**NATIONAL QUALITY FORUM**

**NQF-ENDORSED DIABETES MEASURES FOR MAINTENANCE REVIEW**

<table>
<thead>
<tr>
<th>NQF#</th>
<th>Title</th>
<th>Description</th>
<th>Numerator</th>
<th>Denominator</th>
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</thead>
<tbody>
<tr>
<td>0272</td>
<td>Diabetes Short-term Complications Admission Rate (PQI 1)</td>
<td>This measure is used to assess the number of admissions for diabetes short-term complications per 100,000 persons.</td>
<td>All discharges of age 18 years and older with ICD-9-CM principal diagnosis code for short-term complications (ketoacidosis, hyperosmolarity, coma).</td>
<td>Population in Metropolitan Statistical Area or County, age 18 years and older.</td>
</tr>
<tr>
<td>0274</td>
<td>Diabetes Long-term Complications Admission Rate (PQI 3)</td>
<td>This measure is used to assess the number of admissions for diabetes long-term complications per 100,000 persons.</td>
<td>All discharges age 18 years and older with ICD-9-CM principal diagnosis code for long-term complications (renal, eye, neurological, circulatory, or complications not otherwise specified).</td>
<td>Population in Metropolitan Statistical Area or County, age 18 years and older.</td>
</tr>
<tr>
<td>0285</td>
<td>Rate of Lower-extremity Amputation among Patients with Diabetes (PQI 16)</td>
<td>This measure is used to assess the number of lower-extremity amputations among patients with diabetes per 100,000 persons.</td>
<td>All discharges of age 18 years and older with ICD-9-CM procedure code for lower-extremity amputation and diagnosis code of diabetes in any field.</td>
<td>Population in Metropolitan Statistical Area or County, age 18 years and older.</td>
</tr>
<tr>
<td>0638</td>
<td>Uncontrolled Diabetes Admission Rate (PQI 14)</td>
<td>This measure is used to assess the number of admissions for uncontrolled diabetes per 100,000 persons.</td>
<td>All discharges of age 18 years and older with ICD-9-CM principal diagnosis code for uncontrolled diabetes, without mention of a short-term or long-term complication.</td>
<td>Population in Metropolitan Statistical Area or County, age 18 years and older.</td>
</tr>
</tbody>
</table>
This form will be used by stewards to submit measure information and by reviewers to evaluate the measures.

**Measure Stewards:** Complete all non-shaded areas of the form. All requested information should be entered directly into this form. The information requested is directly related to NQF’s measure evaluation criteria and will be used by reviewers to determine if the evaluation criteria have been met. The specific relevant subcriteria language is provided in a Word comment within the form and will appear if your cursor is over the highlighted area.

The measure steward has the opportunity to identify and present the information that demonstrates the measure meets the criteria. Additional materials will only be considered supplemental. Do not rely solely on materials provided at URLs or in attached documents to provide measure specifications or to demonstrate meeting the criteria. If supplemental materials are provided, be sure to indicate specific page numbers/web page locations for the relevant information.

**Reviewers:** Complete all yellow highlighted areas of the form. Evaluate the extent to which each subcriterion is met and then overall, the extent to which each major criterion is met. Provide the rationale for your rating.

Evaluation ratings of the extent to which the criteria are met:

- **H**=High (unquestionably demonstrated to meet the criterion)
- **M**=Moderate (demonstrated to moderately meet the criterion)
- **L**=Low (addressed but demonstrated to only minimally meet the criterion)
- **N**=No (NOT addressed; OR incorrectly addressed; OR demonstrated to NOT meet the criterion)
- **NA**=Not applicable (only an option for a few subcriteria as indicated)

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**MEASURE DESCRIPTIVE INFORMATION**

- **NQF #0272**
- **Title of Measure:** Diabetes Short-term Complications Admission Rate (PQI 1)

**Brief description of measure** (including type of score, measure focus, target population, time, e.g., Percentage of adult patients aged 18-75 years receiving one or more HbA1c tests per year):
This measure is used to assess the number of admissions for diabetes short-term complications per 100,000 persons.

- **Type of Measure:** Outcome
- **If “Other”, please describe:**
- **If included in a composite or paired with another measure, please identify composite or paired measure**

Select the most relevant priority area(s), quality domain(s), and consumer need(s).

- **National Priority Partners Priority Area**
  - [ ] patient and family engagement
  - [ ] population health
  - [ ] safety
  - [ ] care coordination
  - [ ] palliative and end of life care
  - [ ] overuse

- **IOM Quality Domain**
  - [x] effectiveness
  - [ ] efficiency
  - [ ] equity
  - [ ] patient-centered
  - [ ] safety
  - [ ] timeliness

- **Consumer Care Need**
  - [ ] Getting Better
  - [ ] Living With Illness
  - [x] Staying Healthy

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**CONDITIONS FOR CONSIDERATION BY NQF**

Four conditions must be met before proposed measures may be considered and evaluated for suitability as voluntary consensus standards:

A. The measure is in the public domain or an intellectual property agreement (measure steward agreement) is signed. **Public domain only applies to governmental organizations. All non-government organizations must sign a measure steward agreement even if measures are made publicly and freely available.**

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Do you attest that the measure steward holds intellectual property rights to the measure and the right to use any aspects of the measure owned by another entity (e.g., risk model, code set)? ☑ Yes

Measure Steward Agreement (updated Nov 08)
- Signed and Submitted or ☑ Government entity-public domain (If measure steward agreement not signed for non-government entities, do not submit)

Please check if either of the following apply:
- ☑ Proprietary Measure
- ☑ Proprietary Complex Measure w/fees

B. The measure owner/steward verifies there is an identified responsible entity and process to maintain and update the measure on a schedule that is commensurate with the rate of clinical innovation, but at least every 3 years. ☑ Yes (If no, do not submit)

Month and Year of most recent review/update: September 2010
What is the frequency for review/update of this measure? annually
When is the next scheduled review/update for this measure? April 2011
Describe maintenance activity since endorsement (e.g., review of supporting evidence/guidelines, modify specifications, review/update of codes, additional testing, risk adjustment calibration, collecting/monitoring use and performance on the measure):

We have continued to monitor this indicator on an annual basis. We complete a review of ICD-9-CM and MS-DRG coding updates annually and apply changes to the AHRQ Quality Indicator software. Second, we receive feedback from users which aids in refining indicator definitions to improve measure and risk adjustment performance and usability. Finally we update the risk-adjustment and benchmarking parameters annually using the most recent AHRQ and census data.

C. The intended use of the measure includes both public reporting and quality improvement.

Purpose: ☑ Public reporting ☑ Internal quality improvement
☐ Accountability ☐ Accreditation ☐ Payment incentive ☐ Other, describe:
(If not intended for both public reporting and quality improvement, do not submit)

D. The requested measure submission information is complete.

I have checked that the submission is complete and all the information needed to evaluate the measure is provided in the form; any blank fields indicate that no information is provided. ☑ Yes (If not complete, do not submit)

(for NQF staff use) Have all conditions for consideration been met?
Staff Notes (if submission returned):

Met

1. IMPORTANCE TO MEASURE AND REPORT

Extent to which the specific measure focus is important to making significant gains in health care quality (safety, timeliness, effectiveness, efficiency, equity, patient-centeredness) and improving health outcomes for a specific high impact aspect of healthcare where there is variation in or overall poor performance. Measures must be judged to be important to measure and report in order to be evaluated against the remaining criteria.

1a. High Impact

(for NQF staff use) Specific NPP goal: Not related to a specific NPP goal.

Demonstrated high impact aspect of healthcare (Select the most relevant)
- ☑ affects large numbers
- ☑ leading cause of morbidity/mortality
- ☑ severity of illness
- ☐ frequently performed procedure
- ☑ patient/societal consequences of poor quality
- ☐ other, describe:

Summary of Evidence of High Impact: Diabetic ketoacidosis, hyperosmolarity (HHNS), and coma are life-
threatening complications of diabetes mellitus, particularly type 1 or insulin dependent diabetes mellitus (IDDM). Diabetic emergencies arise when there is an excess of glucose or insulin. Often these admissions were due to lack of adherence to insulin treatment. Interventions aimed at improving diabetic glucose control have been shown to reduce hospitalizations.


1b. Opportunity for Improvement

Current Measure Scores (Provide current measure scores and trends related to improvement since last date of endorsement)

Date(s): 2008  Data/Sample: Nationwide Inpatient Sample

Descriptive statistics of measure scores (e.g., distribution by quartile/decile, mean, median, SD, min, max):

Based on the 2008 national statistics for diabetes short-term complications http://hcupnet.ahrq.gov the 2008 rates are as follows:

Overall rate per 100,000: 61.51; Risk adjusted rate: 59.72
Male: 64.76
Female: 58.43

Age groups: 18-39: 75.69; 40-64: 58.73; 65-74: 36.73; 75+: 32.76

If no variation or no overall poor performance across providers, explain why it is important to measure and report:

If no current measure scores, provide evidence that demonstrates a performance gap:

1c. Evidence-Based
Process-Outcome Relationship For non-outcome measures, briefly describe the relationship to desired outcome. For outcomes, describe why it is relevant to the target population: As a prevention quality indicator, short-term diabetes complication rate is not a measure of hospital quality, but rather one measure of outpatient and other health care. Rates of diabetes may vary systematically by area, creating bias for this indicator. Examination of both inpatient and outpatient data may provide a more complete picture of diabetes care.

When was the evidence for this measure last reviewed? 2010

Type of Evidence Check all that apply

- Evidence-based guideline
- Meta-analysis
- Randomized controlled trial
- Cohort study
- Observational study
- Expert opinion
- Systematic synthesis of research

Other (Please describe): Systematic synthesis of research

Summary of Current Evidence as described above for type of measure; for outcomes, summarize any evidence that healthcare services/care processes influence the outcome: Hospital admission for diabetes short-term complications is a PQI that would be of most interest to comprehensive health care delivery systems. Short-term diabetic emergencies arise from the imbalance of glucose and insulin, which can result from deviations in proper care, misadministration of insulin, or failure to follow a proper diet.

Although risk adjustment with age and sex does not impact the relative or absolute performance of areas, this indicator should be risk-adjusted. Some areas may have higher rates of diabetes as a result of racial composition and systematic differences in other risk factors.

Areas with high rates of diabetic emergencies may want to examine education practices, access to care, and other potential causes of non-compliance when interpreting this indicator. Also, areas may consider examining the rates of hyperglycemic versus hypoglycemic events when interpreting this indicator.

Face validity: High-quality outpatient management of patients with diabetes has been shown to lead to reductions in almost all types of serious avoidable hospitalizations. However, tight control may be associated with more episodes of hypoglycemia, which leads to more admissions.

Precision: Based on empirical evidence, this indicator is moderately precise, with a raw area level rate of 36 per 100,000 persons and a standard deviation of 24.6. The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is moderate, at 51.7%, indicating that some of the observed differences in age-sex adjusted rates do not represent true differences in area performance. Using multivariate signal extraction techniques appears to have little additional impact on estimating true differences across areas.

Minimum bias: Minorities have higher rates of diabetes, and higher hospitalization rates may result in areas with higher minority concentrations. Empirical results show that area rankings and absolute performance are not affected by age-sex risk adjustment.

Construct validity: Studies of precipitating events of admission for diabetic emergencies often rely on self-report, which may be a biased measurement in and of itself. The results of one study showed that over 60% of patients with known and treated diabetes had made an error in insulin administration or had omitted insulin. In a potentially under-served population of urban African-Americans, two-thirds of admissions were due to cessation of insulin therapy—over half of the time for financial or other difficulties obtaining insulin.

Bindman reported that an area’s self-rated access to care report explained 46% of the variance in admissions for diabetes, although the analysis was not restricted to diabetic emergencies. Weissman found that uninsured patients had more than twice the risk of admission for diabetic ketoacidosis and coma than privately insured patients.

Wang et al. (2009) modified the denominator to reflect only adults with diabetes to avoid sensitivity to diabetes prevalence in the population to demonstrate that age-adjusted short-term hospitalizations for diabetes fell 15% during 1998-2006 (p = 0.18).

Fosters true quality improvement: Because diabetic emergencies are potentially life-threatening, hospitals...
are unlikely to fail to admit patients requiring hospitalization.

Prior use: Admission for diabetic emergencies was included in both Billings’ and Weissman’s sets of avoidable hospitalization measures. This indicator, defined as a provider-level indicator, was an original HCUP QI

►Rating of evidence: NA  ►Method for rating evidence: NA

►Summary of Controversy/Contradictory Evidence: NA

►Citations for Evidence (other than guideline):

►Quote the Specific guideline recommendation: People with diabetes should receive medical care from a physician-coordinated team. Such teams may include, but are not limited to, physicians, nurse practitioners, physician's assistants, nurses, dietitians, pharmacists, and mental health professionals with expertise and a special interest in diabetes. It is essential in this collaborative and integrated team approach that individuals with diabetes assume an active role in their care. The management plan should be formulated as a collaborative therapeutic alliance among the patient and family, the physician, and other members of the health care team. A variety of strategies and techniques should be used to provide adequate education and development of problem-solving skills in the various aspects of diabetes management. Implementation of the management plan requires that each aspect is understood and agreed on by the patient and the care providers and that the goals and treatment plan are reasonable. Any plan should recognize diabetes self-management education (DSME) and ongoing diabetes support as an integral component of care. In developing the plan, consideration should be given to the patient's age, school or work schedule and conditions, physical activity, eating patterns, social situation and cultural factors, and presence of complications of diabetes or other medical conditions.


►National Guideline Clearinghouse or other URL: 

►Rating of strength of recommendation: B  ►Method for rating strength of recommendation (if different from USPSTF, also describe rating and how it relates to USPSTF): During the comprehensive medical literature review, preference was given to high quality systematic reviews, meta-analyses, and clinical trials over the past ten years, plus existing nationally recognized treatment guidelines from the leading specialty societies.

►Rationale for using this guideline over others: This guideline supports the indicator by providing actionable interventions to improve patient outcomes. The guideline was recently released by a recognized national clinical organization.

Staff Notes to Reviewers:

Reviewers: Was the threshold criterion, Importance to Measure and Report, met?

Rationale:  Y

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# 2. Scientific Acceptability of Measure Properties

Extent to which the measure, as specified, produces consistent (reliable) and credible (valid) results about the quality of care when implemented.

## 2a. Measure Specifications

*In the future, NQF will require measure stewards to provide a URL link to a web page where current detailed specifications can be obtained.*

► Do you have a web page where current detailed measure specifications can be obtained? [ ] No [ ] Yes


### 2a. Precisely Specified

#### Measure Changes

► Were any modifications made to the measure specifications since the last endorsement date? [ ] Yes [ ] No  If yes, briefly identify and provide the rationale:

► If modifications made, are the measure changes likely to result in a substantial change in the current measurement baseline scores? [ ] Yes [ ] No  If yes, please explain:

#### Numerator Statement

*Brief, text description of the numerator - what is being measured about the target population, e.g. target condition, event, or outcome:*

All discharges of age 18 years and older with ICD-9-CM principal diagnosis code for short-term complications (ketoacidosis, hyperosmolarity, coma).

Exclude cases:
- transfer from a hospital (different facility)
- transfer from a Skilled Nursing Facility (SNF) or Intermediate Care Facility (ICF)
- transfer from another health care facility
- MDC 14 (pregnancy, childbirth, and puerperium)

#### Numerator Time Window

*The time period in which cases are eligible for inclusion in the numerator:*

Calendar year

#### Numerator Details

*All information required to collect/calculate the numerator, including all codes, logic, and definitions:*

Include ICD-9-CM diagnosis codes:
- 25010  DM KETO T2, DM CONT
- 25011  DM KETO T1, DM CONT
- 25012  DM KETO T2, DM UNCONT
- 25013  DM KETO T1, DM UNCONT
- 25020  DM W/ HYPROM T2, DM CONT
- 25021  DM W/ HYPROM T1, DM CONT
- 25022  DM W/ HYPROM T2, DM UNCNT
- 25023  DM W/ HYPROM T1, DM UNCNT
- 25030  DM COMA NEC TYP II, DM CNT
- 25031  DM COMA NEC T1, DM CNT
- 25032  DM COMA NEC T2, DM UNCONT
- 25033  DM COMA NEC T1, DM UNCONT

Exclude Cases:
Transfer from a hospital, SNF, ICF or another health care facility:

SID ASORUCE codes:
- 2 - Another hospital
- 3 - Another facility, including long term care
**POINTOFORIGINUB04 Codes:**

4 - Transfer from a hospital
5 - Transfer from a Skilled Nursing Facility (SNF) or Intermediate Care Facility (ICF)
6 - Transfer from another health care facility

**Denominator Statement** *(Brief, text description of the denominator - target population being measured):*

Population in Metropolitan Statistical Area or County, age 18 years and older.

**Target population gender:** ☑ Male ☑ Female  
**Target population age range:** 18 and older

**Denominator Time Window** *(The time period in which cases are eligible for inclusion in the denominator):*

Time window is a single point in time (July 1 of calendar year).

**Denominator Details** *(All information required to collect/calculate the denominator - the target population being measured - including all codes, logic, and definitions):*

Population in Metropolitan Statistical Area or County, age 18 years and older.

**Denominator Exclusions** *(Brief text description of exclusions from the target population):*

Under age 18.

**Denominator Exclusion Details** *(All information required to collect exclusions to the denominator, including all codes, logic, and definitions):*

**Stratification Details/Variables** *(All information required to stratify the measure including the stratification variables, all codes, logic, and definitions):*

Observed (raw) rates may be stratified by areas, age groups, race/ethnicity categories and sex. Risk adjustment of the data is recommended using age and sex. Reliability adjustment is also recommended.

**Risk Adjustment Type:** ☑ No risk adjustment necessary  ☑ analysis by subgroup  ☑ case-mix adjustment  ☑ paired data at patient level  ☑ risk-adjustment devised specifically for this measure/condition  ☑ risk adjustment method widely or commercially available  ☑ Other (specify)

**Risk Adjustment Methodology/Variables** *(List risk adjustment variables and describe conceptual models, statistical models, or other aspects of model or method):*

The predicted value for each case is computed using standard logistic regression and covariates for gender and age (in 5-year age groups). (There is also an optional model that includes an adjustment for area-level SES based on the percent of the population under the Federal poverty level). The reference population used in the regression is the universe of discharges for states that participate in the HCUP State Inpatient Databases (SID) for the year 2007, a database consisting of approximately 35 million discharges from 43 states. The expected rate is computed as the sum of the predicted value for each case divided by the number of cases for the unit of analysis of interest (i.e., county or state). The risk adjusted rate is computed using indirect standardization as the observed rate divided by the expected rate, multiplied by the reference population rate.

**Detailed risk model attached** ☑ OR at web page URL:


**Type of Score:** Rate/proportion  
**If “Other”, please describe:**

**Interpretation of Score** *(Classifies interpretation of score according to whether better quality is associated with a higher score, a lower score, a score falling within a defined interval, or a passing score)*

Better quality = Lower score  
**If “Other”, please describe:**

**Calculation Algorithm** *(Describe the calculation of the measure as a flowchart or series of steps):*

Each Prevention Quality Indicator (PQI) expressed as a rate, is defined as outcome of interest/population at risk or numerator/denominator. The Quality Indicators software performs five steps to produce the PQI rates. 1) Discharge-level data is used to mark inpatient records containing outcomes of interest. 2) Identify
For provider PQIs, such as short-term complications from diabetes, populations at risk are derived from hospital discharge records. 3) Calculate observed rates. Using output data from steps 1 and 2, PQI rates are calculated for user-specified combinations of stratifiers. 4) Risk adjust the PQI rates. Regression coefficients from a reference population database are applied to the observed rates in the risk-adjustment process. The risk-adjusted rates will then reflect the age and sex distribution of data in the reference population. 5) Create multivariate signal extraction (MSX) smoothed rates. Shrinkage factors are applied to the risk-adjusted rates for each PQI in the MSX process. For each PQI, the shrinkage estimate reflects a reliability adjustment unique to each indicator. Full information on PQI algorithms and specification can be found at http://qualityindicators.ahrq.gov/pqi_download.htm.

Describe the method for discriminating performance (e.g., significance testing):
Significance testing is not prescribed by the software. Users may define their methods of discriminating performance according to their application. Although all cases are measured, the rate is considered a sample in time, given the variations in case mix over time. Confidence intervals can be calculated, but again are not prescribed.

Sampling (Survey) Methodology If measure is based on a sample (or survey), provide instructions for obtaining the sample, conducting the survey and guidance on minimum sample size (response rate):
The application of this indicator uses administrative data.

Data Source Check the source(s) for which the measure is specified and tested.
- Electronic administrative data/claims
- Electronic Health/Medical Record
- Electronic Clinical Data (e.g., MDS)
- Registry data (or database)
- Lab data
- Pharmacy data
- Paper Medical Record/flowsheet
- Survey-patient (e.g., CAHPS)
- Survey-provider
- Documentation of original self-assessment (e.g., SF-36)
- Management data
- Public health data/vital statistics
- Special or unique data, specify:

Identify the specific data source/data collection instrument (e.g. name of database, clinical registry, collection instrument, etc.); include Web page URL where available: Hospital administrative discharge data. See data requirements in the AHRQ QI Windows Application Documentation: http://www.qualityindicators.ahrq.gov/software.htm

Data dictionary/code table attached OR at web page URL:

Level of Measurement/Analysis (For what entity will the scores be computed?)
Check the level(s) for which the measure is specified and tested.
- Clinician: Individual Group Other
- Facility/Agency (e.g., hospital, nursing home)
- Multi-site/corporate chain
- Integrated delivery system
- Health plan
- Prescription drug plan
- Program: Disease management QIO Other
- Other
- Population: National Regional/network State Counties/Cities Other (Please describe):
- All levels

Applicable Care Settings
Check the setting(s) for which the measure is specified and tested.
Ambulatory Care: Amb Surgery Center Office Clinic Emergency Dept Hospital Outpatient
- Assisted Living
- Behavioral health/psychiatric unit
- Dialysis Facility
- Emergency medical services/ambulance
- Group Home
- Home Hospice
- Hospital
- Long term acute care hospital
- Nursing home/ Skilled Nursing Facility (SNF)
- Rehabilitation Facility
- Other (Please describe): This indicator uses hospital data to examine ambulatory care and access.
- Unspecified or “not applicable”
- All settings

Clinical Services (Healthcare services being measured)
Check the service(s) for which the measure is specified and tested.

### Clinicians:
- Physicians (MD/DO)
- Nurses
- PA/NP/Advanced Practice Nurse
- Chiropractor
- PT/OT/Speech
- Respiratory Therapy
- Dietician/Nutritional professional
- Dentist/Oral surgeon
- Psychologist/LCSW
- Audiologist
- Podiatrist
- Optometrist
- Pharmacist
- Other

### Behavioral Health:
- Mental health
- Substance use treatment
- Other
- Dialysis
- Hospice/Palliative care
- Laboratory
- Imaging services
- Home health
- Other

### TESTING/ANALYSIS

Extent to which the measure, as specified, produces consistent (reliable) and credible (valid) results about the quality of care when implemented.

#### 2b.-2e., 2f. Testing

> Have you conducted any testing of measure properties (e.g., reliability, validity, exclusions, disparities, comparability of data sources, risk adjustment) since last endorsement date? [ ] Yes [ ] No

> If yes, provide information on date, data/sample, type of testing, and results (for each area of testing): *We conduct ongoing measure maintenance including a review of the reference population and re-estimation of the risk adjustment model and reliability statistics annually. A link to the most current risk adjustment model is included and discussed in section 2a.*

#### 2f. Identification of Meaningful Differences in Performance

> Describe identification of statistically significant and practically/clinically meaningful differences in performance scores identified in 1b (e.g., differences from a reference such as state or national average or criterion value):

Males have a higher diabetes short-term complications rate than females (64.76 vs. 58.43 per 100,000) and the diabetes short-term complications rate decreases with age with 18-39 year olds having the highest rate (18-39: 75.69; 40-64: 58.73; 65-74: 3.6.73; 75+: 32.76).

Reference: 2008 Nationwide Inpatient Sample


### Staff Notes to Reviewers:

**Reviewers:** Overall, to what extent was the criterion, *Scientific Acceptability of Measure Properties*, met?

**Rationale:**

### 3. USABILITY

Extent to which intended audiences (e.g., consumers, purchasers, providers, policy makers) can understand the results of the measure and are likely to find them useful for decision making.

#### 3a. Meaningful, understandable, and useful information

> Is the measure currently in use? [ ] Yes [ ] No

> If used in a public reporting initiative, Name of initiative(s), locations, Web page URL(s): Hundreds of
users have downloaded AHRQ Quality Indicators software. The following is a sampling of public reports that use the measure:
Nevada Compare Care, Nevada, http://www.nevadacomparecare.net/monahrq/home.html

► If used in other programs/initiatives (e.g., quality improvement), Name of initiative(s), locations, Web page URL(s): The software is publically available and free of charge (http://www.qualityindicators.ahrq.gov/). Users apply the software to their own administrative data (UB-04 or claims) that is readily available. Hundreds of users have downloaded AHRQ Quality Indicators software.

► If not in current use or use is unknown, provide rationale why continued endorsement should be considered:

► What might be the practical impact of ending NQF endorsement for the measure? NQF endorsement increases users confidence in the reliability and validity of using this measure to assess healthcare delivery quality.

► Testing of Interpretability Have you conducted any testing of interpretability of measure results for public reporting and/or quality improvement since endorsement? ☐ Yes ☒ No If yes, provide information on date, data/sample, type of testing, and results:

3b/3c. Relation to other NQF-endorsed measures

► Are there similar or related NQF-endorsed measures? (search here): ☐ Other measures for same target population ☐ Other measures on same topic ☒ No similar measures

► NQF # and Title of similar or related measures:

3b. Harmonization
If this measure is related to measure(s) already endorsed by NQF (e.g., same topic, but different target population/setting/data source or different topic but same target population):

► Are the measure specifications harmonized, or if not, why?

3c. Distinctive or Additive Value
If this measure is similar to measure(s) already endorsed by NQF (i.e., on the same topic and the same target population):

► Describe the distinctive, improved, or additive value this measure provides to existing NQF-endorsed measures:

Staff Notes to Reviewers (including additions/changes to related or similar measures):

Reviewers: Overall, to what extent was the criterion, Usability, met? Rationale:
Extent to which the required data are readily available, retrievable without undue burden, and can be implemented for performance measurement.

4b. Electronic Sources  
(Note: Measure stewards will be asked to specify the data elements for electronic health records at a later date)

- Are all the data elements available electronically? (elements that are needed to compute measure scores entered directly into defined, computer-readable fields e.g., electronic health record electronic claims)  Yes  ☐ No
- If not, specify the near-term path to achieve electronic capture by most providers.

4d. Susceptibility to inaccuracies, errors, or unintended consequences

- Have any inaccuracies, errors, and/or unintended consequences been identified? (include any susceptibility to problems due to any changes to the measure specifications)  ☐ Yes  ☐ No
- If yes, describe the problem and any modifications or actions taken:

Wang et al. (2010) observe that the denominator is sensitive to variations in diabetes prevalence and thus are not ideal for examining changes in access to and quality of ambulatory care for individuals with diabetes.


4e. Implementation

- Have you obtained any information on implementation issues? (e.g., through audits, user groups, individual requests)  ☐ Yes  ☐ No
- Have any problems with data collection (e.g., cost/burden, timing/frequency, availability of data/missing data, patient confidentiality, etc.) been identified?  ☐ Yes  ☐ No
- If yes, describe the problem and any modifications or actions taken:

Staff Notes to Reviewers:

Reviewers: Overall, to what extent was the criterion, Feasibility, met?  
Rationale:

Reviewers: Overall, to what extent are all the criteria met?  
Rationale:

Recommendation: Continue Endorsement  ☐  Do not continue endorsement  ☐

CONTACT INFORMATION

Measure Steward (Intellectual Property Owner)
Organization: Agency for Healthcare Research and Quality  
Street Address: 540 Gaither Road  City: Rockville  State: MD  ZIP: 20850

Point of Contact: First Name: John  MI:  Last Name: Bott  Credentials (MD, MPH, etc.): MSSW, MBA  
Email: john.bott@ahrq.hhs.gov  Telephone: 301-427-1317 ext:

Other Organizations:
<table>
<thead>
<tr>
<th>Copyright statement/disclaimers:</th>
<th>The AHRQ QI software is publicly available. We have no copyright disclaimers.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional Information:</td>
<td></td>
</tr>
<tr>
<td>Date of Submission (MM/DD/YY):</td>
<td>10/29/10</td>
</tr>
</tbody>
</table>
The National Quality Forum

Measure Maintenance Submission & Evaluation Form
Version 4.0 August 2009

This form will be used by stewards to submit measure information and by reviewers to evaluate the measures.

Measure Stewards: Complete all non-shaded areas of the form. All requested information should be entered directly into this form. The information requested is directly related to NQF’s measure evaluation criteria and will be used by reviewers to determine if the evaluation criteria have been met. The specific relevant subcriteria language is provided in a Word comment within the form and will appear if your cursor is over the highlighted area.

The measure steward has the opportunity to identify and present the information that demonstrates the measure meets the criteria. Additional materials will only be considered supplemental. Do not rely solely on materials provided at URLs or in attached documents to provide measure specifications or to demonstrate meeting the criteria. If supplemental materials are provided, be sure to indicate specific page numbers/web page locations for the relevant information.

Reviewers: Complete all yellow highlighted areas of the form. Evaluate the extent to which each subcriterion is met and then overall, the extent to which each major criterion is met. Provide the rationale for your rating.

Evaluation ratings of the extent to which the criteria are met:
H=High (unquestionably demonstrated to meet the criterion)
M=Moderate (demonstrated to moderately meet the criterion)
L=Low (addressed BUT demonstrated to only minimally meet the criterion)
N=No (NOT addressed; OR incorrectly addressed; OR demonstrated to NOT meet the criterion)
NA=Not applicable (only an option for a few subcriteria as indicated)

Date of Last Endorsement Action: November 15, 2007

MEASURE DESCRIPTIVE INFORMATION

NQF# 0274 Title of Measure: Diabetes Long-term Complications Admission Rate (PQI 3)

Brief description of measure (including type of score, measure focus, target population, e.g., Percentage of adult patients aged 18-75 years receiving one or more HbA1c tests per year):
This measure is used to assess the number of admissions for diabetes long-term complications per 100,000 persons.

Select the most relevant priority area(s), quality domain(s), and consumer need(s).

National Priority Partners Priority Area
- patient and family engagement
- population health
- safety
- care coordination
- palliative and end of life care
- overuse

IOM Quality Domain
- effectiveness
- efficiency
- equity
- patient-centered
- safety
- timeliness

Consumer Care Need
- Getting Better
- Living With Illness
- Staying Healthy

CONDITIONS FOR CONSIDERATION BY NQF

Four conditions must be met before proposed measures may be considered and evaluated for suitability as voluntary consensus standards:

A. The measure is in the public domain or an intellectual property agreement (measure steward agreement) is signed. Public domain only applies to governmental organizations. All non-governmental organizations must sign a measure steward agreement even if measures are made publicly and freely available.
Do you attest that the measure steward holds intellectual property rights to the measure and the right to use any aspects of the measure owned by another entity (e.g., risk model, code set)? □ Yes □ No

Measure Steward Agreement (updated Nov 08)
□ Signed and Submitted OR □ Government entity-public domain
(If measure steward agreement not signed for non-government entities, do not submit)

Please check if either of the following apply:
□ Proprietary Measure □ Proprietary Complex Measure w/fees

The measure owner/steward verifies there is an identified responsible entity and process to maintain and update the measure on a schedule that is commensurate with the rate of clinical innovation, but at least every 3 years. □ Yes □ No

Month and Year of most recent review/update: September 2010
What is the frequency for review/update of this measure? □ Annually
When is the next scheduled review/update for this measure? □ April 2011
Describe maintenance activity since endorsement (e.g., review of supporting evidence/guidelines, modify specifications, review/update of codes, additional testing, risk adjustment calibration, collecting/monitoring use and performance on the measure):
We have continued to monitor this indicator on an annual basis. We complete a review of ICD-9-CM and MS-DRG coding updates annually and apply changes to the AHRQ Quality Indicator software. Second, we receive feedback from users which aids in refining indicator definitions to improve measure and risk adjustment performance and usability. Finally we update the risk-adjustment and benchmarking parameters annually using the most recent AHRQ and census data.

The intended use of the measure includes both public reporting and quality improvement.

Purpose: □ Public reporting □ Internal quality improvement
□ Accountability □ Accreditation □ Payment incentive □ Other, describe:
(If not intended for both public reporting and quality improvement, do not submit)

The requested measure submission information is complete.

I have checked that the submission is complete and all the information needed to evaluate the measure is provided in the form; any blank fields indicate that no information is provided. □ Yes □ No

(For NQF staff use) Have all conditions for consideration been met?
Staff Notes (if submission returned):

1. IMPORTANCE TO MEASURE AND REPORT

Extent to which the specific measure focus is important to making significant gains in health care quality (safety, timeliness, effectiveness, efficiency, equity, patient-centeredness) and improving health outcomes for a specific high impact aspect of healthcare where there is variation in or overall poor performance. Measures must be judged to be important to measure and report in order to be evaluated against the remaining criteria.

1a. High Impact

(for NQF staff use) Specific NPP goal: Not related to a specific NPP goal.

Demonstrated high impact aspect of healthcare (Select the most relevant)
□ affects large numbers □ leading cause of morbidity/mortality □ severity of illness
□ frequently performed procedure □ patient/societal consequences of poor quality
□ other, describe:

Summary of Evidence of High Impact: Several observational studies have linked improved glycemic
control to substantially lower risks of developing complications in both Type 1 and Type 2 diabetes. Given that appropriate adherence to therapy and consistent monitoring of glycemic control help to prevent complications, high-quality outpatient care should lower long-term complications rates.


1b. Opportunity for Improvement

►Current Measure Scores (Provide current measure scores and trends related to improvement since last date of endorsement)
Date(s): 2008 Data/Sample: Nationwide Inpatient Sample

►Descriptive statistics of measure scores (e.g., distribution by quartile/decile, mean, median, SD, min, max):
Based on the 2008 national statistics for diabetes long-term complications (http://hcupnet.ahrq.gov)
The 2008 rates are as follows:
Overall rate per 100,000: 128.21; Risk adjusted rate: 123.66
Male: 138.06
Female: 118.87

Age groups: 18-39: 33.11; 40-64: 138.63; 65-74: 290.83; 75+: 368.45

►If no variation or no overall poor performance across providers, explain why it is important to measure and report:

►If no current measure scores, provide evidence that demonstrates a performance gap:

1c. Evidence-Based

►Process-Outcome Relationship For non-outcome measures, briefly describe the relationship to desired
outcome. For outcomes, describe why it is relevant to the target population: As a prevention quality indicator, long-term diabetes complication rate is not a measure of hospital quality, but rather one measure of outpatient and other health care. Rates of diabetes may vary systematically by area, creating bias for this indicator. Examination of both inpatient and outpatient data may provide a more complete picture of diabetes care.

► When was the evidence for this measure last reviewed? 2010

► Type of Evidence  Check all that apply
- Evidence-based guideline
- Meta-analysis
- Randomized controlled trial
- Cohort study
- Observational study
- Expert opinion
- Systematic synthesis of research
- Other (Please describe):

► Summary of Current Evidence as described above for type of measure; for outcomes, summarize any evidence that healthcare services/care processes influence the outcome): Hospital admission for diabetes long-term complications is a PQI that would be of most interest to comprehensive health care delivery systems. Long-term diabetes complications are thought to arise from sustained long-term poor control of diabetes. Intensive treatment programs have been shown to decrease the incidence of long-term complications in both Type 1 and Type 2 diabetes.

Sociodemographic characteristics of the population, such as race, may bias the indicator, since Native Americans and Hispanic Americans have higher rates of diabetes and poorer glycemic control. The importance of these factors as they relate to admission rates is unknown. Risk adjustment for observable characteristics, such as racial composition of the population, is recommended.

It is unclear whether poor glycemic control arises from poor quality medical care, non-compliance of patients, lack of education, or access to care problems. Areas with high rates may wish to examine these factors when interpreting this indicator.

Face validity: Several observational studies have linked improved glycemic control to substantially lower risks of developing complications in both Type 1 and Type 2 diabetes (Gaster & Hirsch, 1998). Given that appropriate adherence to therapy and consistent monitoring of glycemic control help to prevent complications, high-quality outpatient care should lower long-term complication rates. However, adherence to guidelines aimed at reducing complications (including eye and foot examinations and diabetic education) has been described as modest, with only one-third of patients receiving all essential services.

Precision: Diabetes affects a large number of people, as do diabetic complications. However, few studies have documented hospitalization rates for diabetic complications and the extent to which they vary across areas. Based on empirical evidence, this indicator is moderately precise, with a raw area level rate of 80.8 per 100,000 population and a standard deviation of 58.1. The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is high, at 75.6%, indicating that the observed differences in age-sex adjusted rates likely represent true differences across areas.

Minimum bias: Rates of diabetes are higher in black, Hispanic, and especially Native American populations than in other ethnic groups. Hyperglycemia appears to be particularly frequent among Hispanic and Native American populations (Harris, 1998). The duration of diabetes is positively associated with the development of complications. Empirical results show that area rankings and absolute performance are moderately affected by age-sex risk adjustment.

Construct validity: Compliance of physicians and patients is essential to achieve good outcomes, and it seems likely that problems with both access to and quality of care, as well as patient compliance, may contribute to the occurrence of complications. Based on empirical results, areas with high rates of diabetes long-term complications also tend to have high rates of admission for other ACSCs.

Wang et al. (2009) modified the denominator to reflect only adults with diabetes to avoid sensitivity to diabetes prevalence in the population to demonstrate that age-adjusted preventable hospitalization for long-term diabetes complications fell 23% during 1998-2006 (p < 0.01).
Fosters true quality improvement: Providers may decrease admission rates by failing to hospitalize patients who would truly benefit from inpatient care. No published evidence indicates that worse health outcomes are associated with reduced hospitalization rates for long-term complications of diabetes.

Prior use: This indicator, defined as a hospital-level indicator, is an original HCUP QI.

► Rating of evidence: NA 
► Method for rating evidence: NA

► Summary of Controversy/Contradictory Evidence: NA

► Citations for Evidence (other than guideline):

► Quote the Specific guideline recommendation: People with diabetes should receive medical care from a physician-coordinated team. Such teams may include, but are not limited to, physicians, nurse practitioners, physician's assistants, nurses, dietitians, pharmacists, and mental health professionals with expertise and a special interest in diabetes. It is essential in this collaborative and integrated team approach that individuals with diabetes assume an active role in their care. The management plan should be formulated as a collaborative therapeutic alliance among the patient and family, the physician, and other members of the health care team. A variety of strategies and techniques should be used to provide adequate education and development of problem-solving skills in the various aspects of diabetes management. Implementation of the management plan requires that each aspect is understood and agreed on by the patient and the care providers and that the goals and treatment plan are reasonable. Any plan should recognize diabetes self-management education (DSME) and ongoing diabetes support as an integral component of care. In developing the plan, consideration should be given to the patient's age, school or work schedule and conditions, physical activity, eating patterns, social situation and cultural factors, and presence of complications of diabetes or other medical conditions.


► Rating of strength of recommendation: B 
► Method for rating strength of recommendation (if different from USPSTF, also describe rating and how it relates to USPSTF): During the comprehensive medical literature review, preference was given to high quality systematic reviews, meta-analyses, and clinical trials over the past ten years, plus existing nationally recognized treatment guidelines from the leading specialty societies.

► Rationale for using this guideline over others: This guideline supports the indicator by providing actionable interventions to improve patient outcomes. The guideline was recently released by a recognized national clinical organization.

Staff Notes to Reviewers:

Reviewers: Was the threshold criterion, Importance to Measure and Report, met?
Rationale: 1 Y 0 N
## 2. SCIENTIFIC ACCEPTABILITY OF MEASURE PROPERTIES

Extent to which the measure, as specified, produces consistent (reliable) and credible (valid) results about the quality of care when implemented.

### 2a. MEASURE SPECIFICATIONS

In the future, NQF will require measure stewards to provide a URL link to a web page where current detailed specifications can be obtained.

- **Do you have a web page where current detailed measure specifications can be obtained?**  
  - [ ] No  
  - [x] Yes

  **If yes, provide Web page URL:**
  
  ![URL](http://www.qualityindicators.ahrq.gov/downloads/pqi/TechSpecs42/PQI%2003%20Diabetes%20Long-term%20Complications%20Admission%20Rate.pdf)

#### 2a. Precisely Specified

**Measure Changes**

- **Were any modifications made to the measure specifications since the last endorsement date?**  
  - [ ] Yes  
  - [ ] No

  **If yes, briefly identify and provide the rationale:**

- **If modifications made, are the measure changes likely to result in a substantial change in the current measurement baseline scores?**  
  - [ ] Yes  
  - [ ] No

  **If yes, please explain:**

- **Numerator Statement (Brief, text description of the numerator - what is being measured about the target population, e.g. target condition, event, or outcome):**

  All discharges age 18 years and older with ICD-9-CM principal diagnosis code for long-term complications (renal, eye, neurological, circulatory, or complications not otherwise specified).

  **Exclude cases:**
  
  - transfer from a hospital (different facility)
  - transfer from a skilled Nursing Facility (SNF) or Intermediate Care Facility (ICF)
  - transfer from another health care facility
  - MDC 14 (pregnancy, childbirth, and puerperium)

- **Numerator Time Window (The time period in which cases are eligible for inclusion in the numerator):**

  Time window is a calendar year.

- **Numerator Details (All information required to collect/calculate the numerator, including all codes, logic, and definitions):**

  Include ICD-9-CM diagnosis codes:
  
  25040 DM RENAL COMP T2 CONT
  25041 DM RENAL COMP T1 CONT
  25042 DM RENAL COMP T2 UNCNT
  25043 DM RENAL COMP T1 UNCNT
  25050 DM EYE COMP T2 CONT
  25051 DM EYE COMP T1 CONT
  25052 DM EYE COMP T2 UNCNT
  25053 DM EYE COMP T1 UNCNT
  25060 DM NEURO COMP T2 CONT
  25061 DM NEURO COMP T1 CONT
  25062 DM NEURO COMP T2 UNCNT
  25063 DM NEURO COMP T1 UNCNT
  25070 DM CIRCU DIS T2 CONT
  25071 DM CIRCU DIS T1 CONT
  25072 DM CIRCU DIS T2 UNCNT
  25073 DM CIRCU DIS T1 UNCNT
  25080 DM W COMP NEC T2 CONT
Exclude cases:
Transfer from a hospital, SNF, ICF or another health care facility:

SID ASORUCE codes:
2 - Another hospital
3 - Another facility, including long term care

POINTOFORIGINUB04 Codes:
4 - Transfer from a hospital
5 - Transfer from a Skilled Nursing Facility (SNF) or Intermediate Care Facility (ICF)
6 - Transfer from another health care facility

Denominator Statement (*Brief, text description of the denominator - target population being measured*):
Population in Metropolitan Statistical Area or County, age 18 years and older.

Target population gender: ☑ Male ☑ Female Target population age range: 18 and older

Denominator Time Window (*The time period in which cases are eligible for inclusion in the denominator*):
Time window is a single point in time (July 1 of calendar year).

Denominator Details (*All information required to collect/calculate the denominator - the target population being measured - including all codes, logic, and definitions*):
Population in Metropolitan Statistical Area or County, age 18 years and older.

Denominator Exclusions (*Brief text description of exclusions from the target population*):
Under age 18.

Denominator Exclusion Details (*All information required to collect exclusions to the denominator, including all codes, logic, and definitions*):

Stratification Details/Variables (*All information required to stratify the measure including the stratification variables, all codes, logic, and definitions*):
Observed (raw) rates may be stratified by areas, age groups, race/ethnicity categories and sex. Risk adjustment of the data is recommended using age and sex. Reliability adjustment is also recommended.

Risk Adjustment Type: ☐ No risk adjustment necessary ☑ analysis by subgroup ☑ case-mix adjustment ☑ paired data at patient level ☑ risk-adjustment devised specifically for this measure/condition ☑ risk adjustment method widely or commercially available ☐ Other (specify)

Risk Adjustment Methodology/Variables (*List risk adjustment variables and describe conceptual models, statistical models, or other aspects of model or method*):
The predicted value for each case is computed using standard logistic regression and covariates for gender and age (in 5-year age groups). (There is also an optional model that includes an adjustment for area-level SES based on the percent of the population under the Federal poverty level). The reference population used in the regression is the universe of discharges for states that participate in the HCUP State Inpatient Databases (SID) for the year 2007, a database consisting of approximately 35 million discharges from 43 states. The expected rate is computed as the sum of the predicted value for each case divided by the number of cases for the unit of analysis of interest (i.e., county or state). The risk adjusted rate is computed using indirect standardization as the observed rate divided by the expected rate, multiplied by the reference population rate.
NQF #

- Detailed risk model attached [ ] OR at web page URL:

- Type of Score: Rate/proportion ▶ If “Other”, please describe:

- Interpretation of Score (Classifies interpretation of score according to whether better quality is associated with a higher score, a lower score, a score falling within a defined interval, or a passing score)
  Better quality = Lower score ▶ If “Other”, please describe:

- Calculation Algorithm (Describe the calculation of the measure as a flowchart or series of steps):
  Each Prevention Quality Indicator (PQI) expressed as a rate, is defined as outcome of interest/population at risk or numerator/denominator. The Quality Indicators software performs five steps to produce the PQI rates.
  1) Discharge-level data is used to mark inpatient records containing outcomes of interest.
  2) Identify populations at risk. For provider PQIs, such as short-term complications from diabetes, populations at risk are derived from hospital discharge records.
  3) Calculate observed rates. Using output data from steps 1 and 2, PQI rates are calculated for user-specified combinations of stratifiers.
  4) Risk adjust the PQI rates. Regression coefficients from a reference population database are applied to the observed rates in the risk-adjustment process. The risk-adjusted rates will then reflect the age and sex distribution of data in the reference population.
  5) Create multivariate signal extraction (MSX) smoothed rates. Shrinkage factors are applied to the risk-adjusted rates for each PQI in the MSX process. For each PQI, the shrinkage estimate reflects a reliability adjustment unique to each indicator. Full information on PQI algorithms and specification can be found at http://qualityindicators.ahrq.gov/pqi_download.htm.

- Describe the method for discriminating performance (e.g., significance testing):
  Significance testing is not prescribed by the software. Users may define their methods of discriminating performance according to their application. Although all cases are measured, the rate is considered a sample in time, given the variations in case mix over time. Confidence intervals can be calculated, but again are not prescribed.

- Sampling (Survey) Methodology If measure is based on a sample (or survey), provide instructions for obtaining the sample, conducting the survey and guidance on minimum sample size (response rate):
  The application of this indicator uses administrative data.

- Data Source Check the source(s) for which the measure is specified and tested.
  - Electronic administrative data/claims
  - Electronic Health/Medical Record
  - Electronic Clinical Data (e.g., MDS)
  - Registry data (or database)
  - Lab data
  - Pharmacy data
  - Paper Medical Record/flowsheet
  - Survey-patient (e.g., CAHPS)
  - Survey-provider
  - Documentation of original self-assessment (e.g., SF-36)
  - Management data
  - Public health data/vital statistics
  - Special or unique data, specify:

- Identify the specific data source/data collection instrument (e.g. name of database, clinical registry, collection instrument, etc.); include Web page URL where available: Hospital administrative discharge data. See data requirements in the AHRQ QI Windows Application Documentation:
  http://www.qualityindicators.ahrq.gov/software.htm

- Data dictionary/code table attached [ ] OR at web page URL:

- Level of Measurement/Analysis (For what entity will the scores be computed?)
  Check the level(s) for which the measure is specified and tested.
  - Clinician: [ ] Individual  [ ] Group  [ ] Other
    Facility/Agency (e.g., hospital, nursing home)
    Multi-site/corporate chain
    Integrated delivery system
    Health plan
    Prescription drug plan
  - Program: [ ] Disease management  [ ] QIO  [ ] Other
    [ ] All levels

- Applicable Care Settings
Check the setting(s) for which the measure is specified and tested.

**Ambulatory Care:**

- [ ] Assisted Living
- [ ] Behavioral health/psychiatric unit
- [ ] Dialysis Facility
- [ ] Emergency medical services/ambulance
- [ ] Group Home
- [ ] Home
- [ ] Hospice
- [ ] Ambulatory Surgery Center
- [ ] Clinic
- [ ] Emergency Dept
- [ ] Hospital Outpatient
- [ ] Hospital
- [ ] Long term acute care hospital
- [ ] Nursing home/ Skilled Nursing Facility (SNF)
- [ ] Rehabilitation Facility
- [ ] Other (Please describe): This indicator utilizes hospital data to examine ambulatory care and access.
- [ ] Unspecified or “not applicable”
- [ ] All settings

**Clinical Services (Healthcare services being measured)**

Check the service(s) for which the measure is specified and tested.

**Clinicians:**

- [ ] Physicians (MD/DO)
- [ ] Nurses
- [ ] PA/NP/Advanced Practice Nurse
- [ ] Chiropractor
- [ ] PT/OT/ Speech
- [ ] Respiratory Therapy
- [ ] Dietician/Nutritional professional
- [ ] Dentist/Oral surgeon
- [ ] Psychologist/LCSW
- [ ] Audiologist
- [ ] Podiatrist
- [ ] Optometrist
- [ ] Pharmacist
- [ ] Other

**Behavioral Health:**

- [ ] Mental health
- [ ] Substance use treatment
- [ ] Other
- [ ] Dialysis
- [ ] Hospice/Palliative care
- [ ] Laboratory
- [ ] Imaging services
- [ ] Home health
- [ ] Other

### TESTING/ANALYSIS

Extent to which the measure, as specified, produces consistent (reliable) and credible (valid) results about the quality of care when implemented.

2b.-2e., 2f. Testing

► Have you conducted any testing of measure properties (e.g., reliability, validity, exclusions, disparities, comparability of data sources, risk adjustment) since last endorsement date?  
- [ ] Yes
- [ ] No

► If yes, provide information on date, data/sample, type of testing, and results (for each area of testing): We conduct ongoing measure maintenance including a review of the reference population and re-estimation of the risk adjustment model and reliability statistics annually. A link to the most current risk adjustment model is included and discussed in section 2a.

2f. Identification of Meaningful Differences in Performance

► Describe identification of statistically significant and practically/clinically meaningful differences in performance scores identified in 1b (e.g., differences from a reference such as state or national average or criterion value):

Males have higher rates (138.06/100,000) than females (118.87/100,000) and the rates increase dramatically with age: 18-39: 33.11; 40-64: 138.63; 65-74: 290.83; 75+: 368.45.

► Supplemental testing information attached [ ] OR at web page URL:


Staff Notes to Reviewers:

Reviewers: Overall, to what extent was the criterion, Scientific Acceptability of Measure Properties, met?  
Rationale:
### 3. Usability

Extent to which intended audiences (e.g., consumers, purchasers, providers, policy makers) can understand the results of the measure and are likely to find them useful for decision making.

<table>
<thead>
<tr>
<th>3a. Meaningful, understandable, and useful information</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶ Is the measure currently in use? ☒ Yes ☐ No</td>
</tr>
<tr>
<td>▶ If used in other programs/initiatives (e.g., quality improvement), Name of initiative(s), locations, Web page URL(s): The software is publically available and free of charge (<a href="http://www.qualityindicators.ahrq.gov/">http://www.qualityindicators.ahrq.gov/</a>). Users apply the software to their own administrative data (UB-04 or claims) that is readily available. Hundreds of users have downloaded AHRQ Quality Indicators software.</td>
</tr>
<tr>
<td>▶ If not in current use or use is unknown, provide rationale why continued endorsement should be considered:</td>
</tr>
<tr>
<td>▶ What might be the practical impact of ending NQF endorsement for the measure? NQF endorsement increases users confidence in the reliability and validity of using this measure to assess healthcare delivery quality.</td>
</tr>
<tr>
<td>▶ Testing of Interpretability Have you conducted any testing of interpretability of measure results for public reporting and/or quality improvement since endorsement? ☐ Yes ☒ No If yes, provide information on date, data/sample, type of testing, and results:</td>
</tr>
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### 3b/3c. Relation to other NQF-endorsed measures

<table>
<thead>
<tr>
<th>3b. Harmonization</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶ Are there similar or related NQF-endorsed measures? (search here): ☐ Other measures for same target population ☐ Other measures on same topic ☒ No similar measures</td>
</tr>
<tr>
<td>▶ NQF # and Title of similar or related measures:</td>
</tr>
</tbody>
</table>

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<tr>
<th>3c. Distinctive or Additive Value</th>
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<tbody>
<tr>
<td>▶ Are the measure specifications harmonized, or if not, why?</td>
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<table>
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<tr>
<th>3c. Distinctive or Additive Value</th>
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</thead>
<tbody>
<tr>
<td>▶ Describe the distinctive, improved, or additive value this measure provides to existing NQF-endorsed measures:</td>
</tr>
</tbody>
</table>
Staff Notes to Reviewers (including additions/changes to related or similar measures):

Reviewers: Overall, to what extent was the criterion, **Usability**, met?
Rationale:

![3](H) ![H](M) ![M](L) ![N](N)

### 4. FEASIBILITY

Extent to which the required data are readily available, retrievable without undue burden, and can be implemented for performance measurement.

#### 4b. Electronic Sources  *(Note: Measure stewards will be asked to specify the data elements for electronic health records at a later date)*

- Are all the data elements available electronically? *(elements that are needed to compute measure scores entered directly into defined, computer-readable fields e.g., electronic health record electronic claims)* □ Yes □ No
- If not, specify the near-term path to achieve electronic capture by most providers.

#### 4d. Susceptibility to inaccuracies, errors, or unintended consequences

- Have any inaccuracies, errors, and/or unintended consequences been identified? *(include any susceptibility to problems due to any changes to the measure specifications)* □ Yes □ No

If yes, describe the problem and any modifications or actions taken:

Wang et al. (2010) observe that the denominator is sensitive to variations in diabetes prevalence and thus are not ideal for examining changes in access to and quality of ambulatory care for individuals with diabetes.


#### 4e. Implementation

- Have you obtained any information on implementation issues? *(e.g., through audits, user groups, individual requests)* □ Yes □ No
- Have any problems with data collection (e.g., cost/burden, timing/frequency, availability of data/missing data, patient confidentiality, etc.) been identified? □ Yes □ No
- If yes, describe the problem and any modifications or actions taken:

Staff Notes to Reviewers:

Reviewers: Overall, to what extent was the criterion, **Feasibility**, met?
Rationale:

![4](H) ![H](M) ![M](L) ![N](N)

Reviewers: Overall, to what extent are all the criteria met?
Rationale:

Recommendation: Continue Endorsement □ Do not continue endorsement □
# CONTACT INFORMATION

**Measure Steward (Intellectual Property Owner)**  
**Organization:** Agency for Healthcare Research and Quality  
**Street Address:** 540 Gaither Road  
**City:** Rockville  
**State:** MD  
**ZIP:** 20850  

**Point of Contact:**  
**First Name:** John  
**MI:**  
**Last Name:** Bott  
**Credentials (MD, MPH, etc.):** MSSW, MBA  
**Email:** john.bott@ahrq.hhs.gov  
**Telephone:** 301-427-1317 ext:  

**Other Organizations:**

# ADDITIONAL INFORMATION

**Copyright statement/disclaimers:** The AHRQ QI software is publicly available. We have no copyright disclaimers.

**Additional Information:**

**Date of Submission (MM/DD/YY):** 10/29/10
This form will be used by stewards to submit measure information and by reviewers to evaluate the measures.

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Evaluation ratings of the extent to which the criteria are met:
- **H**=High (unquestionably demonstrated to meet the criterion)
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- **NA**=Not applicable (only an option for a few subcriteria as indicated)

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**MEASURE DESCRIPTIVE INFORMATION**

- **NQF #** 0285
- **Title of Measure:** Rate of Lower-extremity Amputation among Patients with Diabetes (PQI 16)
- **Brief description of measure** (including type of score, measure focus, target population, time, e.g., Percentage of adult patients aged 18-75 years receiving one or more HbA1c tests per year):
  
  This measure is used to assess the number of lower-extremity amputations among patients with diabetes per 100,000 persons.

- **Type of Measure:** Outcome
- **If “Other”, please describe:**
- **If included in a composite or paired with another measure, please identify composite or paired measure**

**Select the most relevant priority area(s), quality domain(s), and consumer need(s).**

- **National Priority Partners Priority Area**
  - patient and family engagement
  - population health
  - safety
  - care coordination
  - palliative and end of life care
  - overuse

- **IOM Quality Domain**
  - effectiveness
  - efficiency
  - equity
  - patient-centered
  - safety
  - timeliness

- **Consumer Care Need**
  - Getting Better
  - Living With Illness
  - Staying Healthy

---

**CONDITIONS FOR CONSIDERATION BY NQF**

Four conditions must be met before proposed measures may be considered and evaluated for suitability as voluntary consensus standards:

- **A.** The measure is in the public domain or an intellectual property agreement (measure steward agreement) is signed. Public domain only applies to governmental organizations. All non-government organizations must
sign a measure steward agreement even if measures are made publicly and freely available.

- Do you attest that the measure steward holds intellectual property rights to the measure and the right to use any aspects of the measure owned by another entity (e.g., risk model, code set)? □ Yes □ No

- Measure Steward Agreement (updated Nov 08)
  □ Signed and Submitted OR □ Government entity-public domain
  (If measure steward agreement not signed for non-government entities, do not submit)

- Please check if either of the following apply:
  □ Proprietary Measure □ Proprietary Complex Measure w/fees

B. The measure owner/steward verifies there is an identified responsible entity and process to maintain and update the measure on a schedule that is commensurate with the rate of clinical innovation, but at least every 3 years. □ Yes (If no, do not submit)

- Month and Year of most recent review/update: September 2010
- What is the frequency for review/update of this measure? □ annually □ quarterly □ biannually □ triannually □ other, describe:

- Describe maintenance activity since endorsement (e.g., review of supporting evidence/guidelines, modify specifications, review/update of codes, additional testing, risk adjustment calibration, collecting/monitoring use and performance on the measure):
  We have continued to monitor this indicator on an annual basis. We complete a review of ICD-9-CM and MS-DRG coding updates annually and apply changes to the AHRQ Quality Indicator software. Second, we receive feedback from users which aids in refining indicator definitions to improve measure and risk adjustment performance and usability. Finally we update the risk-adjustment and benchmarking parameters annually using the most recent AHRQ and census data.

C. The intended use of the measure includes both public reporting and quality improvement.

- Purpose: □ Public reporting □ Internal quality improvement □ Accountability □ Accreditation □ Payment incentive □ Other, describe:
  (If not intended for both public reporting and quality improvement, do not submit)

D. The requested measure submission information is complete.

- I have checked that the submission is complete and all the information needed to evaluate the measure is provided in the form; any blank fields indicate that no information is provided. □ Yes (If not complete, do not submit)

(for NQF staff use) Have all conditions for consideration been met?
Staff Notes (if submission returned): Met □ Yes □ No

1. IMPORTANCE TO MEASURE AND REPORT

Extent to which the specific measure focus is important to making significant gains in health care quality (safety, timeliness, effectiveness, efficiency, equity, patient-centeredness) and improving health outcomes for a specific high impact aspect of healthcare where there is variation in or overall poor performance. Measures must be judged to be important to measure and report in order to be evaluated against the remaining criteria.

1a. High Impact

(for NQF staff use) Specific NPP goal: Not related to a specific NPP goal.

- Demonstrated high impact aspect of healthcare (Select the most relevant)
  □ affects large numbers □ leading cause of morbidity/mortality □ severity of illness □ frequently performed procedure □ patient/societal consequences of poor quality □ other, describe:
Summary of Evidence of High Impact: Diabetes is a major risk factor for lower-extremity amputation, which can be caused by infection, neuropathy, and microvascular disease. Proper and continued treatment and glucose control may reduce the incidence of lower-extremity amputation, and lower rates represent better quality care. At the clinician level, a recent study showed that diabetics receive care according to guidelines only 45% of the time. Analysis by AHRQ indicates an empiric rate for this indicator of 36.8 per 100,000 population, leaving substantial room for improvement.


1b. Opportunity for Improvement

Current Measure Scores (Provide current measure scores and trends related to improvement since last date of endorsement)
Date(s): 2008 Data/Sample: Nationwide Inpatient Sample

Descriptive statistics of measure scores (e.g., distribution by quartile/decile, mean, median, SD, min, max):
Based on the 2008 national statistics for lower extremity amputations among patients with diabetes (http://hcupnet.ahrq.gov)
The 2008 rates are as follows:
Overall rate per 100,000: 36.14; Risk adjusted rate: 34.74
Male: 48.35
Female: 24.56
Age groups: 18-39: 3.66; 40-64: 41.32; 65-74: 99.09; 75+: 101.53

If no variation or no overall poor performance across providers, explain why it is important to measure and report:
If no current measure scores, provide evidence that demonstrates a performance gap:

1c. Evidence-Based

Process-Outcome Relationship For non-outcome measures, briefly describe the relationship to desired outcome. For outcomes, describe why it is relevant to the target population: As a prevention quality indicator, the rate of lower extremity amputations among diabetic patients is not a measure of hospital quality, but rather one measure of outpatient and other health care. Rates of diabetes may vary systematically by area, creating bias for this indicator. Examination of both inpatient and outpatient data may provide a more complete picture of diabetes care.

When was the evidence for this measure last reviewed? 2010

Type of Evidence Check all that apply

- Evidence-based guideline
- Meta-analysis
- Randomized controlled trial
- Cohort study
- Observational study
- Expert opinion
- Systematic synthesis of research
- Other (Please describe):

Summary of Current Evidence as described above for type of measure; for outcomes, summarize any evidence that healthcare services/care processes influence the outcome:

Hospital admissions for lower-extremity amputation among patients with diabetes is a PQI that would be of most interest to comprehensive health care delivery systems.

Lower-extremity amputation (LEA) affects up to 15% of all patients with diabetes in their lifetimes (Mayfield et al. 1998). A combination of factors may lead to this high rate of amputation, including minor trauma to the feet, which is caused by loss of sensation and may lead to gangrene (Pecoraro, Reiber, Burgess, 1998). Proper long-term glucose control, diabetes education, and foot care are some of the interventions that can reduce the incidence of infection, neuropathy, and microvascular diseases. Healthy People 2010 has set a goal of reducing the number of LEAs to 1.8 per 1,000 persons with diabetes.

Studies have shown that LEA varies by age and sex, and age-sex risk adjustment affects moderately the relative performance of areas. Race may bias the indicator, since the rates of diabetes and poor glycemic control are higher among Native Americans and Hispanic Americans. However, results must be interpreted with care when adjusting for race, because poor quality care may also vary systematically with racial composition.

Face Validity: In the United States, diabetes is the leading cause of nontraumatic amputations (approximately 57,000 per year) (CDC, 1999). Possible interventions include foot clinics, wearing proper footwear, and proper care of feet and foot ulcers (Pecoraro et al. 1990).

Precision: Based on empirical evidence, this indicator is moderately precise, with a raw area level rate of 30.5 per 100,000 population and a substantial standard deviation of 42.7. The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is moderate, at 68.5%, indicating that some of the observed differences in age-sex adjusted rates likely do not represent true differences in area performance. Using multivariate signal extraction techniques appears to have little additional impact on estimating true differences across areas.

Minimum Bias: Several sociodemographic variables are associated with the risk of lower-extremity amputation, including age, duration of diabetes, and sex (Mayfield et al. 1998; Selby & Zhang 1995). Empirical results show that age-sex adjustment affects the relative performance of areas.

Construct Validity: Several studies of intervention programs have noted a decrease in amputation risk. One recent study noted a 1-year post-intervention decrease of 79% in amputations in a low-income African American population. Interventions included foot care education, assistance in finding properly fitting footwear, and prescription footwear (Patout et al. 200). One observational study found that patients who receive no outpatient diabetes education have a three-fold higher risk of amputation than those receiving care (Reiber, Pacoraro, Koepsell, 1992).
Wang et al. (2009) modified the denominator to reflect only adults with diabetes to avoid sensitivity to diabetes prevalence in the population to demonstrate that age-adjusted preventable hospitalization for lower-extremity amputations fell 37% during 1998–2006 (p < 0.01).

Fosters Quality Improvement: Given the severity of conditions requiring lower-extremity amputation, hospitals are unlikely to fail to admit patients requiring hospitalization.

Prior Use: This indicator is not widely used; however, it is included in the DEMPAQ measure set for outpatient care.

► Rating of evidence: NA  ► Method for rating evidence: NA

► Summary of Controversy/Contradictory Evidence: NA


► Quote the Specific guideline recommendation: People with diabetes should receive medical care from a physician-coordinated team. Such teams may include, but are not limited to, physicians, nurse practitioners, physician's assistants, nurses, dietitians, pharmacists, and mental health professionals with expertise and a special interest in diabetes. It is essential in this collaborative and integrated team approach that individuals with diabetes assume an active role in their care.

The management plan should be formulated as a collaborative therapeutic alliance among the patient and family, the physician, and other members of the health care team. A variety of strategies and techniques should be used to provide adequate education and development of problem-solving skills in the various aspects of diabetes management. Implementation of the management plan requires that each aspect is understood and agreed on by the patient and the care providers and that the goals and treatment plan are reasonable. Any plan should recognize diabetes self-management education (DSME) and ongoing diabetes support as an integral component of care. In developing the plan, consideration should be given to the patient's age, school or work schedule and conditions, physical activity, eating patterns, social situation and cultural factors, and presence of complications of diabetes or other medical conditions.


► Rating of strength of recommendation: B  ► Method for rating strength of recommendation (If different from USPSTF, also describe rating and how it relates to USPSTF): During the comprehensive medical literature review, preference was given to high quality systematic reviews, meta-analyses, and clinical trials over the past ten years, plus existing nationally recognized treatment guidelines from the
leading specialty societies.

► Rationale for using this guideline over others: This guideline supports the indicator by providing actionable interventions to improve patient outcomes. The guideline was recently released by a recognized national clinical organization.

Staff Notes to Reviewers:

Reviewers: Was the threshold criterion, Importance to Measure and Report, met? Rationale:

<table>
<thead>
<tr>
<th>Y</th>
<th>N</th>
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2. SCIENTIFIC ACCEPTABILITY OF MEASURE PROPERTIES

Extent to which the measure, as specified, produces consistent (reliable) and credible (valid) results about the quality of care when implemented.

2a. MEASURE SPECIFICATIONS

In the future, NQF will require measure stewards to provide a URL link to a web page where current detailed specifications can be obtained.

► Do you have a web page where current detailed measure specifications can be obtained? □ No ☑ Yes

2a. Precisely Specified

Measure Changes

► Were any modifications made to the measure specifications since the last endorsement date? □ Yes ☑ No If yes, briefly identify and provide the rationale:

► If modifications made, are the measure changes likely to result in a substantial change in the current measurement baseline scores? □ Yes ☑ No If yes, please explain:

► Numerator Statement (Brief, text description of the numerator - what is being measured about the target population, e.g. target condition, event, or outcome):

All discharges of age 18 years and older with ICD-9-CM procedure code for lower-extremity amputation and diagnosis code of diabetes in any field.

Exclude cases:
- transfer from a hospital (different facility)
- transfer from a Skilled Nursing Facility (SNF) or Intermediate Care Facility (ICF)
- transfer from another health care facility
- MDC 14 (pregnancy, childbirth, and puerperium)
- trauma

► Numerator Time Window (The time period in which cases are eligible for inclusion in the numerator): Time window is a calendar year.

► Numerator Details (All information required to collect/calculate the numerator, including all codes, logic, and definitions):

ICD-9 CM Lower-Extremity Amputation codes:
- 8410 LOWER LIMB AMPUTAT NOS
- 8411 TOE AMPUTATION
- 8412 AMPUTATION THROUGH FOOT
- 8413 DISARTICATION OF ANKLE
- 8414 AMPUTAT THROUGH MALLEOLI
- 8415 BELOW KNEE AMPUTAT NEC
- 8416 DISARTICATION OF KNEE
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<th>Description</th>
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<tr>
<td>8417</td>
<td>ABOVE KNEE AMPUTATION</td>
</tr>
<tr>
<td>8418</td>
<td>DISARTICULATION OF HIP</td>
</tr>
<tr>
<td>8419</td>
<td>HINDQUARTER AMPUTATION</td>
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</tbody>
</table>

Include ICD-9-CM diabetes diagnosis codes:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>25000</td>
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<tr>
<td>25001</td>
<td>DMI WO CMP NT ST UNCNTRL</td>
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<tr>
<td>25002</td>
<td>DMII WO CMP UNCNTRL</td>
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<tr>
<td>25003</td>
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<tr>
<td>25011</td>
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<td>25012</td>
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<td>25013</td>
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<tr>
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<td>25070</td>
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<tr>
<td>25093</td>
<td>DMI UNSPF UNCNTRLD</td>
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</tbody>
</table>

Exclude Cases:
Transfer from a hospital, SNF, ICF or another health care facility:

SID ASORUCE codes:
2 - Another hospital
3 - Another facility, including long term care

POINTOFORIGINUB04 Codes:
4 - Transfer from a hospital
5 - Transfer from a Skilled Nursing Facility (SNF) or Intermediate Care Facility (ICF)
6 - Transfer from another health care facility

Trauma ICD-9-CM diagnosis in any field:
8950 AMPUTATION TOE 8971 AMPUTAT BK, UNILAT-COMPL
Denominator Statement (Brief, text description of the denominator - target population being measured):
Population in Metropolitan Statistical Area or County, age 18 years and older.

Target population gender: ♂ Male ♂ Female Target population age range: 18 and older

Denominator Time Window (The time period in which cases are eligible for inclusion in the denominator): Time window is a single point in time (July 1 of calendar year).

Denominator Details (All information required to collect/calculate the denominator - the target population being measured - including all codes, logic, and definitions):
Population in Metropolitan Statistical Area or County, age 18 years and older.

Denominator Exclusions (Brief text description of exclusions from the target population):
Under age 18.

Denominator Exclusion Details (All information required to collect exclusions to the denominator, including all codes, logic, and definitions):

Stratification Details/Variables (All information required to stratify the measure including the stratification variables, all codes, logic, and definitions):
Observed (raw) rates may be stratified by areas, age groups, race/ethnicity categories and sex. Risk adjustment of the data is recommended using age and sex. Reliability adjustment is also recommended.

Risk Adjustment Type: ☐ No risk adjustment necessary ☑ analysis by subgroup ☒ case-mix adjustment ☐ paired data at patient level ☐ risk-adjustment devised specifically for this measure/condition ☐ risk adjustment method widely or commercially available ☐ Other (specify)

Risk Adjustment Methodology/Variables (List risk adjustment variables and describe conceptual models, statistical models, or other aspects of model or method):
The predicted value for each case is computed using standard logistic regression and covariates for gender and age (in 5-year age groups). (There is also an optional model that includes an adjustment for area-level SES based on the percent of the population under the Federal poverty level). The reference population used in the regression is the universe of discharges for states that participate in the HCUP State Inpatient Databases (SID) for the year 2007, a database consisting of approximately 35 million discharges from 43 states. The expected rate is computed as the sum of the predicted value for each case divided by the number of cases for the unit of analysis of interest (i.e., county or state). The risk adjusted rate is computed using indirect standardization as the observed rate divided by the expected rate, multiplied by the reference population rate.

Detailed risk model attached ☐ OR at web page URL:

Type of Score: Rate/proportion ☑ If “Other”, please describe:

Interpretation of Score (Classifies interpretation of score according to whether better quality is associated with a higher score, a lower score, a score falling within a defined interval, or a passing score)
Better quality = Lower score ☑ If “Other”, please describe:

Calculation Algorithm (Describe the calculation of the measure as a flowchart or series of steps):
Each Prevention Quality Indicator (PQI) expressed as a rate, is defined as outcome of interest/population at risk or numerator/denominator. The Quality Indicators software performs five steps to produce the PQI
1) Discharge-level data is used to mark inpatient records containing outcomes of interest. 2) Identify populations at risk. For provider PQIs, such as short-term complications from diabetes, populations at risk are derived from hospital discharge records. 3) Calculate observed rates. Using output data from steps 1 and 2, PQI rates are calculated for user-specified combinations of stratifiers. 4) Risk adjust the PQI rates. Regression coefficients from a reference population database are applied to the observed rates in the risk-adjustment process. The risk-adjusted rates will then reflect the age and sex distribution of data in the reference population. 5) Create multivariate signal extraction (MSX) smoothed rates. Shrinkage factors are applied to the risk-adjusted rates for each PQI in the MSX process. For each PQI, the shrinkage estimate reflects a reliability adjustment unique to each indicator. Full information on PQI algorithms and specification can be found at http://qualityindicators.ahrq.gov/pqi_download.htm.

Describe the method for discriminating performance (e.g., significance testing):
Significance testing is not prescribed by the software. Users may define their methods of discriminating performance according to their application. Although all cases are measured, the rate is considered a sample in time, given the variations in case mix over time. Confidence intervals can be calculated, but again are not prescribed.

Sampling (Survey) Methodology If measure is based on a sample (or survey), provide instructions for obtaining the sample, conducting the survey and guidance on minimum sample size (response rate): The application of this indicator uses administrative data.

Data Source Check the source(s) for which the measure is specified and tested.

- Electronic administrative data / claims
- Electronic Health/Medical Record
- Electronic Clinical Data (e.g., MDS)
- Registry data (or database)
- Lab data
- Pharmacy data
- Paper Medical Record/flowsheet
- Survey-patient (e.g., CAHPS)
- Survey-provider
- Documentation of original self-assessment (e.g., SF-36)
- Management data
- Public health data/vital statistics
- Special or unique data, specify:

Identify the specific data source/data collection instrument (e.g. name of database, clinical registry, collection instrument, etc.); include Web page URL where available: Hospital administrative discharge data. See data requirements in the AHRQ QI Windows Application Documentation: http://www.qualityindicators.ahrq.gov/software.htm

Data dictionary/code table attached or at web page URL: http://www.qualityindicators.ahrq.gov/downloads/winqi/AHRQ_QI_Windows_Software_Documentation_V41a.pdf, page 11, Table 3.1

Level of Measurement/Analysis (For what entity will the scores be computed?) Check the level(s) for which the measure is specified and tested.

- Clinician: Individual □ Group □ Other
- Facility/Agency (e.g., hospital, nursing home)
- Multi-site/corporate chain
- Integrated delivery system
- Health plan
- Prescription drug plan
- Program: Disease management □ QIO □ Other
- Population: National □ Regional/network □ State □ Counties/Cities □ Other (Please describe): □ All levels

Applicable Care Settings Check the setting(s) for which the measure is specified and tested.

Ambulatory Care: □ Amb Surgery Center □ Office □ Clinic □ Emergency Dept □ Hospital Outpatient

- Assisted Living
- Behavioral health/psychiatric unit
- Dialysis Facility
- Emergency medical services/ambulance
- Group Home
- Home
- Hospice
- Hospital
- Long term acute care hospital
- Nursing home/ Skilled Nursing Facility (SNF)
- Rehabilitation Facility
- Other (Please describe): This indicator uses hospital data to examine ambulatory care and access.
- Unspecified or “not applicable” □ All settings
## Clinical Services
(Healthcare services being measured)
Check the service(s) for which the measure is specified and tested.

**Clinicians:**
- [ ] Physicians (MD/DO)
- [ ] Nurses
- [ ] PA/NP/Advanced Practice Nurse
- [ ] Chiropractor
- [ ] PT/OT/Speech
- [ ] Respiratory Therapy
- [ ] Dietician/Speech Therapist
- [ ] Psychologist/LCSW
- [ ] Audiologist
- [ ] Podiatrist
- [ ] Optometrist
- [ ] Pharmacist
- [ ] Other

**Behavioral Health:**
- [ ] Mental health
- [ ] Substance use treatment
- [ ] Other
- [ ] Dialysis
- [ ] Hospice/Palliative care
- [ ] Laboratory
- [ ] Imaging services
- [ ] Home health
- [ ] Other

### TESTING/ANALYSIS

Extent to which the measure, as specified, produces consistent (reliable) and credible (valid) results about the quality of care when implemented.

**2b.-2e., 2f. Testing**

► Have you conducted any testing of measure properties (e.g., reliability, validity, exclusions, disparities, comparability of data sources, risk adjustment) since last endorsement date? ❌ Yes □ No

► If yes, provide information on date, data/sample, type of testing, and results (for each area of testing):

We conduct ongoing measure maintenance including a review of the reference population and re-estimation of the risk adjustment model and reliability statistics annually. A link to the most current risk adjustment model is included and discussed in section 2a.

### 2f. Identification of Meaningful Differences in Performance

► Describe identification of statistically significant and practically/clinically meaningful differences in performance scores identified in 1b (e.g., differences from a reference such as state or national average or criterion value):

Males and the elderly have significantly higher per 100,000 rates of lower extremity amputations than females and younger persons with diabetes:

- Male: 48.35
- Female: 24.56

Reference: 2008 Nationwide Inpatient Sample

► Supplemental testing information attached ❌ OR at web page URL:


### Staff Notes to Reviewers:

Reviewers: Overall, to what extent was the criterion, Scientific Acceptability of Measure Properties, met?
Rationale:

### 3. USABILITY

Extent to which intended audiences (e.g., consumers, purchasers, providers, policy makers) can understand the results of the measure and are likely to find them useful for decision making.

**3a. Meaningful, understandable, and useful information**

► Is the measure currently in use? ❌ Yes □ No
If used in a public reporting initiative, Name of initiative(s), locations, Web page URL(s): Hundreds of users have downloaded AHRQ Quality Indicators software. The following is a sampling of public reports that use the measure:

- Nevada Compare Care, Nevada, http://www.nevadacomparecare.net/monahrq/home.html
- Prevention Quality Indicators in New York State, New York, https://apps.nyhealth.gov/statistics/prevention/quality_indicators/start.map;jsessionid=CC8D9531A2427E03B9314BA6E625B1B3

If used in other programs/initiatives (e.g., quality improvement), Name of initiative(s), locations, Web page URL(s): The software is publically available and free of charge (http://www.qualityindicators.ahrq.gov/). Users apply the software to their own administrative data (UB-04 or claims) that is readily available. Hundreds of users have downloaded AHRQ Quality Indicators software.

If not in current use or use is unknown, provide rationale why continued endorsement should be considered:

What might be the practical impact of ending NQF endorsement for the measure? NQF endorsement increases users confidence in the reliability and validity of using this measure to assess healthcare delivery quality.

Testing of Interpretability
Have you conducted any testing of interpretability of measure results for public reporting and/or quality improvement since endorsement? □ Yes □ No
If yes, provide information on date, data/sample, type of testing, and results:

3b/3c. Relation to other NQF-endorsed measures

Are there similar or related NQF-endorsed measures? (search here):
□ Other measures for same target population □ Other measures on same topic □ No similar measures

NQF # and Title of similar or related measures:

3b. Harmonization
If this measure is related to measure(s) already endorsed by NQF (e.g., same topic, but different target population/setting/data source or different topic but same target population):
- Are the measure specifications harmonized, or if not, why?

3c. Distinctive or Additive Value
If this measure is similar to measure(s) already endorsed by NQF (i.e., on the same topic and the same target population):
- Describe the distinctive, improved, or additive value this measure provides to existing NQF-endorsed measures:

Staff Notes to Reviewers (including additions/changes to related or similar measures):

Reviewers: Overall, to what extent was the criterion, Usability, met?
Rationale:
## 4. FEASIBILITY

Extent to which the required data are readily available, retrievable without undue burden, and can be implemented for performance measurement.

### 4b. Electronic Sources  
(Note: Measure stewards will be asked to specify the data elements for electronic health records at a later date)

- Are all the data elements available electronically? *(elements that are needed to compute measure scores entered directly into defined, computer-readable fields e.g., electronic health record electronic claims)*
  - Yes □  No □

  - If not, specify the near-term path to achieve electronic capture by most providers.

### 4d. Susceptibility to inaccuracies, errors, or unintended consequences

- Have any inaccuracies, errors, and/or unintended consequences been identified? *(include any susceptibility to problems due to any changes to the measure specifications)*
  - Yes □  No □

  - If yes, describe the problem and any modifications or actions taken:

  Wang et al. (2010) observe that the denominator is sensitive to variations in diabetes prevalence and thus are not ideal for examining changes in access to and quality of ambulatory care for individuals with diabetes.


### 4e. Implementation

- Have you obtained any information on implementation issues? *(e.g., through audits, user groups, individual requests)*
  - Yes □  No □

- Have any problems with data collection (e.g., cost/burden, timing/frequency, availability of data/missing data, patient confidentiality, etc.) been identified?
  - Yes □  No □

  - If yes, describe the problem and any modifications or actions taken:

Staff Notes to Reviewers:

<table>
<thead>
<tr>
<th>Reviewers: Overall, to what extent was the criterion, Feasibility, met?</th>
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<td>Rationale:</td>
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<tr>
<th>Reviewers: Overall, to what extent are all the criteria met?</th>
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<tbody>
<tr>
<td>Rationale:</td>
</tr>
</tbody>
</table>

| Recommendation: Continue Endorsement □  Do not continue endorsement □ |

### CONTACT INFORMATION

Measure Steward (Intellectual Property Owner)  
Organization: Agency for Healthcare Research and Quality  
Street Address: 540 Gaither Road  
City: Rockville  
State: MD  
ZIP: 20850

Point of Contact: First Name: John  
MI:  
Last Name: Bott  
Credentials (MD, MPH, etc.): MSSW, MBA  
Email: john.bott@ahrq.hhs.gov  
Telephone: 301-427-1317 ext:
<table>
<thead>
<tr>
<th>Other Organizations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADDITIONAL INFORMATION</td>
</tr>
<tr>
<td>Copyright statement/disclaimers: The AHRQ QI software is publicly available. We have no copyright disclaimers.</td>
</tr>
<tr>
<td>Additional Information:</td>
</tr>
<tr>
<td>Date of Submission (MM/DD/YY): 10/29/10</td>
</tr>
</tbody>
</table>
This form will be used by stewards to submit measure information and by reviewers to evaluate the measures.

**Measure Stewards:** Complete all non-shaded areas of the form. All requested information should be entered directly into this form. The information requested is directly related to NQF’s measure evaluation criteria and will be used by reviewers to determine if the evaluation criteria have been met. The specific relevant subcriteria language is provided in a Word comment within the form and will appear if your cursor is over the highlighted area.

The measure steward has the opportunity to identify and present the information that demonstrates the measure meets the criteria. Additional materials will only be considered supplemental. Do not rely solely on materials provided at URLs or in attached documents to provide measure specifications or to demonstrate meeting the criteria. If supplemental materials are provided, be sure to indicate specific page numbers/ web page locations for the relevant information (web page links preferred).

**Reviewers:** Complete all yellow highlighted areas of the form. Evaluate the extent to which each subcriterion is met and then overall, the extent to which each major criterion is met. Provide the rationale for your rating.

**Evaluation ratings of the extent to which the criteria are met**
H=High (unquestionably demonstrated to meet the criterion)
M=Moderate (demonstrated to moderately meet the criterion)
L=Low (addressed BUT demonstrated to only minimally meet the criterion)
N=No (NOT addressed; OR incorrectly addressed; OR demonstrated to NOT meet the criterion)
NA=Not applicable (only an option for a few subcriteria as indicated)

---

**MEASURE DESCRIPTIVE INFORMATION**

**NQF# 0638  Title of Measure: Uncontrolled Diabetes Admission Rate (PQI 14)**

**Brief description of measure (including type of score, measure focus, target population, time, e.g., Percentage of adult patients aged 18-75 years receiving one or more HbA1c tests per year):**
This measure is used to assess the number of admissions for uncontrolled diabetes per 100,000 persons.

**Type of Measure:** Outcome  
**If “Other”, please describe:**

**If included in a composite or paired with another measure, please identify composite or paired measure**

Select the most relevant priority area(s), quality domain(s), and consumer need(s).

**National Priority Partners Priority Area**
- patient and family engagement
- population health
- safety
- care coordination
- palliative and end of life care
- overuse

**IOM Quality Domain**
- effectiveness
- efficiency
- equity
- patient-centered
- safety

**Consumer Care Need**
- Getting Better
- Living With Illness
- Staying Healthy

---

**CONDITIONS FOR CONSIDERATION BY NQF**

Four conditions must be met before proposed measures may be considered and evaluated for suitability as voluntary consensus standards:

A. The measure is in the public domain or an intellectual property agreement (measure steward agreement) is signed. Public domain only applies to governmental organizations. All non-government organizations must sign a measure steward agreement even if measures are made publicly and freely available.
Do you attest that the measure steward holds intellectual property rights to the measure and the right to use any aspects of the measure owned by another entity (e.g., risk model, code set)? Yes

Measure Steward Agreement (updated Nov 08)
Signed and Submitted OR Government entity-public domain
(If measure steward agreement not signed for non-government entities, do not submit)

Please check if either of the following apply:
Proprietary Measure Proprietary Complex Measure w/fees

B. The measure owner/steward verifies there is an identified responsible entity and process to maintain and update the measure on a schedule that is commensurate with the rate of clinical innovation, but at least every 3 years. Yes (If no, do not submit)

Month and Year of most recent review/update: September 2010
What is the frequency for review/update of this measure? annually
When is the next scheduled review/update for this measure? April 2011
Describe maintenance activity since endorsement (e.g., review of supporting evidence/guidelines, modify specifications, review/update of codes, additional testing, risk adjustment calibration, collecting/monitoring use and performance on the measure):
We have continued to monitor this indicator on an annual basis. We complete a review of ICD-9-CM and MS-DRG coding updates annually and apply changes to the AHRQ Quality Indicator software. Second, we receive feedback from users which aids in refining indicator definitions to improve measure and risk adjustment performance and usability. Finally we update the risk-adjustment and benchmarking parameters annually using the most recent AHRQ and census data.

C. The intended use of the measure includes both public reporting and quality improvement.
Purpose: Public reporting Internal quality improvement
Accountability Accreditation Payment incentive Other, describe:
(If not intended for both public reporting and quality improvement, do not submit)

D. The requested measure submission information is complete.
I have checked that the submission is complete and all the information needed to evaluate the measure is provided in the form; any blank fields indicate that no information is provided. Yes
(If not complete, do not submit)

(for NQF staff use) Have all conditions for consideration been met?
Staff Notes (if submission returned):

1. IMPORTANCE TO MEASURE AND REPORT

Extent to which the specific measure focus is important to making significant gains in health care quality (safety, timeliness, effectiveness, efficiency, equity, patient-centeredness) and improving health outcomes for a specific high impact aspect of healthcare where there is variation in or overall poor performance. Measures must be judged to be important to measure and report in order to be evaluated against the remaining criteria.

1a. High Impact

(for NQF staff use) Specific NPP goal: Not related to a specific NPP goal.

Demonstrated high impact aspect of healthcare (Select the most relevant)
affects large numbers leading cause of morbidity/mortality severity of illness
frequently performed procedure patient/societal consequences of poor quality
other, describe:
Summary of Evidence of High Impact: Uncontrolled diabetes should be used in conjunction with short-
term complications of diabetes, which include diabetic ketoacidosis, hyperosmolarity, and coma. Proper outpatient treatment and adherence to care may reduce the incidence of uncontrolled diabetes, and lower rates represent better quality care.

**Citations for Evidence of High Impact:**

1b. Opportunity for Improvement

**Current Measure Scores** *(Provide current measure scores and trends related to improvement since last date of endorsement)*

**Date(s):** 2008  
**Data/Sample:** Nationwide Inpatient Sample

**Descriptive statistics of measure scores** *(e.g., distribution by quartile/decile, mean, median, SD, min, max):*

Based on the 2008 national statistics for uncontrolled diabetes (http://hcupnet.ahrq.gov)

The 2008 rates are as follows:

- Overall rate per 100,000: 23.02; Risk adjusted rate: 22.46
- Male: 22.51
- Female: 23.51

- Age groups: 18-39: 9.99; 40-64: 27.75; 65-74: 38.35; 75+:45.80

**If no variation or no overall poor performance across providers, explain why it is important to measure and report:**

**If no current measure scores, provide evidence that demonstrates a performance gap:**

1c. Evidence-Based

**Process-Outcome Relationship** *(For non-outcome measures, briefly describe the relationship to desired outcome)*
outcome. For outcomes, describe why it is relevant to the target population: As a prevention quality indicator, the uncontrolled diabetes rate is not a measure of hospital quality, but rather one measure of outpatient and other health care. Rates of diabetes may vary systematically by area, creating bias for this indicator. Examination of both inpatient and outpatient data may provide a more complete picture of diabetes care.

► When was the evidence for this measure last reviewed? 2010

► Type of Evidence Check all that apply

- Evidence-based guideline
- Meta-analysis
- Randomized controlled trial
- Cohort study
- Observational study
- Expert opinion
- Systematic synthesis of research
- Other (Please describe):

► Summary of Current Evidence as described above for type of measure; for outcomes, summarize any evidence that healthcare services/care processes influence the outcome): Hospital admission for uncontrolled diabetes is a PQI that would be of most interest to comprehensive health care delivery systems. Healthy People 2010 has established a goal to reduce the hospitalization rate for uncontrolled diabetes in persons 18-64 years of age from 7.2 per 10,000 population to 5.4 per 10,000 population (DHHS, 2010). Combining this indicator with the short-term diabetes indicator will result in the Healthy People 2010 measure, except that this QI excludes transfers from another institution to reduce double counting of cases. As a result the rate for the AHRQ QI may be minimally lower than the Healthy People 2010 indicator. This indicator is moderately precise. The observed differences across areas likely reflect true differences in area performance. Age-sex adjustment slightly changes area rankings.

Face validity:
High-quality outpatient management of diabetic patients has been shown to lead to reductions in almost all types of serious avoidable hospitalizations. However, tight control may be associated with more episodes of hypoglycemia that lead to more admissions.

Precision:
Based on empirical evidence, this indicator is moderately precise, with a raw area level rate of 34.7 per 100,000 population and a standard deviation of 28.1.

The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is high, at 72.6%, indicating that the observed differences in age-sex adjusted rates likely represent true differences in area performance. Using multivariate signal extraction techniques appears to have little additional impact on estimating true differences across areas.

Minimum bias:
Minorities have higher rates of diabetes, and higher hospitalization rates may result in areas with higher minority concentrations. Empirical results show that area rankings in the highest and lowest deciles are slightly affected by age-sex adjustment.

Construct validity:
Based on empirical results, areas with high rates of uncontrolled diabetes also tend to have high rates of admission for other ACSCs.

Wang et al. (2009) modified the denominator to reflect only adults with diabetes to avoid sensitivity to diabetes prevalence in the population to demonstrate that age-adjusted preventable hospitalization for uncontrolled diabetes complications fell 58% during 1998-2006 (p < 0.01).

Fosters true quality improvement:
Because diabetic emergencies are potentially life-threatening, hospitals are unlikely to fail to admit patients requiring hospitalization.

Prior use:
This measure corresponds closely with the measure of short-term diabetes that was developed by Billings et al. The key exception is the ICD-9-CM codes 25002 and 25003, which are the only codes included for uncontrolled diabetes.

► Rating of evidence: NA ► Method for rating evidence: NA

► Summary of Controversy/Contradictory Evidence: NA

► Citations for Evidence (other than guideline):
Quote the Specific guideline recommendation: People with diabetes should receive medical care from a physician-coordinated team. Such teams may include, but are not limited to, physicians, nurse practitioners, physician's assistants, nurses, dietitians, pharmacists, and mental health professionals with expertise and a special interest in diabetes. It is essential in this collaborative and integrated team approach that individuals with diabetes assume an active role in their care. The management plan should be formulated as a collaborative therapeutic alliance among the patient and family, the physician, and other members of the health care team. A variety of strategies and techniques should be used to provide adequate education and development of problem-solving skills in the various aspects of diabetes management. Implementation of the management plan requires that each aspect is understood and agreed on by the patient and the care providers and that the goals and treatment plan are reasonable. Any plan should recognize diabetes self-management education (DSME) and ongoing diabetes support as an integral component of care. In developing the plan, consideration should be given to the patient's age, school or work schedule and conditions, physical activity, eating patterns, social situation and cultural factors, and presence of complications of diabetes or other medical conditions.


Rating of strength of recommendation: B

Method for rating strength of recommendation (If different from USPSTF, also describe rating and how it relates to USPSTF): During the comprehensive medical literature review, preference was given to high quality systematic reviews, meta-analyses, and clinical trials over the past ten years, plus existing nationally recognized treatment guidelines from the leading specialty societies.

Rationale for using this guideline over others: This guideline supports the indicator by providing actionable interventions to improve patient outcomes. The guideline was recently released by a recognized national clinical organization.

Staff Notes to Reviewers:

Reviewers: Was the threshold criterion, Importance to Measure and Report, met?
Rationale: Y

2. SCIENTIFIC ACCEPTABILITY OF MEASURE PROPERTIES

Extent to which the measure, as specified, produces consistent (reliable) and credible (valid) results about the quality of care when implemented.

2a. MEASURE SPECIFICATIONS

In the future, NQF will require measure stewards to provide a URL link to a web page where current detailed specifications can be obtained.
Do you have a web page where current detailed measure specifications can be obtained? ☐ No ☑ Yes
If yes, provide Web page URL: Http://www.qualityindicators.ahrq.gov/downloads/pqi/TechSpecs42/PQI14 Uncontrolled Diabetes Admission Rate.pdf

2a. Precisely Specified

Measure Changes
Were any modifications made to the measure specifications since the last endorsement date? ☐ Yes ☑ No If yes, briefly identify and provide the rationale:
If modifications made, are the measure changes likely to result in a substantial change in the current measurement baseline scores? ☐ Yes ☑ No If yes, please explain:

Numerator Statement (Brief, text description of the numerator - what is being measured about the target population, e.g. target condition, event, or outcome):
All discharges of age 18 years and older with ICD-9-CM principal diagnosis code for uncontrolled diabetes, without mention of a short-term or long-term complication.

Exclude cases:
- transfer from a hospital (different facility)
- transfer from a skilled Nursing Facility (SNF) or Intermediate Care Facility (ICF)
- transfer from another health care facility
- MDC 14 (pregnancy, childbirth, and puerperium)

Numerator Time Window (The time period in which cases are eligible for inclusion in the numerator):
Time window is a calendar year.

Numerator Details (All information required to collect/calculate the numerator, including all codes, logic, and definitions):
Include ICD-9-CM diagnosis codes:
25002 DM, T2, UNCONT
25003 DM, T1, UNCONT

Exclude Cases:
Transfer from a hospital, SNF, ICF or another health care facility:
SID ASORUCE codes:
2 - Another hospital
3 - Another facility, including long term care

POINTOFORIGINUB04 Codes:
4 - Transfer from a hospital
5 - Transfer from a Skilled Nursing Facility (SNF) or Intermediate Care Facility (ICF)
6 - Transfer from another health care facility

Denominator Statement (Brief, text description of the denominator - target population being measured):
Population in Metropolitan Statistical Area or County, age 18 years and older.

Target population gender: ☑ Male ☐ Female Target population age range: 18 and older

Denominator Time Window (The time period in which cases are eligible for inclusion in the denominator):
Time window is a single point in time (July 1 of the calendar year).

Denominator Details (All information required to collect/calculate the denominator - the target population being measured - including all codes, logic, and definitions):
Population in Metropolitan Statistical Area or County, age 18 years and older.

Denominator Exclusions (Brief text description of exclusions from the target population):
Under age 18.
Denominator Exclusion Details (All information required to collect exclusions to the denominator, including all codes, logic, and definitions):

Stratification Details/Variables (All information required to stratify the measure including the stratification variables, all codes, logic, and definitions):

- Observed (raw) rates may be stratified by areas, age groups, race/ethnicity categories and sex. Risk adjustment of the data is recommended using age and sex. Reliability adjustment is also recommended.

Risk Adjustment Type:
- [ ] No risk adjustment necessary
- [ ] analysis by subgroup
- [ ] case-mix adjustment
- [ ] paired data at patient level
- [ ] risk-adjustment devised specifically for this measure/condition
- [ ] risk adjustment method widely or commercially available
- [ ] Other (specify)

Risk Adjustment Methodology/Variables (List risk adjustment variables and describe conceptual models, statistical models, or other aspects of model or method):

- The predicted value for each case is computed using standard logistic regression and covariates for gender and age (in 5-year age groups). (There is also an optional model that includes an adjustment for area-level SES based on the percent of the population under the Federal poverty level). The reference population used in the regression is the universe of discharges for states that participate in the HCUP State Inpatient Databases (SID) for the year 2007, a database consisting of approximately 35 million discharges from 43 states. The expected rate is computed as the sum of the predicted value for each case divided by the number of cases for the unit of analysis of interest (i.e., county or state). The risk adjusted rate is computed using indirect standardization as the observed rate divided by the expected rate, multiplied by the reference population rate.

Detailed risk model attached [ ] OR at web page URL:

Type of Score: Rate/proportion

Interpretation of Score (Classifies interpretation of score according to whether better quality is associated with a higher score, a lower score, a score falling within a defined interval, or a passing score):
- Better quality = Lower score
- If “Other”, please describe:

Calculation Algorithm (Describe the calculation of the measure as a flowchart or series of steps):

Each Prevention Quality Indicator (PQI) expressed as a rate, is defined as outcome of interest/population at risk or numerator/denominator. The Quality Indicators software performs five steps to produce the PQI rates.

1) Discharge-level data is used to mark inpatient records containing outcomes of interest. 2) Identify populations at risk. For provider PQIs, such as short-term complications from diabetes, populations at risk are derived from hospital discharge records. 3) Calculate observed rates. Using output data from steps 1 and 2, PQI rates are calculated for user-specified combinations of stratifiers. 4) Risk adjust the PQI rates. Regression coefficients from a reference population database are applied to the observed rates in the risk-adjustment process. The risk-adjusted rates will then reflect the age and sex distribution of data in the reference population. 5) Create multivariate signal extraction (MSX) smoothed rates. Shrinkage factors are applied to the risk-adjusted rates for each PQI in the MSX process. For each PQI, the shrinkage estimate reflects a reliability adjustment unique to each indicator. Full information on PQI algorithms and specification can be found at http://qualityindicators.ahrq.gov/pqi_download.htm.

Describe the method for discriminating performance (e.g., significance testing):

Significance testing is not prescribed by the software. Users may define their methods of discriminating performance according to their application. Although all cases are measured, the rate is considered a sample in time, given the variations in case mix over time. Confidence intervals can be calculated, but again are not prescribed.

Sampling (Survey) Methodology

If measure is based on a sample (or survey), provide instructions for obtaining the sample, conducting the survey and guidance on minimum sample size (response rate):

The application of this indicator uses administrative data.

Data Source

- [ ] Electronic administrative data/ claims
- [ ] Survey-patient (e.g., CAHPS)
Electronic Health/Medical Record  
Electronic Clinical Data (e.g., MDS)  
Registry data (or database)  
Lab data  
Pharmacy data  
Paper Medical Record/flowsheet  

- Identify the specific data source/data collection instrument (e.g. name of database, clinical registry, collection instrument, etc.); include Web page URL where available: Hospital administrative discharge data. See data requirements in the AHRQ QI Windows Application Documentation: [http://www.qualityindicators.ahrq.gov/software.htm](http://www.qualityindicators.ahrq.gov/software.htm)


- Level of Measurement/Analysis (For what entity will the scores be computed?) Check the level(s) for which the measure is specified and tested.

<table>
<thead>
<tr>
<th>Clinician:</th>
<th>Facility/Agency (e.g., hospital, nursing home)</th>
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<tbody>
<tr>
<td></td>
<td>Multi-site/corporate chain</td>
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<td>Integrated delivery system</td>
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<td></td>
<td>Health plan</td>
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<td>Prescription drug plan</td>
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<tr>
<th>Program:</th>
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<td>QIO</td>
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<td>Other</td>
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<th>Population:</th>
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<td>Regional/network</td>
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<td>State</td>
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<td>Counties/Cities</td>
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<td></td>
<td>Other (Please describe):</td>
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<td></td>
<td>All levels</td>
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</table>

- Applicable Care Settings Check the setting(s) for which the measure is specified and tested.

<table>
<thead>
<tr>
<th>Ambulatory Care:</th>
<th>Office</th>
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<tbody>
<tr>
<td>Amb Surgery Center</td>
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<tr>
<td>Clinic</td>
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<tr>
<td>Emergency Dept</td>
<td></td>
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<tr>
<td>Hospital Outpatient</td>
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</table>

  |  | Hospital |
  |  | Nursing home/ Skilled Nursing Facility (SNF) |
  |  | Rehabilitation Facility |

  | Other (Please describe): This indicator uses hospital data to examine ambulatory care and access. |
  | Unspecified or “not applicable” |
  | All levels |

- Clinical Services (Healthcare services being measured) Check the service(s) for which the measure is specified and tested.

  | Physicians (MD/DO) |
  | Nurses |
  | PA/NP/Advanced Practice Nurse |
  | Chiropractor |
  | PT/OT/Speech |
  | Respiratory Therapy |
  | Dietician/Nutritional professional |
  | Dentist/Oral surgeon |
  | Psychologist/LCSW |
  | Audiologist |
  | Podiatrist |
  | Optometrist |
  | Pharmacist |

  | Behavioral Health: |
  | Mental health |
  | Substance use treatment |
  | Other |

  | Dialysis |
  | Hospice/Palliative care |
  | Laboratory |
  | Imaging services |
  | Home health |
  | Other |

- Testing/Analysis Extent to which the measure, as specified, produces consistent (reliable) and credible (valid) results about the quality of care when implemented.
2b.-2e., 2f. Testing
► Have you conducted any testing of measure properties (e.g., reliability, validity, exclusions, disparities, comparability of data sources, risk adjustment) since last endorsement date? ☑ Yes ☐ No

► If yes, provide information on date, data/sample, type of testing, and results (for each are of testing): We conduct ongoing measure maintenance including a review of the reference population and re-estimation of the risk adjustment model and reliability statistics annually. A link to the most current risk adjustment model is included and discussed in section 2a.

2f. Identification of Meaningful Differences in Performance
► Describe identification of statistically significant and practically/clinically meaningful differences in performance scores identified in 1b (e.g., differences from a reference such as state or national average or criterion value):
Males have a slightly lower rate than females (22.51/100,000 versus 23.51/100,000 respectively) and there are significant changes in rates of uncontrolled diabetes admissions with age: 18-39: 9.99; 40-64: 27.75; 65-74: 38.35; 75+:45.80
Reference: 2008 Nationwide Inpatient Sample

► Supplemental testing information attached ☐ OR at web page URL:

Staff Notes to Reviewers:
Reviewers: Overall, to what extent was the criterion, Scientific Acceptability of Measure Properties, met? Rationale:

3. USABILITY
Extent to which intended audiences (e.g., consumers, purchasers, providers, policy makers) can understand the results of the measure and are likely to find them useful for decision making.

3a. Meaningful, understandable, and useful information
► Is the measure currently in use? ☑ Yes ☐ No

► If used in a public reporting initiative, Name of initiative(s), locations, Web page URL(s): Hundreds of users have downloaded AHRQ Quality Indicators software. The following is a sampling of public reports that use the measure:
Nevada Compare Care, Nevada, http://www.nevadacomparecare.net/monahrq/home.html

► If used in other programs/initiatives (e.g., quality improvement), Name of initiative(s), locations, Web page URL(s): The software is publically available and free of charge (http://www.qualityindicators.ahrq.gov/). Users apply the software to their own administrative data (UB-04 or claims) that is readily available. Hundreds of users have downloaded AHRQ Quality Indicators software.

► If not in current use or use is unknown, provide rationale why continued endorsement should be considered:
What might be the practical impact of ending NQF endorsement for the measure? NQF endorsement increases users confidence in the reliability and validity of using this measure to assess healthcare delivery quality.

Testing of Interpretability: Have you conducted any testing of interpretability of measure results for public reporting and/or quality improvement since endorsement? □ Yes □ No
If yes, provide information on date, data/sample, type of testing, and results:

3b/3c. Relation to other NQF-endorsed measures

Are there similar or related NQF-endorsed measures? (search here):
□ Other measures for same target population □ Other measures on same topic □ No similar measures

NQF # and Title of similar or related measures:

3b. Harmonization
If this measure is related to measure(s) already endorsed by NQF (e.g., same topic, but different target population/setting/data source or different topic but same target population):

Are the measure specifications harmonized, or if not, why?

3c. Distinctive or Additive Value
If this measure is similar to measure(s) already endorsed by NQF (i.e., on the same topic and the same target population):
Describe the distinctive, improved, or additive value this measure provides to existing NQF-endorse measures:

Staff Notes to Reviewers (including additions/changes to related or similar measures):

Reviewers: Overall, to what extent was the criterion, Usability, met?
Rationale:

4. FEASIBILITY
Extent to which the required data are readily available, retrievable without undue burden, and can be implemented for performance measurement.

4b. Electronic Sources (Note: Measure stewards will be asked to specify the data elements for electronic health records at a later date)

Are all the data elements available electronically? (elements that are needed to compute measure scores entered directly into defined, computer-readable fields e.g., electronic health record electronic claims) □ Yes □ No
If not, specify the near-term path to achieve electronic capture by most providers.

4d. Susceptibility to inaccuracies, errors, or unintended consequences

Have any inaccuracies, errors, and/or unintended consequences been identified? (include any susceptibility to problems due to any changes to the measure specifications) □ Yes □ No
If yes, describe the problem and any modifications or actions taken:
Wang et al. (2010) observe that the denominator is sensitive to variations in diabetes prevalence and thus are not ideal for examining changes in access to and quality of ambulatory care for individuals with diabetes.

4e. Implementation

► Have you obtained any information on implementation issues? (e.g., through audits, user groups, individual requests) ☑ Yes ☐ No

► Have any problems with data collection (e.g., cost/burden, timing/frequency, availability of data/missing data, patient confidentiality, etc.) been identified? ☑ Yes ☐ No

► If yes, describe the problem and any modifications or actions taken:

Staff Notes to Reviewers:

Reviewers: Overall, to what extent was the criterion, Feasibility, met?
Rationale:

Reviewers: Overall, to what extent are all the criteria met?
Rationale:

Recommendation: Continue Endorsement ☐ Do not continue endorsement ☑

CONTACT INFORMATION

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ADDITIONAL INFORMATION

Copyright statement/disclaimers: The AHRQ QI software is publicly available. We have no copyright disclaimers.

Additional Information:

Date of Submission (MM/DD/YY): 10/29/10
Appendix B - Technical Specifications
AHRQ Prevention Quality Indicators

The PQI definitions use ICD-9-CM codes valid from October 1, 1994 to September 30, 2005. Specifications are from AHRQ PQIs, version 2.1, revision 4, November 15, 2004.

The data source for all measures is administrative data (electronic claims).

<table>
<thead>
<tr>
<th>Area</th>
<th>Measure</th>
<th>Source of Measure</th>
<th>Measure Maintenance Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes Mellitus (DM)</td>
<td>Diabetes Uncontrolled and Short-Term Complications Admission Rate</td>
<td>AHRQ (PQIs 1 and 14)</td>
<td>AHRQ</td>
</tr>
<tr>
<td></td>
<td>Diabetes Long-Term Complications Admission Rate</td>
<td>AHRQ (PQI 3)</td>
<td>AHRQ</td>
</tr>
<tr>
<td></td>
<td>Rate of Lower-Extremity Amputation Among Patients With Diabetes</td>
<td>AHRQ (PQI 16)</td>
<td>AHRQ</td>
</tr>
</tbody>
</table>

See tables below for Numerator, Denominator and Exclusion Criteria for each of the measures above

### Diabetes Short-term Complications Admission Rate (PQI 1)

**Numerator:**

Discharges with ICD-9-CM principal diagnosis code for short-term complications (ketoacidosis, hyperosmolarity, coma) or with a principal diagnosis code for uncontrolled diabetes, without mention of a short-term or long-term complication (see below).

All non-maternal/non-neonatal discharges of age 18 years and older.

Exclude:

Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium) and MDC 15 (newborns and other neonates).

Include ICD-9-CM diagnosis codes:

<table>
<thead>
<tr>
<th>ICD-9-CM Diagnosis Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>25010</td>
<td>DM KETO T2, DM CONT</td>
</tr>
<tr>
<td>25011</td>
<td>DM KETO T1, DM CONT</td>
</tr>
<tr>
<td>25012</td>
<td>DM KETO T2, DM UNCONT</td>
</tr>
<tr>
<td>25013</td>
<td>DM KETO T1, DM UNCONT</td>
</tr>
<tr>
<td>25020</td>
<td>DM W/ HYPROSM T2, DM CONT</td>
</tr>
<tr>
<td>25021</td>
<td>DM W/ HYPROSM T1, DM CONT</td>
</tr>
<tr>
<td>25022</td>
<td>DM W/ HYPROSM T2, DM UNCONT</td>
</tr>
<tr>
<td>25030</td>
<td>DM COMA NEC TYP II, DM CONT</td>
</tr>
<tr>
<td>25031</td>
<td>DM COMA NEC T1, DM CONT</td>
</tr>
<tr>
<td>25032</td>
<td>DM COMA NEC T2, DM UNCONT</td>
</tr>
<tr>
<td>25033</td>
<td>DM COMA NEC T1, DM UNCONT</td>
</tr>
<tr>
<td>25002</td>
<td>DM, T2, UNCONT</td>
</tr>
</tbody>
</table>

**Denominator:**
### Diabetes Short-term Complications Admission Rate (PQI 1)

**Population in MSA or county, age 18 years and older.**

### Diabetes Long-term Complications Admission Rate (PQI 3)

**Numerator:**

Discharges with ICD-9-CM principal diagnosis code for long-term complications (renal, eye, neurological, circulatory, or complications not otherwise specified) (see below).

All non-maternal/non-neonatal discharges of age 18 years and older.

**Exclude:**

Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium) and MDC 15 (newborns and other neonates).

**Include ICD-9-CM diagnosis codes:**

- 25040 DM RENAL COMP T2 CONT
- 25041 DM RENAL COMP T1 CONT
- 25042 DM RENAL COMP T2 UNCNT
- 25043 DM RENAL COMP T1 UNCNT
- 25050 DM EYE COMP T2 CONT
- 25051 DM EYE COMP T1 CONT
- 25052 DM EYE COMP T2 UNCNT
- 25053 DM EYE COMP T1 UNCNT
- 25060 DM NEURO COMP T2 CONT
- 25061 DM NEURO COMP T1 CONT
- 25062 DM NEURO COMP T2 UNCNT
- 25063 DM NEURO COMP T1 UNCNT
- 25070 DM CIRCU DIS T2 CONT
- 25071 DM CIRCU DIS T1 CONT
- 25072 DM CIRCU DIS T2 UNCNT
- 25073 DM CIRCU DIS T1 UNCNT
- 25080 DM W COMP NEC T2 CONT
- 25081 DM W COMP NEC T1 CONT
- 25082 DM W COMP NEC T2 UNCNT
- 25083 DM W COMP NEC T1 UNCNT
- 25090 DM W COMPL NOS T2 CONT
- 25091 DM W COMPL NOS T1 CONT
- 25092 DM W COMPL NOS T2 UNCNT
- 25093 DM W COMPL NOS T1 UNCNT

**Denominator:**

Population in MSA or county, age 18 years and older.

### Rate of Lower-extremity Amputation among Patients with Diabetes (PQI 16)

**Numerator:**

Discharges with ICD-9-CM procedure code for lower-extremity amputation (see below) in any field and diagnosis code of diabetes in any field (see below).

All non-maternal/non-neonatal discharges of age 18 years and older.

**Exclude:**

Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium), MDC 15 (newborns and other neonates), and trauma diagnosis code (see below) in any field.

**Include ICD-9-CM procedure codes:**

- 8410 LOWER LIMB AMPUTAT NOS
- 8411 TOE AMPUTATION
- 8415 BELOW KNEE AMPUTAT NEC
- 8416 DISARTICULATION OF KNEE

---

## Rate of Lower-extremity Amputation among Patients with Diabetes (PQI 16)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8412</td>
<td>AMPUTATION THROUGH FOOT</td>
<td>8417</td>
<td>ABOVE KNEE AMPUTATION</td>
</tr>
<tr>
<td>8413</td>
<td>DISARTICULATION OF ANKLE</td>
<td>8418</td>
<td>DISARTICULATION OF HIP</td>
</tr>
<tr>
<td>8414</td>
<td>AMPUTAT THROUGH MALLEOLI</td>
<td>8419</td>
<td>HINDQUARTER AMPUTATION</td>
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**ICD-9-CM diagnosis codes for diabetes:**

<table>
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<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
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<td>25050</td>
<td>DMII OPHTH NT ST UNCNTRLD</td>
</tr>
<tr>
<td>25001</td>
<td>DMII WO CMP NT ST UNCNTRLD</td>
<td>25051</td>
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<tr>
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<td>DMII OPHTH UNCNTRLD</td>
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<td>DMII OPHTH UNCNTRLD</td>
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<tr>
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<td>25060</td>
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<tr>
<td>25011</td>
<td>DMII KETO NT ST UNCNTRLD</td>
<td>25061</td>
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<td>25012</td>
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<td>25070</td>
<td>DMII CIRC NT ST UNCNTRLD</td>
</tr>
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<td>25021</td>
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<td>25071</td>
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<td>25073</td>
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</tr>
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<td>DMII OTH NT ST UNCNTRLD</td>
</tr>
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</tr>
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<td>25032</td>
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<td>DMII OTH UNCNTRLD</td>
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<tr>
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<td>DMII RENL NT ST UNCNTRLD</td>
<td>25090</td>
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<td>DMII RENL NT ST UNCNTRL</td>
<td>25091</td>
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<td>25043</td>
<td>DMII RENAL UNCNTRL</td>
<td>25093</td>
<td>DMII UNSPF UNCNTRLD</td>
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</table>

Exclude ICD-9-CM diagnosis codes associated with trauma:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>8950</td>
<td>AMPUTATION TOE</td>
<td>8971</td>
<td>AMPUT BK, UNILAT-COMPL</td>
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<tr>
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<td>8960</td>
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<td>8973</td>
<td>AMPUT ABV KN, UNIL-COMPL</td>
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<tr>
<td>8961</td>
<td>AMPUT FOOT, UNILAT-COMPL</td>
<td>8974</td>
<td>AMPUT LEG, UNILAT NOS</td>
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<tr>
<td>8962</td>
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<td>8975</td>
<td>AMPUT LEG, UNIL NOS-COMP</td>
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<td>8963</td>
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<td>8976</td>
<td>AMPUTATION LEG, BILAT</td>
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<td>8970</td>
<td>AMPUT BELOW KNEE, UNILAT</td>
<td>8977</td>
<td>AMPUTAT LEG, BILAT-COMPL</td>
</tr>
</tbody>
</table>

**Denominator:**

Population in MSA or county, age 18 years and older.
Appendix A
Clinical Rationale and Detailed Evidence for Prevention Quality Indicators

This appendix contains brief summaries of the details of the literature review and the empirical evaluation for each PQI. A full report on the literature review and empirical evaluation can be found in Refinement of the HCUP Quality Indicators by the UCSF-Stanford EPC, available at http://www.qualityindicators.ahrq.gov/. Detailed coding information for each PQI is provided in Appendix A. Additional references, information on measure development, empirical testing, etc. is available at from AHRQ and can be downloaded from the QI website at http://qualityindicators.ahrq.gov/pqi_download.htm.

All PQIs are risk-adjusted by the patient age and sex.

<table>
<thead>
<tr>
<th>Diabetes Mellitus (DM)</th>
<th>Clinical Rationale and Associated Guidelines</th>
</tr>
</thead>
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<tr>
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<td>Diabetes Uncontrolled and Short-Term Complications Admission Rate (PQIs 1 and 14)</td>
</tr>
<tr>
<td></td>
<td>Diabetes Long-Term Complications Admission Rate (PQI 3)</td>
</tr>
<tr>
<td></td>
<td>Rate of Lower-Extremity Amputation Among Patients With Diabetes (PQI 16)</td>
</tr>
</tbody>
</table>

Diabetes Uncontrolled and Short-term Complications Admission Rate (PQI 1 and 14)

Uncontrolled and short-term complications of diabetes mellitus include diabetic ketoacidosis, hyperosmolarity, and coma. These life-threatening emergencies arise when a patient experiences an excess of glucose (hyperglycemia) or insulin (hypoglycemia). The combination of PQIs 1 and 14 creates the Healthy People 2010 indicator.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper outpatient treatment and adherence to care may reduce the incidence of uncontrolled diabetes and short-term complications, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>Admissions for uncontrolled diabetes or short-term complications per 100,000 population.</td>
</tr>
</tbody>
</table>

Diabetes Long-term Complications Admission Rate (PQI 3)

Long-term complications of diabetes mellitus include renal, eye, neurological, and circulatory disorders. Long-term complications occur at some time in the majority of patients with diabetes to some degree.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper outpatient treatment and adherence to care may reduce the incidence of diabetic long-term complications, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>Admissions for diabetic long-term complications per 100,000 population.</td>
</tr>
</tbody>
</table>

Rate of Lower-extremity Amputation among Patients with Diabetes (PQI 16)

Diabetes is a major risk factor for lower-extremity amputation, which can be caused by infection, neuropathy, and microvascular disease.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper and continued treatment and glucose control may reduce the incidence of lower-extremity amputation, and lower rates represent better quality care.</th>
</tr>
</thead>
</table>
Admissions for lower-extremity amputation in patients with diabetes per 100,000 population.

Diabetes References
4. Weissman JS, Gatsonis C, Epstein AM. Rates of avoidable hospitalization by insurance status in Massachusetts and Maryland. JAMA 1992;268(17):2388-94. Weissman found that uninsured patients had more than twice the risk of admission for diabetic ketoacidosis and coma than privately insured patients.
10. Pecoraro RE, Reiber BE, Burgess EM. Pathways to diabetic limb amputation. Basis of prevention. Diabetes Care 1990;13(5):513-21. A combination of factors may lead to this high rate of amputation, including minor trauma to the feet, which is caused by loss of sensation and may lead to gangrene.
11. Healthy People 2010, Office of Disease Prevention and Health Promotion. U.S. Department of Health and Human Services. Proper long-term glucose control, diabetes education, and foot care are some of the interventions that can reduce the incidence of infection, neuropathy, and microvascular diseases. Healthy People 2010 has set a goal of reducing the number of LEAs to 1.8 per 1,000 persons with diabetes.
found that patients who receive no outpatient diabetes education have a three-fold higher risk of amputation than those receiving care.
AHRQ Quality Indicators

Guide to Prevention Quality Indicators:
Hospital Admission for
Ambulatory Care Sensitive Conditions

Department of Health and Human Services
Agency for Healthcare Research and Quality
http://www.qualityindicators.ahrq.gov

October 2001
AHRQ Pub. No. 02-R0203
Revision 4 (November 24, 2004)
Citation

Preface

In health care as in other arenas, that which cannot be measured is difficult to improve. Providers, consumers, policy makers, and others seeking to improve the quality of health care need accessible, reliable indicators of quality that they can use to flag potential problems, follow trends over time, and identify disparities across regions, communities, and providers. As noted in a 2001 Institute of Medicine study, *Envisioning the National Health Care Quality Report*, it is important that such measures cover not just acute care but multiple dimensions of care: staying healthy, getting better, living with illness or disability, and coping with the end of life.

The Agency for Healthcare Research and Quality (AHRQ) Quality Indicators (QIs) are one Agency response to this need for a multidimensional, accessible family of quality indicators. They include a family of measures that providers, policy makers, and researchers can use with inpatient data to identify apparent variations in the quality of either inpatient or outpatient care. AHRQ’s Evidence-Based Practice Center (EPC) at the University of California San Francisco (UCSF) and Stanford University adapted, expanded, and refined these indicators based on the original Healthcare Cost and Utilization Project (HCUP) Quality Indicators developed in the early 1990s.

The new AHRQ QIs are organized into three modules: Prevention Quality Indicators (PQIs), Inpatient Quality Indicators (IQIs), and Patient Safety Indicators (PSIs). AHRQ has published the three modules as a series. Full technical information on the first two modules can be found in *Refinement of the HCUP Quality Indicators (Summary), May 2001* prepared by the UCSF-Stanford EPC. It can be accessed at [http://www.qualityindicators.ahrq.gov/downloads.htm](http://www.qualityindicators.ahrq.gov/downloads.htm).

This first module focuses on preventive care services—outpatient services geared to staying healthy and living with illness. Researchers and policy makers have agreed for some time that inpatient data offer a useful window on the quality of preventive care in the community. Inpatient data provide information on admissions for “ambulatory care sensitive conditions” that evidence suggests could have been avoided, at least in part, through better outpatient care. Hospitals, community leaders, and policy makers can then use such data to identify community need levels, target resources, and track the impact of programmatic and policy interventions.

One of the most important ways we can improve the quality of health care in America is to reduce the need for some of that care by providing appropriate, high-quality preventive services. For this to happen, however, we need to be able to track not only the level of outpatient services but also the outcome of the services people do or do not receive. The PQIs are intended to facilitate such efforts. The PQIs are already being applied at the national level in the National Healthcare Quality Report ([http://qualitytools.ahrq.gov/qualityreport](http://qualitytools.ahrq.gov/qualityreport)) and National Healthcare Disparities Report ([http://qualitytools.ahrq.gov/disparitiesreport](http://qualitytools.ahrq.gov/disparitiesreport)). As always, we would appreciate hearing from those who use our measures and tools so that we can identify how they are used, how they can be refined, and how we can measure and improve the quality of the tools themselves.

Irene Fraser, Ph.D., Director
Center for Organization and Delivery Studies

The programs for the Prevention Quality Indicators (PQIs) can be downloaded from [http://www.qualityindicators.ahrq.gov/pqi_download.htm](http://www.qualityindicators.ahrq.gov/pqi_download.htm). Instructions on how to use the programs to calculate the PQI rates are contained in the companion text, *Prevention Quality Indicators: Software Documentation*.  

Version 2.1  
Revision 4 (November 24, 2004)
Acknowledgments

This product is based on the work of many individuals who contributed to its development and testing.

The following staff from the Evidence-based Practice Center (EPC) at UCSF-Stanford performed the evidence review, completed the empirical evaluation, and created the programming code and technical documentation for the new Quality Indicators:

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Laura Spofford

Contributors from the Agency for Healthcare Research and Quality:

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H. Joanna Jiang, Ph.D.
Margaret Coopey, R.N., M.G.A, M.P.S.

Support efforts, including refinement and enhancement of the AHRQ Quality Indicators and related products, are provided by the Support for Quality Indicators contract team.

The following individuals from Battelle Memorial Institute, Stanford University, and University of California (UC) constitute the Support for Quality Indicators-II core team:

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Elaine Keller, M.Ed.
Kathryn M. McDonald, M.M.
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Jeff Schoenborn, BS

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Mary B. Haines, Contract Officer

We also wish to acknowledge the contribution of the peer reviewers of the evidence report and the beta-testers of the software products, whose input was invaluable.
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Introduction to the AHRQ Prevention Quality Indicators

Prevention is an important role for all health care providers. Providers can help individuals stay healthy by preventing disease, and they can prevent complications of existing disease by helping patients live with their illnesses. To fulfill this role, however, providers need data on the impact of their services and the opportunity to compare these data over time or across communities. Local, State, and Federal policymakers also need these tools and data to identify potential access or quality-of-care problems related to prevention, to plan specific interventions, and to evaluate how well these interventions meet the goals of preventing illness and disability.

The Agency for Healthcare Research and Quality (AHRQ) Prevention Quality Indicators (PQIs) represent one such tool. Local, State, or national data collected using the PQIs can flag potential problems resulting from a breakdown of health care services by tracking hospitalizations for conditions that should be treatable on an outpatient basis, or that could be less severe if treated early and appropriately. The PQIs represent the current state of the art in measuring the outcomes of preventive and outpatient care through analysis of inpatient discharge data.

What Are the Prevention Quality Indicators?

The PQIs are a set of measures that can be used with hospital inpatient discharge data to identify "ambulatory care sensitive conditions" (ACSCs). ACSCs are conditions for which good outpatient care can potentially prevent the need for hospitalization, or for which early intervention can prevent complications or more severe disease.

Even though these indicators are based on hospital inpatient data, they provide insight into the quality of the health care system outside the hospital setting. Patients with diabetes may be hospitalized for diabetic complications if their conditions are not adequately monitored or if they do not receive the patient education needed for appropriate self-management. Patients may be hospitalized for asthma if primary care providers fail to adhere to practice guidelines or to prescribe appropriate treatments. Patients with appendicitis who do not have ready access to surgical evaluation may experience delays in receiving needed care, which can result in a life-threatening condition—perforated appendix. The PQIs consist of the following 16 ambulatory care sensitive conditions, which are measured as rates of admission to the hospital:

<table>
<thead>
<tr>
<th>PQI Number</th>
<th>Prevention Quality Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Diabetes short-term complication admission rate</td>
</tr>
<tr>
<td>2</td>
<td>Perforated appendix admission rate</td>
</tr>
<tr>
<td>3</td>
<td>Diabetes long-term complication admission rate</td>
</tr>
<tr>
<td>4</td>
<td>Pediatric asthma admission rate</td>
</tr>
<tr>
<td>5</td>
<td>Chronic obstructive pulmonary disease admission rate</td>
</tr>
<tr>
<td>6</td>
<td>Pediatric gastroenteritis admission rate</td>
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<tr>
<td>7</td>
<td>Hypertension admission rate</td>
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<tr>
<td>8</td>
<td>Congestive heart failure admission rate</td>
</tr>
<tr>
<td>9</td>
<td>Low birth weight rate</td>
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<tr>
<td>10</td>
<td>Dehydration admission rate</td>
</tr>
<tr>
<td>11</td>
<td>Bacterial pneumonia admission rate</td>
</tr>
<tr>
<td>12</td>
<td>Urinary tract infection admission rate</td>
</tr>
<tr>
<td>13</td>
<td>Angina admission without procedure</td>
</tr>
<tr>
<td>14</td>
<td>Uncontrolled diabetes admission rate</td>
</tr>
<tr>
<td>15</td>
<td>Adult asthma admission rate</td>
</tr>
<tr>
<td>16</td>
<td>Rate of lower-extremity amputation among patients with diabetes</td>
</tr>
</tbody>
</table>
Although other factors outside the direct control of the health care system, such as poor environmental conditions or lack of patient adherence to treatment recommendations, can result in hospitalization, the PQIs provide a good starting point for assessing quality of health services in the community. Because the PQIs are calculated using readily available hospital administrative data, they are an easy-to-use and inexpensive screening tool. They can be used to provide a window into the community—to identify unmet community health care needs, to monitor how well complications from a number of common conditions are being avoided in the outpatient setting, and to compare performance of local health care systems across communities.

How Can the PQIs Be Used in Quality Assessment?

While these indicators use hospital inpatient data, their focus is on outpatient health care. Except in the case of patients who are readmitted soon after discharge from a hospital, the quality of inpatient care is unlikely to be a significant determinant of admission rates for ambulatory care sensitive conditions. Rather, the PQIs assess the quality of the health care system as a whole, and especially the quality of ambulatory care, in preventing medical complications. As a result, these measures are likely to be of the greatest value when calculated at the population level and when used by public health groups, State data organizations, and other organizations concerned with the health of populations.¹

These indicators serve as a screening tool rather than as definitive measures of quality problems. They can provide initial information about potential problems in the community that may require further, more in-depth analysis. Policy makers and health care providers can use the PQIs to answer questions such as:

- How does the low birth weight rate in my State compare with the national average?
- What can the pediatric indicators in the PQIs tell me about the adequacy of pediatric primary care in my community?
- Does the admission rate for diabetes complications in my community suggest a problem in the provision of appropriate outpatient care to this population?
- How does the admission rate for congestive heart failure vary over time and from one region of the country to another?

State policy makers and local community organizations can use the PQIs to assess and improve community health care. For example, an official at a State health department wants to gain a better understanding of the quality of care provided to people with diabetes in her State. She selects the four PQIs related to diabetes and applies the statistical programs downloaded from the AHRQ Web site to hospital discharge abstract data collected by her State.

Based on output from the programs, she examines the age- and sex-adjusted admission rates for these diabetes PQIs for her State as a whole and for communities within her State. The programs provide output that she uses to compare different population subgroups, defined by age, ethnicity, or gender. She finds that admission rates for short-term diabetes complications and uncontrolled diabetes are especially high in a major city in her State and that there are differences by race/ethnicity. She also applies the PQI programs to multiple years of her State’s data to track trends in hospital admissions over time. She discovers that the trends for these two PQIs are increasing in this city but are stable in the rest of the State. She then compares the figures from her State to national and regional averages on these PQIs using HCUPnet—an online query system providing access to statistics based on HCUP data.²

¹ Individual hospitals that are sole providers for communities and that are involved in outpatient care may be able to use the PQI programs. Managed care organizations and health care providers with responsibility for a specified enrolled population can use the PQI programs but must provide their own population denominator data.
² HCUPnet can be found at http://hcup.ahrq.gov/HCUPnet.asp and provides instant access to national and regional data from the Healthcare Cost and Utilization Project, a Federal-State-industry partnership in health data maintained by the Agency for Healthcare Research and Quality.
State average is slightly higher than the regional and national averages, but the averages for this city are substantially higher.

After she has identified disparities in admission rates in this community and in specific patient groups, she further investigates the underlying reasons for those disparities. She attempts to obtain information on the prevalence of diabetes across the State to determine if prevalence is higher in this city than in other communities. Finding no differences, she consults with the State medical association to begin work with local providers to discern if quality-of-care problems underlie these disparities. She contacts hospitals and physicians in this community to determine if community outreach programs can be implemented to encourage patients with diabetes to seek care and to educate them on lifestyle modifications and diabetes self-management. She then helps to develop specific interventions to improve care for people with diabetes and reduce preventable complications and resulting hospitalizations.

**What does this Guide Contain?**

This guide provides background information on the PQIs. First, it describes the origin of the entire family of AHRQ Quality Indicators. Second, it provides an overview of the methods used to identify, select, and evaluate the AHRQ Quality Indicators. Third, the guide summarizes the PQIs specifically, describes strengths and limitations of the indicators, documents the evidence that links the PQIs to the quality of outpatient health care services, and then provides in-depth two-page descriptions of each PQI. Finally, two appendices present additional technical background information. The first appendix outlines the specific definitions of each PQI, with complete ICD-9-CM coding specifications. The second appendix provides the details of the empirical methods used to explore the PQIs.
Origins and Background of the Quality Indicators

In the early 1990s, in response to requests for assistance from State-level data organizations and hospital associations with inpatient data collection systems, AHRQ developed a set of quality measures that required only the type of information found in routine hospital administrative data—diagnoses and procedures, along with information on patient’s age, gender, source of admission, and discharge status. These States were part of the Healthcare Cost and Utilization Project, an ongoing Federal-State-private sector collaboration to build uniform databases from administrative hospital-based data.

AHRQ developed these measures, called the HCUP Quality Indicators, to take advantage of a readily available data source—administrative data based on hospital claims—and quality measures that had been reported elsewhere. The 33 HCUP QIs included measures for avoidable adverse outcomes, such as in-hospital mortality and complications of procedures; use of specific inpatient procedures thought to be overused, underused, or misused; and ambulatory care sensitive conditions.

Although administrative data cannot provide definitive measures of health care quality, they can be used to provide indicators of health care quality that can serve as the starting point for further investigation. The HCUP QIs have been used to assess potential quality-of-care problems and to delineate approaches for dealing with those problems. Hospitals with high rates of poor outcomes on the HCUP QIs have reviewed medical records to verify the presence of those outcomes and to investigate potential quality-of-care problems. For example, one hospital that detected high rates of admissions for diabetes complications investigated the underlying reasons for the rates and established a center of excellence to strengthen outpatient services for patients with diabetes.

Development of the AHRQ Quality Indicators

Since the original development of the HCUP QIs, the knowledge base on quality indicators has increased significantly. Risk-adjustment methods have become more readily available, new measures have been developed, and analytic capacity at the State level has expanded considerably. Based on input from current users and advances to the scientific base for specific indicators, AHRQ funded a project to refine and further develop the original QIs. The project was conducted by the UCSF-Stanford EPC.

The major constraint placed on the UCSF-Stanford EPC was that the measures could require only the type of information found in hospital discharge abstract data. Further, the data elements required by the measures had to be available from most inpatient administrative data systems. Some State data systems contain innovative data elements, often based on additional information from the medical record. Despite the value of these record-based data elements, the intent of this project was to create measures that were based on a common denominator discharge data set, without the need for additional data collection. This was critical for two reasons. First, this constraint would result in a tool that could be used with any inpatient administrative data, thus making it useful to most data systems. Second, this would enable national and regional benchmark rates to be provided using HCUP data, since these benchmark rates would need to be calculated using the universe of data available from the States.

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AHRQ Quality Indicator Modules

The work of the UCSF-Stanford EPC resulted in the AHRQ Quality Indicators, which are available as three separate modules:

- **Prevention Quality Indicators.** These indicators consist of "ambulatory care sensitive conditions," hospital admissions that evidence suggests could have been avoided through high-quality outpatient care or that reflect conditions that could be less severe, if treated early and appropriately.

- **Inpatient Quality Indicators.** These indicators reflect quality of care inside hospitals and include inpatient mortality; utilization of procedures for which there are questions of overuse, underuse, or misuse; and volume of procedures for which there is evidence that a higher volume of procedures is associated with lower mortality.

- **Patient Safety Indicators.** These indicators also reflect quality of care inside hospitals, but focus on surgical complications and other iatrogenic events.
Methods of Identifying, Selecting, and Evaluating the Quality Indicators

In developing the new quality indicators, the UCSF-Stanford EPC applied the Institute of Medicine’s widely cited definition of quality care: “the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.” They formulated six specific key questions to guide the development process:

- Which indicators are currently in use or described in the literature that could be defined using hospital discharge data?
- What are the quality relationships reported in the literature that could be used to define new indicators using hospital discharge data?
- What evidence exists for indicators not well represented in the original indicators—pediatric conditions, chronic disease, new technologies, and ambulatory care sensitive conditions?
- Which indicators have literature-based evidence to support face validity, precision of measurement, minimum bias, and construct validity of the indicator?
- What risk-adjustment method should be suggested for use with the recommended indicators, given the limits of administrative data and other practical concerns?
- Which indicators perform well on empirical tests of precision of measurement, minimum bias, and construct validity?

As part of this project, the UCSF-Stanford EPC identified quality indicators reported in the literature and used by health care organizations, evaluated the original quality indicators and potential indicators using literature review and empirical methods, incorporated risk adjustment for comparative analysis, and developed new programs that could be employed by users with their own hospital administrative data. This section outlines the steps used to arrive at a final set of quality measures.

Step 1: Obtain Background Information on QI Use

The project team at the UCSF-Stanford EPC interviewed 33 individuals affiliated with hospital associations, business coalitions, State data groups, Federal agencies, and academia about various topics related to quality measurement, including indicator use, suggested indicators, and other potential contacts. Interviews were tailored to the specific expertise of interviewees. The sample was not intended to be representative of any population; rather, individuals were selected to include QI users and potential users from a broad spectrum of organizations in both the public and private sectors.

Three broad audiences were considered for the quality measures: health care providers and managers, who could use the quality measures to assist in initiatives to improve quality; public health policy makers, who could use the information from indicators to target public health interventions; and health care purchasers, who could use the measures to guide decisions about health policies.

Step 2: Search the Literature to Identify Potential QIs

The project team performed a structured review of the literature to identify potential indicators. They used Medline to identify the search strategy that returned a test set of known applicable articles in the most concise manner. Using the Medical Subject Heading (MeSH) terms “hospital, statistic, and methods” and “quality indicators” resulted in approximately 2,600 articles published in 1994 or later. After

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screening titles and abstracts for relevancy, the search yielded 181 articles that provided information on potential quality indicators based on administrative data.

Clinicians, health services researchers, and other team members abstracted information from these articles in two stages. In the first stage, preliminary abstraction, they evaluated each of the 181 identified articles for the presence of a defined quality indicator, clinical rationale, and strengths and weaknesses. To qualify for full abstraction, the articles must have explicitly defined a novel quality indicator. Only 27 articles met this criterion. The team collected information on the definition of the quality indicator, validation, and rationale during full abstraction.

In addition, they identified additional potential indicators using the CONQUEST database; the National Library of Healthcare Indicators developed by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO); a list of ORYX-approved indicators provided by JCAHO; and telephone interviews.

**Step 3: Review the Literature to Evaluate the QIs According to Predetermined Criteria**

The project team evaluated each potential quality indicator against the following six criteria, which were considered essential for determining the reliability and validity of a quality indicator:

- **Face validity.** An adequate quality indicator must have sound clinical or empirical rationale for its use. It should measure an important aspect of quality that is subject to provider or health care system control.

- **Precision.** An adequate quality indicator should have relatively large variation among providers or areas that is not due to random variation or patient characteristics. This criterion measures the impact of chance on apparent provider or community health system performance.

- **Minimum bias.** The indicator should not be affected by systematic differences in patient case-mix, including disease severity and comorbidity. In cases where such systematic differences exist, an adequate risk adjustment system should be possible using available data.

- **Construct validity.** The indicator should be related to other indicators or measures intended to measure the same or related aspects of quality. In general, better outpatient care (including, in some cases, adherence to specific evidence-based treatment guidelines) can reduce patient complication rates.

- **Fosters real quality improvement.** The indicator should be robust to possible provider manipulation of the system. In other words, the indicator should be insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care.

- **Application.** The indicator should have been used in the past or have high potential for working well with other indicators. Sometimes looking at groups of indicators together is likely to provide a more complete picture of quality.

Based on the initial review, the team identified and evaluated over 200 potential indicators using these criteria. Of this initial set, 45 indicators passed this initial screen and received comprehensive literature and empirical evaluation. In some cases, whether an indicator complemented other promising indicators was a consideration in retaining it, allowing the indicators to provide more depth in specific areas.

For this final set of 45 indicators, the team reviewed an additional 2,000 articles to provide evidence on indicators during the evaluation phase. They searched Medline for articles relating to each of the six areas of evaluation described above. Clinicians and health services researchers reviewed the literature for evidence and prepared a referenced summary description on each indicator.
As part of the review process, the team assessed the link between each indicator and health care quality along the following dimensions:

- **Proxy.** Some indicators do not specifically measure a patient outcome or a process measure of quality. Rather, they measure an aspect of care that is correlated with process measures of quality or patient outcomes. These indicators are best used in conjunction with other indicators measuring similar aspects of clinical care, or when followed with more direct and in-depth investigations of quality.

- **Selection bias.** Selection bias results when a substantial percentage of care for a condition is provided in the outpatient setting, so the subset of inpatient cases may be unrepresentative. In these cases, examination of outpatient care or emergency room data may help reduce selection bias.

- **Information bias.** Quality indicators are based on information available in hospital discharge data sets, but some missing information may actually be important to evaluating the outcomes of hospital care. In these cases, examination of missing information may help to improve indicator performance.

- **Confounding bias.** Patient characteristics may substantially affect performance on a measure and may vary systematically across areas. In these cases, adequate risk adjustment may help to improve indicator performance.

- **Unclear construct validity.** Problems with construct validity include uncertain or poor correlations with widely accepted process measures or with risk-adjusted outcome measures. These indicators would benefit from further research to establish their relationship with quality care.

- **Easily manipulated.** Quality indicators may create perverse incentives to improve performance without actually improving quality. Although very few of these perverse responses have been proven, they are theoretically important and should be monitored to ensure true quality improvement.

- **Unclear benchmark.** For some indicators, the “right rate” has not been established, so comparison with national, regional, or peer group means may be the best benchmark available. Very low PQI rates may flag an underuse problem; that is, providers may fail to hospitalize patients who would benefit from inpatient care. On the other hand, overuse of acute care resources may potentially occur when patients who do not clinically require inpatient care are hospitalized.

### Step 4: Perform a Comprehensive Evaluation of Risk Adjustment

The project team identified potential risk-adjustment systems by reviewing the applicable literature and asking the interviewees in step 1 to identify their preferences. Generally, users preferred that the system be (1) open, with published logic; (2) cost-effective, with data collection costs minimized and additional data collection being well justified; (3) designed using a multiple-use coding system, such as those used for reimbursement; and (4) officially recognized by government, hospital groups, or other organizations.

In general, diagnosis-related groups (DRGs) seemed to fit more of the user preference-based criteria than other alternatives. A majority of the users interviewed already used the 3M™ All-Patient Refined DRG® (APR-DRG) system, which has been reported to perform well in predicting resource use and death when compared to other DRG-based systems.

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6 Information on the 3M™ APR-DRG system is available at [http://www.3m.com/us/healthcare/his/products/coding/refined_drg.jhtml](http://www.3m.com/us/healthcare/his/products/coding/refined_drg.jhtml).
APR-DRGs were used to conduct indicator evaluations to determine the impact of measured differences in patient severity on the relative performance of providers and to provide the basis for implementing APR-DRGs as an optional risk-adjustment system for hospital-level QI measures. The implementation of APR-DRGs is based on an ordinary least squares regression model. Area indicators (including all PQIs) were risk-adjusted only for age and sex differences. Detailed information on the risk-adjustment methods can be found in Appendix B.

**Step 5: Evaluate the Indicators Using Empirical Analyses**

The project team conducted extensive empirical testing of all potential indicators using the 1995-97 HCUP State Inpatient Databases (SID) and Nationwide Inpatient Sample (NIS) to determine precision, bias, and construct validity. The 1997 SID contains uniform data on inpatient stays in community hospitals for 22 States covering approximately 60% of all U.S. hospital discharges. The NIS is designed to approximate a 20% of U.S. community hospitals and includes all stays in the sampled hospitals. Each year of the NIS contains between 6 million and 7 million records from about 1,000 hospitals. The NIS combines a subset of the SID data, hospital-level variables, and hospital and discharge weights for producing national estimates. The project team conducted tests to examine three things: precision, bias, and construct validity.

**Precision.** The first step in the analysis involved precision tests to determine the reliability of the indicator for distinguishing real differences in provider performance. For indicators that may be used for quality improvement, it is important to know with what precision, or surety, a measure can be attributed to an actual construct rather than random variation.

For each indicator, the variance can be broken down into three components: variation within a provider (actual differences in performance due to differing patient characteristics), variation among providers (actual differences in performance among providers), and random variation. An ideal indicator would have a substantial amount of the variance explained by between-provider variance, possibly resulting from differences in quality of care, and a minimum amount of random variation. The project team performed four tests of precision to estimate the magnitude of between-provider variance on each indicator:

- Signal standard deviation was used to measure the extent to which performance of the QI varies systematically across hospitals or areas.
- Provider/area variation share was used to calculate the percentage of signal (or true) variance relative to the total variance of the QI.
- Signal-to-noise ratio was used to measure the percentage of the apparent variation in QIs across providers that is truly related to systematic differences across providers and not random variations (noise) from year to year.
- In-sample R-squared was used to identify the incremental benefit of applying multivariate signal extraction methods for identifying additional signal on top of the signal-to-noise ratio.

In general, random variation is most problematic when there are relatively few observations per provider, when adverse outcome rates are relatively low, and when providers have little control over patient outcomes or variation in important processes of care is minimal. If a large number of patient factors that are difficult to observe influence whether or not a patient has an adverse outcome, it may be difficult to separate the “quality signal” from the surrounding noise. Two signal extraction techniques were applied to improve the precision of an indicator:

- Univariate methods were used to estimate the “true” quality signal of an indicator based on information from the specific indicator and 1 year of data.
- Multivariate signal extraction (MSX) methods were used to estimate the “true” quality signal based on information from a set of indicators and multiple years of data. In most cases, MSX
methods extracted additional signal, which provided much more precise estimates of true hospital or area quality.

**Bias.** To determine the sensitivity of potential QIs to bias from differences in patient severity, unadjusted performance measures for specific hospitals were compared with performance measures that had been adjusted for age and gender. All of the PQIs and some of the Inpatient Quality Indicators (IQIs) could only be risk-adjusted for age and sex. The 3M™ APR-DRG System Version 12 with Severity of Illness and Risk of Mortality subclasses was used for risk adjustment of the utilization indicators and the in-hospital mortality indicators, respectively. Five empirical tests were performed to investigate the degree of bias in an indicator:

- Rank correlation coefficient of the area or hospital with (and without) risk adjustment—gives the overall impact of risk adjustment on relative provider or area performance.
- Average absolute value of change relative to mean—highlights the amount of absolute change in performance, without reference to other providers’ performance.
- Percentage of highly ranked hospitals that remain in high decile—reports the percentage of hospitals or areas that are in the highest deciles without risk adjustment that remain there after risk adjustment is performed.
- Percentage of lowly ranked hospitals that remain in low decile—reports the percentage of hospitals or areas that are in the lowest deciles without risk adjustment that remain there after risk adjustment is performed.
- Percentage that change more than two deciles—identifies the percentage of hospitals whose relative rank changes by a substantial percentage (more than 20%) with and without risk adjustment.

**Construct validity.** Construct validity analyses provided information regarding the relatedness or independence of the indicators. If quality indicators do indeed measure quality, then two measures of the same construct would be expected to yield similar results. The team used factor analysis to reveal underlying patterns among large numbers of variables—in this case, to measure the degree of relatedness between indicators. In addition, they analyzed correlation matrices for indicators.
Summary Evidence on the Prevention Quality Indicators

The rigorous evaluations performed by the UCSF-Stanford EPC, based on literature review and empirical testing of indicators, resulted in 16 indicators that reflect ambulatory care sensitive conditions (ACSCs). These ACSCs have been reported and tested in a number of published studies involving consensus processes involving panels of expert physicians, using a range of methodologies and decision criteria. Two sets of ambulatory care sensitive conditions are widely used:

- The set developed by John Billings in conjunction with the United Hospital Fund of New York includes 28 ambulatory care sensitive conditions, identified by a panel of six physicians.\(^7\)
- The set developed by Joel Weissman includes 12 avoidable admissions identified through review of the literature and evaluation by a panel of physicians.\(^8\)

Many of the ACSCs have practice guidelines associated with them, including almost all of the chronic conditions and about half of the acute medical or pediatric conditions. Studies have shown that better outpatient care (including, in some cases, adherence to specific evidence-based treatment guidelines) can reduce patient complication rates of existing disease, including complications leading to hospital admissions. Empirically, most of the hospital admission rates for ACSCs are correlated with each other, suggesting that common underlying factors influence many of the rates.

Five of these 16 PQIs were included in the original HCUP QIs—perforated appendix, low birth weight, pediatric asthma, diabetes short-term complications, and diabetes long-term complications—where they were measured at the hospital level. In contrast, the 16 new indicators are constructed at the community level, defined as a Metropolitan Statistical Area (MSA) or a rural county. For each indicator, lower rates indicate potentially better quality.

Table 1 summarizes the results of the literature review and empirical evaluations on the PQIs. It lists each indicator, provides its definition, rates its empirical performance, recommends a risk adjustment strategy, and summarizes important caveats identified from the literature review.

Rating of performance on empirical evaluations, as described in step 5 above, ranged from 0 to 26. (The average score for these 16 PQIs is 14.6.) The scores were intended as a guide for summarizing the performance of each indicator on four empirical tests of precision (signal variance, area-level share, signal ratio, and R-squared) and five tests of minimum bias (rank correlation, top and bottom decile movement, absolute change, and change over two deciles), as described in the previous section and in Appendix B.

The magnitude of the scores, shown in the Empirical Rating column, provides an indication of the relative rankings of the indicators. These scores were based on indicator performance after risk-adjustment and smoothing; that is, they represent the “best estimate” of the indicator’s true value after accounting for case-mix and reliability. The score for each individual test is an ordinal ranking (e.g., very high, high, moderate, and low). The final summary score was derived by assigning a weight to each ranking (e.g., 3, 2, 1, 0) and summing across these nine individual tests. Higher scores indicate better performance on the empirical tests.

The Literature Review Findings column summarizes evidence specific to each potential concern on the link between the PQIs and quality of care, as described in step 3 above. A question mark (?) indicates that the concern is theoretical or suggested, but no specific evidence was found in the literature.

\(^8\)Weissman, JS, Gatsonis C, Epstein AM. Rates of avoidable hospitalization by insurance status in Massachusetts and Maryland. JAMA 1992;268(17):2388-94.
A check mark (✔) indicates that the concern has been demonstrated in the literature. For additional details on the results of the literature review, see “Detailed Evidence for the Prevention Quality Indicators.”

A complete description of each PQI is included later in the guide under “Detailed Evidence for Prevention Quality Indicators” and in Appendix A. Details on the empirical methods can be found in Appendix B.

### Table 1. Prevention Quality Indicators

<table>
<thead>
<tr>
<th>Indicator Name (Number)</th>
<th>Description</th>
<th>Risk Adjustment Incorporated</th>
<th>Empirical Performance</th>
<th>Literature Review Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes Short-term Complication Admission Rate (PQI 1)</td>
<td>Number of admissions for diabetes short-term complications per 100,000 population.</td>
<td>Age and sex.</td>
<td>Area Rate: 46.7 Area SD: 35.3 Pop. Rate: 50.9 Rating: 14</td>
<td>? Proxy ? Confounding bias</td>
</tr>
<tr>
<td>Perforated Appendix Admission Rate (PQI 2)</td>
<td>Number of admissions for perforated appendix as a share of all admissions for appendicitis within an area.</td>
<td>Age and sex.</td>
<td>Area Rate: 32.5 per 100 Area SD: 16.0 Pop. Rate: 30.5 per 100 Rating: 17</td>
<td>? Proxy</td>
</tr>
<tr>
<td>Diabetes Long-term Complication Admission Rate (PQI 3)</td>
<td>Number of admissions for long-term diabetes per 100,000 population.</td>
<td>Age and sex.</td>
<td>Area Rate: 112.6 Area SD: 67.6 Pop. Rate: 113.8 Rating: 11</td>
<td>? Proxy ? Confounding bias ? Easily manipulated ✓ Unclear benchmark</td>
</tr>
<tr>
<td>Pediatric Asthma Admission Rate (PQI 4)</td>
<td>Number of admissions for pediatric asthma per 100,000 population.</td>
<td>Age and sex.</td>
<td>Area Rate: 164.6 Area SD: 182.5 Pop. Rate: 188.8 Rating: 18</td>
<td>? Proxy ? Easily manipulated ✓ Unclear benchmark</td>
</tr>
<tr>
<td>Chronic Obstructive Pulmonary Disease Admission Rate (PQI 5)</td>
<td>Number of admissions for COPD per 100,000 population.</td>
<td>Age and sex.</td>
<td>Area Rate: 344.3 Area SD: 277.7 Pop. Rate: 248.6 Rating: 17</td>
<td>? Proxy ? Confounding bias ? Easily manipulated ✓ Unclear benchmark</td>
</tr>
<tr>
<td>Pediatric Gastroenteritis Admission Rate (PQI 6)</td>
<td>Number of admissions for pediatric gastroenteritis per 100,000 population.</td>
<td>Age and sex.</td>
<td>Area Rate: 112.3 Area SD: 137.8 Pop. Rate: 87.7 Rating: 17</td>
<td>? Proxy ? Unclear construct ? Easily manipulated ✓ Unclear benchmark</td>
</tr>
<tr>
<td>Hypertension Admission Rate (PQI 7)</td>
<td>Number of admissions for hypertension per 100,000 population.</td>
<td>Age and sex.</td>
<td>Area Rate: 50.2 Area SD: 49.3 Pop. Rate: 44.4 Rating: 14</td>
<td>? Proxy ? Easily manipulated ✓ Unclear benchmark</td>
</tr>
<tr>
<td>Congestive Heart Failure Admission Rate (PQI 8)</td>
<td>Number of admissions for CHF per 100,000 population.</td>
<td>Age and sex.</td>
<td>Area Rate: 502.8 Area SD: 250.8 Pop. Rate: 457.7 Rating: 14</td>
<td>? Proxy ? Easily manipulated ✓ Unclear benchmark</td>
</tr>
<tr>
<td>Indicator Name (Number)</td>
<td>Description</td>
<td>Risk Adjustment Incorporated</td>
<td>Empirical Performance</td>
<td>Literature Review Findings</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------</td>
<td>------------------------------</td>
<td>-----------------------</td>
<td>---------------------------</td>
</tr>
</tbody>
</table>
| Low Birth Weight Rate (PQI 9) | Number of low birth weight births as a share of all births in an area. | Not risk adjusted. | Area Rate: 6.0 per 100
Area SD: 3.8
Pop. Rate: 5.9 per 100 | ? Proxy
? Confounding bias
✓ Unclear construct |
| Dehydration Admission Rate (PQI 10) | Number of admissions for dehydration per 100,000 population. | Age and sex. | Area Rate: 174.9
Area SD: 131.2
Pop. Rate: 139.9 | ? Proxy
? Unclear construct
? Easily manipulated
✓ Unclear benchmark |
| Bacterial Pneumonia Admission Rate (PQI 11) | Number of admissions for bacterial pneumonia per 100,000 population. | Age and sex. | Area Rate: 503.9
Area SD: 306.8
Pop. Rate: 349.7 | ? Proxy
? Unclear construct
? Easily manipulated
✓ Unclear benchmark |
| Urinary Tract Infection Admission Rate (PQI 12) | Number of admissions for urinary infection per 100,000 population. | Age and sex. | Area Rate: 158.5
Area SD: 97.7
Pop. Rate: 137.9 | ? Proxy
? Unclear construct
? Easily manipulated
✓ Unclear benchmark |
| Angina without Procedure Admission Rate (PQI 13) | Number of admissions for angina without procedure per 100,000 population. | Age and sex. | Area Rate: 82.3
Area SD: 78.0
Pop. Rate: 55.1 | ? Proxy
? Unclear construct
? Easily manipulated
✓ Unclear benchmark |
| Uncontrolled Diabetes Admission Rate (PQI 14) | Number of admissions for uncontrolled diabetes per 100,000 population. | Age and sex. | Area Rate: 27.2
Area SD: 33.9
Pop. Rate: 23.0 | ? Proxy
? Confounding bias
? Easily manipulated |
| Adult Asthma Admission Rate (PQI 15) | Number of admissions for asthma in adults per 100,000 population. | Age and sex. | Area Rate: 98.4
Area SD: 79.2
Pop. Rate: 110.9 | ? Proxy
? Easily manipulated
✓ Unclear benchmark |
| Rate of Lower-extremity Amputation Among Patients with Diabetes (PQI 16) | Number of admissions for lower-extremity amputation among patients with diabetes per 100,000 population. | Age and sex. | Area Rate: 37.5
Area SD: 28.2
Pop. Rate: 36.8 | ? Proxy
? Unclear construct |

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**Notes:***

a Higher scores in the **Empirical Performance** column indicate better performance on the nine empirical tests. Unadjusted means and standard deviations (SD) were calculated using the 2002 SID from 35 states. The area rates are average area rates and area standard deviation based on 2,440 geographic areas (counties) in the 2002 SID. The population rate is based on all discharges in the 2002 SID for 35 states (as opposed to average area rates).

b Notes under Literature Review Findings:

**Proxy** – Indicator does not directly measure patient outcomes but an aspect of care that is associated with the outcome; thus, it is best used with other indicators that measure similar aspects of care.

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Confounding bias – Patient characteristics may substantially affect the performance of the indicator; risk adjustment is recommended.
Unclear construct – There is uncertainty or poor correlation with widely accepted process measures. 
Easily manipulated – Use of the indicator may create perverse incentives to improve performance on the indicator without truly improving quality of care.
Unclear benchmark – The “correct rate” has not been established for the indicator; national, regional, or peer group averages may be the best benchmark available.

? – The concern is theoretical or suggested, but no specific evidence was found in the literature.
✓ – Indicates that the concern has been demonstrated in the literature.

Smoothing recommended (details provided in Appendix B).
Bias was not tested because adequate risk adjustment for low birth weight was not available.
Uncontrolled diabetes is designed to be combined with diabetes short-term complications

Revision 4 of the PQIs provides the option to generate condition-specific rates (e.g., using the number of diabetics in the denominator) by state and age. Table 2 provides the Empirical Performance rates for the four diabetes-related PQIs, expressed per 1,000.

Table 2. Diabetes-related Prevention Quality Indicators

<table>
<thead>
<tr>
<th>Indicator Name (Number)</th>
<th>Description</th>
<th>Risk Adjustment Incorporated</th>
<th>Empirical Performance</th>
<th>Literature Review Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes Short-term Complication Admission Rate (PQI 1)</td>
<td>Number of admissions for diabetes short-term complications per 1,000 diabetic.</td>
<td>N/A</td>
<td>Area Rate: 7.3&lt;br&gt;Area SD: 1.3&lt;br&gt;Pop. Rate: 7.3&lt;br&gt;Rating: 14</td>
<td>? Proxy&lt;br&gt;✓ Confounding bias</td>
</tr>
<tr>
<td>Diabetes Long-term Complication Admission Rate (PQI 3)</td>
<td>Number of admissions for long-term diabetes per 1,000 diabetic.</td>
<td>N/A</td>
<td>Area Rate: 15.7&lt;br&gt;Area SD: 2.7&lt;br&gt;Pop. Rate: 16.3&lt;br&gt;Rating: 11</td>
<td>? Proxy&lt;br&gt;✓ Confounding bias&lt;br&gt;✓ Easily manipulated&lt;br&gt;✓ Unclear benchmark</td>
</tr>
<tr>
<td>Uncontrolled Diabetes Admission Rate (PQI 14)</td>
<td>Number of admissions for uncontrolled diabetes per 1,000 diabetic.</td>
<td>N/A</td>
<td>Area Rate: 2.8&lt;br&gt;Area SD: 1.3&lt;br&gt;Pop. Rate: 3.3&lt;br&gt;Rating: 14</td>
<td>? Proxy&lt;br&gt;✓ Confounding bias&lt;br&gt;✓ Easily manipulated</td>
</tr>
<tr>
<td>Rate of Lower-extremity Amputation Among Patients with Diabetes (PQI 16)</td>
<td>Number of admissions for lower-extremity amputation among patients with diabetes per 1,000 diabetic.</td>
<td>N/A</td>
<td>Area Rate: 5.2&lt;br&gt;Area SD: 0.9&lt;br&gt;Pop. Rate: 5.3&lt;br&gt;Rating: 10°</td>
<td>? Proxy&lt;br&gt;✓ Unclear construct</td>
</tr>
</tbody>
</table>

a Based on 35 states in 2002 SID.

Strengths and Limitations in Using the PQIs

The PQIs represent the current state of the art in assessing quality of health services in local communities using inpatient discharge data. These indicators measure the outcomes of preventive care for both acute illness and chronic conditions, reflecting two important components of the quality of preventive care—effectiveness and timeliness. For example, with effective drug therapy in the outpatient setting, hospital admissions for hypertension can be prevented. Likewise, accurate diagnosis and timely access to surgical treatment will help reduce the incidence of perforated appendix. The PQIs are thus valuable tools for identifying potential quality problems in outpatient care that help to set the direction for more in-depth investigation. Because the PQIs are based on readily available data—hospital discharge
abstracts—resource requirements are minimal. With uniform definitions and standardized programs, the PQIs will allow comparisons across States, regions, and local communities over time.

Despite the unique strengths of the PQIs, there are several issues that should be considered when using these indicators. First, for some PQIs, differences in socioeconomic status have been shown to explain a substantial part—perhaps most—of the variation in PQI rates across areas. The complexity of the relationship between socioeconomic status and PQI rates makes it difficult to delineate how much of the observed relationships are due to true access to care difficulties in potentially underserved populations, or due to other patient characteristics, unrelated to quality of care, that vary systematically by socioeconomic status. For some of the indicators, patient preferences and hospital capabilities for inpatient or outpatient care might explain variations in hospitalizations. In addition, environmental conditions that are not under the direct control of the health care system can substantially influence some of the PQIs. For example, the COPD and asthma admission rates are likely to be higher in areas with poorer air quality.

Second, the evidence related to potentially avoidable hospital admissions is limited for each indicator, because many of the indicators have been developed as parts of sets. Only five studies have attempted to validate individual indicators rather than whole measure sets. A limitation of this literature is that relatively little is known about which components represent the strongest measures of access and quality. Most of the five papers that did report on individual indicators also used a single variable, such as median area-specific income or rural residence, for construct validation. All but one of these papers included adjustment only for demographic factors (e.g., age, sex, and race).

Third, despite the relationships demonstrated at the patient level between higher quality ambulatory care and lower rates of hospital admission, few studies have directly addressed the question of whether effective treatments in outpatient settings would reduce the overall incidence of hospitalizations. The extent to which the reporting of admission rates for ambulatory care sensitive conditions may lead to changes in ambulatory practices and admission rates also is unknown. Providers may admit patients who do not clinically require inpatient care or they may do the opposite—fail to hospitalize patients who would benefit from inpatient care.

Questions for Future Work

The limitations discussed above suggest some directions for future work on development and use of the PQIs. Additional data and linkages could provide insights into the underlying causes of hospitalization for these conditions and could facilitate the exploration of potential interventions to prevent such events.

- Studies examining health and risk behaviors in a population could illuminate patient factors associated with the incidence of ambulatory care sensitive conditions.
- Examining environmental data, such as air pollution levels, could provide insight into factors outside the direct control of the health care system that are associated with hospitalization for such conditions.
- Exploring differences in disease prevalence in specific areas could help to discern whether

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variations in hospitalization rates can be attributed to differences in disease burden across communities that would exist even with optimum preventive care.

- Studies could examine the relationship between rural-urban location and distance to health care resources and hospital admission for ambulatory care sensitive conditions. Such studies would require information on patients’ residence such as patient ZIP codes.

- Linkages with data on local medical resources could help to illuminate the relationship between hospitalization for ACSCs and the supply of medical services and resources, such as the number of primary care and specialty physicians in a community or the supply of hospital beds. For example, the Dartmouth Atlas provides analyses for the Medicare population that suggest that the supply of hospital beds in a community is linked to ambulatory care sensitive admissions, but reported no relationship with local physician supply.\(^\text{14}\)

- Physician office data and outpatient clinic data may provide important information regarding care prior to hospital admission. Outpatient data would enable analyses that examine the processes of care that can prevent hospitalizations due to these conditions.

- Combining inpatient data with emergency department data would support the construction of a more complete picture of quality of care related to ambulatory care sensitive conditions. Some of these conditions are seen in emergency departments without being admitted for inpatient care. This is particularly relevant for the uninsured or underinsured who are more likely to use emergency departments as a routine source of care.

Detailed Evidence for Prevention Quality Indicators

This section provides an abbreviated presentation of the details of the literature review and the empirical evaluation for each PQI, including:

- The relationship between the indicator and quality of health care services
- A suggested benchmark or comparison
- The definition of each indicator
- The outcome of interest (or numerator)
- The population at risk (or denominator)
- The results of the empirical testing

Empirical testing rated the statistical performance of each indicator, as described in step 5 in the previous section. Scores ranged from 0 to 26 (mean for these 16 PQIs = 14.6), except for low birth weight for which bias was not tested because adequate risk adjustment was not available. The scores are intended as a guide for summarizing the performance of each indicator on four empirical tests of precision (signal variance, area-level share, signal ratio, and R-squared) and five tests of minimum bias (rank correlation, top and bottom decile movement, absolute change, and change over two deciles), as described in the previous section and in Appendix B. Raw unadjusted rates and SD are calculated using 2002 SID from 35 states. These rates are population rates based on all eligible discharges, as opposed to the average area rates reported in Table 1.

The magnitude of the scores, shown under Empirical Rating, provides an indication of the relative rankings of the indicators. These scores were based on indicator performance after risk-adjustment and smoothing, that is, they represent the “best estimate” of the indicator’s true value after accounting for case-mix and reliability. The score for each individual test is an ordinal ranking (e.g., very high, high, moderate, and low). The final summary score was derived by assigning a weight to each ranking (e.g., 3, 2, 1, 0) and summing across these nine individual tests. Higher scores indicate better performance on the empirical tests. The two-page descriptions for each indicator also include a discussion of the summary of evidence, the limitations on using each indicator, and details on:

- Face validity – Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

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15 The state data organizations that participated in the 2002 HCUP SID: California Office of Statewide Health Planning & Development; Colorado Health & Hospital Association; Connecticut - Chime, Inc.; Florida Agency for Health Care Administration; Georgia: An Association of Hospitals & Health Systems; Hawaii Health Information Corporation; Illinois Health Care Cost Containment Council; Iowa Hospital Association; Kansas Hospital Association; Kentucky Department for Public Health; Maine Health Data Organization; Maryland Health Services Cost Review; Massachusetts Division of Health Care Finance and Policy; Michigan Health & Hospital Association; Minnesota Hospital Association; Missouri Hospital Industry Data Institute; Nebraska Hospital Association; Nevada Department of Human Resources; New Jersey Department of Health & Senior Services; New York State Department of Health; North Carolina Department of Health and Human Services; Ohio Hospital Association; Oregon Association of Hospitals & Health Systems; Pennsylvania Health Care Cost Containment Council; Rhode Island Department of Health; South Carolina State Budget & Control Board; South Dakota Association of Healthcare Organizations; Tennessee Hospital Association; Texas Health Care Information Council; Utah Department of Health; Vermont Association of Hospitals and Health Systems; Virginia Health Information; Washington State Department of Health; West Virginia Health Care Authority; Wisconsin Department of Health & Family Services.
• Precision – Is there a substantial amount of provider or community level variation that is not attributable to random variation?

• Minimum bias – Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

• Construct validity – Does the indicator perform well in identifying true (or actual) quality-of-care problems?

• Fosters true quality improvement – Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

• Prior use – Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

Summary of Evidence Reported for All or Multiple PQIs

The literature review of the evidence related to potentially avoidable hospital admissions is limited for each indicator because many of the individual indicators have been developed as parts of sets. This section provides a summary of the general evidence reviewed applicable to all PQIs.

• Precision. The precision of avoidable hospitalization rates is likely to depend on the size of the denominator.

• Minimum bias. Previous studies have documented several characteristics that are associated with either the risk of an avoidable hospitalization (at the individual level) or the avoidable hospitalization rate (at the area level), including prevalence of the condition, race, socioeconomic status (SES), chronic disease and health of the population. These characteristics may be confounding factors, but also might be measuring subtle aspects of access to care.

• Construct validity. Most previous studies have assessed the validity of an entire set of avoidable hospital conditions, rather than each condition alone, and have used SES as a marker of access to care. These studies have repeatedly shown strong correlations between household income and avoidable hospitalizations, both at the individual level and the area level. At the zip code level, income alone explains 51-84% of the variability in ACS admission rates across 15 metropolitan areas in the US. This association is substantially weaker among persons 65 or more years of age, as one would expect if it is driven by access to care rather than underlying social factors. Avoidable hospitalization rates are higher among uninsured or Medicaid-enrolled persons than among privately insured persons, even after adjustment for race and income.

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Fewer studies have tested true measures of access to care. In the best of these studies, Bindman and colleagues showed that self-reported “difficulty in receiving medical care when needed” explained 50% of the variability in hospitalization rates for 5 chronic medical conditions (asthma, CHF, COPD, diabetes, and hypertension). Adjustment for condition prevalence, propensity to seek care, physician admitting style, and ecological measures of income, education, insurance, race, and gender, had little effect on the association. Having a regular source of care, and primary care physician/population ratios, were also independently associated with avoidable hospitalization rates, when substituted for self-reported access. These relationships did not hold in two separate studies of rural zip codes, suggesting that avoidable hospitalization rates are invalid indicators of access in rural areas.

In other studies, the physician/population ratio for family and general physicians has been more strongly associated with avoidable hospitalization rates than measures that include internists, pediatricians, or all physicians. In studies of Medicaid populations, provider continuity in ambulatory care and usual care received from a community health center were associated with lower avoidable hospitalization rates, and not having a primary care physician was associated with higher rates of avoidable hospitalization. However, having a regular source of care (for more than 50% of physician office visits) was not associated with lower avoidable hospitalization rates.

Several studies of Medicare beneficiaries have shown weak and inconsistent associations between access indicators and avoidable hospitalization rates. For example, persons in the Medicare Current Beneficiary Survey who reported problems obtaining health care, or lived in a health professional shortage area, were not at increased risk of preventable hospitalization. Instead, their risk was heavily influenced by clinical factors. However, beneficiaries in fair or poor health reportedly were at increased risk if they lived in a primary care shortage area. An area-level analysis based on Medicare claims suggests that the association between admission rates and physician/population ratios is limited to the 10% of health care service areas with the most severe shortage of physicians.

A full report on the literature review and empirical evaluation can be found in Refinement of the HCUP Quality Indicators by the UCSF-Stanford EPC, available at http://www.qualityindicators.ahrq.gov/. Detailed coding information for each PQI is provided in Appendix A.

Diabetes Short-term Complications Admission Rate (PQI 1)

Short-term complications of diabetes mellitus include diabetic ketoacidosis, hyperosmolarity, and coma. These life-threatening emergencies arise when a patient experiences an excess of glucose (hyperglycemia) or insulin (hypoglycemia).

### Relationship to Quality
Proper outpatient treatment and adherence to care may reduce the incidence of diabetic short-term complications, and lower rates represent better quality care.

### Benchmark
State, regional, or peer group average.

### Definition
Admissions for diabetic short-term complications per 100,000 population.

### Outcome of Interest

- Age 18 years and older.
- Exclude patients transferring from another institution, MDC 14 (pregnancy, childbirth, and puerperium), or MDC 15 (newborns and neonates).

### Population at Risk
Population in MSA or county, age 18 years and older.

### Empirical Results and Rating
Rate (2002): 50.9 per 100,000 population
Rating: 14

### Summary of Evidence
Hospital admission for diabetes short-term complications is a PQI that would be of most interest to comprehensive health care delivery systems. Short-term diabetic emergencies arise from the imbalance of glucose and insulin, which can result from deviations in proper care, misadministration of insulin, or failure to follow a proper diet.

Although risk adjustment with age and sex does not impact the relative or absolute performance of areas, this indicator should be risk-adjusted. Some areas may have higher rates of diabetes as a result of racial composition and systematic differences in other risk factors.

Areas with high rates of diabetic emergencies may want to examine education practices, access to care, and other potential causes of non-compliance when interpreting this indicator. Also, areas may consider examining the rates of hyperglycemic versus hypoglycemic events when interpreting this indicator.

### Limitations on Use
As a PQI, short-term diabetes complication rate is not a measure of hospital quality, but rather one measure of outpatient and other health care. Rates of diabetes may vary systematically by area, creating bias for this indicator. Examination of both inpatient and outpatient data may provide a more complete picture of diabetes care.

### Details
**Face validity:** Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

High-quality outpatient management of patients with diabetes has been shown to lead to reductions in almost all types of serious avoidable hospitalizations. However, tight control may be associated with more episodes of hypoglycemia, which leads to more admissions.

**Precision:** Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Based on empirical evidence, this indicator is moderately precise, with a raw area level rate of 36 per 100,000 population and a standard deviation of 24.6.
The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is moderate, at 51.7%, indicating that some of the observed differences in age-sex adjusted rates do not represent true differences in area performance. Using multivariate signal extraction techniques appears to have little additional impact on estimating true differences across areas.

Minimum bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

Minorities have higher rates of diabetes, and higher hospitalization rates may result in areas with higher minority concentrations. Empirical results show that area rankings and absolute performance are not affected by age-sex risk adjustment.

Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?

Studies of precipitating events of admission for diabetic emergencies often rely on self-report, which may be a biased measurement in and of itself. The results of one study showed that over 60% of patients with known and treated diabetes had made an error in insulin administration or had omitted insulin. In a potentially underserved population of urban African-Americans, two-thirds of admissions were due to cessation of insulin therapy—over half of the time for financial or other difficulties obtaining insulin.

Bindman reported that an area’s self-rated access to care report explained 46% of the variance in admissions for diabetes, although the analysis was not restricted to diabetic emergencies. Weissman found that uninsured patients had more than twice the risk of admission for diabetic ketoacidosis and coma than privately insured patients.

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Because diabetic emergencies are potentially life-threatening, hospitals are unlikely to fail to admit patients requiring hospitalization.

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

Admission for diabetic emergencies was included in both Billings' and Weissman's sets of avoidable hospitalization measures. This indicator, defined as a provider-level indicator, was an original HCUP QI.
Perforated Appendix Admission Rate (PQI 2)

Perforated appendix may occur when appropriate treatment for acute appendicitis is delayed for a number of reasons, including problems with access to care, failure by the patient to interpret symptoms as important, and misdiagnosis and other delays in obtaining surgery.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Timely diagnosis and treatment may reduce the incidence of perforated appendix, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>State, regional, or peer group average.</td>
</tr>
<tr>
<td>Definition</td>
<td>Admissions for perforated appendix per 100 admissions for appendicitis within MSA or county.</td>
</tr>
<tr>
<td>Outcome of Interest</td>
<td>Discharges with ICD-9-CM diagnosis code for perforation or abscess of appendix in any field.</td>
</tr>
<tr>
<td></td>
<td>Exclude patients transferring from another institution, MDC 14 (pregnancy, childbirth, and puerperium), or MDC 15 (newborns and neonates).</td>
</tr>
<tr>
<td>Population at Risk</td>
<td>Discharges with diagnosis code for appendicitis in any field within MSA or county.</td>
</tr>
</tbody>
</table>
| Empirical Results and Rating | Rate (2002): 30.5 per 100 eligible discharges  
Rating: 17 (Smoothing recommended) |

Summary of Evidence

Hospital admission for perforated appendix is a PQI that would be of most interest to comprehensive health care delivery systems. With prompt and appropriate care, acute appendicitis should not progress to perforation or rupture. Rates for perforated appendix are higher in the uninsured or underinsured in both adult and pediatric populations, which may be caused by patients failing to seek appropriate care, difficulty in accessing care, or misdiagnoses and poor quality care.

Perforated appendix rates vary systematically by race, although the cause is unknown. Areas with high rates of perforated appendix may want to target points of intervention by using chart reviews and other supplemental data to investigate the reasons for delay in receiving surgery. Hospital contributions to the overall area rate may be particularly useful for this indicator, because misdiagnoses and other delays in receiving surgery in an emergency room may contribute substantially to the rate.

Limitations on Use

As a PQI, admission for perforated appendix is not a measure of hospital quality, but rather one measure of outpatient and other health care.

Details

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

Perforated appendix results from delay in surgery, potentially reflecting problems in access to ambulatory care, misdiagnosis, and other delays in obtaining surgery.

Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Perforated appendix occurs in one-fourth to one-third of hospitalized acute appendicitis patients. Based on empirical evidence, this indicator is precise, with a raw area level rate of 33.3% and a substantial standard deviation of 14.4%.

Relative to other indicators, a higher percentage of the variation occurs at the area level rather than the discharge level. However, the signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than

random variation) is low, at 26.5%, indicating that much of the observed differences in age-sex adjusted rates likely do not represent true differences across areas. Applying multivariate signal extraction methods can improve estimation of true differences in area performance.

Minimum bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

Higher rates of perforated appendix have been noted in males, patients with mental illness or substance abuse disorders, people with diabetes, and blacks, as well as in children under the age of 4 (although appendicitis is rare in this age group).

Some of the observed variation in performance is due to systematic differences in patient characteristics. No evidence exists in the literature that clinical characteristics that would vary systematically increase the likelihood of perforated appendix. Therefore, this indicator is unlikely to be clinically biased. Empirical results show that area rankings and absolute performance are not affected by age-sex risk adjustment.

Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?

Braveman et al. found that the rate of perforated appendix was 50% higher for patients with no insurance or Medicaid than HMO-covered patients, and 20% higher for patients with private fee-for-service insurance. A follow-up study by Blumberg et al. concluded that the high rate of perforated appendix in the black population at an HMO may be explained by delay in seeking care, rather than differences in the quality of health care. Weissman et al. found that uninsured (but not Medicaid) patients are at increased risk for ruptured appendix after adjusting for age and sex.

Based on empirical results, areas with high rates of perforated appendix admissions tend to have lower rates of admissions for other ACSCs.

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Use of this quality indicator might lead to more performance of appendectomies in cases of questionable symptoms, in addition to reducing the occurrence of rupture.

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

Perforated appendix was included in the original HCUP QI indicator set, as well as in Weissman's set of avoidable hospitalizations.

41 Braveman et al., 1994.

44 Weissman JS, Gatsonis C, Epstein AM. Rates of avoidable hospitalization by insurance status in Massachusetts and Maryland. JAMA 1992;268(17)2388-94.
Diabetes Long-term Complications Admission Rate (PQI 3)

Long-term complications of diabetes mellitus include renal, eye, neurological, and circulatory disorders. Long-term complications occur at some time in the majority of patients with diabetes to some degree.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper outpatient treatment and adherence to care may reduce the incidence of diabetic long-term complications, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>State, regional, or peer group average.</td>
</tr>
<tr>
<td>Definition</td>
<td>Admissions for diabetic long-term complications per 100,000 population.</td>
</tr>
<tr>
<td>Outcome of Interest</td>
<td>Discharges with ICD-9-CM principal diagnosis codes for long-term complications of diabetes (renal, eye, neurological, circulatory, or complications not otherwise specified).</td>
</tr>
<tr>
<td></td>
<td>Age 18 years and older.</td>
</tr>
<tr>
<td></td>
<td>Exclude patients transferring from another institution, MDC 14 (pregnancy, childbirth, and puerperium), or MDC 15 (newborns and neonates).</td>
</tr>
<tr>
<td>Population at Risk</td>
<td>Population in MSA or county, age 18 years and older.</td>
</tr>
<tr>
<td>Empirical Results and Rating</td>
<td>Rate (2002): 113.8 per 100,000 population</td>
</tr>
</tbody>
</table>

Summary of Evidence

Hospital admission for diabetes long-term complications is a PQI that would be of most interest to comprehensive health care delivery systems. Long-term diabetes complications are thought to arise from sustained long-term poor control of diabetes. Intensive treatment programs have been shown to decrease the incidence of long-term complications in both Type 1 and Type 2 diabetes.

Sociodemographic characteristics of the population, such as race, may bias the indicator, since Native Americans and Hispanic Americans have higher rates of diabetes and poorer glycemic control. The importance of these factors as they relate to admission rates is unknown. Risk adjustment for observable characteristics, such as racial composition of the population, is recommended.

It is unclear whether poor glycemic control arises from poor quality medical care, non-compliance of patients, lack of education, or access to care problems. Areas with high rates may wish to examine these factors when interpreting this indicator.

Limitations on Use

As a PQI, diabetes long-term complication rate is not a measure of hospital quality, but rather one measure of outpatient and other health care. Rates of diabetes may vary systematically by area, creating bias for this indicator. Examination of both inpatient and outpatient data may provide a more complete picture of diabetes care.

Details

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

Several observational studies have linked improved glycemic control to substantially lower risks of developing complications in both Type 1 and Type 2 diabetes.\(^{45}\) Given that appropriate adherence to therapy and consistent monitoring of glycemic control help to prevent complications, high-quality outpatient care should lower long-term complication rates. However, adherence to guidelines aimed at

reducing complications (including eye and foot examinations and diabetic education) has been described as modest, with only one-third of patients receiving all essential services.

Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Compliance of physicians and patients is essential to achieve good outcomes, and it seems likely that problems with both access to and quality of care, as well as patient compliance, may contribute to the occurrence of complications.

Based on empirical results, areas with high rates of diabetes long-term complications also tend to have high rates of admission for other ACSCs.

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Providers may decrease admission rates by failing to hospitalize patients who would truly benefit from inpatient care. No published evidence indicates that worse health outcomes are associated with reduced hospitalization rates for long-term complications of diabetes.

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

This indicator, defined as a hospital-level indicator, is an original HCUP QI.

Minim bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is high, at 75.6%, indicating that the observed differences in age-sex adjusted rates likely represent true differences across areas.

Minimum bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

The duration of diabetes is positively associated with the development of complications. Empirical results show that area rankings and absolute performance are moderately affected by age-sex risk adjustment.

Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?

Rates of diabetes are higher in black, Hispanic, and especially Native American populations than in other ethnic groups. Hyperglycemia appears to be particularly frequent among Hispanic and Native American populations. The duration of diabetes is positively associated with the development of complications. Empirical results show that area rankings and absolute performance are moderately affected by age-sex risk adjustment.

Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?


Pediatric Asthma Admission Rate (PQI 4)

Asthma is the most common chronic disease in childhood and is one of the most frequent admitting diagnoses in children’s hospitals. Most published studies combine admission rates for children and adults; therefore, areas may wish to examine this indicator together with the adult asthma indicator.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper outpatient treatment may reduce admissions for asthma in the pediatric population, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>State, regional, or peer group average.</td>
</tr>
<tr>
<td>Definition</td>
<td>Admissions for pediatric asthma per 100,000 population.</td>
</tr>
<tr>
<td>Outcome of Interest</td>
<td>Discharges with ICD-9-CM principal diagnosis codes for asthma.</td>
</tr>
<tr>
<td></td>
<td>Age less than 18 years old.</td>
</tr>
<tr>
<td></td>
<td>Exclude patients transferring from another institution, MDC 14 (pregnancy, childbirth, and puerperium), or MDC 15 (newborns and neonates).</td>
</tr>
<tr>
<td>Population at Risk</td>
<td>Population in MSA or county, age less than 18 years.</td>
</tr>
<tr>
<td>Empirical Results and Rating</td>
<td>Rate (2002): 188.8 per 100,000 population                                           Rating: 18</td>
</tr>
</tbody>
</table>

Summary of Evidence

Hospital admission for pediatric asthma is a PQI that would be of most interest to comprehensive health care delivery systems.

Healthy People 2010 has set a goal to reduce the admission rate for asthma to 2.5 per 10,000 population for children under 5 years, and 7.7 per 10,000 population for people ages 5-65 years. Adherence to the guidelines for asthma management has been associated with lower admission rates.

This indicator is measured with high precision, and the observed variance reflects true differences in area performance. Risk adjustment for age and sex does not appear to affect area rankings. A review of the literature indicates that some children may be at risk for admission due to comorbidities, genetic factors, and environmental triggers. It is unclear which of these factors would vary by area, nor is the impact of parental compliance well understood. Race should be adjusted for in comparing rates across areas.

Limitations on Use

As a PQI, pediatric asthma is not a measure of hospital quality, but rather one measure of outpatient and other health care.

Providers may reduce admission rates without actually improving quality by shifting care to an outpatient setting. Admission rates that are drastically below or above the average or recommended rates should be examined.

Details

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

In the United States, asthma affects an estimated 4.8 million children and adolescents, and in 1993, it was the cause of 198,000 admissions and 342 deaths in persons aged 24 and younger. Adherence to the treatment guidelines—which emphasize appropriate diagnosis of asthma, a physician-patient relationship, management of asthma symptoms with medications, appropriate prophylactic and maintenance therapy, and adequate follow-up care—can reduce admission rates.


**Precision:** Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Because asthma is one of the most common reasons for pediatric hospitalization, relatively precise estimates of asthma admission across areas or hospitals can be obtained. Admission rates for asthma tend to be higher during peak times of viral respiratory infections (winter) and allergy seasons (spring and fall), so a consistent time period for measurement must be ensured. Based on empirical evidence, this indicator is precise, with a raw level rate of 154.1 and a standard deviation of 143.9.

The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is high, at 85.1%, indicating that the observed differences in age-sex adjusted rates likely represent true differences across areas.

**Minimum bias:** Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

Environmental triggers for pediatric asthma include indoor allergens such as tobacco smoke and outdoor air pollution. Race represents one of the most complex potentially biasing factors. Black patients have been shown to have higher asthma admission rates, even when stratifying for income and age. Adjustment for race is recommended. Empirical results show that area rankings are not affected by age-sex risk adjustment.

**Construct validity:** Does the indicator perform well in identifying true (or actual) quality-of-care problems?

Some admissions with asthma are unavoidable and appropriate. Studies have shown that asthma hospitalization rates are associated with median household income (at the area level) and lack of insurance (at the individual level). Lin et al. showed that admission rates were higher in areas with higher poverty, minority populations, unemployment, and lower education levels.

**Fosters true quality improvement:** Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Because some pediatric asthma can be managed on an outpatient basis, an appropriate shift to outpatient care may occur. Providers may decrease their rates by failing to hospitalize patients who would benefit from inpatient care.

**Prior use:** Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

This indicator was originally developed by Billings et al. in conjunction with the United Hospital Fund of New York. It was adopted by the Institute of Medicine and has been widely used in studies of avoidable hospitalizations.

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52NHLBI/NAEPP, 1997.


Chronic Obstructive Pulmonary Disease Admission Rate (PQI 5)

Chronic obstructive pulmonary disease (COPD) comprises three primary diseases that cause respiratory dysfunction—asthma, emphysema, and chronic bronchitis—each with distinct etiologies, treatments, and outcomes. This indicator examines emphysema and bronchitis; asthma is discussed separately for children and adults.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper outpatient treatment may reduce admissions for COPD, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>State, regional, or peer group average.</td>
</tr>
<tr>
<td>Definition</td>
<td>Admissions for COPD per 100,000 population.</td>
</tr>
<tr>
<td>Outcome of Interest</td>
<td>Discharges with ICD-9-CM principal diagnosis codes for COPD.</td>
</tr>
<tr>
<td></td>
<td>Age 18 years and older.</td>
</tr>
<tr>
<td></td>
<td>Exclude patients transferring from another institution, MDC 14 (pregnancy, childbirth, and puerperium), or MDC 15 (newborns and neonates).</td>
</tr>
<tr>
<td>Population at Risk</td>
<td>Population in MSA or county, age 18 years and older.</td>
</tr>
<tr>
<td>Empirical Results and Rating</td>
<td>Rate (2002): 248.6 per 100,000 population</td>
</tr>
<tr>
<td>Rating</td>
<td>17</td>
</tr>
</tbody>
</table>

Summary of Evidence

Hospital admission for COPD is a PQI that would be of most interest to comprehensive health care delivery systems. COPD can often be controlled in an outpatient setting. Areas may wish to use chart reviews to understand more clearly whether admissions are a result of poor quality care or other problems.

This indicator is measured with high precision, and the observed variance likely reflects true differences across areas. Risk adjustment for age and sex appears to most affect the areas with the highest rates. Several factors that are likely to vary by area may influence the progression of the disease, including smoking and socioeconomic status. Risk adjustment for observable characteristics is recommended.

Areas may wish to identify hospitals that contribute the most to the overall area rate for this indicator. The patient populations served by these hospitals may be a starting point for interventions.

Limitations on Use

As a PQI, COPD is not a measure of hospital quality, but rather one measure of outpatient and other health care. This indicator has unclear construct validity, because it has not been validated except as part of a set of indicators.

Providers may reduce admission rates without actually improving quality by shifting care to an outpatient setting. Some COPD care takes place in emergency rooms, so combining inpatient and emergency room data may give a more accurate picture.

Details

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

Admissions for COPD include exacerbations of COPD, respiratory failure, and (rarely) lung volume reduction surgery or lung transplantation. Practice guidelines for COPD have been developed and published over the last decade. With appropriate outpatient treatment and compliance, hospitalizations for the exacerbations of COPD and decline in lung function should be minimized.

Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

COPD accounts for a substantial number of hospital admissions, suggesting that the indicator is reasonably precise.\textsuperscript{57} Based on empirical evidence, this indicator is very precise, with a raw area level rate of 324.0 per 100,000 population and a standard deviation of 203.8.

The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is very high, at 93.4\%, indicating that the differences in age-sex adjusted rates likely represent true differences across areas.

\textit{Minimal bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?}

Factors that have been associated with increased admissions for COPD include disease severity, smoking status, age, and socioeconomic status, which are candidates for risk adjustment. Empirical results show that area rankings and absolute performance are somewhat affected by age-sex risk adjustment.

\textit{Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?}

Bindman et al. reported that self-reported access to care explained 27\% of the variation in COPD hospitalization rates at the ZIP code cluster level.\textsuperscript{58} Millman et al. found that low-income ZIP codes had 5.8 times more COPD hospitalizations per capita than high-income ZIP codes.\textsuperscript{59} Physician adherence to practice guidelines and patient compliance also influence the effectiveness of therapy.

Based on empirical results, areas with high rates of COPD admissions also tend to have high rates of admissions for other ACSCs.


\textit{Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?}

One study found that higher rates of COPD admission may in part reflect improvements in access to care, which results in more detection of significant respiratory impairment in the community.\textsuperscript{60} A decline in COPD admission rates may simply reflect a reverse change in coding practices.

\textit{Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?}

This indicator was originally developed by Billings et al. in conjunction with the United Hospital Fund of New York.\textsuperscript{51} It was subsequently adopted by the Institute of Medicine and has been widely used in studies of avoidable hospitalizations.

Pediatric Gastroenteritis Admission Rate (PQI 6)

Pediatric gastroenteritis, which is one of the most common reasons for pediatric hospitalizations, can be treated on an outpatient basis.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper outpatient treatment may reduce admissions for gastroenteritis in the pediatric population, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>State, regional, or peer group average.</td>
</tr>
<tr>
<td>Definition</td>
<td>Admissions for pediatric gastroenteritis per 100,000 population.</td>
</tr>
<tr>
<td>Outcome of Interest</td>
<td>Discharges with ICD-9-CM principal diagnosis codes for gastroenteritis.</td>
</tr>
<tr>
<td></td>
<td>Age less than 18 years.</td>
</tr>
<tr>
<td></td>
<td>Exclude patients transferring from another institution, MDC 14 (pregnancy, childbirth, and puerperium), or MDC 15 (newborns and neonates).</td>
</tr>
<tr>
<td>Population at Risk</td>
<td>Population in MSA or county, age less than 18 years.</td>
</tr>
<tr>
<td>Empirical Results and Rating</td>
<td>Rate (2002): 87.7 per 100,000 population</td>
</tr>
<tr>
<td></td>
<td>Rating: 17</td>
</tr>
</tbody>
</table>

Summary of Evidence

Hospital admission for pediatric gastroenteritis is a PQI that would be of most interest to comprehensive health care delivery systems. Gastroenteritis accounts for nearly 10% of all admissions of children under 5 years of age. This indicator is measured with good precision, and most of the observed variation reflects true differences across areas.

Admissions may be precipitated by poor quality care, lack of compliance with care, and poor access to care, or may be due to environmental causes. Clear guidelines have been published by the Centers for Disease Control and Prevention and the American Academy of Pediatrics; however, there is little compelling evidence that adherence to these guidelines reduces admission rates because many admissions appear to be discretionary and inappropriate. Areas with high rates may want to identify disease severity by looking at the degree of dehydration of patients and comorbidities to establish whether or not admissions are discretionary, appropriate, or due to poor quality care.

Limitations on Use

As a PQI, admission for pediatric gastroenteritis is not a measure of hospital quality, but rather one measure of outpatient and other health care. This indicator has unclear construct validity, because it has not been validated except as part of a set of indicators. Providers may reduce admission rates without actually improving quality by shifting care to an outpatient setting.

Details

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

Gastroenteritis is a common illness in childhood. Treatment guidelines emphasize the importance of appropriate rehydration therapy for mild to moderate dehydration resulting from gastroenteritis to avoid the need for hospitalization. A physician panel agreed that timely and effective ambulatory care would reduce the risk of hospitalization for gastroenteritis.

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Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Relatively precise estimates of gastroenteritis admission across areas or hospitals can be obtained. Gastroenteritis varies seasonally, so care must be taken to ensure a consistent time period for measurement. The wide variation across areas in admission rates may cause random variation in a particular year to be considerable for less populated areas.

The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is high, at 77.8%, indicating that the observed differences in age-sex-adjusted rates likely represent true differences across areas.

Minimum bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

Some admissions for gastroenteritis are unavoidable. However, most children admitted with gastroenteritis appear to have no underlying problems (70%), and most are rehydrated within 12 hours (79%). One study suggests that complicated gastroenteritis admissions may be more common among children of low socioeconomic status. Empirical results show that area rankings are not affected by age-sex risk adjustment.

Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?

No published studies have specifically addressed the construct validity of this indicator. Millman et al. reported that low-income ZIP codes had 1.9 times more pediatric gastroenteritis hospitalizations per capita than high-income ZIP codes.65

Based on empirical results, areas with high rates of pediatric gastroenteritis admissions also tend to have high rates of admissions for other ACSCs.

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Because the optimal hospitalization rate for this condition has not been defined, providers may decrease their rates by failing to hospitalize patients who would truly benefit from inpatient care or by hospitalizing marginally appropriate patients with other concomitant conditions.

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

This indicator was originally developed by Billings et al. in conjunction with the United Hospital Fund of New York. It was subsequently adopted by the Institute of Medicine and has been widely used in a variety of studies of preventable hospitalizations.

Some admissions for gastroenteritis are unavoidable. However, most children admitted with gastroenteritis appear to have no underlying problems (70%), and most are rehydrated within 12 hours (79%). One study suggests that complicated gastroenteritis admissions may be more common among children of low socioeconomic status. Empirical results show that area rankings are not affected by age-sex risk adjustment.

Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?

No published studies have specifically addressed the construct validity of this indicator. Millman et al. reported that low-income ZIP codes had 1.9 times more pediatric gastroenteritis hospitalizations per capita than high-income ZIP codes.65

---

Hypertension Admission Rate (PQI 7)

Hypertension is a chronic condition that is often controllable in an outpatient setting with appropriate use of drug therapy.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper outpatient treatment may reduce admissions for hypertension, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>State, regional, or peer group average.</td>
</tr>
<tr>
<td>Definition</td>
<td>Admissions for hypertension per 100,000 population.</td>
</tr>
<tr>
<td>Outcome of Interest</td>
<td>Discharges with ICD-9-CM principal diagnosis codes for hypertension.</td>
</tr>
<tr>
<td></td>
<td>Age 18 years and older.</td>
</tr>
<tr>
<td></td>
<td>Exclude discharges with specified cardiac procedure codes in any field, patients transferring from another institution, MDC 14 (pregnancy, childbirth, and puerperium), or MDC 15 (newborns and neonates).</td>
</tr>
<tr>
<td>Population at Risk</td>
<td>Population in MSA or county, age 18 years and older.</td>
</tr>
</tbody>
</table>
| Empirical Results and Rating | Rate (2002): 44.4 per 100,000 population  
Rating: 14 |

Summary of Evidence

Hospital admission for hypertension is a PQI that would be of most interest to comprehensive health care delivery systems. Little evidence exists regarding the validity of this indicator, although one study did relate admission rates to access to care problems. This indicator is measured with adequate precision, but some of the variance in age-sex adjusted rates does not reflect true differences in area performance. Adjustment for age-sex is recommended.

Areas may wish to identify hospitals that contribute the most to the overall area rate for this indicator. The patient populations served by these hospitals may be a starting point for interventions.

Limitations on Use

As a PQI, hypertension is not a measure of hospital quality, but rather one measure of outpatient and other health care. Providers may reduce admission rates without actually improving quality by shifting care to an outpatient setting.

Details

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

Hypertension is often controllable in an outpatient setting with appropriate use of drug therapy.

Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Although hypertension is a common condition, hospitalizations for complications of hypertension are relatively uncommon. One study noted that hypertension accounted for only 0.5% of total admissions for ACSCs.66

Based on empirical evidence, this indicator is moderately precise, with a raw area level rate of 37.1 per 100,000 population and a substantial standard deviation of 32.2. The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is moderate, at 69.9%, indicating that some of the observed differences in age-sex adjusted rates likely do not represent true differences in area performance.

Minimum bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk

adjustment and statistical methods to remove most or all bias?

Little evidence exists on potential biases for this indicator. The age structure of the population may possibly affect admission rates for this condition. Weissman et al. reported a reduction of 100% in relative risk for Medicaid patients when adjusting for age and sex. No evidence was found on the effects of comorbidities such as obesity or other risk factors that may vary systematically by area on admission rates for hypertension complications in the area. Empirical results show that age-sex adjustment affects the ranking of those areas in the highest decile.

Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?

Bindman et al. found that an area’s self-rated access to care explained 22% of admissions for hypertension. Weissman et al. found that uninsured patients had a relative risk of admission for hypertension of 2.38 in Massachusetts after adjustment for age and sex, while Maryland had a corresponding relative risk of 1.93. Millman et al. reported that low-income ZIP codes had 7.6 times more hypertension hospitalizations per capita than high-income ZIP codes.

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Little evidence exists on the impact of this quality improvement measure on the delivery of outpatient care for hypertension. There is no published evidence of worse health outcomes in association with reduced hospitalization rates for hypertension. Such an effect seems implausible, given that only the most serious episodes of accelerated or malignant hypertension are treated on an inpatient basis.

Prior use: Has the indicator been used effectively in practice? Does it have potential for working well with other indicators?

This indicator was included originally developed by Billings et al. in conjunction with the United Hospital Fund of New York. It was subsequently adopted by the Institute of Medicine and has been widely used in a variety of studies of avoidable or preventable hospitalizations. This indicator was also included in Weissman’s set of avoidable hospitalizations.

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Congestive Heart Failure Admission Rate (PQI 8)

Congestive heart failure (CHF) can be controlled in an outpatient setting for the most part; however, the disease is a chronic progressive disorder for which some hospitalizations are appropriate.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper outpatient treatment may reduce admissions for CHF, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>State, regional, or peer group average.</td>
</tr>
<tr>
<td>Definition</td>
<td>Admissions for CHF per 100,000 population.</td>
</tr>
<tr>
<td>Outcome of Interest</td>
<td>Discharges with ICD-9-CM principal diagnosis codes for CHF.</td>
</tr>
<tr>
<td></td>
<td>Age 18 years and older.</td>
</tr>
<tr>
<td></td>
<td>Exclude patients discharged with specified cardiac procedure codes in any field, patients transferring from another institution, MDC 14 (pregnancy, childbirth, and puerperium), or MDC 15 (newborns and neonates).</td>
</tr>
<tr>
<td>Population at Risk</td>
<td>Population in MSA or county, age 18 years and older.</td>
</tr>
</tbody>
</table>
| Empirical Results and Rating | Rate (2002): 457.7 per 100,000 population  
|                          | Rating: 14                                                                                           |

Summary of Evidence

Congestive heart failure is a PQI that would be of most interest to comprehensive health care delivery systems. This indicator is measured with high precision, and most of the observed variance reflects true differences across areas.

Risk adjustment for age and sex appears to affect the areas with the highest and lowest raw rates. Areas with high rates may wish to examine the clinical characteristics of their patients to check for a more complex case mix. Patient age, clinical measures such as heart function, and other management issues may affect admission rates.

As the causes for admissions may include poor quality care, lack of patient compliance, or problems accessing care, areas may wish to review CHF patient records to identify precipitating causes and potential targets for intervention.

Limitations on Use

As a PQI, CHF is not a measure of hospital quality, but rather one measure of outpatient and other health care. Providers may reduce admission rates without actually improving quality by shifting care to an outpatient setting.

Some CHF care takes place in emergency rooms. As such, combining inpatient and emergency room data may give a more accurate picture of this indicator.

Details

*Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?*

Physician management of patients with congestive heart failure differs significantly by physician specialty. Such differences in community practices may be reflected in differences in CHF admission rates.

*Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?*

Relatively precise estimates of admission rates for CHF can be obtained, although random variation may be important for small hospitals and rural areas. Based on empirical evidence,


this indicator is very precise, with a raw area level rate of 521.0 per 100,000 population and a standard deviation of 286.5.

The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is very high, at 93.0%, indicating that the observed differences in age-sex adjusted rates very likely represent true differences across areas.

Minimum bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

Important determinants of outcomes with CHF include certain demographic variables, such as patient age; clinical measures; management issues; and treatment strategies. Limited evidence exists on the extent to which these factors can explain area differences in CHF admission rates. Empirical results show that area rankings and absolute performance are somewhat affected by age-sex risk adjustment.

Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?

Billings et al. found that low-income ZIP codes in New York City had 4.6 times more CHF hospitalizations per capita than high-income ZIP codes. Millman et al. reported that low-income ZIP codes had 6.1 times more CHF hospitalizations per capita than high-income ZIP codes.

Based on empirical results, areas with high rates of CHF also tend to have high rates of admission for other ACSCs.

Fosters true quality improvement: Is the indicator insulated from perverse incentives for

providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Outpatient interventions such as the use of protocols for ambulatory management of low-severity patients and improvement of access to outpatient care would most likely decrease inpatient admissions for CHF.

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

This indicator was originally developed by Billings et al. in conjunction with the United Hospital Fund of New York. It was subsequently adopted by the Institute of Medicine and has been widely used in a variety of studies of avoidable hospitalizations.

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**Notes:**


Low Birth Weight Rate (PQI 9)

Infants may be low birth weight because of inadequate intrauterine growth or premature birth. Risk factors include sociodemographic and behavioral characteristics, such as low income and tobacco use during pregnancy.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper preventive care may reduce incidence of low birth weight, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>State, regional, or peer group average.</td>
</tr>
<tr>
<td>Definition</td>
<td>Number of low birth weight infants per 100 births.</td>
</tr>
<tr>
<td>Outcome of Interest</td>
<td>Number of births with ICD-9-CM diagnosis codes for birth weight less than 2500 grams in any field.</td>
</tr>
<tr>
<td></td>
<td>Exclude patients transferring from another institution.</td>
</tr>
<tr>
<td>Population at Risk</td>
<td>All births (discharges in MDC 15, newborns and neonates) in MSA or county.</td>
</tr>
<tr>
<td>Empirical Results and Rating</td>
<td>Rate (2002): 5.9 per 100 eligible births</td>
</tr>
<tr>
<td></td>
<td>Rating: 11 out of 16 (Bias was not tested because adequate risk adjustment for low birth weight was not available.) (Smoothing recommended)</td>
</tr>
</tbody>
</table>

Summary of Evidence

Low birth weight is a PQI that would be of most interest to comprehensive health care delivery systems. Healthy People 2010 has set a goal of reducing the percentage of low birth weight infants to 0.9%.79

Mothers who give birth to low birth weight infants generally receive less prenatal care than others, and prenatal care persists as a risk factor for low birth weight when adjusting for potential confounds. However, comprehensive care programs in high-risk women have failed to reduce low birth weights. In some studies, specific counseling aimed at reducing a specific risk factor in a specific population may have some impact on reducing low birth weight.

Adequate risk adjustment may require linkage to birth records, which record many of the sociodemographic and behavioral risk factors noted in the literature review (race, age, drug use, stress). Birth records in some States are a rich source of information that could help to identify causes of low birth weight and help to delineate potential areas of intervention.

Where risk adjustment is not possible, results may provide some guidance to case mix in the

Limitations on Use

As a PQI, low birth weight is not a measure of hospital quality, but rather one measure of outpatient and other health care. This indicator could have substantial bias that would require additional risk adjustment from birth records or clinical data.

Details

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

Risk factors for low birth weight may be addressed with adequate prenatal care and education. Prenatal education and care programs have been established to help reduce low birth weight and other complications in high-risk populations.

Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Although low birth weight births account for only a small fraction of total births, the large number of births suggest that this indicator should be

precisely measurable for most areas. Based on empirical evidence, this indicator is precise, with a raw area level rate of 3.9% and a standard deviation of 2.3%. The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is moderate, at 67.1%, indicating that some of the observed differences in age-sex adjusted rates do not represent true differences in area performance.

Minimum bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

Socioeconomic measures such as parental education and income have been shown to be negatively associated with rates of low birth weight infants. Demographic factors such as age and race also appear important, and may be correlated with socioeconomic factors. Mothers under 17 years and over 35 years are at a higher risk of having low birth weight infants. One study of all California singleton births in 1992 found that after risk adjustment, having a black mother remained a significant risk factor. Little evidence exists on the extent to which each of these factors contributes to differences in the rate of low birth weight births across geographic areas.

Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?

While specific studies have demonstrated an impact of particular interventions, especially in high-risk populations, evidence on the impact of better prenatal care on low birth weight rates for area populations is less well developed. In one study, the use of prenatal care accounted for less than 15% of the differences between low birth weight in black and white mothers enrolled in an HMO. However, increasing the level of prenatal care was associated with lower rates of low birth weight, particularly in the black patient population.

Low birth weight is inversely related to the other ACSCs and is positively related to perforated appendix rate. Empirical evidence suggests that this indicator at an area level could be potentially biased.

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Use of this indicator is unlikely to lead to apparent reductions in the rate of low birth weight births that did not represent true reductions.

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

Low birth weight is an indicator in the Health Plan Employer Data and Information Set (HEDIS) measure set for insurance groups and is used by United Health Care and the University Hospital Consortium. This indicator, along with very low birth weight, was previously an HCUP QI.

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Dehydration Admission Rate (PQI 10)

Dehydration is a serious acute condition that occurs in frail patients and patients with other underlying illnesses following insufficient attention and support for fluid intake. Dehydration can for the most part be treated in an outpatient setting, but it is potentially fatal for elderly, very young children, frail patients, or patients with serious comorbid conditions.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper outpatient treatment may reduce admissions for dehydration, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>State, regional, or peer group average.</td>
</tr>
<tr>
<td>Definition</td>
<td>Admissions for dehydration per 100,000 population.</td>
</tr>
<tr>
<td>Outcome of Interest</td>
<td>Discharges with ICD-9-CM principal diagnosis code for hypovolemia (276.5).</td>
</tr>
<tr>
<td></td>
<td>Exclude patients transferring from another institution, MDC 14 (pregnancy, childbirth, and puerperium), or MDC 15 (newborns and other neonates).</td>
</tr>
<tr>
<td>Population at Risk</td>
<td>Population in MSA or county.</td>
</tr>
<tr>
<td>Empirical Results and Rating</td>
<td>Rate (2002): 139.9 per 100,000 population</td>
</tr>
</tbody>
</table>

Summary of Evidence
Hospital admission for dehydration is a PQI that would be of most interest to comprehensive health care delivery systems. Admission for dehydration is somewhat common, suggesting that the indicator will be measured with adequate precision, and most of the observed variation is likely to reflect true differences in admission rates.

This indicator is subject to minimal bias. Risk adjustment appears to affect modestly the areas with the highest and lowest rates. Age may be a particularly important factor, and the indicator should be risk-adjusted for age. Areas with high rates of dehydration admissions also tend to have high rates of admission for other ACSCs.

The considerable variations across areas suggest opportunities for quality improvement in care for patients at risk for dehydration. When high rates of dehydration are identified for a particular hospital, additional study may uncover problems in primary or emergency care in the surrounding area. Appropriate interventions can be developed to address those problems.

Limitations on Use
As a PQI, dehydration is not a measure of hospital quality, but rather one of the measures of outpatient and other health care.

This indicator has unclear construct validity, because it has not been validated except as part of a set of indicators. Providers may reduce admission rates without actually improving quality by shifting care to an outpatient setting. Some dehydration care takes place in emergency rooms. As such, combining inpatient and emergency room data may give a more accurate picture of this indicator.

Details
Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

Dehydration is a potentially fatal condition, and appropriate attention to fluid status can prevent the condition. If left untreated in older adults, serious complications, including death (over 50%), can result.

Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Little evidence exists in the literature on the precision of this indicator. Based on empirical

by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Use of this indicator might lead to higher thresholds of admission for patients with dehydration, potentially denying needed care to some patients. Because some dehydration can be managed on an outpatient basis, a shift to outpatient care may occur.

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

This indicator was originally developed by Billings et al. in conjunction with the United Hospital Fund of New York.

The age structure of the population may affect admission rates for this condition, as the elderly and very young are more susceptible to dehydration. Socioeconomic factors may also affect admission rates. Differences in thresholds for admission of patients with dehydration may contribute to area rate differences. Empirical results show that area rankings are not affected by age-sex risk adjustment.

Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?

Billings et al. found that low-income ZIP codes in New York City had 2 times more dehydration hospitalizations per capita than high-income ZIP codes.\textsuperscript{87} Household income explained 42\% of this variation. In addition, Millman et al.\textsuperscript{88} reported that low-income ZIP codes had 2 times more dehydration hospitalizations per capita than high-income ZIP codes.

Based on empirical results of this study, areas with high rates of dehydration admissions also tend to have high rates of admission for other ACSCs.

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance


Bacterial Pneumonia Admission Rate (PQI 11)

Bacterial pneumonia is a relatively common acute condition, treatable for the most part with antibiotics. If left untreated in susceptible individuals—such as the elderly—pneumonia can lead to death.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper outpatient treatment may reduce admissions for bacterial pneumonia in non-susceptible individuals, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>State, regional, or peer group average.</td>
</tr>
<tr>
<td>Definition</td>
<td>Admissions for bacterial pneumonia per 100,000 population.</td>
</tr>
<tr>
<td>Outcome of Interest</td>
<td>Discharges with ICD-9-CM principal diagnosis code for bacterial pneumonia.</td>
</tr>
<tr>
<td></td>
<td>Exclude patients with sickle cell anemia or HB-S disease, patients transferring from another institution, MDC 14 (pregnancy, childbirth, and puerperium), or MDC 15 (newborns and neonates).</td>
</tr>
<tr>
<td>Population at Risk</td>
<td>Population in MSA or county.</td>
</tr>
</tbody>
</table>
| Empirical Results and Rating | Rate (2002): 349.7 per 100,000 population  
Rating: 17 | quality by shifting care to an outpatient setting. Because some pneumonia care takes place in an emergency room setting, combining inpatient and emergency room data may give a more accurate picture of this indicator. |

Summary of Evidence
Hospital admission for bacterial pneumonia is a PQI that would be of most interest to comprehensive health care delivery systems. High admission rates may reflect a large number of inappropriate admissions or low-quality treatment with antibiotics. Admission for pneumonia is relatively common, suggesting that the indicator will be measured with good precision, and most of the observed variation reflects true differences in admission rates.

This indicator is subject to some moderate bias, and risk adjustment appears to affect the areas with the highest rates the most. Age may be a particularly important factor, and the indicator should be risk-adjusted for this factor. Areas may wish to examine the outpatient care for pneumonia and pneumococcal vaccination rates to identify potential processes of care that may reduce admission rates. The patient populations served by hospitals that contribute the most to the overall area rate for pneumonia may be a starting point for interventions.

Limitations on Use
As a PQI, admission for bacterial pneumonia is not a measure of hospital quality, but rather one measure of outpatient and other health care.

This indicator has unclear construct validity, because it has not been validated except as part of a set of indicators. Providers may reduce admission rates without actually improving quality by shifting care to an outpatient setting. Because some pneumonia care takes place in an emergency room setting, combining inpatient and emergency room data may give a more accurate picture of this indicator.

Details

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

Vaccination for pneumococcal pneumonia in the elderly and early management of bacterial respiratory infections on an ambulatory basis may reduce admissions with pneumonia. A vaccine developed for the elderly has been shown to be 45% effective in preventing hospitalizations during peak seasons.\(^{69}\)

Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Little evidence exists in the literature on the precision or variation in pneumonia admission rates. Based on empirical evidence, this indicator is precise, with a raw area level rate of 395.6 per 100,000 population and a standard deviation of 208.5.

The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is very high, at 92.9%, indicating that the observed differences in age-sex adjusted rates likely represent true differences across areas. Using multivariate signal extraction techniques appears to have little additional impact on estimating true differences across areas.

Minimum bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

A review of the literature suggests that comorbidities or other risk factors that may vary systematically by area do not significantly affect the incidence of hospitalization for pneumonia. Differences in thresholds for admission of patients with bacterial pneumonia may contribute to area rate differences. Empirical results show that area rankings and absolute performance are somewhat affected by age-sex risk adjustment.

Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?

Billings et al. found that low-income ZIP codes in New York City had 5.4 times more pneumonia admissions per capita than high-income ZIP codes. Household income explained 53% of this variation. In addition, Millman et al. reported that low-income ZIP codes had 5.4 times more pneumonia hospitalizations per capita than high-income ZIP codes.

Based on empirical results, areas with high rates of bacterial pneumonia admissions also tend to have high rates of admissions for other ACSCs.

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Use of this indicator might lead to higher thresholds of admission for pneumonia patients. Because pneumonia can be managed on an outpatient basis, a shift to outpatient care may occur, which might be inappropriate for more severely ill patients.

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

This indicator was included in Weissman’s set of avoidable hospitalizations.

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92 Weissman JS, Gatsonis C, Epstein AM. Rates of avoidable hospitalization by insurance status in Massachusetts and Maryland JAMA 1992;268(17)2388-94.
Urinary Tract Infection Admission Rate (PQI 12)

Urinary tract infection is a common acute condition that can, for the most part, be treated with antibiotics in an outpatient setting. However, this condition can progress to more clinically significant infections, such as pyelonephritis, in vulnerable individuals with inadequate treatment.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper outpatient treatment may reduce admissions for urinary infection, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>State, regional, or peer group average.</td>
</tr>
<tr>
<td>Definition</td>
<td>Admissions for urinary tract infection per 100,000 population.</td>
</tr>
<tr>
<td>Outcome of Interest</td>
<td>Discharges with ICD-9-CM principal diagnosis code for urinary tract infection.</td>
</tr>
<tr>
<td></td>
<td>Exclude patients transferring from another institution, MDC 14 (pregnancy, childbirth, and puerperium), or MDC 15 (newborns and neonates).</td>
</tr>
<tr>
<td>Population at Risk</td>
<td>Population in MSA or county.</td>
</tr>
<tr>
<td>Empirical Results and Rating</td>
<td>Rate (2002): 137.9 per 100,000 population Rating: 11</td>
</tr>
</tbody>
</table>

Summary of Evidence

Hospital admission for urinary tract infection is a PQI that would be of most interest to comprehensive health care delivery systems. Admission for urinary tract infection is uncommon, but the observed variation is likely to reflect true differences across areas.

Risk adjustment appears to affect the areas with the highest rates the most, and using this indicator without risk adjustment may result in the misidentification of some areas as outliers. This indicator is subject to some moderate bias and should be adjusted for age and sex. The patient populations served by hospitals that contribute the most to the overall area rate for urinary tract infection may be a starting point for interventions.

Limitations on Use

As a PQI, admission for urinary tract infection is not a measure of hospital quality, but rather one measure of outpatient and other health care. This indicator has unclear construct validity, because it has not been validated except as part of a set of indicators. Providers may reduce admission rates without actually improving quality by shifting care to an outpatient setting. Some urinary tract infection care takes place in emergency rooms. As such, combining inpatient and emergency room data may give a more accurate picture of this indicator.

Details

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

Uncomplicated urinary tract infections can be treated with antibiotics in the ambulatory setting; however, inappropriate treatment can lead to more serious complications. Admission for urinary tract infection among children, which is rare, is associated with physiological abnormalities.

Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Little evidence exists in the literature on the precision and variation associated with this indicator. Based on empirical evidence, this indicator is precise, with a raw area level rate of 145.1 per 100,000 population and a standard deviation of 89.5. The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is high, at 84.9%, indicating that the observed differences in age-sex adjusted rates likely represent true differences across areas. Using multivariate signal extraction techniques appears to have little additional impact on estimating true differences across areas.
Minimum bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

Differences in thresholds for admission of patients with urinary tract infection may contribute to area rate differences. Empirical results show that area rankings and absolute performance are somewhat affected by age-sex risk adjustment.

Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?

Billings et al. found that low-income ZIP codes in New York City had 2.2 times more urinary tract infection admissions than high-income ZIP codes. Household income explained 28% of this variation. In addition, Millman et al. reported that low-income ZIP codes had 2.8 times more urinary tract infection hospitalizations per capita than high-income ZIP codes.

Based on empirical results, areas with high admission rates for urinary tract infections also tend to have high admission rates for other ACSCs.

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Use of this indicator might lead to higher thresholds of admission for patients with urinary tract infections.

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

This indicator was originally developed by Billings et al. in conjunction with the United

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95 Weissman JS, Gatsonis C, Epstein AM. Rates of avoidable hospitalization by insurance status in Massachusetts and Maryland. JAMA 1992;268(17)2388-94.
Angina without Procedure Admission Rate (PQI 13)

Both stable and unstable angina are symptoms of potential coronary artery disease. Effective management of coronary disease reduces the occurrence of major cardiac events such as heart attacks, and may also reduce admission rates for angina.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper outpatient treatment may reduce admissions for angina (without procedures), and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>State, regional, or peer group average.</td>
</tr>
<tr>
<td>Definition</td>
<td>Admissions for angina (without procedures) per 100,000 population.</td>
</tr>
<tr>
<td>Outcome of Interest</td>
<td>Discharges with ICD-9-CM principal diagnosis codes for angina.</td>
</tr>
<tr>
<td></td>
<td>Age 18 years and older.</td>
</tr>
<tr>
<td></td>
<td>Exclude discharges with a procedure code for cardiac procedure, patients transferring from another institution, MDC 14 (pregnancy, childbirth, and puerperium), or MDC 15 (newborns and neonates).</td>
</tr>
<tr>
<td>Population at Risk</td>
<td>Population in MSA or county, age 18 years and older.</td>
</tr>
<tr>
<td>Empirical Results and Rating</td>
<td>Rate (2002): 55.1 per 100,000 population</td>
</tr>
<tr>
<td></td>
<td>Rating: 19</td>
</tr>
</tbody>
</table>

Summary of Evidence

Hospital admission for angina is a PQI that would be of most interest to comprehensive health care delivery systems. Admission for angina is relatively common, suggesting that the indicator will be measured with good precision. The observed variation likely reflects true differences in area performance.

Age-sex adjustment has a moderate impact. Other risk factors for consideration include smoking, hyperlipidemia, hypertension, diabetes, and socioeconomic status. The patient populations served by hospitals that contribute the most to the overall area rate for angina may be a starting point for interventions.

Limitations on Use

As a PQI, angina without procedure is not a measure of hospital quality, but rather one measure of outpatient and other health care. This indicator has unclear construct validity, because it has not been validated except as part of a set of indicators. Providers may reduce admission rates without actually improving quality of care by shifting care to an outpatient setting. Some angina care takes place in emergency rooms. Combining inpatient and emergency room data may give a more accurate picture.

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

Stable angina can be managed in an outpatient setting using drugs such as aspirin and beta blockers, as well as advice to change diet and exercise habits. Effective treatments for coronary artery disease reduce admissions for serious complications of ischemic heart disease, including unstable angina.

Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Reasonably precise estimates of area angina rates should be feasible, as one study shows that unstable angina accounts for 16.3% of total


admissions for ACSCs. Based on empirical evidence, this indicator is adequately precise, with a raw area level rate of 166.0 per 100,000 population and a standard deviation of 135.7.

The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is very high, at 91.6%, indicating that the observed differences in age-sex adjusted rates likely represent true differences across areas. Using multivariate signal extraction techniques appears to have little additional impact on estimating true differences across areas.

**Minimum bias:** Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

No evidence exists in the literature on the potential bias of this indicator. The incidence of angina is related to age structure and risk factors (smoking, hyperlipidemia, hypertension, diabetes) in a population. Elderly age (over 70), diabetes, and hypertension have also been associated with being at higher risk for angina.

**Construct validity:** Does the indicator perform well in identifying true (or actual) quality-of-care problems?

Billings et al. found that low-income ZIP codes in New York City had 2.3 times more angina hospitalizations than high-income ZIP codes. Household income explained 13% of this variation. In addition, Millman et al. reported that low-income ZIP codes had 2.7 times more angina hospitalizations per capita than high-income ZIP codes.

Based on empirical study, areas with high rates of angina admissions tend to have higher rates of other ACSC admissions.

**Fosters true quality improvement:** Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Use of this quality indicator might raise the threshold for admission of angina patients. Because some angina can be managed on an outpatient basis, a shift to outpatient care may occur but is unlikely for severe angina.

**Prior use:** Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

This indicator was originally developed by Billings et al. in conjunction with the United Hospital Fund of New York.

Uncontrolled Diabetes Admission Rate (PQI 14)

Uncontrolled diabetes should be used in conjunction with short-term complications of diabetes, which include diabetic ketoacidosis, hyperosmolarity, and coma.*

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper outpatient treatment and adherence to care may reduce the incidence of uncontrolled diabetes, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>State, regional, or peer group average.</td>
</tr>
<tr>
<td>Definition</td>
<td>Admissions for uncontrolled diabetes per 100,000 population.</td>
</tr>
<tr>
<td>Outcome of Interest</td>
<td>Discharges with ICD-9-CM principal diagnosis codes for uncontrolled diabetes, without mention of a short-term or long-term complication.</td>
</tr>
<tr>
<td></td>
<td>Age 18 years and older.</td>
</tr>
<tr>
<td></td>
<td>Exclude patients transferring from another institution, MDC 14 (pregnancy, childbirth, and puerperium), or MDC 15 (newborns and neonates).</td>
</tr>
<tr>
<td>Population at Risk</td>
<td>Population in MSA or county, age 18 years and older.</td>
</tr>
</tbody>
</table>
| Empirical Results and Rating | Rate (2002): 23.0 per 100,000 population  
Rating: 14 |  |

* This indicator is designed to be combined with “Short Term Diabetes Complication Admission Rate” to create the Healthy People 2010 indicator. To do so, users may simply add the rates of the two indicators together.

Summary of Evidence

Hospital admission for uncontrolled diabetes is a PQI that would be of most interest to comprehensive health care delivery systems. Healthy People 2010 has established a goal to reduce the hospitalization rate for uncontrolled diabetes in persons 18-64 years of age from 7.2 per 10,000 population to 5.4 per 10,000 population. Combining this indicator with the short-term diabetes indicator will result in the Healthy People 2010 measure, except that this QI excludes transfers from another institution to reduce double counting of cases. As a result the rate for the AHRQ QI may be minimally lower than the Healthy People 2010 indicator.

This indicator is moderately precise. The observed differences across areas likely reflect true differences in area performance. Age-sex adjustment slightly changes area rankings.

Limitations on Use

As a PQI, uncontrolled diabetes is not a measure of hospital quality, but rather one measure of outpatient and other health care. Rates of diabetes may vary systematically by area, creating bias for this indicator.

Details

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

High-quality outpatient management of diabetic patients has been shown to lead to reductions in almost all types of serious avoidable hospitalizations. However, tight control may be associated with more episodes of hypoglycemia that lead to more admissions.

Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Based on empirical evidence, this indicator is moderately precise, with a raw area level rate of 34.7 per 100,000 population and a standard deviation of 28.1.

The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance

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rather than random variation) is high, at 72.6%, indicating that the observed differences in age-sex adjusted rates likely represent true differences in area performance. Using multivariate signal extraction techniques appears to have little additional impact on estimating true differences across areas.

Minimum bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

Minorities have higher rates of diabetes, and higher hospitalization rates may result in areas with higher minority concentrations. Empirical results show that area rankings in the highest and lowest deciles are slightly affected by age-sex adjustment.

Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?

Based on empirical results, areas with high rates of uncontrolled diabetes also tend to have high rates of admission for other ACSCs.

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Because diabetic emergencies are potentially life-threatening, hospitals are unlikely to fail to admit patients requiring hospitalization.

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

This measure corresponds closely with the measure of short-term diabetes that was developed by Billings et al. and described in this document.102 The key exception is the ICD-9-CM codes 25002 and 25003, which are the only codes included for uncontrolled diabetes.

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Adult Asthma Admission Rate (PQI 15)

Asthma is one of the most common reasons for hospital admission and emergency room care. Most cases of asthma can be managed with proper ongoing therapy on an outpatient basis. Most published studies combine admission rates for children and adults; therefore, areas may wish to examine this indicator together with pediatric asthma.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper outpatient treatment may reduce the incidence or exacerbation of asthma requiring hospitalization, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>State, regional, or peer group average.</td>
</tr>
<tr>
<td>Definition</td>
<td>Admissions for adult asthma per 100,000 population.</td>
</tr>
<tr>
<td>Outcome of Interest</td>
<td>Discharges with ICD-9-CM principal diagnosis codes for asthma.</td>
</tr>
<tr>
<td></td>
<td>Age 18 years and older.</td>
</tr>
<tr>
<td></td>
<td>Exclude patients transferring from another institution, MDC 14 (pregnancy, childbirth, and puerperium), or MDC 15 (newborns and neonates).</td>
</tr>
<tr>
<td>Population at Risk</td>
<td>Population in MSA or county, age 18 years and older.</td>
</tr>
<tr>
<td>Empirical Results and Rating</td>
<td>Rate (2002): 110.9 per 100,000 population Rating: 16</td>
</tr>
</tbody>
</table>

Summary of Evidence

Hospital admission for asthma is a PQI that would be of most interest to comprehensive health care delivery systems.

Environmental factors such as air pollution, occupational exposure to irritants, or other exposure to allergens have been shown to increase hospitalization rates or exacerbate asthma symptoms. While race has been shown to be associated with differences in admission rates, it is unclear whether this is due to differences in severity of disease or inadequate access to care. Adjustment for race is recommended.

Admission rates have been associated with lower socioeconomic status. Areas may wish to identify hospitals that contribute the most to the overall area rate for this indicator. The patient populations served by these hospitals may be a starting point for interventions.

Limitations on Use

As a PQI, adult asthma is not a measure of hospital quality, but rather one measure of outpatient and other health care. Providers may reduce admission rates without actually improving quality by shifting care to an outpatient setting.

Admission rates that are drastically below or above the average or recommended rates should be further examined.

Details

*Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?*

According to the National Asthma Education Program, asthma is a readily treatable chronic disease that can be managed effectively in the outpatient setting.103 Observational studies offer some evidence that inhaled steroids may decrease risk of admission by up to 50%.104 105


Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Asthma is a common cause of admission for adults, and as such this measure is likely to have adequate precision. Based on empirical evidence, this indicator is adequately precise, with a raw area level rate of 107.9 per 100,000 population and a standard deviation of 81.7. The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is high, at 83.6%, indicating that the observed differences in age-sex adjusted rates likely represent true differences across areas.

Minimum bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

Numerous environmental risk factors for asthma have been identified, including allergens, tobacco smoke, and outdoor air pollution. Race represents one of the most complex potentially biasing factors for this indicator. Black patients have consistently been shown to have higher asthma admission rates, even when stratifying for income and age. Adjustment for race is recommended. Empirical results show that area rankings are not affected by age-sex risk adjustment.

Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?

Billings et al. found that low-income ZIP codes in New York City had 6.4 times more asthma hospitalizations than high-income ZIP codes. Household income explained 70% of this variation. In addition, Millman et al. reported that low-income ZIP codes had 5.8 times more asthma hospitalizations per capita than high-income ZIP codes.

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

There is little evidence to suggest that asthmatics are being inappropriately denied admission to the hospital. However, because some asthma can be managed on an outpatient basis, a shift to outpatient care may occur.

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

This indicator was originally developed by Billings et al. in conjunction with the United Hospital Fund of New York, and is included in Weissman’s set of avoidable hospitalizations.

Numerous environmental risk factors for asthma have been identified, including allergens, tobacco smoke, and outdoor air pollution. Race represents one of the most complex potentially biasing factors for this indicator. Black patients have consistently been shown to have higher asthma admission rates, even when stratifying for income and age. Adjustment for race is recommended. Empirical results show that area rankings are not affected by age-sex risk adjustment.

Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?

Billings et al. found that low-income ZIP codes in New York City had 6.4 times more asthma hospitalizations than high-income ZIP codes. Household income explained 70% of this variation. In addition, Millman et al. reported that low-income ZIP codes had 5.8 times more asthma hospitalizations per capita than high-income ZIP codes.

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

There is little evidence to suggest that asthmatics are being inappropriately denied admission to the hospital. However, because some asthma can be managed on an outpatient basis, a shift to outpatient care may occur.

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

This indicator was originally developed by Billings et al. in conjunction with the United Hospital Fund of New York, and is included in Weissman’s set of avoidable hospitalizations.
Rate of Lower-extremity Amputation among Patients with Diabetes (PQI 16)

Diabetes is a major risk factor for lower-extremity amputation, which can be caused by infection, neuropathy, and microvascular disease.

<table>
<thead>
<tr>
<th>Relationship to Quality</th>
<th>Proper and continued treatment and glucose control may reduce the incidence of lower-extremity amputation, and lower rates represent better quality care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>State, regional, or peer group average.</td>
</tr>
<tr>
<td>Definition</td>
<td>Admissions for lower-extremity amputation in patients with diabetes per 100,000 population.</td>
</tr>
<tr>
<td>Outcome of Interest</td>
<td>Discharges with ICD-9-CM procedure codes for lower-extremity amputation in any field and diagnosis code for diabetes in any field.</td>
</tr>
<tr>
<td></td>
<td>Age 18 years and older.</td>
</tr>
<tr>
<td></td>
<td>Exclude discharges with trauma, patients transferring from another institution, MDC 14 (pregnancy, childbirth, and puerperium), or MDC 15 (newborns and neonates).</td>
</tr>
<tr>
<td>Population at Risk</td>
<td>Population in MSA or county, age 18 years and older.</td>
</tr>
<tr>
<td>Empirical Results and Rating</td>
<td>Rate (2002): 36.8 per 100,000 population Rating:10 (Smoothing recommended)</td>
</tr>
</tbody>
</table>

Summary of Evidence

Hospital admissions for lower-extremity amputation among patients with diabetes is a PQI that would be of most interest to comprehensive health care delivery systems.

Lower-extremity amputation (LEA) affects up to 15% of all patients with diabetes in their lifetimes. A combination of factors may lead to this high rate of amputation, including minor trauma to the feet, which is caused by loss of sensation and may lead to gangrene. Proper long-term glucose control, diabetes education, and foot care are some of the interventions that can reduce the incidence of infection, neuropathy, and microvascular diseases. Healthy People 2010 has set a goal of reducing the number of LEAs to 1.8 per 1,000 persons with diabetes.

Studies have shown that LEA varies by age and sex, and age-sex risk adjustment affects moderately the relative performance of areas. Race may bias the indicator, since the rates of diabetes and poor glycemic control are higher among Native Americans and Hispanic Americans. However, results must be interpreted with care when adjusting for race, because poor quality care may also vary systematically with racial composition.

Limitations on Use

As a PQI, lower-extremity amputations among patients with diabetes is not a measure of hospital quality, but rather one measure of outpatient and other health care. PQIs are correlated with each other and may be used in conjunction as an overall examination of outpatient care.

Details

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

In the United States, diabetes is the leading cause of nontraumatic amputations (approximately 57,000 per year). Possible

References:
interventions include foot clinics, wearing proper footwear, and proper care of feet and foot ulcers.\textsuperscript{114}

**Precision:** Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Based on empirical evidence, this indicator is moderately precise, with a raw area level rate of 30.5 per 100,000 population and a substantial standard deviation of 42.7.

The signal ratio (i.e., the proportion of the total variation across areas that is truly related to systematic differences in area performance rather than random variation) is moderate, at 68.5\%, indicating that some of the observed differences in age-sex adjusted rates likely do not represent true differences in area performance. Using multivariate signal extraction techniques appears to have little additional impact on estimating true differences across areas.

**Minimum bias:** Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

Several sociodemographic variables are associated with the risk of lower-extremity amputation, including age, duration of diabetes, and sex.\textsuperscript{115,116} Empirical results show that age-sex adjustment affects the relative performance of areas.

**Construct validity:** Does the indicator perform well in identifying true (or actual) quality-of-care problems?

Several studies of intervention programs have noted a decrease in amputation risk. One recent study noted a 1-year post-intervention decrease of 79\% in amputations in a low-income African American population. Interventions included foot care education, assistance in finding properly fitting footwear, and prescription footwear.\textsuperscript{117} One observational study found that patients who receive no outpatient diabetes education have a three-fold higher risk of amputation than those receiving care.\textsuperscript{118}

**Fosters true quality improvement:** Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Given the severity of conditions requiring lower-extremity amputation, hospitals are unlikely to fail to admit patients requiring hospitalization.

**Prior use:** Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

This indicator is not widely used; however, it is included in the DEMPAQ measure set for outpatient care.

---

\textsuperscript{114}Pecoraro et al. 1990.
\textsuperscript{115}Mayfield et al. 1998.
References


Appendix A: Prevention Quality Indicator Definitions

Definitions use ICD-9-CM codes valid from October 1, 1994 to September 30, 2005. For ICD-9-CM codes introduced after October 1995, the date of introduction is indicated after the code label. For example, "OCT96-" indicates the ICD-9-CM code was introduced in October 1996.

### Diabetes Short-term Complications Admission Rate (PQI 1)

**Numerator:**

Discharges with ICD-9-CM principal diagnosis code for short-term complications (ketoacidosis, hyperosmolarity, coma) (see below).

All non-maternal/non-neonatal discharges of age 18 years and older.

**Exclude:**

Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium) and MDC 15 (newborns and other neonates).

**Include ICD-9-CM diagnosis codes:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>25010</td>
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</tr>
<tr>
<td>25011</td>
<td>DM KETO T1, DM CONT</td>
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<td>25013</td>
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<td>25020</td>
<td>DM W/ HYPROSM T2, DM CONT</td>
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<tr>
<td>25021</td>
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</tr>
</tbody>
</table>

**Denominator:**

Population in MSA or county, age 18 years and older.

### Perforated Appendix Admission Rate (PQI 2)

**Numerator:**

Discharges with ICD-9-CM diagnosis code for perforations or abscesses of appendix (see below) in any field.

**Exclude:**

Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium) and MDC 15 (newborns and other neonates).

**Include ICD-9-CM diagnosis codes (outcome of interest):**

<table>
<thead>
<tr>
<th>Code</th>
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</tr>
</thead>
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<tr>
<td>5400</td>
<td>AC APPEND W PERITONITIS</td>
</tr>
<tr>
<td>5401</td>
<td>ABSCESS OF APPENDIX</td>
</tr>
</tbody>
</table>
### Perforated Appendix Admission Rate (PQI 2)

**Denominator:**

Number of discharges with diagnosis code for appendicitis in any field in MSA or county.

Include ICD-9-CM diagnosis codes (population at risk):

<table>
<thead>
<tr>
<th>Code</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>5400</td>
<td>AC APPEND W PERITONITIS</td>
</tr>
<tr>
<td>5401</td>
<td>ABSCESS OF APPENDIX</td>
</tr>
<tr>
<td>5409</td>
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</tr>
<tr>
<td>541</td>
<td>APPENDICITIS NOS</td>
</tr>
</tbody>
</table>

### Diabetes Long-term Complications Admission Rate (PQI 3)

**Numerator:**

Discharges with ICD-9-CM principal diagnosis code for long-term complications (renal, eye, neurological, circulatory, or complications not otherwise specified) (see below).

All non-maternal/non-neonatal discharges of age 18 years and older.

Exclude:

Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium) and MDC 15 (newborns and other neonates).

Include ICD-9-CM diagnosis codes:

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<thead>
<tr>
<th>Code</th>
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<td>25040</td>
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<tr>
<td>25042</td>
<td>DM RENAL COMP T2 UNCNT</td>
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<tr>
<td>25043</td>
<td>DM RENAL COMP T1 UNCNT</td>
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<td>DM EYE COMP T2 CONT</td>
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**Denominator:**

Population in MSA or county, age 18 years and older.
### Pediatric Asthma Admission Rate (PQI 4)

**Numerator:**

Discharges with ICD-9-CM principal diagnosis code of asthma (see below).

All non-maternal/non-neonatal discharges of under age 18.

**Exclude:**

Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium) and MDC 15 (newborns and other neonates).

Include ICD-9-CM diagnosis codes:

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<thead>
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<th>Code</th>
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<th>Code</th>
<th>Description</th>
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</tr>
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<tr>
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<td>49381</td>
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<td>49391</td>
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<tr>
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<td>49392</td>
<td>ASTHMA W ACUTE EXACERBTN OCT00-</td>
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</tbody>
</table>

**Denominator:**

Population in MSA or county, under age 18.

### Chronic Obstructive Pulmonary Disease (COPD) Admission Rate (PQI 5)

**Numerator:**

Discharges with ICD-9-CM principal diagnosis code for COPD (see below).

All non-maternal/non-neonatal discharges of age 18 years and older.

**Exclude:**

Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium) and MDC 15 (newborns and other neonates).

Include ICD-9-CM diagnosis codes:

<table>
<thead>
<tr>
<th>Code</th>
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<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
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<td>4920</td>
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<td>4928</td>
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<td>4911</td>
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<tr>
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<td>49121</td>
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<td>496</td>
<td>CHR AIRWAY OBSTRUCT NEC</td>
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</table>

*Qualifies only if accompanied by secondary diagnosis of 491.xx, 492.x, 494.x or 496 (i.e., any other code on this list).

**Denominator:**

Population in MSA or county, age 18 years and older.
### Pediatric Gastroenteritis Admission Rate (PQI 6)

#### Numerator:

Discharges with ICD-9-CM principal diagnosis code for gastroenteritis (see below).

All non-maternal/non-neonatal discharges under age 18.

**Exclude:**

Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium) and MDC 15 (newborns and other neonates).

**Include ICD-9-CM diagnosis codes:**

<table>
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<tr>
<th>Code</th>
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<td>00863</td>
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<td>0092</td>
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</tr>
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<td>5589</td>
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</tr>
</tbody>
</table>

#### Denominator:

Population in MSA or county, under age 18.
Hypertension Admission Rate (PQI 7)

Numerator:

Discharges with ICD-9-CM principal diagnosis code for hypertension (see below).

All non-maternal/non-neonatal discharges of age 18 years and older.

Exclude:

Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium), MDC 15 (newborns and other neonates), and discharges with cardiac procedure codes (see below) in any field.

Include ICD-9-CM diagnosis codes:

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<th>Code</th>
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<tbody>
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Exclude ICD-9-CM procedure codes:

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<td>3541</td>
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<tr>
<td>3542</td>
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<td>3553</td>
<td>PROST REPAIR VENTRIC DEF</td>
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<td>CONDUIT ARTIUM-PULM ART</td>
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<td>HEART REPAIR REVISION</td>
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<td>PERC HEART VALVULOPLASTY</td>
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<td>OTHER HEART SEPTA OPS</td>
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<tr>
<td>3599</td>
<td>OTHER HEART VALVE OPS</td>
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**Denominator:**

Population in MSA or county, age 18 years and older.
## Congestive Heart Failure (CHF) Admission Rate (PQI 8)

### Numerator:

Discharges with ICD-9-CM principal diagnosis code for CHF (see below).

All non-maternal/non-neonatal discharges of age 18 years and older.

Exclude:

Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium), MDC 15 (newborns and other neonates), and discharges with cardiac procedure codes (see below) in any field.

Include ICD-9-CM diagnosis codes:

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Exclude ICD-9-CM procedure codes:

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<td>IMPL CRT DEFIBRILLAT OCT02-</td>
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<td>IMP/REP LEAD LF VEN SYS OCT02-</td>
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### Congestive Heart Failure (CHF) Admission Rate (PQI 8)

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<tr>
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<td>REPL CARDIODEFIB GENRATR</td>
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</tbody>
</table>

#### Denominator:

Population in MSA or county, age 18 years and older.
**Low Birth Weight Rate (PQI 9)**

**Numerator:**

Number of births with ICD-9-CM diagnosis code for less than 2500 grams (see below) in any field.

Exclude:

Transfer from other institution.

Include ICD-9-CM diagnosis codes:

76400 LIGHT-FOR-DATES WTNOS
76401 LIGHT-FOR-DATES <500G
76402 LT-FOR-DATES 500-749G
76403 LT-FOR-DATES 750-999G
76404 LT-FOR-DATES 1000-1249G
76405 LT-FOR-DATES 1250-1499G
76406 LT-FOR-DATES 1500-1749G
76407 LT-FOR-DATES 1750-1999G
76408 LT-FOR-DATES 2000-2499G
76410 LT-FOR-DATE W/MAL WTNOS
76411 LT-FOR-DATE W/MAL <500G
76412 LT-DATE W/MAL 500-749G
76413 LT-DATE W/MAL 750-999G
76414 LT-DATE W/MAL 1000-1249G
76415 LT-DATE W/MAL 1250-1499G
76416 LT-DATE W/MAL 1500-1749G
76417 LT-DATE W/MAL 1750-1999G
76418 LT-DATE W/MAL 2000-2499G
76420 FETAL MALNUTRITION WTNOS
76421 FETAL MALNUTRITION <500G
76422 FETAL MALNUTR 500-749G
76423 FETAL MAL 750-999G
76424 FETAL MAL 1000-1249G
76425 FETAL MAL 1250-1499G
76426 FETAL MAL 1500-1749G
76427 FETAL MALNUTR 1750-1999G
76428 FETAL MALNUTR 2000-2499G

**Denominator:**

All births (discharges in MDC 15 – newborns and other neonates) in MSA or county.
Dehydration Admission Rate (PQI 10)

**Numerator:**
Discharges with ICD-9-CM principal diagnosis code for hypovolemia (see below).

**Exclude:**
Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium) and MDC 15 (newborns and other neonates).

**Include ICD-9-CM diagnosis code:**
2765 HYPOVOLEMIA

**Denominator:**
Population in MSA or county.

Bacterial Pneumonia Admission Rate (PQI 11)

**Numerator:**
Discharges with ICD-9-CM principal diagnosis code for bacterial pneumonia (see below).

**Exclude:**
Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium), MDC 15 (newborns and other neonates), and discharges with diagnosis code for sickle cell anemia or HB-S disease (see below) in any field.

**Include ICD-9-CM diagnosis codes:**
- 481 PNEUMOCOCCAL PNEUMONIA
- 482 H.INFLUENZA PNEUMONIA
- 4820 STREP PNEUMONIA UNSPEC
- 4823 GRP A STREP PNEUMONIA
- 48231 GRP A STREP PNEUMONIA
- 48232 GRP B STREP PNEUMONIA
- 48239 OTH STREP PNEUMONIA
- 481 PNEUMOCOCCAL PNEUMONIA
- 4822 H.INFLUENZA PNEUMONIA
- 4829 BACTERIAL PNEUMONIA NOS
- 4830 MYCOPLASMA PNEUMONIA
- 4831 CHLAMYDIA PNEUMONIA OCT96-
- 4838 OTH SPEC ORG PNEUMONIA
- 485 BRONCOPNEUMONIA ORG NOS
- 488 PNEUMONIA, ORGANISM NOS
- 4829 BACTERIAL PNEUMONIA NOS
- 4830 MYCOPLASMA PNEUMONIA
- 4831 CHLAMYDIA PNEUMONIA OCT96-
- 4838 OTH SPEC ORG PNEUMONIA
- 485 BRONCOPNEUMONIA ORG NOS
- 488 PNEUMONIA, ORGANISM NOS

**Exclude ICD-9-CM diagnosis codes:**
- 28241 THLASEMA HB-S W/O CRISIS OCT03-
- 28242 THLASEMA HB-S W/O CRISIS OCT03-
- 28260 SICKLE-CELL ANEMIA NOS
- 28261 HB-S DISEASE W/O CRISIS
- 28262 HB-S DISEASE WITH CRISIS

**Denominator:**
Population in MSA or county.
Urinary Tract Infection Admission Rate (PQI 12)

Numerator:
Discharges with ICD-9-CM principal diagnosis code of urinary tract infection (see below).

Exclude:
Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium) and MDC 15 (newborns and other neonates).

Include ICD-9-CM diagnosis codes:
- 59000 CHR PYELONEPHRITIS NOS
- 59001 CHR PYELONEPH W MED NECR
- 59010 AC PYELONEPHRITIS NOS
- 59011 AC PYELONEPHR W MED NECR
- 5902 RENAL/PERIRENAL ABSCESS
- 5903 PYELOURETERITIS CYSTICA

Denominator:
Population in MSA or county.

Angina without Procedure Admission Rate (PQI 13)

Numerator:
Discharges with ICD-9-CM principal diagnosis code for angina (see below).
All non-maternal/non-neonatal discharges of age 18 years and older.

Exclude:
Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium), MDC 15 (newborns and other neonates), and discharges with a procedure code for cardiac procedure (see below) in any field.

Include ICD-9-CM diagnosis codes:
- 4111 INTERMED CORONARY SYND
- 41181 CORONARY OCCLSN W/O MI
- 41189 AC ISCHEMIC HRT DIS NEC

Exclude ICD-9-CM procedure codes:
- 0050 IMPL CRT PACEMAKER SYS OCT02-
- 0051 IMPL CRT DEFIBRILLAT OCT02-
- 0052 IMP/REP LEAD LF VEN SYS OCT02-
- 0053 IMP/REP CRT PACEMKR GEN OCT02-
- 0054 IMP/REP CRT DEFIB GENAT OCT02-
- 3500 CLOSED VALVOTOMY NOS
- 3501 CLOSED AORTIC VALVOTOMY
- 3502 CLOSED MITRAL VALVOTOMY
- 3503 CLOSED PULMON VALVOTOMY

### Angina without Procedure Admission Rate (PQI 13)

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<th>Code</th>
<th>Description</th>
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<td>GRAFT REP ENDOCAR CUSHION</td>
<td>3776</td>
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<td>3570</td>
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<td>REMOVAL OF LEAD W/O REPL</td>
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<td>ATRIA SEPTA DEF REP NEC</td>
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<td>3779</td>
<td>REVIS OR RELOCATE POCKET</td>
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<tr>
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<td>3782</td>
<td>INT INSERT 1-CHAM, RATE</td>
</tr>
<tr>
<td>3583</td>
<td>TOT REP TRUNCUS ARTERIOS</td>
<td>3783</td>
<td>INT INSERT DUAL-CHAM DEV</td>
</tr>
<tr>
<td>3584</td>
<td>TOT COR TRANSPOS GRT VES</td>
<td>3785</td>
<td>REPL PACEM W 1-CHAM, NON</td>
</tr>
<tr>
<td>3591</td>
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<td>3786</td>
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<td>3787</td>
<td>REPL PACEM W DUAL-CHAM</td>
</tr>
<tr>
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<td>3789</td>
<td>REVISE OR REMOVE PACEMAK</td>
</tr>
<tr>
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<td>CONDUIT ARTIUM-PULM ART</td>
<td>3794</td>
<td>IMPLT/REPL CARDDEFFIB TOT</td>
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<tr>
<td>3595</td>
<td>HEART REPAIR REVISION</td>
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### Denominator:

Population in MSA or county, age 18 years and older.
### Uncontrolled Diabetes Admission Rate (PQI 14)

**Numerator:**

Discharges with ICD-9-CM principal diagnosis code for uncontrolled diabetes, without mention of a short-term or long-term complication (see below).

All non-maternal/non-neonatal discharges of age 18 years and older.

**Exclude:**

Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium) and MDC 15 (newborns and other neonates).

**Include ICD-9-CM diagnosis codes:**

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<td>25002</td>
<td>DM, T2, UNCONT</td>
</tr>
<tr>
<td>25003</td>
<td>DM, T1, UNCONT</td>
</tr>
</tbody>
</table>

**Denominator:**

Population in MSA or county, age 18 years and older.

May be combined with diabetes short-term complications as a single indicator as a simple sum of the rates to form the Health People 2010 indicator (note that the AHRQ QI excludes transfers to avoid double counting cases).

### Adult Asthma Admission Rate (PQI 15)

**Numerator:**

Discharges with ICD-9-CM principal diagnosis code of asthma (see below).

All non-maternal/non-neonatal discharges age 18 years and older.

**Exclude:**

Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium) and MDC 15 (newborns and other neonates).

**Include ICD-9-CM diagnosis codes:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<td>49310</td>
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<td>49320</td>
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**Denominator:**

Population in MSA or county, age 18 years and older.
Rate of Lower-extremity Amputation among Patients with Diabetes (PQI 16)

Numerator:

Discharges with ICD-9-CM procedure code for lower-extremity amputation (see below) in any field and diagnosis code of diabetes in any field (see below).

All non-maternal/non-neonatal discharges of age 18 years and older.

Exclude:

Transfer from other institution, MDC 14 (pregnancy, childbirth, and puerperium), MDC 15 (newborns and other neonates), and trauma diagnosis code (see below) in any field.

Include ICD-9-CM procedure codes:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<td>TOE AMPUTATION</td>
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<td>8413</td>
<td>DISARTICULATION OF ANKLE</td>
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<tr>
<td>8414</td>
<td>AMPUTAT THROUGH MALLEOLI</td>
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<td>8415</td>
<td>BELOW KNEE AMPUTAT NEC</td>
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<tr>
<td>8416</td>
<td>DISARTICATION OF KNEE</td>
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<tr>
<td>8417</td>
<td>ABOVE KNEE AMPUTATION</td>
</tr>
<tr>
<td>8418</td>
<td>DISARTICATION OF HIP</td>
</tr>
<tr>
<td>8419</td>
<td>HINDQUARTER AMPUTATION</td>
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ICD-9-CM diagnosis codes for diabetes:

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<th>Description</th>
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<td>25001</td>
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</tr>
<tr>
<td>25002</td>
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<tr>
<td>25003</td>
<td>DMII WO CMP UNCNTRLD</td>
</tr>
<tr>
<td>25010</td>
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<tr>
<td>25011</td>
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</tr>
<tr>
<td>25012</td>
<td>DMII KETOACD UNCONTROLD</td>
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<td>25013</td>
<td>DMI KETOACD UNCONTROLD</td>
</tr>
<tr>
<td>25020</td>
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<td>25021</td>
<td>DMI HPRSM NT ST UNCNTRLD</td>
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<tr>
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<tr>
<td>25023</td>
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<td>25030</td>
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Exclude ICD-9-CM diagnosis codes associated with trauma:

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Denominator:

Population in MSA or county, age 18 years and older.
Appendix B: Detailed Methods

This appendix describes the methods used by the University of California-San Francisco (UCSF) Evidence-based Practice Center to refine the Healthcare Cost and Utilization Project (HCUP) quality indicators.

Semi-structured Interviews

The project team and previous developers of the HCUP Quality Indicators (HCUP QIs) developed a contact list of individuals associated with hospital associations, business coalitions, State data groups, and Federal agencies. This list was designed to include QI users and potential users from a broad spectrum of organizations in both the public and private sectors; it was not intended as a representative sample. All contacts were faxed an introductory letter and asked to participate as advisors on the project with a short telephone interview. This request was well received; only six out of 37 declined participation themselves without suggesting an alternative respondent. Overall, the 31 contacts phoned expressed interest in the study, offering many suggestions and comments. The composition of the 31 interviewees is as follows: three consultants, two Federal agency employees, one health plan medical director, five representatives of hospital associations, one international academic researcher, four representatives of private accreditation groups, two representatives of private data groups, two members of professional organizations, five representatives of provider and other private organizations, three representatives of State data groups, and three representatives of other health care organizations.

The semi-structured interviews were designed to identify potential indicators, concerns of end users, and other factors important in the development of quality indicators that may not be captured in the published literature. Thus, academic researchers, whose work is more likely to appear in peer-reviewed journals, were reserved as peer reviewers for the final document. As a result, the results of the semi-structured interviews are not intended to be a non-biased representation of the opinions regarding quality indicators, but rather a sampling of those opinions not likely to be available in the peer-reviewed literature.

The interviewers solicited information on the development and use of quality indicators by the targeted organizations, as well as other known measures and additional contacts. Interviewers used a semi-structured interview and recorded information from the interview on a data-collection form. Further, some advisors provided the project team with materials regarding quality indicators and the use of HCUP QIs.

Quality Indicators Evaluation Framework

Six areas were considered essential for evaluating the reliability and validity of a proposed quality indicator. Several sources contributed to the development of the evaluation criteria framework: (1) results of the semi-structured interviews, including the interests and concerns of HCUP QI users, (2) task order document describing the Agency for Healthcare Research and Quality’s (AHRQ) interests, (3) evidence available in the policy and research literature and (4) evidence available through statistical analyses. The six criteria were quite similar to the criteria for “testing the scientific strength of a measure” proposed by McGlynn and Asch. They describe a measure as reliable “if, when repeatedly applied to the same population, the same result is obtained a high proportion of the time.” They propose evaluating validity in terms of face validity, criterion validity (“an objective assessment of the ability of the measure to predict a score on some other measure that serves as the evaluation criterion”), and construct validity (“whether the correlations between the measure and other measures are of the right magnitude and in the right direction”). Criterion validity was viewed as an assessment of bias (criterion #3), where the “gold standard” measure is purged of bias due to severity of illness. Face validity captures a variety of concepts discussed by McGlynn and Siu, including the importance of the condition, the efficacy of
available treatments (e.g., the ability of providers to improve outcomes), and the potential for improvement in quality of care.\[2\]

Evidence supporting the use of current and candidate quality indicators was assembled in terms of the following six areas.

- **Face validity**: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?
- **Precision**: Is there a substantial amount of provider or community level variation that is not attributable to random variation?
- **Minimum bias**: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?
- **Construct validity**: Does the indicator perform well in identifying true (or actual) quality-of-care problems?
- **Fosters real quality improvement**: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?
- **Application**: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

In addition to the above framework, the Donabedian paradigm of structure, process, and outcome was followed to categorize current (HCUP) and candidate QIs.\[3, 4\] For example, potentially inappropriate utilization falls into the category of process, while in-hospital mortality, adverse events, and complication rates represent outcome measures.

Three broad audiences for the quality measures were considered: health care providers and managers, who would use the quality measures to assist in initiatives to improve quality; public health policy-makers, who would use the information from indicators to target public health interventions; and health care purchasers and consumers, who would potentially use the measures to guide decisions about health policies and providers. Because of the limitations of quality indicators derived based on administrative data, the focus was primarily on applications oriented to “screening for potential quality problems.” For the purpose of the Evaluation Framework, indicators must at least pass tests indicating that they are appropriate for the use of screening. The rest of this section provides a more detailed explanation of each part of the Evaluation Framework, considering these three audiences wherever differences have been noted in the literature.

- **Face validity**: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

This question considers the degree to which potential users view the quality indicator as important and informative. There are two parts to this question: Does the indicator relate to an aspect of health care that users regard as important? And does performance on the measure credibly indicate high-quality care? Obviously, face validity will be influenced by how well the indicator performs in the other areas covered in the Evaluation Framework. Clinicians tend to distrust outcome measures because of concerns over the adequacy of risk adjustment and the multiple factors beyond providers’ control that contribute to poor outcomes. Other critics add that outcome measures suffer from imprecision (with random noise outweighing provider differences) and important selection biases (e.g., due to variations in admitting practices). Addressing this issue at the outset serves as a point of reference for the findings of the literature review and empirical analysis.
Broadly speaking, consumers, health care payers, regulators, and public health officials are likely to be most interested in measures based on outcomes that are relatively frequent, costly, or have serious implications for an individual’s health. In addition, there should be reason to believe that the outcome may be (at least somewhat) under providers’ control (in other words, controlled trials or well-designed cohort studies have shown that specific diagnostic or therapeutic modalities may reduce its frequency or severity). Outcome measures might include operative mortality rates or mortality after hospitalization with serious acute illnesses such as a heart attack. These measures seem most intuitive, since they assess the main outcomes that medical treatments are intended to affect.

Perhaps surprisingly, however, reports of hospital mortality rates appear to have little effect on where patients seek their care. One reason may be that many patients describe difficulty in interpreting indicators involving mortality and morbidity rates, and consequently view them as unhelpful. Another reason may be that providers prefer measures of process, particularly if there is reason to believe (generally from randomized controlled trials) that certain processes truly lead to better patient outcomes. Patients appear to prefer reports of other patients’ satisfaction with care, and especially informal recommendations from family, friends, and their own physicians. Thus, developing indicators with high face validity for patients may require active participation from patients, targeting aspects of care identified as important in patient surveys, or taking additional steps to enhance provider perceptions about the validity of outcome measures.

Many providers view outcome-based QIs with considerable skepticism. For most outcomes, the impacts of random variation and patient factors beyond providers’ control often overwhelm differences attributable to provider quality. Consequently, providers tend to support measures of quality based on processes of care that have been documented in clinical trials to lead to better health outcomes in relatively broad groups of patients — for example, the processes of acute MI care measured in the Cooperative Cardiovascular Project. Such process measures focus precisely on the aspects of care under providers’ control. As long as the process measures are based on evidence of effectiveness, they serve as useful proxies for outcome measures that would otherwise be difficult to observe or measure. For example, when using inpatient discharge data only, it is not possible to ascertain out-of-hospital mortality. In general, process measures are not as noisy as outcome measures, because they are less subject to random variation. They also suggest specific steps that providers may take to improve outcomes or reduce costs—even if such outcome improvements are difficult to document at the level of particular providers.

The relationship between some structural quality measures and important outcomes has been well-documented, although some concerns remain about the interpretation of the measures. These measures include measures of hospital volume for volume-sensitive conditions, technological capabilities (e.g., ability to perform certain intensive procedures like coronary angioplasty), and teaching status. All of these measures have limited face validity, because they are widely acknowledged to be weak surrogates for true quality of care. For example, many low-volume hospitals have been shown to achieve excellent outcomes, whereas many high-volume hospitals have surprisingly poor outcomes.

- Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

The impact of chance on apparent provider or community health system performance must be considered. Unobserved patient and environmental factors may result in substantial differences in performance among providers in the absence of true quality differences. Moreover, the same providers may appear to change from year to year, in the absence of changes in the care they deliver. Thus, using “raw” quality data will often result in poorly reproducible, or imprecise, measurements, giving an incorrect impression of provider quality.

An extensive literature on the importance of random variations in quality measures now exists. In general, random variation is most problematic when there are relatively few observations per provider, when adverse outcome rates are relatively low, and when providers have little control over...
patient outcomes or when variation in important processes of care is minimal. If a large number of patient factors that are difficult to observe influence whether or not a patient has an adverse outcome, it may be difficult to separate the "quality signal" from the surrounding noise. The evidence on the precision of each of the evaluated QIs was reviewed. Empirical methods can be used to assess both the importance of sample size and the importance of provider effects (versus patient and area effects) in explaining observed variation in the measure.

But this is not entirely a statistical question, and considerations of mechanisms and concerns related to face validity can also be helpful in assessing the precision of a measure. For example, if better hospitals invariably admit sicker patients, then the apparent variation in a measure at the hospital level will be significantly less than the true variation (see the discussion of unbiasedness below). In such a case, other sources of evidence suggesting that a measure is valid or that such bias exists can be helpful in assessing the quality measure. The literature review encompasses both empirical and other sources of evidence on measure precision, and the empirical analysis presents systematic evidence on the extent of provider-level or area-level variation in each quality measure.

Statistical techniques can account for random variations in provider performance by estimating the extent to which variation across providers appears to be clustered at the provider level, versus the extent to which it can be explained by patient and area effects.\(^{68-71}\) Under reasonable statistical assumptions, the resulting estimates of the extent to which quality truly varies at the provider or area level can be used to "smooth" or "shrink" estimates of the quality of specific providers or areas. The methods are Bayesian: the data used to construct the quality measures are used to update a “prior” distribution of provider quality estimates, so that the “posterior” or smoothed estimate of a provider’s (or area’s) quality is a best guess, reflecting the apparent patient- and provider-level (or area-level) variance of measure performance.

- **Minimum bias:** Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

A QI may exhibit precision, but nonetheless yield inaccurate results due to systematic measurement biases. Extensive research has documented the importance of selection problems in interpreting many quality measures, especially measures related to mortality.\(^{72-76}\) Such biases may have two basic forms: differences in admitting practices between two hospitals produce non-random samples from the same underlying patient population (selection biases) or the patient populations may in fact contain different case-mixes. Selection effects presumably exert a greater influence on measures involving elective admissions and procedures, for which physician admission and treatment practice styles show marked variation.\(^{56, 57}\) Nonetheless, selection problems exist even for conditions involving urgent “non-discretionary” admissions, likely due to modest practice variation, and non-random distribution of patient characteristics across hospital catchment areas.\(^{59, 77}\) The attention of researchers and quality analysts has focused on developing valid models to adjust for patient factors, especially when comparing hospital mortality.\(^{72, 74}\)

The principal statistical approach to address concerns about bias is risk adjustment.\(^{78, 79, 60, 61, 80-86}\) Numerous risk adjustment instruments currently exist, but current methods are far from perfect.\(^{79, 87}\) In general, risk adjustment methods are based on data drawn from administrative data and medical chart reviews.\(^{78}\) Previous studies suggest that administrative data have at least two major limitations. First, coding errors and variations are common; some diagnoses are frequently entered with errors and with some inconsistency across hospitals.\(^{68-90}\) Factors affecting the accuracy of these codes include restrictions on the number of secondary diagnoses permitted, as well as systematic biases in documentation and coding practices introduced by awareness that risk-adjustment and reimbursement are related to the presence of particular complications.\(^{91-96}\)

Second, most administrative data sources do not distinguish disorders that can be in-hospital complications from pre-existing comorbidities.\(^{78, 97}\) To the extent that diagnoses such as shock and
pulmonary edema may result from poor quality of care, their incorporation in prediction models may bias estimates of expected mortality, and even favor hospitals whose care results in more complications. One proprietary risk-adjustment system has been shown to be significantly biased by its inclusion of conditions that actually developed after admission, but this study was limited to one condition (acute MI) and its conclusions are somewhat controversial.\cite{86, 99} In another study, estimates of mortality differences between municipal and voluntary hospitals in New York City were substantially affected by whether potential complications were excluded from risk-adjustment.\cite{61} New York and California have recently added a “6th digit” to ICD-9-CM codes to distinguish secondary diagnoses present at admission from those that developed during hospitalization. This refinement may allow valid comparisons of risk-adjusted mortality using administrative data for certain conditions, although the accuracy of the “6th digit” has not been established.\cite{100}

Clinically based risk adjustment systems supplement hospital discharge data with information available from medical records. Because exact clinical criteria can be specified for determining whether a diagnosis is present, coding errors are diminished. In addition, complications can be distinguished from comorbidities focusing on whether the diagnosis was present at admission.\cite{79} Because the number of clinical variables that may potentially influence outcomes is small, and because these factors differ to some extent across diseases and procedures, progress in risk-adjustment has generally occurred by focusing on patients with specific conditions. Thus, sophisticated chart-based risk adjustment methods have been developed and applied for interpreting mortality rates for patients undergoing cardiac surgery and interventional cardiology procedures; critically ill patients; patients undergoing general surgery; and medical patients with acute myocardial infarction, community-acquired pneumonia, and upper gastrointestinal hemorrhage.\cite{29, 36, 85, 101-107}

However, chart-based risk adjustment methods are not without their own limitations. First, especially for severely ill patients and those who die soon after admission—some of the most important patients for computing many quality measures—complete diagnosis information may not have been ascertained prior to death, and therefore would not be in the patient’s medical record. Important observations might be missing for such patients, resulting in biased estimates in the risk-adjusted model. Second, medical chart reviews are very costly, and so routine collection of detailed risk information is not always feasible. As a result, the impact of chart-based risk adjustment may vary across measures. For some measures, its impact is modest and does not substantially alter relative rankings of providers.\cite{113-116} For others, it is much more important.\cite{79, 97, 108-112} Of course, because all risk adjustment methods generally leave a substantial amount of outcome variation unexplained, it is possible that unmeasured differences in patient mix are important even in the most detailed chart-based measures.

For each quality measure, this report reviews the evidence on whether important systematic differences in patient mix exist at the provider and community level, and whether various risk adjustments significantly alter the quality measure for particular providers. A distinction is made between risk adjustment methods that rely on administrative data and have been validated with clinical data, and those that are not validated. Risk adjustment methods requiring clinical data cannot be applied to the HCUP data, and therefore are not covered in this report. The empirical analysis then assesses whether a common approach to risk adjustment using administrative data—the 3M™ All Patient Refined Diagnosis Related Groups (APR-DRG) system—significantly alters the quality measure for specific providers. Emphasis is placed on the impact on relative measures of performance (whether risk adjustment affects which hospitals are regarded as high- or low-quality) rather than absolute measures of performance (whether risk adjustment affects a hospital’s quantitative performance on the quality measure). As noted above, this system is not ideal, because it provides only four severity levels within each base APR-DRG, omits important physiologic and functional predictors, and potentially misadjusts for iatrogenic complications. Information on the 3M™ APR-DRG system is available at http://www.3m.com/us/healthcare/his/products/coding/refined_drg.jhtml.

A remaining methodological issue concerns the appropriateness of adjusting for certain “risk factors.”\cite{117-128} For example, “Do Not Resuscitate” status may be associated with differences in care that not only reflect patient preferences (e.g., less use of intensive treatments) but also true differences in quality of care (e.g., inadequate physician visits), resulting in increased complications that would result in
a “Do Not Resuscitate” order, and increased mortality.\textsuperscript{127} Importantly, the prevalence of patients with DNR status may vary nonrandomly between hospitals, with large referral centers having greater percentages of patients seeking (and receiving) aggressive medical care.\textsuperscript{128}

Adjusting for race implies that patients of different races respond differently to the same treatments, when patients of different races may actually receive different treatments. A substantial literature documents systematic differences in the care delivered to patients by race and gender.\textsuperscript{116, 129-135} For example, African-American diabetics undergo limb amputations more often than do diabetics of other races.\textsuperscript{136} Thus, wherever possible it is noted if review of the literature indicates particularly large differences in a quality measure by race or gender. Some gender or race differences may be due to either patient preference or physiological differences that would be appropriate to include in a risk adjustment model. In other cases, differences denote lower quality care, and in this case race and gender should not be included in the risk adjustment model. Where applicable, this is noted in the literature review.

- Construct validity: Does the indicator perform well in identifying true (or actual) quality-of-care problems?

Ideally, a hospital will perform well on a quality measure if and only if it does not have a significant quality problem, and will perform poorly if and only if it does. In practice, of course, no measure performs that well. The analyses of noise and bias problems with each measure are intended to assess two of the principal reasons why a hospital might appear relatively good or bad (or not appear so) when it really is not (or really is). Detecting quality problems is further complicated by the fact that adverse outcomes are often the result of the course of an illness, rather than an indication of a quality problem at a hospital. Formally, one would like to know the sensitivity and specificity of a quality measure, or at least the positive predictive value (PPV) of a quality measure for detecting a true hospital quality problem.\textsuperscript{119}

When available, for each measure, any existing literature was reviewed on its sensitivity or PPV for true provider quality problems. In most cases, however, no true gold standard, or ideal measure of quality, was found. Therefore, construct validity was tested, i.e., the construct is that different measures of quality, on the same patients, should be related at each other at the provider level, even if it is not always clear which measure is better. It may be easier to ask “is the indicator correlated with other, accepted measures of quality at the provider level?” rather than “does the indicator perform well in identifying providers with quality problems?” For example, studies have validated survey rankings of “best” hospitals by examining the relation with actual process and outcome measures for AMI, and peer review failure rates with HCFA risk-adjusted mortality rates.\textsuperscript{137, 138}

- Fosters real quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Ideally, when quality measures are used to guide quality improvement initiatives or reward good providers, the best way for a provider to perform well on the measure is to provide high-quality care. Unfortunately, many quality indicators appear to at least leave open the possibility of improving measured performance without improving true quality of care.

In measures that are risk-adjusted, measured performance can be improved by “upcoding” — including more comorbid diagnoses in order to increase apparent severity of illness.\textsuperscript{63, 96} Systematic biases in diagnostic codes were observed after the introduction of the Prospective Payment System and may also explain much of the apparent reduction in adjusted mortality attributed to the Cardiac Surgery Reporting System in New York.\textsuperscript{95-96} The extent to which upcoding is a problem probably increases with

\textsuperscript{119} The PPV represents that the chance that a positive test result reflects a “true positive.” It combines the properties of the test itself (e.g., sensitivity and specificity for detecting quality problems) with the prevalence of true quality problems in the target population.
the ambiguity of the specific data element, and decreases when auditing programs maximize the reliability and validity of submitted data. In recent years, an aggressive auditing program has significantly reduced the extent to which comorbidities not substantiated by the medical chart are recorded for Medicare patients, leading some analysts to conclude that “upcoding” is no longer as substantial of a problem for Medicare patients. However, such audit standards have generally not been imposed on the State discharge databases used in the HCUP project. In this review, indicators for which risk adjustment appears to be important are noted, and thus upcoding is a potentially important problem.

Indicators capturing patient morbidity, such as adverse events and complications, must overcome a reporting bias in the reverse direction (i.e., toward under-reporting). With some exceptions, most hospitals in most States rely on voluntary incident reporting for adverse events. Such methods are known to detect only a fraction of true adverse drug events (ADEs). The Institute of Medicine has recently recommended mandatory reporting systems for adverse events emanating from certain egregious errors. However, the JCAHO’s sentinel reporting system tracks many of these same errors (e.g., operating on the wrong patient or body part, suicide or rape of an inpatient), and it was received very negatively by hospitals, despite being a voluntary system. Thus, the degree to which mandatory reporting requirements alleviate or exacerbate reporting bias for adverse events remains to be seen. In addition, high-quality hospitals with sophisticated error detection systems may report errors more frequently, leading to high apparent complication rates in hospitals that may have superior quality in other dimensions.

Perverse incentives may arise from the criteria used to define or identify the target patient population. For instance, restricting mortality measures to inpatient deaths potentially allows hospitals to lower their mortality rates simply by discharging patients to die at home or in other institutions. Measures of surgical site infections and other complications of hospital care that only capture in-hospital events will similarly reward hospitals that merely reduce length of stay by discharging or transferring high-risk cases. Early concerns that surgeons in New York avoided operating on high-risk patients may have proved unfounded, though this issue remains unsettled. In general, the incentive for providers to avoid treating sicker patients remains a significant concern for outcome-based quality measures.

The available evidence on each of these possible undesirable responses to the use of each quality measure was reviewed. For the most part, evidence was lacking on responses to indicators, particularly since many of the proposed indicators have not been subjected to public reporting. Potential responses were noted when appropriate.

• Application: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

While important problems exist with many specific applications of HCUP QIs and other quality indicators, they have been applied in a range of settings. As noted in the section on face validity, these applications broadly include initiatives to improve provider quality and initiatives to provide quality-related information to providers and consumers. Studies describing its use in these activities were reviewed for each quality indicator. However, a thorough review of the non-peer reviewed literature was not conducted. Therefore, indicators may have been adopted, and may continue to be used, by many provider organizations or Government agencies.

A recent systematic review more comprehensively summarizes the literature on the impact of performance reports on consumers, providers, and purchasers. Useful and accurate information on quality remains a desirable goal for consumers and providers alike. The interest in quality and the resulting data and research has had some impact on the field of health services research. For instance, the HCUP project has provided a valuable resource for a number of studies in health services research.
Literature Review of Quality Indicators

A literature review was conducted to identify quality indicators reported as such and potential quality measures. The result of this first stage was a comprehensive list of measures that could be defined based on routinely collected hospital discharge data. In the second phase, the literature was searched for further evidence on these indicators to provide information on their suitability for the new QI set. This second phase resulted in a comprehensive bibliography for each indicator. In addition, a subset of the entire indicator list was selected for detailed review using specific evaluation criteria. The entire process for this systematic review of the literature is described in the following sections.

Phase 1: Identification of Indicators

Step 1: Selecting the articles. To locate literature pertaining to quality indicators, a strategic literature search was conducted using the Medline database. Over 30 search strategies were compared using Medical Subject Headings (MeSH) based on their ability to retrieve a set of key articles known to the project team. Successful combinations of MeSH term searches returned all the key articles. The final MeSH terms used were “hospital, statistic and methods” and “quality indicators.” Articles were also limited to those published in 1994 or later. Articles prior to 1994 had been reviewed for the original QI development. This search returned approximately 2,600 articles—the highest number of known key articles in the most concise manner.

Articles were screened using the titles and abstracts for preliminary abstraction. To qualify for preliminary abstraction, the articles must have described a potential indicator or quality relationship that could be adequately defined using administrative data, and be generalizable to a national data set. For the purpose of this study, a quality indicator was defined as an explicit measure (defined by the developer) of some aspect of health care quality. Some literature defines only a quality relationship, in that the article expounds on a process or structural aspect of a health care provider that is related to better outcomes. However, the author does not specifically define or recommend that the relationship be used as a quality measure. In this case, the article only describes a quality relationship, not a quality indicator. Only 181 articles met the criteria for preliminary abstraction. This reflects the small number of quality indicators with published formal peer-reviewed evaluations.

Step 2: Preliminary abstraction. The preliminary round was designed to screen articles for applicability and quality, to obtain and assess the clinical rationale of the indicators, and to identify those articles with enough detail for a more comprehensive abstraction. Nine abstractors participated in this phase. Five of these abstractors were medical doctors with health services research training. The remaining four abstractors were familiar with the project and the literature, and included a project manager, the research coordinator, and two undergraduate research assistants.

The articles were sorted into clinical groupings. The research coordinator rated these clinical groupings according to the amount of clinical knowledge required to abstract the articles. Those requiring the most clinical knowledge were assigned to physicians, while those requiring the least clinical knowledge were assigned to the undergraduate research assistants. Abstractors selected clinical groupings that were of interest or that corresponded to their clinical specialties.

Abstractors recorded information about each article on a one-page abstraction form. Information coded included:

- Indicator type (i.e. mortality, readmission, potentially overused procedures)
- Clinical domain (i.e. medical, surgical, obstetric, pediatric, and psychiatric)
- Measure category (i.e. structure, process, proxy-outcome, and outcome)
- Clinical rationale for the indicators
- Use of longitudinal data
• Use of data beyond hospital discharge data
• Strengths and weaknesses identified by the author
• Strengths and weaknesses not identified by the author.

Each abstraction form was reviewed by the research coordinator for quality of the abstraction and for accuracy of the coding. All data were then entered into a Microsoft Access database.

**Step 3: Full abstraction.** The purpose of the full abstraction phase was to identify potential indicators for the new QI set, and to assess the evidence for validity of existing indicators. To accomplish this, only articles that described an indicator in conjunction with specific and comprehensive information on its validity were fully abstracted. Four of the original abstractors participated in this phase of the abstraction. Three of these abstractors were medical doctors, the fourth a master’s level research coordinator.

Each of the articles for preliminary abstraction and the corresponding abstraction form was reviewed by both the research coordinator and the project manager independently. To qualify for full abstraction, the articles needed to meet the previously noted criteria and the following criteria:

- Define a quality indicator, as opposed to only a relationship that was not formulated or explicitly proposed as a measurement tool
- Discuss a novel indicator, as opposed to indicators defined elsewhere and used in the article only to discuss its relationship with another variable (i.e., socioeconomic status, race, urbanization)
- Define an indicator based on administrative data only.

Only 27 articles met these formal criteria. This highlights an important aspect of the literature on quality indicators: most indicators are based on published clinical literature to identify important patient and provider characteristics and processes of care for specific clinical conditions; there is also a substantial literature on technical aspects such as severity adjustment, coding, and data collection. It should be noted that, while only 27 articles qualified for formal abstraction, these are not the only useful articles. Many articles provide important information about quality measurement. However, few quality indicators are specifically defined, evaluated, and reported in the literature besides descriptive information on the process of development. (The Complication Screening Program is a noteworthy and laudable exception that has been extensively validated in the published literature, mostly by the developers). This evidence report will be an important contribution to the paucity of literature on indicator validation.

An abstraction form was filled out for each indicator defined in an article. The abstraction form coded the following information:

- All the information coded in the preliminary abstraction form
- Measure administrative information (i.e. developer, measure set name, year published)
- Level of care (primary (prevention), secondary (screening or early detection) or tertiary (treatment to prevent mortality/morbidity))
- Scoring method (i.e. rate, ratio, mean, proportion)
- A priori suggested quality standard (i.e. accepted benchmark, external comparison, and internal comparison)
- Indicator definition (numerator, denominator statements, inclusions, and exclusions)
- Extent of prior use
- Current status (i.e. measure defined, pilot tested, implemented, discontinued)
• Scientific support for measure (i.e. published guidelines, clinician panel, literature review, revision of pre-existing instruments, theory only)
• Other essential references for the measure
• Validity testing
• Risk adjustment.

If the measure included risk adjustment, a separate form for the risk adjustment method was filled out. This included:

• Method administrative information
• Adjustment rationale
• Classification or analytic approach (i.e. stratification, logistic or linear regression)
• System development method (i.e. logistic regression, score based on empirical model, a priori/clinical judgment)
• Published performance for discrimination and calibration
• Use of comorbidities, severity of illness, or patients demographics
• Use of longitudinal data, or additional data sources beyond discharge data
• Extent of current use
• Other essential references for the method
• Abstractor comments.

The abstraction forms were reviewed by the research coordinator and entered into a Microsoft Access database.

Parallel Step: Supplementing literature review using other sources. Because the literature in this area is not the primary source for reporting the use of quality indicators, a list of suitable indicators was compiled from a variety of sources. As previously noted, the phone interviews with project advisors led to information on some indicators. In addition, the Internet sites of known organizations using quality indicators; the CONQUEST database; National Library of Healthcare Indicators (NLHI), developed by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO); and a list of ORYX-approved indicators provided by the JCAHO were searched. Indicators that could be defined using administrative data were recorded in an indicator database.

Breakdown of indicators by primary source. During Phase 1, no one literature search was sufficiently sensitive for the purpose of identifying either quality indicators or quality relationships. In addition, there was relatively little literature defining quality indicators. Web sites, organizations, and additional literature describing quality indicators were searched to be confident that a large percentage of the quality indicators in use were identified. In general, most volume, utilization, and ACSC indicators have been described primarily in the literature. On the other hand, the primary sources for most mortality and length of stay indicators were current users or databases of indicators. However, many indicators found in the literature were also reported by organizations, and vice versa. Thus, it is difficult to delineate which indicators were derived only from the literature and which were derived from the parallel step described above.

Phase 2: Evaluation of Indicators

The result of Phase 1 was a list of potential indicators with varied information on each depending on the source. Since each indicator relates to an area that potentially screens for quality issues, a
structured evaluation framework was developed to determine measurement performance. A series of literature searches were then conducted to assemble the available scientific evidence on the quality relationship each indicator purported to measure. Due to limited resources, not all of the indicators identified in Phase 1 could be reviewed, and therefore some were selected for detailed review using the evaluation framework. The criteria used to select these indicators are described later.

**Step 1. Development of evaluation framework.** As described previously, a structured evaluation of each indicator was developed and applied to assess indicator performance in six areas:

- Face validity
- Precision
- Minimum bias
- Construct validity
- Fosters real quality improvement
- Prior use.

**Step 2. Identification of the evidence.** The literature was searched for evidence in each of the six areas of indicator performance described above, and in the clinical areas addressed by the indicators. The search strategy used for Phase 2 began with extensive electronic searching of MEDLINE, PsycINFO, and the Cochrane Library.\(^{[170-172]}\) A decision was made not to search EMBASE on the grounds that the studies of quality measurement necessarily must take into account the particular health care system involved.\(^{[173]}\) In contrast to conducting systematic reviews of purely clinical topics, it was reasoned that the European literature not captured in the Medline database or Cochrane Library would almost certainly represent studies of questionable relevance to the U.S. health system.

The extensive electronic search strategy involved combinations of MeSH terms and keywords pertaining to clinical conditions, study methodology, and quality measurement (Figure B-1).

Additional literature searches were conducted using specific measure sets as "keywords". These included "Maryland Quality Indicators Project," "HEDIS and low birth weight, or cesarean section, or frequency, or inpatient utilization," "IMSystem," "DEMPAQ," and "Complications Screening Program."

The bibliographies of key articles were searched, and the Tables of Contents of general medical journals were hand searched, as well as journals focusing in health services research or in quality measurement. This list of journals included *Medical Care, Health Services Research, Health Affairs, Milbank Quarterly, Inquiry, International Journal for Quality in Healthcare,* and *the Joint Commission Journal on Quality Improvement.* These literature searches and on-line screening for relevancy retrieved over 2,000 additional articles, which were added to the project database. These articles were used for evaluations of individual indicators.

The use of medical literature databases likely eliminated much of the “gray literature” that may be applicable to this study. Given the limitations and scope of this study, a formal search of the “gray literature” was not completed beyond that which was previously known by the project team or resulted from telephone interviews.
Step 3. Selection of a sub-set of indicators. Since there were too many indicators identified in Phase 1 (literature search and parallel steps) for detailed evaluation using the Evaluation Framework, criteria were developed to select a group for further evaluation. These criteria were intended to be top-level evaluations of the face validity and precision of the indicators. A subset of indicators was selected for preliminary empirical evaluation. To do this, first the indicators related to complications were disqualified for this particular report, since they will be included in an expansion to the report that will include patient safety indicators. Second, all of the current HCUP QIs (except those related to complications of care) were selected for empirical evaluation. Third, the priority of clinical areas well covered by the current HCUP indicator set was lowered (for example, obstetrical indicators). Finally, a set of criteria for selection was applied to the remaining indicators.

The following were specific criteria for evaluation for all indicators:

- Indicator must be definable with HCUP data (i.e., uses only administrative data available in HCUP data set).
  - Conditions that affect at least 1% of hospitalized patients or 20% of providers, as tested using the Nationwide Inpatient Sample data set
  - Conditions that are the subject of public reporting, previous use, or large dollar volume
  - Clear relationship to quality apparent as evaluated by clinical judgment of health services researchers and medical doctors.

In addition, several specific criteria were noted for the indicator types:

- Volume:
  - Widely documented volume-outcome relationship
  - Recent evidence regarding volume-outcome relationship
• Utilization rates:
  < Condition must have an alternative surgical or medical therapy with lower/higher morbidity or mortality.

• Ambulatory care sensitive conditions:
  < Differences in patient management practices for that condition
  < Existence of treatment guidelines, and evidence of failure to comply.

• In-hospital mortality
  < Relatively homogenous group.

When selecting between competing alternatives that met all the above criteria, the choice was made to evaluate clinical areas in depth rather than evaluating a large breadth of indicators. To do this, multiple aspects in one clinical domain were evaluated (i.e., evaluations of CABG, PTCA, and AMI; stroke and carotid endarterectomy). In these clinical areas, at least two different types of indicators were evaluated (i.e., mortality and utilization).

The selected indicators were then evaluated empirically, using preliminary tests of precision. Those demonstrating adequate precision were then evaluated by a literature review (Phase 2), as well as further empirical analysis.

**Step 4. Evaluation of evidence.** The abstracts from relevant articles for each indicator were reviewed and selected according to the following criteria:

- The article addressed some aspect of the six areas of indicator performance.
- The article was relevant to a national sample, rather than a local population.

Based on this literature, a team member or clinician developed a draft write-up of the indicator following the evaluation framework. The literature review strategy is depicted in the flow diagram in Figure B-2.

**Risk Adjustment of HCUP Quality Indicators**

“Raw” unadjusted measures of hospital or area performance for each indicator are simple means constructed from the HCUP discharge data and census population counts. Obviously, simple means do not account for differences in the indicators that are attributable to differences in patient mix across hospitals that are measured in the discharge data, or demographic differences across areas. In general, risk adjustment involves conducting a multivariate regression to adjust expected performance for these measured patient and population characteristics. Although complex, multivariate regression methods are the standard technique for risk-adjustment because they permit the simultaneous consideration of multiple patient characteristics and interaction among those characteristics. The interpretation of the risk-adjusted estimate is straightforward: it is the value of the indicator expected at that hospital if the hospital had an “average” patient case-mix.

This section contains the methods for the evaluation of risk adjustment systems, leading to the decision to use APR-DRGs. The purpose of this evaluation is to briefly outline the evidence regarding the use of risk adjustment systems for evaluating potential bias in indicators and for risk adjusting established indicators to compare provider performance. The first section discusses criteria used to evaluate the risk adjustment systems. Such criteria arise from the literature-based evidence on risk adjustment systems, as well as user criteria obtained through the semi-structured telephone interviews. Second, the methods used to implement APR-DRGs empirically in the new QI set are outlined. The methods for risk-adjustment of the hospital level quality indicators are described. An analogous method was used for the
area level quality indicators. However, the area level indicators account only for demographic differences.

**Risk Adjustment Literature Review Methods**

The literature review for risk adjustment of the HCUP QIs combined evaluation criteria common to evidence studies on the performance of risk adjustment systems with additional considerations of importance to the potential HCUP QI users. These considerations were determined through semi-structured interviews with users, discussed earlier in this report. In general, users viewed risk adjustment as an important component of the HCUP QIs’ refinement. State data organizations and agencies involved in reporting of hospital performance measures especially tended to view risk-adjustment as essential for the validity of the results and acceptance by participating hospitals. Concerns that patient severity differed systematically among providers, and that this difference might drive the performance results, was frequently mentioned as a reason for limited reporting and public release of the HCUP QIs to date, especially for outcome-oriented measures like mortality following common elective procedures.

**Literature-based Criteria for Evaluating Risk Adjustment Systems**

HCUP QI users were concerned about the validity or performance of possible risk adjustment systems. Evidence was assessed on the performance of risk-adjustment systems from published reports using the following commonly applied criteria.\[79, 87, 174]\n
- **Classification and analytic approach.** Risk adjustment systems have been developed to predict complications, resource use, and mortality. Alternative analytic approaches included stratification (assigning individuals to mutually exclusive cells), logistic regression, or linear regression (calculating an expected level of medical utilization based on a statistical model). Methods based on logistic or linear statistical models are generally able to consider more dimensions of patient characteristics than stratification. Even more effective approaches might involve combining multivariate adjustment and stratification through propensity score methods and accounting for the relationship between aspects of disease severity that are measured and those that are not.\[175, 176]\n
- **System development method.** Risk adjustment classifications may be based either on an empirical model clinical judgment or some combination. For example, an assessment of whether two heart attack patients are expected to have similar outcomes can be based on statistical tests or clinical expertise or both.\[79]\n
- **Feasibility.** Feasibility is largely determined by the data requirements of the risk-adjustment method. We reviewed whether a system required hospital data elements other than those found on the discharge abstract (e.g., data from medical charts or laboratory data) or non-hospital data (e.g., outpatient hospital or physician data). We also evaluated whether the method was likely to be enhanced with discharge data that included a unique patient identifier, so that risk adjusters could be developed based on data from multiple hospitalizations or encounters. Because only a subset of the States participating in HCUP collect supplementary data beyond discharge abstracts or unique patient identifiers for use in longitudinal analyses, a risk adjustment system was selected that did not depend on such information.
Figure B-2: Literature Review Strategy

Phase 1. Identification of Indicators

Search strategy development
- Evaluation of MeSH terms
- Identification of MeSH terms locating key articles

Articles exported to project database

Literature search results in 2,800 articles
Selection of articles for abstraction by the following criteria:
- Articles identifying potential QIs
- Articles generalizable to a national data set
- Indicator defined using administrative data

Preliminary abstraction of 181 articles
Results of process:
- Learned that literature does not follow 1:1 article-to-indicator pattern
- Identified measures used in research
- Identified sources for indicator definitions

Selection of articles for full abstraction by the following criteria:
- Articles define quality indicator
- Articles do not discuss only a relationship to some other variable
- Articles present a new indicator or indicator set
- Indicator based on administrative data

Full abstraction of 27 articles
Results of process:
- Learned few articles identified indicators
- Learned that only some empirical testing is performed on indicators
- Identified some new indicators

List of indicators

Obtained indicator definitions from:
- Joint Commission on Accreditation of Healthcare Organizations (JCAHO)
- Telephone interviews
- Web searching
- CONQUEST
- National Library of Healthcare Indicators (NLHI)
- Sources referenced in literature
Phase 2. Evaluation of Indicators

**Development of evaluation framework**
- Face validity
- Precision
- Minimum bias
- Construct validity
- Fosters real quality improvement
- Application

**Identification of evidence**
- Literature search to identify literature-based evidence for selected indicators, using multiple search strategies and screening
- Literature search results in additional 2,000 articles

**Selection of subset of indicators**
- Indicators must be definable with HCUP data
- Conditions that affect at least 1% of hospitalized patients or 20% of providers
- Conditions that are the subject of public reporting, previous use, or large dollar volume
- Clear relationship to quality apparent
- Criteria for specific indicator types as described above

**Preliminary empirical tests of precision**
- Selected measures with adequate performance on tests of precision (1% provider-level variation for provider indicators, 0.1% for area-level indicators) for full evaluation with literature review

**Project database**
- Final EndNote database includes 4,600 citations for articles relating to quality, derived from both Phase 1 and Phase 2 searches

**Evaluation**
- Used relevant articles from project database to evaluate evidence for each selected indicator according to the evaluation framework
• Empirical performance: Discrimination. A critical aspect of the performance of a risk-adjustment model is the extent to which the model predicts a higher probability of an event for patients who actually experience the event. The statistical test of discrimination is generally expressed as a C-statistic or R2 (how much of the variation in the patient level data the model explains). In general, systems that discriminate more have the potential to influence QI measures more substantially. Many severity-adjustment systems were designed primarily to predict in subsequent periods (e.g., resource consumption next year). However, for purposes of evaluating QI performance, the estimation of concurrent risk is more important (i.e., differences in the likelihood of experiencing an outcome in the current time period). Ideally, discrimination would be assessed using an R2 or other statistic of predicted variation that is computed on a separate data source from the one used to develop the model, to avoid “over-fitting” (i.e., the model might appear do well in part because it explains nonsystematic variations in the data used to develop it).

• Empirical performance: Calibration. Calibration is a measure of whether the mean of the predicted outcomes equals the mean of the actual outcomes for the entire population and for population subgroups. The statistical test is often expressed as a Chi-square or “goodness-of-fit” for the equivalence of means of population subgroups. Even if the severity-adjustment system does not predict well at the level of individuals, it may predict well at the aggregate (group) level of, say, women, 70-74 years of age. Over-fitting will be an issue here as well, unless a different data source is used to validate the model than was used to estimate the model.

Not many risk-adjustment systems have been evaluated in published reports using all of these criteria, nor have they been evaluated using consistent data sources. These limitations of the literature on risk adjustment complicate comparisons of risk adjustment systems based on performance criteria. In the end, the user-specified criteria determined a narrow set of potential risk adjustment systems to consider. The performance criteria delineated between these potential systems and informed the empirical evaluation of the impact of risk adjustment on the assessment of provider and area quality.

User-specified Criteria for Evaluating Risk Adjustment Systems

Evidence on the performance of a risk adjustment system is a primary consideration for HCUP QI users, and is essential to the validity of reported performance measures. However, users also cited other factors as potentially important determinants of the acceptance of HCUP QIs reporting by hospitals, State regulators and State legislatures, and other potential consumers of hospital performance data. These factors included the following:

• "Open" systems preferable to “black box” systems. Although there was no specific prohibition against using proprietary systems vs. systems in the public domain, there was a preference for using "open" systems where the risk adjustment logic was published and available for scrutiny by interested parties.

• Data collection costs minimized and well-justified. The widespread recognition that data collection was costly for hospitals meant that any risk-adjustment system that would be imposed on hospitals had to justify the cost of data collection by documenting that the additional information led to substantially different and more accurate inferences about performance. At least one State had stopped using a risk adjustment system that required medical chart review because the high cost of implementation was not considered worth the efficiency gained from improved accuracy.

• Multiple-use coding system. Some risk adjustment systems were designed to categorize patients according to expected resource use, defined either as charges or length of stay, while others were designed to categorize patients according to expected health outcomes, including mortality and complications. For example, several States calculated and reported mortality rates by
diagnosis-related group (DRG). These users generally believed that a risk-adjustment system for health outcomes based on discharge records that relied on the same diagnostic groups used for reimbursement was more likely to be accurate than a system that relied on codes used for quality and health outcome comparisons only, since there would be less financial and audit incentives to record codes accurately for the latter. Thus, coding systems that affected reimbursement for at least some patients were likely to capture diagnoses and procedures reported in medical charts.

One potentially important limitation of relying on codes that are also used for payment is that changes in reimbursement-related coding practices (e.g., as a result of tighter Medicare rules implemented in 1996) may alter apparent severity. However, because of the financial implications of changes in coding practices, any significant changes are likely to be identified and reported by payers, and so can be considered in interpreting variations and trends in reported quality measures.

- Official recognition. Many users indicated that systems that had been supported or otherwise recognized by Government agencies such as AHRQ were preferable to other systems, because such support facilitated acceptance by legislative and hospital groups. Adoption of the HCUP QIs themselves was often justified in part by their sponsorship by AHRQ. State agencies, especially those from smaller States, often cited the lack of staff resources and expertise needed to make independent evaluations of competing indicator sets and risk adjustment methods.

**Risk Adjustment Empirical Methods**

The APR-DRG system, with severity and risk of mortality classifications, was used in two ways:

- To evaluate the impact of measured differences in patient severity on the relative performance of hospitals and areas, by comparing QI measures with and without risk adjustment
- To risk-adjust the hospital- and area-specific measures.

The available literature on the impact of risk adjustment on indicator performance is limited, but suggests that at least in some cases different systems may give different results. Problems of incomplete or inconsistent coding across institutions are probably important contributing factors to the differences in results. Thus, definitive risk adjustment for some indicators may require detailed reviews of medical charts and additional data sources (charts may also be incomplete), just as definitive quality measures for many indicators may require additional sources of information. However, the importance of random variations in patients means that whatever risk adjustment and quality measurement system is chosen should be used in conjunction with statistical methods that seek to minimize other sources of noise and bias.

The empirical analysis is intended to illustrate the approach of combining risk adjustment with smoothing techniques, including suggestive evidence on the importance of risk adjustment for potential new QIs, using a risk adjustment system that can be implemented on discharge data by most HCUP QI users. The empirical analysis is supplemented with a review of the clinical literature to identify additional clinical information that is important to consider for certain indicators. In particular, the literature review highlights a few indicators where risk adjustment with additional clinical data has been shown to be particularly important, and where important differences in case mix seem less likely to be related to the secondary diagnoses used to risk-adjust discharge data.

This section describes how risk-adjustment is implemented using patient demographics (age and sex) along with the APR-DRG classification system. The next section describes statistical methods used to account for additional sources of noise and bias not accounted for by observed patient characteristics. By applying these methods to all of the potential new QIs, the relative importance of both risk adjustment and smoothing can be evaluated in terms of the relative performance of hospitals (or areas) compared to the “raw” unadjusted QIs based on simple means from NIS discharge data. The simple means fail to account both for differences in the indicators that are attributable to systematic differences in measured
and unmeasured patient mix across hospitals/areas that are measured in the discharge data, and for random variations in patient mix. A multivariate regression approach was adopted to adjust performance measures for measured differences in patient mix, which permits the inclusion of multiple patient demographic and severity characteristics.

Specifically, if it is denoted whether or not the event associated with a particular indicator \( \gamma_k \) \((k=1,...,K)\) was observed for a particular patient \( i \) at hospital/area \( j \) \((j=1,...,J)\) in year \( t \) \((t=1,...,T)\), then the regression to construct a risk-adjusted “raw” estimate of a hospital or area’s performance on each indicator can be written as:

\[
\gamma_{ijt}^k = M_{jt}^k + Z_{ijt}^k \Pi_t^k + \varepsilon_{ijt}^k
\]

where

- \( \gamma_{ijt}^k \) is the \( k \)th quality indicator for patient \( i \) discharged from hospital/area \( j \) in year \( t \) (i.e., whether or not the event associated with the indicator occurred on that discharge);
- \( M_{jt}^k \) is the “raw” adjusted measure for indicator \( k \) for hospital/area \( j \) in year \( t \) (i.e., the hospital/area “fixed effect” in the patient-level regression);
- \( Z_{ijt}^k \) is a vector of patient covariates for patient \( i \) discharged from hospital/area \( j \) in year \( t \) (i.e., the patient-level measures used as risk adjusters);
- \( \Pi_t^k \) is a vector of parameters in each year \( t \), giving the effect of each patient risk adjuster on indicator \( k \) (i.e., the magnitude of the risk adjustment associated with each patient measure); and
- \( \varepsilon_{ijt}^k \) is the unexplained residual in this patient-level model.

The hospital or area specific intercept \( M_{jt}^k \) is the “raw” adjusted measure of a hospital or area’s performance on the indicator, holding patient covariates constant. In most of the empirical analysis that follows, the patient-level analysis is conducted using data from all hospitals and areas. (The model shown implies that each hospital or area has data for all years, and with each year has data on all outcomes; however, this is not essential to apply risk adjustment methods.)

These patient-level regressions were estimated by linear ordinary least-squares (OLS). In general, the dependent variables in the regressions are dichotomous, which raises the question of whether a method for binary dependent variables such as logit or probit estimation might be more appropriate. However, previous work by McClellan and Staiger has successfully used OLS regression for similar analyses of hospital/area differences in outcomes. In addition, estimating logit or probit models with hospital or area fixed effects cannot be done with standard methods; it requires computationally intensive conditional maximum likelihood methods that are not easily extended to multiple years and multiple measures.\(^{[177]}\)

A commonly used “solution” to this problem is to estimate a logit model without hospital or area effects, and then to use the resulting predictions as estimates of the expected outcome. However, this method yields biased estimates and predictions of hospital performance. In contrast, it is easy to incorporate hospital or area fixed effects into OLS regression analysis, the resulting estimates are not biased, and the hospital or area fixed effects provide direct and easily-interpretable estimates of the outcome rate for a particular hospital or area measure in a particular year, holding constant all observed patient characteristics.

Of course, it is possible that a linear probability model is not the correct functional form. However, as in earlier work, a very flexible functional form is specified, including full interactions among age and sex covariates as well as a full set of APR-DRG risk adjusters. In the sensitivity analyses for selected quality measures, this flexible linear probability model produced estimates of the effects of the risk adjusters that did not differ substantially from nonlinear (logit and probit) models. Another potential limitation of the OLS approach is that it may yield biased estimates of confidence intervals, because the
errors of a linear probability model are necessarily heteroskedastic. Given the large sample sizes for the parameters estimated from these regressions (most indicators involve thousands of “denominator” discharges per year), such efficiency is not likely to be an important concern. Nevertheless, models were estimated using Weighted Least Squares to account for heteroskedasticity, to see if estimates were affected [178]. Very similar estimates of adjusted indicator performance were obtained.

Specifically, in addition to age, sex, and age*sex interactions as adjusters, the model also included the APR-DRG category for the admission and the APR-DRG constructed severity subclass (or risk-of-mortality subclass for mortality measures). APR-DRGs are a refinement of the DRGs used by the Centers for Medicare and Medicaid Services (formerly the Health Care Financing Administration), with additional classifications for non-Medicare cases (e.g., neonates). The severity subclass evaluates the episode of care on a scale of 1 (minor) to 4 (extreme). In the APR-DRG Version 12, Severity of Illness is defined as the “extent of physiologic de-compensation or organ system loss of function.” The APR-DRG severity of illness subclass was designed principally to predict resource use, particularly length-of-stay. As such, because this risk-adjustment system was not designed to predict utilization rates, for example, the evaluation of each indicator does not consider lack of impact of risk-adjustment to be evidence of lack of real bias. However, impact of risk-adjustment is considered to be evidence of problems of potential bias. The literature review further informs potential sources of bias, and the prior use of each indicator may require collection of supplemental data for confounding clinical conditions.

For each indicator, the APR-DRG groupings in the Major Diagnostic Category (MDC) related to that indicator were excluded from the risk adjustment model. The groupings are either medical (based on diagnoses) or surgical (based on procedures), and groupings in the MDC of the same type were excluded. For example, for the Coronary Artery Bypass Graft rate indicator, all surgical APR-DRGs in MDC ‘05’ (‘Diseases and Disorders of the Circulatory System’) were excluded. For GI Hemorrhage mortality, all medical APR-DRGs in MDC ‘06’ (‘Diseases and Disorders of the Digestive System’) were excluded. Some of the indicators fall into only a few DRG categories. All discharges with carotid endarterectomy, for example, were within DRG ‘005’, (‘Extracranial Vascular Procedures’). These indicators relied primarily on the severity subclass, which is independent of the DRG.

Actual implementation of the model involves running a regression with potentially a few thousand variables (each DRG divided into four severity subclasses) on millions of observations, straining the capacity of most statistical software and computer systems. In order to limit the number of covariates (DRG groups) in the model, the total number was restricted to 165 categories (DRG by severity), which was for all indicators sufficient to include 80% of discharges. All severity or risk-of-mortality subgroups were maintained for each APR-DRG included in the model in the construction of the raw adjusted estimates. The adjusted estimates of hospital performance are reported and used to compute descriptive statistics for each indicator in each year. They are also used to construct smoothed estimates of each indicator.

The risk-adjusted estimates of hospital performance (age, gender, APR-DRG) and area performance (age, gender only) were used to construct descriptive statistics and smoothed estimates for each QI.

**Empirical Methods**

**Analysis Approach**

**Data sources.** The data sources used in the empirical evaluation were the 1995-97 Nationwide Inpatient Sample (NIS), which has been used for previous HCUP QI development, and the complete State Inpatient Data (SID) for five HCUP participating States (California, Florida, Illinois, New York, and Pennsylvania). The annual NIS consists of about 6 million discharges and over 900 hospitals. The NIS contains all-payer data on hospital inpatient stays from selected States (Arizona, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Illinois, Iowa, Kansas, Maryland, Massachusetts, Missouri, New Jersey, New York, Oregon, Pennsylvania, South Carolina, Tennessee, Utah, Washington, and Wisconsin). All discharges from sampled hospitals are included in the NIS database. The NIS is
designed to approximate a 20% sample of U.S. community hospitals, defined as all non-Federal, short-
term, general, and other specialty hospitals, excluding hospital units of institutions. Included among 
community hospitals are specialty hospitals such as obstetrics-gynecology, ear-nose-throat, short-term 
rehabilitation, orthopedic, and pediatric. Excluded are long-term hospitals, psychiatric hospitals, and 
alcoholism/chemical dependency treatment facilities. A complete description of the content of the NIS, 
including details of the participating States discharge abstracts, can be found on the Agency for 

The SID sample consisted of 10 million discharges and over 1,300 hospitals in over 200 
metropolitan areas. Only the SID empirical results are reported, because the provider-level results were 
similar in both data sources, and the SID data were needed for the direct construction of area measures. 
All of the quality indicators can be constructed from the NIS with two caveats: First, the area measures 
are based on a weighted sample of discharges and are less precise than if complete State discharge data 
are used; and second, even though hospital sampling for the NIS was supposed to allow construction of a 
representative sample at the State level, it is possible that the Metropolitan Service Area (MSA)-level 
samples are not representative (i.e., biased). These limitations are not applicable when using the 
software on the full data from the SID to construct measures based on complete data from area hospitals.

Reported quality indicators. All potential indicators were assessed empirically by developing 
and conducting statistical tests for evaluation framework criteria of precision, bias, and construct validity. 
For each statistical test, we calculated up to four different estimates of indicator performance. First, the 
raw indicator was the simple observed value (e.g., the rate or volume) for each provider or area. Second, 
the adjusted indicator was based on the use of multivariate regression to account for differences among 
providers in demographics and comorbidities (defined using the 3M™ APR-DRG) of patients, and among 
areas in demographics of the population. Third, univariate smoothing techniques were applied to 
estimate the amount of random error relative to the true difference in performance (the “reliability”) for 
each indicator. Fourth, new multivariate signal extraction methods were applied by combining 
information from multiple indicators over several years to extract more quality signal from each individual 
indicator than is possible with the univariate methods.

Overview of empirical analysis. The approach included several stages and generated a series 
of analyses on potential quality indicators that sequentially assessed some of the problems identified in 
the literature review. For reference, the “raw” or minimally adjusted indicator was constructed, based on 
the discharge data for each hospital and census data for each area. This measure was then “risk-
adjusted” through a discharge-level regression that included controls for patient mix. The hospital-level 
and area-level fixed effects in these regressions are the estimates of quality indicators that are typically 
reported for particular hospitals and areas, and they typically reflect substantial noise. In the second stage 
of the analysis, these estimates were then “smoothed” using a Bayesian procedure to yield a best-guess 
estimate of true hospital or area performance on the indicator—the “signal” in the observed noisy 
measure. This was done in two ways. First, a univariate approach was used, in which the distribution of 
the indicator itself is used to construct the best guess. This is the smoothing or shrinkage approach most 
widely used in the literature on provider quality. Second, a multivariate approach was used, in which 
the joint distribution of a large number of indicators (and the indicator of interest in previous time periods) 
is used to construct the best-guess estimate of performance. In general, the covariation among different 
indicators and within each indicator over time implies that much more precise estimates of true hospital or 
area quality can be generated using this multivariate signal extraction approach. All of the estimates of 
factor loadings and correlations are based on smoothed estimates, which helps to improve the ability to 
detect correlations, thereby addressing the multidimensionality of quality. Finally, summary statistics are 
reported describing the performance of the indicator in terms of the principal domains described in the 
literature review: precision, bias, and construct validity.

Intuition Behind Univariate and Multivariate Methods

An important limitation of many quality indicators is their imprecision, which complicates the 
reliable identification of persistent differences among providers in performance. The imprecision in quality 
indicators arises from two sources. The first is sampling variation, which is a particular problem for
indicators based on small numbers of patients per provider (where the particular patients treated by the
provider in a given year are considered a “sample” of the entire population who might have been treated
or will be treated in the near future). The amount of variation due to the particular sample of patients is
often large relative to the total amount of provider-level variation that is observed in any given quality
indicator. A second source of imprecision arises from non-persistent factors that are not sensitive to the
size of the sample; for example, a severe winter results in higher than usual rates of pneumonia mortality.
Both small samples and other one-time factors that are not sensitive to sample size can add considerable
volatility to quality indicators. Also, it is not the absolute amount of imprecision that matters, but rather the
amount of imprecision relative to the underlying signal (i.e., true provider-level variation) that dictates the
reliability of any particular indicator. Even indicators based on relatively large samples with no non-
persistent factors at work can be imprecise if the true level of variation among providers is negligible.

The approach to account for the imprecision or lack of reliability is a generalization of the idea of
applying a “shrinkage factor” to each provider’s estimate so that less reliable estimates are shrunk toward
the national average. These “reliability-adjusted” estimates are sometimes referred to as “smoothed”
estimates (because provider performance is less volatile over time) or “filtered” estimates (because the
methods filter out the non-systematic noise, much like a radio filters our background noise to improve the
radio signal). If the observed provider variation = signal variation + noise variation, then the shrinkage
factor would be signal variation ÷ (signal variation + noise variation). For example, suppose that the
observed variation among providers in the in-hospital pneumonia mortality rate was a standard deviation
of 10.2 percentage points, and the signal variation was a standard deviation of 5.0 percentage points.
Then the shrinkage factor for this indicator is 0.240 = (0.050^2) ÷ (0.102^2). The generalization of this
approach seeks to extract additional signal using information on the relationship among multiple
indicators over time.

Many of the key ideas behind the reliability-adjusted or filtered estimates are illustrated through a
simple example. Suppose that one wants to evaluate a particular provider’s performance based on in-
hospital mortality rates among patients admitted with pneumonia, and data are available for the most
recent 2 years. Consider the following three possible approaches: (1) use only the most recent mortality
rate, (2) construct a simple average of the mortality rates from the 2 recent years, or (3) ignore the
provider’s mortality rate and assume that mortality is equal to the national average. The best choice
among these three approaches depends on two important considerations: the signal-to-noise ratio in the
provider’s data and how strongly correlated performance is from one year to the next.

For example, suppose that the mortality rate for the provider was based on only a few patients,
and one had reason to believe that mortality did not vary much across providers. Then one would be
tempted to choose the last option and ignore the provider’s own data because of its low reliability (e.g.,
low signal-to-noise ratio). This is the idea of simple shrinkage estimators, in which less reliable estimates
are shrunk toward the average for all providers. Alternatively, if one had reason to believe that provider
mortality changed very slowly over time, one might choose the second option in hopes that averaging the
data over 2 years would reduce the noise in the estimates by effectively increasing the sample size in the
provider. Even with large numbers of patients, one might want to average over years if idiosyncratic
factors (such as a bad winter) affected mortality rates from any single year. Finally, one would tend to
choose the first option, and rely solely on mortality from the most recent year, if such idiosyncratic factors
were unimportant, if the provider admitted a large number of patients each year, and if mortality was likely
to have changed from the previous year.

The method of creating filtered estimates formalizes the intuition from this simple example. The
filtered estimates are a combination of the provider’s own quality indicator, the national average, and the
provider’s quality indicators from past years or other patient outcomes. As suggested by the example, to
form the optimal combination, one must know the amount of noise and signal variance in each indicator,
as well as the correlation across indicators in the noise and signal variance.

The noise variance (and covariance) is estimated in a straightforward manner for each provider,
based on the number of patients on which each indicator is based. To estimate the signal variance (and
covariance) for each quality indicator, the noise variance is subtracted from the total variance observed in
each indicator across providers (which reflects both signal and noise variance). In other words, the observed variation in quality indicators is sure to overstate the amount of actual variation across providers (because of the noise in the indicators). Therefore, the amount of true variation in performance is estimated based on how much the observed variation exceeded what would have been expected due to sampling error. Importantly, this method does not assume that provider performance is correlated from one year to the next (or that performance is correlated across indicators). Instead, these correlations are estimated directly from the data, and information from past years or other indicators is incorporated only to the extent that these empirically estimated correlations are large.

Smoothed Estimates of Hospital Performance

For each hospital, a vector of $K$ adjusted indicator estimates was observed over $T$ years from estimating the patient-level regressions (1) run separately by year for each indicator as described in the preceding section. Each indicator is a noisy estimate of true hospital quality; in other words, it is likely that hospitals that performed especially well or badly on the measure did so at least in part due to chance. This fact is incorporated in Bayesian methods for constructing best-guess “posterior” estimates of true provider performance based on observed performance and the within-provider noise in the measures.

In particular, let $M_j$ be the $1 \times TK$ vector of estimated indicator performance for hospital $j$. Then:

$$M_j = \mu_j + \epsilon_j$$

Where $\mu_j$ is a $1 \times TK$ vector of the true hospital intercepts for hospital $j$, and $\epsilon_j$ is the estimation error (which has a mean zero and is uncorrelated with $\mu_j$). Note that the variance of $\epsilon_j$ can be estimated from the patient-level regressions, since this is simply the variance of the regression estimates $M_j$. In particular, $E(\epsilon_j' \epsilon_j) = \Omega_j$ and $E(\epsilon_j' \epsilon_s) = 0$ for $t \neq s$, where $\Omega_j$ is the covariance matrix of the intercept estimates for hospital $j$ in year $t$.

A linear combination of each hospital's observed indicators must be created in such a way that it minimizes the mean-squared prediction error. In other words, the following hypothetical regression should be run:

$$\mu_{jt}^k = M_j \beta_{jt}^k + \nu_{jt}^k$$

but cannot be run directly, since $\mu_j$ is unobserved and the optimal $\beta$ varies by hospital and year. While equation (3) cannot be directly estimated, it is possible to estimate the parameters for this hypothetical regression. In general, the minimum mean squared error linear predictor of $\mu_j$ is given by $M_j \beta$, where $\beta = \left[ E(M_j'M_j) \right]^{-1} E(M_j'\mu_j)$. This best linear predictor depends on two moment matrices:

$$E(M_j'M_j) = E(\mu_j'\mu_j) + E(\epsilon_j'\epsilon_j)$$

$$E(M_j'\mu_j) = E(\mu_j'\mu_j)$$

The required moment matrices are estimated directly as follows:

- Estimate $E(\epsilon_j'\epsilon_j)$ with the patient-level OLS estimate of the covariance matrix for the parameter estimates $M_j$. Call this estimate $S_j$. Note that $S_j$ varies across hospitals.

- Estimate $E(\mu_j'\mu_j)$ by noting that $E(M_j'M_j'S_j) = E(\mu_j'\mu_j)$. If assumed that $E(\mu_j'\mu_j)$ is the same for all hospitals, then it can be estimated by the sample average of $M_j'M_j'S_j$. Note that it is easy
to relax the assumption that $E(\mu_j^t|\mu_j)$ is the same for all hospitals by calculating $M_j^tM_j-S_j$ for subgroups of hospitals.

With estimates of $E(\mu_j^t|\mu_j)$ and $E(\epsilon_t^j|\epsilon_j)$, one can form least squares estimates of the parameters in equation 3 which minimize the mean squared error. Analogous to simple regression, the prediction of a hospital’s true intercept is given by:

$$\hat{\mu}_j = M_j^t E(M_j^tM_j)^{-1} E(M_j^t\mu_j) = M_j^t \left[ E(\mu_j^t|\mu_j) + E(\epsilon_t^j|\epsilon_j) \right]^{-1} E(\mu_j^t|\mu_j)$$

using estimates of $E(\mu_j^t|\mu_j)$ and $E(\epsilon_t^j|\epsilon_j)$ in place of their true values. One can use the estimated moments to calculate other statistics of interest as well, such as the standard error of the prediction and the $r^2$-squared for equation 3, based on the usual least squares formulas. Estimates based on equation (5) are referred to as “filtered” estimates, since the key advantage of such estimates is that they optimally filter out the estimation error in the raw quality indicators.

Equation 5 in combination with estimates of the required moment matrices provides the basis for estimates of hospital quality. Such estimates of hospital quality have a number of attractive properties. First, they incorporate information in a systematic way from many outcome indicators and many years into the predictions of any one outcome. Moreover, if the moment matrices were known, the estimates of hospital quality represent the optimal linear predictors, based on a mean squared error criterion. Finally, these estimates maintain many of the attractive aspects of existing Bayesian approaches, while dramatically simplifying the complexity of the estimation. It is possible to construct univariate smoothed estimates of hospital quality, based on empirical estimates for particular measures, using the models just described but restricting the dimension of $M_j^t$ to only a particular indicator $k$ and time period $t$. Of course, to the extent that the provider indicators are correlated with each other and over time, this will result in a less precise (efficient) estimate.

With many years of data, it helps to impose some structure on $E(\mu_j^t|\mu_j)$ for two reasons. First, this improves the precision of the estimated moments by limiting the number of parameters that need to be estimated. Second, a time series structure allows for out-of-sample forecasts. A non-stationary, first-order Vector Autoregression structure (VAR) is used. The VAR model is a generalization of the usual autoregressive model, and assumes that each hospital’s quality indicators in a given year depend on the hospital’s quality indicators in past years plus a contemporaneous shock that may be correlated across quality indicators. In most of what follows, a non-stationary first-order VAR is assumed for $\mu_{jt}$ ($1xK$), where:

$$\mu_{jt} = \mu_{j,t-1} \Phi + u_{jt}, \text{ with } V(u_{jt}) = \Sigma \text{ and } V(\mu_{jt}) = \Gamma$$

Thus, estimates are needed of the lag coefficient ($\Phi$), the variance matrix of the innovations ($\Sigma$), and the initial variance condition ($\Gamma$), where $\Sigma$ and $\Gamma$ are symmetric $KxK$ matrices of parameters and $\Phi$ is a general $KxK$ matrix of parameters, for a total of $2K^2+K$ parameters. For example, 10 parameters must be estimated for a VAR model with two outcomes ($K=2$).

The VAR structure implies that $E(M_j^tM_j-S_j) = E(\mu_j^t|\mu_j) = f(\Phi,\Sigma,\Gamma)$. Thus, the VAR parameters can be estimated by Optimal Minimum Distance (OMD) methods, i.e., by choosing the VAR parameters so that the theoretical moment matrix, $f(\Phi,\Sigma,\Gamma)$, is as close as possible to the corresponding sample moments from the sample average of $M_j^tM_j-S_j$. More specifically, let $d_j$ be a vector of the non-redundant (lower triangular) elements of $M_j^tM_j-S_j$, and let $d$ be a vector of the corresponding moments from the true moment matrix, so that $d=g(\Phi,\Sigma,\Gamma)$. Then the OMD estimates of $(\Phi,\Sigma,\Gamma)$ minimize the following OMD objective function:
\[ q = \mathbf{M} \left[ \overline{\mathbf{d}} - g(\Phi, \Sigma, \Gamma) \right]' \mathbf{V}^{-1} \left[ \overline{\mathbf{d}} - g(\Phi, \Sigma, \Gamma) \right] \]

where \( \mathbf{V} \) is the sample estimate of the covariance matrix for \( \mathbf{d} \), and \( \overline{\mathbf{d}} \) is the sample average of \( \mathbf{d} \). If the VAR model is correct, the value of the objective function, \( g \), will be distributed \( \chi^2(p) \) where \( p \) is the degree of over-identification (the difference between the number of elements in \( \mathbf{d} \) and the number of parameters being estimated). Thus, \( q \) provides a goodness of fit statistic that indicates how well the VAR model fits the actual covariances in the data.

Finally, estimated \( \mathbf{R}^2 \) statistics are used to evaluate the filtered estimates’ ability to predict (in sample) and forecast (out-of-sample) variation in the true intercepts, and to compare methods used to conventional methods (e.g., simple averages, or univariate shrinkage estimators). If true hospital intercepts (\( \mu \)) were observed, a natural metric for evaluating the predictions would be the sample \( \mathbf{R}^2 \)-squared:

\[ R^2 = 1 - \left( \frac{\sum_{j=1}^{N} \hat{\nu}_j^2}{\sum_{j=1}^{N} \mu_j^2} \right) \]

where
\[ \hat{\nu}_j = \mu_j - \hat{\mu}_j \]

is the prediction error. Of course \( \mu \) is not observed. Therefore, an estimate is constructed using the estimate of \( \mathbf{E}(\mu_j, \mu) \) for the denominator, and the estimate of
\[ \mathbf{E} \left[ (\mu_j - \hat{\mu}_j)(\mu_j - \hat{\mu}_j) \right] \]

for the terms in the numerator (where this can be constructed from the estimated moment matrices in equations 4.1 and 4.2). Finally, a weighted \( \mathbf{R}^2 \)-squared is reported (weighting by the number of patients treated by each hospital).

As in earlier work using this method for cardiac care in the adult population, the indicators are validated using out-of-sample performance, based on forecasts (e.g., using the first 2 years of data to predict in subsequent year) and based on split-sample prediction (e.g., using one-half of the patient sample to predict outcome indicators in the other half of the sample). For evaluating out-of-sample forecasts, a modified \( \mathbf{R}^2 \)-squared of the forecast is constructed that estimates the fraction of the systematic (true) hospital variation in the outcome measure (\( \mathbf{M} \)) that was explained:

\[ \hat{R}^2 = 1 - \left( \frac{\sum_{j=1}^{N} \hat{\nu}_j^2}{\sum_{j=1}^{N} (\mathbf{M}_j^2 - \mathbf{S}_j)} \right) \]

where
\[ \hat{\nu}_j = \mathbf{M}_j - \hat{\mu}_j \]

is the forecast error and \( \mathbf{S}_j \) is the OLS estimate of the variance of the estimate \( \mathbf{M}_j \). This modified \( \mathbf{R}^2 \)-squared estimates the amount of variance in the true hospital effects that has been forecast. Note that because these are out-of-sample forecasts, the \( \mathbf{R}^2 \)-squared can be negative, indicating that the forecast performed worse than a naive forecast in which one assumed that quality was equal to the national average at all hospitals.
Empirical Analysis Statistics

Using the methods just described, a set of statistical tests was constructed to evaluate precision, bias, and construct validity. Each of the key statistical test results for these evaluation criteria was summarized and explained in the beginning of this appendix. Tables B1-B3 provides a summary of the statistical analyses and their interpretation. Indicators were tested for precision first, and ones that performed poorly were eliminated from further consideration. Bias and construct validity were assessed for all recommended indicators.

### Table B-1: Precision Tests

<table>
<thead>
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<th>Measure</th>
<th>Statistic</th>
<th>Interpretation</th>
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<tbody>
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<td></td>
<td><strong>Measure</strong>. Is most of the variation in an indicator at the level of the provider? Do smoothed estimates of quality lead to more precise measures?</td>
</tr>
<tr>
<td>a. Raw variation in indicator</td>
<td>Provider Standard Deviation</td>
<td>Provider variation is signal variation + noise variation. What percentage of the total variation (patient + provider) is between-provider variation (a measure of how much variation is subject to provider control). Risk adjustment can either increase or decrease true variation.</td>
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<td></td>
<td>Signal Standard Deviation</td>
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<td>Provider/Area Share</td>
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<td></td>
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<td><strong>Unadjusted</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Age-sex adjusted</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Age-sex+APR-DRG adjusted</strong></td>
</tr>
<tr>
<td>b. Univariate smoothing</td>
<td>Signal/Signal-to-noise ratio:</td>
<td>Estimates what percentage of the observed variation between providers reflects “true” quality differences versus random noise. Risk adjustment can increase or decrease estimates of “true” quality differences.</td>
</tr>
<tr>
<td></td>
<td>Unadjusted</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age-sex adjusted</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age-sex + APR-DRG adjusted</td>
<td></td>
</tr>
<tr>
<td>c. MSX methods</td>
<td>In-sample R-squared:</td>
<td>To the extent that indicators are correlated with each other and over time, MSX methods can extract more “signal” (a higher percentage of observed variation between providers that reflects “true” quality).</td>
</tr>
<tr>
<td></td>
<td>Unadjusted</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age-sex adjusted</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age-sex + APR-DRG adjusted</td>
<td></td>
</tr>
</tbody>
</table>
### Table B-2: Bias Tests

<table>
<thead>
<tr>
<th>Measure</th>
<th>Statistic</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bias. Does risk-adjustment change the assessment of relative provider performance, after accounting for reliability? Is the impact greatest among the best or worst performers, or overall? What is the magnitude of the change in performance?</td>
<td>Rank correlation coefficient (Spearman)</td>
<td>Risk-adjustment matters to the extent that it alters the assessment of relative provider performance. This test determines the impact overall.</td>
</tr>
<tr>
<td>a. MSX methods: unadjusted vs. age, sex, APR-DRG risk adjustment</td>
<td>Average absolute value of change relative to mean</td>
<td>This test determines whether the absolute change in performance was large or small relative to the overall mean.</td>
</tr>
<tr>
<td></td>
<td>Percentage of the top 10% of providers that remains the same</td>
<td>This test measures the impact at the highest rates (in general, the worse performers, except for measures like VBAC).</td>
</tr>
<tr>
<td></td>
<td>Percentage of the bottom 10% of providers that remains the same</td>
<td>This test measures the impact at the lowest rates (in general, the best performers, except for measures like VBAC).</td>
</tr>
<tr>
<td></td>
<td>Percentage of providers that move more than two deciles in rank (up or down)</td>
<td>This test determines the magnitude of the relative changes.</td>
</tr>
</tbody>
</table>

### Table B-3: Construct Validity Tests

<table>
<thead>
<tr>
<th>Measure</th>
<th>Statistic</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct validity. Is the indicator related to other indicators in a way that makes clinical sense? Do methods that remove noise and bias make the relationship clearer?</td>
<td>Pearson correlation coefficient</td>
<td>Are indicators correlated with other indicators in the direction one might expect?</td>
</tr>
<tr>
<td>a. Correlation of indicator with other indicators</td>
<td>Factor loadings</td>
<td>Do indicators load on factors with other indicators that one might expect?</td>
</tr>
<tr>
<td>b. Factor loadings of indicator with other indicators</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
References for Appendix B


62. Halm EA, Lee C, Chassin MR. How is volume related to quality in health care? A systematic review of the research literature: Institute of Medicine, National Academy of Sciences, Division of Health Care Services, Committee on Quality of Care in America; 2000 May 1.


98. Romano PS, Chan BK. Risk-adjusting acute myocardial infarction mortality: are APR-DRGs the right tool? Health Serv Res 2000;34(7):1469-89.


Appendix C: Log of Revisions to PQI Documentation and Software Version 2.1, Revision 4

The following table summarizes the revisions made to the PQI software, software documentation and the Guide to Patient Safety Indicators (Guide) document in release version 2.1, revision 4. The table lists the component(s) affected by the change and a short summary of the changes that were made.

<table>
<thead>
<tr>
<th>Component (Software (SAS and SPSS), Software Documentation, and Guide)</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The years for which the ICD-9-CM and DRG codes defining PQIs are valid was amended to be through FY 2005 instead of FY 2004, that is, the codes in the software are effective through September 30, 2005.</td>
<td></td>
</tr>
<tr>
<td>2. Added new module that calculates condition-specific rates for the diabetes PQIs across stratifiers.</td>
<td></td>
</tr>
<tr>
<td>Software Documentation (SAS and SPSS)</td>
<td>Table 3 was amended to include the 2003 census data (i.e., QICTY03.TXT and QICTYA03.TXT) and condition-specific module files (PQSASC2 and QICTYC03.TXT).</td>
</tr>
<tr>
<td>Software (SAS and SPSS)</td>
<td>Added the 2003 census data (i.e., QICTY03.TXT and QICTYA03.TXT) and condition-specific module files (PQSASC2 and QICTYC03.TXT).</td>
</tr>
<tr>
<td>Guide</td>
<td>Rearranged the sequence of PQIs to place in numerical order.</td>
</tr>
<tr>
<td>Software (SAS)</td>
<td>Inserted “PQ” in format names for age aggregations in SAS programs to distinguish these formats from similarly named formats used by other indicator software.</td>
</tr>
</tbody>
</table>
Appendix D: ICD-9-CM and DRG Coding Updates in PQI Release Version 2.1, Revision 4

For Fiscal Year 2005 (effective 10-1-2004) there were no ICD-9-CM or DRG coding changes that affected indicator definitions. Refer to the Prevention Quality Indicators Archive (http://www.qualityindicators.ahrq.gov/pqi_archive.htm) for changes to indicator definitions made in previous PQI revisions.