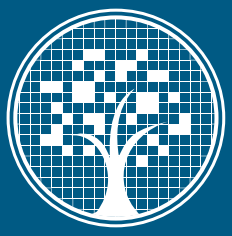

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HCUP Methods Series

Methods Applying AHRQ Quality Indicators to Healthcare and Utilization Project (HCUP) Data for the Fifth (2007) National Healthcare Disparities Report

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Methods Applying AHRQ Quality Indicators to Healthcare Cost and Utilization Project (HCUP) Data for the Fifth (2007) National Healthcare Disparities Report

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January 4, 2008

The Agency for Healthcare Research and Quality (AHRQ) Quality Indicators (QIs) were applied to the HCUP hospital discharge data for several measures in this report. The AHRQ QIs are measures of quality associated with processes of care that occurred in an outpatient or an inpatient setting. The QIs rely solely on hospital inpatient administrative data and, for this reason, are screens for examining quality that may indicate the need for more in-depth studies. The AHRQ QIs used for this report include four sets of measures:

- Prevention Quality Indicators (PQIs)—or ambulatory care sensitive conditions—identify hospital admissions that evidence suggests could have been avoided, at least in part, through high-quality outpatient care (AHRQ, 2006).

- Inpatient Quality Indicators (IQIs) reflect quality of care inside hospitals and include measures of utilization of procedures for which there are questions of overuse, underuse, or misuse (AHRQ, 2006).

- Patient Safety Indicators (PSIs) reflect quality of care inside hospitals, by focusing on surgical complications and other iatrogenic events (AHRQ, 2006).

- Pediatric Quality Indicators (PDIs) reflect quality of care inside hospitals and identify potentially avoidable hospitalizations among children (AHRQ, 2006).

The QI measures selected for this report are described in Table 1 at the end of this methods section.

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

The 2004 HCUP State Inpatient Databases (SID), a *census* of hospitals (with all of their discharges), from 23 participating States were used to create a disparities analysis file designed to provide national estimates on disparities for this report. A sample of hospitals from the following States were included Arizona, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Kansas, Maryland, Massachusetts, Michigan, Missouri, New Hampshire, New Jersey, New York, Rhode Island, South Carolina, Tennessee, Texas, Virginia, Vermont, and

Wisconsin. For the list of the HCUP data sources, see Table 2 at the end of this methods section.

To apply the AHRQ Quality Indicators to HCUP hospital discharge data, several steps were taken: 1) QI software review and modification, 2) acquisition of population-based data, 3) general preparation of HCUP data, 4) special methods for race/ethnicity reporting, and 5) identification of statistical methods. These steps, described briefly below, are presented in greater detail in the *Technical Specifications for HCUP Measures* in the *2007 National Healthcare Quality Report* and the *National Healthcare Disparities Report* (Barrett, Houchens, Coffey, et al., 2007), available from AHRQ on request.

1. **QI Software Review and Modification.** For this report, we started with the following QI software versions: PQI Version 3.0, IQI Version 3.0, PSI Version 3.0, and PDI Version 3.0b. Because each of these software modules was developed for State and hospital-level rates, rather than national rates, some changes to the QI calculations were necessary. (For details, see Barrett, Houchens, Coffey, et al., 2007). We also added two indicators particularly relevant to the structure of the NHQR, for patients age 65 years and older: immunization-preventable influenza and adult asthma admissions.

2. **Acquisition of Population-Based Data.** The next step was to acquire data for the numerator and denominator populations for the QIs. A QI is a measure of a event that occurs in a hospital, requiring a numerator count of the event of interest and a denominator count of the population (within the hospital or within the geographic area) to which the event relates. For the numerator counts of the AHRQ QIs, we used HCUP data selected from the SID for a disparities analysis file (described under Step 4 below).

   We identified two sources of denominator counts for all reporting categories and for all adjustment categories listed in the HCUP-based tables. The HCUP data were used for national-level discharge denominator counts for QIs that related to *providers.* Population ZIP-Code-level counts by age and gender from Claritas (a vendor that compiles and adds value to Bureau of Census data for sale) were used for denominator counts for QIs that related to *geographic areas*. For the area-based QIs, we also used the Claritas population data for risk adjustment by age and male-female gender.

   Claritas uses intra-census methods to estimate ZIP-Code-level statistics (Claritas, Inc., 2004). ZIP-Code-level counts were necessary for statistics by median income and urban-rural location of the patient's ZIP Code.

3. **Special Methods for Race/Ethnicity Reporting:** Race and ethnicity measures can be problematic in hospital discharge databases. Many hospitals do not code race and ethnicity completely. Because race/ethnicity is a pivotal measure for the NHDR, we explored the reporting of the race/ethnicity data in the 37 States that participate in 2004 HCUP SID. Nine States did not provide information on patient race to HCUP. Five States did not report Hispanic ethnicity. The remaining 23 States were used for the creation of the disparities analysis file. The following table demonstrates the representation by region of the 23 States.

Region	Number of States used for the disparities analysis file	Number of States in the region	Percent of States in the region included in the disparities analysis file
Northeast	7	9	78%
Midwest	4	12	33%
South	8	16	50%
West	4	13	31%
Total	23	50	46%

The table below compares aggregated totals of various measures for the 23 States as a percent of the national measure. In 2004, the 23 States accounted for 60 percent of U.S. hospital discharges (based on the American Hospital Association's Annual Survey). They accounted for about 60 percent of White and African Americans in the nation (based on 2004 Claritas data) and about 80% of Asian/Pacific Islanders and Hispanics.

Measure	Total of 23 HCUP States with race/ethnicity as a percent of national total
Hospital discharges	60%
Total resident population	64%*
Population by race/ethnicity:	
White	59%*
African American	65%*
Asian/Pacific Islander	80%*
Hispanic	83%*
Population by age:	
Population under age 18	64%*
Population age 18-64	64%*
Population over age 64	63%*
Population with income under the poverty level	66%**

*Calculated using 2004 Claritas and 1990 Census race definitions.
**Calculated using Kaiser Family Foundation statehealthfacts.org data based on pooled March 2004 and 2005 Current Population Surveys.

Data on Hispanics is collected differently among the States and also can differ from the Census methodology of collecting information on race (White, African American, Asian, American Native) separately from ethnicity (Hispanic, non-Hispanic). States often collect Hispanic ethnicity as one of several categories that include race. Clerks use these combined race/ethnicity categories to classify patients on admission to the hospital, often by observing rather than asking the patient. The HCUP databases maintain the combined categorization of race and ethnicity. When a State and its hospitals collect Hispanic

ethnicity separately from race, HCUP processing for a uniform database, uses Hispanic ethnicity to override any other race category.

4. **Preparation of HCUP Data and Development of the Disparities Analysis File.** Several HCUP data issues had to be resolved before applying the QI algorithms. First, we selected community[1] hospitals only from the 23 States and eliminated rehabilitation hospitals in the 2004 SID because the completeness of reporting for rehabilitation hospitals was inconsistent across States.

   Second, community hospitals from these 23 States were sampled to approximate a 40-percent stratified sample of U.S. community hospitals. The sampling strata were defined based on five hospital characteristics: geographic region, hospital control (i.e., public, private not-for-profit, and proprietary), urbanized location, teaching status, and bed size. Hospitals were excluded from the sampling frame if the coding of patient race was suspect (i.e., more than 30% of the discharges in the hospital had the race reported as "other", more than 50% of the discharges in the hospital had no information on the race of the patient, all of the discharges in the hospital had race coded as white, other, or missing, or 100% of the discharges in the hospital had race coded as white and the hospital had more than 50 beds).

   Once the 40-percent sample was drawn, discharge-level weights were developed to produce national-level estimates when applied to the disparities analysis file. The sampling and weighting strategy used for the disparities analysis file is similar to the method used to create the HCUP Nationwide Inpatient Sample (NIS), except that the disparities analysis file samples from 23 of the 37 States included in the 2004 NIS and is a 40-percent sample of community hospitals rather than a 20-percent sample as in the NIS. The final disparities analysis file included about 14.7 million hospital discharges from almost 1,800 hospitals.

   Third, for missing age, gender, ZIP Code, race/ethnicity, and payer data that occurred on a small proportion of discharge records, we used a "hot deck" imputation method (which draws donors from strata of similar hospitals and patients) to assign values while preserving the variance within the data.

   Fourth, we assigned median household income, in addition to hospital urban-rural location based on ZIP Code data obtained from Claritas. The urban-rural location of the patient was already on the HCUP data.

   The 2007 NHDR also includes information derived from the 2003 disparities analysis file. This data file was developed using the 2003 SID and approach described above. For more details, refer to the *Methods Applying AHRQ Quality Indicators to Healthcare Cost and Utilization Project (HCUP) Data for the Fourth (2006) National Healthcare Disparities Report* (Coffey, Barrett, Houchens, et al., 2006).

5. **Statistical Methods.** Identification of statistical issues included the following: age-gender adjustment for all QIs; severity/comorbidity adjustment for the discharge-based IQIs, PSIs, and PDIs; and derivation of standard errors and appropriate hypothesis tests.

[1] *Community* hospitals are defined by the AHA as "non-Federal, short-term, general, and other specialty hospitals, excluding hospital units of institutions." Specialty hospitals included among community hospitals are obstetrics-gynecology, ear-nose-throat, short-term rehabilitation, orthopedic, and pediatric institutions. Also included are public hospitals and academic medical centers. Excluded are short-term rehabilitation hospitals, long-term hospitals, psychiatric hospitals, and alcoholism/chemical dependency treatment facilities.

- *Age-Gender Adjustment*. For the PQIs and area-based IQIs, PSIs, and PDIs, age-gender adjustments were made for age and gender differences across population subgroups and were based on methods of direct standardization (Fleiss, 1973). Age was categorized into 18 five-year increments. The AHRQ QI software uses a similar, but different approach, to adjust the area-based QIs. We relied on direct standardization because of the additional reporting categories and population denominators required in the NHDR.
- *Age, Gender, Severity, and Comorbidity Adjustment*.

  For the discharge-based *PSI*s, adjustments were made for age, gender, age-gender interaction, DRG cluster, and comorbidity, using the regression-based standardization that is part of the AHRQ PSI software.

  For the discharge-based *IQI*s, adjustments were made for age, gender, age-gender interaction, and 3M™ All Patient Refined Diagnosis Related Groups (APR-DRGs) risk of mortality or severity score using the regression-based standardization that is part of the AHRQ IQI software.

  For the discharge-based *PDI*s, adjustments were made for age, gender, DRG and MDC clusters, and comorbidity, using the regression-based standardization that is part of the AHRQ PDI software. Measure-specific stratification by risk group, clinical category, procedure type was also applied.
- *Standard Errors and Hypothesis Tests*. Standard errors calculations for the rates were based on the HCUP report entitled "Calculating Nationwide Inpatient Sample (NIS) Variances" (Houchens, et al., 2005). There is no sampling error associated with Claritas census population counts. The appropriate statistics were obtained through the Statistical Analysis System (SAS) procedure called PROC SURVEYMEANS. The threshold selected for reporting estimates in this report is a relative standard error less than 30% and at least 10 unweighted cases in the denominator. Statistical calculations are explained in Appendix A to this report and in Barrett, Houchens, and Coffey et al. (2007).

Caveats

Some caution should be used in interpreting the AHRQ QI statistics presented in this report. The caveats relate to inter-State differences in data collection:

Data Collection Differences among States: Organizations that collect statewide data, generally collect data using the Uniform Bill (UB-92) formats, and, for earlier data, the Uniform Hospital Discharge Data Set (UHDDS) format. However, not every statewide data organization collects all data elements nor codes them the same way. For this report, uneven availability of a few data elements underlie some estimates, as noted next.

Data Elements Needed in Some QIs: Two data elements not available in every State that are required for certain QIs are: "secondary procedure day" and "admission type" (elective, urgent, and emergency). These data elements are used to exclude specific cases from some QI measures. The PSIs that use secondary procedure day were modified to not use this information for any State. Admission type of elective and newborn are used in four PSIs. We imputed the missing admission type using available information. For all States except California, an admission type of "elective" was assigned if the DRG did not indicate trauma, delivery, or newborn. An admission type of newborn was assigned if the DRG indicated a

newborn. For California, that did not provide any information on admission type, information on scheduled admissions was used to identify elective admissions and DRGs were used to identify newborn admissions.

Number of Clinical Fields: Another data collection issue relates to the number of fields that statewide data organizations permit for reporting patients' diagnoses and procedures during the hospitalization and whether they specifically require coding of external-cause of injury (E codes). The SID for different States contain as few as 6 or as many as 30 fields for reporting diagnoses and procedures, as shown in Table 3 at the end of this methods section. The more fields used, the more quality-related events that can be captured in the statewide databases. However, even for States with 30 diagnosis fields available in the year 2004, 95 percent of their discharge records captured all of patients' diagnoses in 10 to 13 data elements. For States with 30 procedure fields available, 95 percent of records captured all of patients' procedures in 5 fields. Thus, limited numbers of fields available for reporting diagnoses and procedures are unlikely to have much effect on results, because all statewide data organizations participating in HCUP allow at least 9 diagnoses and 6 procedures. We decided not to truncate artificially the diagnosis and procedure fields reported, so that the full richness of the databases would be used.

Another issue relates to external cause of injury reporting. Eight of the 27 Patient Safety Indicators use external cause of injury (E code) data to help identify complications of care or to exclude cases (e.g., poisonings, self-inflicted injury, trauma) from numerators and denominators, as shown in Table 4 at the end of this methods section. Although E codes in the AHRQ PSI software have been augmented wherever possible with the related non-E codes in the ICD-9-CM system, see Table 4 for specific details. E codes are still included in some AHRQ PSI definitions, and uneven capture of these data has the potential of affecting some PSI rates and should be kept in mind when judging the level of these events.

Race/ethnicity coding: Even excluding hospitals with a large proportion of race/ethnicity coding that was missing, there may still remain differences in racial and ethnicity coding among States that affect estimates. For example, some States include Hispanic ethnicity as a category among racial categories, some ask about Hispanic ethnicity separately from race. At the hospital-level, policies vary on methods for collecting such data. Some hospitals ask the patient to identify their race and ethnicity, some determine it from observation. The effect of these and other unmeasured differences in coding of race and ethnicity across the States and hospitals cannot be assessed.

Table 1. AHRQ Quality Indicators Selected for the National Healthcare Disparities Report

QI No.	Description
Prevention Quality Indicators	
PQI 1	Admissions for diabetes with short-term complications* (excluding obstetric admissions and transfers from other institutions) per 100,000 population, age 18 years and older * Ketoacidosis, hyperosmolarity, or coma.
PQI 2	Admissions with perforated appendix per 1000 admissions, age 18 years and older, with appendicitis (excluding obstetric admissions and transfers from other institutions)
PQI 3	Admissions for diabetes with long-term complications* (excluding obstetric admissions and transfers from other institutions) per 100,000 population, age 18 years and older * Renal, eye, neurological, circulatory, or other unspecified complications.
PQI 5	Admissions for chronic obstructive pulmonary disease (COPD) (excluding obstetric admissions and transfers from other institutions) per 100,000 population, age 18 years and older
PQI 7	Admissions for hypertension (excluding patients with cardiac procedures, obstetric conditions, and transfers from other institutions) per 100,000 population, age 18 years and older
PQI 11	Bacterial pneumonia admissions (excluding sickle cell or hemoglobin-S conditions, transfers from other institutions, and obstetric admissions) per 100,000 population, age 18 years and older
PQI 13	Admissions for angina without procedure (excluding patients with cardiac procedures, transfers from other institutions, and obstetric admissions) per 100,000 population, age 18 years and older
PQI 14	Admissions for uncontrolled diabetes without complication* (excluding obstetric and neonatal admissions and transfers from other institutions) per 100,000 population, age 18 years and older* * Without short-term (ketoacidosis, hyperosmolarity, coma) or long-term (renal, eye, neurological, circulatory, other unspecified) complications.
PQI 15	Adult asthma admissions (excluding patients with cystic fibrosis or anomalies of the respiratory system, obstetric admissions, and transfers from other institutions) per 100,000 population, age 18 years and older
PQI 15 (modified)	Adult asthma admissions (excluding patients with cystic fibrosis or anomalies of the respiratory system, obstetric admissions, and transfers from other institutions) per 100,000 population, age 65 years and older
Pediatric Quality Indicators	
PDI 06	Deaths per 1000 pediatric heart surgery admissions, patients age less than 18 years (excluding obstetric admission; patients with transcatheter interventions as single cardiac procedures, performed without bypass but with catheterization; patients with septal defects as single cardiac procedures without bypass; heart transplant; premature infants with patent ductus arteriosus (PDA) closure as only cardiac procedure; and age less than 30 days with PDA closure as only cardiac procedure; transfers to another hospital; patients with unknown disposition; and neonates with a birth weight less than 500 grams)
PDI 14	Pediatric asthma admissions (excluding patients with cystic fibrosis or anomalies of the respiratory system and transfers from other institutions) per 100,000 population, age 2 years to 17 years
PDI 15	Admissions for diabetes with short-term complications* (excluding transfers from other institutions) per 100,000 population, age 6 years to 17 years * Ketoacidosis, hyperosmolarity, or coma.
PDI 16	Admissions for pediatric gastroenteritis (excluding patients with gastrointestinal abnormalities or bacterial Gastroenteritis, and transfers from other institutions) per 100,000 population, age 4 months to 17 years
Inpatient Quality Indicators	
IQI 8	Deaths per 1000 admissions with esophageal resection for cancer (excluding obstetric and neonatal admissions and transfers to another hospital), age 18 years or older
IQI 9	Deaths per 1000 admissions with pancreatic resection for cancer (excluding obstetric and neonatal admissions and transfers to another hospital), age 18 years or older
IQI 11	Deaths per 1000 admissions with abdominal aortic aneurysm (AAA) repair (excluding obstetric and neonatal admissions and transfers to another hospital), age 18 years or older
IQI 12	Deaths per 1000 admissions with coronary artery bypass graft (excluding obstetric and neonatal admissions and transfers to another hospital), age 40 and older

IQI 15	Deaths per 1000 admissions with acute myocardial infarction (AMI) as principal diagnosis (excluding transfers to another hospital), age 18 and older
IQI 16	Deaths per 1000 admissions with congestive heart failure (CHF) as principal diagnosis (excluding obstetric and neonatal admissions and transfers to another hospital) , age 18 and older
IQI 20	Deaths per 1000 admissions with pneumonia as principal diagnosis (excluding obstetric and neonatal admissions and transfers to another hospital), age 18 and older
IQI 30	Deaths per 1000 adult admissions age 40 and older with percutaneous transluminal coronary angioplasties (PTCA) (excluding obstetric and neonatal admissions and transfers to another hospital)
Patient Safety Indicators	
PSI 1	Complications of anesthesia in any secondary diagnosis per 1000 surgical discharges (excluding patients with anesthesia complications as a principal diagnosis and patients with self-inflicted injury, poisoning due to anesthetics, and active drug dependence or abuse), age 18 years or older or obstetric admissions
PSI 2	Deaths per 1000 admissions in low mortality DRGs (DRGs with a NIS 1997 benchmark of less than 0.5% mortality, excluding trauma, immunocompromised, and cancer patients), age 18 years or older or obstetric admissions
PSI 3	Decubitus ulcers per 1000 discharges of length 5 or more days (excluding transfers, patients admitted from long-term-care facilities, patients with diseases of the skin, subcutaneous tissue, and breast, and obstetrical admissions*), age 18 years or older * Also excludes admissions specifically for such problems, such as cases from earlier admissions or from other hospitals.
PSI 4	Failure to rescue or deaths per 1000 discharges having developed specified complications of care during hospitalization (excluding patients transferred in or out, patients admitted from long-term-care facilities), age 18 years to 74 years
PSI 5	Foreign body accidentally left in during procedure per 1000 medical and surgical discharges*, age 18 years or older or obstetric admissions * Also excludes admissions specifically for treatment of foreign body left, such as cases from earlier admissions or from other hospitals.
PSI 6	Iatrogenic pneumothorax per 1000 discharges (excluding obstetrical admissions and patients with trauma, thoracic surgery, lung or pleural biopsy, or cardiac surgery*), age 18 years or older * Also excludes admissions specifically for iatrogenic pneumothorax, such as cases from earlier admissions or from other hospitals. Includes barotrauma (including acute respiratory distress syndrome) and central line placement.
PSI 7	Selected infections due to medical care per 1000 medical and surgical discharges (excluding immunocompromised and cancer patients, stays under 2 days, and admissions specifically for such infections*), age 18 years or older or obstetric admissions * Also excludes admissions specifically for such infections, such as cases from earlier admissions, from other hospitals, or from other settings.
PSI 8	Postoperative hip fracture for adults per 1000 surgical patients age 18 years and older who were not susceptible to falling* (excluding obstetrical admissions) * That is, excluding patients with musculoskeletal disease; those admitted for seizures, syncope, stroke, coma, cardiac arrest, poisoning, trauma, delirium, psychoses, anoxic brain injury; patients with metastatic cancer, lymphoid malignancy, bone malignancy, and self-inflicted injury.
PSI 9	Postoperative hemorrhage or hematoma with surgical drainage or evacuation, not verifiable as following surgery*, per 1000 surgical discharges (excluding obstetrical admissions), age 18 years or older * Postoperative hemorrhage or hematoma is not verifiable as following surgery because information on day of procedure is not available for all discharges. Also, excludes admissions specifically for such problems, such as cases from earlier admissions, from other hospitals, or from other settings.

PSI 10	Postoperative physiologic and metabolic derangements per 1000 elective surgical discharges (excluding some serious disease* and obstetric admissions), age 18 years and older * That is, excluding patients with diabetic coma and patients with renal failure who also were diagnosed with AMI, cardiac arrhythmia, cardiac arrest, shock, hemorrhage, or gastrointestinal hemorrhage.
PSI 11	Postoperative respiratory failure per 1000 elective surgical discharges with an operating room procedure (excluding patients with respiratory disease, circulatory disease, neuromuscular disorders, obstetric conditions, and admissions specifically for acute respiratory failure), age 18 years and older
PSI 12	Postoperative pulmonary embolus (PE) or deep vein thrombosis (DVT) per 1000 surgical discharges (excluding patients admitted for DVT, obstetrics, and plication of vena cava before or after surgery*), age 18 years or older * Also excludes admissions specifically for such thromboembuli, such as cases from earlier admissions, from other hospitals, or from other settings.
PSI 13	Postoperative sepsis per 1000 elective-surgery discharges with an operating room procedure (excluding patients admitted for infection; patients with cancer or immunocompromised states, obstetric conditions, stays under 4 days, and admissions specifically for sepsis), age 18 years or older
PSI 14	Reclosure of postoperative abdominal wound dehiscence per 1000 abdominopelvic-surgery discharges (excluding immunocompromised patients, stays under 2 days, and obstetric conditions*), age 18 years or older * Also excludes admissions specifically for such wound dehiscence, such as cases from earlier admissions or from other hospitals.
PSI 15	Accidental puncture or laceration during procedures per 1000 discharges (excluding obstetric admissions*), age 18 years or older * Also excludes admissions specifically for such problems, such as cases from earlier admissions or from other hospitals.
PSI 17	Birth trauma - injury to neonate per 1000 live births (excluding preterm and osteogenesis imperfecta births)
PSI 18	Obstetric trauma with 3rd or 4th degree lacerations per 1000 instrument-assisted vaginal deliveries
PSI 19	Obstetric trauma with 3rd or 4th degree lacerations per 1000 vaginal deliveries without instrument assistance
PSI 20	Obstetric trauma with 3rd or 4th degree lacerations per 1000 Cesarean deliveries

Table 2. Sources of HCUP Data

State	Data Source
Arizona	Arizona Department of Health Services
Arkansas	Arkansas Department of Health and Human Services
California	Office of Statewide Health Planning & Development
Colorado	Colorado Hospital Association
Connecticut	Chime, Inc.
Florida	Florida Agency for Health Care Administration
Georgia	Georgia Hospital Association (GHA)
Hawaii	Hawaii Health Information Corporation
Kansas	Kansas Hospital Association
Maryland	Health Services Cost Review Commission
Massachusetts	Division of Health Care Finance and Policy
Michigan	Michigan Health & Hospital Association
Missouri	Hospital Industry Data Institute
New Hampshire	New Hampshire Department of Health & Human Services
New Jersey	New Jersey Department of Health & Senior Services
New York	New York State Department of Health
Rhode Island	Rhode Island Department of Health
South Carolina	South Carolina State Budget & Control Board
Tennessee	Tennessee Hospital Association
Texas	Texas Department of State Health Services
Vermont	Vermont Association of Hospitals and Health Systems
Virginia	Virginia Health Information
Wisconsin	Wisconsin Department of Health & Family Services

Table 3. Number of diagnosis and procedure fields by State, 2004

State	Maximum number of diagnoses	Maximum number of procedures
Arizona	11	6
Arkansas	9	6
California	30	21
Colorado	15	15
Connecticut	30	30
Florida	10	10
Georgia	10	6
Hawaii	15	15
Kansas	30	25
Massachusetts	16	15
Maryland	16	15
Michigan	30	30
Missouri	30	25
New Hampshire	10	6
New Jersey	10	8
New York	17	15
Rhode Island	12	11
South Carolina	12	10
Tennessee	10	6
Texas	10	6
Virginia	10	6
Vermont	21	20
Wisconsin	10	6

Table 4. Use of E codes in the Patient Safety Indicators, Version 3.0

PSI *	Codes used for defining the numerator		Codes used for defining exclusions	
	E codes	**Similar ICD-9-CM codes**	**E codes**	**Similar ICD-9-CM codes**
1	E8763, E8551, E9381 – E9389	9681-9684, 9687	Self-inflicted injury (E95nn)	None
5	E8710 – E8719	9984, 9987	None	None
8	None	None	Self-inflicted injury (E95nn) Poisoning (E85nn, E86nn, E95nn, E96nn, E98nn)	9600-9799
15	E8700 – E8709	9982	None	None
16	E8760	9996-9997	None	None
21	E8710 – E8719	9984, 9987	None	None
25	E8700 – E8709	9982	None	None
26	E8760	9996-9997	None	None

* All other PSIs do not use E codes.

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Appendix A
Statistical Methods

This appendix explains the statistical methods and gives formulas for the calculations of standard errors and hypothesis tests. These statistics are derived from the disparities analysis file created from the HCUP SID and Claritas (a vendor that compiles and adds value to Bureau of Census data). For disparities analysis file estimates, the standard errors are calculated as described in the HCUP report entitled "Calculating Nationwide Inpatient Sample (NIS) Variances" (Houchens, et al., 2005). We will refer to this report simply as the NIS Variance Report throughout this appendix. This method takes into account the cluster and stratification aspects of the disparities analysis file sample design when calculating these statistics using the SAS procedure PROC SURVEYMEANS. For Claritas population counts, there is no sampling error.

Even though the disparities analysis file contains discharges from a finite sample of hospitals, we treat the sample as though it was drawn from an infinite population. We do not employ finite population correction factors in estimating standard errors. We take this approach because we view the outcomes as a result of myriad processes that go into treatment decisions rather than being the result of specific, fixed processes generating outcomes for a specific population and a specific year. We consider the disparities analysis file to be a sample from a "super-population" for purposes of variance estimation. Further, we assume the counts (of QI events) to be binomial.

1. Area Population QIs using Claritas Population Data

a. Standard error estimates for discharge rates per 100,000 population using the 2004 Claritas population data.

The observed rate was calculated as follows:

$$R = 100{,}000 \cdot \frac{\sum_{i=1}^{n} w_i x_i}{N} = 100{,}000 \cdot \frac{S}{N}. \qquad \text{(A.1)}$$

w_i and $x_{i,}$ respectively, are the discharge weight and variable of interest for patient i in the disparities analysis file. To obtain the estimate of *S* and its standard error, SE_S, we followed instructions in the NIS Variance Report.

The population count in the denominator is a constant. Consequently, the standard error of the rate *R* was calculated as:

$$SE_R = 100{,}000 \;\; SE_S / N. \qquad \text{(A.2)}$$

b. Standard error estimates for age/sex adjusted inpatient rates per 100,000 population using the 2004 Claritas data.

We adjusted rates for age and sex using the method of direct standardization (Fleiss, 1973). We estimated the observed rates for each of 36 age/sex categories. We then calculated a weighted average of those 36 rates using weights proportional to the percentage of a

standard population in each cell. Therefore, the adjusted rate represents the rate that would be expected for the observed study population if it had the same age and sex distribution as the standard population.

For the standard population we used the age and sex distribution of the U.S. as a whole according to the year 2000. In theory, differences among adjusted rates were not attributable to differences in the age and sex distributions among the comparison groups because the rates were all calculated with a common age and sex distribution.

The adjusted rate was calculated as follows (and subsequently multiplied by 100,000):

$$\mathrm{A} = \frac{\sum_{g=1}^{36} N_{g,std} \sum_{i=1}^{n(g)} \frac{w_{g,i} x_{g,i}}{N_{g,obs}}}{\sum_{g=1}^{36} N_{g,std}} = \frac{\sum_{g=1}^{36} \sum_{i=1}^{n(g)} \frac{N_{g,std}}{N_{g,obs}} w_{g,i} x_{g,i}}{N_{std}} = \frac{\sum_{g=1}^{36} \sum_{i=1}^{n(g)} w^{*}_{g,i} x_{g,i}}{N_{std}} = \frac{S^{*}}{N_{std}}. \quad \text{(A.3)}$$

g = index for the 36 age/sex cells.
$N_{g,std}$ = Standard population for cell g (year 2000 total U.S. population in cell g).
$N_{g,obs}$ = Observed population for cell g (year 2001 subpopulation in cell g, e.g., Medicare insureds, age greater than 65, etc.).
$n(g)$ = Number in the sample for cell g.
$x_{g,i}$ = Observed quality indicator for observation i in cell g (e.g., 0 or 1 indicator).
$w_{g,i}$ = Disparities analysis file discharge weight for observation i in cell g.

The estimates for the numerator, S^*, and its standard error, SE_{S^*}, were calculated in similar fashion to the unadjusted estimates for the numerator S in formula A.1. The only difference was that the weight for patient i in cell g was redefined to account for the weighting for direct standardization and the discharge weight as:

$$w^{*}_{g,i} = \frac{N_{g,std}}{N_{g,obs}} \cdot w_{g,i} \quad \text{(A.4)}$$

Following instructions in the NIS Variance Report, we used PROC SURVEYMEANS to obtain the estimate of S^* (A.3), the weighted sum in the numerator using the revised weights (A.4), and the estimate SE_{S^*}, the standard error of the weighted sum S^*. The denominator of the rate is a constant. Therefore, the standard error of the adjusted rate, A, was calculated as

$$SE_A = 100{,}000 \; SE_{S^*} / N_{std}. \quad \text{(A.5)}$$

2. Provider-based QIs using Weighted Discharge Data (Disparities Analysis File**)**

a. Standard error estimates for inpatient rates per 1,000 discharges using discharge counts in both the numerator and the denominator.

We calculated the observed rate as follows:

$$R = 1{,}000 \cdot \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i} = 1{,}000 \cdot \frac{S}{N}. \qquad \text{(A.6)}$$

Following instructions in the HCUP NIS Variance Report, we used PROC SURVEYMEANS to obtain estimates of the discharge weighted mean, *S/N*, and the standard error of that weighted mean, $SE_{S/N}$. We multiplied this standard error by 1,000.

b. Standard error estimates for age/sex adjusted inpatient rates per 1,000 discharges using inpatient counts in both the numerator and the denominator.

We used the 2000 Nationwide Inpatient Sample estimates for the standard inpatient population age-sex distribution. For each of the 36 age-sex categories, we estimated the number of U.S. inpatient discharges, $\hat{N}_{g,std}$, in category g. We calculated the directly adjusted rate:

$$\mathrm{A} = 1{,}000 \cdot \frac{\sum_{g=1}^{36} \hat{N}_{g,std} \dfrac{\sum_{i=1}^{n(g)} w_{g,i} x_{g,i}}{\sum_{i=1}^{n(g)} w_{g,i}}}{\sum_{g=1}^{36} \hat{N}_{g,std}} = 1{,}000 \cdot \sum_{g=1}^{36} \hat{P}_{g,std} \frac{\sum_{i=1}^{n(g)} w_{g,i} x_{g,i}}{\sum_{i=1}^{n(g)} w_{g,i}}. \qquad \text{(A.7)}$$

g = index for the 36 age/sex cells.
$\hat{N}_{g,std}$ = Standard inpatient population for cell g (Estimate of year 2000 total U.S. inpatient population for cell g).
n(g) = Number in the sample for cell g.
$x_{g,i}$ = Observed quality indicator for observation i in cell g.
$w_{g,i}$ = Disparities analysis file discharge weight for observation i in cell g.

Note that $\hat{P}_{g,std} = \dfrac{\hat{N}_{g,std}}{\sum_{g=1}^{36} \hat{N}_{g,std}}$ is the proportion of the standard inpatient population in cell g.

Consequently, the adjusted rate is a weighted average of the cell-specific rates with cell weights equal to $\hat{P}_{g,std}$. These cell weights are merely a convenient, reasonable standard

inpatient population distribution for the direct standardization. Therefore, we treat these cell weights as constants in the variance calculations:

$$SE(A) = \sqrt{Var(A)} = 1{,}000 \cdot \sqrt{Var\left(\sum_{g=1}^{36} \hat{P}_{g,std} \frac{\sum_{i=1}^{n(g)} w_{g,i} x_{g,i}}{\sum_{i=1}^{n(g)} w_{g,i}} \right)} = 1{,}000 \cdot \sqrt{\sum_{g=1}^{36} \hat{P}^2_{g,std} \cdot Var\left(\frac{\sum_{i=1}^{n(g)} w_{g,i} x_{g,i}}{\sum_{i=1}^{n(g)} w_{g,i}} \right)}. \quad \text{(A.8)}$$

The variance of the ratio enclosed in parentheses was estimated separately for each cell g by squaring the SE calculated using the method of section 2.a:

$$SE(A) = 1{,}000 \cdot \sqrt{\sum_{g=1}^{36} \hat{P}^2_{g,std} \cdot \left\{ SE(R_g) \right\}^2}$$

$$R_g = \frac{\sum_{i=1}^{n(g)} w_{g,i} x_{g,i}}{\sum_{i=1}^{n(g)} w_{g,i}} \quad \text{(A.9)}$$

Following instructions in the HCUP NIS Variance Report, we used PROC SURVEYMEANS to obtain estimates of the discharge- and standardization-weighted means, R_g, and their standard errors.

3. Significance tests.

Let R_1 and R_2 be either observed or adjusted rates calculated for comparison groups 1 and 2, respectively. Let SE_1 and SE_2 be the corresponding standard errors for the two rates. We calculated the test statistic and (two-sided) p-value:

$$t = \frac{R_1 - R_2}{\sqrt{SE_1^2 + SE_2^2}}$$

$$p = 2 * \text{Prob}(Z > |t|) \quad \text{(A.10)}$$

where Z is a standard normal variate.

Note: the following functions calculate p in SAS and EXCEL:

SAS: p = 2 * (1 - PROBNORM(ABS(t)));

EXCEL: = 2*(1- NORMDIST(ABS(t),0,1,TRUE))