TECHNICAL NOTES
for the Hospital Performance Report

December 2013

Pennsylvania Health Care Cost Containment Council
Report Period: Calendar Year 2012
January 1, 2012 through December 31, 2012 Discharges

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Technical Notes
Calendar Year 2012 Hospital Performance Report

OVERVIEW

This document serves as a technical supplement to the Calendar Year 2012 *Hospital Performance Report (HPR).* These Technical Notes describe the methodology used and outline the development of the report format and presentation. Data tables containing information about overall statewide results and the cases excluded from the analysis are also included.

Measures Reported in the HPR

The HPR presents several quality measures for adult cases (≥ 18 years of age), regardless of payer, in various medical conditions and surgical procedures.

The measures included in this report are:

- **Case Volume** – For each hospital, the number of cases (discharges) for each condition/procedure, after exclusions, is reported.
- **Risk-adjusted Mortality Rating** – In-hospital mortality was identified in the patient discharge record as a discharge status of "20." The rating identifies whether the hospital's observed mortality rate is significantly higher than, significantly lower than, or not significantly different than expected based on patient risk factors. This measure is reported for each hospital.
- **Risk-adjusted Readmission for Any Reason Rating** – A hospital readmission is defined as an acute care rehospitalization, for any reason, which occurred within 30 days of the discharge date of the original hospitalization. The rating identifies whether the hospital's observed readmission rate is significantly higher than, significantly lower than, or not significantly different than expected based on patient risk factors. This measure is reported for each hospital.
- **Average Hospital Charge (adjusted by case-mix at the regional level)** – Hospital charge is the patient total charge excluding professional fees. For each hospital, the average adjusted charge for each condition/procedure is reported.
- **Average Payment** – The overall statewide average payment (unadjusted) is shown for three payer categories: Medicare fee-for-service (FFS), Medicaid FFS, and Medicaid managed care organization (MCO). The average payment reflects the amount paid for the inpatient hospitalization and is shown for each condition/procedure and each MS-DRG within a given condition or procedure to account for variations in case-mix. Payments are displayed at the statewide level only. Medicare FFS payments are calculated using the claim payment amount obtained from the Centers for Medicare and Medicaid Services (CMS). Payments from Medicare Advantage plans (e.g., Medicare HMOs) are not included. Medicaid FFS and MCO payments are based on the claim payment amounts obtained from the Pennsylvania Department of Public Welfare. The payment data displayed in this report corresponds to calendar year 2011 hospitalizations as this is the most recent payment data available to PHC4. Patient liabilities (e.g., coinsurance and deductible dollar amounts) are not included.

Measures not suitable for a particular condition/procedure are not analyzed and not reported. For example, readmission ratings are not reported for the Colorectal Procedures category to avoid counting readmissions that may have been planned for cancer treatment.

Selection of Medical Conditions and Surgical Procedures for the HPR

The conditions/procedures selected for the *HPR* were chosen primarily because they: 1) were described in the literature as high cost, high mortality groups of patients, 2) had a high frequency of hospitalization, high rate of mortality, or high rate of readmissions, or 3) showed high variation across hospitals in the rates of mortality or readmissions. In addition, since the report included data from acute care facilities regardless of bed size, conditions/procedures were selected that were prevalent at smaller facilities as well as at larger facilities. Both medical and surgical categories were chosen so that both types of patients would be evaluated in the report.

The conditions/procedures were defined based on specific MS-DRGs and/or ICD-9-CM (International Classification of Diseases, Ninth Revision, Clinical Modification) codes and were designed to represent clinically cohesive groups of patients. Appendix Table A lists the codes used to define each of the conditions and procedures in the *HPR*. Cases that were deemed to be clinically complex were excluded. For example, cases with HIV infection (ICD-9-CM code 042, in any position) were excluded from all conditions/procedures.

Appendix Table B shows the statewide results for the measures and conditions/procedures displayed in the Calendar Year 2012 *HPR*.

Report Layout

The report is comprised of three separate "area" reports. Each area report includes, for each condition/procedure, results for individual hospitals in the area as well as summary information for both the area and the state overall. The three areas allow a geographically-refined comparison among acute care facilities. These areas are further divided into a total of nine regions.

Subdivision of Three Pennsylvania Areas into Nine Regions:

Western Pennsylvania

1 *Southwestern PA*—Allegheny, Armstrong, Beaver, Butler, Fayette, Greene, Washington, and Westmoreland Counties
2 *Northwestern PA*—Cameron, Clarion, Clearfield, Crawford, Elk, Erie, Forest, Jefferson, Lawrence, McKean, Mercer, Potter, Venango, and Warren Counties
3 *Southern Allegheny*—Bedford, Blair, Cambria, Indiana, and Somerset Counties

Central and Northeastern Pennsylvania

4 *Northcentral PA*—Centre, Clinton, Columbia, Lycoming, Mifflin, Montour, Northumberland, Snyder, Tioga, and Union Counties
5 *Southcentral PA*—Adams, Cumberland, Dauphin, Franklin, Fulton, Huntingdon, Juniata, Lancaster, Lebanon, Perry, and York Counties
6 *Northeastern PA*—Bradford, Lackawanna, Luzerne, Monroe, Pike, Sullivan, Susquehanna, Wayne, and Wyoming Counties

Southeastern Pennsylvania

7 *Lehigh Valley/Reading*—Berks, Carbon, Lehigh, Northampton, and Schuylkill Counties
8 *Suburban Philadelphia*—Bucks, Chester, Delaware, and Montgomery Counties
9 *City of Philadelphia*—Philadelphia County

DATA COLLECTION AND VERIFICATION

The data for the *HPR*, obtained from the UB-04 (Uniform Billing) form, was submitted electronically to the Pennsylvania Health Care Cost Containment Council by Pennsylvania general acute care (GAC) and specialty GAC hospitals. Federal hospitals were not included.

The data included demographic information, hospital charges, and diagnosis and procedure codes (ICD-9-CM).

Additionally, laboratory test results were submitted by hospitals to the Council for a select group of acute care inpatient records. For the period of this report (Q1, 2012 through Q4, 2012), these submissions covered nearly (but not more than) 50 percent of acute care hospital discharges. Hospitals were required to submit the highest and/or lowest result(s) for a maximum of 29 laboratory tests as collected from patients during the initial segment of their hospitalization. The requirements for submitting this data are specified elsewhere (refer to PHC4's *Laboratory Data Reporting Manual,* accessible at www.phc4.org). In brief, for patients admitted prior to 6:00 p.m., only laboratory results collected on Day 1 of the admission were to be submitted. For patients admitted after 6:00 p.m., results were to be submitted for tests collected on the day of admission (Day 1) through the next calendar day (Day 2).

Facilities submitted data to the Council on a quarterly basis (within 90 days from the last day of each quarter). Upon receipt of the data, verification was performed to assure data were submitted in a readable format. Extensive quality assurance checks were completed and laboratory data submissions were matched to inpatient records. Error reports for UB-04 data were then generated and returned to each facility with an opportunity to correct any problems. Similarly, laboratory test results were evaluated each quarter and summary reports indicating any anomalies were sent to each facility, again with an opportunity to make corrections.

Hospitals Not Reported

Results were not displayed for the following types of hospitals:

- hospitals that closed, merged into other facilities, or recently opened
- pediatric hospitals
- hospitals with less than five records in all conditions/procedures in this report
- hospitals with extensive data errors

See Appendix Table C for detailed information. Although data and analyses specific to these facilities were not displayed in the *HPR*, their valid, adult (≥ 18 years of age) records were retained in the reference database (unless noted otherwise) for the statistical analyses.

Handling of Anomalous Laboratory Test Results

The calculation of hospital-specific risk-adjusted outcomes relied heavily on the submission of valid and accurate laboratory test data. As noted, hospitals were given the opportunity to correct data anomalies (laboratory data that was so unreasonably high or low that it was most plausibly representative of a data error). Hospitals were notified of anomalous laboratory data submissions via specific feedback reports, provided on a quarterly basis. Since anomalous data that was not corrected had the potential to inaccurately skew all hospitals' final risk-adjusted results, such extreme values were replaced with default (typical) values when calculating a patient's risk of mortality or readmission. In effect, such lab results were treated as if they were missing in which neither penalty nor credit relative to the implicated data was applied in the calculation of a patient's risk.

STUDY POPULATION

Inclusion Criteria

The study populations for the *HPR* included usable records from all Pennsylvania GAC and specialty GAC hospitals in calendar year 2011. All records that met the definition criteria for each of the conditions and procedures included in this report, as described in the "Overview" and Table

A of this document, were included. During the study period there were 177 facilities in Pennsylvania.

General Exclusion Criteria

The number of cases included in any single type of analysis varied because each reported measure had its own unique set of exclusion criteria (see "Measure-Specific Exclusions" section).

However, the following types of records were excluded from all measures for all reported conditions and procedures.

Universal Exclusions:

- Records with errors (e.g., systematic errors in coding of essential data fields such as discharge status, dates, charges, etc.)
- Duplicate records
- Records with discharge dates not in study period
- Records with missing or invalid discharge status (see Appendix Table D for valid codes)
- Non-adult records (< 18 years) or records with invalid age (e.g., records that did not have the necessary data for the calculation of age or for which age was > 120 years)
- Patients with HIV infection (records with ICD-9-CM code 042 in any position)
- Patients who left against medical advice (records with a discharge status code of 07)
- Patients transferred to acute care facilities (short-term care, federal, long-term care, or critical access facilities; records with a discharge status code of 02, 43, 63, or 66)

A special exclusion criterion was applied to the Colorectal Procedures study population. Cases involving abdominal trauma (i.e., records with one of the following ICD-9-CM codes, in any position: 863.0 to 864.19, 865.00 to 865.19, 866.00 to 866.13, 867.0 to 867.9, 868.00 to 869.1, 879.2 to 879.9, 902.0 to 902.9, 908.1, 908.2, 908.4, 908.6, 908.9, 922.2, 935.2, 936, 937, 938, or 947.3) were excluded from all measures.

Measure-Specific Exclusions

In addition to the cases excluded from the general study population (see "General Exclusion Criteria" section), individual hospitalizations were excluded from outcome analyses when the data in the record was insufficient or inappropriate to the measure of interest. For example, patients that died were excluded from the readmission analysis but not the mortality analysis. See Appendix Table E for a listing of all records excluded by type and volume. Described below are some of the more complex exclusion criteria that were applied to specific measures.

Exclusions from Readmission Analysis

Length of stay outliers were excluded from the readmissions analyses. The 99th percentile was used as the trim point. If the length of stay of a particular record was in excess of the trim point for a given condition/procedure, that record was not used for the readmission analysis.

Also excluded were those patients who died during hospitalization, were non-Pennsylvania residents, were discharged to hospice, or were missing vital linking information (i.e., social security number). See Appendix Table E for complete list of exclusions.

Exclusions from Average Charge Analysis: Trimming

Outlier charges (cases) were trimmed (deleted) from the average charge analysis. Exclusion of outliers was imperative for the elimination of extreme values that otherwise would have had a significant and unrepresentative impact on the mean (average), which was the primary descriptive measure used for the analysis of charges.

Trim points for average charge for each condition or procedure were calculated using the "+/- 3.0 interquartile range" method (IQR). Trimming was done at the level of the MS-DRG; therefore, separate trim points were used for each individual MS-DRG in a condition/procedure. Since charges varied dramatically among geographic regions for the same MS-DRG, trim points were calculated at the regional level for each MS-DRG. Nine different sets of upper and lower trim points were used for each individual MS-DRG for the nine regions in this report.

Trim points for average charge were determined as follows:

Q1 = the first quartile (25^{th} percentile charge value) of all patient records from the comparative database in a particular condition/procedure

Q3 = the third quartile (75^{th} percentile charge value) of all patient records from the comparative database in a particular condition/procedure

IQR = Q3 – Q1

Lower Trim Point = Q1 – (3.0 x IQR)

Upper Trim Point = Q3 + (3.0 x IQR)

Exclusions from Average Payment Analysis

Payments were reported for Medicare fee-for-service, Medicaid fee-for-service, and Medicaid managed care organization records only. Records not identified as having a payment from one of these payers were excluded. Average payments were reported at the statewide level and not at the hospital level. The following types of records were excluded from this analysis.

Medicare FFS Payment Analysis Exclusions:

- Records excluded from the mortality analysis
- Records with no matching payment data
- Records for which the hospital indicated the payer was not Medicare FFS
- Records for which CMS indicated there was payment made by a primary payer other than CMS
- Records for which CMS indicated the payment was ≤ $1000

Medicaid FFS and MCO Payment Analysis Exclusions:

- Records excluded from the mortality analysis
- Records with no matching payment data
- Records for which Medicaid indicated there was higher payment made by a primary payer other than Medicaid
- Records for which Medicaid indicated the payment was ≤ $1000

CALCULATING HOSPITAL-SPECIFIC OUTCOMES

Separate analyses were performed to determine, for each hospital and condition/procedure, the actual percent of mortality, the actual percent of readmission for any reason, and the actual average charge. Each hospital's risk profile was used to calculate expected values; this was done to adjust for the risk inherent to each particular hospital's patient population. For mortality and readmissions, significance tests were conducted to determine whether the difference between a hospital's actual and expected values was too large to be attributed solely to chance. These results were displayed as ratings. For charges, actual average values were adjusted to account for variations in case-mix across MS-DRGs (see the "Special Considerations for Average Charge" section for details).

Determining Actual (Observed) Values

Mortality Percent	This percent was determined by dividing the total number of hospitalizations ending in death by the number of hospitalizations in the mortality analysis for a particular condition or procedure.
Readmission for Any Reason Percent	This percent was determined by dividing the number of discharges readmitted at least once for an acute care condition[1], to any GAC or specialty GAC hospital within 30 days of discharge, by the total number of discharges included in the readmissions analysis for a particular condition or procedure. A hospitalization that resulted in more than one readmission within 30 days was counted only once in the numerator even though it resulted in multiple readmissions. If, over the study period, a patient had multiple discharges in the same condition/procedure, each discharge was independently investigated to determine whether it had a readmission within 30 days of that discharge. Therefore, a single patient could have contributed more than one readmission to the numerator count (i.e., one for each of the multiple discharges that were in the same condition/procedure). Same day readmissions were included only if the original hospitalization resulted in a discharge to "home."[2]
Average Charge	This value was determined as the average (arithmetic mean) charge for the hospitalizations included in the charge analysis for a particular condition or procedure.

Determining Expected (Predicted) Values

Regression techniques were used to construct "risk models" for predicting the risk of mortality or readmission. Each model was a mathematical formula used to predict a patient's probability of death or readmission based on relevant risk factors. Included were patient risk factors such as abnormal laboratory test results collected from the beginning of the hospital stay, chronic comorbidities, demographic data, etc. Cases with these risk factors were given more "credit" in the calculation, leading to a higher predicted probability of mortality or readmission. A hospital's predicted rate was the average predicted probability across all its discharges in a given condition/procedure.

Model Development

The first step in building the risk adjustment models was to prepare a reference database. UB-04 data and laboratory test results from 2008 through 2009 adult (age $\geq$ 18 years) discharges from PA acute care hospitals were used. These records were limited to those included in the PHC4 list of 35 Diseases, Procedures, and Medical Conditions for which hospitals were required to submit laboratory data (this list is accessible at www.phc4.org). Lab results that did not meet quality standards were eliminated from this reference database. For example, when the quarterly median value of all records representing a given lab test from a given hospital was higher/lower than the statewide 5^{th}/95^{th} percentile value, respectively, the corresponding lab results were removed from the reference database. Such data was determined to be highly irregular and not suitable for inclusion in a database used for developing risk models.

Using the reference database, model selection ultimately identified risk factors that were statistically significant predictors of the relevant event (i.e., mortality or readmission).

[1] Readmissions for conditions related to behavioral health, physical rehabilitation, mental health, or skilled nursing were not included.

[2] "Home" discharges included those patients who were discharged to: 1) home or self care (discharge status code 01), 2) home under the care of an organized Home Health Service Organization in anticipation of covered skilled care (discharge status code 06), or 3) Court/Law Enforcement (discharge status code 21). See Appendix Table D for descriptions of discharge status codes.

Demographic data, laboratory test results, chronic comorbidities (identified by ICD-9-CM codes), and UB-04-derived factors were tested for significance. In addition, special high-risk populations identified in the current scientific literature were evaluated as possible risk-adjustment factors. Each condition and procedure was modeled separately using binary logistic regression. Risk factors were considered statistically significant in a model if they met the $p < 0.10$ significance criteria. However, risk factors were evaluated for relevance by considering both mathematical (statistical significance) and clinical perspectives (clinically important populations). Factors lacking face validity were eliminated.

Potential risk factors were added to the model using the following prioritization: 1) patient demographics (gender, race/ethnicity, age) were given first priority since these data elements were available for every record, 2) laboratory test results were given second highest priority, 3) ICD.9.CM code-based variables were evaluated third, and 4) other UB-04-derived data elements (e.g., cases identified as having been transferred from skilled nursing facilities) were evaluated last. All factors within a class were evaluated before considering factors from the next class. This approach was followed to maximize the stronger predictive power of the laboratory data.

Patient age is a well-recognized predictor of health outcomes. For each model, multiple alternative designs of the age factor were tested to determine which approach best fit the data (i.e., provided the highest model likelihood). The patient age was tested as a linear, linear spline with up to two knots, quadratic, or categorical factor. Typically the linear spline approach yielded the best results.

In building the risk models, laboratory test results were partitioned into five categories, A through E, with one category reflective of "typical" results for hospitalized patients and four additional categories representative of abnormal results generally associated with increased risk. Records with missing lab values were combined with records in the typical category. For each individual model, categories with similar results were combined to minimize the complexity of the model while still maintaining its specificity. All combinations that met the following criteria were considered:

- Minimum volume: each category was required to have at least 1% of the total volume.
- Order of risk: categories farther away from the typical category were required to have rates of increasing risk (e.g., when the typical category was defined as level A, categories B, C, D, and E were required to have increasingly higher rates of mortality).
- Significance: categories were required to have significantly different rates of risk.

In the final model, all records in a specified abnormal category received the same amount of credit (regardless of how extreme the lab value within the category).

To avoid developing models that were "overfitted" (i.e., unnecessarily complex models with factors that may be insignificant when applied to a different dataset), a statistical criterion called the *Schwarz criterion* was used. This application avoided the problem of overfitting by including a penalty value for each factor as it was added to the model. In this way, the best end point for the model build (i.e., the point in which no more factors should be added to the model) could be determined.

The final step in the model development process was to evaluate the stability of each factor in the prepared model. The *bootstrap technique* was used to identify and eliminate factors that were unstable and unlikely to predict the same level of risk when applied to other (future) datasets. Using this technique, one hundred sample datasets were randomly generated from the reference database. Records were allowed to appear multiple times in the sample datasets if they were selected repeatedly. The prepared model was then fit to each sample dataset to determine if each factor maintained significance ($p<0.10$) in at least 75% of the sample models. This same approach was used to eliminate any factor that did not have a consistently positive numeric value/coefficient (reflective of an increased risk) or a consistently negative coefficient (indicative of a decreased risk) in at least 75% of the sample models; see the "Calculation of Expected

Values" section below for a description of model coefficients. Factors that failed this test were either regrouped if possible or were eliminated.

Calculation of Expected Values

The final risk models estimated the relative effects (β_n) that each of the risk factors had on the relevant outcome value for each hospitalization. The model equations took the following form:

$\beta X = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 \ldots$

where:

β_n = the relevant model coefficient (β_0 is the intercept)
x_n = the value of the risk factor for a hospitalization

(risk factors that were binary, e.g., yes/no, were coded as yes = 1 and no = 0)

These models were then used to calculate the predicted values (e.g., predicted probability of death or readmission) for each individual hospitalization (after exclusions). The risk factor values (X) were multiplied by the model coefficients (β) and summed to determine the value βX for each hospitalization.

Using logistic regression modeling, the predicted value was calculated as:

$$p = \frac{e^{\beta X}}{1 + e^{\beta X}}$$

where $e \approx 2.7182818285$

The expected value for an individual hospital was the average of these predicted values for all hospitalizations (at that hospital) for a given condition/procedure. See Appendix Table F for an example of a logistic regression model and the calculations involved.

Special Considerations for Average Charge

For the conditions and procedures that included more than one MS-DRG in their definition, case-mix adjustment was used to calculate a composite average charge for the combined MS-DRGs representing the condition. This adjustment was made at the level of the nine Pennsylvania regions and was used to account for hospital variation in the mix of cases across MS-DRGs.

For example, the condition Chronic Obstructive Pulmonary Disease was comprised of a subset of cases in MS-DRGs 190, 191 and 192. The charges associated with MS-DRGs 190, 191 and 192 were adjusted according to the number of patients and the average charge associated with treating patients in each of these three MS-DRGs within a particular Pennsylvania region. See Appendix Table G for a detailed example of a case-mix adjustment calculation. As a result of using this method, the average charge for a condition that contained cases from a single MS-DRG (e.g., Chest Pain or Hypotension and Fainting) was ultimately reported without adjustment.

Determining Statistical Ratings

Significance tests (using the binomial distribution, see below) were performed for the mortality and readmissions measures. To account for random variation, statistical evaluation was used to determine whether the difference between a hospital's observed and expected values was *too large* to be attributed solely to chance.

Binomial Distribution

The use of the binomial distribution required the following assumptions:

- Each observation included in the study had one of two observable events (e.g., mortality vs. no mortality). In other words, the response was dichotomous.
- The probability of the event (e.g., mortality) for each observation studied within a condition/procedure was equal to the probability provided by the risk models.
- The result for any one observation in the analyses had no impact on the result of another observation. In other words, the observations were independent.

The probability distribution for a specific hospital's outcome in one area of analysis was based on the hospital's predicted or expected values. Using the probability distribution, a p-value was calculated for each observed value. This p-value was the probability, or likelihood, that the value could have occurred by chance. If it was very unlikely ($p < 0.05$; see "Inferential Error" section below) that the observed or actual value could have occurred only by chance, it was concluded that the observed value was "significantly different" from the expected value.

Calculation of p-values

The binomial distribution defined a probability of each potential outcome (e.g., the probability of observing exactly 3 deaths out of 40) according to the binomial formula:

$$P(a) = \left[\frac{N!}{a!(N-a)!}\right] p^a (1-p)^{N-a}$$

where:

a was the number of events (e.g., mortalities) that were observed (i.e., a = 1 mortality, a = 2 mortalities, etc.) in N hospitalizations. The value of "a" ranged from 0 through N (in other words, $0 \leq a \leq N$)

P(a) was the probability that exactly "a" events would be observed

N was the number of hospitalizations in a particular hospital's condition/procedure.

p was the overall expected rate (e.g., expected percent mortality) for a particular hospital's condition/procedure.

The rating process evaluated both fewer than expected as well as greater than expected mortalities. Thus, a two-tailed test was used. In the example 3 deaths out of 40, the probability associated with the left-hand tail was the sum of the probability for 0, 1, 2, or 3 deaths out of 40. The probability of the right-hand tail was the sum of the probabilities at the upper end of the range (40, 39, 38…) until that sum was as close as possible to (but still less than) the probability associated with the left-hand tail. The two-tailed p-value was the sum of the probability of the left-hand and right-hand tails.

The two-tailed p-value was calculated for each hospital within each condition or procedure.

Inferential Error

A type of inferential error that can be made in statistics is called a Type I error or "false positive." The probability of committing a Type I error is equal to the level of significance established by the researcher. For the current analysis, the level of significance was set to 0.05.

In the context of the *HPR*, a Type I error would have occurred when the difference between the actual mortality percent and the expected mortality percent was declared statistically significant,

when in fact, the difference was due to chance. That is, for a particular condition or procedure, the hospital was declared to be statistically higher or lower than expected when in reality the hospital's level of performance was comparable to its expected performance, as determined by its risk profile. Since the level of significance was set to 0.05, there was a 5% chance (or 1 in 20) of committing this type of error.

Assignment of Statistical Rating

A statistical rating of higher than expected or lower than expected was assigned to each hospital if the difference between what was observed and what was expected in a particular condition/procedure was statistically significant. The p-value, calculated in terms of a "two-tailed" test, was compared to the level of significance. For example, in determining the mortality rating for each hospital:

- If the calculated p-value was less than 0.05, then the conclusion was made that the difference between what was expected and what was observed was statistically significant.
  - If the actual mortality percent was less than expected, the hospital was assigned the symbol "○" (as shown in the *HPR*) to indicate that the mortality percent was significantly less than expected for a particular condition or procedure.
  - If the actual mortality percent was higher than expected, the hospital was assigned the symbol "●" (as shown in the *HPR*) to indicate that the mortality percent was significantly greater than expected for a particular condition or procedure.
- If the calculated p-value was greater than or equal to 0.05, then the conclusion was made that the difference between the expected mortality percent and the actual mortality percent was *not* statistically significant. It *cannot be concluded* that the actual mortality percent for that particular hospital in that particular condition/procedure was different from the expected mortality percent derived from the particular hospital's risk profile. In this case the hospital was assigned the symbol "⊙" (as shown in the *HPR*).

Minimum Cases Needed for Reporting

Mortality, Readmissions, and Charges

Whenever the number of cases analyzed for a particular measure (after exclusions) was less than five, "NR" (not reported) was displayed in place of a particular result. Hospitals with less than five records in all of the reported conditions and procedures were not displayed in the report. See Appendix Table C for a listing of these hospitals.

Statewide Average Payments

"NR" was displayed in the average payment column when the number of cases within a single MS-DRG was ten or fewer.

APPENDIX

TABLE A
Medical Conditions and Surgical Procedures in the
Calendar Year 2012 *Hospital Performance Report*

The following table defines the 16 conditions and procedures included in this report. The ICD-9-CM codes (principal diagnosis [PDx] and/or principal procedure [PPx]) and MS-DRGs used to define each condition/procedure are applicable to CMS Grouper Versions 29.0 and 30.0. Clinically complex cases that are excluded from these study populations are identified as footnotes.

Condition/Procedure[1]	Principal Diagnosis and/or Procedure Codes	MS-DRGs
Abnormal Heartbeat	PDx: 426.0, 426.10, 426.11, 426.12, 426.13, 426.2, 426.3, 426.4, 426.50, 426.51, 426.52, 426.53, 426.54, 426.6, 426.7, 426.81, 426.82, 426.89, 426.9, 427.0, 427.1, 427.2, 427.31, 427.32, 427.60, 427.61, 427.69, 427.81, 427.89, 427.9, 746.86, 785.0	242, 243, 244, 246, 247, 248, 249, 250, 251, 258, 259, 260, 261, 262, 286, 287, 308, 309, 310
Chest Pain	None	313
Chronic Obstructive Pulmonary Disease (COPD)	PDx: 491.20, 491.21, 491.22, 492.0, 492.8, 496, 506.4	190, 191, 192
Colorectal Procedures[2]	PPx: 17.31, 17.32, 17.33, 17.34, 17.35, 17.36, 17.39, 45.71, 45.72, 45.73, 45.74, 45.75, 45.76, 45.79, 45.81, 45.82, 45.83, 45.92, 45.94, 46.03, 46.10, 46.11, 46.13, 46.42, 46.43, 46.52, 46.76, 46.94, 48.40, 48.42, 48.43, 48.49, 48.50, 48.51, 48.52, 48.59, 48.62, 48.63, 48.69, 48.75, 48.76, 70.72	329, 330, 331, 332, 333, 334
Congestive Heart Failure (CHF)	PDx: 398.91, 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.9	286, 287, 291, 292, 293
Diabetes – Medical Management	PDx: 249.0x, 249.1x, 249.2x, 249.3x, 249.4x, 249.6x, 249.7x, 249.8x, 249.9x, 250.0y, 250.1y, 250.2y, 250.3y, 250.4y, 250.6y, 250.7y, 250.8y, 250.9y (x = 0,1; y = 0-3)	073, 074, 299, 300, 301, 637, 638, 639, 698, 699, 700
Gallbladder Removal – Laparoscopic	PPx: 51.23, 51.24	411, 412, 413, 417, 418, 419
Gallbladder Removal – Open	PPx: 51.21, 51.22	411, 412, 413, 414, 415, 416
Heart Attack – Medical Management	PDx: 410.01, 410.11, 410.21, 410.31, 410.41, 410.51, 410.61, 410.71, 410.81, 410.91	280, 281, 282, 283, 284, 285
Hypotension and Fainting	None	312
Kidney and Urinary Tract Infections	PDx: 590.00, 590.01, 590.10, 590.11, 590.2, 590.3, 590.80, 590.9, 595.x (x = 0-3), 595.81, 595.89, 595.9, 599.0	689, 690
Kidney Failure – Acute	PDx: 584.5, 584.6, 584.7, 584.8, 584.9	682, 683, 684
Pneumonia – Aspiration	PDx: 507.0	177, 178, 179
Pneumonia – Infectious	PDx: 480.0, 480.1, 480.2, 480.3, 480.8, 480.9, 481, 482.0, 482.1, 482.2, 482.30, 482.31, 482.32, 482.39, 482.40, 482.41, 482.42, 482.49, 482.81, 482.82, 482.83, 482.84, 482.89, 482.9, 483.0, 483.1, 483.8, 485, 486, 487.0, 488.01, 488.11, 488.81	177, 178, 179, 193, 194, 195
Septicemia	PDx: 038.0, 038.10, 038.11, 038.12, 038.19, 038.2, 038.3, 038.40, 038.41, 038.42, 038.43, 038.44, 038.49, 038.8, 038.9, 995.90, 995.91, 995.92	870, 871, 872
Stroke	PDx: 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91	061, 062, 063, 064, 065, 066

[1] Cases with HIV Infections (ICD-9-CM code 042, in any position) were excluded from all conditions and procedures.
[2] Cases with abdominal trauma were excluded. Abdominal trauma was defined by the following ICD-9-CM codes: 863.0 to 864.19, 865.00 to 865.19, 866.00 to 866.13, 867.0 to 867.9, 868.00 to 869.1, 879.2 to 879.9, 902.0 to 902.9, 908.1, 908.2, 908.4, 908.6, 908.9, 922.2, 935.2, 936, 937, 938, or 947.3.

TABLE B

Statewide Utilization and Outcome Data, by Condition/Procedure

Condition/Procedure	Cases[1] (n)	Mortality[2] (%)	Readmission for Any Reason[2] (%)	Average Charge[2]
Abnormal Heartbeat	44,083	0.9	14.8	$38,850
Chest Pain	13,747	0.1	13.3	$20,464
Chronic Obstructive Pulmonary Disease (COPD)	31,028	0.7	21.6	$26,969
Colorectal Procedures	13,404	2.1	NR	$78,579
Congestive Heart Failure (CHF)	42,731	2.8	24.5	$33,169
Diabetes – Medical Management	16,662	0.6	21.0	$26,649
Gallbladder Removal – Laparoscopic	12,527	0.3	6.9	$42,427
Gallbladder Removal – Open	1,823	0.6	10.4	$66,455
Heart Attack – Medical Management	11,266	8.8	NR	$38,227
Hypotension and Fainting	14,478	0.3	11.8	$23,243
Kidney and Urinary Tract Infections	23,799	0.6	16.2	$23,661
Kidney Failure – Acute	22,594	3.3	22.4	$31,287
Pneumonia – Aspiration	8,152	6.8	23.0	$41,274
Pneumonia – Infectious	36,964	2.5	16.4	$29,766
Septicemia	39,832	13.7	NR	$51,257
Stroke	21,002	4.0	13.8	$40,240

[1] Number of cases after mortality exclusions
[2] Value shown was based on records after all relevant exclusions were removed.
NR: Not Reported

TABLE C
Hospitals Not Reported in the Calendar Year 2012 *Hospital Performance Report*

The CY2012 *Hospital Performance Report* included usable discharge records from all GAC/SGAC Pennsylvania facilities in the reported time period. There were 177 facilities in Pennsylvania during the study period.

Hospital Name	Reason Hospital was Not Reported
Facilities that Closed/Merged:	
Marian Community	Closed facility – effective 02/28/2012
Montgomery	Closed facility – effective 09/29/2012
Saint Catherine	Closed facility – effective 04/20/2012
New Facilities:	
Einstein Montgomery	Opened 9/29/2012 – sufficient data not yet available
St. Luke's Anderson	Opened 11/04/2011 – sufficient data not yet available
UPMC East	Opened 06/07/2012 – sufficient data not yet available
Wellspan Surgery and Rehab	Opened 8/1/2012 – sufficient data not yet available
Wills Eye	Opened 8/26/2013 – sufficient data not yet available
Children's Hospitals:	
Children's Hospital Philadelphia	Children's hospital
Children's Hospital Pittsburgh	Children's hospital
Shriners/Philadelphia	Children's hospital
St. Christopher's Children's	Children's hospital
Facilities with Low Volume of Records in the *Hospital Performance Report*:	
The following facilities had less than 5 records in all conditions/procedures in this report.	
Advanced Surgical	Low volume
Barix Clinics/PA	Low volume
Coordinated Health Ortho	Low volume
Edgewood Surgical	Low volume
OSS Orthopedic	Low volume
Rothman Specialty	Low volume
Surg Spec/Coordinated	Low volume
Facility with Extensive Data Errors:	
Albert Einstein (Einstein Medical Center)	Facility submitted 2012 data that included significant technical errors.

TABLE D
Valid Discharge Status Codes

Code	Description
01	Discharged to home or self-care (routine discharge)
02	Discharged/transferred to a short-term general hospital for inpatient care
03	Discharged/transferred to skilled nursing facility (SNF) with Medicare certification in anticipation of skilled care
04	Discharged/transferred to a facility that provides custodial or supportive care
05	Discharged/transferred to a designated cancer center or children's hospital
06	Discharged/transferred to home under care of organized home health service organization in anticipation of covered skilled care
07	Left against medical advice or discontinued care
20	Expired
21	Discharged/transferred to court/law enforcement
43	Discharged/transferred to a federal health care facility
50	Discharged to hospice—home
51	Discharged to hospice—medical facility (certified) providing hospice level of care
61	Discharged/transferred to a hospital-based Medicare approved swing bed
62	Discharged/transferred to an inpatient rehabilitation facility (IRF) including rehabilitation distinct part units of a hospital
63	Discharged/transferred to a Medicare certified long term care hospital (LTCH)
64	Discharged/transferred to a nursing facility certified under Medicaid but not certified under Medicare
65	Discharged/transferred to a psychiatric hospital or psychiatric distinct part unit of a hospital
66	Discharged/transferred to a critical access hospital (CAH)
70	Discharged/transferred to another type of health care institution not defined elsewhere in this code list

TABLE E
Statewide Exclusions from Analyses, by Measure

The exclusions are listed in the order in which they were removed from the reference database.

	Mortality		Readmission for Any Reason		Average Charge	
	Cases (n)	Cases (%)	Cases (n)	Cases (%)	Cases (n)	Cases (%)
Total Cases Before Exclusions	377,232	100.0	307,049	100.0	377,232	100.0
Exclusions:						
Records with errors	0	0.0	0	0.0	0	0.0
Duplicate records	29	<0.1	26	<0.1	29	<0.1
Discharge date not in time period	11	<0.1	10	<0.1	11	<0.1
Missing or invalid discharge status	31	<0.1	29	<0.1	31	<0.1
Non-adult (< 18) or invalid age	7,867	2.1	7,266	2.4	7,867	2.1
Patients with HIV Infection	450	0.1	425	0.1	450	0.1
Patients with abdominal trauma[1]	89	<0.1	NA	NA	89	<0.1
Patients who left against medical advice	3,854	1.0	3,437	1.1	3,854	1.0
Patients transferred to GAC facilities	10,809	2.9	6,266	2.0	10,809	2.9
Patients who died	NA	NA	5,168	1.7	NA	NA
Invalid length of stay	NA	NA	0	0.0	NA	NA
Length of stay outliers	NA	NA	2,489	0.8	NA	NA
Non-Pennsylvania residents	NA	NA	9,848	3.2	NA	NA
Patients discharged to hospice	NA	NA	5,705	1.9	NA	NA
Missing or invalid social security number	NA	NA	2,191	0.7	NA	NA
Invalid charges	NA	NA	NA	NA	147	<0.1
Charge outliers	NA	NA	NA	NA	6,203	1.6
No reference data	NA	NA	NA	NA	1,351	0.4
Intermediary Hospitalization	NA	NA	258	0.1	NA	NA
Total Exclusions	23,140	6.1	43,118	14.0	30,841	8.2
Total Cases in Analysis	354,092	93.9	263,931	86.0	346,391	91.8

[1] This exclusion is only applicable to the Colorectal Procedures study population.
NA: Not Applicable

TABLE F
Example of Logistic Regression

Calculations Used in Determining Expected Mortality Rates for a Given Hospital
Medical Condition: Abnormal Heartbeat

Total Cases: Number of hospitalizations for a hospital after exclusions (equal to n).

Actual Percent Mortality: Total number of cases that died / total number of hospitalizations.

Expected Percent Mortality: Mean of the predicted probability of death for each hospitalization.

Step 1: Calculate the predicted probability of death for each hospitalization (PDeath):

$$\beta X = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots \beta_{40} x_{40}$$

$$= -9.7153 + (0.0293)(x_1) + (0.0959)(x_2) + (0.4325)(x_3) + \ldots (0.4040)(x_{40})$$

where:

x_1 = Age
x_2 = Age > 90
x_3 = Urea Nitrogen Blood (BUN) = 26 - <41 mg/dL
…
x_{40} = Heart Failure (1 if true, 0 if false)

β's are the regression coefficients that correspond to each respective risk factor (x).

$$\text{PDeath} = \frac{e^{\beta X}}{1 + e^{\beta X}}$$

where $e \approx 2.7182818285$

Step 2: Calculate the mean PDeath for a hospital (expected percent of deaths):

$$\text{Mean PDeath} = \frac{\Sigma\ \text{PDeath}}{n}$$

TABLE G
Example of Case-Mix Adjustment

Calculations Used in Determining Average Charge for a Hospital
Region: Southwestern PA
Medical Condition: COPD

Total Cases:	Number of hospitalizations for a hospital after charges exclusions (equal to n).
Actual Charge:	Mean of the charges for each hospitalization.
Expected Charge:	Mean of the predicted charges for each hospitalization. Step 1: Calculate each hospitalization's predicted charge (PChg): The PChg for each record is equal to the average charge for all hospitalizations (after exclusion) in the hospital's same region, condition, and MS-DRG within the condition. Region 1 - Southwestern PA, COPD, MS-DRG 190: ..... $18,870 or Region 1 - Southwestern PA, COPD, MS-DRG 191: ..... $16,221 or Region 1 - Southwestern PA, COPD, MS-DRG 192: ..... $11,981 Step 2: Calculate the mean PChg for a hospital (expected charge): $\text{Mean PChg} = \frac{\Sigma \text{ PChg}}{n}$
Case-Mix-Adjusted Charge:	$\frac{\text{Mean Actual Chg}}{\text{Mean PChg}}$ (Region 1 Actual Charge)