Applying the AHRQ Pediatric Quality Indicators to Hospital Data

What is the purpose of this tool? This tool provides guidance on how to calculate your hospital's rates for the AHRQ Pediatric Quality Indicators (PDIs) and how to use those rates to assess the hospital's performance on the indicators. AHRQ has developed SAS programs and free QI software for Windows that you can use to calculate your PDI rates. This tool provides the following information:

- Overview of the AHRQ PDIs, data requirements, and issues involved in using them.
- Descriptions of the rates calculated for the PDIs and how to work with them.
- An example of how to interpret a hospital's PDI rates.
- Guidance for assessing performance on the PDIs (trends and comparators).

Who are the target audiences? The primary audiences for this tool are two groups of hospital staff.

- Quality and safety staff, as well as clinical and other staff (e.g., quality and/or patient safety officer at the hospital) involved in pediatric quality improvement work, should be involved in assessing the hospital's performance on the PDIs and making decisions on priorities for improvement.
- Statisticians, data analysts, and programmers can help calculate the PDIs using data available from the hospital and relevant information from other sources.

Whenever possible, this information is designed to be usable by the quality program staff. Some of the information is technical, however, and is intended for statistician or programmer audiences.

How can this tool help you? You can use this tool to help calculate and interpret the hospital rates for the PDIs as part of your hospital's quality improvement work. The examples and guidance provided should help you understand the different types of PDI rates generated by the AHRQ SAS program or QI Windows software and to assess your hospital's performance over time and in comparison to other hospitals.

How does this tool relate to others? This tool should be used together with the tool on *PDI Rates Generated by the AHRQ SAS Programs* (Tool B.2). That tool provides guidance on how to work with the SAS programs and QI Windows software used to calculate the PDIs for your hospital and describes how to read and use the output from the programs. By guiding your calculation of the PDI rates for your hospitals, this tool also is a resource for *PowerPoint and Excel Worksheets on Data, Trends, and Rates* (Tool B.3), which you can use to display your PDI rates for presentations.

Note: This tool was updated based on the test software available at the time of the Pediatric QI Toolkit revision (as of March 2016). Refer to AHRQ's QI software Web site (http://www.qualityindicators.ahrq.gov/software) for the most updated information on the software.

Working With the Quality Indicators

The AHRQ Quality Indicators (QIs) are designed to assess health care quality. The QIs consist of four modules measuring various aspects of quality, of which the Pediatric Quality Indicators (PDIs) were developed specifically for children. This toolkit addresses the PDIs relevant to the pediatric inpatient setting. Refer to the *PDI Fact Sheet* (Tool A.1a) in this toolkit for a summary description of these indicators.

The AHRQ PDIs are available for public use at no charge. Resource materials on the PDIs can be downloaded at http://www.qualityindicators.ahrq.gov/Modules/pdi_resources.aspx. Be sure to download three types of files for the PDI modules: (1) Technical_Specifications, which provides detailed information about definitions for the PDIs; (2) the QI Software, which includes SAS programs or a free Windows application for calculating the PDIs; and (3) the QI Software Instructions, which provide step-by-step instructions of how to run the software.

Types of Rates for Quality Indicators

The AHRQ QI software can generate four types of PDI rates, which serve different purposes. These are the observed rates, expected rates, risk-adjusted rates, and smoothed rates. Three types of counts are involved in the calculation of each of these rates, which define either the numerator or denominator for a rate.

The definitions of the four rates and the counts used to calculate them are shown in the box below. Precise definitions with mathematical detail are presented in the appendix.

The **rates for each indicator** are calculated as follows:

Observed rate = **Observed events**/**Eligible population**

Expected rate = **Expected events**/**Eligible population**

Risk-adjusted rate = (**Observed events**/**Expected events**) * reference population rate

Smoothed rate = Risk-adjusted rate * weight – reference population rate * (1 − weight)

The **counts** that are used to calculate the rates of each indicator are determined as follows:

Eligible population = for each PDI, the total number of a hospital's discharges that qualified for the eligible population for that specific indicator

Observed events = for each PDI, the total sum of events that occurred in the eligible population for that specific indicator

Expected events = for each PDI, the total sum of events expected to occur for that specific indicator if the hospital had average performance comparable to the reference population, considering its case mix

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Data Used in Calculating the PDI Rates

Note: The information provided below related to expected, risk-adjusted, and smoothed rates is not applicable to v6.0 of the SAS and WinQI software, which only calculate observed rates when using ICD-10[i] data. The information about the expected, risk-adjusted, and smoothed rates are provided here because this information will still be relevant when looking at past performance (using ICD-9 codes and software). In addition, software to calculate expected, risk-adjusted, and smoothed rates is expected to become available in the future after national rates have been established using the ICD-10 codes.

Reference Population for the PDIs

The expected, risk-adjusted, and smoothed rates for the hospital-level PDIs are calculated using data for a reference population. AHRQ uses the Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases (SID) as the reference population. The SID is a large database of hospital discharge data maintained by AHRQ. It contains data for all hospital discharges from 47 States, representing more than 95 percent of all U.S. hospital discharges (for more information, see www.hcup-us.ahrq.gov/sidoverview.jsp).

Using this dataset, AHRQ performs statistical analyses to calculate reference-population PDI rates and identify risk factors. These measures are available as part of the AHRQ programs to calculate the PDI rates; hospitals do not have to do these calculations themselves.

Weights for the Smoothed Rates

The smoothed rates are calculated using weights that reflect the stability of your hospital's PDI rates, which are affected by the size of your hospital's patient population and the types of quality and safety events that occur in your hospital. When your hospital runs the QI software, weights are applied to the risk-adjusted rates for each PDI. These weights "shrink" the hospital's risk-adjusted rate toward the overall mean from the SID. The shrinkage estimate is called a "reliability adjustment."

For a hospital with less reliable PDI rate estimates, its smoothed rates will shrink more toward the SID mean, compared with smoothed rates for a hospital with more reliable rates. The resulting rates will have smaller year-to-year fluctuations in performance, so they will appear "smoother" than the raw rates.

Explanations of the Four Types of PDI Rates

Observed Rate

The observed rate (also called the raw rate) is the actual rate at which events measured by the indicator occurred in your hospital. If the hospital's primary interest is to identify cases for further followup and quality improvement, a review of the observed rates would be useful to identify PDIs that may be of concern. However, the observed rates are primarily intended to provide context for the user.

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[i] ICD-10 = International Classification of Diseases, 10th Revision. ICD-9 refers to the 9th Revision.

The observed rate is usually not appropriate for comparison across hospitals or over time because hospitals' patient case mixes can vary. If the number of eligible discharges for a PDI is small, the observed rate may appear to vary widely over time, even though the hospital's real performance on that indicator may not have changed. Therefore, to do other assessments, such as focusing on positive or negative performance, or comparisons with other hospitals, it is necessary to use the observed rate along with one of the other available rates.

Expected Rate

This rate currently is not available using the SAS or WinQI software v6.0. The expected rate is the rate a hospital would have if it had performed the same as the reference population given the provider's actual case mix (e.g., age, gender, diagnosis-related group [DRG], and comorbidity categories). The expected rate considers only the patient characteristics of a hospital's eligible discharges, not the actual observed events at the hospital.

Each eligible hospital stay is assigned an expected probability that a particular indicator event will occur based on the frequency with which the event occurred during similar stays in the reference population from the SID. The expected probabilities for the set of discharges are summed to obtain the number of expected events, which is then divided by your hospital's eligible population. The QI software contains the set of regression coefficients developed for each indicator from the SID, which the software uses to calculate and sum the probabilities to obtain the counts of expected events (see box above).

Another commonly used measure is:

Observed to Expected (O/E) ratio = observed rate/expected rate

If a hospital's observed rate for an indicator is higher than its expected rate (an O/E ratio greater than 1), the hospital performed worse than the reference population with an equivalent patient case mix. If the observed rate is lower than the expected rate (an O/E ratio less than 1), the hospital performed better than the reference population for that indicator with an equivalent case mix.

Risk-Adjusted Rate

This rate currently is not available using the SAS or WinQI software v6.0. The risk-adjusted rate is an estimate of how a hospital would perform on an indicator for an average case mix of patients, rather than for its own case mix. In other words, the risk-adjusted rate is the rate the hospital would have if it its case mix were the same as the case mix in the reference population. This is the rate that should be used for making comparisons across hospitals, or for comparisons within your hospital over time, because it adjusts for differences in the patient mix and allows you to examine real changes in performance.

The risk adjustments account for differences in the age, sex, modified DRG, and comorbidity between a particular hospital and the entire SID. (Different DRGs and comorbidities are relevant for different PDIs.) To calculate a risk-adjusted rate, a hospital's observed rate is divided by its expected rate to obtain the O/E ratio. Then the O/E ratio is multiplied by the indicator rate for the reference population from the SID.

Smoothed Rate

This rate currently is not available using the SAS or WinQI software v6.0. The smoothed rate is a weighted average of the hospital's risk-adjusted rate and the reference population rate, where the weight reflects the reliability of the hospital's risk-adjusted rate. The smoothed rate can be used to assess whether any difference between a hospital's risk-adjusted rate and the reference population rate is likely to remain in the next measurement period.

When the hospital runs the QI software, a shrinkage factor is applied to the risk-adjusted rate for each PDI. The resulting rate will appear "smoother" than the observed rate, meaning that the smoothed rate will have smaller year-to-year fluctuations in performance. More information on interpreting smoothed rates can be found in the AHRQ publications *Guide to Inpatient Quality Indicators* and *Guide to Patient Safety Indicators*, both of which are available on the AHRQ Web site.

Your hospital can compare its smoothed rate for an indicator with its risk-adjusted rate by calculating the following ratio:

$$\text{Smoothed Rate Ratio} = \frac{\text{smoothed rate} - \text{reference population rate}}{\text{risk-adjusted rate} - \text{reference population rate}}$$

You can use this ratio to determine whether the difference between your hospital's risk-adjusted rate and the reference population rate is likely to remain in the next measurement period. The larger the ratio, the more similar the smoothed rate is to the risk-adjusted rate. AHRQ suggests that if the ratio is greater than 0.80, the difference is likely to persist (whether the difference is positive or negative). If the ratio is less than 0.80, a greater share of the difference may be due to random differences in patient characteristics (that are not controlled for in the risk-adjustment model) due to small numbers in the patient population.

If your hospital has a relatively small number of eligible discharges for a particular PDI, it may not be possible to precisely estimate changes in rates for that PDI over time. If the ratio indicates that the risk-adjusted rate is unlikely to persist over time, AHRQ suggests that you use the smoothed rate for comparison to others instead of the risk-adjusted rate and that you interpret these comparisons with caution. Alternatively, you might calculate the risk-adjusted rate using discharges from more than one year, which will make the rate more stable (reliable).

An Example That Illustrates Use of the PDI Rates

In this example, two hypothetical hospitals (A and B) are assessing their performance on PDI 02, Pressure Ulcers. The rates calculated for each hospital are summarized here; these rates for the two hospitals are discussed below, including examples of how you should interpret the rate comparisons as you assess the performance of your hospital on these indicators. ***Note that the currently available SAS and WinQI v6.0 software programs cannot provide the expected, risk-adjusted, and smoothed rates when using ICD-10 data.***

Rates for PDI 02	Hospital A	Hospital B
Observed rate	0.02	0.06
Expected rate	0.04	0.10
Risk-adjusted rate	0.025	0.03
Smoothed rate	0.026	0.04

1. First, the two hospitals calculate their ***observed rates*** for PDI 02. Hospital A has an observed rate of 0.02 or 20/1,000, and Hospital B has an observed rate of 0.06 or 60/1,000. The national rate (from the SID) for PDI 02 is 0.05. It is not clear whether Hospital A or Hospital B has better or worse than average performance on PDI 02, compared with the SID rate, because they may have different case mixes than the SID population.

2. Hospital A has an ***expected rate*** of 0.04 for PDI 02. Since its expected rate is lower than the SID rate (0.05), its mix of patients is at *lower risk* for PDI 02 than the average case mix. Since its expected rate is higher than its observed rate, the hospital is performing better than expected on its case mix of patients. Hospital B has an expected rate of 0.10. Since its expected rate is higher than the SID rate (0.05), its mix of patients is at *higher risk* of PDI 02 than the average case mix. Since its expected rate is higher than its observed rate, the hospital also is performing better than expected on its case mix of patients.

3. Then the two hospitals calculate their ***risk-adjusted rates*** for PDI 02. Hospital A has a risk-adjusted rate of 0.025 = (0.02/0.04) * 0.05) and Hospital B has a risk adjusted rate of 0.03 = (0.06/0.10) * 0.05). The rates are calculated by multiplying each hospital's ratio of observed to expected rate by the SID rate of 0.05. These risk-adjusted rates suggest that Hospital A is performing slightly better on PDI 02 than Hospital B, and both hospitals are performing better than average, as represented by the SID rate. (Note that a lower rate for a PDI signifies better performance because fewer adverse events have occurred, in this case fewer patients with pressure ulcers.)

4. Hospital A is a relatively large hospital and has a ***smoothed rate*** of 0.026 on PDI 02, which is only slightly more similar to the reference population (SID) rate than its risk-adjusted rate. The smoothed-rate ratio discussed above takes a value of 0.96, suggesting that Hospital A's strong performance on PDI 02 is likely to persist. Hospital B is a small hospital that sees a small number of patients who are eligible for PDI 02. Hospital B has a smoothed rate of 0.04 and the smoothed-rate ratio takes a value of 0.50, which suggests that Hospital B's apparent good performance may not persist over time; that is, it may not reflect real performance. Hospital B may want to consider using the smoothed rate in comparing its performance on PDI 02 to others, or it could recalculate the risk-adjusted rate for PDI 02 using 2 years of discharge data to gain more stability in its rates.

Preparing To Calculate the PDI Rates

Hospital discharge data are required for the AHRQ PDIs. The needed data elements can be classified into the following categories:

- Hospital information, such as county.
- Patient demographics, such as age, gender, and race.
- Admission information, such as admission time (year, quarter), type (emergency vs. elective), admission source (from another hospital, emergency room in the same hospital).

- International Classification of Diseases, 10th Revision (ICD-10-CM) diagnosis and procedure codes, and classifications based on those codes, such as Medicare Severity diagnosis-related groups (MS-DRGs) and major diagnostic categories (MDCs).
- Discharge information, such as length of stay, payer for hospital charges, and disposition of patient (died vs. transferred to another facility).

Detailed information about data elements, such as variable names, descriptions, and formats, is provided by AHRQ on its Web site (www.qualityindicators.ahrq.gov/modules/pdi_resources.aspx).

AHRQ recommends that individual hospitals ensure that their datasets use the variable names and formats required by the SAS programs before applying the programs to their datasets. The data elements in the PDIs are based on the coding specifications used in the HCUP SID. The SID coding specifications are similar to the Uniform Bill (UB-04) but not identical. For data elements used in the AHRQ PDIs, crosswalks between the SID and UB-04 coding specifications are included in the SID documentation available at http://hcup-us.ahrq.gov/db/state/siddbdocumentation.jsp. You can use the crosswalks to ensure that your hospital's discharge data are consistent with the SID coding system.

Some coding and measurement issues involved in calculating the QIs are summarized here:

- **Treatment of Missing Values.** The AHRQ QI software handles missing data by requiring confirmation for the assignment of a poor outcome or negative event. For example, to be assigned as a death, each case must actually be coded as a death; missing data are considered neutral. In addition, missing data for some elements results in the exclusion of that case from the denominator, whereas for a few other elements, the case is retained. For details about the impact of missing data for each data element, see the AHRQ Web site (www.qualityindicators.ahrq.gov/modules/pdi_resources.aspx).
- **Dealing With a Small Population at Risk.** The QI software calculates the observed rates regardless of the size of the population at risk. However, PDI rates based on only a few cases (i.e., a small population at risk) should be interpreted with caution. AHRQ recommends that, in some performance measurement work, rates be suppressed when fewer than 30 cases are in the denominator. This exclusion rule serves two purposes: (1) it eliminates unstable estimates based on too few cases; and (2) it helps protect the identities of patients.

Where To Turn for Help

Some hospitals may rely on an outside agency, such as the State hospital association or a parent organization, to analyze their data and produce their QIs. For assistance in obtaining these measures, you should contact these organizations.

Appendix. Formulas and Uses for the Four Types of PDI Rates

Type of Rate	Brief Description	Way To Use It
Observed Rate	Raw rate generated by the QI software using a hospital's discharge data Formula: $R^k = \dfrac{\sum_j Y_j^k}{\sum_j D_j^k}$ where k indexes the QIs, j indexes the hospital's annual discharges, Y_j^k is a 0/1 variable taking the value 1 if discharge j meets the criteria for QI k, and D_j^k is a 0/1 variable taking the value 1 if discharge j is eligible for QI k.	Used to identify PDI areas of strength and those needing improvement; and for comparison with expected rates to identify PDI areas of strength and need for improvement.
Expected rate ***(Not currently available from the QI software for ICD-10)***	Rate the hospital would have if it had performed the same as the reference population given the provider's actual case mix (e.g., age, gender, DRG, and comorbidity categories) Formula: $E^k = \dfrac{\sum_j \hat{e}_j^k}{\sum_j D_j^k}$ where n addition to the symbols defined above, $\hat{e}_j^k = \hat{\beta}^k X_j^k$ the predicted probability of QI k occurring on discharge j given the risks (X_j^k) present in discharge j where $\hat{\beta}^k$ is a vector of parameter estimates from a regression of the risks on occurrences of QI k in the SID.	Used for comparison with the observed rate within the same hospital to identify PDI areas of strength and need for improvement.
Risk-adjusted rate ***(Not currently available from the QI software for ICD-10)***	Rate the hospital would have if it had the same case mix as the SID given the hospital's actual performance. Formula: $A^k = \dfrac{\sum_j Y_j^k}{\sum_j \hat{e}_j^k} * (R_{SID}^k)$ where in addition to the symbols defined above, R_{SID} is the raw rate for QI k in the entire SID.	Used for comparison (to other hospitals or sets of hospitals) to assess performance relative to others.
Smoothed rate ***(Not currently available from the QI software for ICD-10)***	Weighted average of the hospital's risk-adjusted rate and the reference population rate, where the weight reflects the reliability of the hospital's risk-adjusted rate (a function of the number of eligible discharges). Formula: where in addition to the symbols defined above, w^k is a measure of the reliability of the hospital's risk-adjusted rate.	Used for comparison with the risk-adjusted rate within the same hospital to determine the reliability of the risk-adjusted rate over time. Also used instead of the risk-adjusted rate for comparing with others if the risk-adjusted rate is not reliable over time.