



Quality Indicator User Guide: Pediatric Quality Indicators (PDI) Composite Measures Version 4.4

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Chapter 1. Overview

The goal in developing composite measures was to provide a measure that could be used to monitor performance over time or across regions and populations using a method that applied at the national, regional, State or provider/area level. Potential benefits of composite measures are to: summarize quality across multiple indicators, improve the ability to detect differences, identify important domains and drivers of quality, prioritize action for quality improvement, make current decisions about future (unknown) health care needs and avoid cognitive “shortcuts”. Despite these potential advantages there are concerns with composite measures, such as: masking important differences and relations among components, not being actionable, not being representative of parts of the health care system that contribute most to quality or detracting from the impact and credibility of reports. In weighing the benefits and concerns of composite measures there are also a number of potential uses to consider, such as: consumer use for selecting a hospital or health plan, provider use for identifying domains and drivers of quality, purchasers use for selection of hospitals or health plans to improve employee health and policymakers use for setting policy priorities to improve the health of a population. This document provides a technical overview for AHRQ QI users.

What Are the Composites?

Provider-Level Composite

Applying these criteria to the PDIs, one could advocate for separate composites based on the type of adverse event (e.g., postoperative). However, in general, the component indicators apply to the same providers and show at least some positive correlation with one another. Therefore, the initial composite includes all the provider-level indicators (see table below), with the exception of foreign body (PDI #3) and transfusion reaction (PDI #13), which are reported as counts. Future development might examine sub-composites for certain indicators.

Table 1. AHRQ PDI Composite Measure Components¹

Pediatric Patient Safety for Selected Indicators (PDI #19)
PDI #01 Accidental Puncture or Laceration Rate
PDI #02 Pressure Ulcer Rate
PDI #05 Iatrogenic Pneumothorax Rate
PDI #08 Postoperative Hemorrhage or Hematoma Rate ²
PDI #09 Postoperative Respiratory Failure Rate ²
PDI #10 Postoperative Sepsis Rate
PDI #11 Postoperative Wound Dehiscence Rate
PDI #12 Central Venous Catheter-Related Blood Stream Infection Rate

¹ This composite measure (i.e., PDI #19) is endorsed by the National Quality Forum (NQF: #532).

² This measure is not included in the NQF endorsed composite measure.

Area-Level Composites (Overall, Acute, and Chronic)

The area-level Pediatric Quality Indicators (PDI) are measures of potentially avoidable hospitalizations for Ambulatory Care Sensitive Conditions (ACSCs), which, though they rely on hospital discharge data, are intended to reflect issues of access to, and quality of, ambulatory care

in a given geographic area. The PDI composites are intended to improve the statistical precision of the individual PDI, allowing for greater discrimination in performance among areas and improved ability to identify potentially determining factors in performance.

An overall composite captures the general concept of potentially avoidable hospitalization connecting the individual PDI measures, which are all rates at the area level. Separate composite measures were created for acute and chronic conditions to investigate different factors influencing hospitalization rates for each condition. See Table 2 for the measures that comprise each of the three PDI composites. The PDI composites provide the following advantages:

- Provide assessment of quality and disparity
- Provide baselines to track progress
- Identify information gaps
- Emphasize interdependence of quality and disparities
- Promote awareness and change

Table 2. AHRQ PDI Composite Measure¹

Overall Composite (PDI #90)	
PDI #14 Asthma Admission Rate	PDI #16 Gastroenteritis Admission Rate
PDI #15 Diabetes Short-Term Complications Admission Rate	PDI #18 Urinary Tract Infection Admission Rate
Acute Composite (PDI #91)	
PDI #16 Gastroenteritis Admission Rate	PDI #18 Urinary Tract Infection Admission Rate
Chronic Composite (PDI #92)	
PDI #14 Asthma Admission Rate	PDI #15 Diabetes Short-Term Complications Admission Rate

¹ These composite measure (i.e., PDI #90, #91, and #92) are not endorsed by the National Quality Forum.

Chapter 2. Calculation

How Are the Composites Created?

Provider-Level Composite

The composite measures are evaluated using three criteria: discrimination, forecasting, and construct validity.

Discrimination is the ability of the composite measure to differentiate performance as measured by statistically significant deviations from the average performance.

Forecasting is the ability of the composite measure to predict performance for each of the component indicators. Ideally, the forecasting performance would reflect the weighting of the components, in the sense that forecasting would maximize the differences for the most highly weighted components.

Construct validity is the degree of association between the composite and other aggregate measures of quality. In this report we look primarily at the consistency in the composites with one another. A broader analysis of construct validity would examine the relationship between the composites and external measures of quality or other factors that might influence quality.

Steps for creating the composite:

Step 1. Compute the risk-adjusted rate and confidence interval

The AHRQ QI risk-adjusted rate is computed based on a hierarchical logistic regression model for calculating a predicted value for each case. Then the predicted values among all the cases in the hospital are averaged to compute the expected rate. The risk-adjusted rate is computed using indirect standardization as the observed rate (OR) divided by the expected rate (ER), with the result multiplied by the reference population rate: $(RR) = (OR/ER \times PR)$.

Step 2. Scale the risk-adjusted rate using the reference population

The relative magnitudes of the rates vary from indicator to indicator. To combine the component indicators using a common scale, each indicator's risk-adjusted rate is divided by the reference population rate to yield a ratio. The components of the composite are therefore defined in terms of a ratio to the reference population rate for each indicator. The component indicators are scaled by the reference population rate, so each indicator reflects the degree of deviation from the overall average performance.

Step 3. Compute the reliability-adjusted ratio

The reliability-adjusted ratio (RAR) is computed as the weighted average of the risk-adjusted ratio and the reference population ratio, where the weights vary from 0 to 1, depending on the degree of reliability for the indicator and provider (or other unit of analysis).

$RAR = [\text{risk-adjusted ratio} \times \text{weight}] + [\text{reference population ratio} \times (1 - \text{weight})]$

For small providers, the weight is closer to 0. For large providers, the weight is closer to 1. For a given provider, if the denominator is 0, then the weight assigned is 0 (i.e., the reliability-adjusted ratio is the reference population ratio).

Step 4. Select the component weights

The composite measure is the weighted average of the scaled and reliability-adjusted ratios for the component indicators. Some examples of possible weights follow, though others are possible:

Single indicator weight. In this case, the composite is simply the reliability-adjusted ratio for a single indicator. The reference population rate is the same among all providers.

Equal weight. In this case, each component indicator is assigned an identical weight based on the number of indicators. That is, the weight equals 1 divided by the number of indicators in the composite (e.g., $1/8 = 0.1250$).

Numerator weight. A numerator weight is based on the relative frequency of the numerator for each component indicator in the reference population. In general, a numerator weight reflects the amount of harm in the outcome of interest, in this case a potentially preventable adverse event. One might also use weights that reflect the amount of excess mortality or complications associated with the adverse event, or the amount of confidence one has in identifying events (i.e., the positive predictive value).

Denominator weight. A denominator weight is based on the relative frequency of the denominator for each component indicator in the reference population. In general, a denominator weight reflects the amount of risk of experiencing the outcome of interest in a given population. For example, the denominator weight might be based on the demographic composition of a health plan, the employees of a purchaser, a State, an individual hospital, or a single patient.

Factor weight. A factor weight is based on some sort of analysis that assigns each component indicator a weight that reflects the contribution of that indicator to the common variation among the indicators. The component indicator that is most predictive of that common variation is assigned the highest weight.

Step 5. Construct the composite measure

The composite measure is the weighted average of the component indicators using the selected weights and the scaled and reliability-adjusted indicators.

$$\text{Composite} = [\text{indicator1 RAR} \times \text{weight1}] + [\text{indicator2 RAR} \times \text{weight2}] + \dots + [\text{indicatorN RAR} \times \text{weightN}]$$

The confidence interval of the composite is based on the standard error of the composite, which is the square root of the variance. The variance is computed based on the signal variance covariance matrix and the reliability weights.

Area-Level Composites (Overall, Acute, and Chronic)

The composites were created through a workgroup¹ that included discussion of conceptual issues related to the composite (e.g., single composite vs. separate composites) and analyses using 2003 State Inpatient Data (SID) from the Healthcare Cost and Utilization Project (HCUP)².

The PDI composites' components are combined by summing the component numerators (i.e., hospitalizations) because each PDI measure has a common denominator. The Perforated Appendix indicator (PDI #17) is excluded because the denominator differs (i.e., based on a discharge structure).

Weights. The number of hospitalizations (i.e., prevalence of the condition) was used as the “weight” for combining the component indicators. Both hospital days and costs were also examined as possible approaches for weighting the data and yielded substantively similar results.

Calculation. Descriptive statistics for 12 of the PQIs (the adult version of the PDI) were calculated as hospitalizations per 100,000 persons for the entire dataset and by county. Correlations and factor loadings for the county level rates (adjusted for age and gender) were examined. Ultimately, the composites are constructed by summing the hospitalizations across the component conditions and dividing by the population. Rates can optionally be adjusted for age, sex and socio-economic status when comparing across regions or demographic groups.

Validation. The relation between the composite and other area measures potentially related to access to care (e.g., hospital beds per population and primary care physician density) were examined.

¹ Agency for Healthcare Research and Quality Quality Indicators. (April 7, 2006). *Prevention Quality Indicators (PQI) Composite Measure Workgroup Final Report*. Available: http://www.qualityindicators.ahrq.gov/modules/pqi_resources.aspx.

² The state data organizations that participated in the 2003 HCUP SID: Arizona Department of Health Services; 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; Indiana Hospital & Health Association; 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 Hampshire Department of Health & Human Services; 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. <http://hcup-us.ahrq.gov>.

Chapter 3. Use

How Have the Composites Changed?

Provider-Level Composite

With each new release of the AHRQ QI, the reference population is updated to the most current HCUP data available. The numerator and denominator weights are updated to reflect the indicator technical specifications as applied to the reference population.

Area-Level Composites (Overall, Acute, and Chronic)

The specifications of the PDI Composites have not changed since the initial release. There have been changes to the component PDI that constitute the composite, which can be found on the AHRQ QI website in the Log of Coding Updates and Revisions document (http://www.qualityindicators.ahrq.gov/modules/pdi_resources.aspx).

What Are the Current Uses of the Composites?

Provider-Level Composite

Users must use these “NQF Numerator Weights” when using the AHRQ QI software to compute the composite measures using their own data and when comparing the results of the software with the results reported under the Hospital Inpatient Quality Reporting (IQR) Program (formerly known as the Reporting of Hospital Quality Data for Annual Payment Update (RHQDAPU) program). The following table provides the NQF weights for this composite measure. The sum of the weights for the indicators included in the same composite always equals one.

Table 3. NQF Numerator Weights for the Pediatric Patient Safety for Selected Indicators Composite

Indicator	Label	Weight USEPOA = 0 ¹	Weight USEPOA = 1 ¹
PDI 01	Accidental Puncture or Laceration Rate	0.2431	0.2608
PDI 02	Pressure Ulcer Rate	0.1122	0.1413
PDI 05	Iatrogenic Pneumothorax Rate	0.0548	0.0547
PDI 08 ²	Postoperative Hemorrhage or Hematoma Rate	0.0	0.0
PDI 09 ²	Postoperative Respiratory Failure Rate	0.0	0.0
PDI10	Postoperative Sepsis Rate	0.2257	0.2119
PDI 11	Postoperative Wound Dehiscence Rate	0.0072	0.009
PDI 12	Central Venous Catheter-Related Blood Stream Infection Rate	0.3569	0.3223
SUM		0.9999	1.0000

¹ The use of POA results in different weights for the composite. Without POA, USEPOA = 0; With POA, USEPOA = 1.

Source: 2008 State Inpatient Databases, Healthcare Cost and Utilization Program, Agency for Healthcare Research and Quality. Note: in Version 3.2, PDI #2 is labeled “Decubitus Ulcer” and PDI #12 is labeled “Selection Infection due to Medical Care.”

² These weights are set to zero because these measures are not included in the NQF Endorsed Composite.

Area-Level Composites (Overall, Acute, and Chronic)

The PDI composites are intended to be used to provide national estimates that can be tracked over time and to provide state and county level estimates that can be compared with the national estimate and to each other.

The following two questions were examined in the initial creation of the composite:

Does disease prevalence impact variability?

As anticipated, areas with higher rates of diabetes and hypertension show higher hospitalizations, particularly in the chronic composite. However, for asthma the contrary relation is true suggesting other confounding factors.

Is variability driven by poverty status?

Areas with low levels of poverty also show lower hospitalization rates for each of the PDI composites, which is independent of access to care.

Additional Resources

See the AHRQ QI website for additional resources and downloads:
http://www.qualityindicators.ahrq.gov/modules/pdi_resources.aspx.

Agency for Healthcare Research and Quality, “Pediatric Quality Indicators (PDI) Composite Measure Workgroup Final Report,” (March 2008). The report is available at
http://www.qualityindicators.ahrq.gov/modules/pdi_resources.aspx.