Quality Indicator User Guide: Patient Safety Indicators (PSI) Composite Measures
Version 4.3

Prepared for:

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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 Composites

Applying these criteria to the PSIs, 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 (non-obstetric) indicators (see table below) with the exception of Death among Surgical Inpatients (PSI #4) which is itself a composite and foreign body (PSI #5) and transfusion reaction (PSI #16), which are reported as counts. Future development might examine sub-composites for certain indicators.

Table 1. AHRQ PSI Composite Measure

Patient Safety for Selected Indicators (PSI #90)	
PSI #03 Pressure Ulcer Rate[1]	PSI #11 Postoperative Respiratory Failure Rate
PSI #06 Iatrogenic Pneumothorax Rate[1]	PSI #12 Postoperative Pulmonary Embolism or Deep Vein Thrombosis Rate[1]
PSI #07 Central Venous Catheter-Related Blood Stream Infection Rate[1]	PSI #13 Postoperative Sepsis Rate[1]
PSI #08 Postoperative Hip Fracture Rate[1]	PSI #14 Postoperative Wound Dehiscence Rate[1]
PSI #09 Postoperative Hemorrhage or Hematoma Rate	PSI #15 Accidental Puncture or Laceration Rate[1]
PSI #10 Postoperative Physiologic and Metabolic Derangement Rate	

[1] These measures are part of the NQF Endorsed Composite (i.e., PSI #90, NQF: #531).

Chapter 2. Calculation

How Are the Composites Created?

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.

Composite = [indicator1 RAR × weight1] + [indicator2 RAR × weight2] + . . . + [indicatorN RAR × 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.

Chapter 3. Use

How Have the Composites Changed?

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.

What Are the Current Uses of the Composites?

Under the Hospital Inpatient Quality Reporting (IQR) Program (formerly known as the Reporting of Hospital Quality Data for Annual Payment Update (RHQDAPU) program) [1] the Centers for Medicare & Medicaid Services (CMS) adopted Patient Safety Indicators developed by AHRQ for use in "Hospital Compare"; a comparative public report of hospital performance. One of the adopted indicators is a composite measure: Patient Safety for Selected Indicators.

The PSI composite was ultimately endorsed by the National Quality Forum (NQF) in 2009[2] and will therefore appear in the 2011 Hospital Compare report.

Users must use these "NQF 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 RHQDAPU. 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.

Note that the weight for some of the component indicators is zero. The reason is that the composite measures developed in the AHRQ workgroup final reports included all of the relevant indicators regardless whether the indicator was endorsed by NQF. However, the evaluation criteria applied by NQF required that the components of a composite be either NQF endorsed as individual measures or determined to have met the criteria for endorsement of an individual measure. In the version of the AHRQ QI composite measures submitted to NQF, component indicators that did not meet these criteria were assigned a weight of zero[3]. This method is simply a way of operationalizing the concept that the NQF-endorsed composites adopted by CMS do not include component indicators that were judged by the NQF not to meet the criteria for stand-alone endorsement.

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[1] Agency for Healthcare Research and Quality, "AHRQ Quality Indicators Computing Composites of the AHRQ QI Rates Under the RHQDAPU Program," (February 2010). The report is available at http://www.qualityindicators.ahrq.gov/modules/psi_resources.aspx.

[2] Another AHRQ QI composite – Pediatric Patient Safety for Selected Indicators – was also endorsed by NQF but is not included in the IQR program because it applies only to the pediatric population.

[3] Postoperative respiratory failure (PSI #11) was recently endorsed by NQF (August 5, 2009) and is under evaluation for inclusion in the Patient Safety for Selected Indicators composite.

Table 2. NQF Weights for the Patient Safety for Selected Indicators Composite

Indicator	Label	Weight USEPOA = 0[1]	Weight USEPOA = 1[1]
PSI 03	Pressure Ulcer Rate	0.5295	0.1357
PSI 06	Iatrogenic Pneumothorax Rate	0.0318	0.0614
PSI 07	Central Venous Catheter-Related Blood Stream Infection Rate	0.0478	0.0831
PSI 08	Postoperative Hip Fracture Rate	0.0022	0.0005
PSI 09	Postoperative Hemorrhage or Hematoma Rate	0.0	0.0
PSI 10	Postoperative Physiologic and Metabolic Derangement Rate	0.0	0.0
PSI 11	Postoperative Respiratory Failure Rate	0.0	0.0
PSI 12	Postoperative Pulmonary Embolism or Deep Vein Thrombosis Rate	0.1527	0.2209
PSI 13	Postoperative Sepsis Rate	0.0309	0.0536
PSI 14	Postoperative Wound Dehiscence Rate	0.0064	0.0159
PSI 15	Accidental Puncture or Laceration Rate	0.1988	0.4289
SUM		1.0001	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, PSI #3 is labeled "Decubitus Ulcer" and PSI #7 is labeled "Selection Infection due to Medical Care."

Additional Resources

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

Agency for Healthcare Research and Quality, "Patient Safety Indicators (PSI) Composite Measure Workgroup Final Report," (March 2008). The report is available at
http://www.qualityindicators.ahrq.gov/modules/psi_resources.aspx.