

Technical Report

Measure development for the Campaign for Effective Patient Care using patient discharge data

Laurence Baker, Ph.D.¹

The California HealthCare Foundation plans to release findings associated with this measure development effort for the following procedures: angiography, percutaneous coronary intervention (PCI), coronary artery bypass graft surgery (CABG), carotid endarterectomy, hip replacement, knee replacement, cholecystectomy, induction of child birth, cesarean section, vaginal birth after delivery (VBAC), hysterectomy, mastectomy and weight loss surgery. In addition, we developed several other measures using specifications that parallel specifications used in the Dartmouth Atlas that, while not part of the main set of results CHCF will present, are used below in comparisons with results from the Atlas.

1. Overview

The purpose of this analysis is to construct measures of the frequency with which various treatments are used, on a population basis, for HRRs and HSAs in California. The analysis is based on 2005-2009 hospital discharge data from the California Office of Statewide Health Planning and Development (OSHPD). To construct the measures, a set of treatments of interest was defined (see table below), and the number of hospitalizations in which each treatment observed was calculated. Each hospitalization was assigned to the HSA and HRR in which the patient lived. This data was then combined with area population data to produce measures of the rate of use of the treatment, per population. Regression adjustment was used to account for variations across areas in age, sex, race, education, income, and insurance status.

2. HRRs and HSAs

Data in this project are developed for Hospital Referral Regions (HRRs) and Hospital Service Areas (HSAs), according to the definitions developed in the Dartmouth Atlas project. HRRs and HSAs are collections of ZIP codes constructed to define areas appropriate for studying health care utilization.

The Dartmouth Atlas defines HRRs and HSAs as follows:

Hospital Referral Regions (HRRs) represent regional health care markets for tertiary medical care that generally requires the services of a major referral center. The regions were defined by determining where patients were referred for major cardiovascular surgical procedures and for neurosurgery. Each hospital service area (HSA) was examined to determine where most of its residents went for these services. The result was the aggregation of the 3,436 hospital service areas into 306 HRRs [for the entire United States]. Each HRR has at least one city where both major cardiovascular surgical procedures and neurosurgery are performed.

¹ Dr. Baker is Professor of Health Research and Policy and Chief of Health Services Research at the Stanford University School of Medicine. He performed this analysis acting as a consultant to the Campaign for Effective Patient Care.

Hospital Service Areas (HSAs) are local health care markets for hospital care. An HSA is a collection of ZIP codes whose residents receive most of their hospitalizations from the hospitals in that area. HSAs were defined by assigning ZIP codes to the hospital area where the greatest proportion of their Medicare residents were hospitalized. Minor adjustments were made to ensure geographic contiguity. This process resulted in 3,436 HSAs [in the entire United States]. When these regions were created in the early 1990s, most hospital service areas contained only one hospital. In the intervening years, hospital closures have left some HSAs with no hospital; these HSAs have been maintained as distinct areas in order to preserve the continuity of the database.

More information about HRRs and HSAs can be found at <http://www.dartmouthatlas.org/>.

This project focused on 24 HRRs designated by the Dartmouth Atlas as falling within California, and 209 HSAs located within those HRRs. There are 13 HSAs that are designated as California HSAs but that are within HRRs that are designated as falling in Nevada, Arizona, or Oregon. These HSAs are excluded.

HRRs are made up of HSAs. Some HRRs cross state boundaries, and include HSAs that fall within more than one state. Based on inspection of the HRR maps in the Dartmouth Atlas,² the set of California HRRs appears to contain almost exclusively HSAs that fall entirely within the California state boundaries. The one exception is the Sacramento HRR, which is almost entirely contained in California but appears to contain one HSA that includes part of Nevada.

After the measures were calculated, inspection of data from the South Lake Tahoe HSA suggested the possibility of inaccuracy, likely induced by people from South Lake Tahoe going to hospitals in Nevada for care, which would not be reflected in our data. A choice was made to exclude data on South Lake Tahoe HSA from further analyses, and results presented from the project thus only include 208 HSAs.

3. Identification of ZIP codes for study

The lists of ZIP codes assigned to California HRRs and HSAs by the Dartmouth Atlas project were obtained from the Atlas website (<http://www.dartmouthatlas.org/tools/downloads.aspx>). Separate HSA and HRR definitions are available for 2005, 2006, and 2007. This project also uses data from 2008 and 2009. Since the Atlas has not released definitions specific to 2008 and 2009 yet, the 2007 definitions were applied to the 2008 and 2009 hospitalization data.

The final measures produced by the project are ratios of the number of hospitalizations to area population. The area population measures for each HSA and HRR are constructed from public use ZIP-code-level population files obtained from the U.S. Census Bureau. It was thus necessary to compare the set of ZIP codes that are included in the HRR and HSA definitions with the set of ZIP codes for which Census population data is available, and construct the set of ZIP codes that are common to both.

Across the 3 years 2005-2007, there are 2,632 ZIP codes that appear at least once as part of a California HSA or HRR (2,619 in 2005, 2,613 in 2006, and 2,605 in 2007). Of these, 1,658 (63%) also appear in the ZIP code level population data files released by the Census Bureau. 21 of these could not be linked to a

² See <http://www.dartmouthatlas.org/downloads/atlas/98Atlas.pdf>

California county and were dropped, leaving 1,637. From these, those that never had any residents appear in the discharge data files were also dropped, leaving 1,519 ZIP codes in the final analysis. These are referred to as “eligible ZIP codes.”

While many ZIP codes included in the Dartmouth HRR and HSA definitions are dropped, this has little impact on the analysis since the dropped ZIP codes collectively have very low population. The set of eligible ZIP codes includes very nearly all of the California population. For example, the average 2005-2009 estimated population age 40 and over in the eligible ZIP codes is 15.87 million. The estimated statewide population 40 and over in 2007 from the California Department of Finance is 16.15 million.

4. Construction of measures

We identified a number of treatments on which measurement efforts were focused, aiming to select primarily treatments where patient shared decision making would be a relevant issue. Some of the treatments selected are based on previous work by: the Dartmouth Atlas; the Agency for Healthcare Quality and Research, particularly the AHRQ Inpatient Quality Indicators project; Health Dialog; or the Joint Commission.

For each treatment selected, a numerator and a denominator were defined. Numerators and denominators are all defined for particular populations. For many of the treatments, numerators and denominators are defined for persons age 20 and over, but some are defined for persons age 40 and over. Some are also restricted by sex (e.g. mastectomy is only defined for women).

Numerators count the number of times a hospitalization containing a given treatment is observed in the defined population. Some numerators are defined over all hospitalizations for people meeting that age and sex criteria, and others are defined for subsets of hospitalizations (e.g. for elective angiography, only hospitalizations where there is no evidence that the patient had an AMI, unstable angina, or shock.)

In most cases, denominators count the area population meeting the defined age and sex criteria. For labor and delivery treatments, the denominators count deliveries to women residing in the area that meet certain criteria.

The following table summarizes the measures analyzed in the project.

	Demographic Group	Denominator	Sources
Elective Angiography	age 40+	Area population	Project
Elective CABG	age 40+	Area population	Project
Elective PCI	age 40+	Area population	Project
Elective CABG or PCI	age 40+	Area population	Project
Elective stent	age 40+	Area population	Project
Any angiography	age 20+	Area population	Dartmouth

Any CABG	age 40+	Area population	Dartmouth, AHRQ
Any PCI	age 40+	Area population	Dartmouth
Any CABG or PCI	age 40+	Area population	Project
Cesarean delivery	Women age 20+	Delivery Hosp's	AHRQ
Any induction	Women age 20+	Delivery Hosp's	Project
Elective induction	Women age 20+	Delivery Hosp's	Project; JC
VBAC	Women age 20+	Delivery Hosp's	AHRQ
Total hip replacement	age 20+	Area population	Dartmouth
Total knee replacement	age 20+	Area population	Dartmouth
Back surgery	age 20+	Area population	Dartmouth
Vertebroplasty	age 20+	Area population	Project
Cholecystectomy	age 20+	Area population	Dartmouth
Colectomy for cancer	age 20+	Area population	Dartmouth
Carotid endarterectomy	age 20+	Area population	Dartmouth, AHRQ
Hysterectomy	Women age 20+	Area population	AHRQ
Lower extremity revascularization	age 20+	Area population	Dartmouth
Unilateral mastectomy for cancer	Women age 20+	Area population	Dartmouth
Radical prostatectomy	Men age 40+	Area population	Dartmouth
TURP for BPH	Men age 40+	Area population	Dartmouth
Aortic/mitral valve replacement	age 20+	Area population	Dartmouth
Weight loss surgery	age 20+	Area population	Health Dialog
Hospitalization with hip fracture	age 20+	Area population	Dartmouth

*Project = defined by the investigators as part of the project

4.a. Numerator calculations

For each measure, a detailed set of specifications was developed, identifying specific ICD-9 procedure codes, DRG codes, and/or ICD-9 diagnosis codes that would identify the receipt of treatment and (where specified) the appropriate patient group. The complete set of specifications for all measures examined can be found in Appendix 3.

All OSHPD discharge records for 2005-2009 were searched to identify hospitalizations meeting the criteria for each measure. Unless otherwise indicated in the specifications, the presence of an ICD-9 treatment or diagnosis code was determined based on up to 21 procedure codes or, respectively, up to 25 diagnosis codes reported in the OSHPD data. The same hospitalization could appear for more than one measure if the hospitalization met the criteria for more than one measure.

The sets of hospitalization records were then restricted to hospitalizations with a valid reported patient age, where the patient was a resident of a California county, and where the admission took place in an acute care hospital (as opposed to other types of hospitals, such as rehabilitation hospitals). These restrictions removed small numbers of records.

The sets were then further restricted to those where the patient was a resident of one of the eligible ZIP codes. This restriction removed approximately 4 percent of the records. The following table reports the rates of exclusion by measure.

Measure	Total Cases	In CA HRR with eligible ZIP		in CA HSA, with eligible ZIP	
		N	%	N	%
Elective angiography	118,955	114,490	96%	114,761	96%
Elective CABG	33,029	31,844	96%	31,907	97%
Elective PCI	77,075	74,431	97%	74,548	97%
Elective CABG or PCI	109,801	105,981	97%	106,160	97%
Elective stent	72,260	69,770	97%	69,883	97%
Any angiography	532,863	514,652	97%	515,612	97%
Any CABG	92,880	89,625	96%	89,810	97%
Any PCI	269,249	260,471	97%	260,900	97%
Any CABG or PCI	358,922	347,010	97%	347,612	97%
Cesarean delivery	303,494	294,477	97%	295,336	97%
Any induction	344,129	332,573	97%	333,755	97%
Elective induction	108,200	104,440	97%	104,796	97%
VBAC	31,060	30,261	97%	30,301	98%
Total hip replacement	108,334	104,146	96%	104,622	97%
Total knee replacement	218,461	210,183	96%	211,487	97%
Back surgery	245,538	234,899	96%	236,132	96%
Vertebroplasty	5,900	5,728	97%	5,737	97%
Cholecystectomy	224,344	216,398	96%	217,591	97%
Colectomy for cancer	36,530	35,371	97%	35,510	97%
Carotid Endarterectomy	40,220	38,811	96%	39,021	97%
Hysterectomy	213,668	205,129	96%	206,384	97%
Lower extremity revasc.	26,525	25,707	97%	25,797	97%
Unilateral mastectomy for cancer	25,960	25,003	96%	25,149	97%
Radical prostatectomy	33,483	32,181	96%	32,309	96%
TURP for BPH	41,260	39,837	97%	39,978	97%
Aortic/mitral valve replace	37,527	36,244	97%	36,333	97%

Weight loss surgery	13,447	12,873	96%	12,930	96%
Hosp for hip fracture	135,968	131,753	97%	132,380	97%

This produced the set of data used in the calculation of rates by area. Each resulting hospitalization was assigned to an HSA and an HRR based on the reported patient residence ZIP code, and the total number of hospitalizations for each measure for each area was computed.

4.b. Denominator calculations

Population data for each HSA and HRR were derived from the ZIP code level population data by the U.S. Census Bureau, based on the 2000 census. The census bureau does not release annual ZIP code level files. To account for changes over time in population, each ZIP code was assigned to a California county (based on prevalence of population) and annual county-level population files constructed by the Rand Corporation, which are updated for year to year population changes, were used to update the 2000 ZIP-code level data, to construct estimates of county population (by age and sex) for each year 2005-2009. These were then aggregated to determine population by age and sex for each HSA and HRR.

For the labor and delivery measures – cesarean delivery, induction, and VBAC – denominators are the number of qualifying deliveries to women residing in each area. These data were derived from the discharge data, using specifications included in Appendix 3.

4.c. Unadjusted measures

Unadjusted measures are simply the ratio of the number of qualifying hospitalizations in each area to the area population (or, for labor and delivery measures, the number of qualifying births in the area). They reflect the use of the procedure of interest as a function of population.

For confidentiality reasons, rates from any HSA or HRR with less than 15 numerator hospitalizations are suppressed.

4.d. Adjusted measures

Results adjusting for variations across areas in demographics and other characteristics were also computed. Regression adjustment was performed based on ZIP code level regressions estimated using generalized linear models (GLM) with a Poisson distribution and a log-link. The regressions adjusted for the following characteristics:

Age - the percent of the 2000 zip code population in each of 14 groups (20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, 85 and over):

Sex – the percent of the 2000 zip code population male and female

Race – the percent of the 2000 zip code population Black, the percent Asian, and the percent Hispanic.

Education rates – the share of the 2000 zip code population in each of 5 groups based on the amount of schooling completed (less than high school, high school graduate, some college, college graduate, any schooling beyond college graduation)

Income – the 1999 per capita income of the zip code

Population insurance status – the share of 2005-2009 hospitalizations in the OSHPD data in each of 9 groups (Medicare FFS, Medicare HMO, Medicaid FFS, Medicaid HMO, Private HMO, Private PPO, Private FFS, Self Pay, and Other)

We also explored controlling for population health status using two additional measures: the rate of AMI hospitalizations per 100,000 population at the Zip Code level,³ and the rate of hospitalizations in which the patient has a diabetes diagnosis code⁴ per 100,000 population at the Zip Code level. We computed adjusted measures without and then with these two additional controls in the model.

Sample means are shown in the following table. (These means are computed using the Zip Code as the unit of measurement.)

³ The presence of any of the following codes in any diagnosis field was taken to indicate an AMI hospitalization: 410.10, 410.01, 410.10, 410.11, 410.20, 410.21, 410.30, 410.31, 410.40, 410.41, 410.50, 410.51, 410.60, 410.61, 410.70, 410.71, 410.80, 410.81, 410.90, 410.91. Rates are computed on the population over age 20.

⁴ The presence of any of the following codes in any diagnosis field was taken to indicate a hospitalization of interest: 250.0, 250.00, 250.01, 250.02, 250.03, 250.1, 250.10, 250.11, 250.12, 250.13, 250.2, 250.20, 250.21, 250.22, 250.23, 250.3, 250.30, 250.31, 250.32, 250.33, 250.4, 250.40, 250.41, 250.42, 250.43, 250.5, 250.50, 250.51, 250.52, 250.53, 250.6, 250.60, 250.61, 250.62, 250.63, 250.7, 250.70, 250.71, 250.72, 250.73, 250.8, 250.80, 250.81, 250.82, 250.83, 250.9, 250.90, 250.91, 250.92, 250.93, 658.0, 648.00, 648.01, 648.02, 648.03, 648.04. Rates are computed on the population over age 20.

Measure	Mean
Per Capita Income (1999) [000s]	4.74
Percent population female (2000)	49.69%
Percent of the population 25-29 (2000)	6.28%
Percent of the population 30-34 (2000)	7.02%
Percent of the population 35-39 (2000)	8.22%
Percent of the population 40-44 (2000)	8.28%
Percent of the population 45-49 (2000)	7.56%
Percent of the population 50-54 (2000)	6.65%
Percent of the population 55-59 (2000)	5.09%
Percent of the population 60-64 (2000)	4.11%
Percent of the population 65-69 (2000)	3.60%
Percent of the population 70-74 (2000)	3.30%
Percent of the population 75-79 (2000)	2.64%
Percent of the population 80-84 (2000)	1.72%
Percent of the population 85 and over (2000)	1.37%
Percent of the population Black (2000)	4.45%
Percent of the population Asian (2000)	7.47%
Percent of the population Hispanic (2000)	25.48%
Percent of the population high school grad (2000)	21.69%
Percent of the population with some college (2000)	31.07%
Percent of the population college graduate (2000)	15.78%
Percent of the population more than college grad (2000)	9.16%
Share of hospitalizations Medicare FFS (2005-09)	26.41%
Share of hospitalizations Medicare HMO (2005-09)	7.70%
Share of hospitalizations Medicaid FFS (2005-09)	17.15%
Share of hospitalizations Medicaid HMO (2005-09)	4.95%
Share of hospitalizations Private HMO (2005-09)	18.31%
Share of hospitalizations Private PPO (2005-09)	14.32%
Share of hospitalizations Private FFS (2005-09)	2.88%
Share of hospitalizations self pay (2005-09)	3.24%
AMI hospitalizations per 100000	46.26
Diabetes hospitalizations per 100000	470.44

N=7,595 (1,519 zip codes * 5 years)

Adjusted measures were computed for each area, holding area characteristics fixed at their sample means.

In some cases, the regression model failed to converge, particularly for HSA-level data due to the presence of HSAs with few numerator hospitalizations. In these cases, models were progressively estimated using fewer HSAs, incrementally in groups of 25 HSAs (i.e. if estimation with 209 HSAs failed, try 200, then 175, then 150, etc until successful estimation was achieved.)

5. Measures by age group

After computing measures including all eligible hospitalizations, separate measures were computed for patients under age 65 and age 65 and over. These were computed as described above, limiting the numerator and denominator populations to hospitalizations and population in the relevant age groups. Labor and delivery measures were not computed for the over-65 population.

6. Comparison with Dartmouth

One check on the validity of the measures is to compare them to other independently computed measures. The Dartmouth Atlas reports rates for many of the same procedures we studied, for individuals in traditional (FFS) Medicare who are age 65 and over.

In cases where there were comparable measures, I computed the correlation coefficient between our adjusted OSHPD-based HRR measure for the over 65 population (for 2005-2009) and the Dartmouth (adjusted⁵) HRR measure for the traditional FFS population from 2005. The ratio of the highest and lowest HRR, and the correlation between the two measures are shown in the following table. Correlations are generally quite high, indicating that the general patterns seen in our data and the Dartmouth atlas data are similar.

	Hi-Low Ratio OSHPD	Hi-Low Ratio Dartmouth	Correlation
Any Angiography ⁶	2.91	2.28	0.79
Any CABG ⁶	2.42	2.11	0.83
Any angioplasty (PCI) ⁶	2.21	3.29	0.86
Hip replacement	2.12	2.08	0.68
Knee replacement	1.90	1.98	0.80
Back Surgery	2.51	2.37	0.72
Cholecystectomy	2.12	1.93	0.63

⁵ Dartmouth measures are adjusted for age, sex, and race.

⁶ Note that these specifications differ from the specifications “elective angiography, CABG, and PCI” on which we focus in the main report. The measures used here follow the same specifications as those in the Dartmouth Atlas.

Colectomy for cancer	1.54	1.96	0.39
Carotid Endarterectomy	2.83	3.84	0.91
Lower extremity revascularization	2.45	4.29	0.80
Unilateral mastectomy for cancer	2.85	2.64	0.53
TURP for BPH	4.84	4.75	0.79
Aortic/mitral valve replacement	1.72	3.32	0.80
Hospitalization for hip fracture	1.70	1.51	0.79

8. Calculations using the ASC data

Some procedures may be performed in Ambulatory Surgery Centers as well as in hospitals. We also obtained data on ASC procedures from OSHPD and conducted some analyses using these data. This was done following the same procedures described above.

We only computed ASC measures for some of the study conditions. We explored measures capturing angiography, angioplasty (PCI), stents, cholecystectomy, carotid endarterectomy, back surgery, unilateral mastectomy, and weight loss surgery. For carotid endarterectomy, we found too few cases to do any meaningful analyses and this was not pursued further. For angioplasty (PCI) and stent measures, we found a small number of cases but enough to do analyses at the HRR level. For the other measures, enough cases were found for analyses.

The ASC data identify procedures using CPT codes instead of ICD-9 procedure codes. This required the development of a separate set of specifications for the procedures of interest. These were done using the Ingenix crosswalk between ICD-9 procedure codes and CPT codes. Specifications are included below in Appendix 4. Note that the correspondence between CPT and ICD-9 procedure codes is not precise, which may induce variations between the ASC and hospital discharge data. Of particular note, back surgery coding seemed particularly difficult to convert from ICD-9 to CPT, so the comparability of PDD and ASC measures for back surgery is suspect.

9. Locality rates

A measure of interest is the amount of the time a patient whose residence is in a particular HSA or HRR receives treatment at a hospital located in the same HSA or HRR. We refer to these rates as “locality rates.” Locality rates were for all of the measures based on patient discharge data, at both the HRR and HSA levels. In general, locality rates for HRRs are quite high, 70% or higher in most cases. Rates for HSAs are often lower, as might be expected as patients are more willing to travel for some types of procedures. For some HSAs for some measures, locality rates are 0 indicating that no patients resident in a given HSA sought care in the same HSA. One common reason for this would be that hospitals in the HSA do not provide the service, as might be the case for some advanced services like angioplasty (PCI) or CABG.

10. Correlations between rates for patients over and under age 65.

Previous work by Dartmouth has focused on patients over age 65, and there has been some interest in the extent to which patterns of variation identified in older patients are also found in younger patients. We used our data to compute correlations between the HRR and HSA level rates for each measures. Correlations using HSA-level data are shown in the following table. They are generally quite high, though lower for a few measures. In the following table, correlations using HRR-level data are shown, and are generally similar.

Over and Under-65 Correlations using data at the HSA level

measure	Correlations		
	Unadjusted	Adjusted (no AMI/diab)	Adjusted (+AMI/diab)
Elective Angiography	0.86	0.89	0.89
Elective CABG	0.77	0.74	0.74
Elective PCI	0.89	0.93	0.93
Elective CABG or PCI	0.86	0.91	0.91
Elective Stent	0.89	0.93	0.93
Any Angiography	0.71	0.77	0.77
Any CABG	0.74	0.76	0.76
Any PCI	0.80	0.83	0.83
Any CABG or PCI	0.78	0.82	0.82
Total hip replacement	0.73	0.53	0.53
Total knee replacement	0.60	0.72	0.72
Back surgery	0.63	0.51	0.51
Cholecystectomy	0.71	0.72	0.72
Colectomy	0.20	0.23	0.23
Carotid Endarterectomy	0.77	0.65	0.65
Hysterectomy	0.45	0.64	0.64
Lower extremity revascularization	0.46	0.40	0.40
Unilateral mastectomy	0.64	0.52	0.52
Radical prostatectomy	0.66	0.69	0.69
TURP for BPH	0.70	0.68	0.68
Aortic/mitral value replacement	0.51	0.38	0.38
Weight loss surgery	0.41	0.30	0.30
Hospitalization with hip fracture	0.24	0.18	0.18

Over and under-65 correlations using data at the HRR level

measure	Correlations			
	Unadjusted	Adjusted (no AMI/diab)		Adjusted (+AMI/diab)
Elective Angiography	0.89	0.88		0.88
Elective CABG	0.83	0.81		0.81
Elective angioplasty (PCI)	0.92	0.91		0.91
Elective CABG or PCI	0.90	0.89		0.89
Elective Stent	0.92	0.92		0.92
Any Angiography	0.84	0.82		0.82
Any CABG	0.90	0.82		0.82
Any PCI	0.83	0.85		0.85
Any CABG or PCI	0.85	0.82		0.82
Total hip replacement	0.86	0.65		0.65
Total knee replacement	0.84	0.74		0.74
Back surgery		0.72	0.75	0.75
Vertebroplasty		0.83	0.91	0.91
Cholecystectomy	0.92	0.80		0.80
Colectomy	0.23	0.18	-0.18	
Carotid Endarterectomy	0.91	0.82		0.82
Hysterectomy	0.77	0.87		0.87
Lower extremity revascularization		0.75	0.74	0.74
Unilateral mastectomy	0.80	0.74		0.74
Radical prostatectomy			0.80	0.76
TURP for BPH			0.93	0.87
Aortic/mitral value replacement			0.59	0.44
Weight loss surgery	0.65	0.48		0.48
Hospitalization with hip fracture		0.61	0.44	0.44

11. Examining treatments where less variation is expected.

The authors of the Dartmouth Atlas have sometimes noted that there are treatments such as hospitalization for a hip fracture and colectomy, where one would expect less variation than would be observed in some of the treatments on which we focus because, principally, there is less discretion in the use of these treatments and they are less likely to be driven by preferences. Examining variations for these treatments may thus provide valuable information about the validity of the analysis – if in fact

less variation is observed for them, it would be consistent with the validity of our methods. We computed HRR-level rates for the over-65 population for hospitalization for hip fracture and colectomy and compared them to rates reported in the Dartmouth Atlas. We find comparable amounts of variation in our data to the amount of variation reported for the same measures across the same HRRs in the Atlas. We also find less variation in these measures than in the measures on which we focus. We take this evidence as consistent with the validity of our methods.

Specifically, for colectomy, we find that the ratio of the highest to lowest HRR in California is 1.54, compared to a ratio reported in Dartmouth Atlas data of 1.96, and notably lower than the ratios of 2 or more found for the other conditions we examine. Similarly, for hospitalization for hip fracture, we find a high-low ratio of 1.70, compared to 1.53 for data reported in the Atlas and also lower than the ratios for the other conditions we examine.

Appendix 1: HRRs included in the analysis

HRR Number	HRR City Name	HRR State
65	Alameda County	CA
25	Bakersfield	CA
31	Chico	CA
33	Contra Costa County	CA
43	Fresno	CA
56	Los Angeles	CA
58	Modesto	CA
62	Napa	CA
23	Orange County	CA
69	Palm Springs/Rancho Mirage	CA
73	Redding	CA
77	Sacramento	CA
78	Salinas	CA
79	San Bernardino	CA
80	San Diego	CA
81	San Francisco	CA
82	San Jose	CA
83	San Luis Obispo	CA
85	San Mateo County	CA
86	Santa Barbara	CA
87	Santa Cruz	CA
89	Santa Rosa	CA
91	Stockton	CA

Appendix 2: HSAs included in the analysis

HSA Number	HSA City Name	HSA State	HRR Number	HRR City Name	HRR State
5001	Alameda	CA	65	Alameda County	CA
5004	Anaheim	CA	23	Orange County	CA
5005	Antioch	CA	33	Contra Costa County	CA
5006	Apple Valley	CA	79	San Bernardino	CA
5007	Arcadia	CA	56	Los Angeles	CA
5008	Arcata	CA	73	Redding	CA
5009	Arroyo Grande	CA	83	San Luis Obispo	CA
5012	Auburn	CA	77	Sacramento	CA
5013	Avalon	CA	56	Los Angeles	CA
5015	Bakersfield	CA	25	Bakersfield	CA
5017	Banning	CA	79	San Bernardino	CA
5018	Barstow	CA	79	San Bernardino	CA
5019	Bellflower	CA	56	Los Angeles	CA
5020	Berkeley	CA	65	Alameda County	CA
5021	Big Bear Lake	CA	79	San Bernardino	CA
5024	Brawley	CA	80	San Diego	CA
5028	Burbank	CA	56	Los Angeles	CA
5029	Burlingame	CA	85	San Mateo County	CA
5031	Camarillo	CA	96	Ventura	CA
5032	Canoga Park	CA	56	Los Angeles	CA
5033	Carmichael	CA	77	Sacramento	CA
5034	Castro Valley	CA	65	Alameda County	CA
5036	Chester	CA	31	Chico	CA
5037	Chico	CA	31	Chico	CA
5038	Chino	CA	79	San Bernardino	CA
5040	Chula Vista	CA	80	San Diego	CA
5041	Clearlake	CA	62	Napa	CA
5043	Coalinga	CA	43	Fresno	CA
5044	Colusa	CA	77	Sacramento	CA
5045	Concord	CA	33	Contra Costa County	CA
5046	Corcoran	CA	43	Fresno	CA
5047	Corona	CA	23	Orange County	CA

Appendix 2: HSAs included in the analysis

HSA Number	HSA City Name	HSA State	HRR Number	HRR City Name	HRR State
5048	Coronado	CA	80	San Diego	CA
5050	Covina	CA	56	Los Angeles	CA
5052	Culver City	CA	56	Los Angeles	CA
5053	Daly City	CA	85	San Mateo County	CA
5054	Davis	CA	77	Sacramento	CA
5055	Deer Park	CA	62	Napa	CA
5056	Delano	CA	25	Bakersfield	CA
5057	Dinuba	CA	43	Fresno	CA
5059	Downey	CA	56	Los Angeles	CA
5060	Duarte	CA	56	Los Angeles	CA
5062	El Centro	CA	80	San Diego	CA
5063	Encinitas	CA	80	San Diego	CA
5064	Encino	CA	56	Los Angeles	CA
5065	Escondido	CA	80	San Diego	CA
5066	Eureka	CA	73	Redding	CA
5068	Fairfield	CA	33	Contra Costa County	CA
5069	Fall River Mills	CA	73	Redding	CA
5070	Fallbrook	CA	80	San Diego	CA
5071	Folsom	CA	77	Sacramento	CA
5072	Fontana	CA	79	San Bernardino	CA
5073	Fort Bragg	CA	62	Napa	CA
5074	Fortuna	CA	73	Redding	CA
5075	Fountain Valley	CA	23	Orange County	CA
5077	Fremont	CA	65	Alameda County	CA
5078	Fresno	CA	43	Fresno	CA
5079	Fullerton	CA	23	Orange County	CA
5080	Garberville	CA	62	Napa	CA
5081	Garden Grove	CA	23	Orange County	CA
5082	Gardena	CA	56	Los Angeles	CA
5083	Gilroy	CA	82	San Jose	CA
5084	Glendale	CA	56	Los Angeles	CA
5085	Glendora	CA	56	Los Angeles	CA
5086	Granada Hills	CA	56	Los Angeles	CA

Appendix 2: HSAs included in the analysis

HSA Number	HSA City Name	HSA State	HRR Number	HRR City Name	HRR State
5087	Grass Valley	CA	77	Sacramento	CA
5088	Greenbrae	CA	81	San Francisco	CA
5089	Greenville	CA	31	Chico	CA
5090	Gridley	CA	77	Sacramento	CA
5091	Hanford	CA	43	Fresno	CA
5092	Harbor City	CA	56	Los Angeles	CA
5094	Hawthorne	CA	56	Los Angeles	CA
5095	Hayward	CA	65	Alameda County	CA
5096	Healdsburg	CA	89	Santa Rosa	CA
5097	Hemet	CA	79	San Bernardino	CA
5098	Hollister	CA	82	San Jose	CA
5100	Huntington Beach	CA	23	Orange County	CA
5102	Indio	CA	80	San Diego	CA
5103	Inglewood	CA	56	Los Angeles	CA
5282	Irvine	CA	23	Orange County	CA
5104	Jackson	CA	77	Sacramento	CA
5105	Joshua Tree	CA	69	Palm Springs/Rancho Mira	CA
5106	King City	CA	78	Salinas	CA
5108	La Jolla	CA	80	San Diego	CA
5109	La Mesa	CA	80	San Diego	CA
5112	Laguna Hills	CA	23	Orange County	CA
5114	Lake Isabella	CA	25	Bakersfield	CA
5115	Lakeport	CA	62	Napa	CA
5116	Lakewood	CA	56	Los Angeles	CA
5117	Lancaster	CA	56	Los Angeles	CA
5118	Lindsay	CA	25	Bakersfield	CA
5119	Livermore	CA	65	Alameda County	CA
5120	Lodi	CA	77	Sacramento	CA
5121	Loma Linda	CA	79	San Bernardino	CA
5122	Lompoc	CA	86	Santa Barbara	CA
5124	Long Beach	CA	56	Los Angeles	CA
5125	Los Alamitos	CA	23	Orange County	CA
5126	Los Angeles	CA	56	Los Angeles	CA
5127	Los Banos	CA	58	Modesto	CA

Appendix 2: HSAs included in the analysis

HSA Number	HSA City Name	HSA State	HRR Number	HRR City Name	HRR State
5130	Lynwood	CA	56	Los Angeles	CA
5131	Madera	CA	43	Fresno	CA
5133	Manteca	CA	91	Stockton	CA
5136	Martinez	CA	33	Contra Costa County	CA
5137	Marysville	CA	77	Sacramento	CA
5138	Merced	CA	58	Modesto	CA
5139	Mission Hills	CA	56	Los Angeles	CA
5140	Mission Viejo	CA	23	Orange County	CA
5141	Modesto	CA	58	Modesto	CA
5144	Montebello	CA	56	Los Angeles	CA
5145	Monterey	CA	78	Salinas	CA
5146	Monterey Park	CA	56	Los Angeles	CA
5285	Morgan Hill	CA	82	San Jose	CA
5148	Mount Shasta	CA	73	Redding	CA
5149	Mountain View	CA	82	San Jose	CA
5150	Napa	CA	62	Napa	CA
5151	National City	CA	80	San Diego	CA
5155	Newport Beach	CA	23	Orange County	CA
5157	Northridge	CA	56	Los Angeles	CA
5158	Norwalk	CA	56	Los Angeles	CA
5159	Novato	CA	81	San Francisco	CA
5160	Oakdale	CA	58	Modesto	CA
5161	Oakland	CA	65	Alameda County	CA
5162	Oceanside	CA	80	San Diego	CA
5163	Ojai	CA	96	Ventura	CA
5165	Orange	CA	23	Orange County	CA
5166	Oroville	CA	31	Chico	CA
5167	Oxnard	CA	96	Ventura	CA
5168	Palm Springs	CA	69	Palm Springs/Rancho Mira	CA
5171	Panorama City	CA	56	Los Angeles	CA
5172	Paradise	CA	31	Chico	CA
5173	Paramount	CA	56	Los Angeles	CA
5174	Pasadena	CA	56	Los Angeles	CA

Appendix 2: HSAs included in the analysis

HSA Number	HSA City Name	HSA State	HRR Number	HRR City Name	HRR State
5177	Petaluma	CA	89	Santa Rosa	CA
5179	Pinole	CA	81	San Francisco	CA
5180	Pittsburg	CA	33	Contra Costa County	CA
5182	Placerville	CA	77	Sacramento	CA
5287	Pleasanton	CA	65	Alameda County	CA
5183	Pomona	CA	56	Los Angeles	CA
5185	Porterville	CA	25	Bakersfield	CA
5187	Poway	CA	80	San Diego	CA
5189	Rancho Mirage	CA	69	Palm Springs/Rancho Mira	CA
5190	Red Bluff	CA	31	Chico	CA
5191	Redding	CA	73	Redding	CA
5192	Redlands	CA	79	San Bernardino	CA
5194	Redwood City	CA	85	San Mateo County	CA
5197	Ridgecrest	CA	79	San Bernardino	CA
5198	Riverside	CA	79	San Bernardino	CA
5199	Roseville	CA	77	Sacramento	CA
5200	Sacramento	CA	77	Sacramento	CA
5201	Salinas	CA	78	Salinas	CA
5202	San Andreas	CA	91	Stockton	CA
5203	San Bernardino	CA	79	San Bernardino	CA
5204	San Clemente	CA	23	Orange County	CA
5205	San Diego	CA	80	San Diego	CA
5206	San Dimas	CA	56	Los Angeles	CA
5208	San Francisco	CA	81	San Francisco	CA
5209	San Gabriel	CA	56	Los Angeles	CA
5210	San Jose	CA	82	San Jose	CA
5211	San Leandro	CA	65	Alameda County	CA
5212	San Luis Obispo	CA	83	San Luis Obispo	CA
5213	San Mateo	CA	85	San Mateo County	CA
5214	San Pablo	CA	81	San Francisco	CA
5215	San Pedro	CA	56	Los Angeles	CA
5288	San Ramon	CA	33	Contra Costa County	CA
5218	Santa Ana	CA	23	Orange County	CA

Appendix 2: HSAs included in the analysis

HSA Number	HSA City Name	HSA State	HRR Number	HRR City Name	HRR State
5219	Santa Barbara	CA	86	Santa Barbara	CA
5221	Santa Cruz	CA	87	Santa Cruz	CA
5222	Santa Maria	CA	86	Santa Barbara	CA
5223	Santa Monica	CA	56	Los Angeles	CA
5224	Santa Paula	CA	96	Ventura	CA
5225	Santa Rosa	CA	89	Santa Rosa	CA
5226	Sebastopol	CA	89	Santa Rosa	CA
5227	Selma	CA	43	Fresno	CA
5229	Simi Valley	CA	96	Ventura	CA
5230	Solvang	CA	86	Santa Barbara	CA
5231	Sonoma	CA	89	Santa Rosa	CA
5232	Sonora	CA	58	Modesto	CA
5233	South El Monte	CA	56	Los Angeles	CA
5234	South Laguna	CA	23	Orange County	CA
5236	South San Francisco	CA	85	San Mateo County	CA
5237	Stanford	CA	85	San Mateo County	CA
5239	Stockton	CA	91	Stockton	CA
5289	Sun City	CA	79	San Bernardino	CA
5244	Tarzana	CA	56	Los Angeles	CA
5246	Templeton	CA	83	San Luis Obispo	CA
5247	Thousand Oaks	CA	96	Ventura	CA
5248	Torrance	CA	56	Los Angeles	CA
5249	Tracy	CA	91	Stockton	CA
5251	Tulare	CA	25	Bakersfield	CA
5252	Turlock	CA	58	Modesto	CA
5253	Ukiah	CA	62	Napa	CA
5254	Upland	CA	79	San Bernardino	CA
5255	Vacaville	CA	33	Contra Costa County	CA
5256	Valencia	CA	56	Los Angeles	CA
5257	Vallejo	CA	81	San Francisco	CA

Appendix 2: HSAs included in the analysis

HSA Number	HSA City Name	HSA State	HRR Number	HRR City Name	HRR State
5258	Van Nuys	CA	56	Los Angeles	CA
5259	Ventura	CA	96	Ventura	CA
5260	Victorville	CA	79	San Bernardino	CA
5261	Visalia	CA	25	Bakersfield	CA
5262	Walnut Creek	CA	33	Contra Costa County	CA
5263	Watsonville	CA	87	Santa Cruz	CA
5264	Weaverville	CA	73	Redding	CA
5265	West Covina	CA	56	Los Angeles	CA
5270	Whittier	CA	56	Los Angeles	CA
5271	Wildomar/Murrieta	CA	80	San Diego	CA
5272	Willits	CA	62	Napa	CA
5274	Woodland	CA	77	Sacramento	CA
5278	Yuba City	CA	77	Sacramento	CA

Appendix 3: PDD Coding Specifications

Elective Angiography (Elective exclusions based on Lin et al, JAMA 2008) [OK]

male and female [sex=1 or 2]

age 40 and over [agecat20>=10 and agecat20 ne 00]

residence in CA county [patcnty ne 00]

acute care institution [typ_care=1]

not in MDC 14

and any of the following procedure codes are present

37.22 Left heart cardiac catheterization

37.23 Combined right and left heart cardiac catheterization

88.55 Coronary arteriography using a single catheter

88.56 Coronary arteriography using two catheters

88.57 Other and unspecified coronary arteriography

and none of the following diagnosis codes are present

AMI (410.XX)

includes:

41000	AMI ANTEROLATERAL, UNSPEC
41001	AMI ANTEROLATERAL, INIT
41002	AMI ANTEROLATERAL, SUBSEQ
41010	AMI ANTERIOR WALL, UNSPEC
41011	AMI ANTERIOR WALL, INIT
41012	AMI ANTERIOR WALL, SUBSEQ
41020	AMI INFEROLATERAL, UNSPEC
41021	AMI INFEROLATERAL, INIT
41022	AMI INFEROLATERAL, SUBSEQ
41030	AMI INFEROPOST, UNSPEC
41031	AMI INFEROPOST, INITIAL
41032	AMI INFEROPOST, SUBSEQ
41040	AMI INFERIOR WALL, UNSPEC
41041	AMI INFERIOR WALL, INIT
41042	AMI INFERIOR WALL, SUBSEQ
41050	AMI LATERAL NEC, UNSPEC
41051	AMI LATERAL NEC, INITIAL
41052	AMI LATERAL NEC, SUBSEQ
41060	TRUE POST INFARCT, UNSPEC

41061	TRUE POST INFARCT, INIT
41062	TRUE POST INFARCT, SUBSEQ
41070	SUBENDO INFARCT, UNSPEC
41071	SUBENDO INFARCT, INITIAL
41072	SUBENDO INFARCT, SUBSEQ
41080	AMI NEC, UNSPECIFIED
41081	AMI NEC, INITIAL
41082	AMI NEC, SUBSEQUENT
41090	AMI NOS, UNSPECIFIED
41091	AMI NOS, INITIAL
41092	AMI NOS, SUBSEQUENT

Unstable angina

4111	Intermediate coronary syndrome
41181	Acute coronary occlusion without myocardial infarction
41189	Other acute and subacute forms of ischemic heart disease - other (coronary insufficiency; subendocardial ischemia)

Shock

78551	Cardiogenic shock
78559	Shock without mention of trauma - Other

and the patient was not admitted through the ED of the discharging hospital (adm_src3 ne 1 - The admitting hospital's Emergency Room (ER))

and the patient was not transferred from another acute care institution (adm_src1 ne 5 or 6 - Acute (Inpatient) Hospital Care or Other (Inpatient) Hospital Care)

Appendix 3: PDD Coding Specifications

Elective CABG (Elective exclusions based on Lin et al, JAMA, 2008) [OK]

male and female [sex=1 or 2]

age 40 and over [agecat20>=10 and agecat20 ne 00]

residence in CA county [patcnty ne 00]

acute care institution [typ_care=1]

not in MDC 14

and any of the following procedure codes are present

36.10 Aortocoronary bypass for heart revascularization, not otherwise specified

36.11 (Aorto)coronary bypass of one coronary artery

36.12 (Aorto)coronary bypass of two coronary arteries

36.13 (Aorto)coronary bypass of three coronary arteries

36.14 (Aorto)coronary bypass of four or more coronary arteries

36.15 Single internal mammary-coronary artery bypass

36.16 Double internal mammary-coronary artery bypass

36.17 Abdominal - coronary artery bypass

36.19 Other bypass anastomosis for heart revascularization

and none of the following diagnosis codes are present

AMI (410.XX)

includes:

41000 AMI ANTEROLATERAL, UNSPEC

41001 AMI ANTEROLATERAL, INIT

41002 AMI ANTEROLATERAL, SUBSEQ

41010 AMI ANTERIOR WALL, UNSPEC

41011 AMI ANTERIOR WALL, INIT

41012 AMI ANTERIOR WALL, SUBSEQ

41020 AMI INFEROLATERAL, UNSPEC

41021 AMI INFEROLATERAL, INIT

41022 AMI INFEROLATERAL, SUBSEQ

41030 AMI INFEROPOST, UNSPEC

41031 AMI INFEROPOST, INITIAL

41032 AMI INFEROPOST, SUBSEQ

41040 AMI INFERIOR WALL, UNSPEC

41041 AMI INFERIOR WALL, INIT
 41042 AMI INFERIOR WALL, SUBSEQ
 41050 AMI LATERAL NEC, UNSPEC
 41051 AMI LATERAL NEC, INITIAL
 41052 AMI LATERAL NEC, SUBSEQ
 41060 TRUE POST INFARCT, UNSPEC
 41061 TRUE POST INFARCT, INIT
 41062 TRUE POST INFARCT, SUBSEQ
 41070 SUBENDO INFARCT, UNSPEC
 41071 SUBENDO INFARCT, INITIAL
 41072 SUBENDO INFARCT, SUBSEQ
 41080 AMI NEC, UNSPECIFIED
 41081 AMI NEC, INITIAL
 41082 AMI NEC, SUBSEQUENT
 41090 AMI NOS, UNSPECIFIED
 41091 AMI NOS, INITIAL
 41092 AMI NOS, SUBSEQUENT

Unstable angina

4111 Intermediate coronary syndrome
 41181 Acute coronary occlusion without myocardial infarction
 Other acute and subacute forms of ischemic heart disease - other
 41189 (coronary insufficiency; subendocardial ischemia)

Shock

78551 Cardiogenic shock
 78559 Shock without mention of trauma - Other

and the patient was not admitted through the ED of the discharging hospital (adm_src3 ne 1 - The admitting hospital's Emergency Room (ER))

and the patient was not transferred from another acute care institution (adm_src1 ne 5 or 6 - Acute (Inpatient) Hospital Care or Other (Inpatient) Hospital Care)

Appendix 3: PDD Coding Specifications

Elective Angioplasty (PCI) (Elective exclusions based on Lin et al, JAMA, 2008) [OK]

male and female [sex=1 or 2]

age 40 and over [agecat20>=10 and agecat20 ne 00]

residence in CA county [patcnty ne 00]

acute care institution [typ_care=1]

not in MDC 14

any any of the following procedure codes are present

00.66 Percutaneous transluminal coronary angioplasty [PTCA] or coronary atherectomy

36.01 PTCA-1 vessel w/o agent

36.02 PTCA-1 vessel with agent

36.05 PTCA-multiple vessel

36.06 Insertion of non-drug-eluting coronary artery stent(s)

36.07 Insertion of drug-eluting coronary artery stent(s)

36.09 Other removal of coronary artery obstruction

and none of the following diagnosis codes are present

AMI (410.XX)

includes:

41000 AMI ANTEROLATERAL, UNSPEC

41001 AMI ANTEROLATERAL, INIT

41002 AMI ANTEROLATERAL, SUBSEQ

41010 AMI ANTERIOR WALL, UNSPEC

41011 AMI ANTERIOR WALL, INIT

41012 AMI ANTERIOR WALL, SUBSEQ

41020 AMI INFEROLATERAL, UNSPEC

41021 AMI INFEROLATERAL, INIT

41022 AMI INFEROLATERAL, SUBSEQ

41030 AMI INFEROPOST, UNSPEC

41031 AMI INFEROPOST, INITIAL

41032 AMI INFEROPOST, SUBSEQ

41040 AMI INFERIOR WALL, UNSPEC

41041 AMI INFERIOR WALL, INIT

41042 AMI INFERIOR WALL, SUBSEQ

41050 AMI LATERAL NEC, UNSPEC

41051 AMI LATERAL NEC, INITIAL

41052 AMI LATERAL NEC, SUBSEQ

41060	TRUE POST INFARCT, UNSPEC
41061	TRUE POST INFARCT, INIT
41062	TRUE POST INFARCT, SUBSEQ
41070	SUBENDO INFARCT, UNSPEC
41071	SUBENDO INFARCT, INITIAL
41072	SUBENDO INFARCT, SUBSEQ
41080	AMI NEC, UNSPECIFIED
41081	AMI NEC, INITIAL
41082	AMI NEC, SUBSEQUENT
41090	AMI NOS, UNSPECIFIED
41091	AMI NOS, INITIAL
41092	AMI NOS, SUBSEQUENT

Unstable angina

4111	Intermediate coronary syndrome
41181	Acute coronary occlusion without myocardial infarction
41189	Other acute and subacute forms of ischemic heart disease - other (coronary insufficiency; subendocardial ischemia)

Shock

78551	Cardiogenic shock
78559	Shock without mention of trauma - Other

and the patient was not admitted through the ED of the discharging hospital (adm_src3 ne 1 - The admitting hospital's Emergency Room (ER))

and the patient was not transferred from another acute care institution (adm_src1 ne 5 or 6 - Acute (Inpatient) Hospital Care or Other (Inpatient) Hospital Care)

Appendix 3: PDD Coding Specifications

Elective revascularization (CABG or PCI); (Elective exclusions based on Lin et al, JAMA, 2008)
[OK]

male and female [sex=1 or 2]
age 40 and over [agecat20>=10 and agecat20 ne 00]
residence in CA county [patcnty ne 00]
acute care institution [typ_care=1]
not in MDC 14

any any of the following procedure codes are present

- 00.66 Percutaneous transluminal coronary angioplasty [PTCA] or coronary atherectomy
- 36.01 PTCA-1 vessel w/o agent
- 36.02 PTCA-1 vessel with agent
- 36.05 PTCA-multiple vessel
- 36.06 Insertion of non-drug-eluting coronary artery stent(s)
- 36.07 Insertion of drug-eluting coronary artery stent(s)
- 36.09 Other removal of coronary artery obstruction

- 36.10 Aortocoronary bypass for heart revascularization, not otherwise specified
- 36.11 (Aorto)coronary bypass of one coronary artery
- 36.12 (Aorto)coronary bypass of two coronary arteries
- 36.13 (Aorto)coronary bypass of three coronary arteries
- 36.14 (Aorto)coronary bypass of four or more coronary arteries
- 36.15 Single internal mammary-coronary artery bypass
- 36.16 Double internal mammary-coronary artery bypass
- 36.17 Abdominal - coronary artery bypass
- 36.19 Other bypass anastomosis for heart revascularization

and none of the following diagnosis codes are present

AMI (410.XX)

includes:

- 41000 AMI ANTEROLATERAL, UNSPEC
- 41001 AMI ANTEROLATERAL, INIT
- 41002 AMI ANTEROLATERAL, SUBSEQ
- 41010 AMI ANTERIOR WALL, UNSPEC
- 41011 AMI ANTERIOR WALL, INIT
- 41012 AMI ANTERIOR WALL, SUBSEQ

41020	AMI INFEROLATERAL, UNSPEC
41021	AMI INFEROLATERAL, INIT
41022	AMI INFEROLATERAL, SUBSEQ
41030	AMI INFEROPOST, UNSPEC
41031	AMI INFEROPOST, INITIAL
41032	AMI INFEROPOST, SUBSEQ
41040	AMI INFERIOR WALL, UNSPEC
41041	AMI INFERIOR WALL, INIT
41042	AMI INFERIOR WALL, SUBSEQ
41050	AMI LATERAL NEC, UNSPEC
41051	AMI LATERAL NEC, INITIAL
41052	AMI LATERAL NEC, SUBSEQ
41060	TRUE POST INFARCT, UNSPEC
41061	TRUE POST INFARCT, INIT
41062	TRUE POST INFARCT, SUBSEQ
41070	SUBENDO INFARCT, UNSPEC
41071	SUBENDO INFARCT, INITIAL
41072	SUBENDO INFARCT, SUBSEQ
41080	AMI NEC, UNSPECIFIED
41081	AMI NEC, INITIAL
41082	AMI NEC, SUBSEQUENT
41090	AMI NOS, UNSPECIFIED
41091	AMI NOS, INITIAL
41092	AMI NOS, SUBSEQUENT

Unstable angina

4111	Intermediate coronary syndrome
41181	Acute coronary occlusion without myocardial infarction
41189	Other acute and subacute forms of ischemic heart disease - other (coronary insufficiency; subendocardial ischemia)

Shock

78551	Cardiogenic shock
78559	Shock without mention of trauma - Other

and the patient was not admitted through the ED of the discharging hospital (adm_src3 ne 1 - The admitting hospital's Emergency Room (ER))

and the patient was not transferred from another acute care institution (adm_src1 ne 5 or 6 - Acute (Inpatient) Hospital Care or Other (Inpatient) Hospital Care)

Appendix 3: PDD Coding Specifications

Elective stent (elective exclusions based on Lin et al, JAMA, 2008) [OK]

male and female [sex=1 or 2]
age 40 and over [agecat20>=10 and agecat20 ne 00]
residence in CA county [patcnty ne 00]
acute care institution [typ_care=1]
not in MDC 14

any any of the following procedure codes are present

36.06 Insertion of non-drug-eluting coronary artery stent(s)

36.07 Insertion of drug-eluting coronary artery stent(s)

and none of the following diagnosis codes are present

AMI (410.XX)

includes:

41000 AMI ANTEROLATERAL, UNSPEC
41001 AMI ANTEROLATERAL, INIT
41002 AMI ANTEROLATERAL, SUBSEQ
41010 AMI ANTERIOR WALL, UNSPEC
41011 AMI ANTERIOR WALL, INIT
41012 AMI ANTERIOR WALL, SUBSEQ
41020 AMI INFEROLATERAL, UNSPEC
41021 AMI INFEROLATERAL, INIT
41022 AMI INFEROLATERAL, SUBSEQ
41030 AMI INFEROPOST, UNSPEC
41031 AMI INFEROPOST, INITIAL
41032 AMI INFEROPOST, SUBSEQ
41040 AMI INFERIOR WALL, UNSPEC
41041 AMI INFERIOR WALL, INIT
41042 AMI INFERIOR WALL, SUBSEQ
41050 AMI LATERAL NEC, UNSPEC
41051 AMI LATERAL NEC, INITIAL
41052 AMI LATERAL NEC, SUBSEQ
41060 TRUE POST INFARCT, UNSPEC
41061 TRUE POST INFARCT, INIT
41062 TRUE POST INFARCT, SUBSEQ
41070 SUBENDO INFARCT, UNSPEC
41071 SUBENDO INFARCT, INITIAL
41072 SUBENDO INFARCT, SUBSEQ
41080 AMI NEC, UNSPECIFIED
41081 AMI NEC, INITIAL
41082 AMI NEC, SUBSEQUENT

41090 AMI NOS, UNSPECIFIED
41091 AMI NOS, INITIAL
41092 AMI NOS, SUBSEQUENT

Unstable angina

4111 Intermediate coronary syndrome
41181 Acute coronary occlusion without myocardial infarction
41189 Other acute and subacute forms of ischemic heart disease -
other (coronary insufficiency; subendocardial ischemia)

Shock

78551 Cardiogenic shock
78559 Shock without mention of trauma - Other

and the patient was not admitted through the ED of the discharging hospital
(adm_src3 ne 1 - The admitting hospital's Emergency Room (ER))

and the patient was not transferred from another acute care institution (adm_src1
ne 5 or 6 - Acute (Inpatient) Hospital Care or Other (Inpatient) Hospital Care)

Appendix 3: PDD Coding Specifications

Any angiography [OK]

male and female [sex=1 or 2]

age 20 and over [agecat20>=06 and agecat20 ne 00]

residence in CA county [patcnty ne 00]

acute care institution [typ_care=1]

not in MDC 14

and any of the following procedure codes are present

37.22 Left heart cardiac catheterization

37.23 Combined right and left heart cardiac catheterization

88.55 Coronary arteriography using a single catheter

88.56 Coronary arteriography using two catheters

88.57 Other and unspecified coronary arteriography

Appendix 3: PDD Coding Specifications

Any CABG [OK]

male and female [sex=1 or 2]

age 40 and over [agecat20>=10 and agecat20 ne 00]

residence in CA county [patcnty ne 00]

acute care institution [typ_care=1]

not in MDC 14

and any of the following procedure codes are present

- 36.10 Aortocoronary bypass for heart revascularization, not otherwise specified
- 36.11 (Aorto)coronary bypass of one coronary artery
- 36.12 (Aorto)coronary bypass of two coronary arteries
- 36.13 (Aorto)coronary bypass of three coronary arteries
- 36.14 (Aorto)coronary bypass of four or more coronary arteries
- 36.15 Single internal mammary-coronary artery bypass
- 36.16 Double internal mammary-coronary artery bypass
- 36.17 Abdominal - coronary artery bypass
- 36.19 Other bypass anastomosis for heart revascularization

Appendix 3: PDD Coding Specifications

Any PCI [OK]

male and female [sex=1 or 2]

age 40 and over [agecat20>=10 and agecat20 ne 00]

residence in CA county [patcnty ne 00]

acute care institution [typ_care=1]

not in MDC 14

and any of the following procedure codes are present

- 00.66 Percutaneous transluminal coronary angioplasty [PTCA] or coronary atherectomy
- 36.01 PTCA-1 vessel w/o agent
- 36.02 PTCA-1 vessel with agent
- 36.05 PTCA-multiple vessel
- 36.06 Insertion of non-drug-eluting coronary artery stent(s)
- 36.07 Insertion of drug-eluting coronary artery stent(s)
- 36.09 Other removal of coronary artery obstruction

Appendix 3: PDD Coding Specifications

Any Revascularization (CABG or PCI) [OK]

male and female [sex=1 or 2]

age 40 and over [agecat20>=10 and agecat20 ne 00]

residence in CA county [patcnty ne 00]

acute care institution [typ_care=1]

not in MDC 14

any any of the following procedure codes are present

00.66 Percutaneous transluminal coronary angioplasty [PTCA] or coronary atherectomy

36.01 PTCA-1 vessel w/o agent

36.02 PTCA-1 vessel with agent

36.05 PTCA-multiple vessel

36.06 Insertion of non-drug-eluting coronary artery stent(s)

36.07 Insertion of drug-eluting coronary artery stent(s)

36.09 Other removal of coronary artery obstruction

36.10 Aortocoronary bypass for heart revascularization, not otherwise specified

36.11 (Aorto)coronary bypass of one coronary artery

36.12 (Aorto)coronary bypass of two coronary arteries

36.13 (Aorto)coronary bypass of three coronary arteries

36.14 (Aorto)coronary bypass of four or more coronary arteries

36.15 Single internal mammary-coronary artery bypass

36.16 Double internal mammary-coronary artery bypass

36.17 Abdominal - coronary artery bypass

36.19 Other bypass anastomosis for heart revascularization

Appendix 4: ASC Coding Specifications

Elective angiography (Elective exclusions based on Lin et al JAMA 2008)

male and female [sex=M or F]

age 40 and over [agecat20>=10 and agecat20 ne 00]

residence in CA county [patcnty ne 00]

and any of the following procedure codes are present

- 93510 Left heart catheterization, retrograde, from the brachial artery, axillary artery or femoral artery; percutaneous
- 93511 Left heart catheterization, retrograde, from the brachial artery, axillary artery or femoral artery; by cutdown
- 93514 Left heart catheterization by left ventricular puncture
- 93524 Combined transeptal and retrograde left heart catheterization

- 93526 Combined right heart catheterization and retrograde left heart catheterization

- 93527 Combined right heart catheterization and transeptal left heart catheterization through intact septum (with or without retrograde left heart catheterization)
- 93528 Combined right heart catheterization with left ventricular puncture (with or without retrograde left heart catheterization)

- 93529 Combined right heart catheterization and left heart catheterization through existing septal opening (with or without retrograde left heart catheterization)
- 93531 Combined right heart catheterization and retrograde left heart catheterization, for congenital cardiac anomalies
- 93532 Combined right heart catheterization and transeptal left heart catheterization through intact septum with or without retrograde left heart catheterization, for congenital cardiac anomalies
- 93533 Combined right heart catheterization and transeptal left heart catheterization through existing septal opening, with or without retrograde left heart catheterization, for congenital cardiac anomalies

and none of the following diagnosis codes are present

AMI (410.XX)

includes:

- 41000 AMI ANTEROLATERAL, UNSPEC
- 41001 AMI ANTEROLATERAL, INIT

41002 AMI ANTEROLATERAL, SUBSEQ
 41010 AMI ANTERIOR WALL, UNSPEC
 41011 AMI ANTERIOR WALL, INIT
 41012 AMI ANTERIOR WALL, SUBSEQ
 41020 AMI INFEROLATERAL, UNSPEC
 41021 AMI INFEROLATERAL, INIT
 41022 AMI INFEROLATERAL, SUBSEQ
 41030 AMI INFEROPOST, UNSPEC
 41031 AMI INFEROPOST, INITIAL
 41032 AMI INFEROPOST, SUBSEQ
 41040 AMI INFERIOR WALL, UNSPEC
 41041 AMI INFERIOR WALL, INIT
 41042 AMI INFERIOR WALL, SUBSEQ
 41050 AMI LATERAL NEC, UNSPEC
 41051 AMI LATERAL NEC, INITIAL
 41052 AMI LATERAL NEC, SUBSEQ
 41060 TRUE POST INFARCT, UNSPEC
 41061 TRUE POST INFARCT, INIT
 41062 TRUE POST INFARCT, SUBSEQ
 41070 SUBENDO INFARCT, UNSPEC
 41071 SUBENDO INFARCT, INITIAL
 41072 SUBENDO INFARCT, SUBSEQ
 41080 AMI NEC, UNSPECIFIED
 41081 AMI NEC, INITIAL
 41082 AMI NEC, SUBSEQUENT
 41090 AMI NOS, UNSPECIFIED
 41091 AMI NOS, INITIAL
 41092 AMI NOS, SUBSEQUENT

Unstable angina

4111 Intermediate coronary syndrome
 41181 Acute coronary occlusion without myocardial infarction
 Other acute and subacute forms of ischemic heart disease - other (coronary
 41189 insufficiency; subendocardial ischemia)

Shock

78551 Cardiogenic shock
 78559 Shock without mention of trauma - Other

Appendix 4: ASC Coding Specifications

Elective angioplasty (PCI) (elective exclusions based on Lin et al, JAMA, 2008)

male and female [sex=M or F]

age 40 and over [agecat20>=10 and agecat20 ne 00]

residence in CA county [patcnty ne 00]

and any of the following procedure codes are present

92980 Transcatheter placement of an intracoronary stent(s), percutaneous, with or without other therapeutic intervention, any method; single vessel

92981 Transcatheter placement of an intracoronary stent(s), percutaneous, with or without other therapeutic intervention, any method; each additional vessel (List separately in addition to code for primary procedure)

92982 Percutaneous transluminal coronary balloon angioplasty; single vessel

92984 Percutaneous transluminal coronary balloon angioplasty; each additional vessel (List separately in addition to code for primary procedure)

92995 Percutaneous transluminal coronary atherectomy, by mechanical or other method, with or without balloon angioplasty; single vessel

92996 Percutaneous transluminal coronary atherectomy, by mechanical or other method, with or without balloon angioplasty; each additional vessel (List separately in addition to code for primary procedure)

and none of the following diagnosis codes are present

AMI (410.XX)

includes:

41000 AMI ANTEROLATERAL, UNSPEC

41001 AMI ANTEROLATERAL, INIT

41002 AMI ANTEROLATERAL, SUBSEQ

41010 AMI ANTERIOR WALL, UNSPEC

41011 AMI ANTERIOR WALL, INIT

41012 AMI ANTERIOR WALL, SUBSEQ

41020 AMI INFEROLATERAL, UNSPEC

41021 AMI INFEROLATERAL, INIT

41022 AMI INFEROLATERAL, SUBSEQ

41030 AMI INFEROPOST, UNSPEC
 41031 AMI INFEROPOST, INITIAL
 41032 AMI INFEROPOST, SUBSEQ
 41040 AMI INFERIOR WALL, UNSPEC
 41041 AMI INFERIOR WALL, INIT
 41042 AMI INFERIOR WALL, SUBSEQ
 41050 AMI LATERAL NEC, UNSPEC
 41051 AMI LATERAL NEC, INITIAL
 41052 AMI LATERAL NEC, SUBSEQ
 41060 TRUE POST INFARCT, UNSPEC
 41061 TRUE POST INFARCT, INIT
 41062 TRUE POST INFARCT, SUBSEQ
 41070 SUBENDO INFARCT, UNSPEC
 41071 SUBENDO INFARCT, INITIAL
 41072 SUBENDO INFARCT, SUBSEQ
 41080 AMI NEC, UNSPECIFIED
 41081 AMI NEC, INITIAL
 41082 AMI NEC, SUBSEQUENT
 41090 AMI NOS, UNSPECIFIED
 41091 AMI NOS, INITIAL
 41092 AMI NOS, SUBSEQUENT

Unstable angina

4111 Intermediate coronary syndrome
 41181 Acute coronary occlusion without myocardial infarction
 Other acute and subacute forms of ischemic heart disease - other (coronary
 41189 insufficiency; subendocardial ischemia)

Shock

78551 Cardiogenic shock
 78559 Shock without mention of trauma - Other

Appendix 4: ASC Coding Specifications

Elective Stent (elective exclusions based on Lin et al, JAMA, 2008)

male and female [sex=M or F]

age 40 and over [agecat20>=10 and agecat20 ne 00]

residence in CA county [patcnty ne 00]

and any of the following procedure codes are present

92980 Transcatheter placement of an intracoronary stent(s), percutaneous, with or without other therapeutic intervention, any method; single vessel

92981 Transcatheter placement of an intracoronary stent(s), percutaneous, with or without other therapeutic intervention, any method; each additional vessel (List separately in addition to code for primary procedure)

and none of the following diagnosis codes are present

41000 AMI ANTEROLATERAL, UNSPEC
41001 AMI ANTEROLATERAL, INIT
41002 AMI ANTEROLATERAL, SUBSEQ
41010 AMI ANTERIOR WALL, UNSPEC
41011 AMI ANTERIOR WALL, INIT
41012 AMI ANTERIOR WALL, SUBSEQ
41020 AMI INFEROLATERAL, UNSPEC
41021 AMI INFEROLATERAL, INIT
41022 AMI INFEROLATERAL, SUBSEQ
41030 AMI INFEROPOST, UNSPEC
41031 AMI INFEROPOST, INITIAL
41032 AMI INFEROPOST, SUBSEQ
41040 AMI INFERIOR WALL, UNSPEC
41041 AMI INFERIOR WALL, INIT
41042 AMI INFERIOR WALL, SUBSEQ
41050 AMI LATERAL NEC, UNSPEC
41051 AMI LATERAL NEC, INITIAL
41052 AMI LATERAL NEC, SUBSEQ
41060 TRUE POST INFARCT, UNSPEC
41061 TRUE POST INFARCT, INIT
41062 TRUE POST INFARCT, SUBSEQ
41070 SUBENDO INFARCT, UNSPEC
41071 SUBENDO INFARCT, INITIAL

41072 SUBENDO INFARCT, SUBSEQ
41080 AMI NEC, UNSPECIFIED
41081 AMI NEC, INITIAL
41082 AMI NEC, SUBSEQUENT
41090 AMI NOS, UNSPECIFIED
41091 AMI NOS, INITIAL
41092 AMI NOS, SUBSEQUENT

4111 Intermediate coronary syndrome
41181 Acute coronary occlusion without myocardial infarction
Other acute and subacute forms of ischemic heart disease - other (coronary
41189 insufficiency; subendocardial ischemia)

78551 Cardiogenic shock
78559 Shock without mention of trauma - Other

Appendix 4: ASC Coding Specifications

Any Angiography

male and female [sex=M or F]

age 20 and over [agecat20>=06 and agecat20 ne 00]

residence in CA county [patcnty ne 00]

and any of the following procedure codes are present

- 93510 Left heart catheterization, retrograde, from the brachial artery, axillary artery or femoral artery; percutaneous
- 93511 Left heart catheterization, retrograde, from the brachial artery, axillary artery or femoral artery; by cutdown
- 93514 Left heart catheterization by left ventricular puncture
- 93524 Combined transseptal and retrograde left heart catheterization

- 93526 Combined right heart catheterization and retrograde left heart catheterization
- 93527 Combined right heart catheterization and transseptal left heart catheterization through intact septum (with or without retrograde left heart catheterization)
- 93528 Combined right heart catheterization with left ventricular puncture (with or without retrograde left heart catheterization)
- 93529 Combined right heart catheterization and left heart catheterization through existing septal opening (with or without retrograde left heart catheterization)
- 93531 Combined right heart catheterization and retrograde left heart catheterization, for congenital cardiac anomalies
- 93532 Combined right heart catheterization and transseptal left heart catheterization through intact septum with or without retrograde left heart catheterization, for congenital cardiac anomalies
- 93533 Combined right heart catheterization and transseptal left heart catheterization through existing septal opening, with or without retrograde left heart catheterization, for congenital cardiac anomalies

Appendix 4: ASC Coding Specifications

Any PCI

male and female [sex=M or F]

age 40 and over [agecat20>=10 and agecat20 ne 00]

residence in CA county [patcnty ne 00]

and any of the following procedure codes are present

- | | |
|-------|--|
| 92980 | Transcatheter placement of an intracoronary stent(s), percutaneous, with or without other therapeutic intervention, any method; single vessel |
| 92981 | Transcatheter placement of an intracoronary stent(s), percutaneous, with or without other therapeutic intervention, any method; each additional vessel (List separately in addition to code for primary procedure) |
| 92982 | Percutaneous transluminal coronary balloon angioplasty; single vessel |
| 92984 | Percutaneous transluminal coronary balloon angioplasty; each additional vessel (List separately in addition to code for primary procedure) |
| 92995 | Percutaneous transluminal coronary atherectomy, by mechanical or other method, with or without balloon angioplasty; single vessel |
| 92996 | Percutaneous transluminal coronary atherectomy, by mechanical or other method, with or without balloon angioplasty; each additional vessel (List separately in addition to code for primary procedure) |