



ORIGINAL RESEARCH

Trends in Reoperative Coronary Artery Bypass Graft Surgery for Older Adults in the United States, 1998 to 2017

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BACKGROUND: The likelihood of undergoing reoperative coronary artery bypass graft surgery (CABG) is important for older patients who are considering first-time CABG. Trends in the reoperative CABG for these patients are unknown.

METHODS AND RESULTS: We used the Medicare fee-for-service inpatient claims data of adults undergoing isolated first-time CABG between 1998 and 2017. The primary outcome was time to first reoperative CABG within 5 years of discharge from the index surgery, treating death as a competing risk. We fitted a Cox regression to model the likelihood of reoperative CABG as a function of patient baseline characteristics. There were 1 666 875 unique patients undergoing first-time isolated CABG and surviving to hospital discharge. The median (interquartile range) age of patients did not change significantly over time (from 74 [69–78] in 1998 to 73 [69–78] in 2017); the proportion of women decreased from 34.8% to 26.1%. The 5-year rate of reoperative CABG declined from 0.77% (95% CI, 0.72%–0.82%) in 1998 to 0.23% (95% CI, 0.19%–0.28%) in 2013. The annual proportional decline in the 5-year rate of reoperative CABG overall was 6.6% (95% CI, 6.0%–7.1%) nationwide, which did not differ across subgroups, except the non-white non-black race group that had an annual decline of 8.5% (95% CI, 6.2%–10.7%).

CONCLUSIONS: Over a recent 20-year period, the Medicare fee-for-service patients experienced a significant decline in the rate of reoperative CABG. In this cohort of older adults, the rate of declining differed across demographic subgroups.

Key Words: older adults ■ reoperative CABG ■ trend

Survival after coronary revascularization procedures has steadily improved over time despite increasing patient complexity,^{1–3} but the long-term rate of reoperative coronary artery bypass graft surgery (CABG) and how it has changed over time remain unknown. Characterizing the rate of reoperative CABG after initial revascularization is important from a patient perspective, because CABG is associated with a long recovery time and the majority of patients prefer percutaneous coronary intervention (PCI) over CABG, even in a hypothetical scenario where PCI is associated with higher risks of death and repeat revascularization.^{4,5} Therefore, information regarding the

chance of undergoing reoperative CABG should be part of shared-decision making.⁶ However, evolution of this important outcome has only been characterized in a voluntary registry⁷ or within trial data.⁸

The role of reoperative CABG is limited to select situations, including when the disease is not amenable to PCI or in patients with an occluded internal mammary artery graft to the left anterior descending artery.⁹ Reoperative CABG is also recommended when there is an indication that patients with significant coronary disease require another open-heart operation. Patient populations with indications for reoperative CABG have likely changed substantially,

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CLINICAL PERSPECTIVE

What Is New?

- We characterized the contemporary rate of reoperative coronary artery bypass graft surgery within 5 years after the first-time coronary artery bypass graft surgery and its trend over a 20-year period.

What Are The Clinical Implications?

- Older adult patients undergoing first-time coronary artery bypass graft surgery can expect that the likelihood of having to undergo reoperative coronary artery bypass graft surgery is extremely low, with a 5-year rate of 0.2%.

Nonstandard Abbreviations and Acronyms

CABG	coronary artery bypass graft
CMS	Centers for Medicare & Medicaid Services
FFS	fee-for-service
PCI	percutaneous coronary intervention

because techniques for PCI have improved and transcatheter approaches to valve replacement have emerged.¹⁰ Furthermore, the operative mortality and morbidity of reoperative CABG are relatively high.^{11–14} It is therefore important to identify how the rate of reoperative CABG evolved over time and what contemporary rates are.

In this study, we aimed to characterize the long-term rate of reoperative CABG in older adults, to assess the trends in the rate of reoperative CABG over 20 years, and whether the rate differed across patient subgroups.

METHODS

The Yale University Institutional Review Board reviewed the study protocol and granted a waiver of informed consent for the use of the de-identified database. Restricted by our Data Use Agreement with the Centers for Medicare & Medicaid Services (CMS), the Medicare data used for this study cannot be made publicly available to other researchers for purposes of reproducing the results or replicating the procedure. However, Medicare data are available from CMS via the Researcher Data Assistance Center upon request (https://www.cms.gov/Research-Statistics-Data-and-Systems/Files-for-Order/Data-Disclosures-Data-Agreements/DUA_-_Forms.html).

Data Source and Patients

We used Medicare inpatient fee-for-service (FFS) claims data from the Centers for Medicare & Medicaid Services (CMS) to identify Medicare patients aged ≥ 65 years who underwent isolated CABG during an acute care hospitalization in the United States from January 1, 1998 through December 31, 2017, based on the *International Classification of Diseases, Ninth and Tenth Revisions, Clinical Modification (ICD-9 CM and ICD-10 CM)* procedure codes (Table S1). There were 2 131 269 individuals who underwent CABG, of whom 1 666 875 underwent isolated, nonconcomitant, first-time CABG and were discharged alive. We excluded patients with evidence of prior CABG, including those with prior Medicare FFS hospitalization for CABG before the index CABG hospitalization or having the diagnosis code indicating the past history of CABG at the time of first CABG between 1998 and 2017. This cohort of first-time isolated CABG was the baseline sample. We excluded patients who died during the index hospitalization because the aim of our study was to characterize the rate of reoperative CABG. Excluded concomitant cases were those including any valve operations, aortic operations, implantation of durable ventricular assist device, and noncardiac operations (Tables S2 and S3). We obtained information on patients' death and transition to Medicare Advantage plans from the Medicare enrollment file obtained from CMS.

Patient Baseline Characteristics

Demographic information included age, sex, and race (white, black, or other). We identified cardiovascular risk factors (hypertension, diabetes mellitus, atherosclerotic disease, unstable angina, previous myocardial infarction, previous heart failure, peripheral vascular disease, stroke, and other cerebrovascular diseases), geriatric conditions (dementia, functional disability, and malnutrition), and other conditions (renal failure, chronic obstructive pulmonary disease, pneumonia, respiratory failure, liver disease, cancer, major psychiatric disorders, depression, and trauma). The comorbidities were defined according to the Hierarchical Condition Categories to assemble clinically coherent codes into candidate variables. This system was developed by physician and statistical consultants under a contract to CMS and has been used in prior studies.^{15–17} We determined comorbidities from a combination of secondary diagnosis codes for the index hospitalization and principal and secondary diagnosis codes for all hospitalizations over 12 months preceding the index CABG hospitalization. Because the maximum number of diagnosis codes in Medicare data increased from 10 to 25 in 2011,¹⁸ we restricted the 2011 to 2017 data to the first

10 diagnosis codes to calculate comorbidities, which has been demonstrated to yield the most consistent number of diagnoses when the data that cross 2011.¹⁹ This is also a commonly adopted approach.^{19–21}

Outcome

The outcome was reoperative isolated or concomitant CABG within 5 years of discharge for the initial CABG.

The time zero to count preoperative CABG was at the discharge. We included both isolated and concomitant reoperative CABG, because we aimed to characterize the rate of reoperative CABG irrespective of whether the indication was driven by the primary valvular disease or graft failure, in order to inform patients and clinicians. For patients with more than 1 reoperative CABG, the first reoperative CABG was selected. Patients who switched to a managed care plan before

Table 1. Patient Characteristics

Variables	1998 to 2002	2003 to 2007	2008 to 2012	2013 to 2017
N	637 875	477 163	299 432	252 405
Age, median (IQR), y	74 (69–78)	74 (69–79)	73 (69–79)	73 (69–78)
Female	219 042 (34.3)	154 200 (32.3)	90 341 (30.2)	67 988 (26.9)
Race				
White	585 602 (91.8)	430 519 (90.2)	268 755 (89.8)	222 711 (88.2)
Black	26 618 (4.2)	24 283 (5.1)	15 835 (5.3)	13 529 (5.4)
Other	25 655 (4.0)	22 361 (4.7)	14 842 (5.0)	16 165 (6.4)
Comorbidity				
Heart failure	47 118 (7.4)	31 882 (6.7)	19 059 (6.4)	17 056 (6.8)
Myocardial infarction	42 035 (6.6)	26 021 (5.5)	17 859 (6.0)	16 600 (6.6)
Unstable angina	50 930 (8.0)	23 345 (4.9)	10 919 (3.6)	8241 (3.3)
Chronic atherosclerosis	352 302 (55.2)	255 965 (53.6)	160 796 (53.7)	122 413 (48.5)
Respiratory failure	7905 (1.2)	6929 (1.5)	7284 (2.4)	7966 (3.2)
Hypertension	394 950 (61.9)	312 421 (65.5)	184 047 (61.5)	144 601 (57.3)
Stroke	5817 (0.9)	4633 (1.0)	3034 (1.0)	2694 (1.1)
Cerebrovascular disease	27 747 (4.3)	20 228 (4.2)	12 708 (4.2)	9231 (3.7)
Renal failure	26 543 (4.2)	44 145 (9.3)	47 582 (15.9)	49 758 (19.7)
Chronic obstructive pulmonary disease	116 992 (18.3)	100 203 (21.0)	48 419 (16.2)	38 016 (15.1)
Pneumonia	27 280 (4.3)	25 705 (5.4)	20 773 (6.9)	17 212 (6.8)
Protein-calorie malnutrition	5165 (0.8)	6280 (1.3)	8730 (2.9)	8447 (3.3)
Dementia	6253 (1.0)	6339 (1.3)	5084 (1.7)	4826 (1.9)
Functional disability	4725 (0.7)	3400 (0.7)	2532 (0.8)	2484 (1.0)
Peripheral vascular disease	38 021 (6.0)	30 555 (6.4)	19 106 (6.4)	13 583 (5.4)
Metastatic cancer	22 295 (3.5)	18 212 (3.8)	11 564 (3.9)	9228 (3.7)
Trauma in past year	13 674 (2.1)	14 146 (3.0)	7716 (2.6)	4967 (2.0)
Major psychiatric disorder	5150 (0.8)	4173 (0.9)	3704 (1.2)	2802 (1.1)
Liver disease	8013 (1.3)	7236 (1.5)	5134 (1.7)	5507 (2.2)
Depression	14 504 (2.3)	14 640 (3.1)	10 710 (3.6)	9954 (3.9)
Diabetes mellitus	195 199 (30.6)	158 437 (33.2)	105 064 (35.1)	99 710 (39.5)
Outcomes				
30-d mortality	4877 (0.8)	3332 (0.7)	2176 (0.7)	1801 (0.7)
1-y mortality	29 834 (4.7)	23 196 (4.9)	14 040 (4.7)	10 556 (4.2)
Discharge to home	356 172 (55.8)	201 450 (42.4)	103 286 (34.5)	76 868 (30.5)
Discharge to home with home health services	157 178 (24.6)	159 418 (33.4)	111 201 (37.1)	92 329 (36.6)
Discharge to skilled nursing home	72 170 (11.3)	66 086 (13.9)	50 366 (16.8)	47 981 (19.0)
Discharge to hospice	147 (0.02)	554 (0.12)	460 (0.15)	434 (0.17)
Transferred to another acute-care hospital	43 899 (6.9)	3879 (0.8)	272 (0.1)	104 (0.04)
Other discharge destination	8309 (1.3)	45 776 (9.6)	33 847 (11.3)	34 689 (13.7)
Length of stay, median (IQR), d	8 (6–11)	8 (6–11)	8 (6–11)	8 (6–11)

IQR indicates interquartile range.

undergoing reoperative CABG were censored. We defined 1-year crude mortality using Medicare enrollment file as all-cause death occurring within 1 year of the index operation. Deaths during the 5-year follow-up period without a reoperative CABG hospitalization were treated as a competing risk.

Statistical Analysis

We compared patients' baseline characteristics over the study period and fit a single-variable Cox regression to describe the observed association between 5-year reoperative CABG and each of the individual characteristics. To assess the change in the rate of 5-year reoperative CABG over the study period, we fit the Cox regression to model the likelihood of reoperative CABG as a function of patient baseline characteristics, including an ordinal time variable that ranged from 0 to 19, corresponding to years 1998 (time=0) through 2017 (time=19), to represent the annual change in reoperative CABG rates. Patients without a full 5-year follow-up period were censored in the analysis. We also fitted the model separately for age, sex, and race subgroups. Deaths before reoperative CABG were addressed using the Fine and Gray method for competing risks.²² The Lee, Wei, and Amato method²³ of robust sandwich variance matrix estimation was used to adjust for within-hospital clustering of patients. Analyses were conducted with the use of SAS software, version 9.4 (SAS Institute). To facilitate data presentation, patient characteristics were reported in 5-year intervals: 1998 to 2002, 2003 to 2007, 2008 to 2012, and 2013 to 2017. All statistical testing was 2-sided, and $P < 0.05$ was considered statistically significant. The study followed the guidelines for cohort studies described in the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for Reporting Observational Studies.²⁴

RESULTS

Study Sample and Patient Characteristics

There were 1 666 875 unique Medicare FFS patients aged 65 years or older who underwent first-time isolated CABG and were discharged alive during the 20-year period. Between 1998 and 2017, the number of first-time isolated CABG in the FFS Medicare population declined from 528 to 166 per 100 000 beneficiaries/y; the median (interquartile range) age of patients did not change significantly over time (from 74 [69–78] to 73 [69–78]); the proportion of women decreased from 34.8% to 26.1%; the proportion of black patients increased from 4.2% to 5.4%.

Most comorbidities increased during the study period, including renal failure, pneumonia, protein-calorie malnutrition, dementia, functional disability, liver

disease, and diabetes mellitus, while chronic atherosclerotic disease, cerebrovascular disease, and chronic obstructive pulmonary disease decreased (Table 1). Median (interquartile range) length of stay remained similar from 8 (6–11) to 8 (6–11) days. Patients discharged directly to home without home care decreased from 60.0% to 29.4% while discharge to a skilled nursing facility increased from 11.2% to 18.6%. Mortality within 30 days of the index operation, excluding in-hospital deaths, remained stable from 0.8% to 0.8% while crude 1-year mortality decreased from 4.6% to 4.3%.

Rate of Reoperative CABG

The single-variable Cox regression found that older age and male sex were associated with a lower likelihood of reoperative CABG. The presence of most of the comorbidities, including heart failure, renal failure, stroke, and functional disability, were associated with lower likelihood of reoperative CABG (Table 2). The rate of reoperative CABG

Table 2. Observed Patient Baseline Characteristics Associated With Reoperative CABG

Variables	Risk Ratio (95% CI)
Age, per 1-y increase	0.95 (0.95–0.96)
Male sex (ref. female)	0.70 (0.66–0.73)
Comorbidity	
Heart failure	0.88 (0.80–0.97)
Myocardial infarction	0.89 (0.81–0.99)
Unstable angina	1.49 (1.37–1.61)
Chronic atherosclerosis	1.01 (0.96–1.05)
Respiratory failure	0.83 (0.68–1.00)
Hypertension	1.15 (1.10–1.21)
Stroke	0.66 (0.49–0.88)
Cerebrovascular disease	1.08 (0.97–1.20)
Renal failure	0.70 (0.64–0.77)
Chronic obstructive pulmonary disease	0.98 (0.93–1.04)
Pneumonia	0.84 (0.75–0.94)
Protein-calorie malnutrition	0.49 (0.38–0.65)
Dementia	0.43 (0.32–0.59)
Functional disability	0.71 (0.52–0.97)
Peripheral vascular disease	1.12 (1.03–1.23)
Trauma in past year	0.88 (0.76–1.03)
Major psychiatric disorder	0.70 (0.53–0.93)
Blood loss anemia	0.86 (0.82–0.90)
Depression	0.97 (0.84–1.11)
Diabetes mellitus	0.91 (0.87–0.96)
Asthma	1.16 (1.00–1.34)

The table shows the observed association between patient baseline characteristics and the likelihood of reoperative CABG during 5-year follow-up. Risk ratio > 1 is associated with increased likelihood of reoperative CABG. CABG indicates coronary artery bypass graft.

within 5 years decreased significantly and steadily over the 20-year period (Figure 1). When restricting to patients with a full 5-year follow-up period, the observed 5-year rate of reoperative CABG declined from 0.77% (95% CI, 0.72%–0.82%) in 1998 to 0.23% (95% CI, 0.19%–0.28%) in 2013 (Table 3). This decline between 1998 and 2013 occurred across all evaluated demographic subgroups, but was most prominent in women, non-white and non-black race, and age 75 to 84 years old, with percent changes of 67.3% (61.1%–75.0%), 86.9% (77.5%–96.3%), and 70.5% (63.2%–77.4%), respectively (Table 3). The rate of reoperative CABG was consistently the lowest across years until 2011 in patients older than age 85 years, and non-white and non-black race declined rapidly to become the demographic subgroup with the lowest rate after 2011. The findings did not change substantially when accounting for patient characteristics and geographic differences. The annual proportional decline in the 5-year rate of reoperative CABG was 6.6% (95% CI, 6.0%–7.1%) nationwide, which was consistent across subgroups, except the non-white non-black race group that had an annual decline of 8.5% (95% CI, 6.2%–10.7%) (Figure 2).

DISCUSSION

Between 1998 and 2017, the rate of reoperative CABG among Medicare FFS beneficiaries was low and declined significantly. In this cohort of older adults, the decline over time occurred across all demographic subgroups evaluated, with women, non-white and non-black race, and patients ages 75 to 84 years old showing the largest decline.

This study extends the prior literature in several ways. First, many studies reporting on the rate of reoperative CABG are more than a decade old,^{25–28} often limited to the pre-PCI era, and limited to centers that may not be representative of the national cohort.^{3,7,29,30} Therefore, the long-term rate of reoperative CABG in the contemporary era and how the rate had changed over time up to recent years remained unknown. With the complete follow-up information provided by claims data, our study allowed for comprehensive characterization of 5-year follow-up data over 2 decades. Second, the time-dependent likelihood of reoperative CABG since the time of initial CABG has not been characterized well in the contemporary era. While the Society of Thoracic Surgeons Adult Cardiac Surgery Database provided

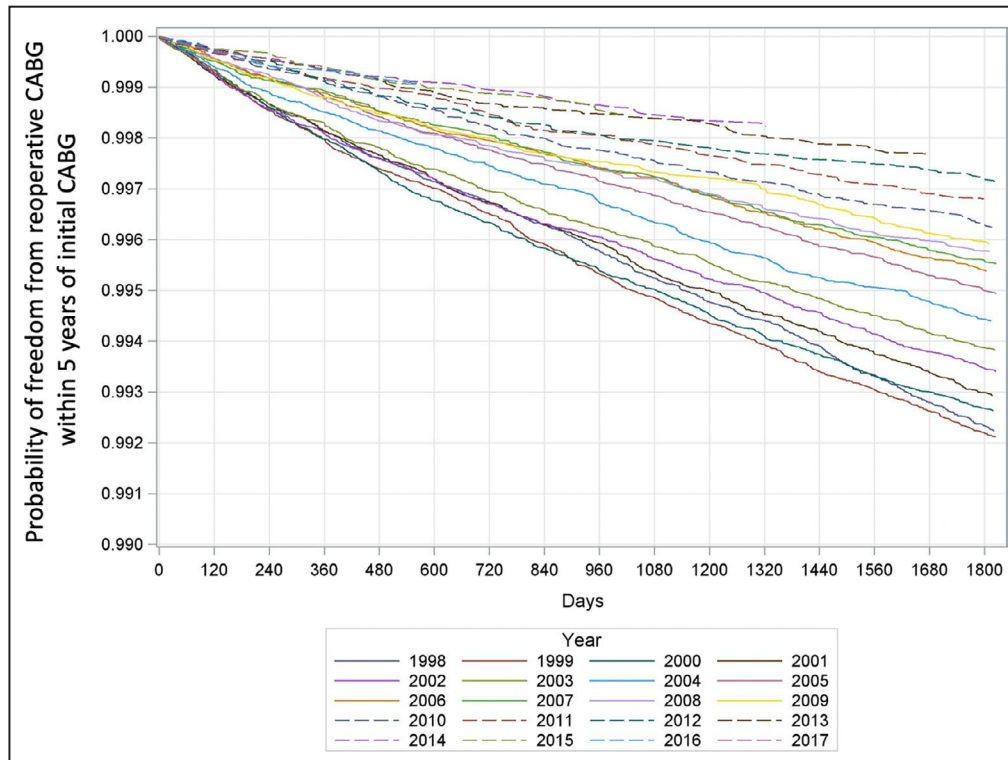


Figure 1. Kaplan-Meier estimate of the 5-year rate of reoperative coronary artery bypass graft by era. The figure shows a steadily declining 5-year rate of reoperative CABG surgery over time. Each line represents the survival estimate of the cohort that underwent CABG in the indicated year. CABG indicates coronary artery bypass graft.

the national-level utilization of reoperative CABG,³¹ the study only reported on the cross-sectional data without patient-level longitudinal follow-up. A study linking the Society of Thoracic Surgeons Adult Cardiac Surgery Database and Medicare FFS data reported declining rate of repeat revascularization over time after CABG, but the study included data only up to 2007,²⁸ at which time the 5-year rate of any revascularization after CABG was about 9%. Our study provided an insight into the contemporary likelihood of reoperative CABG by demonstrating that the likelihood increased essentially linearly since the time of initial CABG. Of note, the 5-year rate of reoperative CABG in our study matched with the report of the Society of Thoracic Surgeons data linked to Medicare data²⁸ during the overlapping time period of 1991 to 2007 at 0.6%. Third, sex- and race-based difference in the utilization and outcome of CABG has been demonstrated,³² but such differences in the rate of reoperative CABG had not been examined extensively. Our study demonstrated that the rate of reoperative CABG and time-to-reoperative CABG differed across sociodemographic subgroups.

There are several potential explanations for what we observed. First, the decline in the use of reoperative CABG over time likely is because of the combination of improvement in the secondary prevention after initial CABG, increasing utilization of PCI,³³ transcatheter valve procedures that reduced the need for concomitant reoperative CABG in the setting of primary valve indication,¹⁰ and possible increase in the graft longevity with technical improvement and multi-arterial graft use. Although long-term outcome of initial revascularization is favorable in CABG compared with PCI,³⁴ data on outcomes of reoperative CABG compared with repeat PCI are conflicting.^{3,14} Our finding that older age and presence of comorbidity were associated with lower likelihood of reoperative CABG may be because older and more comorbid patients were likely treated via PCI rather than CABG. A prior multicenter observational study of older adults with acute myocardial infarction suggest that there may be a treatment assignment of patients with more functional reserve toward a more invasive treatment modality.³⁵

Studies have reported that the rate of repeat revascularization, via CABG or PCI at 5 years, is 8% to 26%.^{28,36,37} Our observation that <0.3% of the patients underwent reoperative CABG indicates that reoperative CABG is used for only a small proportion of patients in need of repeat revascularization. This is important because having to undergo CABG is a significant event from a patient perspective, especially at the time of repeat revascularization when the patients are older. Because older adults are increasingly susceptible to functional decline after a cardiovascular event,³⁵

Table 3. Annual Trends in the 5-Year Rate of Reoperative CABG by Demographic Subgroup

Subgroups	1998	2000	2002	2004	2006	2008	2010	2012	2013
Age 65–74 y	0.90 (0.83–0.98)	0.86 (0.79–0.93)	0.80 (0.73–0.87)	0.71 (0.63–0.78)	0.57 (0.50–0.65)	0.52 (0.44–0.59)	0.43 (0.36–0.51)	0.36 (0.29–0.44)	0.27 (0.21–0.33)
Age 75–84 y	0.61 (0.53–0.68)	0.60 (0.53–0.67)	0.50 (0.44–0.56)	0.40 (0.33–0.46)	0.34 (0.27–0.40)	0.30 (0.23–0.37)	0.32 (0.24–0.40)	0.18 (0.12–0.25)	0.18 (0.12–0.25)
Age 85+ y	0.34 (0.14–0.54)	0.28 (0.12–0.43)	0.26 (0.11–0.41)	0.14 (0.02–0.26)	0.15 (0.02–0.28)	0.25 (0.07–0.44)	0.08 (–0.03 to 0.20)	0.14 (–0.02 to 0.29)	0.10 (–0.04 to 0.23)
White race	0.76 (0.71–0.82)	0.73 (0.68–0.78)	0.65 (0.60–0.70)	0.57 (0.52–0.62)	0.45 (0.40–0.51)	0.41 (0.36–0.47)	0.38 (0.33–0.44)	0.30 (0.24–0.35)	0.22 (0.17–0.26)
Black race	0.72 (0.45–0.99)	0.71 (0.48–0.94)	0.75 (0.51–0.99)	0.36 (0.18–0.54)	0.58 (0.33–0.84)	0.59 (0.31–0.86)	0.36 (0.14–0.59)	0.26 (0.05–0.48)	0.68 (0.34–1.0)
Other race	0.99 (0.68–1.29)	0.84 (0.58–1.10)	0.68 (0.44–0.91)	0.59 (0.36–0.83)	0.45 (0.22–0.68)	0.42 (0.18–0.66)	0.30 (0.08–0.51)	0.13 (–0.02–0.29)	0.04 (–0.04 to 0.13)
Female	0.98 (0.88–1.08)	0.85 (0.76–0.94)	0.83 (0.74–0.92)	0.65 (0.55–0.74)	0.59 (0.49–0.69)	0.49 (0.39–0.59)	0.45 (0.35–0.55)	0.32 (0.22–0.42)	0.27 (0.18–0.36)
Male	0.66 (0.60–0.72)	0.67 (0.61–0.73)	0.57 (0.52–0.62)	0.52 (0.46–0.57)	0.40 (0.34–0.46)	0.39 (0.33–0.45)	0.34 (0.29–0.40)	0.27 (0.22–0.33)	0.22 (0.17–0.27)
Overall	0.77 (0.72–0.82)	0.73 (0.68–0.78)	0.66 (0.61–0.70)	0.56 (0.51–0.61)	0.46 (0.41–0.51)	0.42 (0.37–0.47)	0.38 (0.32–0.43)	0.29 (0.24–0.34)	0.23 (0.19–0.28)

The table shows annual trends in the 5-year rate (%) of reoperative CABG between 1998 and 2013 by demographic subgroups. Biennial data are shown, except for 2012 and 2013 data, which are consecutive. For example, the 5-year rate of reoperative CABG was 0.77% in 1998 for the overall cohort. CABG indicates coronary artery bypass graft.

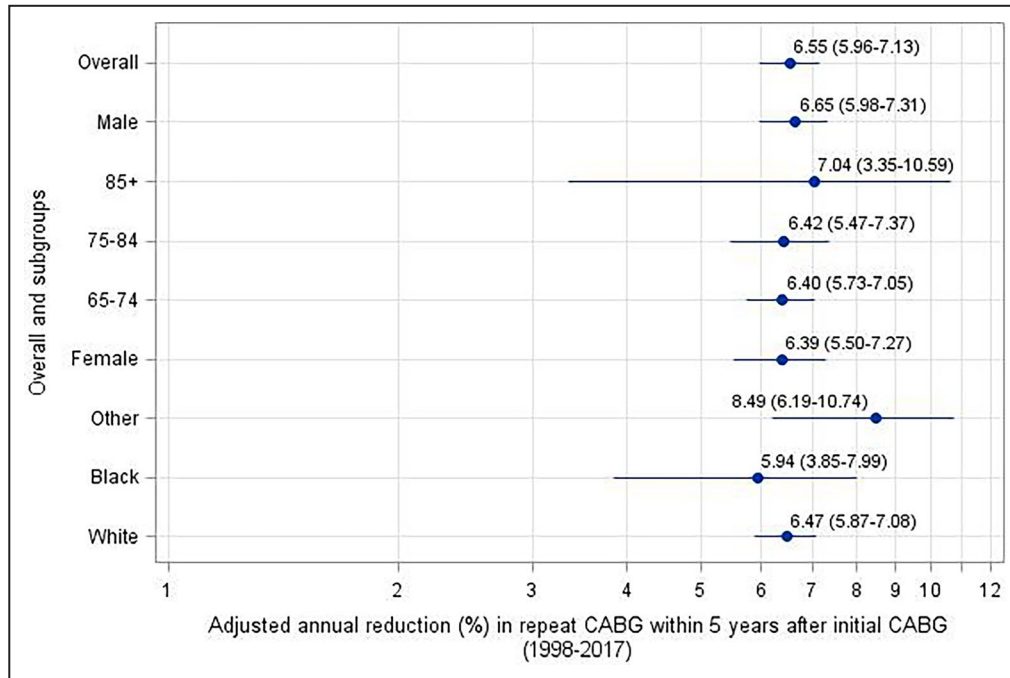


Figure 2. Adjusted annual percent reduction in the 5-year rate of reoperative CABG by demographic subgroups.

The figure demonstrates adjusted annual percent reduction of the 5-year rate of reoperative CABG. The overall cohort and all examined subgroups had a decline in the rate of reoperative CABG within 5 years of the initial CABG. CABG indicates coronary artery bypass graft.

the possibility of having to undergo reoperative CABG should be part of shared-decision making. Significant mortality and morbidity associated with reoperative CABG¹² may explain the current predominance of PCI for repeat revascularization. Guidelines have class II recommendations for PCI as the first choice over CABG for repeat revascularization⁹ in most scenarios, but a rigorous comparative effectiveness study to guide the optimal approach for repeat revascularization is still needed.

From the patient's perspective, undergoing PCI rather than CABG for recurrent need for revascularization may be favorable. For example, a patient survey showed that the majority of patients prefer PCI over CABG to treat multivessel coronary artery disease even when the presented hypothetical risk of 1-year death and repeat procedures were higher in PCI than CABG.⁵ This is an especially important consideration because in the same survey, physicians tended to prefer CABG over PCI based on the hypothetical risk differential. This potential discrepancy between physician and patient's values highlight the significance of the perceived burden of having to undergo an open heart operation. Our finding of a steadily declining 5-year rate of undergoing reoperative CABG to <0.3% provides important information to patients who are considering first-time CABG.

Limitations

Limitations of this study include the following. Because our data set consisted of only patients who were hospitalized, we could not evaluate the rate of repeat PCI, the majority of which are performed in outpatient settings.³⁸ We evaluated patients who were Medicare FFS beneficiaries, and the observed rate of reoperative CABG in this cohort of older adults is likely lower than the rate in a younger population. Additionally, it is possible that the findings may not extend to Medicare Advantage beneficiaries, which have increased in number over time. We censored patients who switched to a Medicare Advantage plan after undergoing the initial CABG under a Medicare FFS plan to avoid excluding this cohort altogether. Additionally, we risk adjusted our model to account for potential changes in the composition of the comorbidity profile, which is known to differ between Medicare FFS and Advantage plan beneficiaries. Claims data did not allow for assessment of granular clinical data pertinent to CABG, such as cross-clamp time and the number of arterial grafts used. Therefore, this limited our ability to further understand which improvements in the care process had impacts on the declining rate of reoperative CABG. However, our study aim was not to elucidate factors associated with the declining rate but rather to identify the contemporary rate of reoperative CABG

and how it changed over time. The long study period may be susceptible to coding practice change. While the coding practice change may have affected the captured comorbidity diagnoses, it is unlikely that a significant procedural event such as CABG was susceptible to such changes.

CONCLUSIONS

Over the last 20 years, the Medicare FFS beneficiaries experienced a significant decline in the rate of reoperative CABG. In the contemporary era, the 5-year rate of reoperative CABG in older adults was <0.3%, indicating that only a small fraction of patients in need of repeat revascularization are treated by reoperative CABG. Patients undergoing first-time CABG could expect an extremely low chance of having to undergo reoperative CABG at 5 years.

ARTICLE INFORMATION

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Affiliations

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co-founder of Heartbeat Health, Inc, a cardiology healthcare platform. The remaining authors have no disclosures to report.

Supplemental Materials

Tables S1–S3

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SUPPLEMENTAL MATERIAL

Table S1. ICD-10 code for CABG.

ICD-10-PCS Code	ICD-10-PCS Code Label
0210083	Bypass Coronary Artery, One Artery from Coronary Artery with Zooplastic Tissue, Open Approach
0210088	Bypass Coronary Artery, One Artery from Right Internal Mammary with Zooplastic Tissue, Open Approach
0210089	Bypass Coronary Artery, One Artery from Left Internal Mammary with Zooplastic Tissue, Open Approach
0210093	Bypass Coronary Artery, One Artery from Coronary Artery with Autologous Venous Tissue, Open Approach
0210098	Bypass Coronary Artery, One Artery from Right Internal Mammary with Autologous Venous Tissue, Open Approach
0210099	Bypass Coronary Artery, One Artery from Left Internal Mammary with Autologous Venous Tissue, Open Approach
0210483	Bypass Coronary Artery, One Artery from Coronary Artery with Zooplastic Tissue, Percutaneous Endoscopic Approach
0210488	Bypass Coronary Artery, One Artery from Right Internal Mammary with Zooplastic Tissue, Percutaneous Endoscopic Approach
0210489	Bypass Coronary Artery, One Artery from Left Internal Mammary with Zooplastic Tissue, Percutaneous Endoscopic Approach
0210493	Bypass Coronary Artery, One Artery from Coronary Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0210498	Bypass Coronary Artery, One Artery from Right Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0210499	Bypass Coronary Artery, One Artery from Left Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0211083	Bypass Coronary Artery, Two Arteries from Coronary Artery with Zooplastic Tissue, Open Approach
0211088	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Zooplastic Tissue, Open Approach
0211089	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Zooplastic Tissue, Open Approach
0211093	Bypass Coronary Artery, Two Arteries from Coronary Artery with Autologous Venous Tissue, Open Approach
0211098	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Autologous Venous Tissue, Open Approach
0211099	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Autologous Venous Tissue, Open Approach
0211483	Bypass Coronary Artery, Two Arteries from Coronary Artery with Zooplastic Tissue, Percutaneous Endoscopic Approach
0211488	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Zooplastic Tissue, Percutaneous Endoscopic Approach
0211489	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Zooplastic Tissue, Percutaneous Endoscopic Approach
0211493	Bypass Coronary Artery, Two Arteries from Coronary Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0211498	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0211499	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0212083	Bypass Coronary Artery, Three Arteries from Coronary Artery with Zooplastic Tissue, Open Approach

0212088	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Zooplastic Tissue, Open Approach
0212089	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Zooplastic Tissue, Open Approach
0212093	Bypass Coronary Artery, Three Arteries from Coronary Artery with Autologous Venous Tissue, Open Approach
0212098	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Autologous Venous Tissue, Open Approach
212099	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Autologous Venous Tissue, Open Approach
0212483	Bypass Coronary Artery, Three Arteries from Coronary Artery with Zooplastic Tissue, Percutaneous Endoscopic Approach
0212488	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Zooplastic Tissue, Percutaneous Endoscopic Approach
0212489	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Zooplastic Tissue, Percutaneous Endoscopic Approach
0212493	Bypass Coronary Artery, Three Arteries from Coronary Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0212498	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0212499	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0213083	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Zooplastic Tissue, Open Approach
0213088	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Zooplastic Tissue, Open Approach
0213089	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Zooplastic Tissue, Open Approach
0213093	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Autologous Venous Tissue, Open Approach
0213098	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Autologous Venous Tissue, Open Approach
0213099	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Autologous Venous Tissue, Open Approach
0213483	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Zooplastic Tissue, Percutaneous Endoscopic Approach
0213488	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Zooplastic Tissue, Percutaneous Endoscopic Approach
0213489	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Zooplastic Tissue, Percutaneous Endoscopic Approach
0213493	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0213498	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0213499	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021008C	Bypass Coronary Artery, One Artery from Thoracic Artery with Zooplastic Tissue, Open Approach
021008F	Bypass Coronary Artery, One Artery from Abdominal Artery with Zooplastic Tissue, Open Approach
021008W	Bypass Coronary Artery, One Artery from Aorta with Zooplastic Tissue, Open Approach
021009C	Bypass Coronary Artery, One Artery from Thoracic Artery with Autologous Venous Tissue, Open Approach

021009F	Bypass Coronary Artery, One Artery from Abdominal Artery with Autologous Venous Tissue, Open Approach
021009W	Bypass Coronary Artery, One Artery from Aorta with Autologous Venous Tissue, Open Approach
02100A3	Bypass Coronary Artery, One Artery from Coronary Artery with Autologous Arterial Tissue, Open Approach
02100A3	Bypass Coronary Artery, One Artery from Coronary Artery with Autologous Arterial Tissue, Open Approach
02100A8	Bypass Coronary Artery, One Artery from Right Internal Mammary with Autologous Arterial Tissue, Open Approach
02100A9	Bypass Coronary Artery, One Artery from Left Internal Mammary with Autologous Arterial Tissue, Open Approach
02100AC	Bypass Coronary Artery, One Artery from Thoracic Artery with Autologous Arterial Tissue, Open Approach
02100AF	Bypass Coronary Artery, One Artery from Abdominal Artery with Autologous Arterial Tissue, Open Approach
02100AW	Bypass Coronary Artery, One Artery from Aorta with Autologous Arterial Tissue, Open Approach
02100J3	Bypass Coronary Artery, One Artery from Coronary Artery with Synthetic Substitute, Open Approach
02100J8	Bypass Coronary Artery, One Artery from Right Internal Mammary with Synthetic Substitute, Open Approach
02100J9	Bypass Coronary Artery, One Artery from Left Internal Mammary with Synthetic Substitute, Open Approach
02100JC	Bypass Coronary Artery, One Artery from Thoracic Artery with Synthetic Substitute, Open Approach
02100JF	Bypass Coronary Artery, One Artery from Abdominal Artery with Synthetic Substitute, Open Approach
02100JW	Bypass Coronary Artery, One Artery from Aorta with Synthetic Substitute, Open Approach
02100K3	Bypass Coronary Artery, One Artery from Coronary Artery with Nonautologous Tissue Substitute, Open Approach
02100K8	Bypass Coronary Artery, One Artery from Right Internal Mammary with Nonautologous Tissue Substitute, Open Approach
02100K9	Bypass Coronary Artery, One Artery from Left Internal Mammary with Nonautologous Tissue Substitute, Open Approach
02100KC	Bypass Coronary Artery, One Artery from Thoracic Artery with Nonautologous Tissue Substitute, Open Approach
02100KF	Bypass Coronary Artery, One Artery from Abdominal Artery with Nonautologous Tissue Substitute, Open Approach
02100KW	Bypass Coronary Artery, One Artery from Aorta with Nonautologous Tissue Substitute, Open Approach
02100Z3	Bypass Coronary Artery, One Artery from Coronary Artery, Open Approach
02100Z8	Bypass Coronary Artery, One Artery from Right Internal Mammary, Open Approach
02100Z9	Bypass Coronary Artery, One Artery from Left Internal Mammary, Open Approach
02100ZC	Bypass Coronary Artery, One Artery from Thoracic Artery, Open Approach
02100ZF	Bypass Coronary Artery, One Artery from Abdominal Artery, Open Approach
021048C	Bypass Coronary Artery, One Artery from Thoracic Artery with Zooplastic Tissue, Percutaneous Endoscopic Approach
021048F	Bypass Coronary Artery, One Artery from Abdominal Artery with Zooplastic Tissue, Percutaneous Endoscopic Approach
021048W	Bypass Coronary Artery, One Artery from Aorta with Zooplastic Tissue, Percutaneous Endoscopic Approach
021049C	Bypass Coronary Artery, One Artery from Thoracic Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach

021049F	Bypass Coronary Artery, One Artery from Abdominal Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021049W	Bypass Coronary Artery, One Artery from Aorta with Autologous Venous Tissue, Percutaneous Endoscopic Approach
02104A3	Bypass Coronary Artery, One Artery from Coronary Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02104A8	Bypass Coronary Artery, One Artery from Right Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02104A9	Bypass Coronary Artery, One Artery from Left Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02104AC	Bypass Coronary Artery, One Artery from Thoracic Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02104AF	Bypass Coronary Artery, One Artery from Abdominal Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02104AW	Bypass Coronary Artery, One Artery from Aorta with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02104J3	Bypass Coronary Artery, One Artery from Coronary Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02104J8	Bypass Coronary Artery, One Artery from Right Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02104J9	Bypass Coronary Artery, One Artery from Left Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02104JC	Bypass Coronary Artery, One Artery from Thoracic Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02104JF	Bypass Coronary Artery, One Artery from Abdominal Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02104JW	Bypass Coronary Artery, One Artery from Aorta with Synthetic Substitute, Percutaneous Endoscopic Approach
02104K3	Bypass Coronary Artery, One Artery from Coronary Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02104K8	Bypass Coronary Artery, One Artery from Right Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02104K9	Bypass Coronary Artery, One Artery from Left Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02104KC	Bypass Coronary Artery, One Artery from Thoracic Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02104KF	Bypass Coronary Artery, One Artery from Abdominal Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02104KW	Bypass Coronary Artery, One Artery from Aorta with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02104Z3	Bypass Coronary Artery, One Artery from Coronary Artery, Percutaneous Endoscopic Approach
02104Z8	Bypass Coronary Artery, One Artery from Right Internal Mammary, Percutaneous Endoscopic Approach
02104Z9	Bypass Coronary Artery, One Artery from Left Internal Mammary, Percutaneous Endoscopic Approach
02104ZC	Bypass Coronary Artery, One Artery from Thoracic Artery, Percutaneous Endoscopic Approach
02104ZF	Bypass Coronary Artery, One Artery from Abdominal Artery, Percutaneous Endoscopic Approach
021108C	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Zooplastic Tissue, Open Approach
021108F	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Zooplastic Tissue, Open Approach
021108W	Bypass Coronary Artery, Two Arteries from Aorta with Zooplastic Tissue, Open Approach
021109C	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Autologous Venous Tissue, Open Approach

021109F	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Autologous Venous Tissue, Open Approach
021109W	Bypass Coronary Artery, Two Arteries from Aorta with Autologous Venous Tissue, Open Approach
02110A3	Bypass Coronary Artery, Two Arteries from Coronary Artery with Autologous Arterial Tissue, Open Approach
02110A8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Autologous Arterial Tissue, Open Approach
02110A9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Autologous Arterial Tissue, Open Approach
02110AC	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Autologous Arterial Tissue, Open Approach
02110AF	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Autologous Arterial Tissue, Open Approach
02110AW	Bypass Coronary Artery, Two Arteries from Aorta with Autologous Arterial Tissue, Open Approach
02110J3	Bypass Coronary Artery, Two Arteries from Coronary Artery with Synthetic Substitute, Open Approach
02110J8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Synthetic Substitute, Open Approach
02110J9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Synthetic Substitute, Open Approach
02110JC	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Synthetic Substitute, Open Approach
02110JF	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Synthetic Substitute, Open Approach
02110JW	Bypass Coronary Artery, Two Arteries from Aorta with Synthetic Substitute, Open Approach
02110K3	Bypass Coronary Artery, Two Arteries from Coronary Artery with Nonautologous Tissue Substitute, Open Approach
02110K8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Nonautologous Tissue Substitute, Open Approach
02110K9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Nonautologous Tissue Substitute, Open Approach
02110KC	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Nonautologous Tissue Substitute, Open Approach
02110KF	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Nonautologous Tissue Substitute, Open Approach
02110KW	Bypass Coronary Artery, Two Arteries from Aorta with Nonautologous Tissue Substitute, Open Approach
02110Z3	Bypass Coronary Artery, Two Arteries from Coronary Artery, Open Approach
02110Z8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary, Open Approach
02110Z9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary, Open Approach
02110ZC	Bypass Coronary Artery, Two Arteries from Thoracic Artery, Open Approach
02110ZF	Bypass Coronary Artery, Two Arteries from Abdominal Artery, Open Approach
021148C	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Zooplastic Tissue, Percutaneous Endoscopic Approach
021148F	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Zooplastic Tissue, Percutaneous Endoscopic Approach
021148W	Bypass Coronary Artery, Two Arteries from Aorta with Zooplastic Tissue, Percutaneous Endoscopic Approach
021149C	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021149F	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach

021149W	Bypass Coronary Artery, Two Arteries from Aorta with Autologous Venous Tissue, Percutaneous Endoscopic Approach
02114A3	Bypass Coronary Artery, Two Arteries from Coronary Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02114A8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02114A9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02114AC	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02114AF	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02114AW	Bypass Coronary Artery, Two Arteries from Aorta with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02114J3	Bypass Coronary Artery, Two Arteries from Coronary Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02114J8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02114J9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02114JC	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02114JF	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02114JW	Bypass Coronary Artery, Two Arteries from Aorta with Synthetic Substitute, Percutaneous Endoscopic Approach
02114K3	Bypass Coronary Artery, Two Arteries from Coronary Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02114K8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02114K9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02114KC	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02114KF	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02114KW	Bypass Coronary Artery, Two Arteries from Aorta with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02114Z3	Bypass Coronary Artery, Two Arteries from Coronary Artery, Percutaneous Endoscopic Approach
02114Z8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary, Percutaneous Endoscopic Approach
02114Z9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary, Percutaneous Endoscopic Approach
02114ZC	Bypass Coronary Artery, Two Arteries from Thoracic Artery, Percutaneous Endoscopic Approach
02114ZF	Bypass Coronary Artery, Two Arteries from Abdominal Artery, Percutaneous Endoscopic Approach
021208C	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Zooplastic Tissue, Open Approach
021208F	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Zooplastic Tissue, Open Approach
021208W	Bypass Coronary Artery, Three Arteries from Aorta with Zooplastic Tissue, Open Approach
021209C	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Autologous Venous Tissue, Open Approach

021209F	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Autologous Venous Tissue, Open Approach
021209W	Bypass Coronary Artery, Three Arteries from Aorta with Autologous Venous Tissue, Open Approach
02120A3	Bypass Coronary Artery, Three Arteries from Coronary Artery with Autologous Arterial Tissue, Open Approach
02120A8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Autologous Arterial Tissue, Open Approach
02120A9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Autologous Arterial Tissue, Open Approach
02120AC	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Autologous Arterial Tissue, Open Approach
02120AF	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Autologous Arterial Tissue, Open Approach
02120AW	Bypass Coronary Artery, Three Arteries from Aorta with Autologous Arterial Tissue, Open Approach
02120J3	Bypass Coronary Artery, Three Arteries from Coronary Artery with Synthetic Substitute, Open Approach
02120J8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Synthetic Substitute, Open Approach
02120J9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Synthetic Substitute, Open Approach
02120JC	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Synthetic Substitute, Open Approach
02120JF	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Synthetic Substitute, Open Approach
02120JW	Bypass Coronary Artery, Three Arteries from Aorta with Synthetic Substitute, Open Approach
02120K3	Bypass Coronary Artery, Three Arteries from Coronary Artery with Nonautologous Tissue Substitute, Open Approach
02120K8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Nonautologous Tissue Substitute, Open Approach
02120K9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Nonautologous Tissue Substitute, Open Approach
02120KC	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Nonautologous Tissue Substitute, Open Approach
02120KF	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Nonautologous Tissue Substitute, Open Approach
02120KW	Bypass Coronary Artery, Three Arteries from Aorta with Nonautologous Tissue Substitute, Open Approach
02120Z3	Bypass Coronary Artery, Three Arteries from Coronary Artery, Open Approach
02120Z8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary, Open Approach
02120Z9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary, Open Approach
02120ZC	Bypass Coronary Artery, Three Arteries from Thoracic Artery, Open Approach
02120ZF	Bypass Coronary Artery, Three Arteries from Abdominal Artery, Open Approach
021248C	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Zooplasic Tissue, Percutaneous Endoscopic Approach
021248F	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Zooplasic Tissue, Percutaneous Endoscopic Approach
021248W	Bypass Coronary Artery, Three Arteries from Aorta with Zooplasic Tissue, Percutaneous Endoscopic Approach
021249C	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach

021249F	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021249W	Bypass Coronary Artery, Three Arteries from Aorta with Autologous Venous Tissue, Percutaneous Endoscopic Approach
02124A3	Bypass Coronary Artery, Three Arteries from Coronary Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02124A8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02124A9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02124AC	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02124AF	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02124AW	Bypass Coronary Artery, Three Arteries from Aorta with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02124J3	Bypass Coronary Artery, Three Arteries from Coronary Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02124J8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02124J9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02124JC	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02124JF	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02124JW	Bypass Coronary Artery, Three Arteries from Aorta with Synthetic Substitute, Percutaneous Endoscopic Approach
02124K3	Bypass Coronary Artery, Three Arteries from Coronary Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02124K8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02124K9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02124KC	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02124KF	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02124KW	Bypass Coronary Artery, Three Arteries from Aorta with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02124Z3	Bypass Coronary Artery, Three Arteries from Coronary Artery, Percutaneous Endoscopic Approach
02124Z8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary, Percutaneous Endoscopic Approach
02124Z9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary, Percutaneous Endoscopic Approach
02124ZC	Bypass Coronary Artery, Three Arteries from Thoracic Artery, Percutaneous Endoscopic Approach
02124ZF	Bypass Coronary Artery, Three Arteries from Abdominal Artery, Percutaneous Endoscopic Approach
021308C	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Zooplastic Tissue, Open Approach
021308F	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Zooplastic Tissue, Open Approach

021308W	Bypass Coronary Artery, Four or More Arteries from Aorta with Zooplastic Tissue, Open Approach
021309C	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Autologous Venous Tissue, Open Approach
021309F	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Autologous Venous Tissue, Open Approach
021309W	Bypass Coronary Artery, Four or More Arteries from Aorta with Autologous Venous Tissue, Open Approach
02130A3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Autologous Arterial Tissue, Open Approach
02130A8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Autologous Arterial Tissue, Open Approach
02130A9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Autologous Arterial Tissue, Open Approach
02130AC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Autologous Arterial Tissue, Open Approach
02130AF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Autologous Arterial Tissue, Open Approach
02130AW	Bypass Coronary Artery, Four or More Arteries from Aorta with Autologous Arterial Tissue, Open Approach
02130J3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Synthetic Substitute, Open Approach
02130J8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Synthetic Substitute, Open Approach
02130J9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Synthetic Substitute, Open Approach
02130JC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Synthetic Substitute, Open Approach
02130JF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Synthetic Substitute, Open Approach
02130JW	Bypass Coronary Artery, Four or More Arteries from Aorta with Synthetic Substitute, Open Approach
02130K3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Nonautologous Tissue Substitute, Open Approach
02130K8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Nonautologous Tissue Substitute, Open Approach
02130K9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Nonautologous Tissue Substitute, Open Approach
02130KC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Nonautologous Tissue Substitute, Open Approach
02130KF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Nonautologous Tissue Substitute, Open Approach
02130KW	Bypass Coronary Artery, Four or More Arteries from Aorta with Nonautologous Tissue Substitute, Open Approach
02130Z3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery, Open Approach
02130Z8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary, Open Approach
02130Z9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary, Open Approach
02130ZC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery, Open Approach
02130ZF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery, Open Approach
021348C	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Zooplastic Tissue, Percutaneous Endoscopic Approach

021348F	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Zooplastic Tissue, Percutaneous Endoscopic Approach
021348W	Bypass Coronary Artery, Four or More Arteries from Aorta with Zooplastic Tissue, Percutaneous Endoscopic Approach
021349C	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021349F	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021349W	Bypass Coronary Artery, Four or More Arteries from Aorta with Autologous Venous Tissue, Percutaneous Endoscopic Approach
02134A3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02134A8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02134A9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02134AC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02134AF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02134AW	Bypass Coronary Artery, Four or More Arteries from Aorta with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02134J3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02134J8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02134J9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02134JC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02134JF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02134JW	Bypass Coronary Artery, Four or More Arteries from Aorta with Synthetic Substitute, Percutaneous Endoscopic Approach
02134K3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02134K8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02134K9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02134KC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02134KF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02134KW	Bypass Coronary Artery, Four or More Arteries from Aorta with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02134Z3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery, Percutaneous Endoscopic Approach
02134Z8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary, Percutaneous Endoscopic Approach
02134Z9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary, Percutaneous Endoscopic Approach

02134ZC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery, Percutaneous Endoscopic Approach
02134ZF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery, Percutaneous Endoscopic Approach

ICD-9-CM codes for CABG are 36.10 through 36.19.

Table S2. ICD-9-CM codes used to exclude concomitant cardiac and non-cardiac operations.

ICD-9-CM Procedure Code	ICD-9-CM Procedure Description
00.61	Percutaneous angioplasty or atherectomy of precerebral (extracranial) vessel(s)
00.62	Percutaneous angioplasty or atherectomy of intracranial vessel(s)
00.63	Percutaneous insertion of carotid artery stent(s)
00.64	Percutaneous insertion of other precerebral (extracranial) artery stent(s)
00.65	Percutaneous insertion of intracranial vascular stent(s)
32.41	Thoracoscopic lobectomy of lung
32.49	Other lobectomy of lung
33.50	Lung transplantation, not otherwise specified
33.51	Unilateral lung transplantation
33.52	Bilateral lung transplantation
33.60	Combined heart-lung transplantation
35.00	Closed heart valvotomy, unspecified valve
35.01	Closed heart valvotomy, aortic valve
35.02	Closed heart valvotomy, mitral valve
35.03	Closed heart valvotomy, pulmonary valve
35.04	Closed heart valvotomy, tricuspid valve
35.1	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
35.2	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
35.31	Operations on papillary muscle
35.32	Operations on chordae tendineae
35.33	Annuloplasty
35.34	Infundibulectomy
35.35	Operations on trabeculae carneae cordis
35.39	Operations on other structures adjacent to valves of heart
35.41	Enlargement of existing atrial septal defect
35.42	Creation of septal defect in heart

35.5	Repair of unspecified septal defect of heart with prosthesis
35.51	Repair of atrial septal defect with prosthesis, open technique
35.52	Repair of atrial septal defect with prosthesis, closed technique
35.53	Repair of ventricular septal defect with prosthesis, open technique
35.54	Repair of endocardial cushion defect with prosthesis
35.55	Repair of ventricular septal defect with prosthesis, closed technique
35.6	Repair of unspecified septal defect of heart with tissue graft
35.61	Repair of atrial septal defect with tissue graft
35.62	Repair of ventricular septal defect with tissue graft
35.63	Repair of endocardial cushion defect with tissue graft
35.7	Other and unspecified repair of unspecified septal defect of heart
35.71	Other and unspecified repair of atrial septal defect
35.72	Other and unspecified repair of ventricular septal defect
35.73	Other and unspecified repair of endocardial cushion defect
35.81	Total repair of tetralogy of fallot
35.82	Total repair of total anomalous pulmonary venous connection
35.83	Total repair of truncus arteriosus
35.84	Total correction of transposition of great vessels, not elsewhere classified
35.91	Interatrial transposition of venous return
35.92	Creation of conduit between right ventricle and pulmonary artery
35.93	Creation of conduit between left ventricle and aorta
35.94	Creation of conduit between atrium and pulmonary artery
35.95	Revision of corrective procedure on heart
35.96	Percutaneous balloon valvuloplasty
35.98	Other operations on septa of heart
35.99	Other operations on valves of heart
37.31	Pericardiectomy
37.32	Excision of aneurysm of heart
37.33	Excision or destruction of other lesion or tissue of heart, open approach
37.35	Partial ventriculectomy
37.51	Heart transplantation
37.52	Implantation of total internal biventricular heart replacement system
37.53	Replacement or repair of thoracic unit of (total) replacement heart system
37.54	Replacement or repair of other implantable component of (total) replacement heart system
37.55	Removal of internal biventricular heart replacement system
37.63	Repair of heart assist system
37.67	Implantation of cardiomyostimulation system
38.11	Head and neck endarterectomy
38.12	Endarterectomy, other vessels of head and neck
38.14	Endarterectomy of Aorta
38.15	Thoracic endarterectomy

38.16	Endarterectomy: Excision of tunica intima of artery to relieve arterial walls thickened by plaque or chronic inflammation. Location includes abdominal arteries excluding abdominal aorta: Celiac, Gastric, Hepatic, Iliac, Mesenteric, Renal, Splenic, Umbilical
38.17	Endarterectomy - abdominal veins: Iliac, Portal, Renal, Splenic, Vena cava.
38.34	Resection of vessel with replacement: Angiectomy, excision of aneurysm (arteriovenous), blood vessel (lesion) with anastomosis (4=aorta, abdominal)
38.42	Resection of vessel with replacement: Angiectomy, excision of aneurysm with replacement (2= other vessels of head and neck; carotid, jugular)
38.44	Resection of vessel with replacement, aorta, abdominal
38.45	Resection of vessel with replacement, thoracic vessels
39.21	Caval-pulmonary artery anastomosis
39.22	Aorta-subclavian-carotid bypass
39.23	Other intrathoracic vascular shunt or bypass
39.24	Aorta-renal bypass
39.25	Aorta-iliac-femoral bypass
39.26	Other intra-abdominal vascular shunt or bypass
39.28	Extracranial-intracranial (EC-IC) vascular bypass
39.29	Other (peripheral) vascular shunt or bypass
39.71	Endovascular implantation of graft in abdominal aorta
39.72	Endovascular embolization or occlusion of head and neck vessels
39.73	Endovascular implantation of graft in thoracic aorta
39.74	Endovascular removal of obstruction from head and neck vessel(s)
39.75	Endovascular embolization or occlusion of vessel(s) of head or neck using bare coils
39.76	Endovascular embolization or occlusion of vessel(s) of head or neck using bioactive coils
39.79	Other endovascular procedures on other vessels
85.22	Resection of quadrant of breast
85.23	Subtotal mastectomy, which excludes quadrant resection (85.22)
85.41	Unilateral simple mastectomy
85.42	Bilateral simple mastectomy
85.43	Unilateral extended simple mastectomy
85.44	Bilateral extended simple mastectomy
85.45	Unilateral radical mastectomy
85.46	Bilateral radical mastectomy
85.47	Unilateral extended radical mastectomy
85.48	Bilateral extended radical mastectomy

Table S3. ICD-10 code to exclude concomitant cardiac and non-cardiac operations.

ICD-10 Code	ICD-10 Code Description
024F07J	Creation of Aortic Valve from Truncal Valve using Autologous Tissue Substitute, Open Approach
024F08J	Creation of Aortic Valve from Truncal Valve using Zooplastic Tissue, Open Approach
024F0JJ	Creation of Aortic Valve from Truncal Valve using Synthetic Substitute, Open Approach
024F0KJ	Creation of Aortic Valve from Truncal Valve using Nonautologous Tissue Substitute, Open Approach
024G072	Creation of Mitral Valve from Common Atrioventricular Valve using Autologous Tissue Substitute, Open Approach
024G082	Creation of Mitral Valve from Common Atrioventricular Valve using Zooplastic Tissue, Open Approach
024G0J2	Creation of Mitral Valve from Common Atrioventricular Valve using Synthetic Substitute, Open Approach
024G0K2	Creation of Mitral Valve from Common Atrioventricular Valve using Nonautologous Tissue Substitute, Open Approach
024J072	Creation of Tricuspid Valve from Common Atrioventricular Valve using Autologous Tissue Substitute, Open Approach
024J082	Creation of Tricuspid Valve from Common Atrioventricular Valve using Zooplastic Tissue, Open Approach
024J0J2	Creation of Tricuspid Valve from Common Atrioventricular Valve using Synthetic Substitute, Open Approach
024J0K2	Creation of Tricuspid Valve from Common Atrioventricular Valve using Nonautologous Tissue Substitute, Open Approach
025F0ZZ	Destruction of Aortic Valve, Open Approach
025F3ZZ	Destruction of Aortic Valve, Percutaneous Approach
025F4ZZ	Destruction of Aortic Valve, Percutaneous Endoscopic Approach
025G0ZZ	Destruction of Mitral Valve, Open Approach
025G3ZZ	Destruction of Mitral Valve, Percutaneous Approach
025G4ZZ	Destruction of Mitral Valve, Percutaneous Endoscopic Approach
025H0ZZ	Destruction of Pulmonary Valve, Open Approach
025H3ZZ	Destruction of Pulmonary Valve, Percutaneous Approach
025H4ZZ	Destruction of Pulmonary Valve, Percutaneous Endoscopic Approach
025J0ZZ	Destruction of Tricuspid Valve, Open Approach
025J3ZZ	Destruction of Tricuspid Valve, Percutaneous Approach
025J4ZZ	Destruction of Tricuspid Valve, Percutaneous Endoscopic Approach
027F04Z	Dilation of Aortic Valve with Drug-eluting Intraluminal Device, Open Approach
027F0DZ	Dilation of Aortic Valve with Intraluminal Device, Open Approach
027F0ZZ	Dilation of Aortic Valve, Open Approach
027F34Z	Dilation of Aortic Valve with Drug-eluting Intraluminal Device, Percutaneous Approach
027F3DZ	Dilation of Aortic Valve with Intraluminal Device, Percutaneous Approach
027F3ZZ	Dilation of Aortic Valve, Percutaneous Approach
027F44Z	Dilation of Aortic Valve with Drug-eluting Intraluminal Device, Percutaneous Endoscopic Approach
027F4DZ	Dilation of Aortic Valve with Intraluminal Device, Percutaneous Endoscopic Approach
027F4ZZ	Dilation of Aortic Valve, Percutaneous Endoscopic Approach
027G04Z	Dilation of Mitral Valve with Drug-eluting Intraluminal Device, Open Approach
027G0DZ	Dilation of Mitral Valve with Intraluminal Device, Open Approach
027G0ZZ	Dilation of Mitral Valve, Open Approach

027G34Z	Dilation of Mitral Valve with Drug-eluting Intraluminal Device, Percutaneous Approach
027G3DZ	Dilation of Mitral Valve with Intraluminal Device, Percutaneous Approach
027G3ZZ	Dilation of Mitral Valve, Percutaneous Approach
027G44Z	Dilation of Mitral Valve with Drug-eluting Intraluminal Device, Percutaneous Endoscopic Approach
027G4DZ	Dilation of Mitral Valve with Intraluminal Device, Percutaneous Endoscopic Approach
027G4ZZ	Dilation of Mitral Valve, Percutaneous Endoscopic Approach
027H04Z	Dilation of Pulmonary Valve with Drug-eluting Intraluminal Device, Open Approach
027H0DZ	Dilation of Pulmonary Valve with Intraluminal Device, Open Approach
027H0ZZ	Dilation of Pulmonary Valve, Open Approach
027H34Z	Dilation of Pulmonary Valve with Drug-eluting Intraluminal Device, Percutaneous Approach
027H3DZ	Dilation of Pulmonary Valve with Intraluminal Device, Percutaneous Approach
027H3ZZ	Dilation of Pulmonary Valve, Percutaneous Approach
027H44Z	Dilation of Pulmonary Valve with Drug-eluting Intraluminal Device, Percutaneous Endoscopic Approach
027H4DZ	Dilation of Pulmonary Valve with Intraluminal Device, Percutaneous Endoscopic Approach
027H4ZZ	Dilation of Pulmonary Valve, Percutaneous Endoscopic Approach
027J04Z	Dilation of Tricuspid Valve with Drug-eluting Intraluminal Device, Open Approach
027J0DZ	Dilation of Tricuspid Valve with Intraluminal Device, Open Approach
027J0ZZ	Dilation of Tricuspid Valve, Open Approach
027J34Z	Dilation of Tricuspid Valve with Drug-eluting Intraluminal Device, Percutaneous Approach
027J3DZ	Dilation of Tricuspid Valve with Intraluminal Device, Percutaneous Approach
027J3ZZ	Dilation of Tricuspid Valve, Percutaneous Approach
027J44Z	Dilation of Tricuspid Valve with Drug-eluting Intraluminal Device, Percutaneous Endoscopic Approach
027J4DZ	Dilation of Tricuspid Valve with Intraluminal Device, Percutaneous Endoscopic Approach
027J4ZZ	Dilation of Tricuspid Valve, Percutaneous Endoscopic Approach
02BF0ZX	Excision of Aortic Valve, Open Approach, Diagnostic
02BF0ZZ	Excision of Aortic Valve, Open Approach
02BF3ZX	Excision of Aortic Valve, Percutaneous Approach, Diagnostic
02BF3ZZ	Excision of Aortic Valve, Percutaneous Approach
02BF4ZX	Excision of Aortic Valve, Percutaneous Endoscopic Approach, Diagnostic
02BF4ZZ	Excision of Aortic Valve, Percutaneous Endoscopic Approach
02BG0ZX	Excision of Mitral Valve, Open Approach, Diagnostic
02BG0ZZ	Excision of Mitral Valve, Open Approach
02BG3ZX	Excision of Mitral Valve, Percutaneous Approach, Diagnostic
02BG3ZZ	Excision of Mitral Valve, Percutaneous Approach
02BG4ZX	Excision of Mitral Valve, Percutaneous Endoscopic Approach, Diagnostic
02BG4ZZ	Excision of Mitral Valve, Percutaneous Endoscopic Approach
02BH0ZX	Excision of Pulmonary Valve, Open Approach, Diagnostic
02BH0ZZ	Excision of Pulmonary Valve, Open Approach
02BH3ZX	Excision of Pulmonary Valve, Percutaneous Approach, Diagnostic
02BH3ZZ	Excision of Pulmonary Valve, Percutaneous Approach
02BH4ZX	Excision of Pulmonary Valve, Percutaneous Endoscopic Approach, Diagnostic

02BH4ZZ	Excision of Pulmonary Valve, Percutaneous Endoscopic Approach
02BJ0ZX	Excision of Tricuspid Valve, Open Approach, Diagnostic
02BJ0ZZ	Excision of Tricuspid Valve, Open Approach
02BJ3ZX	Excision of Tricuspid Valve, Percutaneous Approach, Diagnostic
02BJ3ZZ	Excision of Tricuspid Valve, Percutaneous Approach
02BJ4ZX	Excision of Tricuspid Valve, Percutaneous Endoscopic Approach, Diagnostic
02BJ4ZZ	Excision of Tricuspid Valve, Percutaneous Endoscopic Approach
02CF0ZZ	Extirpation of Matter from Aortic Valve, Open Approach
02CF3ZZ	Extirpation of Matter from Aortic Valve, Percutaneous Approach
02CF4ZZ	Extirpation of Matter from Aortic Valve, Percutaneous Endoscopic Approach
02CG0ZZ	Extirpation of Matter from Mitral Valve, Open Approach
02CG3ZZ	Extirpation of Matter from Mitral Valve, Percutaneous Approach
02CG4ZZ	Extirpation of Matter from Mitral Valve, Percutaneous Endoscopic Approach
02CH0ZZ	Extirpation of Matter from Pulmonary Valve, Open Approach
02CH3ZZ	Extirpation of Matter from Pulmonary Valve, Percutaneous Approach
02CH4ZZ	Extirpation of Matter from Pulmonary Valve, Percutaneous Endoscopic Approach
02CJ0ZZ	Extirpation of Matter from Tricuspid Valve, Open Approach
02CJ3ZZ	Extirpation of Matter from Tricuspid Valve, Percutaneous Approach
02CJ4ZZ	Extirpation of Matter from Tricuspid Valve, Percutaneous Endoscopic Approach
02LH0CZ	Occlusion of Pulmonary Valve with Extraluminal Device, Open Approach
02LH0DZ	Occlusion of Pulmonary Valve with Intraluminal Device, Open Approach
02LH0ZZ	Occlusion of Pulmonary Valve, Open Approach
02LH3CZ	Occlusion of Pulmonary Valve with Extraluminal Device, Percutaneous Approach
02LH3DZ	Occlusion of Pulmonary Valve with Intraluminal Device, Percutaneous Approach
02LH3ZZ	Occlusion of Pulmonary Valve, Percutaneous Approach
02LH4CZ	Occlusion of Pulmonary Valve with Extraluminal Device, Percutaneous Endoscopic Approach
02LH4DZ	Occlusion of Pulmonary Valve with Intraluminal Device, Percutaneous Endoscopic Approach
02LH4ZZ	Occlusion of Pulmonary Valve, Percutaneous Endoscopic Approach
02NF0ZZ	Release Aortic Valve, Open Approach
02NF3ZZ	Release Aortic Valve, Percutaneous Approach
02NF4ZZ	Release Aortic Valve, Percutaneous Endoscopic Approach
02NG0ZZ	Release Mitral Valve, Open Approach
02NG3ZZ	Release Mitral Valve, Percutaneous Approach
02NG4ZZ	Release Mitral Valve, Percutaneous Endoscopic Approach
02NH0ZZ	Release Pulmonary Valve, Open Approach
02NH3ZZ	Release Pulmonary Valve, Percutaneous Approach
02NH4ZZ	Release Pulmonary Valve, Percutaneous Endoscopic Approach
02NJ0ZZ	Release Tricuspid Valve, Open Approach
02NJ3ZZ	Release Tricuspid Valve, Percutaneous Approach
02NJ4ZZ	Release Tricuspid Valve, Percutaneous Endoscopic Approach
02QF0ZJ	Repair Aortic Valve created from Truncal Valve, Open Approach

02QF0ZZ	Repair Aortic Valve, Open Approach
02QF3ZJ	Repair Aortic Valve created from Truncal Valve, Percutaneous Approach
02QF3ZZ	Repair Aortic Valve, Percutaneous Approach
02QF4ZJ	Repair Aortic Valve created from Truncal Valve, Percutaneous Endoscopic Approach
02QF4ZZ	Repair Aortic Valve, Percutaneous Endoscopic Approach
02QG0ZE	Repair Mitral Valve created from Left Atrioventricular Valve, Open Approach
02QG0ZZ	Repair Mitral Valve, Open Approach
02QG3ZE	Repair Mitral Valve created from Left Atrioventricular Valve, Percutaneous Approach
02QG3ZZ	Repair Mitral Valve, Percutaneous Approach
02QG4ZE	Repair Mitral Valve created from Left Atrioventricular Valve, Percutaneous Endoscopic Approach
02QG4ZZ	Repair Mitral Valve, Percutaneous Endoscopic Approach
02QH0ZZ	Repair Pulmonary Valve, Open Approach
02QH3ZZ	Repair Pulmonary Valve, Percutaneous Approach
02QH4ZZ	Repair Pulmonary Valve, Percutaneous Endoscopic Approach
02QJ0ZG	Repair Tricuspid Valve created from Right Atrioventricular Valve, Open Approach
02QJ0ZZ	Repair Tricuspid Valve, Open Approach
02QJ3ZG	Repair Tricuspid Valve created from Right Atrioventricular Valve, Percutaneous Approach
02QJ3ZZ	Repair Tricuspid Valve, Percutaneous Approach
02QJ4ZG	Repair Tricuspid Valve created from Right Atrioventricular Valve, Percutaneous Endoscopic Approach
02QJ4ZZ	Repair Tricuspid Valve, Percutaneous Endoscopic Approach
02RF07Z	Replacement of Aortic Valve with Autologous Tissue Substitute, Open Approach
02RF08Z	Replacement of Aortic Valve with Zooplasic Tissue, Open Approach
02RF0JZ	Replacement of Aortic Valve with Synthetic Substitute, Open Approach
02RF0KZ	Replacement of Aortic Valve with Nonautologous Tissue Substitute, Open Approach
02RF37H	Replacement of Aortic Valve with Autologous Tissue Substitute, Transapical, Percutaneous Approach
02RF37Z	Replacement of Aortic Valve with Autologous Tissue Substitute, Percutaneous Approach
02RF38H	Replacement of Aortic Valve with Zooplasic Tissue, Transapical, Percutaneous Approach
02RF38Z	Replacement of Aortic Valve with Zooplasic Tissue, Percutaneous Approach
02RF3JH	Replacement of Aortic Valve with Synthetic Substitute, Transapical, Percutaneous Approach
02RF3JZ	Replacement of Aortic Valve with Synthetic Substitute, Percutaneous Approach
02RF3KH	Replacement of Aortic Valve with Nonautologous Tissue Substitute, Transapical, Percutaneous Approach
02RF3KZ	Replacement of Aortic Valve with Nonautologous Tissue Substitute, Percutaneous Approach
02RF47Z	Replacement of Aortic Valve with Autologous Tissue Substitute, Percutaneous Endoscopic Approach
02RF48Z	Replacement of Aortic Valve with Zooplasic Tissue, Percutaneous Endoscopic Approach
02RF4JZ	Replacement of Aortic Valve with Synthetic Substitute, Percutaneous Endoscopic Approach
02RF4KZ	Replacement of Aortic Valve with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02RG07Z	Replacement of Mitral Valve with Autologous Tissue Substitute, Open Approach
02RG08Z	Replacement of Mitral Valve with Zooplasic Tissue, Open Approach
02RG0JZ	Replacement of Mitral Valve with Synthetic Substitute, Open Approach
02RG0KZ	Replacement of Mitral Valve with Nonautologous Tissue Substitute, Open Approach
02RG37H	Replacement of Mitral Valve with Autologous Tissue Substitute, Transapical, Percutaneous Approach

02RG37Z	Replacement of Mitral Valve with Autologous Tissue Substitute, Percutaneous Approach
02RG38H	Replacement of Mitral Valve with Zooplastic Tissue, Transapical, Percutaneous Approach
02RG38Z	Replacement of Mitral Valve with Zooplastic Tissue, Percutaneous Approach
02RG3JH	Replacement of Mitral Valve with Synthetic Substitute, Transapical, Percutaneous Approach
02RG3JZ	Replacement of Mitral Valve with Synthetic Substitute, Percutaneous Approach
02RG3KH	Replacement of Mitral Valve with Nonautologous Tissue Substitute, Transapical, Percutaneous Approach
02RG3KZ	Replacement of Mitral Valve with Nonautologous Tissue Substitute, Percutaneous Approach
02RG47Z	Replacement of Mitral Valve with Autologous Tissue Substitute, Percutaneous Endoscopic Approach
02RG48Z	Replacement of Mitral Valve with Zooplastic Tissue, Percutaneous Endoscopic Approach
02RG4JZ	Replacement of Mitral Valve with Synthetic Substitute, Percutaneous Endoscopic Approach
02RG4KZ	Replacement of Mitral Valve with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02RH07Z	Replacement of Pulmonary Valve with Autologous Tissue Substitute, Open Approach
02RH08Z	Replacement of Pulmonary Valve with Zooplastic Tissue, Open Approach
02RH0JZ	Replacement of Pulmonary Valve with Synthetic Substitute, Open Approach
02RH0KZ	Replacement of Pulmonary Valve with Nonautologous Tissue Substitute, Open Approach
02RH37H	Replacement of Pulmonary Valve with Autologous Tissue Substitute, Transapical, Percutaneous Approach
02RH37Z	Replacement of Pulmonary Valve with Autologous Tissue Substitute, Percutaneous Approach
02RH38H	Replacement of Pulmonary Valve with Zooplastic Tissue, Transapical, Percutaneous Approach
02RH38Z	Replacement of Pulmonary Valve with Zooplastic Tissue, Percutaneous Approach
02RH3JH	Replacement of Pulmonary Valve with Synthetic Substitute, Transapical, Percutaneous Approach
02RH3JZ	Replacement of Pulmonary Valve with Synthetic Substitute, Percutaneous Approach
02RH3KH	Replacement of Pulmonary Valve with Nonautologous Tissue Substitute, Transapical, Percutaneous Approach
02RH3KZ	Replacement of Pulmonary Valve with Nonautologous Tissue Substitute, Percutaneous Approach
02RH47Z	Replacement of Pulmonary Valve with Autologous Tissue Substitute, Percutaneous Endoscopic Approach
02RH48Z	Replacement of Pulmonary Valve with Zooplastic Tissue, Percutaneous Endoscopic Approach
02RH4JZ	Replacement of Pulmonary Valve with Synthetic Substitute, Percutaneous Endoscopic Approach
02RH4KZ	Replacement of Pulmonary Valve with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02RJ07Z	Replacement of Tricuspid Valve with Autologous Tissue Substitute, Open Approach
02RJ08Z	Replacement of Tricuspid Valve with Zooplastic Tissue, Open Approach
02RJ0JZ	Replacement of Tricuspid Valve with Synthetic Substitute, Open Approach
02RJ0KZ	Replacement of Tricuspid Valve with Nonautologous Tissue Substitute, Open Approach
02RJ37H	Replacement of Tricuspid Valve with Autologous Tissue Substitute, Transapical, Percutaneous Approach
02RJ37Z	Replacement of Tricuspid Valve with Autologous Tissue Substitute, Percutaneous Approach
02RJ38H	Replacement of Tricuspid Valve with Zooplastic Tissue, Transapical, Percutaneous Approach
02RJ38Z	Replacement of Tricuspid Valve with Zooplastic Tissue, Percutaneous Approach
02RJ3JH	Replacement of Tricuspid Valve with Synthetic Substitute, Transapical, Percutaneous Approach
02RJ3JZ	Replacement of Tricuspid Valve with Synthetic Substitute, Percutaneous Approach
02RJ3KH	Replacement of Tricuspid Valve with Nonautologous Tissue Substitute, Transapical, Percutaneous Approach
02RJ3KZ	Replacement of Tricuspid Valve with Nonautologous Tissue Substitute, Percutaneous Approach
02RJ47Z	Replacement of Tricuspid Valve with Autologous Tissue Substitute, Percutaneous Endoscopic Approach
02RJ48Z	Replacement of Tricuspid Valve with Zooplastic Tissue, Percutaneous Endoscopic Approach

02RJ4JZ	Replacement of Tricuspid Valve with Synthetic Substitute, Percutaneous Endoscopic Approach
02RJ4KZ	Replacement of Tricuspid Valve with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02TH0ZZ	Resection of Pulmonary Valve, Open Approach
02TH3ZZ	Resection of Pulmonary Valve, Percutaneous Approach
02TH4ZZ	Resection of Pulmonary Valve, Percutaneous Endoscopic Approach
02UF07J	Supplement Aortic Valve created from Truncal Valve with Autologous Tissue Substitute, Open Approach
02UF07Z	Supplement Aortic Valve with Autologous Tissue Substitute, Open Approach
02UF08J	Supplement Aortic Valve created from Truncal Valve with Zooplastic Tissue, Open Approach
02UF08Z	Supplement Aortic Valve with Zooplastic Tissue, Open Approach
02UF0JJ	Supplement Aortic Valve created from Truncal Valve with Synthetic Substitute, Open Approach
02UF0JZ	Supplement Aortic Valve with Synthetic Substitute, Open Approach
02UF0KJ	Supplement Aortic Valve created from Truncal Valve with Nonautologous Tissue Substitute, Open Approach
02UF0KZ	Supplement Aortic Valve with Nonautologous Tissue Substitute, Open Approach
02UF37J	Supplement Aortic Valve created from Truncal Valve with Autologous Tissue Substitute, Percutaneous Approach
02UF37Z	Supplement Aortic Valve with Autologous Tissue Substitute, Percutaneous Approach
02UF38J	Supplement Aortic Valve created from Truncal Valve with Zooplastic Tissue, Percutaneous Approach
02UF38Z	Supplement Aortic Valve with Zooplastic Tissue, Percutaneous Approach
02UF3JJ	Supplement Aortic Valve created from Truncal Valve with Synthetic Substitute, Percutaneous Approach
02UF3JZ	Supplement Aortic Valve with Synthetic Substitute, Percutaneous Approach
02UF3KJ	Supplement Aortic Valve created from Truncal Valve with Nonautologous Tissue Substitute, Percutaneous Approach
02UF3KZ	Supplement Aortic Valve with Nonautologous Tissue Substitute, Percutaneous Approach
02UF47J	Supplement Aortic Valve created from Truncal Valve with Autologous Tissue Substitute, Percutaneous Endoscopic Approach
02UF47Z	Supplement Aortic Valve with Autologous Tissue Substitute, Percutaneous Endoscopic Approach
02UF48J	Supplement Aortic Valve created from Truncal Valve with Zooplastic Tissue, Percutaneous Endoscopic Approach
02UF48Z	Supplement Aortic Valve with Zooplastic Tissue, Percutaneous Endoscopic Approach
02UF4JJ	Supplement Aortic Valve created from Truncal Valve with Synthetic Substitute, Percutaneous Endoscopic Approach
02UF4JZ	Supplement Aortic Valve with Synthetic Substitute, Percutaneous Endoscopic Approach
02UF4KJ	Supplement Aortic Valve created from Truncal Valve with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02UF4KZ	Supplement Aortic Valve with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02UG07E	Supplement Mitral Valve created from Left Atrioventricular Valve with Autologous Tissue Substitute, Open Approach
02UG07Z	Supplement Mitral Valve with Autologous Tissue Substitute, Open Approach
02UG08E	Supplement Mitral Valve created from Left Atrioventricular Valve with Zooplastic Tissue, Open Approach
02UG08Z	Supplement Mitral Valve with Zooplastic Tissue, Open Approach
02UG0JE	Supplement Mitral Valve created from Left Atrioventricular Valve with Synthetic Substitute, Open Approach
02UG0JZ	Supplement Mitral Valve with Synthetic Substitute, Open Approach
02UG0KE	Supplement Mitral Valve created from Left Atrioventricular Valve with Nonautologous Tissue Substitute, Open Approach

02UG0KZ	Supplement Mitral Valve with Nonautologous Tissue Substitute, Open Approach
02UG37E	Supplement Mitral Valve created from Left Atrioventricular Valve with Autologous Tissue Substitute, Percutaneous Approach
02UG37Z	Supplement Mitral Valve with Autologous Tissue Substitute, Percutaneous Approach
02UG38E	Supplement Mitral Valve created from Left Atrioventricular Valve with Zooplastic Tissue, Percutaneous Approach
02UG38Z	Supplement Mitral Valve with Zooplastic Tissue, Percutaneous Approach
02UG3JE	Supplement Mitral Valve created from Left Atrioventricular Valve with Synthetic Substitute, Percutaneous Approach
02UG3JZ	Supplement Mitral Valve with Synthetic Substitute, Percutaneous Approach
02UG3KE	Supplement Mitral Valve created from Left Atrioventricular Valve with Nonautologous Tissue Substitute, Percutaneous Approach
02UG3KZ	Supplement Mitral Valve with Nonautologous Tissue Substitute, Percutaneous Approach
02UG47E	Supplement Mitral Valve created from Left Atrioventricular Valve with Autologous Tissue Substitute, Percutaneous Endoscopic Approach
02UG47Z	Supplement Mitral Valve with Autologous Tissue Substitute, Percutaneous Endoscopic Approach
02UG48E	Supplement Mitral Valve created from Left Atrioventricular Valve with Zooplastic Tissue, Percutaneous Endoscopic Approach
02UG48Z	Supplement Mitral Valve with Zooplastic Tissue, Percutaneous Endoscopic Approach
02UG4JE	Supplement Mitral Valve created from Left Atrioventricular Valve with Synthetic Substitute, Percutaneous Endoscopic Approach
02UG4JZ	Supplement Mitral Valve with Synthetic Substitute, Percutaneous Endoscopic Approach
02UG4KE	Supplement Mitral Valve created from Left Atrioventricular Valve with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02UG4KZ	Supplement Mitral Valve with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02UH07Z	Supplement Pulmonary Valve with Autologous Tissue Substitute, Open Approach
02UH08Z	Supplement Pulmonary Valve with Zooplastic Tissue, Open Approach
02UH0JZ	Supplement Pulmonary Valve with Synthetic Substitute, Open Approach
02UH0KZ	Supplement Pulmonary Valve with Nonautologous Tissue Substitute, Open Approach
02UH37Z	Supplement Pulmonary Valve with Autologous Tissue Substitute, Percutaneous Approach
02UH38Z	Supplement Pulmonary Valve with Zooplastic Tissue, Percutaneous Approach
02UH3JZ	Supplement Pulmonary Valve with Synthetic Substitute, Percutaneous Approach
02UH3KZ	Supplement Pulmonary Valve with Nonautologous Tissue Substitute, Percutaneous Approach
02UH47Z	Supplement Pulmonary Valve with Autologous Tissue Substitute, Percutaneous Endoscopic Approach
02UH48Z	Supplement Pulmonary Valve with Zooplastic Tissue, Percutaneous Endoscopic Approach
02UH4JZ	Supplement Pulmonary Valve with Synthetic Substitute, Percutaneous Endoscopic Approach
02UH4KZ	Supplement Pulmonary Valve with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02UJ07G	Supplement Tricuspid Valve created from Right Atrioventricular Valve with Autologous Tissue Substitute, Open Approach
02UJ07Z	Supplement Tricuspid Valve with Autologous Tissue Substitute, Open Approach
02UJ08G	Supplement Tricuspid Valve created from Right Atrioventricular Valve with Zooplastic Tissue, Open Approach
02UJ08Z	Supplement Tricuspid Valve with Zooplastic Tissue, Open Approach
02UJ0JG	Supplement Tricuspid Valve created from Right Atrioventricular Valve with Synthetic Substitute, Open Approach
02UJ0JZ	Supplement Tricuspid Valve with Synthetic Substitute, Open Approach

02UJ0KG	Supplement Tricuspid Valve created from Right Atrioventricular Valve with Nonautologous Tissue Substitute, Open Approach
02UJ0KZ	Supplement Tricuspid Valve with Nonautologous Tissue Substitute, Open Approach
02UJ37G	Supplement Tricuspid Valve created from Right Atrioventricular Valve with Autologous Tissue Substitute, Percutaneous Approach
02UJ37Z	Supplement Tricuspid Valve with Autologous Tissue Substitute, Percutaneous Approach
02UJ38G	Supplement Tricuspid Valve created from Right Atrioventricular Valve with Zooplasic Tissue, Percutaneous Approach
02UJ38Z	Supplement Tricuspid Valve with Zooplasic Tissue, Percutaneous Approach
02UJ3JG	Supplement Tricuspid Valve created from Right Atrioventricular Valve with Synthetic Substitute, Percutaneous Approach
02UJ3JZ	Supplement Tricuspid Valve with Synthetic Substitute, Percutaneous Approach
02UJ3KG	Supplement Tricuspid Valve created from Right Atrioventricular Valve with Nonautologous Tissue Substitute, Percutaneous Approach
02UJ3KZ	Supplement Tricuspid Valve with Nonautologous Tissue Substitute, Percutaneous Approach
02UJ47G	Supplement Tricuspid Valve created from Right Atrioventricular Valve with Autologous Tissue Substitute, Percutaneous Endoscopic Approach
02UJ47Z	Supplement Tricuspid Valve with Autologous Tissue Substitute, Percutaneous Endoscopic Approach
02UJ48G	Supplement Tricuspid Valve created from Right Atrioventricular Valve with Zooplasic Tissue, Percutaneous Endoscopic Approach
02UJ48Z	Supplement Tricuspid Valve with Zooplasic Tissue, Percutaneous Endoscopic Approach
02UJ4JG	Supplement Tricuspid Valve created from Right Atrioventricular Valve with Synthetic Substitute, Percutaneous Endoscopic Approach
02UJ4JZ	Supplement Tricuspid Valve with Synthetic Substitute, Percutaneous Endoscopic Approach
02UJ4KG	Supplement Tricuspid Valve created from Right Atrioventricular Valve with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02UJ4KZ	Supplement Tricuspid Valve with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02VG0ZZ	Restriction of Mitral Valve, Open Approach
02VG3ZZ	Restriction of Mitral Valve, Percutaneous Approach
02VG4ZZ	Restriction of Mitral Valve, Percutaneous Endoscopic Approach
02WF07Z	Revision of Autologous Tissue Substitute in Aortic Valve, Open Approach
02WF08Z	Revision of Zooplasic Tissue in Aortic Valve, Open Approach
02WF0JZ	Revision of Synthetic Substitute in Aortic Valve, Open Approach
02WF0KZ	Revision of Nonautologous Tissue Substitute in Aortic Valve, Open Approach
02WF37Z	Revision of Autologous Tissue Substitute in Aortic Valve, Percutaneous Approach
02WF38Z	Revision of Zooplasic Tissue in Aortic Valve, Percutaneous Approach
02WF3JZ	Revision of Synthetic Substitute in Aortic Valve, Percutaneous Approach
02WF3KZ	Revision of Nonautologous Tissue Substitute in Aortic Valve, Percutaneous Approach
02WF47Z	Revision of Autologous Tissue Substitute in Aortic Valve, Percutaneous Endoscopic Approach
02WF48Z	Revision of Zooplasic Tissue in Aortic Valve, Percutaneous Endoscopic Approach
02WF4JZ	Revision of Synthetic Substitute in Aortic Valve, Percutaneous Endoscopic Approach
02WF4KZ	Revision of Nonautologous Tissue Substitute in Aortic Valve, Percutaneous Endoscopic Approach
02WG07Z	Revision of Autologous Tissue Substitute in Mitral Valve, Open Approach
02WG08Z	Revision of Zooplasic Tissue in Mitral Valve, Open Approach
02WG0JZ	Revision of Synthetic Substitute in Mitral Valve, Open Approach

02WG0KZ	Revision of Nonautologous Tissue Substitute in Mitral Valve, Open Approach
02WG37Z	Revision of Autologous Tissue Substitute in Mitral Valve, Percutaneous Approach
02WG38Z	Revision of Zooplastic Tissue in Mitral Valve, Percutaneous Approach
02WG3JZ	Revision of Synthetic Substitute in Mitral Valve, Percutaneous Approach
02WG3KZ	Revision of Nonautologous Tissue Substitute in Mitral Valve, Percutaneous Approach
02WG47Z	Revision of Autologous Tissue Substitute in Mitral Valve, Percutaneous Endoscopic Approach
02WG48Z	Revision of Zooplastic Tissue in Mitral Valve, Percutaneous Endoscopic Approach
02WG4JZ	Revision of Synthetic Substitute in Mitral Valve, Percutaneous Endoscopic Approach
02WG4KZ	Revision of Nonautologous Tissue Substitute in Mitral Valve, Percutaneous Endoscopic Approach
02WH07Z	Revision of Autologous Tissue Substitute in Pulmonary Valve, Open Approach
02WH08Z	Revision of Zooplastic Tissue in Pulmonary Valve, Open Approach
02WH0JZ	Revision of Synthetic Substitute in Pulmonary Valve, Open Approach
02WH0KZ	Revision of Nonautologous Tissue Substitute in Pulmonary Valve, Open Approach
02WH37Z	Revision of Autologous Tissue Substitute in Pulmonary Valve, Percutaneous Approach
02WH38Z	Revision of Zooplastic Tissue in Pulmonary Valve, Percutaneous Approach
02WH3JZ	Revision of Synthetic Substitute in Pulmonary Valve, Percutaneous Approach
02WH3KZ	Revision of Nonautologous Tissue Substitute in Pulmonary Valve, Percutaneous Approach
02WH47Z	Revision of Autologous Tissue Substitute in Pulmonary Valve, Percutaneous Endoscopic Approach
02WH48Z	Revision of Zooplastic Tissue in Pulmonary Valve, Percutaneous Endoscopic Approach
02WH4JZ	Revision of Synthetic Substitute in Pulmonary Valve, Percutaneous Endoscopic Approach
02WH4KZ	Revision of Nonautologous Tissue Substitute in Pulmonary Valve, Percutaneous Endoscopic Approach
02WJ07Z	Revision of Autologous Tissue Substitute in Tricuspid Valve, Open Approach
02WJ08Z	Revision of Zooplastic Tissue in Tricuspid Valve, Open Approach
02WJ0JZ	Revision of Synthetic Substitute in Tricuspid Valve, Open Approach
02WJ0KZ	Revision of Nonautologous Tissue Substitute in Tricuspid Valve, Open Approach
02WJ37Z	Revision of Autologous Tissue Substitute in Tricuspid Valve, Percutaneous Approach
02WJ38Z	Revision of Zooplastic Tissue in Tricuspid Valve, Percutaneous Approach
02WJ3JZ	Revision of Synthetic Substitute in Tricuspid Valve, Percutaneous Approach
02WJ3KZ	Revision of Nonautologous Tissue Substitute in Tricuspid Valve, Percutaneous Approach
02WJ47Z	Revision of Autologous Tissue Substitute in Tricuspid Valve, Percutaneous Endoscopic Approach
02WJ48Z	Revision of Zooplastic Tissue in Tricuspid Valve, Percutaneous Endoscopic Approach
02WJ4JZ	Revision of Synthetic Substitute in Tricuspid Valve, Percutaneous Endoscopic Approach
02WJ4KZ	Revision of Nonautologous Tissue Substitute in Tricuspid Valve, Percutaneous Endoscopic Approach
I25.700	Atherosclerosis of coronary artery bypass graft(s), unspecified, with unstable angina pectoris
I25.701	Atherosclerosis of coronary artery bypass graft(s), unspecified, with angina pectoris with documented spasm
I25.708	Atherosclerosis of coronary artery bypass graft(s), unspecified, with other forms of angina pectoris
I25.709	Atherosclerosis of coronary artery bypass graft(s), unspecified, with unspecified angina pectoris
I25.710	Atherosclerosis of autologous vein coronary artery bypass graft(s) with unstable angina pectoris
I25.711	Atherosclerosis of autologous vein coronary artery bypass graft(s) with angina pectoris with documented spasm
I25.718	Atherosclerosis of autologous vein coronary artery bypass graft(s) with other forms of angina pectoris
I25.719	Atherosclerosis of autologous vein coronary artery bypass graft(s) with unspecified angina pectoris

I25.720	Atherosclerosis of autologous artery coronary artery bypass graft(s) with unstable angina pectoris
I25.721	Atherosclerosis of autologous artery coronary artery bypass graft(s) with angina pectoris with documented spasm
I25.728	Atherosclerosis of autologous artery coronary artery bypass graft(s) with other forms of angina pectoris
I25.729	Atherosclerosis of autologous artery coronary artery bypass graft(s) with unspecified angina pectoris
I25.730	Atherosclerosis of nonautologous biological coronary artery bypass graft(s) with unstable angina pectoris
I25.731	Atherosclerosis of nonautologous biological coronary artery bypass graft(s) with angina pectoris with documented spasm
I25.738	Atherosclerosis of nonautologous biological coronary artery bypass graft(s) with other forms of angina pectoris
I25.739	Atherosclerosis of nonautologous biological coronary artery bypass graft(s) with unspecified angina pectoris
I25.750	Atherosclerosis of native coronary artery of transplanted heart with unstable angina
I25.751	Atherosclerosis of native coronary artery of transplanted heart with angina pectoris with documented spasm
I25.758	Atherosclerosis of native coronary artery of transplanted heart with other forms of angina pectoris
I25.759	Atherosclerosis of native coronary artery of transplanted heart with unspecified angina pectoris
I25.760	Atherosclerosis of bypass graft of coronary artery of transplanted heart with unstable angina
I25.761	Atherosclerosis of bypass graft of coronary artery of transplanted heart with angina pectoris with documented spasm
I25.768	Atherosclerosis of bypass graft of coronary artery of transplanted heart with other forms of angina pectoris
I25.769	Atherosclerosis of bypass graft of coronary artery of transplanted heart with unspecified angina pectoris
I25.790	Atherosclerosis of other coronary artery bypass graft(s) with unstable angina pectoris
I25.791	Atherosclerosis of other coronary artery bypass graft(s) with angina pectoris with documented spasm
I25.798	Atherosclerosis of other coronary artery bypass graft(s) with other forms of angina pectoris
I25.799	Atherosclerosis of other coronary artery bypass graft(s) with unspecified angina pectoris
I25.810	Atherosclerosis of coronary artery bypass graft(s) without angina pectoris
I25.811	Atherosclerosis of native coronary artery of transplanted heart without angina pectoris
I25.812	Atherosclerosis of bypass graft of coronary artery of transplanted heart without angina pectoris
T82.01XD	Breakdown (mechanical) of heart valve prosthesis, subsequent encounter
T82.01XS	Breakdown (mechanical) of heart valve prosthesis, sequela
T82.02XD	Displacement of heart valve prosthesis, subsequent encounter
T82.02XS	Displacement of heart valve prosthesis, sequela
T82.03XD	Leakage of heart valve prosthesis, subsequent encounter
T82.03XS	Leakage of heart valve prosthesis, sequela
T82.09XD	Other mechanical complication of heart valve prosthesis, subsequent encounter
T82.09XS	Other mechanical complication of heart valve prosthesis, sequela
T82.211D	Breakdown (mechanical) of coronary artery bypass graft, subsequent encounter
T82.211S	Breakdown (mechanical) of coronary artery bypass graft, sequela
T82.212D	Displacement of coronary artery bypass graft, subsequent encounter
T82.212S	Displacement of coronary artery bypass graft, sequela
T82.213D	Leakage of coronary artery bypass graft, subsequent encounter
T82.213S	Leakage of coronary artery bypass graft, sequela
T82.218D	Other mechanical complication of coronary artery bypass graft, subsequent encounter
T82.218S	Other mechanical complication of coronary artery bypass graft, sequela

T82.221D	Breakdown (mechanical) of biological heart valve graft, subsequent encounter
T82.221S	Breakdown (mechanical) of biological heart valve graft, sequela
T82.222D	Displacement of biological heart valve graft, subsequent encounter
T82.222S	Displacement of biological heart valve graft, sequela
T82.223D	Leakage of biological heart valve graft, subsequent encounter
T82.223S	Leakage of biological heart valve graft, sequela
T82.228D	Other mechanical complication of biological heart valve graft, subsequent encounter
T82.228S	Other mechanical complication of biological heart valve graft, sequela
T82.6XXD	Infection and inflammatory reaction due to cardiac valve prosthesis, subsequent encounter
T82.6XXS	Infection and inflammatory reaction due to cardiac valve prosthesis, sequela
X2R.F032	Replacement of Aortic Valve using Zooplastic Tissue, Rapid Deployment Technique, Open Approach, New Technology Group 2
X2R.F332	Replacement of Aortic Valve using Zooplastic Tissue, Rapid Deployment Technique, Percutaneous Approach, New Technology Group 2
X2R.F432	Replacement of Aortic Valve using Zooplastic Tissue, Rapid Deployment Technique, Percutaneous Endoscopic Approach, New Technology Group 2
Z95.1	Presence of aortocoronary bypass graft
Z95.2	Presence of prosthetic heart valve
Z95.3	Presence of xenogenic heart valve
Z95.4	Presence of other heart-valve replacement
I25.10	Atherosclerotic heart disease of native coronary artery without angina pectoris
I25.110	Atherosclerotic heart disease of native coronary artery with unstable angina pectoris
I25.111	Atherosclerotic heart disease of native coronary artery with angina pectoris with documented spasm
I25.118	Atherosclerotic heart disease of native coronary artery with other forms of angina pectoris
I25.119	Atherosclerotic heart disease of native coronary artery with unspecified angina pectoris
I25.3	Aneurysm of heart
I25.41	Coronary artery aneurysm
I25.42	Coronary artery dissection
I25.5	Ischemic cardiomyopathy
I25.6	Silent myocardial ischemia
I25.82	Chronic total occlusion of coronary artery
I25.83	Coronary atherosclerosis due to lipid rich plaque
I25.89	Other forms of chronic ischemic heart disease
I25.9	Chronic ischemic heart disease, unspecified
Q24.5	Malformation of coronary vessels
R57.0	Cardiogenic shock
I25.2	Old myocardial infarction
02HA0QZ	Insertion of Implantable Heart Assist System into Heart, Open Approach
02HA0RJ	Insertion of Short-term External Heart Assist System into Heart, Intraoperative, Open Approach
02HA0RS	Insertion of Biventricular Short-term External Heart Assist System into Heart, Open Approach

02HA0RZ	Insertion of Short-term External Heart Assist System into Heart, Open Approach
02HA3QZ	Insertion of Implantable Heart Assist System into Heart, Percutaneous Approach
02HA3RJ	Insertion of Short-term External Heart Assist System into Heart, Intraoperative, Percutaneous Approach
02HA3RS	Insertion of Biventricular Short-term External Heart Assist System into Heart, Percutaneous Approach
02HA3RZ	Insertion of Short-term External Heart Assist System into Heart, Percutaneous Approach
02HA4QZ	Insertion of Implantable Heart Assist System into Heart, Percutaneous Endoscopic Approach
02HA4RJ	Insertion of Short-term External Heart Assist System into Heart, Intraoperative, Percutaneous Endoscopic Approach
02HA4RS	Insertion of Biventricular Short-term External Heart Assist System into Heart, Percutaneous Endoscopic Approach
02HA4RZ	Insertion of Short-term External Heart Assist System into Heart, Percutaneous Endoscopic Approach
02WA0QZ	Revision of Implantable Heart Assist System in Heart, Open Approach
02WA0RS	Revision of Biventricular Short-term External Heart Assist System in Heart, Open Approach
02WA0RZ	Revision of Short-term External Heart Assist System in Heart, Open Approach
02WA3QZ	Revision of Implantable Heart Assist System in Heart, Percutaneous Approach
02WA3RS	Revision of Biventricular Short-term External Heart Assist System in Heart, Percutaneous Approach
02WA3RZ	Revision of Short-term External Heart Assist System in Heart, Percutaneous Approach
02WA4QZ	Revision of Implantable Heart Assist System in Heart, Percutaneous Endoscopic Approach
02WA4RS	Revision of Biventricular Short-term External Heart Assist System in Heart, Percutaneous Endoscopic Approach
02WA4RZ	Revision of Short-term External Heart Assist System in Heart, Percutaneous Endoscopic Approach

5A02210	Assistance with Cardiac Output using Balloon Pump, Continuous
5A02116	Assistance with Cardiac Output using Other Pump, Intermittent
5A0211D	Assistance with Cardiac Output using Impeller Pump, Intermittent
5A02110	Assistance with Cardiac Output using Balloon Pump, Intermittent
5A02216	Assistance with Cardiac Output using Other Pump, Continuous
5A0221D	Assistance with Cardiac Output using Impeller Pump, Continuous