicative of variations in the effectiveness with which it is performed.

Besides national, state and regional rates, the report presents the following demographic subgroups:

- Medicare eligibility status
- Race
- Medicaid (dual) eligibility
- Gender
- Age
- Rural and Urban residence

Variations in procedure rates and outcomes in any of these groups may be indications of variations in access or variations in the quality of care received.

Though the procedures are performed often, we wish to be able to detect trends and long-term differences in the 3 measures rather than temporary fluctuations. For that reason, we follow 3-year moving averages of the measures. We use the average of the rate for the index year and the 2 preceding years as measures. In the report, when we reference a particular year, we are actually referring to 3 years of data. Thus, the reported value for 2001 covers the years 1999 through 2001 and the value for 1994 includes 1992 through 1994.

We also adjust all rates for the age and sex composition of the denominator. National rates and rates for national subgroups are adjusted by the direct method. State rates are adjusted by the indirect method. In both cases, when the number of discharges or outcomes to be presented falls below 25, we do not report it. State, regional and rural/urban designations refer to the patient’s place of residence.

Results are presented in four graphical forms. Some rates are shown in graphs depicting the 3-year moving average of each year from 1994 to 2001. Other graphs depict only the 3-year average in 2001, the most recent year of this report. These graphs are broken down by patient subgroup, and present vertical bars for each procedure and subgroup. Another type of graph shows the percentage change in 3-year rates between 1994 and 2001, also broken down by procedure and subgroup. The last type of graph shows the ratio of two subgroups’ 3-year averages. A ratio of one means that rates for
the two subgroups are equal. A ratio of greater than one means that the rate for the first named subgroup is higher than the rate of the second.

We do not report measures adjusted for the patient’s clinical condition at the time of admission. The national and state rates we are presenting are indicative of the national or state system’s performance rather a hospital’s. For that reason, the patient’s condition on admission is as important an indicator of system performance as the hospital’s and physician’s ability to overcome the problems of the individual patients presented to them.

The following sections describe key results. Detailed tables showing breakdowns for each measure by year and by subgroup and state are found in Appendix B.
I. NATIONAL RESULTS

A. DISCHARGE RATES

The rates of four procedures, CEA, AAA repair, CABG and LEBY all peak in the late 1990’s before declining into the 2000’s. Declines for AAA repair, CABG and LEBY may reflect partial displacement by less invasive procedures. By contrast, CEA declined after a rapid expansion during the 1990’s, when the indications for the procedures were expanded in response to clinical trials. The increase was observed by Hsia, Moscoe and Krushat between 1989 and 1996 (1998). Despite the concave shape of their growth curves, CABG and CEA rates in 2001 were higher than in 1994, while LEBY and AAA repair rates were lower.

CABG was the most common of these procedures in 2001, with a volume of 4.8 per thousand in our population. Aortic and mitral valve procedures were the least common.
B. MORTALITY RATES

Figure I.2. Cardiovascular Procedures: Three-Year Average 30-Day Mortality per 1000 Beneficiaries

Death rates ranged from 18 per thousand for CEA to 158 per thousand for mitral valve repairs. The death rates reported for Medicare beneficiaries are similar to those reported in other sources such as Birkmeyer et al. (2002), though slightly less because their calculations include death in the original hospital stay, even if it occurs more than thirty days after surgery. CEA mortality from the beginning of the period is higher than that observed by Wennberg et al (1998) in “trial hospitals” (participants in CEA clinical trials) and in non-trial hospitals in 1992 and 1993 and McBean and Gornick (1994) among Medicare beneficiaries in 1992. The difference may reflect age-sex adjustment to a 1999 population, when an older higher risk population received the procedure. The two heart valve procedures are most risky, responsible for 96 and 158 deaths per thousand in 2001.

Mortality for all procedures fell from the beginning to the end of the study period. The greatest proportional declines affected CABG, CEA and mitral valve replacement, which decreased between 10 and 15 percent. During this period Goodney et al. (2002) also observed significant declines in mortality for these procedures among the six monitored here.
C. READMISSION

By contrast with mortality, admission rates have been increasing throughout the nineties. The change may reflect in part changing management strategy as length of stay is shortened and recovery is pursued at home. The risk of readmission within thirty days was greatest for the valve repairs as was mortality risk.
II. MEDICARE ELIGIBILITY RESULTS

A. DISCHARGE RATES

Figure II.1. 2001 Cardiovascular Surgery Rates by Medicare Eligibility Status

Except for LEBY, discharge rates for all surgeries were substantially higher for ESRD than for aged and disabled. ESRD discharge rates exceeded aged by 60 percent (CEA) to 250 percent (mitral valve replacement). In 2001, aged rates exceeded disabled by 100 percent (CABG and mitral valve replacement) to 300 percent (AAA repair). CEA and aortic valve and mitral valve replacement rates increased by more than 50 percent between 1994 and 2001. CABG rates for beneficiaries with ESRD exceeded aged rates by more than 2 to 1. Twelve per thousand received CABG in 2001, more than one percent of all ESRD beneficiaries.
CABG rates for Medicare beneficiaries with ESRD increased by nearly 25 percent between 1994 and 2001, from 9.6 to 12.0 per thousand, while aged rates increased from 5.1 to 5.5, and disabled rates decreased from 3.0 to 2.7. ESRD patients’ discharge rates increased most of all eligibility groups, for CEA, CABG and aortic and mitral valve replacement.

B. MORTALITY RATES

Figure II.3. 2001 Cardiovascular Surgery 30-Day Mortality by Medicare Eligibility Status
Risk of death was uniformly highest for beneficiaries with ESRD who received one of these surgeries. Mortality rates for ESRD exceeded aged rates by 50 to 100 percent for most procedures (except AAA repair). Disabled mortality was the lowest of all eligibility groups for all procedures.

Figure II.4. Change in Cardiovascular Surgery Mortality, 1994-2001, by Medicare Eligibility

While mortality for the aged and disabled decreased, ESRD mortality for AAA repair, CEA, and CABG increased more than 20 percent between 1994 and 2001. Mortality rates for valve replacements improved least for the disabled compared to other eligibility groups.
C. READMISSION RATES

Figure II.5. 2001 Cardiovascular Surgery 30-Day Readmits by Medicare Eligibility Status

Except for CEA, with a readmission rate of 300 per thousand, and LEBY, which is too rarely performed on ESRD to report rates, between one third and one half of beneficiaries with ESRD undergoing any of these procedures in 2001 returned to the hospital within 30 days.

Figure II.6. Change in Cardiovascular Surgery Readmits, 1994-2001, by Medicare Eligibility

Readmission for all eligibility groups increased for all procedures but CEA.

MQMS: Outcomes of Vascular and Cardiac Surgeries
III. RESULTS BY RACE

A. DISCHARGE RATES

Figure III.1. 2001 Cardiovascular Surgery Rates by Race

Black discharge rates were lowest of all races for all of the surgeries we monitored, except LEBY. In 2001, whites’ discharge rates exceeded blacks’ by factors ranging from 70 percent for mitral valve replacement and CABG to 175 percent for CEA.

Figure III.2. Change in Cardiovascular Surgery Rates, 1994-2001, by Race
Racial disparities in discharge rates decreased during the 1990s for all of the procedures that favor whites. Between 1994 and 2001, white CABG rates increased by less than 10 percent, from 4.6 to 5.1, while black rates increased 43 percent from 1.9 to 2.7.

**Figure III.3. CEA Procedures: Discharge Rate by Race**

Both black and white discharge rates for CEA increased during the 1990’s. White rates peaked in 1997 and began to decline, while black rates continued to climb. The ratio of white to black CEA rates declined only slightly from a ratio slightly above 3 to 1 in 1994 to slightly below 3 to 1 in 2001

White discharge rates for AAA repair fell from 0.8 to 0.7, while black rates remained approximately the same, at 0.3 (not shown).
B. MORTALITY RATES

Figure III.4. 2001 Cardiovascular Surgery 30-Day Mortality by Race

Black mortality rates in 2001 exceeded whites’ for all procedures but LEBY, and were the highest of all racial groups for AAA repair, CEA and aortic valve repair. Findings are consistent with a number of other studies that found black CEA (Kennedy, 2002; McBean and Gornick, 1994) and CABG (Bridges et al., 2000; Hartz et al., 2001) mortality higher than white.

Figure III.5. Change in Cardiovascular Surgery Mortality, 1994-2001, by Race
White mortality rates fell for all procedures during the 1990s, while black rates increased for aortic valve replacement, LEBY and CABG.

Figure III.6. CEA Procedures: 30-day Mortality by Race

CEA mortality of all racial groups declined during the 1990s. The fall in black mortality exceeded the white, falling from 29 to 24 per thousand, while white mortality fell from 20 to 17.

Figure III.7. CABG Procedures: 30-Day Mortality by Race
White CABG mortality fell from 63 to 54 per thousand, while black mortality remained approximately the same, 59 in 1994, and 60 in 2001. The similarity of black rates in 1994 and 2001 is deceptive because the rate in 1994 was anomalously low. In 1996, the black rate was 68, and it exceeded the white rate in every year after 1994.

C. READINGMISSION RATES

Figure III.8. 2001 Cardiovascular Surgery 30-Day Readmits by Race

![Readmission Rates Graph]

Black readmission rates exceeded white rates for all surgeries except mitral valve replacement in both 1994 and 2001.
The disparity in black and white readmission rates increased for LEBY, AAA repair and CABG. While white readmission rates for these procedures increased about 10 percent, black rates increased 20 percent or more.
IV. RESULTS BY MEDICAID ELIGIBILITY

A. DISCHARGE RATES

Figure IV.1. Ratio of Cardiovascular Surgery Discharge Rates by Medicaid Status: Non-dual/dual

Except for LEBY, surgical discharge rates for the non-dually eligible were 15 to 45 percent higher than rates for duals. Dual and non-dual discharge rates for mitral valve replacement, AAA repair, CEA and CABG converged during the 1990s (that is, the ratio of rates for non-duals and duals approached one).
CABG discharge rates for duals increased over 25 percent, from 3.4 to 4.4, while non-dual discharge rates increased from 4.4 to 4.8.

B. MORTALITY RATES

Figure IV.3. Ratio of Cardiovascular Surgery Mortality Rates by Medicaid Status: Non-dual/dual
AAA mortality rates were substantially higher for duals than for non-duals in both 1994 and 2001. During those years, non-dual mortality fell from 64 to 42 per thousand, while dual mortality decreased less, from 81 to 74, again, lowering the ratio of mortality rates.

Figure IV.4. CABG Procedures: 30-day Mortality by Medicaid Eligibility

Mortality rates for non-duals receiving CABG declined by nearly 20 percent, from 64 to 54, while dual mortality decreased much less, from 61 to 59, leading to a declining ratio of non-dual to dual post-CABG mortality rate.
Between 1994 and 2001, LEBY mortality for non-duals fell over 10 percent, from 53 to 47, while mortality of duals remained at 45, leading to a similar decline in the ratio of mortality rates.
V. RATES BY AGE

A. DISCHARGE RATES

Figure V.1. 2001 Cardiovascular Surgery Discharge Rates by Age

In 2001, CABG was the most frequently performed procedure for beneficiaries under age 85. Over age 85, CEA and LEBY were more frequently performed than was CABG.

Figure V.2. Growth in Cardiovascular Surgery Discharge Rates by Age

MQMS: Outcomes of Vascular and Cardiac Surgeries
All six surgeries were performed on an older mix of beneficiaries in 2001 than in 1994. Discharge rates for four surgeries, CABG, CEA and aortic and mitral valve replacements increased by 50 percent among beneficiaries age 80 to 84 and by 150 percent among beneficiaries who were 90 to 94.
VI. RATES BY GENDER

A. DISCHARGE RATES

Figure VI.1. Differences in Cardiovascular Surgery Discharge Rates by Gender: Male/Female

Except for mitral valve replacement, males’ discharge rates were substantially greater than females’ rates. Males’ 2001 AAA repair rate was over four times higher than females’.

The disparity in AAA repair decreased from 1994 to 2001. The male discharge rate for AAA fell from 1.3 to 1.1 per thousand, while the female rate remained at 0.3 (not shown).

CABG and CEA disparities also decreased during the 1990s. From 1994 to 2001, the male discharge rate for CABG rose from 6.6 to 7.2 while the female rate rose proportionally more, from 2.6 to 3.0 (not shown). Meanwhile, the male discharge rate for CEA went from 2.8 to 3.9 and the female rate rose from 1.5 to 2.2 (not shown). The decreasing disparity in CABG rates has also been observed by Ferguson et al. (2002), who reported proportions of 25.7 percent of CABGs received by women in 1990 and 28.7 percent in 1999.
B. MORTALITY RATES

Figure VI.2. Differences in Cardiovascular Surgery Mortality by Gender: Male/female

Mortality rates for four surgeries, AAA repair, CABG and aortic and mitral valve replacement, were 15 to 33 percent lower for males than females during the 1990s. LEBY mortality rates of males exceeded female rates.

C. READMISSION RATES

Figure VI.3. Differences in Cardiovascular Surgery Readmits by Gender: Male/female
For these same four surgeries (AAA repair, CABG and aortic and mitral valve replacement), readmission rates for males were 10 to 20 percent lower than for females, leading to ratios of less than one. Only CEA readmission rates were higher for males than for females.
VII. REGIONAL RESULTS

A. DISCHARGE RATES

Figure VII.1. 2001 Cardiovascular Surgery Rates by Geographic Region

Among U.S. regions in 2001, discharge rates for AAA repair, CABG, CEA and LEBY were lowest in the West. From 1994 to 2001, regional discharge rates for these surgeries were lowest in the West in every year, except 1994, when the western CEA rate exceeded the northeastern rate. Regional discharge rates for both CEA and CABG were highest in the South during this period.
Between 1994 and 2001, CEA discharges increased by 40 percent or more in all regions except the West, where they increased by 17 percent. AAA and LEBY discharge rates decreased in all regions, with AAA repair decreases ranging from 6 percent in the Midwest to 25 percent in the West. Other procedures’ discharge rates increased in all regions.

B. MORTALITY RATES

Figure VII.3. 2001 Cardiovascular Surgery Mortality by Geographic Region
In 2001, regional aortic and mitral valve replacement mortality rates were highest in the South. CABG mortality varied substantially among U.S. regions in that year, ranging from 42 per thousand in the Northeast to 62 in the West.

Figure VII.4. Change in Cardiovascular Surgery Mortality, 1994-2001, by Geographic Region

Between 1994 and 2001, CABG mortality decreased by over 30 percent in the Northeast, from 62 to 42 per thousand, more than twice the decline in any other region.
C. READMISSION RATES

Figure VII.5. 2001 Cardiovascular Surgery Readmits by Geographic Region

In 2001, readmission rates were lowest in the West for all six procedures.

Figure VII.6. Change in Cardiovascular Surgery Readmits, 1994-2001, by Geographic Region

Readmission rates increased in all regions from 1994 to 2001, for all procedures except CEA.

MQMS: Outcomes of Vascular and Cardiac Surgeries
VIII. RESULTS FOR URBAN AND RURAL AREAS

A. DISCHARGE RATES

In 2001, discharge rates for rural residents exceeded urban rates by 10 percent or more for AAA repair, CEA and CABG. Urban mitral valve replacement and LEBY rates were higher than rural. From 1994 to 2001, rural discharge rates increased relative to urban rates for all procedures.
B. MORTALITY RATES

Figure VIII.2. Differences in Cardiovascular Surgery Mortality: Rural/urban

In 2001, urban mortality rates for LEBY exceeded rural rates by 10 percent. Mortality rates for other procedures differed little between rural and urban residents.

C. READMISSION RATES

Figure VIII.3. Differences in Cardiovascular Surgery Readmits: Rural/urban

Except for mitral valve replacement, for which rural readmission rates were 10 to 20 percent higher than urban, readmission rates differed little between rural and urban
residents during the 1990s. Readmissions increased at similar rates for both rural and urban residents.
IX. DISCUSSION

These findings suggest a number of areas for additional research. The declining mortality across all surgeries is a striking result and future research should investigate the reasons for it. The reasons for and implications of the West’s differing practice style, with less surgery and fewer readmissions, should also be explored. The study period appears to be one of decreasing disparities by reason of gender, rural residence and race. Explaining the convergence of discharge rates is a potentially interesting subject of research. Mortality rates have not converged as discharge rates have. Future research should investigate whether this implies that quality of care, either inpatient or ambulatory, has lagged for blacks or women. The reason for the high and increasing surgery rates among ESRD patients with their high and increasing risk of mortality should be explored. Research is needed to learn whether the increase in surgeries is appropriate and what it implies about the way ESRD is managed.

A CMS panel was convened to review the surgeries chosen for MQMS, outcomes measures, risk-adjustment methods and analytic categories.

We first reviewed for the panel the reasons behind the selection of the surgeries included in the analysis. The cardiovascular procedures were chosen for a combination of frequency, resource cost, risk of mortality and policy sensitivity. We wanted procedures that could potentially be redirected by regulation or by public release of hospital information. These are also high volume, high cost surgeries. Surgeries often performed on a non-urgent basis can most easily be redirected because the outcome is not adversely affected by travel time. The panel did not recommend particular additional surgeries.

The panel discussed adjustment of outcomes by patient characteristics. We did not risk adjust cardiovascular outcomes, beyond age and sex adjustment, because we are not measuring hospital performance. A surgical outcome measure at the hospital level should be risk adjusted as much as possible. The panel recommended modeling the riskiness of patients, both for potential hospital reporting and to monitor how patient risk at the time of surgery has changed over time.

Though our volume-outcomes analysis was restricted to cancer surgeries, cardiovascular surgeries are far more common and the potential impact of policy for that reason is greater. Some on the panel believed that surgery monitoring should focus on the most frequently performed procedures, such as cardiovascular procedures. However, there are other considerations, such as risk of mortality and susceptibility of outcomes to improvement by policy or public reporting. It was observed that surgeon volume may be a better explanation of the volume mortality correlation for cardiovascular procedures than is hospital volume and that the volume of these procedures is not a candidate for public reporting at the hospital level for that reason. These factors favor some of the less frequently performed surgeries.
The increase in readmissions was especially large and consistent for cardiovascular procedures during the study period. Because of the potentially large resource costs of readmissions, the panel felt that monitoring of readmissions should occur in conjunction with length of stay and perhaps cost. Some on the panel also urged that readmission per cause be monitored because readmission for certain causes is more likely to be related to quality of care.

Some on the panel were concerned about presenting results based on the patient’s place of residence, as opposed to the location of the hospital where care was actually rendered. Discharge rates by patient residence tell us what kind of care patients in different regions are getting, and whether they appear to be receiving too much or not enough treatment depending on where they live. For example, the report indicates that rural residents are no less likely to receive these surgeries and that rural residents have increasing access to surgery.

Arguments for reporting by patient place of residence extend to outcomes. Patients can easily be referred across state lines for elective surgery. Thus, a measure of state performance, or of the performance of rural relative to urban regions, is how well patients or their doctors are doing in finding good hospitals for their care. Some panelists felt it to know where patients are being treated and whether patients at rural hospitals or the hospitals in particular states are doing well. Monitoring outcomes by hospital location is straightforward but suffers from the drawback that discharges cannot be monitored as population rates. We would have to monitor the total number of procedures or the proportion of all procedures performed by hospital location.
REFERENCES


APPENDIX A

MEASURE SPECIFICATIONS
## Appendix A: Measure Specifications

### A. DISCHARGE RATE, READMISSION RATE, AND MORTALITY RATE

<table>
<thead>
<tr>
<th>Measure</th>
<th>Rate of discharges from short-stay hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Case Definition</strong></td>
<td>Depends on the surgery. See Section B, which includes Case selection criteria for each surgery.</td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>Beneficiaries eligible for Medicare in January of each calendar year, enrolled in Part A for the full year, and not enrolled in Medicare managed care at any point in the year. Beneficiaries who died during the calendar year but who would have otherwise qualified are included.</td>
</tr>
</tbody>
</table>
| **Computation**               | Numerator: Number of surgical discharges in a 3-year period  
|                                | Denominator: Number of beneficiaries in the population in a 3-year period  
|                                | Rates are expressed in thousands. |
| **Rationale**                 | Description of surgery use |
| **Data Sources**              | MedPAR File  
|                                | Denominator File  
|                                | CMS Cross-Reference File |
| **Exclusions**                | Missing or invalid values for state, sex, race, Medicare Status  
|                                | Discharges from all hospitals other than short-stay hospitals  
|                                | Duplicate records  
|                                | Discharges from stand-alone emergency rooms  
|                                | Discharges with invalid procedure codes  
|                                | Discharges for Medicare beneficiaries whose Health Insurance Claim Number (HICNO) does not have a match in CMS’s Cross-Reference File  
|                                | Overlapping beneficiary acute-care, short-stay hospital claims |
### Adjustment
Rates are age/sex adjusted using the Medicare Part A FFS population as of July 1, 1999, as the standard population. National-level results are standardized with 18 age/sex groups using direct standardization. State-level results are standardized using indirect standardization, due to smaller sample sizes. Both methods are described in Anderson et al. (1998).

### Period

### Stratifiers
- **Age** (0-54, 55-64, 65-69, 70-74, 75-79, 80-84, 85-89, 90-94, 95+) on July 1 of the reference year.
- **Race** (white, black, other)
- **Sex**
- **Reason for Medicare eligibility** (aged without ESRD, disabled without ESRD, ESRD).
- **Dual enrollment** defined as enrolled in Medicare Part A and with Medicaid buy-in at least one month during the calendar year.*
- **Urban/rural** based on the metropolitan statistical area (MSA) and Bureau of Economic Analysis (BEA) State and County Crosswalk File developed for the CMS' Prospective Payment System. All counties in an MSA are designated as urban; all other counties are considered rural.
- **Census region** of the beneficiary’s residence on March 31 of the year following the reference year
- **State** of the beneficiary’s residence on March 31 of the year following the reference year

---

* The Medicare data do not record true dual enrollment status but only whether a state Medicaid program pays the beneficiary’s Medicare premiums, co-pays, and deductibles. The payment of these Medicare expenses by Medicaid does not always translate into full Medicaid coverage. Nevertheless, the buy-in indicator in the Medicare data is a reasonably accurate indicator of beneficiary poverty.
### Appendix A: Measure Specifications

<table>
<thead>
<tr>
<th><strong>Measure</strong></th>
<th>Beneficiary-level readmission rates following surgical discharges, by type of readmission (for all causes) within 30 days of discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Case Definition</strong></td>
<td>Depends on the surgery. See Section B, which includes Case selection criteria for each surgery.</td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>Medicare beneficiaries eligible for Medicare in January of each calendar year, and enrolled in Part A and FFS for the full calendar year, who had a discharge for the relevant. Beneficiaries who died during the calendar year but who would have otherwise qualified are included.</td>
</tr>
</tbody>
</table>
| **Computation** | **Numerator:** Number of beneficiaries hospitalized for all causes within 30 days of first surgical discharge in a year during a 3-year period  
**Denominator:** Number of beneficiaries with at least one surgical discharge in a year during a 3-year period  
Rates are expressed in thousands. Rates with numerators of 25 or less are suppressed in tables.  
Readmissions include same-day readmissions to the same facility. Maryland readmission rates may not be comparable to those in other states. Maryland is the only state with a waiver from the CMS's prospective payment system. Due to Maryland's all-payer system, transfers may have been counted as readmissions, inflating readmission rates, especially short-term rates.  
Rates do not include beneficiaries who entered managed care or died within the window follow-up period. |
| **Rationale** | Description of surgical outcomes |
| **Data Sources** | MedPAR File  
Denominator File  
CMS Cross-Reference File |
### Exclusions
- Missing or invalid values for state, sex, race, Medicare Status
- Discharges from all hospitals other than short-stay hospitals
- Duplicate records
- Discharges from stand-alone emergency rooms
- Discharges with invalid procedure codes
- Discharges for Medicare beneficiaries whose Health Insurance Claim Number (HICNO) does not have a match in CMS’s Cross-Reference File
- Overlapping beneficiary acute-care, short-stay hospital claims

### Adjustment
Rates are age/sex adjusted using the Medicare Part A FFS population as of July 1, 1999, as the standard population.

National-level results are standardized with 18 age/sex groups using direct standardization. State-level results are standardized using indirect standardization, due to smaller sample sizes. Both methods are described in Anderson et al. (1998).

### Period
<table>
<thead>
<tr>
<th>stratifiers</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>(0-54, 55-64, 65-69, 70-74, 75-79, 80-84, 85-89, 90-94, 95+) on July 1 of the reference year.</td>
</tr>
<tr>
<td>Race</td>
<td>(white, black, other)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Reason for Medicare eligibility</td>
<td>(aged without ESRD, disabled without ESRD, ESRD).</td>
</tr>
<tr>
<td>Dual enrollment</td>
<td>defined as enrolled in Medicare Part A and with Medicaid buy-in at least one month during the calendar year.*</td>
</tr>
<tr>
<td>Urban/rural</td>
<td>based on the metropolitan statistical area (MSA) and Bureau of Economic Analysis (BEA) State and County Crosswalk File developed for the CMS’ Prospective Payment System. All counties in an MSA are designated as urban; all other counties are considered rural.</td>
</tr>
<tr>
<td>Census region</td>
<td>of the beneficiary’s residence on March 31 of the year following the reference year</td>
</tr>
<tr>
<td>State</td>
<td>of the beneficiary’s residence on March 31 of the year following the reference year</td>
</tr>
</tbody>
</table>

* The Medicare data do not record true dual enrollment status but only whether a state Medicaid program pays the beneficiary’s Medicare premiums, co-pays, and deductibles. The payment of these Medicare expenses by Medicaid does not always translate into full Medicaid coverage. Nevertheless, the buy-in indicator in the Medicare data is a reasonably accurate indicator of beneficiary poverty.
## Measure

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality rates among beneficiaries with a surgical hospitalization</td>
<td></td>
</tr>
</tbody>
</table>

## Case Definition

Depends on the surgery. See Section B, which includes Case selection criteria for each surgery.

## Population

Medicare beneficiaries eligible for Medicare in January of each calendar year, and enrolled in Part A and FFS for the full calendar year, who had a discharge for the relevant. Beneficiaries who died during the calendar year but who would have otherwise qualified are included.

## Computation

<table>
<thead>
<tr>
<th>Numerator</th>
<th>Number of beneficiaries who died within 30 days from the day of the first (index) surgical procedure in the year during a 3 year period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denominator</td>
<td>Number of beneficiaries receiving surgery each year in a 3 year period</td>
</tr>
</tbody>
</table>

Rates are expressed in thousands. Rates with numerators of 25 or less are suppressed in tables.

Rate do not include beneficiaries who switched to managed care within the window follow-up period.

## Rationale

Description of surgical outcomes

## Data Sources

- MedPAR File
- Denominator File
- CMS Cross-Reference File

## Exclusions

- Missing or invalid values for state, sex, race, Medicare Status
- Discharges from all hospitals other than short-stay hospitals
- Duplicate records
- Discharges from stand-alone emergency rooms
- Discharges with invalid procedure codes
- Discharges for Medicare beneficiaries whose Health Insurance Claim Number (HICNO) does not have a match in CMS’s Cross-Reference File
- Overlapping beneficiary acute-care, short-stay hospital claims
### Adjustment

Rates are age/sex adjusted using the Medicare Part A FFS population as of July 1, 1999, as the standard population. National-level results are standardized with 18 age/sex groups using direct standardization. State-level results are standardized using indirect standardization, due to smaller sample sizes. Both methods are described in Anderson et al. (1998).

### Period


### Stratifiers

- **Age** (0-54, 55-64, 65-69, 70-74, 75-79, 80-84, 85-89, 90-94, 95+) on July 1 of the reference year.
- **Race** (white, black, other)
- **Sex**
- **Reason for Medicare eligibility** (aged without ESRD, disabled without ESRD, ESRD).
- **Dual enrollment** defined as enrolled in Medicare Part A and with Medicaid buy-in at least one month during the calendar year.*
- **Urban/rural** based on the metropolitan statistical area (MSA) and Bureau of Economic Analysis (BEA) State and County Crosswalk File developed for the CMS' Prospective Payment System. All counties in an MSA are designated as urban; all other counties are considered rural.
- **Census region** of the beneficiary’s residence on March 31 of the year following the reference year
- **State** of the beneficiary’s residence on March 31 of the year following the reference year

* The Medicare data do not record true dual enrollment status but only whether a state Medicaid program pays the beneficiary’s Medicare premiums, co-pays, and deductibles. The payment of these Medicare expenses by Medicaid does not always translate into full Medicaid coverage. Nevertheless, the buy-in indicator in the Medicare data is a reasonably accurate indicator of beneficiary poverty.
B. CASE SELECTION CRITERIA

AAA REPAIR

ICD-9-CM procedure codes:
38.44 RESECTION OF AORTA, ABDOMINAL WITH REPLACEMENT
39.25 AORTA-ILIAC-FEMORAL BYPASS

AND

ICD-9-CM diagnosis codes:
441.4 ABDOMINAL ANEURYSM WITHOUT MENTION OF RUPTURE
441.7 THORACOABDOMINAL ANEURYSM WITHOUT MENTION OF RUPTURE
AORTIC ANEURYSM OF UNSPECIFIED SITE WITHOUT MENTION OF RUPTURE

EXCLUDES

ICD-9-CM procedure codes:
38.45 RESECTION OF THORACIC VESSEL

ICD-9-CM diagnosis codes:
441.1 THORACIC ANEURYSM, RUPTURED
441.2 THORACIC ANEURYSM WITHOUT MENTION OF RUPTURE
441.3 ABDOMINAL ANEURYSM, RUPTURED
441.5 AORTIC ANEURYSM, OF UNSPECIFIED SITE, RUPTURED
441.6 THORACOABDOMINAL ANEURYSM, RUPTURED

CABG

ICD-9-CM procedure codes:
36.10 AORTOCORONARY BYPASS FOR HEART REVASCULARIZATION, NOS
AORTOCORONARY BYPASS OF ONE CORONARY ARTERY
AORTOCORONARY BYPASS OF TWO CORONARY ARTERIES
AORTOCORONARY BYPASS OF THREE CORONARY ARTERIES
AORTOCORONARY BYPASS OF FOUR OR MORE CORONARY ARTERIES
SINGLE INTERNAL MAMMARY-CORONARY ARTERY BYPASS
DOUBLE INTERNAL MAMMARY-CORONARY ARTERY BYPASS

EXCLUDES

ICD-9-CM procedure codes:
35.10 OPEN HEART VALVULOPLASTY WITHOUT REPLACEMENT, UNSPECIFIED VALVE
35.11 OPEN HEART VALVULOPLASTY OF AORTIC VALVE WITHOUT REPLACEMENT
35.12 OPEN HEART VALVULOPLASTY OF MITRAL VALVE WITHOUT REPLACEMENT
35.13 OPEN HEART VALVULOPLASTY OF PULMONARY VALVE WITHOUT REPLACEMENT
35.14 OPEN HEART VALVULOPLASTY OF TRICUSPID VALVE WITHOUT REPLACEMENT
35.20 REPLACEMENT OF UNSPECIFIED HEART VALVE
35.21 REPLACEMENT OF AORTIC VALVE WITH TISSUE GRAFT
35.22 OTHER REPLACEMENT OF AORTIC VALVE
35.23 REPLACEMENT OF MITRAL VALVE WITH TISSUE GRAFT
35.24 OTHER REPLACEMENT OF MITRAL VALVE
35.25 REPLACEMENT OF PULMONARY VALVE WITH TISSUE GRAFT
35.26 OTHER REPLACEMENT OF PULMONARY VALVE
35.27 REPLACEMENT OF TRICUSPID VALVE WITH TISSUE GRAFT
35.28 OTHER REPLACEMENT OF TRICUSPID VALVE

CEA

ICD-9-CM procedure codes:
38.12 ENDAR Terectomy, OTHER VESSELS OF HEAD AND NECK

Appendix A: Measure Specifications
LEBY

ICD-9-CM procedure codes:
OTHER (PERIPHERAL) VASCULAR SHUNT OR BYPASS

EXCLUDES

ICD-9-CM diagnosis codes:
444.21 ARTERIAL EMBOLISM AND THROMBOSIS OF ARTERIES, UPPER EXTREMITY

AORTIC VALVE REPLACEMENT

ICD-9-CM procedure codes:
REPLACEMENT OF AORTIC VALVE WITH TISSUE GRAFT
OTHER REPLACEMENT OF AORTIC VALVE

MITRAL VALVE REPLACEMENT

ICD-9-CM procedure codes:
REPLACEMENT OF MITRAL VALVE WITH TISSUE GRAFT
OTHER REPLACEMENT OF MITRAL VALVE