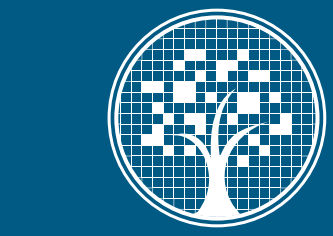

HCUP Methods Series

Methods Applying AHRQ Quality Indicators to Healthcare Cost and Utilization Project (HCUP) Data for the Seventh (2009) National Healthcare Disparities Report

Report # 2009-02

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Methods Applying AHRQ Quality Indicators to Healthcare Cost and Utilization Project (HCUP) Data for the Seventh (2009) National Healthcare Disparities Report

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The Agency for Healthcare Research and Quality (AHRQ) Quality Indicators (QIs) were applied to the HCUP hospital discharge data for several measures in the National Healthcare Disparities Report (NHDR). 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 the NHDR 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, 2007).

- 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, 2007).

- Patient Safety Indicators (PSIs) reflect quality of care inside hospitals, by focusing on surgical complications and other iatrogenic events (AHRQ, 2007).

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

The QI measures generated for possible inclusion in the NHDR are described in Table 1 at the end of this methods report. Not all QIs were used in the NHQR and NHDR.

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 2006 HCUP State Inpatient Databases (SID) were used to create disparities analysis files designed to provide national- and state-level estimates for the NHDR and derivative products. The SID contain a *census* of hospitals (with all of their discharges) from 39 participating States. Of these, the following 25 HCUP States report race/ethnicity of discharges: Arizona, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Kansas, Maryland, Massachusetts,

Michigan, Missouri, New Hampshire, New Jersey, New York, Oklahoma, Rhode Island, South Carolina, Tennessee, Texas, Utah, Vermont, Virginia, and Wisconsin. For the list of data organizations that contribute to the HCUP databases, see Table 2 at the end of this methods report.

For State-level estimates, the SID were used to create individual state-specific disparities analysis files that were designed to provide estimates for the State Snapshots Website, a derivative product of the National Healthcare Quality Report (NHQR), and the NHDR. The steps taken to create State-level disparities analysis files and apply the AHRQ Quality Indicators to the HCUP data for these analyses are described in Appendix A.

In a separate process, the SID were used to create a national disparities analysis file that was designed to provide national estimates for the NHDR, using a sample of hospitals selected from the 25 HCUP States that report race/ethnicity of discharges. Several steps were taken to apply the AHRQ Quality Indicators to HCUP hospital discharge data for national estimates for the NHDR: (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.

1. **QI Software Review and Modification.** For this report, we started with the following QI software versions: PQI Version 3.1, IQI Version 3.1, PSI Version 3.1, and PDI Version 3.1. 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. We also added two indicators particularly relevant to the structure of the NHDR 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 an event that occurs in a hospital, requiring a numerator count of the event of interest and a denominator count of the population (within a hospital or geographic area) to which the event relates.

   For the numerator counts of the AHRQ QIs, we used the disparities analysis file containing HCUP data selected from the SID (described below under Step 4) to create national estimates. For the denominator counts, we identified two sources for all reporting categories and for all adjustment categories listed in the HCUP-based tables. The HCUP data were used for discharge denominator counts for QIs that related to *providers.* Population ZIP-Code-level counts from Claritas (a vendor that compiles and adds value to the U.S. Bureau of Census data) were used for denominator counts for QIs that related to *geographic areas*. Claritas uses intra-census methods to estimate household and demographic statistics for geographic areas (Claritas, Inc., 2006). We also used the Claritas population data for risk adjustment by age and gender for the area-based QIs.

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 practices in the 39 States that participate in 2006 HCUP SID. Ten States did not provide information on patient race to HCUP. Four States did not report Hispanic ethnicity. The remaining 25 States were used for the creation of the disparities analysis file. The following table demonstrates the representation by U.S. Census region of these 25 States.

Census 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	8	9	89%
Midwest	4	12	33%
South	9	16	56%
West	4	13	31%
Total	25	50	50%

The table below compares aggregated totals of various measures for the 25 States as a percent of the national measure. In 2006, the 25 States accounted for 63 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 2006 Claritas data) and over 80 percent of Asian/Pacific Islanders and Hispanics.

Measure	Total of 25 HCUP States with race/ethnicity as a percent of national total
Hospital discharges	63%
Total resident population	66%*
Population by race/ethnicity:	
White	61%*
African American	66%*
Asian/Pacific Islander	81%*
Hispanic	84%*
Population by age:	
Population under age 18	67%*
Population age 18-64	66%*
Population over age 64	65%*
Population with income under the poverty level	66%**

*Calculated using 2006 Claritas data and 1990 Census race definitions (e.g. no option for selecting "two or more races").
**Calculated using Kaiser Family Foundation statehealthfacts.org. Data Source: Urban Institute and Kaiser Commission on Medicaid and the Uninsured estimates based on the Census Bureau's March 2007 and 2008 Current Population Survey (CPS: Annual Social and Economic Supplements).

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 Indian/Alaska 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 assigns the data to the combined race/ethnicity categorization and 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 modified the SID to include hospitals types that were consistent with the NIS. We selected community[1] hospitals from the 25 States and eliminated rehabilitation hospitals in the 2006 SID because the completeness of reporting for rehabilitation hospitals was inconsistent across States.

   Second, community hospitals from these 25 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 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 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 draws its sample from 25 of the 39 States included in the 2006 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 15 million hospital discharges from over 1,900 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 based on ZIP Code data obtained from Claritas. Beginning with the 2008 NHDR, we added reporting by the National Center for Health Statistics (NCHS) county-level classification of urban-rural location, which includes gradations of metropolitan, micropolitan, and non-core counties by population size.

   The 2009 NHDR also reports information derived from the 2001 and 2005 disparities analysis file for comparison. This data file was developed using the 2001 and 2005 SID and the same approach described above. For more details, refer to the *Methods Applying*

[1] *Community* hospitals are defined by the AHA as "non-Federal, short-term, general, and other specialty hospitals, excluding hospital units of institutions." The specialty hospitals included in the AHA definition of "community hospitals" are: obstetrics-gynecology, ear-nose-throat, short-term rehabilitation, orthopedic, and pediatric institutions. The AHA also groups public hospitals and academic medical centers with community hospitals. Excluded from the AHA definition of "community hospitals" are long-term hospitals, psychiatric hospitals, and alcoholism/chemical dependency treatment facilities. For the NHDR analyses, we select all AHA-defined "community hospitals" with the exception of short-term rehabilitation hospitals (beginning with 1998 HCUP data).

AHRQ Quality Indicators to Healthcare Cost and Utilization Project (HCUP) Data for the Sixth (2008) National Healthcare Disparities Report (Coffey, Barrett, Houchens, et al., 2008).

5. **Statistical Methods.** Several statistical issues needed to be addressed when applying the AHRQ QI software to the HCUP data, including: 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.

   - *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. Although the AHRQ QI software uses a similar 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 *PSIs*, 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 *IQIs*, 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 *PDIs*, 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 error 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; therefore, appropriate statistics were obtained through the Statistical Analysis System (SAS) procedure called PROC SURVEYMEANS. QI estimates were included in the NHDR if they reached a threshold defined by a relative standard error less than 30% and at least 10 unweighted cases in the denominator. Estimates that did not satisfy these criteria were set to missing. Statistical calculations are explained in Appendix B to this report.

Evaluating the NHDR Analytic Sample

After creating the 2006 disparities analysis file using the above steps, we evaluated the reliability of national estimates produced with these data by comparing its composition to the 2006 HCUP Nationwide Inpatient Sample (NIS). Appendix C contains the distribution of discharges in both files by key demographic and clinical data elements. Based on these analyses, the 2006 disparities analysis file appears to provide reliable national estimates when compared with the NIS.

Caveats

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

Data Collection Differences Among States: Organizations providing statewide data, generally collect the data using the Uniform Billing formats (UB-92 or UB-04) and, for earlier years, 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 the NHDR, uneven availability of a few data elements underlie some estimates, as noted next.

Data Elements for Exclusions: Three data elements required for certain QIs were not available in every State: "secondary procedure day," "admission type" (elective, urgent, newborn, and emergency), and "present on admission." We modified the AHRQ QI software in instances where these data elements are used to exclude specific cases from the QI measures:

- The PSIs and PDIs that use secondary procedure day were modified to calculate indicators without considering the timing of procedures.
- For QIs that use admission type "elective" and "newborn," 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, which 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.
- For QIs that use present on admission (POA), we modified the AHRQ QI software to calculate indicators without considering whether the condition was present at admission.

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 report. The more fields used, the more quality-related events that can be captured in the statewide databases. However, in an earlier analysis, even for States with 30 diagnosis fields available in the year 2000, 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 artificially truncate the diagnosis and procedure fields used for the NHDR analyses, so that the full richness of the databases would be used.

E Codes: Another issue relates to external cause-of-injury reporting. Eight of the 27 Patient Safety Indicators and three of the Pediatric Quality Indicators use 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 report. Although E codes in the AHRQ PSI and PDI software have been augmented wherever possible with the related non-E codes in the ICD-9-CM system, E codes are still included in some AHRQ PSI and

PDI definitions. Uneven capture of these data has the potential of affecting rates and should be kept in mind when judging the level of these events.

Race/ethnicity coding: Even excluding hospitals when a large proportion of race/ethnicity data was missing, there may still remain differences in race and ethnicity coding among States that affect the estimates. For example, some States include Hispanic ethnicity as one of the racial categories, and others record 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, and others 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 Applied to the HCUP Data 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 8	Admissions for congestive heart failure (excluding patients with cardiac procedures, obstetric conditions, and transfers from other institutions) per 100,000 population, age 18 years and older
PQI 9	Low birth weight infants per 1,000 births (excluding transfers from other institutions)
PQI 10	Admissions for dehydration (excluding obstetrical admissions and transfers from other institutions) per 100,000 population, age 18 and over
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 12	Admissions for urinary tract infections (excluding kidney or urinary tract disorders, patients in an immunocompromised state, transfers from other institutions, and obstetric admissions) per 100,000 population, age 18 and over
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 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
PQI 16	Hospital admissions for lower extremity amputations in patients with diabetes, per 100,000 population
PQI 17	Immunization-preventable pneumococcal pneumonia admissions (excluding transfers from other institutions) per 100,000 population, age 65 and over
PQI 18	Hospital admissions for immunization-preventable influenza per 100,000 population age 65 and over
PQI 90	Overall Prevention Quality Indicator composite per 100,000 population, age 18 and over
PQI 91	Acute Prevention Quality Indicator composite per 100,000 population, age 18 and over
PQI 92	Chronic Prevention Quality Indicator composite per 100,000 population, age 18 and over

QI No.	Description
Pediatric Quality Indicators	
PDI 1	Accidental puncture or laceration during procedure per 1,000 discharges, age less than 18 years
PDI 2	Decubitus ulcers per 1,000 discharges of length 5 or more days[a] (excluding neonates; transfers; patients admitted from long-term care facilities; patients with diseases of the skin, subcutaneous tissue, and breast; and obstetrical admissions), age less than 18 years
PDI 3	Foreign body accidentally left in during procedure per 1,000 medical and surgical discharges (excluding normal newborns and neonates with a birth weight less than 500 grams[a]), age less than 18 years
PDI 4	Iatrogenic pneumothorax per 1,000 discharges (excluding normal newborns and patients with chest trauma, thoracic surgery, lung or pleural biopsy, or cardiac surgery[a]), neonates with a birth weight of 500 to 2500 grams
PDI 5	Iatrogenic pneumothorax per 1,000 discharges (excluding normal newborns, neonates with a birth weight less than 2500 grams, and patients with chest trauma, thoracic surgery, lung or pleural biopsy, or cardiac surgery[a]), age less than 18 years and not a neonate
PDI 6	Deaths per 1,000 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 7	Pediatric heart surgery volume, patients less than 18 years of age (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 8	Postoperative hemorrhage or hematoma with surgical drainage or evacuation, not verifiable as following surgery[a], per 1,000 surgical discharges (excluding neonates with a birth weight less than 500 grams), age less than 18 years
PDI 9	Postoperative respiratory failure per 1,000 elective-surgery discharges with an operating room procedure (excluding patients with respiratory disease, circulatory disease, neuromuscular disorders, neonates with a birth weight less than 500 grams, and admissions specifically for acute respiratory failure), age less than 18 years
PDI 10	Postoperative sepsis per 1,000 surgery discharges with an operating room procedure (excluding patients admitted for infection; neonates; stays under 4 days; and admissions specifically for sepsis), age less than 18 years
PDI 11	Reclosure of postoperative abdominal wound dehiscence per 1,000 abdominopelvic-surgery discharges (excluding immunocompromised patients, stays under 2 days, and neonates with a birth weight less than 500 grams[a]), age less than 18 years
PDI 12	Selected infections due to medical care per 1,000 medical and surgical discharges (excluding normal newborns, neonates with a birth weight less than 500 grams, stays under 2 days, and admissions specifically for such infections), age less than 18 years
PDI 13	Transfusion reactions per 1,000 discharges (excluding neonates[a]), age less than 18 years
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, ages 2-17
PDI 15	Admissions for diabetes with short-term complications* (excluding transfers from other institutions) per 100,000 population, ages 6-17 * 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, ages 3 months to 17 years
PDI 17 *	Admissions with perforated appendix per 1,000 admissions with appendicitis, ages 1-17

QI No.	Description
PDI 18	Admissions for urinary tract infections (excluding kidney or urinary tract disorders, patients in an immunocompromised state, and transfers from other institutions) per 100,000 population, ages 3 months to 17 years
PDI 90	Overall Pediatric Quality Indicator composite per 100,000 population, ages 6-17
PDI 91	Chronic Pediatric Quality Indicator composite (asthma, diabetes) per 100,000 population, ages 6-17
PDI 92	Acute Pediatric Quality Indicator composite (gastroenteritis, urinary tract infections) per 100,000 population, ages 6-17
Inpatient Quality Indicators	
IQI 8	Deaths per 1,000 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 1,000 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 1,000 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 1,000 admissions with coronary artery bypass graft (excluding obstetric and neonatal admissions and transfers to another hospital), age 40 and older
IQI 13	Deaths per 1,000 admissions with craniotomy (excluding patients with a principal diagnosis of head trauma, obstetric and neonatal admissions, and transfers to another hospital), age 18 years or older
IQI 14	Deaths per 1,000 admissions with hip replacement procedures (excluding complicated cases, obstetric and neonatal admissions, and transfers to another hospital), age 18 years or older
IQI 15	Deaths per 1,000 admissions with acute myocardial infarction (AMI) as principal diagnosis (excluding transfers to another hospital), age 18 and older
IQI 16	Deaths per 1,000 admissions with congestive heart failure (CHF) as principal diagnosis (excluding obstetric and neonatal admissions and transfers to another hospital), age 18 and older
IQI 17	Deaths per 1,000 admissions with acute stroke as principal diagnosis (excluding obstetric and neonatal admissions and transfers to another hospital), age 18 years and older
IQI 18	Deaths per 1,000 admissions with gastrointestinal (GI) hemorrhage as principal diagnosis (excluding obstetric and neonatal admissions and transfers to another hospital), age 18 years and older
IQI 19	Deaths per 1,000 admissions with hip fracture as principal diagnosis (excluding obstetric and neonatal admissions and transfers to another hospital), age 18 years and older
IQI 20	Deaths per 1,000 admissions with pneumonia as principal diagnosis (excluding obstetric and neonatal admissions and transfers to another hospital), age 18 and older
IQI 21	Cesarean deliveries per 1,000 deliveries (excluding patients with abnormal presentation, preterm delivery, fetal death, multiple gestation diagnosis codes, or breech procedure codes)
IQI 22	Vaginal birth after cesarean (VBAC) per 1,000 women with previous cesarean deliveries (excluding patients with abnormal presentation, preterm delivery, fetal death, multiple gestation diagnosis codes or breech procedure codes)
IQI 23	Laparoscopic cholecystectomies per 1,000 cholecystectomy procedures (excluding complicated cases and obstetric and neonatal admissions), age 18 years and older
IQI 24	Incidental appendectomies per 1,000 patients with other intra-abdominal procedures (excluding obstetric and neonatal admissions), age 65 years and older
IQI 25	Bilateral cardiac catheterizations per 1,000 heart catheterizations for coronary artery disease (excluding valid indications for right-side catheterization and excluding obstetric and neonatal admissions)
IQI 26	Coronary artery bypass grafts (excluding obstetric and neonatal admissions) per 100,000 population, age 40 years and older
IQI 27	Percutaneous transluminal coronary angioplasties (excluding obstetric and neonatal admissions) per 100,000 population, age 40 years and older
IQI 28	Hysterectomies (excluding obstetric and neonatal conditions, genital cancer, and pelvic trauma) per 100,000 female population, age 18 years and older
IQI 29	Laminectomies or spinal fusions (excluding obstetric and neonatal conditions) per 100,000 population, age 18 years and older

QI No.	Description
IQI 30	Deaths per 1,000 adult admissions age 40 and older with percutaneous transluminal coronary angioplasties (PTCA) (excluding obstetric and neonatal admissions and transfers to another hospital)
IQI 31	Deaths per 1,000 admissions age 18 and older with carotid endarterectomies (CEA) (excluding obstetric and neonatal admissions and transfers to another hospital)
IQI 32	Deaths per 1,000 admissions with acute myocardial infarction (AMI) as principal diagnosis (excluding transfers from another hospital or to another hospital), age 18 years and older
IQI 33	First-time Cesarean deliveries per 1,000 deliveries (excluding patients with abnormal presentation, preterm delivery, fetal death, multiple gestation diagnosis codes, breech procedure codes, or a previous Cesarean delivery diagnosis in any diagnosis field)
IQI 34	Vaginal birth after cesarean (VBAC) per 1,000 women with previous cesarean deliveries with no exclusions
Patient Safety Indicators	
PSI 1	Complications of anesthesia in any secondary diagnosis per 1,000 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 1,000 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 1,000 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 1,000 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 1,000 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 1,000 discharges (excluding obstetrical admissions and patients with chest 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 1,000 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 1,000 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.

QI No.	Description
PSI 9	Postoperative hemorrhage or hematoma with surgical drainage or evacuation, not verifiable as following surgery*, per 1,000 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 1,000 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 1,000 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 embolism (PE) or deep vein thrombosis (DVT) per 1,000 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 1,000 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 1,000 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 1,000 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 16	Transfusion reactions per 1,000 discharges, age 18 years or older or obstetric admissions* * Also excludes admissions specifically for transfusion reactions, such as cases from earlier admissions or from other hospitals.
PSI 17	Birth trauma - injury to neonate per 1,000 live births (excluding preterm and osteogenesis imperfecta births)
PSI 18	Obstetric trauma with 3rd or 4th degree lacerations per 1,000 instrument-assisted vaginal deliveries
PSI 19	Obstetric trauma with 3rd or 4th degree lacerations per 1,000 vaginal deliveries without instrument assistance
PSI 20	Obstetric trauma with 3rd or 4th degree lacerations per 1,000 Cesarean deliveries
PSI 21	Foreign body accidentally left in during procedure* per 100,000 population, age 18 years or older or obstetric admissions * Includes admissions specifically for treatment of foreign body left, such as cases from earlier admissions or from other hospitals.

QI No.	Description
PSI 22	Iatrogenic pneumothorax cases* per 100,000 population (excluding obstetrical admissions, and patients with trauma, thoracic surgery, lung or pleural biopsy, or cardiac surgery), age 18 years or older * Includes admissions specifically for iatrogenic pneumothorax, such as cases from earlier admissions or from other hospitals. Also, includes barotrauma (including acute respiratory distress syndrome) and central line placement.
PSI 23	Selected infections due to medical care* per 100,000 population (excluding immunocompromised or cancer patients and neonates), age 18 years or older or obstetric admissions * Includes admissions specifically for such infections, such as cases from earlier admissions, from other hospitals, or from other settings.
PSI 24	Reclosure of postoperative abdominal wound dehiscence* (excluding immunocompromised and obstetric patients) per 100,000 population, age 18 years or older * Includes admissions specifically for such wound dehiscence, such as cases from earlier admissions or from other hospitals.
PSI 25	Accidental puncture or laceration during procedures* per 100,000 population (excluding obstetric admissions), age 18 years or older * Includes admissions specifically for such problems, such as cases from earlier admissions or from other hospitals.
PSI 26	Transfusion reactions* per 100,000 population (excluding neonates), age 18 years or older or obstetric admissions * Includes admissions specifically for transfusion reactions, such as cases from earlier admissions or from other hospitals.
PSI 27	Postoperative hemorrhage or hematoma with surgical drainage or evacuation, not verifiable as following surgery* (excluding obstetrical admissions), per 100,000 population, 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, includes admissions specifically for such problems, such as cases from earlier admissions or from other hospitals.

Table 2. Sources of HCUP Data for the NHDR Analysis File

State	Data Source
Arizona	Arizona Department of Health Services
Arkansas	Arkansas Department of Health
California	Office of Statewide Health Planning and Development
Colorado	Colorado Hospital Association
Connecticut	Connecticut Hospital Association
Florida	Florida Agency for Health Care Administration
Georgia	Georgia Hospital Association
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 and Senior Services
New York	New York State Department of Health
Oklahoma	Oklahoma 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
Utah	Utah Department of Health
Vermont	Vermont Association of Hospitals and Health Systems
Virginia	Virginia Health Information
Wisconsin	Wisconsin Department of Health and Family Services

* State-level analyses were performed using individual state-specific disparities analysis files specifically designed to provide estimates for the State Snapshot Web site. HCUP data were used to create State-level estimates by community income level and race/ethnicity, when available from participating States, for 14 AHRQ QIs specific to potentially avoidable hospitalizations (as described in Appendix A).

Table 3. Number of diagnosis and procedure fields by State, 2006

State	Maximum number of diagnoses	Maximum number of procedures
Arizona	9	6
Arkansas	9	6
California	25	21
Colorado	15	15
Connecticut	30	30
Florida	31	31
Georgia	10	6
Hawaii	20	15
Kansas	30	25
Maryland	15	15
Massachusetts	15	15
Michigan	30	30
Missouri	30	25
New Hampshire	10	6
New Jersey	9	8
New York	15	15
Oklahoma	16	16
Rhode Island	25	25
South Carolina	10	10
Tennessee	9	6
Texas	25	15
Utah	9	6
Vermont	20	20
Virginia	9	6
Wisconsin	30	30

Table 4. Use of E codes in the AHRQ Quality Indicators, Version 3.1

PSI or PDI *	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**
PSI 1	E8551, E8763, E938n	9681-9684, 9687	Self-inflicted injury (E95nn)	None
PSI 5 PSI 21 PDI 3	E8710 – E8719	9984, 9987	None	None
PSI 8	None	None	Self-inflicted injury (E95nn); Poisoning (E851n, E952n, E86nn, E95nn, E962n, E980n -E982n)	9600-9799
PSI 15 PSI 25 PDI 1	E8700 – E8709	9982	None	None
PSI 16 PSI 26 PDI 13	E8760	9996-9997	None	None

* All other PSIs and PDIs do not use E codes.

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Appendix A
Generating State-Level Quality Indicators by Community Income Quartile and Race/Ethnicity from Healthcare Cost and Utilization Project (HCUP) Data

Prior to the 2009 National Healthcare Disparities Report (NHDR), the Agency for Healthcare Research and Quality (AHRQ) presented only national-level Quality Indicators (QIs) in the NHDR; that is, state-level estimates of health care disparities based on QIs were not provided. Given the varied distribution of race, ethnicity, and socioeconomic groups across states, policymakers increasingly want to know if and how quality of care varies for these different populations. This document describes how state-level QIs by race/ethnicity and community income quartile were generated for the State Snapshots, a derivative product of the National Healthcare Quality Report (NHQR) and the NHDR.

Data from the 2006 State Inpatient Databases (SID), developed and maintained by the Healthcare Cost and Utilization Project (HCUP), were used to create individual state-specific disparities analysis files that were designed to provide estimates for the Focus on Disparities in the State Snapshots Website (http://statesnapshots.ahrq.gov). The AHRQ QIs were applied to the HCUP SID to create 14 state-level measures consisting of selected Prevention Quality Indicators (PQIs) and Pediatric Quality Indicators (PDIs) by race/ethnicity and community income quartile. In general, the following steps were taken to produce the state-level rates: 1) QI software review and modification, 2) acquisition of population-based data, 3) selection of states, 4) assignment of values to HCUP data, 5) selection and weighting of HCUP hospitals, and 6) identification of statistical methods.

1. **QI Software Review and Modification.** For the state-level estimates, we started with the potentially preventable hospitalization measures in PQI Version 3.1 and PDI Version 3.1a.

   These include the following QIs:

QI No.	Description
Prevention Quality Indicators	
PQI 1	Admissions for diabetes with short-term complications
PQI 3	Admissions for diabetes with long-term complications
PQI 5	Admissions for chronic obstructive pulmonary disease (COPD)
PQI 7	Admissions for hypertension
PQI 8	Admissions for congestive heart failure
PQI 11	Bacterial pneumonia admissions
PQI 13	Admissions for angina without procedure
PQI 14	Admissions for uncontrolled diabetes without complications
PQI 15	Adult asthma admissions, age 18 years and older
PQI 15b	Adult asthma admissions, age 65 years and older
PQI 16	Lower extremity amputations among patients with diabetes
PQI 18	Admissions for immunization-preventable influenza
Pediatric Quality Indicators	
PDI 14	Pediatric asthma admissions, age 2 years to 17 years
PDI 15	Admissions for diabetes with short-term complications, age 6 years to 17 years

Although each of these software modules was developed for State and hospital-level rates, some changes to the QI software were necessary to accommodate the additional reporting categories (i.e., race/ethnicity, median income quartile) for the weighted HCUP data.

2. **Acquisition of Population-Based Data.** The next step was to acquire data for the numerator and denominator populations for the selected QIs, which are area-based measures. For the numerator counts of the AHRQ QIs, we used HCUP data selected from the SID for each state-specific disparities analysis file. We identified Claritas as the source of denominator counts as well as data for risk adjustment and information about income. Claritas provides ZIP-Code-level population counts by age, gender, and race, in addition to the median household income. We redistributed into single race categories any portion of the population that is characterized as being of two or more race/ethnicities.

3. **Selection of States.** State-specific disparities files for generating QIs by community income quartile were created for 35 of the 39 states contributing HCUP data in 2006 that agreed to participate in state-level reporting by income group. Because race/ethnicity is a pivotal measure for the NHDR, the creation of state-specific disparities files for generating QIs by race/ethnicity was limited to the 22 of the 25 States that provide information on patient race and Hispanic ethnicity to HCUP and agreed to participate in state-level reporting by race and ethnicity. Additional steps, described below, were taken in an effort to overcome irregularities with race/ethnicity coding in the 25 states.

4. **Assignment of Values to HCUP Data.** The following issues regarding major data elements relevant to the disparities analysis had to be resolved before proceeding with certain other data preparations or applying the QI algorithms:

    - *Standardize Hispanic Ethnicity Coding Across States*. When a State and its hospitals collect Hispanic ethnicity separately from race, HCUP uses Hispanic ethnicity to override any other race category (see the main report for more information on this issue).

    - *Impute for Missing Race/Ethnicity and Other Characteristics.* Because the PQIs and PDIs selected for this report are area-level measures that use total state population in the denominator, minimizing the loss of discharges from the numerator for the QI calculation is critical to producing unbiased QI rates. For missing race, we used a "hot deck" imputation method (which draws donors from strata of similar patients within the same hospital) to assign values while preserving the variance within the data. In all but three States, no more than 7 percent of discharges started out with missing race values. We also used this imputation method for missing age, gender, and ZIP Code data that occurred on a small proportion of discharge records.

    - *Assign Additional Measures for Reporting.* We used an HCUP data element that assigns national quartiles for median household income based on the 2006 Claritas ZIP Code-level data. In 2006, the first community income quartile ("low-income communities") includes patients who resided in ZIP Codes with median annual household income of $37,999 and below. Cut-offs for the second and third community income quartiles are $46,999 and $61,999, respectively.

5. **Selection and Weighting of HCUP Hospitals.** Before applying the QI algorithms, the HCUP SID were further modified to create state-specific disparities analysis files that were consistent across States.

- *Subset to Community Hospitals.* We selected community hospitals and eliminated rehabilitation hospitals from the SID, retaining non-resident discharges. Rehabilitation hospitals are excluded because the completeness of reporting for rehabilitation hospitals was inconsistent across States and because they represent different types of patients than other community hospitals.

- *Calculate Weights for Community Income Analysis.* Because some statewide data organizations do not report data for all community hospitals in the State, state estimates were calculated by weighting hospitals in the SID to the State's universe of community, non-rehabilitation hospitals in the American Hospital Association (AHA) Annual Survey Database based on hospital characteristics including region, urban-rural designation, teaching status, control, and bed size. Discharge weights from sampled hospitals operating for the entire year, but not contributing data for one or more quarters, were adjusted to produce annual estimates for that institution.

- *Calculate Weights for Race-Ethnicity Analysis.* A second set of weights was needed for the 25 state-specific disparities files used for generating QIs by race/ethnicity. We first selected hospitals whose original coding of patient race-ethnicity (i.e. before imputations for missing data) was not "suspect" and eliminated the other hospitals because the quality of the race-ethnicity reporting was suspicious. The same four criteria for exclusion of hospitals with suspect race coding were applied as when creating the national disparities analysis file (see "Preparation of HCUP Data and Development of the Disparities Analysis File" in main report for details). Hospitals in 17 of the 25 States with race/ethnicity data were eliminated due to suspect race coding. Eight states had no hospitals with suspect race coding. Overall, 5 percent of hospitals and 3 percent of discharges were excluded. The table below indicates the reason for excluding hospitals and their associated discharges from the state-level disparities analysis files. Except in a few cases, hospitals in a state were most often excluded because substantial shares of discharges were "other" or "missing" race. We calculated discharge-level weights to account for hospitals excluded because of suspect race coding, community hospitals not reported in the SID, and missing quarters of data.

State-level Disparities Analysis Files for Race/Ethnicity	Excluded for any reason	Percent of Total	Excluded because >30% discharges are "other" race	Excluded because >50% discharges are "missing" race	Excluded because all discharges are white, other or missing	Excluded because all discharges are white and hospital has >50 beds
Total number of hospitals excluded	126	5%	49	60	16	1
Total number of discharges excluded	689,031	3%	217,005	463,324	5,992	2,710

6. **Statistical Methods.** Identification of statistical issues included age-gender adjustment for the PQIs and PDIs and derivation of standard errors and appropriate hypothesis tests (see main report for more detail on statistical methods).

State-level information on community income quartile and race/ethnicity is presented as relative rates in the State Snapshots. For reporting by community income, the age-gender adjusted rate for the lowest income communities (quartile 1) is divided by the age-gender adjusted rate for the highest income communities (quartile 4). For race/ethnicity, the minority adjusted rate is divided by the adjusted rate for Non-Hispanic Whites. Groups within a state that are reported as having different rates from each other have a p-value of less than 0.05 and a difference in QI values of at least 10 percent. States that are reported as having different rates than the U.S. have a difference in relative rate values of at least 10 percent.

Table A-1. AHRQ Quality Indicators Generated *at the State-Level* for Release in the National Healthcare Disparities Report and Derivative Products

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, with appendicitis (excluding obstetric admissions and transfers from other institutions) per 1,000 admissions, age 18 and over
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 8	Admissions for congestive heart failure (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 complications* (excluding obstetric and neonatal admissions and transfers from other institutions) per 100,000 population, age 18 years and older* * 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 15b	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
PQI 16	Lower extremity amputations among patients with diabetes (excluding trauma, obstetric admissions, and transfers from other institutions) per 100,000 population, age 18 years and older
PQI 18	Admissions for immunization-preventable influenza per 100,000 population, age 65 years and older
Pediatric Quality Indicators	
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

QI No.	Description
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.

Appendix B
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 2006 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 2006 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 2006 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 2000 Nationwide Inpatient Sample national 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:

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

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 $\hat{P}_{g,std} = \frac{\hat{N}_{g,std}}{\sum_{g=1}^{36} \hat{N}_{g,std}}$ 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))

Appendix C
Comparison of the Disparities Analysis File and Nationwide Inpatient Sample (NIS), 2006

Weighted Frequencies

Stratum used to sample hospitals				
	Disparities Analysis File		NIS	
NHDR_STRATUM	Frequency	Percent	Frequency	Percent
1: Northeast	7,808,186	19.8	7,808,186	19.8
2: Midwest	9,078,239	23.0	9,078,239	23.0
3: South	15,068,422	38.2	15,068,422	38.2
4: West	7,495,369	19.0	7,495,369	19.0

Age in years at admission				
	Disparities Analysis File		NIS	
AGE	Frequency	Percent	Frequency	Percent
.: Missing	467	0.0	34,511	0.1
.A: Invalid	9	0.0	0	0.0
.C: Inconsistent	3,023	0.0	3,000	0.0
0-17	6,866,491	17.4	6,619,156	16.8
18-44	10,278,449	26.1	10,211,733	25.9
45-64	8,992,882	22.8	9,099,804	23.1
65+	13,308,896	33.7	13,482,012	34.2

Indicator of sex				
	Disparities Analysis File		NIS	
FEMALE	Frequency	Percent	Frequency	Percent
.: Missing	3,403	0.0	100,788	0.3
.A: Invalid	46	0.0	50	0.0
.C: Inconsistent	1,613	0.0	1,865	0.0
0: Male	16,265,934	41.2	16,295,957	41.3
1: Female	23,179,220	58.8	23,051,556	58.4

Primary expected payer				
	Disparities Analysis File		NIS	
PAY1	Frequency	Percent	Frequency	Percent
.: Missing	60,170	0.2	54,521	0.1
.A: Invalid	872	0.0	10,911	0.0
1: Medicare	14,634,982	37.1	14,717,313	37.3
2: Medicaid	7,746,032	19.6	7,688,486	19.5
3: Private Insurance	13,657,877	34.6	13,432,158	34.0
4: Self-pay	1,919,068	4.9	2,037,788	5.2
5: No Charge	194,697	0.5	206,097	0.5
6: Other	1,236,517	3.1	1,302,943	3.3

Patient race/ethnicity[2]				
	Disparities Analysis File		NIS	
RACE	Frequency	Percent	Frequency	Percent
.: Missing	768,400	1.9	10,447,053	26.5
.A: Invalid	907	0.0	1,158	0.0
1: White	26,023,580	66.0	19,131,343	48.5
2: Black	5,789,302	14.7	3,927,605	10.0
3: Hispanic	4,913,804	12.5	4,192,908	10.6
4: Asian/Pacific Islander	925,068	2.3	631,052	1.6
5: Native American	165,312	0.4	209,135	0.5
6: Other	863,843	2.2	909,962	2.3

Location of patient residence				
	Disparities Analysis File		NIS	
PT_URCAT4	Frequency	Percent	Frequency	Percent
.: Missing	0	0	138,847	0.4
1: Large Metropolitan	21,386,407	54.2	20,616,562	52.3
2: Small Metropolitan	10,956,591	27.8	11,225,080	28.5
3: Micropolitan	4,052,695	10.3	4,418,867	11.2
4: Non-CBSA	3,054,523	7.7	3,050,859	7.7

[2] Differences in race distribution are attributable to high rates of missing race on the NIS (27%).

Top 26 DRGs (Combination of Top 25 DRGs for Disparities and NIS file)					
	Disparities Analysis File			NIS	
391: NORMAL NEWBORN	3,243,952	8.2		3,178,034	8.1
373: VAGINAL DELIVERY W/O COMPLICATING DIAGNOSES	2,481,061	6.3		2,443,411	6.2
430: PSYCHOSES	1,065,180	2.7		1,019,821	2.6
371: CESAREAN SECTION W/O CC	1,052,734	2.7		1,012,445	2.6
127: HEART FAILURE & SHOCK	976,458	2.5		991,057	2.5
544: MAJOR JOINT REPLACEMENT OR REATTACHMENT OF LOWER EXTREMITY	829,547	2.1		793,377	2.0
89: SIMPLE PNEUMONIA & PLEURISY AGE >17 W CC	808,583	2.0		833,725	2.1
143: CHEST PAIN	688,237	1.7		720,563	1.8
182: ESOPHAGITIS, GASTROENT & MISC DIGEST DISORDERS AGE >17 W CC	677,618	1.7		700,941	1.8
88: CHRONIC OBSTRUCTIVE PULMONARY DISEASE	650,476	1.6		686,546	1.7
390: NEONATE W OTHER SIGNIFICANT PROBLEMS	646,943	1.6		628,674	1.6
14: SPECIFIC CEREBROVASCULAR DISORDERS EXCEPT TIA	465,317	1.2		461,387	1.2
462: REHABILITATION	444,871	1.1		448,587	1.1
359: UTERINE & ADNEXA PROC FOR NON-MALIGNANCY W/O CC	439,830	1.1		421,728	1.1
174: G.I. HEMORRHAGE W CC	420,598	1.1		420,132	1.1
316: RENAL FAILURE	410,905	1.0		410,209	1.0
416: SEPTICEMIA AGE >17	389,426	1.0		393,868	1.0
558: PERCUTANEOUS CARDIOVASCULAR PROC W DRUG-ELUTING STENT W/O MAJ CV DX	374,720	0.9		415,968	1.1
320: KIDNEY & URINARY TRACT INFECTIONS AGE >17 W CC	374,678	0.9		380,950	1.0
296: NUTRITIONAL & MISC METABOLIC DISORDERS AGE >17 W CC	367,776	0.9		378,149	1.0
138: CARDIAC ARRHYTHMIA & CONDUCTION DISORDERS W CC	345,604	0.9		364,870	0.9
370: CESAREAN SECTION W CC	343,589	0.9		332,815	0.8
372: VAGINAL DELIVERY W COMPLICATING DIAGNOSES	342,017	0.9		346,038	0.9
183: ESOPHAGITIS, GASTROENT & MISC DIGEST DISORDERS AGE >17 W/O CC	324,116	0.8		328,850	0.8
277: CELLULITIS AGE >17 W CC	291,578	0.7		293,204	0.7

Median income of Patient's ZIP Code				
	Disparities Analysis File		NIS	
ZIPINC_QRTL	Frequency	Percent	Frequency	Percent
.: Missing	0	0.0	981,410	2.5
1: First Quartile (lowest income)	11,910,705	30.2	11,079,448	28.1
2: Second Quartile	9,376,492	23.8	9,866,881	25.0
3: Third Quartile	9,553,375	24.2	9,160,689	23.2
4: Fourth Quartile (highest income)	8,609,645	21.8	8,358,429	21.2
A: Invalid	0	0.0	3,359	0.0

Weighted Means

	Disparities Analysis File				NIS		
Variable / Label	Minimum	Maximum	Mean		Minimum	Maximum	Mean
LOS : Length of stay (cleaned)	0	365	4.7		0	365	4.6
NDX : Number of diagnoses on this record	0	31	6.5		0	31	6.4
NPR : Number of procedures on this record	0	31	1.6		0	30	1.6
TOTCHG : Total charges (cleaned)	$25	$999,999	$25,102.1		$25	$999,964	$23,959.8