

## Research Methods

### Files Used in the Atlas

The Atlas depends on the integrated use of databases provided by the American Hospital Association (AHA), the American Medical Association (AMA), and several federal agencies, including the Bureau of the Census, the Centers for Medicare and Medicaid Services (CMS), and the National Center for Health Statistics (NCHS). Table 1 lists these files and provides a short description of the uses made of them in the Atlas.

**Table 1. Data Files Used in Analysis**

File	Source	Description and Use in Analyses
<b>Medicare Files</b>		
Denominator File (100%)	CMS	Contains one record for each Medicare beneficiary, and includes demographic information (age, sex, race), residence (ZIP code), program eligibility and mortality. Used to determine denominators for utilization rates and to determine mortality.
MedPAR File (100%)	CMS	One record for each hospital and skilled nursing facility (SNF) stay by Medicare beneficiaries. Includes data on dates of admission/discharge, diagnoses, procedures and Medicare reimbursements to the hospital. Used for (1) allocation of acute care hospital resources and physicians and (2) numerators for utilization rates. Also used to measure reimbursements for hospital and SNF services.
Carrier file / Physician/Supplier Part B File (100%)	CMS	Includes physician/supplier claims for services paid by the Part B program. A majority of services are provided in office, inpatient, outpatient, home, and nursing home settings. Used to measure physician visit rates, and rates of certain diagnostic procedures and preventive services, as well as reimbursements for physician services.
Outpatient File (100%)	CMS	Includes claims submitted by institutional outpatient providers, such as hospital outpatient departments, rural health clinics, outpatient rehabilitation facilities, and community mental health centers. Used to measure reimbursements to these facilities, as well as rates of certain diagnostic procedures and preventive services delivered at these institutions. Also used to measure visits to rural and federally qualified health centers.
Durable Medical Equipment File (100%)	CMS	Includes claims submitted by durable medical equipment providers. Used to measure reimbursements for durable medical equipment.
Home Health Agency (HHA) File (100%)	CMS	Includes claims submitted by HHA providers. Used to measure reimbursements for and utilization of HHA services.
Hospice File (100%)	CMS	Includes claims submitted by hospice providers. Used to measure reimbursements for and utilization of hospice services.
Medicare Provider of Services File	CMS	Includes a record for each hospital eligible to provide inpatient care through Medicare. Includes location and resource data. Used in measuring acute care resource investments.
Medicare Cost Reports	CMS	Includes a record for each hospital and provides detailed accounting data for the specified year. Used in measuring acute care resource investments.

<b>Resource Files</b>		
Annual Survey of Hospitals	AHA	Includes a record for each hospital registered with the AHA. Used in measuring acute care resources (beds, personnel).
AMA Masterfile	AMA	Includes one record for each allopathic/osteopathic physician with practice ZIP code, self-designated specialty, major professional activities, and federal/ non-federal status. Used to determine specialty-specific counts of physicians in each health care market.
<b>Other Files</b>		
National Hospital Discharge Survey	NCHS	Provides age-sex specific hospital discharge rates for the U.S. as a whole, which were used as the basis for the age-sex adjustment of acute care resources.
National Ambulatory Medical Care Survey (NAMCS)	NCHS	Ambulatory services from samples of patient records selected from a national sample of office-based physicians. Allows estimation of age-sex specific use rates by specialty. Used for age-sex adjustment of physician workforce.
Population Files	U.S. Bureau of the Census	Data from the U.S. Bureau of the Census include age-sex specific estimated counts of residents by ZIP Code Tabulation Area (ZCTA). Used (1) for age-sex adjustment, (2) as denominator for rates of allocated and adjusted resources.
ZIP Code Boundary Files	Tele Atlas Lebanon, NH	Includes records for each ZIP code with the coordinates of the boundary precisely specified. Used as basis for mapping HSAs and HRRs and for assigning ZIP codes appropriately.

## The Geography of Health Care in the United States

### Defining Hospital Service Areas

Hospital Service Areas (HSAs) represent local health care markets for community-based inpatient care. The definitions of HSAs used in the original edition of the Atlas have been retained in subsequent editions in order to provide continuity of the market areas. HSAs were originally defined in three steps using 1993 provider files and 1992-93 utilization data. First, all acute care hospitals in the 50 states and the District of Columbia were identified from the American Hospital Association Annual Survey of Hospitals and the Medicare Provider of Services files and assigned to a location within a town or city. The list of towns or cities with at least one acute care hospital (N=3,953) defined the maximum number of possible HSAs. Second, all 1992 and 1993 acute care hospitalizations of the Medicare population were analyzed according to ZIP code to determine the proportion of residents' hospital stays that occurred in each of the 3,953 candidate HSAs. ZIP codes were initially assigned to the HSA where the greatest proportion (plurality) of residents was hospitalized. Approximately 500 of the candidate HSAs did not qualify as independent HSAs because the plurality of patients living in those cities was hospitalized in other cities.

The third step required visual examination of the ZIP codes used to define each HSA. Maps of ZIP code boundaries were made using files obtained from Geographic Data Technologies (GDT) (now Tele Atlas) and each HSA's component ZIP codes were examined. In order to achieve contiguity of the component ZIP codes for each HSA, "island" ZIP codes were reassigned to the enclosing HSA, and/or HSAs were grouped into larger HSAs (see the Appendix on the Geography of Health Care in the United States for an illustration). Certain ZIP codes used in the Medicare files were restricted in their

use to specific institutions (e.g., a nursing home) or a post office. These “point ZIPs” were assigned to their enclosing ZIP code based on the ZIP code boundary map.

This process resulted in the identification of 3,436 HSAs. In most HSAs, the majority of Medicare hospitalizations occurred in a hospital or hospitals located within the HSA. See the Appendix on the Geography of Health Care in the United States for further details.

### **Defining Hospital Referral Regions**

Hospital referral regions (HRRs) represent health care markets for tertiary medical care. As defined in the 1996 Atlas, each HRR contained at least one HSA that had a hospital or hospitals that performed major cardiovascular procedures and neurosurgery in 1992-93. Three steps were taken to define HRRs.

First, the candidate hospitals and HRRs were identified. A total of 862 hospitals performed at least 10 major cardiovascular procedures (DRGs 103-107) on Medicare enrollees in both years. These hospitals were located within 458 HSAs, thereby defining the maximum number of possible HRRs. Further checks verified that all 458 HSAs included at least one hospital performing the specified major neurosurgical procedures (DRGs 1-3 and 484).

Second, we calculated in each of the 3,436 HSAs in the United States the proportion of major cardiovascular procedures performed in each of the 458 candidate HRRs in 1992-93. Each HSA was then assigned provisionally to the candidate HRR where most patients went for these services.

Third, HSAs were reassigned or further grouped to achieve (a) geographic contiguity, unless major travel routes (e.g., interstate highways) justified separation (this occurred in only two cases, the New Haven, Connecticut and Elmira, New York HRRs); (b) a minimum population size of 120,000; and (c) a high localization index. Because of the large number of hospitals providing cardiovascular services in California, several candidate California HRRs met the above criteria but were found to perform small numbers of cardiovascular procedures. These HRRs were further aggregated according to county boundaries to achieve stability of cardiovascular surgery rates within the areas.

The process resulted in the definition of 306 hospital referral regions. See the Appendix on the Geography of Health Care in the United States for further details.

### **Populations of HSAs and HRRs**

Total population counts are estimated for residents of all ages in each HSA using ZIP code level files obtained from Tele Atlas and Zip Code Tabulation Area (ZCTA) level files from the U.S. Bureau of the Census. Population counts for HRRs are the sum of the counts of the constituent HSAs. These serve as denominators for estimating rates for hospital resource and physician workforce allocations.

For rates that apply to the Medicare-enrolled population, enrollee counts are obtained from the Medicare Denominator file. The annual Medicare enrollee populations include those alive and age 65 to age 99 on June 30 of the measurement year. For physician visit rates, the population above is further restricted to the 20% sample of Medicare enrollees having Medicare Part B physician claims,

who were selected on the basis of the terminal digits in the Social Security number; for each year, we include only those enrolled in Medicare Part B on June 30. For Medicare reimbursement rates, the Medicare population above is restricted to a 5% sample of enrollees, selected on the basis of the terminal digits in their Social Security numbers, entitled to both Medicare A and B services. For all rates, the numerator and the denominator counts exclude those who were enrolled in risk-bearing health maintenance organizations (HMOs) at any time during the year.

## Medicare Program Reimbursement Rates

The numerators for Medicare reimbursement rates come from the 100% claims files described in Table 1. The denominator for rates consists of beneficiaries enrolled in both Medicare Parts A and B on January 1 of the measurement year. Patients enrolled in risk-bearing health maintenance organizations (HMOs) are excluded. Medicare reimbursement rates are summarized by file and then summed to generate the rate of overall Medicare reimbursements.

### Calculation of Adjusted Medicare Reimbursement Rates

Medicare reimbursement rates are indirectly adjusted for sex, race and age, with the corresponding annual Medicare population as the standard using the indirect method. Total fee-for-service (non-capitated) Medicare reimbursement rates are computed as the sum of the component rates.

Price adjustment is based on standardized prices for each service. Medicare reimburses health care providers for hospital admissions based on diagnostic-related groups (DRGs). CMS assigns a given DRG “weight” based on the estimated amount of resources necessary to provide a service. To adjust for the regional variations in reimbursement rates, we assign a standardized price to each DRG, regardless of how much Medicare actually paid per DRG. Our standardized DRG price is determined so as to ensure that total price-adjusted dollar reimbursements in the U.S. in each year are equal to total unadjusted—that is, actual—reimbursements. A similar approach is used for physician payments, which are typically billed on the basis of relative value units (RVUs). Age, sex and race-adjusted RVUs are added up across individual patients—and hence across HRRs—and then priced uniformly using a single national RVU reimbursement “price” for every HRR in the country. Outpatient facility expenditures are adjusted by CMS using the wage index. Thus, for outpatient facility expenditures, we “reverse engineer” expenditures using the local wage index, thereby deflating high outpatient spending in high-cost regions and inflating outpatient spending in low-cost regions. Other, smaller expenditure categories, such as nursing home stays, are adjusted using a common price per day.

## Hospital Resources

Acute care hospital resources consist of hospital beds and personnel. Three tasks are required to estimate the hospital resource rates. First, the resources for each hospital are estimated; second, resources are allocated to populations, proportionate to their rates of use; third, rates are computed and adjusted to take into account differences in age and sex among regions.

## Measuring Hospital Resources

Hospitals are eligible for inclusion if they are located within the 50 states or the District of Columbia and are classified either by Medicare or the AHA as short-term general medical and surgical hospitals (AHA service code = 10); specialty hospitals listed as surgical (code 13), cancer (code 41), heart (code 42), obstetrics and gynecology (code 44), eye, ear, nose and throat (code 45), orthopedic (code 47), or other specialty (code 49); children's hospitals (codes 50, 59); and adult and children's acute long-term care hospitals (codes 80, 90). For inclusion, hospitals must have been open on June 30 of the measurement year. Certain specialty hospitals are excluded if additional information gathered from external sources indicates they do not meet the inclusion criteria, or if they fall into the following categories: Shriners' hospitals, crippled children's hospitals, hospital units of institutions (prisons, colleges, etc.), institutions for mental retardation, psychiatric facilities, rehabilitation or chronic disease facilities, addiction treatment facilities, communication disorders facilities, podiatry facilities, small surgery centers, obstetrics and gynecology clinics, and hospices. Department of Veterans' Affairs hospitals are excluded because of the non-comparability of expenditure and personnel data.

The American Hospital Association Annual Survey file and the Medicare Provider file are searched to identify all non-federal hospitals (AHA control code = 12-33) and federal PHS and Indian Service hospitals (control code = 44,47) that meet the criteria for inclusion.

Hospital beds, full-time equivalent employees (FTEs) and hospital-based registered nurses are ascertained primarily from the AHA file. For hospital beds, the field selected is "hospital beds (including cribs, pediatric and neonatal bassinets) that were set up and staffed at the end of the reporting period". For the hospitals that were non-reporting in the measurement year, we use data from the Medicare Cost Reports to report beds and FTEs. For any remaining non-reporting hospitals not found in the Cost Reports, we use the CMS Provider of Services file to report beds, FTEs and registered nurses.

## Allocation of Hospital Resources

In order to account for the use of care by patients who live in one HSA but obtain care in another, hospital resources for acute care short-term hospitals have been allocated to the HSAs in proportion to the actual patterns of use. This is accomplished using the proportion of all Medicare patient days provided by each specific hospital to each HSA. For example, if 60% of total Medicare inpatient days at a hospital were used by residents of the HSA where the hospital was located, then 60% of that hospital's resources would be assigned to its HSA. If 20% of the Medicare patient days provided by that hospital were used by a neighboring HSA, 20% of the hospital's resources would be assigned to that neighboring HSA.

Children's hospitals and specialty hospitals have too little actual utilization data in the Medicare files to allow their allocation based on hospital-specific proportionate utilization. These hospitals are allocated according to the utilization patterns of all Medicare enrollees residing in the HSA. In other words, if 80% of the patient days in an HSA were provided by hospitals within the HSA, then 80% of the resources of any specialty or children's hospital located within that HSA would be assigned to it.

The use of Medicare data to estimate resources allocated to populations of all ages is justified by studies that show that the geographic patterns of use of hospital care by patients under and over sixty-five years of age are similar. Our own analyses of data from both New York and New England reveal that travel patterns for those under age 65 are nearly identical to those over age 65. Radany and Luft (1993) found similar results in California.

Once each of the hospital resources has been allocated to HSAs, the allocated resources are summed. For example, the allocated beds of each HSA are equal to the sum of allocated acute short-term beds and allocated specialty/children’s beds. For the HSAs located in a given HRR, resources are further summed to obtain the total for the HRR. The resource allocation rates are then adjusted for differences in age and sex using the indirect method, using the U.S. population as the standard.

### Physician Workforce Rates

The methods for allocating and estimating the per capita rates of physicians serving HSAs and HRRs are analogous to the methods used for estimating and allocating hospital resources. The source of information on physicians is the American Medical Association Physician Masterfile. This file has been used extensively to study physician supply and is the only comprehensive data available on physician location, specialty, and level of effort devoted to clinical practice. The physician file classifies physicians according to self-reported level of effort devoted to clinical practice. In this study, we exclude physicians who reported that they worked the majority of the time in medical teaching, administration or research, and part-time physicians working fewer than 20 hours a week in clinical practice. The file also lists ZIP code fields indicating the physician’s primary place of practice. When this information is not available, we use the physician’s preferred professional address to indicate location.

### Physician Specialties

The AMA Masterfile includes the physician’s primary self-designated specialty from a list of 243 specialties. We group these into the categories in Table 2.

**Table 2. Categories of Clinically Active Physicians**

Dartmouth Specialty	AMA Specialty	AMA Codes
All Physicians	All except unspecified (codes US, FLX, TY, 000)	
Primary Physicians	Family Practice	AMF, FM, FP, FSM, GP
	Internal Medicine	HPI, IFP, IM
	Pediatrics	PD
Specialists	All except primary physicians and unspecified	
Medical Specialists	Allergy/Immunology	A, AI, ALI, IG, PDA
	Cardiology	CD, IC, ICE, NC
	Critical Care	CCA, CCM, CCS, IEC, NCC, OCC, PCC
	Dermatology	D, DDL, DS, IMD, PDD, PDM, PRD
	Emergency Medicine	EFM, EM, ESM, ETX, HPE, MEM, UCM, UME
	Endocrinology	DIA, END

	Gastroenterology	GE, HEP
	Geriatrics	FPG, GER, IMG
	Hematology/Oncology	HEM, HO, ND, OMO, ON
	Infectious Disease	ID
	Nephrology	NEP
	Neurology	CHN, CN, MN, N, NDN, NMN, NNM, PMN, VN
	Physical Medicine/Rehab.	MPM, NPR, PM, PMM, PMP, PRS, SCI
	Pulmonology	PUD
	Radiation Oncology	RO
	Rheumatology	RHU
	Other Medical Specialties	ADM, AM, AMI, BE, CBG, CCG, CG, CMG, EP, GPM, HOS, HPM, HYP, IPM, ISM, LM, MDG, MDM, MG, MPH, NTR, OM, OMM, OS, PA, PH, PHM, PHP, PLM, PMD, PTX, PYM, SM, SME, SMI, UM, VM
Hospital-Based Physicians	Anesthesiology	ACA, AN, APM, PAN, PME
	Pathology	ATP, BBK, BLB, CLP, CMP, DLI, DMP, FOP, HMP, ILI, IP, MGP, MM, NA, NP, PCH, PCP, PIP, PLI, PP, PTH, RIP, SP
	Radiology	AR, CTR, DR, ESN, MSR, NM, NR, NRN, PDR, R, RNR, RP, TR, VIR
Surgeons	Cardiovascular/Thoracic Surgery	CDS, CHS, CTS, PCS, TS
	General Surgery	AS, ABS, CRS, GS, SO
	Neurological Surgery	ES, NS, NSP
	Obstetrics/Gynecology	GO, GYN, HPO, MFM, OBG, OBS, REN
	Ophthalmology	OPH, PO
	Orthopedic Surgery	HSO, OAR, OFA, OP, ORS, OSM, OSS, OTR
	Otolaryngology	LAR, NO, OMF, OT, OTO, PDO, RHI
	Plastic & Reconstructive Surgery	CS, FPS, PS, PSH
	Urology	U, UP
	Vascular Surgery	VS
	Other Surgery	CFS, HNS, HS, HSP, HSS, MFS, PHL, PRO, THP, TRS, TTS
Other	Neonatology	NPM
	Psychiatry	ADP, CHP, CPP, FPP, HPN, MP, NUP, P, PFP, PPN, PYA, PYG, PYN, SMN
	Pediatric Surgery	PDS, PMG, PPM
	Other Pediatric Specialties	ADL, CCP, DBP, EMP, MPD, NDP, PDC, PDE, PDI, PDP, PDT, PE, PEM, PG, PHO, PN, PNP, PPR, PRM, PSM, RPM, SMP

**Allocation of Clinically Active Physicians**

Clinically active physicians are assigned to the HSA of their primary place of practice or preferred professional address. Since physicians, like hospitals, provide services to patients residing outside of the HSA in which their practices are located, the physician workforce is allocated to adjust for patient migration. Unfortunately, allocations cannot be based on information about the travel patterns of the patients of individual physicians or information about the use of care outside acute hospitals. For clinically active non-federal physicians, the adjustments are closely analogous to the method used for hospital resources, with an important exception; since the hospital affiliations of the physicians were not determined, the physicians are allocated on the basis of the patterns of inpatient care of all the hospitals located in their HSAs. For example, primary physicians are allocated on the basis of medical DRGs. If an HSA had four primary care physicians and if 25% of the medical DRG patient days at the local hospital(s) were for residents of a neighboring HSA, then the four primary physicians would be estimated to contribute 1.0 FTE primary care physician to the neighboring HSA.

When all physician specialty groups have been allocated to HSAs, their allocated FTEs are summed. The physicians allocated to an HSA represent the total of all federal and non-federal FTE physicians allocated from local as well as remote HSAs. For the HSAs in a given HRR, physician resources are further summed to obtain the total for the HRR. Measures of physicians in residency training programs used in the Atlas are prepared separately using similar methods. The allocated physician rates are adjusted for age and sex using the indirect method, using the U.S. population as the standard.

### Medicare Hospitalization and Surgical Procedure Rates

Hospitalization rates represent counts of the number of discharges that occurred in a defined time period (the numerator) for a specific population (the denominator). The counts of discharges for specific conditions are based on the MedPAR files for the measurement year. The denominator is the corresponding Medicare enrollee population that was enrolled in Medicare Part A on June 30 of the measurement year. In order to ensure that the events counted in the numerator correspond to the denominator population, certain records are excluded, including MedPAR records with a length of stay over 365 days and hospitalizations in psychiatric, rehabilitation or long term care units (special unit codes = S, T, U or V; stay indicator code = N; third digit of Medicare provider number not equal to 0 OR third and fourth digits not equal to 13). Patients enrolled in risk-bearing HMOs at any time during the year (HMO status = A, B or C) are excluded.

### Procedures and Conditions Examined in the Atlas

The specific procedures and conditions, or “numerator events”, and the codes used to identify the event in the file in the most recent analyses posted on our web site are given in Table 3. “Ambulatory care-sensitive conditions” refer to hospitalizations – such as asthma, pneumonia, chronic pulmonary obstructive disease and congestive heart failure – that are preventable when access to primary care is adequate.

**Table 3. Codes Used to Define Conditions and Procedures**

<b>Hospital Discharges</b>	
<b>Event</b>	<b>DRGs</b>
Total Discharges (& Days)	All acute care stays in short term hospitals (LOS truncated at 365 days)
Medical Discharges (& Days)	All medical MS-DRGs
Surgical Discharges (& Days)	All surgical MS-DRGs
Medical Discharges excl. ACS Conditions	Medical discharges – ACS discharges
<b>Discharges for Ambulatory Care-Sensitive Conditions</b>	
<b>Event</b>	<b>ICD-9-CM Diagnosis Codes</b>
Convulsions	780.3x
Chronic Obstructive Pulmonary Disease (COPD)	491xx, 492xx, 494xx, 496xx, 466.0x 466.0x only w/secondary dx 491xx, 492xx, 494xx, 496xx
Bacterial Pneumonia	481xx, 482.2x, 482.3x, 482.9x, 483xx, 485xx, 486xx Excl. secondary dx 282.6x

Asthma	493xx	
Congestive Heart Failure (CHF)	428xx, 402.01, 402.11, 402.91, 518.4x Excl. sx 00.66, 36.1x, 37.5x, or 37.7x	
Hypertension	401.0x, 401.9x, 402.00, 402.10, 402.90 Excl. sx 00.66, 36.1x, 37.5x, or 37.7x	
Angina	411.1x, 411.8x, 413xx Excl. sx 01-86.99	
Cellulitis	681xx, 682xx, 683xx, 686xx Excl. sx 01-86.99, except if 86.0x is the first and only sx code	
Diabetes	250.0x, 250.1x, 250.2x, 250.3x, 250.8x, 250.9x	
Gastroenteritis	558.3, 558.41, 558.42, 558.9x	
Kidney/Urinary Infection	590xx, 599.0x, 599.9x	
Dehydration	276.5x	
<b>Inpatient Surgical Procedures</b>		
<b>Event</b>	<b>Procedure Code(s)</b>	<b>&amp;/or Diagnosis Code(s)</b>
<b>General Surgery</b>		
Cholecystectomy	51.21-51.24	---
Resection for colorectal cancer (colectomy)	17.31-17.39, 45.7-45.79, 45.8	153-153.9, 209.10-209.16
Mastectomy for cancer (female)	85.41, 85.43, 85.45, 85.47	174-174.9, excluding 233.0
<b>Vascular Surgery</b>		
Carotid endarterectomy	38.12	---
Abdominal aortic (AAA) aneurysm repair	38.44, 39.25, 39.71, 39.78	441.3-441.9
Lower extremity revascularization	39.29	Excluding 444.21 or ESRD is true from Denominator file status
Major leg amputation	84.15-84.17	---
<b>Cardiothoracic Surgery</b>		
Coronary artery bypass grafting surgery (CABG)	36.10-36.19	---
Aortic/mitral valve replacement	35.05, 35.06, 35.09, 35.2-35.24	---
Percutaneous coronary interventions (PCI)	00.66, 36.06, 36.07, 36.09	---
Coronary angiography	37.22, 37.23; 88.55-88.57	---
<b>Urology</b>		
Radical prostatectomy (male)	60.5	---
TURP for BPH (male)	60.2, 60.21, 60.29	Dx slots 1-5 = 600-601.4, 601.8, 601.9, 602-602.1, 788.2-788.29, 788.4x
Radical nephrectomy for cancer	55.5-55.51	189-189.1, 189.2, 209.24
<b>Orthopedic Surgery</b>		
Back surgery	03.0, 03.02, 03.09, 03.6, 80.50-80.54, 80.59, 81.00-81.09, 81.31-81.39, 81.61-81.64, 84.60-84.69;	Excluding Dx codes 140-239.9, 324.1, 630-676, 720.0-720.9, 730-730.99, 733.1, 733.10, 733.13, 733.8, 733.81-733.82, 733.95, 805-806.9, 839-839.59, E800-E849.9: Sx codes 03.2-03.29
	03.93, 03.94, 78.50, 78.59, 78.60, 78.69, 78.90, 78.99, 84.51, 84.52, 84.58, 84.59, 84.80-84.85, 86.94-86.96	With exclusions above and only with Dx codes = 353.9, 355.0, 355.9, 721.0-721.4, 721.42, 721.7-721.9, 721.90, 721.91, 722.0, 722.10, 722.11, 722.2, 722.4, 722.5, 722.51, 722.52, 722.6, 722.70-722.73, 722.80, 722.81, 722.83, 722.90-722.93, 723.0, 723.1, 723.8, 724.00-724.03,

		724.09, 724.2-724.6, 724.70, 724.71, 724.79, 724.8, 724.9, 737.0, 737.1, 737.10, 737.19, 737.20, 737.3, 737.30, 737.32, 737.34, 737.39, 737.43, 737.8, 737.9, 738.4, 756.11, 756.12, 846.0, 846.1-846.3, 846.8, 846.9, 847.0, 847.2, 847.9
Hip replacement	81.51	Excluding 820-821.39, 996.4x
Knee replacement	81.54	---
Hospitalization for hip fracture		Primary Dx 820-820.99

**Surgical Procedure Rates**

The rates of inpatient surgery are based on the MedPAR files for the measurement year. The denominators are the mid-year Medicare enrollee population, with the same restrictions as for discharge rates above. The procedure codes used in the MedPAR file are based on the International Classification of Disease, ICD-9-CM. Selection of procedure codes is based on review of the literature and/or consultation with clinical experts. Some rates are suppressed for reasons of data confidentiality. Suppression rules meet current CMS standards. Rates with fewer than 26 expected events are suppressed for reasons of statistical precision.

**Adjusted Procedure and Utilization Rates**

Discharge rates are adjusted using the indirect method for age, sex and race using the national Medicare population as the standard. Sex-specific population estimates are used for prostate and breast procedures. Although the majority of events occurred at most once per person during the study period, we include multiple events to the same person to allow the rates to reflect total health care utilization.

**Quality of Care in the Last Six Months of Life**

For rates pertaining to the last six months of life, the denominator is the Medicare population who died during the measurement year. The percent of Medicare deaths occurring in a hospital is computed using death in a hospital (discharge status='B' in MedPAR file) as the numerator event. For the percent of Medicare patients who were admitted to the ICU in the last six months of life, the numerator event is an admission to an ICU within six months of the death date in the MedPAR file. Rates are age, sex, and race-adjusted and are expressed as a percentage of deaths.

Average days in the hospital, average days in the ICU and average reimbursements for inpatient care per capita are computed using only the portion of the event (hospital stay or ICU stay) falling within the six-month period prior to death. Rates are age, sex and race-adjusted.

## Calculation of Age, Sex, and Race Adjusted Rates

Medicare procedure, condition, and reimbursement rates are adjusted using the indirect method for the following strata: sex, race (black, non-black) and age (65-69, 70-74, 75-79, 80-84, 85-99). The standard population is the U.S. Medicare population age 65 to 99 with Medicare Parts A and B entitlement and no HMO enrollment during the measurement period. The expected counts within HSAs are computed using the stratum-specific crude rates in the standard population, weighting by the stratum-specific population. Observed and expected counts at the HSA level are summed to the HRR level. Indirectly standardized rates for HRRs are then computed from observed and expected counts (Breslow and Day, 1987). A detailed explanation of indirect adjustment is available from the Dartmouth Atlas web site.

This procedure is slightly modified for hospital resource and physician workforce rates. The hospital resource rates are adjusted for differences in age and sex using the indirect method using the U.S. population as the standard. Since the national age-sex specific bed supply rates are not obtainable, these are estimated using the national age-sex specific patient day rates obtained from the National Hospital Discharge Survey. These estimates are used to calculate the expected bed supply in each HSA and HRR. Under the assumption that employee allocations across age and sex groups are also proportionate to patient days, a similar strategy is used to adjust employees.

The allocated physician rates are also adjusted for age and sex using the indirect method using the U.S. population as a standard. As with hospital bed supply rates, the national age-sex specific physician workforce rates are not known. These are estimated using outpatient age, sex and specialty specific physician visit rates from the National Ambulatory Care Survey (NAMCS). These estimates are used to calculate the expected physician supply in each HSA by specialty. Specialties that have too few visits to reliably estimate age-sex specific visit rates (< 800 total NAMCS) use the visit rates of allied specialties. Four NAMCS specialty categories cannot be age and sex adjusted because of the low frequency of ambulatory visits and the lack of allied specialties: pathology, radiology, critical care and “unspecified”. Observed and expected counts of resident physicians are prepared separately using similar methods. The counts are summed to the HRR level and are used to calculate indirectly standardized rates. Rates for combined physician categories are obtained by first summing the observed and expected counts of the component specialties to the HRR level.