TECHNICAL NOTES
for the Hospital Performance Report

December 2022

Pennsylvania Health Care Cost Containment Council
Report Period:
FFY2021 Data – October 1, 2020 through September 30, 2021 Discharges

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Technical Notes
Hospital Performance Report

OVERVIEW

This document serves as a technical supplement to the *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.

New for this Report

The new report period includes inpatient discharges from October 1, 2020 through September 30, 2021.

All International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) codes and Medicare Severity – Diagnosis-Related Groups (MS-DRGs) used to define the conditions in this report were updated, as necessary, to Centers for Medicare and Medicaid Services (CMS) Grouper Version 38, applicable to October 1, 2020 – September 30, 2021 discharges. Appendix Table A provides links to the population definitions and exclusions used for each condition.

Special Note Regarding COVID-19

The COVID-19 pandemic has had a substantial impact on Pennsylvania hospitals since its onset in the early part of 2020. Since that time, hospitals have faced extraordinary challenges in care delivery, particularly for patients diagnosed with COVID-19. While the FFY 2021 *HPR* includes inpatient discharge data from the pandemic period, cases with a COVID-19 diagnosis are excluded from all analyses (see "General Exclusion Criteria" section for details) since these hospitalizations are clinically complex, and measuring hospital outcomes related to these atypical cases is not the intent of this report.

Further, two conditions typically reported in the *HPR*, Pneumonia-Aspiration and Pneumonia-Infectious, are not included in this FFY 2021 report due to limitations in the methodologies used to account for high-risk patients hospitalized for pneumonia during the pandemic period. This is similar to the recent approach taken by the Centers for Medicare and Medicaid Services (CMS)*.

Measures Reported in the *Hospital Performance Report* (*HPR)*

The *HPR* presents several quality measures for 13 different medical conditions for adult cases (≥ 18 years of age), regardless of payer.

The measures included in this report are:

- **Case Volume** – For each hospital, the number of cases (discharges) for each condition, after exclusions, is reported.
- **Risk-adjusted Mortality Rating** – In-hospital mortality is 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

* Centers for Medicare and Medicaid Services. "Hospital Inpatient Prospective Payment Systems for Acute Care Hospitals and the Long-Term Care Hospital Prospective Payment System and Policy Changes and Fiscal Year 2023 Rates", 87 Fed. Reg. 49081, 49109 (August 10, 2022). Available at https://www.federalregister.gov/d/2022-16472.

not significantly different than expected based on patient risk factors. This measure is reported for each hospital.

- **Risk-adjusted Readmission Rating** – A hospital readmission is defined as an acute care unplanned rehospitalization that 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. The Centers for Medicare and Medicaid Services' (CMS) planned readmission algorithm* is used to distinguish readmissions that are typically planned from those that are unplanned. Readmissions identified as planned are not counted in the analyses.
- **Average Hospital Charge (adjusted by case mix at the regional level)** – Hospital charge is the total amount charged to the patient, excluding professional fees. For each hospital, the average adjusted charge for each condition is reported.
- **Average Payment** – The overall statewide average payment (unadjusted) is shown for Medicare fee-for-service (FFS) patients. The average payment reflects the amount paid for the inpatient hospitalizations of Pennsylvania residents only and is shown for each condition and each MS-DRG within a given condition – to account for variations in case mix. Payments are displayed at the statewide level only and 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. Patient liabilities (e.g., coinsurance and deductible dollar amounts) are not included.

Measures Not Reported

Measures unsuitable for a particular condition are not reported. For example, mortality ratings are not reported for conditions (i.e., Chest Pain) with low statewide mortality (less than ten mortalities, after exclusions).

Selection of Medical Conditions for the *HPR*

The conditions selected for the *HPR* were chosen primarily because they: 1) are described in the literature as high cost, high mortality groups of patients, 2) have a high frequency of hospitalization, high rate of mortality, or high rate of readmission, or 3) show high variation across hospitals in the rates of mortality or readmission. In addition, since the report includes data from acute care facilities regardless of bed size, conditions were selected that are prevalent at smaller facilities as well as at larger facilities.

Each condition is designed to represent a clinically cohesive group of patients and is defined using specific MS-DRGs and ICD-10-CM codes. Appendix Table A provides links to the lists the codes that define each of the conditions in the *HPR*. Cases deemed to be clinically complex are excluded. For example, cases with HIV infection (ICD-10-CM diagnosis code B20, in any position) are excluded from all conditions.

Appendix Table B shows the statewide results for the measures and conditions displayed in the *HPR*.

* The CMS planned readmission algorithm version 4.0 is a component of the 2022 All-Cause Hospital-Wide Readmission Measure (version 10.0). See "2022 All-Cause Hospital-Wide Measure Updates and Specifications Report: Hospital-Wide Readmission" available at https://www.qualitynet.org/inpatient/measures/readmission/methodology. The following modifications were applied to the *HPR*: 1) obstetric cases were not counted as unplanned readmissions and 2) AHRQ's Clinical Classifications Software (CCS) v2019.1 (beta version) for ICD-10-CM and v2020.1 (beta version) for ICD-10-PCS were used for code mapping, with relevant coding grouper updates applied by PHC4.

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-10-CM/PCS).

Additionally, laboratory test results were submitted by hospitals to the Council for the records included in this report. 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 (i.e., the entire calendar date of Day 1) were to be submitted. For patients admitted after 6:00 p.m., results were to be submitted for tests collected on the entire calendar date of Day 1 (day of admission) 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. Data accuracy and completeness were the ultimate responsibility of each individual hospital.

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 in this report
- hospitals with extensive data errors or missing data

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 population for each condition reported in the *HPR* included usable records from all Pennsylvania GAC and specialty GAC hospitals during the period October 1, 2020 through September 30, 2021. All records that met the definition criteria for each of the conditions included in this report, as described in the "Overview" and Table A of this document, were included. During the study period there were 164 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.

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-10-CM diagnosis code B20 in any position)
- Patients with a COVID-19 diagnosis (with ICD-10-CM diagnosis code U071 in any position)
- Records representing rehabilitation services, not acute care (identified by revenue codes 0024, 0118, 0128, 0138, 0148, or 0158)
- 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, 66, 82, 88, 91, or 94)

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

Patients who died during hospitalization, discharges with invalid or missing lengths of stay, and any discharge with a length of stay that was more than the established trim point for a given condition (i.e., length of stay outliers) were excluded from the readmissions analyses. The 99th percentile was used as the trim point for determining length of stay outliers.

Also excluded were non-Pennsylvania residents, patients who were discharged to hospice, and discharges that had two or more missing or invalid patient identifier fields. The following patient identifier fields were used for linking hospitalizations: social security number, name, address, birth

date, sex, hospital-assigned medical record number, and insured unique identifier. See Appendix Table E for a 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 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. 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 (see Appendix Table G for a description of Pennsylvania regions).

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

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

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 FFS patients. Average payments were reported at the statewide level and not at the hospital level. The following types of records were excluded from this analysis.

Payment analysis exclusions:

- Records excluded from the mortality analysis
- Records for which CMS indicated the patient was not enrolled in Medicare FFS
- Records with no matching Medicare FFS payment
- Records for which CMS indicated there was payment made by a primary payer other than CMS
- Records for non-Pennsylvania residents
- Records for which CMS indicated the payment was less than the Medicare Part A inpatient hospital deductible for the calendar year.

CALCULATING HOSPITAL-SPECIFIC OUTCOMES

Separate analyses were performed to determine, for each hospital and condition, the actual percent of mortality, the actual percent of readmission, 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 readmission measures, 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 the charge measure, actual average charge 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.

Readmission Percent: This percent was determined by dividing the number of discharges readmitted at least once for an acute care condition*, to any GAC or specialty GAC hospital within 30 days of discharge, by the total number of discharges included in the readmission analysis for a particular condition. 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, 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). Same-day readmissions were included only if the original hospitalization resulted in a discharge to "home."†

Average Charge: This value was determined as the arithmetic mean charge for the hospitalizations included in the charge analysis for a particular condition.

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 portion of the hospital stay, chronic comorbidities, demographic data, socioeconomic status, 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.

* Readmissions for patients diagnosed with COVID-19 (ICD-10-CM diagnosis code U071 in any position), or for conditions related to mental health (identified by MDC 19), substance use disorders (identified by MDC 20), or rehabilitation (identified by revenue codes 0024, 0118, 0128, 0138, 0148 or 0158) were not counted.

† "Home" discharges included those patients who were discharged or transferred to: 1) home or self-care (discharge status code 01), 2) home under care of organized home health service organization in anticipation of covered skilled care (discharge status code 06), 3) court/law enforcement (discharge status code 21), 4) home or self-care with a planned acute care hospital inpatient readmission (discharge status code 81), 5) home under care of organized home health service organization in anticipation of covered skilled care with a planned acute care hospital inpatient readmission (discharge status code 86), or 6) court/law enforcement with a planned acute care hospital inpatient readmission (discharge status code 87). See Appendix Table D for descriptions of discharge status codes.

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 adult (age ≥ 18 years) discharges from PA acute care hospitals were used. The reference database for each model was based on several years of data (two or three years depending on the condition and measure being modeled). 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 in this reference database that did not meet quality standards were replaced with default (typical) values. For example, when the quarterly median value of all records representing a given lab test from a given hospital was lower/higher than the statewide 5^{th}/95^{th} percentile value, respectively, the corresponding lab results were removed from the reference database and replaced with default values since this highly irregular data was 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). Demographic data, laboratory test results, diagnoses and procedures identified by ICD-10-CM/PCS codes (International Classification of Diseases, Tenth Revision, Clinical Modification/Procedure Coding System), and UB-04-derived factors were tested for significance. In addition, special high-risk populations (e.g., chronic disease and acute conditions) identified in the current scientific literature were evaluated as possible risk-adjustment factors. Each condition 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 (patient age and sex) were given first priority since these data elements were available for every record, 2) laboratory test results were given second highest priority, 3) ICD-10-CM/PCS code-based variables were evaluated third, and 4) other UB-04-derived data elements (e.g., race/ethnicity, socioeconomic status, cases identified as having been transferred from skilled nursing facilities, history of prior recent discharge) 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, patient age was tested as a continuous linear or linear spline design with up to two knots to determine which approach best fit the data.

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 without 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 higher rates of 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 or readmission).
- 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. In rare instances, exceptions were made to the Schwarz criterion or the 1% minimum volume criterion for factors identified in the research literature as clinically important.

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, 100 to 250 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.

Finally, factors in the model were investigated to be sure that they were not overly influenced by the effects of a few hospitals. This could be a special concern for factors that may be concentrated in a few hospitals. A hierarchical model was run with a nested random intercept unique for each hospital to assess the power of the factors after accounting for hospital differences. Factors no longer significant or with a changed sign in this hierarchical model 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 $e \approx 2.7182818285$

To account for changes in the statewide rates over time, the intercept (β_0) of the model was adjusted so that the statewide expected rate for the current study period was equal to the actual statewide rate for this same period.

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

Special Considerations for Average Charge

For the conditions 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 and geographic location.

For example, the condition Kidney Failure - Acute was comprised of a subset of cases in MS-DRGs 682, 683, and 684. The charges associated with MS-DRGs 682, 683, and 684 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) was ultimately reported without adjustment.

Determining Statistical Ratings

Significance tests (using the binomial distribution, see the top of next page) were performed for the mortality and readmission 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 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.

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

The rating process evaluated both fewer than expected as well as greater than expected mortalities. Thus, a two-tailed test was used. The two-tailed p-value was calculated for each hospital within each condition. 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.

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, 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 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.
  - 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.
- 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 *could not be concluded* that the actual mortality percent for that particular hospital in that particular condition 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 were not displayed in the report. See Appendix Table C for a listing of these hospitals.

Statewide Average Payments

“NR” (not reported) was displayed when the number of cases within a single MS-DRG for a particular condition was ten or fewer or when displaying such information could permit the calculation of other masked results.

APPENDIX

TABLE A
Definitions—Study Populations and Exclusions

The ICD-10-CM codes and MS-DRGs used to define the study populations and clinically complex exclusions for each of the conditions included in the *Hospital Performance Report* can be downloaded using the links below.

Abnormal Heartbeat
http://www.phc4.org/reports/hpr/21/data/HPR2021Definition_AbnormalHeartbeat.xlsx

Blood Clot in Lung
http://www.phc4.org/reports/hpr/21/data/HPR2021Definition_BloodClotInLung.xlsx

Chest Pain
http://www.phc4.org/reports/hpr/21/data/HPR2021Definition_ChestPain.xlsx

Chronic Obstructive Pulmonary Disease (COPD)
http://www.phc4.org/reports/hpr/21/data/HPR2021Definition_COPD.xlsx

Diabetes – Medical Management
http://www.phc4.org/reports/hpr/21/data/HPR2021Definition_DiabetesMedicalManagement.xlsx

Heart Attack – Medical Management
http://www.phc4.org/reports/hpr/21/data/HPR2021Definition_HeartAttackMedicalManagement.xlsx

Heart Failure
http://www.phc4.org/reports/hpr/21/data/HPR2021Definition_HeartFailure.xlsx

Intestinal Obstruction
http://www.phc4.org/reports/hpr/21/data/HPR2021Definition_IntestinalObstruction.xlsx

Kidney and Urinary Tract Infections
http://www.phc4.org/reports/hpr/21/data/HPR2021Definition_KidneyAndUrinaryTractInfections.xlsx

Kidney Failure – Acute
http://www.phc4.org/reports/hpr/21/data/HPR2021Definition_KidneyFailureAcute.xlsx

Respiratory Failure
http://www.phc4.org/reports/hpr/21/data/HPR2021Definition_RespiratoryFailure.xlsx

Sepsis
http://www.phc4.org/reports/hpr/21/data/HPR2021Definition_Sepsis.xlsx

Stroke
http://www.phc4.org/reports/hpr/21/data/HPR2021Definition_Stroke.xlsx

TABLE B
Statewide Utilization and Outcome Data, by Condition

Condition	Cases[1] (n)	Mortality[2] (%)	Readmission[2] (%)	Average Charge[2]
Abnormal Heartbeat	29,887	1.1	11.6	$61,556
Blood Clot in Lung	8,793	2.6	11.4	$48,142
Chest Pain	3,040	NR	11.6	$31,267
Chronic Obstructive Pulmonary Disease (COPD)	13,256	0.9	21.1	$41,769
Diabetes – Medical Management	16,665	0.7	18.4	$39,803
Heart Attack – Medical Management	7,296	8.5	15.9	$50,410
Heart Failure	48,804	2.4	21.1	$53,558
Intestinal Obstruction	8,748	1.3	12.5	$33,451
Kidney and Urinary Tract Infections	15,496	0.5	14.4	$35,504
Kidney Failure – Acute	19,832	2.7	18.1	$42,008
Respiratory Failure	12,670	10.5	22.8	$75,636
Sepsis	57,037	10.9	17.8	$73,112
Stroke	20,215	3.1	10.6	$60,065

[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 *Hospital Performance Report*

Facilities that closed

- Brandywine
- Cancer Treatment
- Jennersville

Facilities that closed inpatient acute care services

- Delaware County Memorial

Facilities that merged

- Guthrie Towanda Memorial (merged with Robert Packer)
- LVH Coordinated Bethlehem (merged with Lehigh Valley Hospital)
- Penn Highlands Clearfield (merged with Penn Highlands DuBois)
- St Luke's Gnaden Huetten (merged with St Luke's Bethlehem)
- St Luke's Sacred Heart (merged with St Luke's Bethlehem)
- Tyler Memorial (merged with Regional Scranton)

New facilities

- AHN Wexford
- Penn State Hampden

Children's hospitals

- Children's Hosp Phila
- Shriners Children Phila
- St Christopher's Children
- UPMC Children's Hosp Pgh

Facilities not reported due to low volume of records in the Hospital Performance Report (had less than five records for each of the conditions in this report)

- Advanced Surgical
- Edgewood Surgical
- LVH Coordinated Allentown
- OSS Orthopaedic
- Physicians Care
- Rothman Ortho Specialty
- Surgical Inst Reading
- Wills Eye

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 (AMA) 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)
69	Discharged/transferred to a designated disaster alternative care site
70	Discharged/transferred to another type of health care institution not defined elsewhere in this code list
81	Discharged to home or self care (routine discharge) with a planned acute care hospital inpatient readmission
82	Discharged/transferred to a short term general hospital for inpatient care with a planned acute care hospital inpatient readmission
83	Discharged/transferred to a skilled nursing facility with Medicare certification in anticipation of skilled care with a planned acute care hospital inpatient readmission
84	Discharged/transferred to a facility that provides custodial or supportive care with a planned acute care hospital inpatient readmission
85	Discharged/transferred to a designated cancer center or children's hospital with a planned acute care hospital inpatient readmission
86	Discharged/transferred to home under care of organized home health service organization in anticipation of covered skilled care with a planned acute care hospital inpatient readmission
87	Discharged/transferred to court/law enforcement with a planned acute care hospital inpatient readmission
88	Discharged/transferred to a federal health care facility with a planned acute care hospital inpatient readmission
89	Discharged/transferred to a hospital-based Medicare approved swing bed with a planned acute care hospital inpatient readmission
90	Discharged/transferred to an inpatient rehabilitation facility including rehabilitation distinct part units of a hospital with a planned acute care hospital inpatient readmission
91	Discharged/transferred to a Medicare certified long term care hospital with a planned acute care hospital inpatient readmission
92	Discharged/transferred to a nursing facility certified under Medicaid but not certified under Medicare with a planned acute care hospital inpatient readmission
93	Discharged/transferred to a psychiatric hospital or psychiatric distinct part unit of a hospital with a planned acute care hospital inpatient readmission
94	Discharged/transferred to a critical access hospital with a planned acute care hospital inpatient readmission
95	Discharged/transferred to another type of health care institution not defined elsewhere in this code list with a planned acute care hospital inpatient readmission

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		Average Charge	
	Cases (n)	Cases (%)	Cases (n)	Cases (%)	Cases (n)	Cases (%)
Total Cases Before Exclusions	**298,851**	**100.0**	**302,226**	**100.0**	**302,226**	**100.0**
Exclusions:						
Records with errors	0	0.0	0	0.0	0	0.0
Duplicate records	14	<0.1	14	<0.1	14	<0.1
Discharge date not in time period	0	0.0	0	0.0	0	0.0
Missing or invalid discharge status	14	<0.1	14	<0.1	14	<0.1
Non-adult (< 18) or invalid age	4,245	1.4	4,261	1.4	4,261	1.4
Patients with HIV Infection	380	0.1	387	0.1	387	0.1
Patients with COVID-19	20,462	6.8	20,526	6.8	20,526	6.8
Rehabilitation Revenue Code in record	353	0.1	354	0.1	354	0.1
Patients who left against medical advice	5,568	1.9	5,739	1.9	5,739	1.9
Patients transferred to GAC facilities	9,116	3.1	9,192	3.0	9,192	3.0
Patients who died	NA	NA	11,473	3.8	NA	NA
Invalid length of stay	NA	NA	1	<0.1	NA	NA
Length of stay outliers	NA	NA	2,361	0.8	NA	NA
Non-Pennsylvania residents	NA	NA	8,272	2.7	NA	NA
Patients discharged to hospice	NA	NA	9,653	3.2	NA	NA
Multiple missing or invalid patient identifiers	NA	NA	409	0.1	NA	NA
Invalid charges	NA	NA	NA	NA	396	0.1
Charge outliers	NA	NA	NA	NA	5,033	1.7
No reference data	NA	NA	NA	NA	859	0.3
Total Exclusions	**40,152**	**13.4**	**72,656**	**24.0**	**46,775**	**15.5**
Total Cases in Analysis	**258,699**	**86.6**	**229,570**	**76.0**	**255,451**	**84.5**

NA: Not Applicable

TABLE F
Example of Logistic Regression

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

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

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

Expected Percent Mortality: Mean of the predicted probabilities of death among all Abnormal Heartbeat hospitalizations.

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

$$\beta X = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots \beta_{32} x_{32}$$

$$= -7.0989 + (0.0569)(x_1) + (0.7131)(x_2) + (0.1450)(x_3) + \ldots (0.2873)(x_{32})$$

where:

x_1 = Patient age (in years) greater than 65
(0 if patient age is 65 years or younger,
1 if patient age is 66 years,
2 if patient age is 67 years, etc.)

x_2 = Arterial pH lower than 7.36 (1 if true, 0 if false)

x_3 = Aspartate Aminotransferase between 31 U/L and < 61 U/L (1 if true, 0 if false)

…

x_{32} = Chronic Lung Disease (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
Example Hospital: Hospital "A" in Southwestern PA, Region 1
Medical Condition: Kidney Failure – Acute

Total Cases:	Number of Kidney Failure – Acute hospitalizations for hospital A after charges exclusions (equal to n).
Actual Average Charge, Hospital:	Mean of the charges among all Kidney Failure – Acute hospitalizations for hospital A.
Actual Average Charge, Region:	Mean of the charges among all Kidney Failure – Acute hospitalizations for the hospital region (region 1).
Expected Average Charge, Hospital:	Mean of the predicted charges among all Kidney Failure – Acute hospitalizations for hospital A (equal to Mean PChg). Step 1: Calculate each Kidney Failure – Acute hospitalization's predicted charge (PChg): The PChg for each Kidney Failure – Acute record is based on the MS-DRG of the record and is equal to the average charge among all Kidney Failure – Acute hospitalizations (after exclusion) in hospital A's same region in the corresponding DRG. For Region 1, Kidney Failure – Acute: MS-DRG 682: ..... $47,224 or MS-DRG 683: ..... $30,279 or MS-DRG 684: ..... $19,482 Step 2: Calculate the mean PChg for hospital A (expected charge): $\text{Mean PChg} = \frac{\Sigma \text{ PChg}}{n}$
Case Mix Adjusted Charge:	$\frac{\text{Actual Average Charge, Hospital A}}{\text{Expected Average Charge, Hospital A}}$ (Actual Average Charge, Region 1)

9 Pennsylvania Regions:

1 *Southwestern* – Allegheny, Armstrong, Beaver, Butler, Fayette, Greene, Washington, and Westmoreland counties
2 *Northwestern* – 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
4 *Northcentral* – Centre, Clinton, Columbia, Lycoming, Mifflin, Montour, Northumberland, Snyder, Tioga, and Union counties
5 *Southcentral* – Adams, Cumberland, Dauphin, Franklin, Fulton, Huntingdon, Juniata, Lancaster, Lebanon, Perry, and York counties
6 *Northeastern* – Bradford, Lackawanna, Luzerne, Monroe, Pike, Sullivan, Susquehanna, Wayne, and Wyoming counties
7 *Eastcentral* – Berks, Carbon, Lehigh, Northampton, and Schuylkill counties
8 *Southeastern* – Bucks, Chester, Delaware, and Montgomery counties
9 *Philadelphia* – Philadelphia County