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Methods Applying AHRQ Quality Indicators to Healthcare Cost and Utilization Project (HCUP) Data for the Tenth (2012) NHQR and NHDR

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Methods Applying AHRQ Quality Indicators to Healthcare Cost and Utilization Project (HCUP) Data for the Tenth (2012) National Healthcare Quality Report (NHQR) and National Healthcare Disparities Report (NHDR)

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The Agency for Healthcare Research and Quality (AHRQ) Quality Indicators (QIs) were applied to the Healthcare Cost and Utilization Project (HCUP) hospital discharge data for selected measures in the National Healthcare Quality Report (NHQR) and the National Healthcare Disparities Report (NHDR). The NHQR tracks national trends in health care quality. The NHDR examines prevailing disparities in health care delivery as it relates to racial and socioeconomic factors in priority populations.

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 NHQR and 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, 2009).
- 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, 2009).
- Patient Safety Indicators (PSIs) reflect quality of care inside hospitals, by focusing on surgical complications and other iatrogenic events (AHRQ, 2009).
- Pediatric Quality Indicators (PDIs) reflect quality of care inside hospitals and identify potentially avoidable hospitalizations among children (AHRQ, 2009).

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

PREPARATION OF HCUP DATABASES

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 encounter-level health care data. HCUP includes the largest collection of longitudinal hospital care data in the United States, featuring 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, patient safety, access to health care programs, and outcomes of treatments at the national, State and local market levels.

Three HCUP discharge datasets were used for the NHQR:

- The HCUP Nationwide Inpatient Sample (NIS), a nationally stratified *sample* of hospitals (with all of their discharges) from States that contribute data to the NIS dataset (44 States in the 2009 NIS).
- The HCUP State Inpatient Databases (SID), a *census* of hospitals (with all of their discharges) from 44 participating States in 2009.
- The HCUP Nationwide Emergency Department Sample (NEDS), a nationally stratified sample of hospital-based emergency departments (with information for both treat-and-release visits and those resulting in a hospital admission) from 29 states in 2009.

For 2009, the NIS contains roughly 7.8 million discharges from more than 1,000 hospitals and the SID contains about 36.5 million discharges (approximately 91 percent of the 39.4 million discharges in the United States). The NEDS contains approximately 28.9 ED events from 964 hospital-based emergency departments.

For the NHQR, national trends in QI estimates used data from the 1994, 1997, and 2000-2009 NIS. The State-level trends used data from the 2000, 2004, 2007-2009 SID, for States that agreed to participate. Trends for priority populations used data from these same years (for reporting State-level estimates by race/ethnicity, community income quartile, and expected primary payer). National trends in QI rates in inpatient and emergency department settings were estimated from 2009 NIS and NEDS data. For the list of data organizations that contribute to the HCUP databases, see Table 2 at the end of this methods report.

In preparation for the NHQR, NHDR, and derivative products, the HCUP databases needed to be customized as indicated below:

1. The HCUP SID were modified to create analytic files consistent across States.
   - *Subset to Community Hospitals*. For the SID, we selected community[1] hospitals and eliminated rehabilitation hospitals.
   - *Weight for Missing Hospitals*. Because some statewide data organizations do not report data for all community hospitals in the State, we weighted hospitals in the SID to the State's universe of hospitals in the American Hospital Association (AHA) Annual Survey Database based on hospital characteristics.
   - *Weight for Missing Quarters*. Discharges from hospitals operating for the entire year but not contributing data for one or more quarters were weighted up to annual estimates for that institution in the SID.

[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. Starting in 2005, the AHA included long term acute care facilities in the definition of community hospitals, therefore such facilities are included in the NIS sampling frame. These facilities provide acute care services to patients who need long term hospitalization (stays of more than 25 days). Excluded from the AHA definition of "community hospitals" are long-term non-acute care hospitals, psychiatric hospitals, and alcoholism/chemical dependency treatment facilities. For the NHQR analyses, we selected all AHA-defined "community hospitals" with the exception of short-term rehabilitation hospitals (beginning with 1998 HCUP data).

2. The NIS and SID were augmented as necessary for the NHQR and NHDR analyses:
   - *Impute for Missing Characteristics*. For missing age, gender, race/ethnicity, ZIP Code, and expected primary 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.
   - *Assign Additional Measures for Reporting*. We assigned median household income quartile using the Claritas ZIP Code data linked to patient's ZIP Code in the SID.

3. For the NHDR, the HCUP SID were used to create disparities analysis files designed to provide national- and State-level estimates for the report and derivative products. Of the 44 States participating in the 2009 SID, the following 36 HCUP States report race/ethnicity of discharges: Arizona, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Iowa, Illinois, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Missouri, Nevada, New Hampshire, New Jersey, New Mexico, New York, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, Wisconsin, and Wyoming.

   A disparities analysis file was designed to provide *national estimates* for the NHDR, using a weighted sample of hospitals from these 36 HCUP States. Appendix A to this report provides detail on the creation of the disparities analysis file for national estimates. The individual SID were used to create additional disparities analysis files for State-level reporting by race/ethnicity. Appendix B to this report provides detail on the creation of disparities analysis files for State-level estimates.

4. The SID were also used for reporting overall and by priority populations within State (race/ethnicity, community income quartile, and expected primary payer). 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. State-level QI estimates are only reported for participating HCUP Partners that agree to release information.

5. The NIS and NEDS were used to calculate selected PQIs and PDIs in the inpatient and emergency department setting. A description of the data preparation and methods used for national estimates from the NEDS is included in Appendix C.

STEPS TAKEN TO APPLY AHRQ QUALITY INDICATORS TO THE HCUP DATA

To apply the AHRQ Quality Indicators to HCUP hospital discharge data for the NHQR and NHDR, several steps were taken: (1) QI software review and modification, (2) acquisition of population-based data, (3) assignment of QIs to the HCUP databases, and (4) identification of statistical methods.

1. **Review and Modify QI Software.** For the 2012 NHQR and NHDR, we used a "modified version" of the 4.1 software. We started with version 4.1a, included software corrections from version 4.1b, then added software corrections (but not definitional changes) from version 4.2, with the following exception. For PSI 12 ("Post-Operative Pulmonary Embolism or Deep Vein Thrombosis"), we included definitional changes from version 4.3 that exclude unspecified site and veins. This revised definition was applied to all years of data in the NHQR and NHDR to ensure consistency of rates. In addition, we did not utilize the present

on admission (POA) estimation module for the IQIs, PDIs and PSIs since POA indicators were not uniformly available from States that contribute to the HCUP databases. Specific modifications are noted as footnote in the tables. 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 added four indicators particularly relevant to the structure of the NHQR and NHDR. Two indicators were created for discharges age 65 years and older: immunization-preventable influenza, age 65 and over; and asthma admissions, age 65 and over. Two additional indicators were created to facilitate longitudinal analyses by modifying the chronic and overall PQI composite measures to exclude chronic obstructive pulmonary disease (COPD). Because of ICD-9-CM coding changes, chronic obstructive pulmonary disease estimates (PQI 05) for data prior to 2005 are not compatible with rates for 2005 forward.

2. **Acquire Population-Based Data for Denominators and Risk-Adjustment.** The next step was to acquire data for the numerator and denominator populations for the QIs. The AHRQ QIs measure 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 HCUP NIS or NHDR disparities analysis file to create national estimates and used the SID for State-level estimates. For the denominator counts, we identified two sources for all reporting categories and for all adjustment categories listed in the HCUP-based tables. For QIs that related to *providers,* the HCUP data were used for State- and national-level discharge denominator counts. For QIs that related to *geographic areas,* 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. Claritas uses intercensal methods to estimate household and demographic statistics for geographic areas (Claritas, Inc., 2009). We also used the Claritas population data for risk adjustment by age and gender for the area-based QIs.

3. **Assign QI Indicators to the HCUP Databases.** The four AHRQ QI program modules were applied to the prepared SID data using all available diagnoses and procedures reported by each State. The QI indicators from the SID were then linked to the corresponding discharge records on the NIS.

4. **Adapt Statistical Methods to HCUP Data.** 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 Risk Adjustment.* For the PQIs and area-based IQIs, PSIs, and PDIs, the observed rates were risk-adjusted 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 (described in Table 3, Age Groupings for Risk Adjustment). 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 denominators for priority populations required in the NHQR.
   - *Age, Gender, Severity, and Comorbidity Risk Adjustment*.

     For the discharge-based *PSI*s, the observed rates were risk-adjusted for age, gender, age-gender interaction, DRG cluster, and comorbidity using the regression-based

standardization that is part of the AHRQ PSI software, with the following exceptions. When reporting by age, the risk adjustment includes all of the above except age. When reporting by gender, the risk adjustment includes all of the above except gender.

For the discharge-based *IQIs*, risk 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, with the following exceptions. When reporting by age, the risk adjustment includes all of the above except age. When reporting by gender, the risk adjustment includes all of the above except gender.

For the discharge-based *PDIs*, risk 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, and procedure type was also applied, with the following exceptions. When reporting by age, the risk adjustment includes all of the above except age. When reporting by gender, the risk adjustment includes all of the above except gender.

- *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.
- *Masking Rates for Statistical Reliability, Data Quality, and Confidentiality*. QI estimates were included in the NHQR and NHDR if they reached a threshold defined by a relative standard error less than 30% and at least 11 unweighted cases in the denominator. Estimates that did not satisfy these criteria were set to missing. Statistical calculations are explained in Appendix D to this report.

SPECIAL ANALYSES

Calculating Costs Associated with Quality Indicators

The NHQR includes trends in total national costs from 2000 to 2009 for the three PQI composite measures – for acute, chronic, and overall conditions (AHRQ, 2011). Total national costs associated with potentially avoidable hospitalizations were calculated overall for the U.S., by income quartile, and by race/ethnicity.

Total charges were converted to costs using the hospital-level HCUP Cost-to-Charge Ratios based on Hospital Cost Report data from the Centers for Medicare & Medicaid Services (CMS).[2] Costs reflect the actual costs of production, while charges represent what the hospital billed for the stay. Hospital charges reflect the amount the hospital charged for the entire hospital stay and do not include professional (physician) fees. The total cost is the product of the number of stays for each QI measure and the mean cost for each QI measure. This approach compensates for stays for which charges (and thus estimated costs) are not available. Costs were adjusted to 2009 dollars for all years using the price indexes for the gross domestic product (downloaded from the Bureau of Economic Analysis, U.S. Department of Commerce, September 2, 2011).

[2] HCUP Cost-to-Charge Ratio Files. Healthcare Cost and Utilization Project (HCUP). August 2011. Agency for Healthcare Research and Quality, Rockville, MD. www.hcup-us.ahrq.gov/db/state/costtocharge.jsp.

Calculating IQI and PSI Summary Measures

To examine national and state-level trends in inpatient mortality and patient safety events, risk-adjusted rates for select Inpatient Quality Indicators (IQIs) and Patient Safety Indicators (PSIs) were summarized. The three NHQR/NHDR summary measures include: (1) Mortality for selected conditions based on select IQIs; (2) Mortality for selected procedures based on select IQIs; and (3) Patient Safety based on select PSIs. These summary measures were calculated as a weighted sum of risk-adjusted rates for individual IQIs and PSIs. Additional information on the calculation of IQI and PSI Summary Measures is provided in Appendix E.

Determining Benchmarks for State Performance for the Quality Indicators

Based on a recommendation from the Institute of Medicine's report on *Future Directions for the National Healthcare Quality and Disparities Reports*, benchmarks based on a straight average of the top 10 percent of reporting States were determined. For a benchmark to be calculated, rates for at least 30 States needed to be available.

Inpatient and Emergency Department Rates for Selected PQIs and PDIs

Beginning in the 2009 NHQR, the HCUP Nationwide Emergency Department Sample (NEDS) and NIS data were used to examine national and regional differences in inpatient and emergency department rates for selected PQIs and PDIs. Details for this analysis are provided in Appendix C.

CAVEATS

Some caution should be used in interpreting the AHRQ QI statistics presented in the NHQR and NHDR. These caveats relate to the how the QIs were applied, ICD-9-CM coding changes, inter-State differences in data collection, and other more general issues.

Rehabilitation Hospitals: These hospitals are excluded from the 2000-2009 NIS but included in the 1994 and 1997 NIS because of the change in the NIS sampling strategy (beginning in the 1998 NIS). Patients treated in rehabilitation hospitals tend to have lower mortality rates and longer lengths of stay than patients in other community hospitals, and the completeness of reporting for rehabilitation hospitals is very uneven across the States. The elimination of rehabilitation hospitals in 2000-2009 may affect trends in the QIs; however, based on previous analyses, the effect is likely small since only 3 percent of community hospitals are involved.

ICD-9-CM Coding Changes: A number of the AHRQ QIs are based on diagnoses and procedures for which ICD-9-CM coding has generally become more specific over the period of this study. If coding changes cause earlier estimates to not be comparable to the later estimates, then the earlier estimates are not reported. For this reason, the PQI for chronic obstructive pulmonary disease (PQI 5), the overall PQI composite (PQI 90), and chronic PQI composite (PQI 92) are not reported prior to 2005. In addition, birth trauma (PSI 17) is not reported prior to 2004, and QIs for postoperative hemorrhage (PSI 9 and PDI 8) are not reported before 1997.

Data Collection Differences Among States: Organizations providing statewide data generally collect the data using the Uniform Billing format (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 NHQR and 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:

- PDIs and PSIs, other than PSI 4 "Deaths Among Surgical Inpatients with Serious Treatable Complications," that use *procedure day* were modified to calculate indicators without considering the timing of procedures. For PSI 4, the day of principal procedure was used to define inclusion criteria.[3] Affected PSIs and PDIs are shown in Table 4.
- 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. PSIs and PDIs that use POA are shown in Table 5.

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. The SID for different States generally contain as few as 6 or as many as 30 or more fields for reporting diagnoses and procedures, as shown in Table 6. 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 NHQR analyses, so that the full richness of the databases would be used.

E Codes: Another issue relates to external cause-of-injury reporting. Five of the 27 PSIs and one of the PDI 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 7 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

[3] Several States are missing PRDAY1, and so the principal procedure day could not be utilized. The states without PRDAY1 in the 2004-2009 SID include: Ohio, Oklahoma, Utah, and West Virginia. For 2004-2008, Illinois did not provide PRDAY1. For 2004-2007, Washington also did not provide PRDAY1. For 2004, Kansas did not provide PRDAY1.

has the potential of affecting rates and should be kept in mind when judging the level of these events. While all HCUP States report E Codes, the policies on reporting medical misadventures and adverse effects can vary. In particular, California and Washington do not require hospitals to report E codes in the range E870-E879 (medical misadventures and abnormal reactions). Georgia does not report E codes in the range E870-E879 (medical misadventures and abnormal reactions) and E930-E949 (adverse effects). SC does not report E codes in the range E870-E876 (medical misadventures). West Virginia does not require hospitals to report any E Codes.

Adding New States to the NIS: Over time, HCUP has expanded through the participation of additional statewide data organizations. Because each NIS is a sample of hospitals from the States participating in that year (and weighted to the universe of community hospitals nationally), potential exists for different practice patterns across States to influence national measures related to clinical practice over time.

The table below lists the States that were added to HCUP between the years used in this report.

Period	States
1994	AZ, CA, CO, CT, FL, IL, IA, KS, MD, MA, NJ, NY, OR, PA, SC, WA, WI
1995 – 1997	Added GA, HI, MO, TN, UT
1998 – 2000	Added KY, ME, NC, TX, VA, WV
2001	Added MI, MN, NE, RI, VT
2002	Added NV, OH, SD (AZ data not available)
2003	Added AZ, IN, NH (ME data not available)
2004	Added AR (PA data not available)
2005	Added OK (VA data not available)
2006	Added ME, VA
2007	Added WY
2008	Added LA, PA
2009	Added MT, NM

Non-Resident Discharges in State-level Estimates: HCUP databases include discharges from all hospitals in a State, and may include non-residents, including foreign patients, which can bias the results for QIs using area-based denominators (State populations). We had no way to adjust the HCUP data to consistently exclude the non-resident discharges and include discharges for residents hospitalized in other states. Therefore, non-resident discharges were retained in the SID databases for the NHQR and NHDR analyses. Based on an analysis performed with the 2009 SID, the percent of non-resident discharges is between 1% and 13% within a state. Most states were below 10%, but five states (NH, SD, TN, VT, WV) were above 10%.

Variation Among State QI Rates: Variation in State rates can be caused by many factors, including differences in practice patterns, underlying disease prevalence, health behaviors, access to health insurance, income levels of the population, demographics, spending on health services, supply of health care resources, coding conventions, and so on. To understand some of the variation in State rates, we analyzed the 2001 State rates in relation to these types of factors. For more information on this study, refer to the *Methods Applying AHRQ Quality Indicators to the Healthcare Cost and Utilization Project (HCUP) Data for the Ninth (2011) NHQR and NHDR* (Coffey et al., 2011). The report include an appendix that describes the analyses performed for each Prevention Quality Indicator (PQI) included in the NHQR, and the result in terms of whether the factors (with each tested separately because of the limited number of observations) were positively, negatively, or not significantly related to the QIs.

In a subsequent analysis, we investigated sources of variation in Patient Safety Indicator (PSI) rates across States using 2004 data. The analysis concluded there were few state factors (such as state policy, hospital characteristics, coding practices, and socio-demographics) with strong patterns of association to state-level variation in the nine PSI rates studied. The strongest result occurred with coding practices — the number of diagnosis fields coded. Only one in five correlations between the PSIs and state factors were statistically significant, although there is generally no pattern. For more information on this study, refer to the *Methods Applying AHRQ Quality Indicators to the Healthcare Cost and Utilization Project (HCUP) Data for the Ninth (2011) NHQR and NHDR* (Coffey et al., 2011). The report includes the executive summary from the report, *Patient Safety in Hospitals in 2004: Toward Understanding Variation Across States*.

These analyses are intended to help readers understand some of the external factors that may be driving some of the State differences in PQI and PSI rates.

TABLES

Table 1. AHRQ Quality Indicators Applied to the HCUP Data for the National Healthcare Quality Report (NHQR) and National Healthcare Disparities Report (NHDR)

This table includes the list of all AHRQ Quality Indicators (QIs) calculated using HCUP data. Not all of the AHRQ QIs listed below were included in the 2012 NHQR and NHDR.

QI No.	Description
Prevention Quality Indicators[4]	
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 and over
PQI 7	Admissions for hypertension (excluding patients with kidney disease with dialysis access procedures, patients with cardiac procedures, obstetric conditions, and transfers from other institutions) per 100,000 population, age 18 and over
PQI 8	Admissions for congestive heart failure (CHF) (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 and over
PQI 12	Admissions for urinary tract infections (UTI) (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 cardiac procedure (excluding patients with cardiac procedures, transfers from other institutions, and obstetric admissions) per 100,000 population, age 18 and over
PQI 14	Admissions for uncontrolled diabetes without complications* (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)	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 traumatic amputation, obstetric admissions, and transfers from other institutions) per 100,000 population, age 18 and over
PQI 17 (Added)	Immunization-preventable pneumococcal pneumonia admissions (excluding transfers from other institutions) per 100,000 population, age 65 and over
PQI 18 (Added)	Immunization-preventable influenza admissions (excluding transfers from other institutions) per 100,000 population, age 65 years and older
PQI 90	Overall Prevention Quality Indicator (PQI) composite per 100,000 population, age 18 and over

[4] Indicators PQI 4 and PQI 6 are not assigned by the PQI software, version 4.

QI No.	Description
PQI 90X (Added)	Overall Prevention Quality Indicator (PQI) composite per 100,000 population, age 18 and over (modified to exclude COPD for consistency of longitudinal reporting)
PQI 91	Acute Prevention Quality Indicator (PQI) composite per 100,000 population, age 18 and over
PQI 92	Chronic Prevention Quality Indicator (PQI) composite per 100,000 population, age 18 and over
PQI 92X (Added)	Chronic Prevention Quality Indicator (PQI) composite per 100,000 population, age 18 and over (modified to exclude COPD for consistency of longitudinal reporting)
Pediatric Quality Indicators[5]	
PDI 01	Accidental puncture or laceration during procedure per 1,000 discharges (excluding obstetric admissions, admissions involving spinal surgery, normal newborns, and neonates with a birth weight less than 500 grams[a]), age less than 18 years
PDI 02	Pressure ulcers – Stage III or IV – 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; admissions for hemiplegia, paraplagia, quadriplagia, spina bifida, or anoxic brain damage; admissions in which debridement or pedicle graft is the only operating room procedure; and obstetrical admissions), age less than 18 years
PDI 05	Iatrogenic pneumothorax per 1,000 discharges (excluding normal newborns; neonates with a birth weight less than 2500 grams; and patients with chest trauma, pleural effusion, thoracic surgery, lung or pleural biopsy, diaphragmatic surgery repair, or cardiac surgery), age less than 18 years and not a neonate
PDI 06	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 08	Postoperative hemorrhage or hematoma with surgical drainage or evacuation, not verifiable as following surgery, per 1,000 surgical discharges (excluding neonates with a birth weight less than 500 grams; and admissions in which the control of the hemorrhage or hematoma is the only operating room procedure) age less than 18 years
PDI 09	Postoperative respiratory failure per 1,000 elective-surgery discharges with an operating room procedure (excluding patients with respiratory disease; circulatory disease; craniofacial anomalies with laryngeal or pharyngeal surgery, or with a procedure on face *and* a diagnosis of craniofacial abnormalities; neuromuscular disorders; neonates with a birth weight less than 500 grams; and admissions in which the tracheostomy is the only operating room procedure), age less than 18 years
PDI 10	Postoperative sepsis per 1,000 surgery discharges with an operating room procedure of length 4 or more days (excluding patients admitted for infection; admissions with cancer or in an immunocompromised state; admissions specifically for sepsis; and neonates), age less than 18 years
PDI 11	Reclosure of postoperative abdominal wound dehiscence of length 2 or more days per 1,000 abdominopelvic-surgery discharges (excluding immunocompromised patients, and neonates with a birth weight less than 500 grams[a]), age less than 18 years
PDI 12	Central venous catheter-related bloodstream infection per 1,000 medical and surgical discharges of length 2 or more days (excluding normal newborns, neonates with a birth weight less than 500 grams, and admissions specifically for such infections), 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.

[5] Indicator PDI 4 is not assigned by the PDI software, version 4. Incidence measures PDI 3 (foreign body) and PDI 13 (transfusion reaction) are not calculated. Volume measure PDI 7 (pediatric heart surgery) is also not calculated.

QI No.	Description
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 (excluding transfers from other institutions, obstetric admissions, normal newborns, and neonates), ages 1-17
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 (PDI) composite per 100,000 population, ages 6-17
PDI 91	Acute Pediatric Quality Indicator (PDI) composite (gastroenteritis, urinary tract infections) per 100,000 population, ages 6-17
PDI 92	Chronic Pediatric Quality Indicator (PDI) composite (asthma, diabetes) per 100,000 population, ages 6-17
NQI 01	Iatrogenic pneumothorax per 1,000 discharges (excluding normal newborns; neonates with a birth weight less than 500 grams; and admissions with chest trauma, pleural effusion, thoracic surgery, lung/pleural biopsy, diaphragmatic surgery repair, or cardiac surgery), for neonates weighing 500 to 2500 grams
NQI 02	Deaths per 1,000 newborn admissions (excluding newborns weighing less than 500 grams or with any diagnosis of anencephaly, polycystic kidney, trisomy 13, or trisomy 18)
NQI 03	Admissions with central venous catheter-related bloodstream infection per 1,000 discharges of length 2 or more days (excluding cases with a principal diagnosis of sepsis or infection), newborns
Inpatient Quality Indicators[6]	
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 hip fractures, 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 periprosthetic fractures, 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)

[6] Indicator IQI 10 is not assigned by the IQI software, version 4. Volume measures IQI 1 to 7 are not calculated.

QI No.	Description
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 abdominal or pelvic surgery (excluding admissions for cancer of the appendix, admissions with a colectomy or pelvic evisceration, 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 or lower-abdominal 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
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[7]	
PSI 2	Deaths per 1,000 admissions with expected low-mortality* (excluding trauma, immunocompromised, and cancer patients), age 18 years or older or obstetric admissions * DRGs with a NIS 1997 benchmark of less than 0.5% mortality, excluding trauma, immunocompromised, and cancer patients
PSI 3	Pressure ulcers – Stage III or IV – 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; admissions for hemiplegia, paraplagia, quadriplagia, spina bifida, or anoxic brain damage; admissions in which debridement or pedicle graft is the only operating room procedure; and obstetrical admissions*), age 18 years or older * Also excludes admissions specifically for pressure ulcers, such as cases from earlier admissions or from other hospitals.
PSI 4	Deaths per 1,000 elective-surgery admissions having developed specified complications of care* during hospitalizations of length 2 or fewer days (excluding patients transferred in or out, patients admitted from long-term-care facilities, and admissions specifically for specified complications of care), age 18 years to 89 years * Complications of care include acute renal failure, pneumonia, pulmonary embolism, deep vein thrombosis, sepsis, shock, cardiac arrest, gastroentestinal hemorrhage, and acute ulcer

[7] Indicators PSI 1 and 20 are not assigned by the PSI software, version 4. Incidence measures PSI 5 (foreign body) and PSI 16 (transfusion reaction) are not calculated.

QI No.	Description
PSI 6	Iatrogenic pneumothorax per 1,000 discharges (excluding obstetrical admissions and patients with chest trauma, pleural effusion, thoracic surgery, lung or pleural biopsy, diaphragmatic surgery repair, 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.
PSI 7	Central venous catheter-related bloodstream infection per 1,000 medical and surgical discharges of length 2 or more days (excluding immunocompromised and cancer patients, 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 admitted for seizures, syncope, stroke, coma, cardiac arrest, poisoning, trauma, delirium and other psychoses, anoxic brain injury; patients with metastatic cancer, lymphoid malignancy, bone malignancy, and self-inflicted injury; admissions for diseases and disorders of the musculoskeletal system and connective tissue; and admissions in which hip fracture repair is the only operating room procedure.
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; admissions in which the tracheostomy is the only operating room procedure; and admissions for craniofacial anomalies with laryngeal or pharyngeal surgery, or a procedure on face), age 18 years and older
PSI 12	Postoperative pulmonary embolus (PE) or deep vein thrombosis (DVT) per 1,000 surgical discharges (excluding patients admitted for DVT, obstetrics, and interruption 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 of length 4 or more days (excluding patients admitted for infection; patients with cancer or immunocompromised states, obstetric conditions, and admissions specifically for sepsis), age 18 years or older
PSI 14	Reclosure of postoperative abdominal wound dehiscence per 1,000 abdominopelvic-surgery discharges of length 2 or more days (excluding immunocompromised patients, 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 and admissions involving spinal surgery*), 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 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

QI No.	Description
PSI 19	Obstetric trauma with 3rd or 4th degree lacerations per 1,000 vaginal deliveries without instrument assistance
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.
PSI 22	Iatrogenic pneumothorax cases* per 100,000 population (excluding obstetrical admissions, and patients with chest trauma, pleural effusion, thoracic surgery, lung or pleural biopsy, diaphragmatic surgery repair, 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	Central venous catheter-related bloodstream infections* per 100,000 population (excluding immunocompromised or cancer patients), 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 and admissions involving spinal surgery), 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 2009 HCUP Inpatient Data for the NHQR and the NHDR

Sponsored by the Agency for Healthcare Research and Quality (AHRQ), HCUP is a family of databases, software tools, and products developed through the collaboration of State data organizations, hospital associations, private data organizations, and the Federal government.

HCUP would not be possible without the contributions of the following data collection Partners from across the United States:

Data Sources for the HCUP Nationwide Inpatient Sample and State Inpatient Databases	Also included in the disparities analysis files
Arizona Department of Health Services	Yes
Arkansas Department of Health	Yes
California Office of Statewide Health Planning and Development	Yes
Colorado Hospital Association	Yes
Connecticut Hospital Association	Yes
Florida Agency for Health Care Administration	Yes
Georgia Hospital Association	Yes
Hawaii Health Information Corporation	Yes
Illinois Department of Public Health	Yes
Indiana Hospital Association	---
Iowa Hospital Association	Yes
Kansas Hospital Association	Yes
Kentucky Cabinet for Health and Family Services	Yes
Louisiana Department of Health and Hospitals	---
Maine Health Data Organization	Yes
Maryland Health Services Cost Review Commission	Yes
Massachusetts Division of Health Care Finance and Policy	Yes
Michigan Health & Hospital Association	Yes
Minnesota Hospital Association	---
Missouri Hospital Industry Data Institute	Yes
Montana – An Association of Montana Health Care Providers	---
Nebraska Hospital Association	---
Nevada Department of Health and Human Services	Yes
New Hampshire Department of Health & Human Services	Yes
New Jersey Department of Health	Yes
New Mexico Department of Health	Yes
New York State Department of Health	Yes
North Carolina Department of Health and Human Services	---
Ohio Hospital Association	---
Oklahoma State Department of Health	Yes
Oregon Association of Hospitals and Health Systems	Yes

Data Sources for the HCUP Nationwide Inpatient Sample and State Inpatient Databases	Also included in the disparities analysis files
Pennsylvania Health Care Cost Containment Council	Yes
Rhode Island Department of Health	Yes
South Carolina State Budget & Control Board	Yes
South Dakota Association of Healthcare Organizations	Yes
Tennessee Hospital Association	Yes
Texas Department of State Health Services	Yes
Utah Department of Health	Yes
Vermont Association of Hospitals and Health Systems	Yes
Virginia Health Information	Yes
Washington State Department of Health	Yes
West Virginia Health Care Authority	---
Wisconsin Department of Health Services	Yes
Wyoming Hospital Association	Yes

Table 3. Age Groupings for Risk Adjustment

This table shows the 18 categories of patient age, in five-year increments, that are used for risk adjustment. The 36 age-gender categories for risk adjustment are constructed from the 18 age categories split into male-female gender.

Age Groups
0-4
5-9
10-14
15-17
18-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70-74
75-79
80-84
85 or older

Table 4. Use of Secondary Procedure Days in AHRQ Quality Indicators, Version 4.1

Eight PSIs and four PDIs used information on the timing of procedures (PRDAY) to exclude patients:

- PSI 3 – Pressure Ulcer
- PSI 8 – Post-operative hip fractures
- PSI 9 – Post-operative hemorrhage or hematoma
- PSI 10 – Post-operative physiologic/metabolic derangements
- PSI 11 – Post-operative respiratory failure
- PSI 12 – Post-operative pulmonary embolism or deep vein thrombosis
- PSI 14 – Post-operative abdominal wound dehiscence
- PSI 27 – Post-operative hemorrhage or hematoma (area based)

- PDI 2 – Pediatric: Pressure ulcer
- PDI 8 – Pediatric: Post-operative hemorrhage or hematoma
- PDI 9 – Pediatric: Post-operative respiratory failure
- PDI 11 – Pediatric: Post-operative wound dehiscence

Table 5. Use of Present on Admission in AHRQ Quality Indicators, Version 4.1

Among the AHRQ QIs generated for the NHQR and NHDR, 14 PSIs and 16 PDIs used information on whether a condition was present on admission (POA) to exclude patients:

- PSI 3 Pressure Ulcer
- PSI 6 Iatrogenix Pneumothorax
- PSI 7 Central Venous Catheter-Related Bloodstream Infection
- PSI 8 Postoperative Hip Fracture
- PSI 9 Postoperative Hemorrhage or Hematoma
- PSI 10 Postoperative Physiologic and Metabolic Derangements
- PSI 11 Postoperative Respiratory Failure
- PSI 12 Postoperative Pulmonary Embolism or Deep Vein Thrombosis
- PSI 13 Postoperative Sepsis
- PSI 14 Postoperative Abdominal Wound Dehiscence (Provider-based)
- PSI 15 Accidental Puncture or Laceration (Provider-based)

- PDI 1 Pediatric: Accidental Puncture or Laceration
- PDI 2 Pediatric: Pressure Ulcer
- PDI 5 Pediatric: Iatrogenic Pneumothorax
- PDI 8 Pediatric: Postoperative Hemorrhage or Hematoma
- PDI 9 Pediatric: Postoperative Respiratory Failure
- PDI 10 Pediatric: Postoperative Sepsis
- PDI 11 Pediatric: Postoperative Abdominal Wound Dehiscence
- PDI 12 Pediatric: Central Venous Catheter-Related Bloodstream Infection
- NQI 01 Neonatal Iatrogenic Pneumothorax
- NQI 03 Neonatal Central Venous Catheter-Related Bloodstream Infection.

Table 6. Number of Diagnosis and Procedure Fields by State, 2009

State	Maximum Number of Diagnoses	Maximum Number of Procedures
Arizona	25	12
Arkansas	18	8
California	25	21
Colorado	15	15
Connecticut	30	30
Florida	31	31
Georgia	30	30
Hawaii	20	20
Illinois	25	25
Indiana	18	15
Iowa	62	37
Kansas	30	25
Kentucky	25	25
Louisiana	9	6
Maine	10	6
Maryland	30	15
Massachusetts	15	15
Michigan	30	30
Minnesota	28	25
Missouri	30	25
Montana	25	25
Nebraska	9	6
Nevada	33	12
New Hampshire	10	6
New Jersey	24	25
New Mexico	18	6
New York	15	15
North Carolina	24	24
Ohio	15	9
Oklahoma	16	16
Oregon	25	25
Pennsylvania	9	6
Rhode Island	25	25
South Carolina	15	13
South Dakota	77	65
Tennessee	18	6
Texas	25	15
Utah	9	6
Vermont	20	20
Virginia	18	6
Washington	25	25
West Virginia	18	6
Wisconsin	30	30
Wyoming	30	25

Table 7. Use of E codes in the AHRQ Quality Indicators, Version 4.1

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 21	E8710 – E8719	9984, 9987	None	None
PSI 8	None	None	Self-inflicted injury (E95nn); Poisoning (E85nn, E86nn, E951n, E952n, E962nn, E980n-E982n)	9600-9799
PSI 15 PSI 25 PDI 1	E870n	9982	None	None
PSI 26	E8760	9996-9997	None	None

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

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APPENDICES

APPENDIX A:
DEVELOPMENT OF THE DISPARITIES ANALYSIS FILE FOR NATIONAL QI ESTIMATES BY RACE/ETHNICITY

Race and ethnicity measures can be problematic in hospital discharge databases because 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 44 States that participate in 2009 HCUP SID. Six States did not provide information on patient race to HCUP. Two States did not report Hispanic ethnicity. The remaining 36 States were used for the creation of the disparities analysis files (See Table 2 in the main body of the report for the list of States).

The following table demonstrates the representation by U.S. Census region of these 36 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	9	9	100%
Midwest	7	12	58%
South	10	16	63%
West	10	13	77%
Total	36	50	72%

The table below compares aggregated totals of various measures for the 36 States as a percent of the national measure. In 2009, the 36 States accounted for 77 percent of U.S. hospital discharges (based on the American Hospital Association's Annual Survey). They accounted for about 80 percent of White and African Americans in the nation and 95 percent of Asian/Pacific Islanders and Hispanics (based on 2009 Claritas data).

Measure	Total of 36 HCUP States with race/ethnicity as a percent of national total
Hospital discharges	77%
Total resident population	83%
Population by race/ethnicity:	
White	80%*
African American	77%*
Asian/Pacific Islander	93%*
Hispanic	95%*
Population by age:	
Population under age 18	83%*
Population age 18-64	83%*
Population over age 64	82%*
Population by income:	
Population with income under the poverty level	78%**

**Calculated using 2009 Claritas data and 1977 OMB Directive 15 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 2009 and 2010 Current Population Survey (CPS: Annual Social and Economic Supplements), accessed on September 28, 2011.*

HCUP Race Data

HCUP coding includes race and ethnicity in one data element (RACE). Because of variability in the collection of race and ethnicity information in the State data provided to HCUP, HCUP maintains a uniform set of categories based on race definitions used in the 1977 Office of Management and Budget (OMB) Directive 15 (separate categories for Hispanic and five Non-Hispanic racial groups – White, Black, Asian or Pacific Islander, Native American, and Other).

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 to create uniform coding across states. Because of limited reporting of Native American (*American Indian/Alaska Native*) in the HCUP data, counts for Other and American Indian/Alaska Native are combined into "Other" races for the NHDR analyses.

Preparing the Disparities Analysis File

The sampling and weighting strategy used for the disparities analysis file for national estimates by race/ethnicity is similar to the method used to create the HCUP NIS, except that the disparities analysis file draws its sample from 36 of the 44 States included in the 2009 SID and is a 40-percent sample of community hospitals rather than a 20-percent sample as in the NIS.

- First, community hospitals from the 36 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).
- For discharges missing race, a "hot deck" imputation method (which draws donors from strata of similar patients within the same hospital) is used to assign values while preserving the variance within the data.
- 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 final disparities analysis file included about 15.7 million hospital discharges from close to 2,000 hospitals.

The NHDR also reports information derived from the 2001-2008 disparities analysis files for comparison. These additional data files were developed using the year-specific SID and the same approach described above. QI statistics for the back years were re-run using the modified version 4.1 software so that the same version of the QI software is used for all years in a given NHDR release.

Evaluating the Disparities Analysis File

After creating the 2009 disparities analysis file using the above steps, we evaluated the reliability of national estimates produced with these data by comparing its composition to the 2009 NIS. The tables below contain the distribution of discharges in both files by key

demographic and clinical data elements. Based on these analyses, the 2009 disparities analysis file appears to provide reliable national estimates when compared with the NIS.

Weighted Frequencies

Stratum used to sample hospitals				
	2009 Disparities Analysis File		2009 NIS	
NHDR_STRATUM	Frequency	Percent	Frequency	Percent
1: Northeast	7,663,438	19.4%	7,747,709	19.4%
2: Midwest	8,989,260	22.8%	8,989,260	22.8%
3: South	15,146,299	38.4%	15,146,299	38.4%
4: West	7,635,959	19.4%	7,635,959	19.4%

Age in years at admission				
	2009 Disparities Analysis File		2009 NIS	
AGE	Frequency	Percent	Frequency	Percent
.: Missing	5,378	1.4	3,955	1.0
.A: Invalid	251	0.1	218	0.1
.C: Inconsistent	8,610	2.2	47,349	12.0
0-17	6,585,199	16.7	6,288,983	15.9
18-44	9,826,795	24.9	9,921,745	25.2
45-64	9,526,216	24.2	9,628,534	24.4
65+	13,482,507	34.2	13,544,172	34.3

Indicator of sex				
	2009 Disparities Analysis File		2009 NIS	
FEMALE	Frequency	Percent	Frequency	Percent
.: Missing	4,303	0.0	102,302	0.3
.A: Invalid	131	0.0	269	0.0
.C: Inconsistent	1,034	0.0	1,290	0.0
0: Male	16,454,560	41.7	16,440,086	41.7
1: Female	22,974,928	58.3	22,891,009	58.0

Primary expected payer				
	2009 Disparities Analysis File		2009 NIS	
PAY1	Frequency	Percent	Frequency	Percent
.: Missing	63,529	0.2	77,178	0.2
.A: Invalid	1,252	0.0	6,688	0.0
1: Medicare	14,721,517	37.3	14,708,356	37.3
2: Medicaid	8,062,566	20.4	8,027,292	20.4
3: Private Insurance	13,195,379	33.5	12,957,809	32.9
4: Self-pay	1,967,365	5.0	2,184,325	5.5
5: No Charge	213,558	0.5	203,690	0.5
6: Other	1,209,789	3.1	1,269,618	3.2

Patient race/ethnicity[8]				
	2009 Disparities Analysis File		2009 NIS	
RACE	Frequency	Percent	Frequency	Percent
.: Missing	713,777	1.8	5,975,612	15.2
.A: Invalid	1,539	0.0	438	0.0
1: White	26,031,551	66.0	22,041,892	55.9
2: Black	5,737,685	14.5	4,618,324	11.7
3: Hispanic	4,740,940	12.0	4,255,816	10.8
4: Asian/Pacific Islander	988,983	2.5	887,892	2.3
5: Native American	237,823	0.6	263,510	0.7
6: Other	982,658	2.5	1,391,472	3.5

Location of patient residence				
	2009 Disparities Analysis File		2009 NIS	
PL_NCHS	Frequency	Percent	Frequency	Percent
.: Missing	0	0	909,256	2.3
1: Large central metro	12,052,764	30.6	11,661,279	29.6
2: Large fringe metro	9,890,334	25.1	9,331,032	23.7
3: Medium metro	6,634,031	16.8	7,083,731	18.0
4: Small metro	3,792,581	9.6	3,266,508	8.3
5: Micropolitan (nonmetro)	4,110,076	10.4	4,373,602	11.1
6: Noncore (nonmetro)	2,955,169	7.5	2,809,548	7.1

[8] Differences in race distribution are attributable to high rates of missing race on the NIS (20%). The 2009 disparities analysis file uses a modified race variable with missing or invalid values imputed and Native American and Other combined into one racial group.

Top 24 DRGs (Combination of Top 24 DRGs for Disparities and NIS file)				
	2009 Disparities Analysis File		2009 NIS	
DRG, Version 27	Frequency	Percent	Frequency	Percent
795: NORMAL NEWBORN	2,953,758	7.5	2,966,008	7.5
775: VAGINAL DELIVERY W/O COMPLICATING DIAGNOSES	2,304,914	5.8	2,303,885	5.8
885: PSYCHOSES	1,075,711	2.7	1,185,217	3.0
766: CESAREAN SECTION W/O CC/MCC	904,864	2.3	910,721	2.3
470: MAJOR JOINT REPLACEMENT OR REATTACHMENT OF LOWER EXTREMITY W/O MCC	899,738	2.3	913,981	2.3
392: ESOPHAGITIS, GASTROENT & MISC DIGEST DISORDERS W/O MCC	840,170	2.1	835,503	2.1
794: NEONATE W OTHER SIGNIFICANT PROBLEMS	717,544	1.8	718,388	1.8
313: CHEST PAIN	557,354	1.4	576,044	1.5
871: SEPTICEMIA W/O MV 96+ HOURS W MCC	505,641	1.3	488,138	1.2
603: CELLULITIS W/O MCC	492,172	1.2	485,972	1.2
765: CESAREAN SECTION W CC/MCC	469,375	1.2	469,999	1.2
194: SIMPLE PNEUMONIA & PLEURISY W CC	457,307	1.2	451,394	1.1
641: NUTRITIONAL & MISC METABOLIC DISORDERS W/O MCC	424,880	1.1	411,292	1.0
690: KIDNEY & URINARY TRACT INFECTIONS W/O MCC	422,761	1.1	421,354	1.1
743: UTERINE & ADNEXA PROC FOR NON-MALIGNANCY W/O CC/MCC	416,916	1.1	400,351	1.0
291: HEART FAILURE & SHOCK W MCC	379,196	1.0	379,331	1.0
247: PERC CARDIOVASC PROC W DRUG-ELUTING STENT W/O MCC	351,739	0.9	379,217	1.0
287: CIRCULATORY DISORDERS EXCEPT AMI, W CARD CATH W/O MCC	338,239	0.9	346,961	0.9
195: SIMPLE PNEUMONIA & PLEURISY W/O CC/MCC	335,233	0.9	329,309	0.8
312: SYNCOPE & COLLAPSE	334,629	0.8	334,351	0.8
203: BRONCHITIS & ASTHMA W/O CC/MCC	330,064	0.8	330,629	0.8
292: HEART FAILURE & SHOCK W CC	329,740	0.8	335,792	0.9
774: VAGINAL DELIVERY W COMPLICATING DIAGNOSES	329,164	0.8	341,040	0.9
945: REHABILITATION W CC/MCC	320,802	0.8	300,388	0.8

Median income of Patient's ZIP Code				
	2009 Disparities Analysis File		2009 NIS	
ZIPINC_QRTL	Frequency	Percent	Frequency	Percent
.: Missing	0	0	1,223,626	3.1
1: First Quartile (lowest income)	11,584,057	29.4	10,870,293	27.6
2: Second Quartile	10,173,575	25.8	10,189,919	25.8
3: Third Quartile	9,320,279	23.6	9,035,687	22.9
4: Fourth Quartile (highest income)	8,357,045	21.2	8,113,158	20.6
A: Invalid	0	0	2,272	0.0

Weighted Means

	2009 Disparities Analysis File				2009 NIS		
Variable / Label	Minimum	Maximum	Mean		Minimum	Maximum	Mean
LOS: Length of stay (cleaned)	0	365	4.6		0	365	4.6
NDX: Number of diagnoses on this record	0	77	7.9		0	59	7.7
NPR: Number of procedures on this record	0	64	1.6		0	37	1.6
TOTCHG: Total charges (cleaned)	$100	$1,499,961	$31,208.46		$100	$1,499,961	$30,651.32

APPENDIX B:
DEVELOPMENT OF THE DISPARITIES ANALYSIS FILES FOR STATE-LEVEL QI ESTIMATES BY RACE/ETHNICITY

Data from the 2009 SID were used to create individual state disparities analysis files that were designed to provide State-level QI estimates by race/ethnicity. The starting point for State-level disparities analysis files were the SID prepared for the other reporting in the NHQR, as described in the HCUP Databases section of this report. These files were limited to community, non-rehabilitation hospitals. Disparities analysis files were created for the 36 HCUP States that report race/ethnicity of discharges (see Table 2 in the main body of the report for a list of the States).

The following steps were taken to further prepare the State-level files for reporting by race/ethnicity:

1. *Selection of Hospitals.* We first selected hospitals whose original coding of patient race-ethnicity was not "suspect." Hospitals were removed from the State-level disparities analysis files if the quality of the race-ethnicity reporting was suspect, using the same four criteria for exclusion of hospitals with suspect race coding that were applied when creating the national disparities analysis file (see Appendix A for details).

   In 26 of the 36 States with race/ethnicity data, at least one hospital was eliminated due to suspect race coding. Ten states had no hospitals with suspect race coding. Overall, 5.4 percent of hospitals and 2.7 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 coded as "other" or "missing" race.

Exclusions from State-level Disparities Analysis Files for Race/Ethnicity						
Measure	**Excluded for any reason**	**Percent of Total**	**>30% discharges are "other" race**	**>50% discharges are "missing" race**	**All discharges are white, other or missing**	**All discharges are white and hospital has >50 beds**
Total number of hospitals excluded	198	5.4%	79	77	42	0
Total number of discharges excluded	819,341	2.7%	321,156	481,841	16,344	0

2. *Impute for Missing Race/Ethnicity.* Because the area-level measures selected for this report 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.

Typically, most States have no more than seven percent (7%) of discharges starting out with missing race values.

3. *Weighting of Selected Hospitals.* 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. We weighted to the State's universe of hospitals in the American Hospital Association (AHA) Annual Survey Database based on hospital characteristics.

There may be 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.

APPENDIX C:
INPATIENT AND EMERGENCY DEPARTMENT RATES FOR SELECTED CONDITIONS

For the 2012 NHQR, HCUP data were used to examine national and regional differences in inpatient and emergency department (ED) rates for selected AHRQ Prevention Quality Indicators (PQIs), related Pediatric Quality Indicators (PDIs), and selected mental illness and substance use disorders. Table C-1 in this appendix contains a list of PQIs and PDIs examined. Table C-2 contains the list of HCUP Clinical Classifications Software (CCS) categories for mental illness and substance use disorders used in this analysis.

Analysis of PQIs and PDIs

The PQIs are measures of quality associated with processes and outcomes of care that occurred in an outpatient or an inpatient setting. The PQIs rely solely on hospital administrative data and, for this reason, are screens for examining quality that may indicate the need for more in-depth studies. Experts have suggested that using both inpatient and emergency room data may give a more accurate picture of avoidable visits/admissions for some ambulatory care sensitive conditions which can be identified by certain PQIs and PDIs.

Two HCUP databases were used for the analysis:

- The HCUP Nationwide Emergency Department Sample (NEDS), a nationally stratified sample of hospital-based EDs from HCUP States that contribute ED data (29 States in the 2009 NEDS).
- The HCUP Nationwide Inpatient Sample (NIS), a nationally stratified sample of hospitals from HCUP States that contribute inpatient data (44 States in the 2009 NIS).

The 2009 NEDS contains approximately 28.9 million ED events from 964 hospital-based EDs. The NEDS includes information on ED visits that do not result in an admission (i.e., treat-and-release visits and transfers to another hospital) as well as discharge information on patients initially seen in the ED and then admitted to the same hospital. For 2009, the NIS contains roughly 7.8 million inpatient discharges from more than 1,000 hospitals. Discharge-level weights included with the NEDS and NIS are used to produce national estimates.

Several steps were taken to prepare the HCUP databases: (1) QI software review and modification, (2) acquisition of population-based data, (3) general preparation of HCUP data, and (4) identification of statistical methods.

1. **QI Software Review and Modification.** A modification of PQI Version 4.1 was used. The PQIs were developed for use with hospital inpatient discharge data. No guidelines for applying the AHRQ QIs to emergency department data were available when this analysis began. Some of the events in the NEDS are visits for patients initially seen in the emergency room and then admitted to the same hospital (an "ED admission"), and some NEDS events are ED visits that do not result in an inpatient admission (e.g., treat-and-release visits and transfers to another hospital). About 16 percent of records in the 2009 NEDS represent an ED admission. The PQIs rely on the first-listed diagnosis code (DX1) to identify cases with the outcome of interest. For ED admissions, DX1 is the principal diagnosis code and reflects the condition established to be chiefly responsible for a patients' admission to the hospital. Unfortunately, principal diagnosis is not clearly discernible for ED visits that do not result in admission. Coding instructions for outpatient

data specify that the first-listed diagnosis is supposed to be the "reason for visit," which is different than the principal diagnosis. Even though DX1 in ED data is not necessarily the principal diagnosis, using DX1 preserves the concept from the PQI algorithm that the first code has higher priority than others. Therefore, this analysis used the first-listed diagnosis in both the inpatient and ED data analyses.

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 the hospital or within the geographic area) to which the event relates.

   For the numerator counts of the PQI or PDI, we used the HCUP NEDS to create national estimates of all ED visits, ED visits resulting in admission to the same hospital, and all other types of ED visits. We used the HCUP NIS to create national estimates of inpatient admissions including those admitted through the ED. For the denominator counts, 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 all reporting categories. Claritas uses intercensal methods to estimate household and demographic statistics for geographic areas (Claritas, Inc., 2009). We also used the Claritas population data for risk adjustment by age and gender.

3. **Preparation of HCUP Data.** Next, the HCUP NEDS was modified to create an analytic file consistent with the NIS which is already used for other measures in the NHQR. The NEDS consists only of hospital-based EDs from community, non-rehabilitation hospitals and includes discharge weights to the universe of hospital-based ED visits to the U.S. as defined by the American Hospital Association Annual Survey Database. For missing age and gender data that occurred on a small proportion of discharge records, a "hot deck" imputation method (which draws donors from strata of similar hospitals and patients) was used to assign values while preserving the variance within the data.

4. **Statistical Methods.** 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.

5. **Masking Rates for Statistical Reliability, Data Quality, and Confidentiality.** PQI and PDI estimates were included in this analysis if they reached a threshold defined by a relative standard error less than 30% and at least 11 unweighted cases in the denominator. Estimates that did not satisfy these criteria were set to missing.

Analysis of ED Visits for Mental Illness and Substance Use Disorders

The HCUP Nationwide Emergency Department Sample (NEDS) for 2007 to 2009 were used to identify ED visits for mental illness and substance use disorders. Specific disorders are listed in Table C-2.

ED visits were identified by the Clinical Classifications Software (CCS) category for the first-listed diagnosis. No distinction was made between ED visits that resulted in a hospital admission and those that did not. Claritas population data was used to calculate rates per 100,000 residents by age, gender, community income, urban/rural location of patient residence, and region of the United States. Rates were not risk-adjusted.

Table C-1. List of PQIs and PDIs Used to Examine Differences in Inpatient and ED Use

PQI or PDI	Description
PQI 1	Diabetes with short-term complications
PQI 3	Diabetes with long-term complications
PQI 5	Chronic obstructive pulmonary disease
PQI 7	Hypertension
PQI 8	Congestive heart failure
PQI 8B*	Congestive heart failure secondary diagnosis with related symptom as first-listed diagnosis
PQI 10	Dehydration
PQI 11	Bacterial pneumonia
PQI 12	Urinary tract infections
PQI 13	Angina without cardiac procedure
PQI 14	Uncontrolled diabetes without complications
PQI 15	Adult asthma admissions
PQI 15B*	Elderly asthma admissions
PQI 16	Lower extremity amputations among patients with diabetes
PQI 18*	Immunization-preventable influenza
PQI 90	Overall Prevention Quality Indicator (PQI) composite
PQI 91	Acute Prevention Quality Indicator (PQI) composite
PQI 92	Chronic Prevention Quality Indicator (PQI) composite
PDI 14	Pediatric asthma admissions
PDI 15	Pediatric diabetes with short-term complications

* Modified or added version of PQI.

Table C-2. Clinical Classifications Software (CCS) Categories Used to Examine Mental Illness and Substance Use Disorders

DXCCS	Description
Mental Illness Disorders	
650	Adjustment disorders
651	Anxiety disorders
652	Attention-deficit, conduct, and disruptive behavior disorders
655	Disorders usually diagnosed in infancy, childhood, or adolescence
656	Impulse control disorders, NEC
657	Mood disorders
658	Personality disorders
659	Schizophrenia and other psychotic disorders
662	Suicide and intentional self-inflicted injury
670	Miscellaneous disorders
Substance Use Disorders	
660	Alcohol-related disorders
661	Substance-related disorders

APPENDIX D:
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 multiple databases: the NIS, the SID, and Claritas (a vendor that compiles and adds value to Bureau of Census data). For NIS estimates and the disparities analysis file, 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 NIS sample design when calculating these statistics using the SAS procedure PROC SURVEYMEANS. For the SID we used the same procedure omitting the cluster and stratification features. For population counts based on Claritas data, there is no sampling error.

Even though the NIS and the disparities analysis file contain discharges from a finite sample of hospitals and most of the SID databases contain nearly all discharges from nearly all hospitals in the state, we treat the samples as though they were 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 NIS and SID to be samples 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 2009 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 weight and variable of interest for patient i in the NIS or SID. To obtain the estimate of S and its standard error, SE_S, we followed instructions in the NIS Variance Report (modified for the SID, as explained above)

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 2009 Claritas population 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 (described in Table 3 in this methods report, Age Groupings for Risk Adjustment). We then calculated the 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):

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

g = index for the 36 age/sex cells.
$N_{g,std}$ = Standard population for cell g (year 2000 total US population in cell g).
$N_{g,obs}$ = Observed population for cell g (year 2009 subpopulation in cell g, e.g., females, state of California, 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).
$w_{g,i}$ = NIS or SID 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 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 (modified for the SID, as explained above), we used PROC SURVEYMEANS to obtain the estimate of S^*, the weighted sum in the numerator using the revised weights, and the estimate SE_{S^*}, the standard error of the weighted sum S^*. The denominator 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 (SID and NIS)

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 (modified for the SID, as explained above), we used PROC SURVEYMEANS to obtain estimates of the weighted mean, *S/N*, and the standard error of the 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 NIS 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 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.
$w_{g,i}$ = NIS or SID 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 (modified for the SID, as explained above), we used PROC SURVEYMEANS to obtain estimates of the 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:

$$t = \frac{R_1 - R_2}{\sqrt{SE_1^2 + SE_2^2}} \quad \text{(A.10)}$$

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

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 E:
NHQR/NHDR SUMMARY MEASURES FOR PATIENT SAFETY AND MORTALITY FOR SELECTED PROCEDURES AND CONDITIONS

To examine national and state-level trends in inpatient mortality and patient safety events, risk-adjusted rates for select AHRQ Inpatient Quality Indicators (IQIs) and Patient Safety Indicators (PSIs) were summarized.

The three NHQR/NHDR summary measures include the following:

1. Mortality for selected conditions based on select IQIs
2. Mortality for selected procedures based on select IQIs
3. Patient safety based on select PSIs

These summary measures were calculated as a weighted sum of risk-adjusted rates for individual IQIs and PSIs. The weights used to calculate the NHQR/NHDR summary measures were relatively consistent with AHRQ IQI and PSI Composites; however, the methodology employed to perform the calculations differed. The IQI and PSI composites were designed for use with hospital-level rates, while the NHQR/NHDR report only national and state-level statistics.

The NHQR/NHDR summary measure for mortality for selected conditions was based on six IQIs also included in the similar IQI Composite.

IQI	Description	IQI Composite Weight	NHQR/NHDR Summary Measure Weight
IQIs Included in the NHQR/NHDR Summary			
IQI15	Acute Myocardial Infarction	0.1433	0.1433
IQI16	Congestive Heart Failure	0.2739	0.2739
IQI17	Acute Stroke Adult Mortality Rate	0.1329	0.1329
IQI18	Gastrointestinal Hemorrhage	0.1302	0.1302
IQI19	Hip Fracture	0.0678	0.0678
IQI20	Pneumonia	0.2519	0.2519

The IQI composite weights were extracted from the SAS software, version 4.1. They are based on pooled SID denominators (i.e., the relative frequency of the denominators of the component indicators). This approach is known as “opportunity weighting,” because it gives equal weight to each opportunity that the health care system has to do “the right thing,” which in this case is to discharge the patient alive from the hospital. The NHQR/NHDR summary measure weights were the same as the weights in the similar IQI Composite.

The NHQR/NHDR summary measure for mortality for selected procedures was based on four IQIs instead of the eight IQIs included in the similar IQI Composite.

Three IQIs were excluded because the procedures were not high-volume at the state level and, therefore, state-level risk-adjusted rates were often unavailable. The IQI for Hip Replacement has a zero-weight in the IQI Composite because it is not endorsed by the National Quality

Forum. The IQI composite weights were extracted from the SAS software, version 4.1, and were also based on pooled SID denominators. The IQI Composite weights were proportionally reallocated into the NHQR/NHDR summary measure weights to account for the excluded IQIs.

IQI	Description	IQI Composite Weight	NHQR/NHDR Summary Measure Weight
IQIs Included in the NHQR/NHDR Summary			
IQI30	PTCA	0.5659	0.6275
IQI12	CABG	0.2001	0.2219
IQI13	Craniotomy	0.1031	0.1143
IQI11	Abdominal Aortic Aneurysm Repair	0.0328	0.0364
IQIs Excluded in the NHQR/NHDR Summary, but in the IQI Composite			
IQI08	Esophageal Resection	0.0043	0.0000
IQI09	Pancreatic Resection	0.0048	0.0000
IQI14	Hip Replacement	0.0000	0.0000
IQI31	Carotid Endarterectomy	0.0890	0.0000

The NHQR/NHDR summary measure for patient safety was based on seven PSIs instead of the eleven PSIs included in the similar PSI Composite.

PSI	Description	PSI Composite Weight	NHQR/NHDR Summary Measure Weight
PSIs Included in the NHQR/NHDR Summary			
PSI15	Accidental Puncture or Laceration	0.2982	0.3925
PSI12	Postoperative Pulmonary Embolism or Deep Vein Thrombosis	0.2360	0.3106
PSI07	Central Venous Catheter-Related Bloodstream Infections (2008 only)	0.1280	0.1685
PSI06	Iatrogenic Pneumothorax	0.0457	0.0602
PSI13	Postoperative Sepsis (2008 only)	0.0383	0.0504
PSI14	Postoperative Wound Dehiscence	0.0124	0.0163
PSI08	Postoperative Hip Fracture	0.0011	0.0014
PSIs Excluded in the NHQR/NHDR Summary, but in the PSI Composite			
PSI03	Pressure Ulcer	0.2403	0.0000
PSI09	Postoperative Hemorrhage or Hematoma	0.0000	0.0000
PSI10	Postoperative Physiologic and Metabolic Derangement	0.0000	0.0000
PSI11	Postoperative Respiratory Failure	0.0000	0.0000

One PSI Pressure Ulcer was excluded due to its dependence upon reporting whether the diagnosis is present on admission (POA) to the hospital. (This information is not uniformly available across HCUP States). Three PSIs have zero weights in the PSI Composite because they are not endorsed by the National Quality Forum. The PSI composite weights were extracted from the SAS software, version 4.1, and are based on pooled SID numerators (i.e., the relative frequency of the numerators of the component indicators). This approach is known as “event weighting,” because it gives equal weight to each event, regardless of how many patients were evaluated for the occurrence of that event. The PSI Composite weights were

proportionally reallocated into the NHQR/NHDR summary measure weights to account for the excluded PSIs.

Calculation of Summary Measures

Each summary measure was calculated as follows:

$$S = \sum_i a_i X_i$$

Where a_i corresponds to the weight to the i^{th} QI and X_i corresponds to the risk-adjusted rate for the i^{th} QI.

The standard error (SE) of the summary measure is the square-root of the variance:

$$\mathrm{Var}\left(\sum_i a_i X_i\right) = \sum_i a_i^2 \mathrm{Var}(X_i) + \sum_i \sum_{j \neq i} a_i a_j \mathrm{Cov}(X_i, X_j)$$

Where a_i corresponds to the weight to the i^{th} QI and X_i corresponds to the risk-adjusted rate for the i^{th} QI. The correlations actually had very little effect on the estimated SE for the summary measures. For example, in examining mortality for select conditions, the SE was 0.293 if we assume the correlations are zero (i.e., the individual measures are uncorrelated) and the SE was 0.303 if we assume the correlations are those estimated by the covariance matrix of the state-level rates, which were in the range of 70 to 85 percent. Therefore, the SEs were calculated on the assumption that the individual measures were independent of one another, which eliminates the second term on the right-hand side of the formula above.