AHRQ Quality Indicators™

QUALITY INDICATOR USER GUIDE: PATIENT SAFETY INDICATORS (PSI) COMPOSITE MEASURES

Version 2020

Prepared for:
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Contract No. HHSA290201800003G

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July 2020

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1.0 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 hospital/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, hospital use for identifying domains and drivers of quality, purchaser use for selection of hospitals or health plans to improve employee health and policymaker use for setting policy priorities to improve the health of a population. This document provides a technical overview for AHRQ QI™ users.

2.0 What Are the Composites?

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 hospitals and show at least some positive correlation with one another. Therefore, the composite includes all of the hospital-level, non-obstetric indicators (see Table 1 below) with the exception of PSI 4 Death Rate among Surgical Inpatients with Serious Treatable Complications (which itself is a composite) and PSI 5 Retained Surgical Item or Unretrieved Device Fragment Count (which is reported as a count). Future development might examine sub-composites for certain indicators.

Table 1. AHRQ PSI Composite Measure

PSI 90 PATIENT SAFETY FOR SELECTED INDICATORS[1]
PSI 3 Pressure Ulcer Rate
PSI 6 Iatrogenic Pneumothorax Rate
PSI 8 In-Hospital Fall with Hip Fracture Rate
PSI 9 Perioperative Hemorrhage or Hematoma Rate
PSI 10 Postoperative Acute Kidney Injury Requiring Dialysis Rate
PSI 11 Postoperative Respiratory Failure Rate
PSI 12 Perioperative Pulmonary Embolism or Deep Vein Thrombosis Rate
PSI 13 Postoperative Sepsis Rate
PSI 14 Postoperative Wound Dehiscence Rate
PSI 15 Abdominopelvic Accidental Puncture or Laceration Rate

[1] PSI 90 is endorsed by the National Quality Forum (NQF 0531).

3.0 How Are the Composites Created?

The composite measure is 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.

4.0 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 (PR): (RR) = (OR/ER × 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 hospital (or other unit of analysis).
RAR = [risk-adjusted ratio × weight] + [reference population ratio × (1 – weight)]

For small hospitals, the weight is closer to 0. For large hospitals, the weight is closer to 1. For a given hospital, if the denominator is 0, then the weight assigned is 0 (i.e., the RAR is the reference population ratio).

Step 4. Select the component weights

The composite measure is the weighted average of the scaled and RARs for the component indicators. The component weights provided in the PSI software for PSI 90 Patient Safety and Adverse Events Composite are based on numerator weights and harm weights.

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 volume of harm in the outcome of interest, in this case a potentially preventable adverse event.

Harm weight. A harm weight is calculated by multiplying empirical estimates of excess harms associated with the patient safety event by utility weights linked to each of the harms (1-disutility). In general, harm weights measure the severity of the adverse events associated with each of the harms (i.e., outcome severity, or least preferred states from the patient perspective). Excess harms are estimated using statistical models comparing patients with a safety event to those without a safety event in a Centers for Medicare and Medicaid (CMS) Medicare fee-for-service sample that allowed up to one year of follow-up from the discharge date for the hospital stay associated with the index event.

Users may supply their own component weights. Some examples of possible weights follow, though others are possible:

Single indicator weight. In this case, the composite is simply the RAR for a single indicator. The reference population rate is the same among all hospitals.

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).

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.

5.0 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 weights are updated to reflect the indicator technical specifications as applied to the reference population. Harm weights are updated periodically using two years of Medicare Fee-for-Service data. In PSI software version 2020, PSI 07 Central Venous Catheter-Related Blood Stream Infection Rate is not included in the PSI 90 composite.

Prior to v6.0 of the PSI software, weighting of the individual component indicators was based on only numerator weights, calculated on the number of safety-related events for the component indicators in the all-payer reference population. For PSI 90 in PSI software v2020, weighting of the individual component indicators is based on two concepts: the volume of the adverse event and the harm associated with the adverse event.

Harms weights were developed specifically for the AHRQ QIs. Based on literature review and expert opinion from 13 clinical specialists in surgery, internal medicine, nephrology, trauma and emergency care, critical care, nursing, and home healthcare, 37 downstream harms associated with 10 PSIs were defined. For some PSIs, harms were included for up to one year after the PSI event (such as mortality, skilled nursing facility days, and outpatient dialysis). An expert panel then ranked the harms. These rankings, along with information from relevant studies in the literature, were then used to assign disutilities, or a measure of the severity of the adverse effects, associated with each of the harms.

In PSI software v2020, harm weights were calculated by multiplying empirical estimates of the probability of excess harms associated with each patient safety event by the corresponding utility weights (1–disutility). Disutility is the measure of the severity of the adverse events associated with each of the harms (i.e., outcome severity, or least preferred states from the patient perspective). These excess harm probabilities were estimated by comparing patients with a safety-related event to very similar, otherwise eligible patients without that safety-related event over up to one year after the discharge during which the index event happened. Linked claims data for two years of Medicare Fee-for-Service beneficiaries (2012–2013) were used for this analysis. To account for confounders in estimating the marginal impact of each PSI on the risk of excess harms, inverse probability propensity weighting with indicator- and harm-specific propensity models were calculated that included age, sex, racial/ethnic categories, Medicaid eligibility, point of origin, modified Medicare Severity–Diagnosis-Related Group categories,[†] Elixhauser comorbidities,[‡] and co-occurring PSIs.

6.0 What Composite Weights are included in the software?

To utilize the NQF endorsed composite, users must use these "Component Weights" that include both numerator and harm weights, when using the AHRQ QI™ software to compute the composite measure using their own data. Table 2 provides the NQF weights for this composite measure. These component weights are included in the PSI _Composite_Wt_v2020.sas macro. The sum of the component weights for the indicators included in the same composite always equals one.

[†] See the AHRQ Quality Indicator Empirical Methods document at http://www.qualityindicators.ahrq.gov/Modules/Default.aspx

[‡] http://www.hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp

Table 2. Composite Weights for PSI 90 v2020

INDICATOR	HARM WEIGHT	VOLUME WEIGHT	COMPONENT WEIGHT
PSI 3 Pressure Ulcer Rate	0.3080	0.1149	0.1810
PSI 6 Iatrogenic Pneumothorax Rate	0.1381	0.0513	0.0362
PSI 8 In Hospital Fall with Hip Fracture Rate	0.1440	0.0164	0.0121
PSI 9 Perioperative Hemorrhage or Hematoma Rate	0.0570	0.1621	0.0473
PSI 10 Postoperative Acute Kidney Injury Requiring Dialysis Rate	0.3584	0.0340	0.0623
PSI 11 Postoperative Respiratory Failure Rate	0.2219	0.1485	0.1685
PSI 12 Perioperative Pulmonary Embolism or Deep Vein Thrombosis Rate	0.1557	0.2569	0.2045
PSI 13 Postoperative Sepsis Rate	0.3102	0.1510	0.2395
PSI 14 Postoperative Wound Dehiscence Rate	0.1441	0.0137	0.0101
PSI 15 Abdominopelvic Accidental Puncture or Laceration Rate	0.1474	0.0512	0.0386

Source: 2017 State Inpatient Databases, Healthcare Cost and Utilization Program, Agency for Healthcare Research and Quality. 2012-2013 Medicare Fee-for-Service claims data.

7.0 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 (2008). *Patient Safety Indicators (PSI) Composite Measure Workgroup Final Report.* The report is available at https://www.qualityindicators.ahrq.gov/Downloads/Modules/PSI/PSI_Composite_Development.pdf