Technical Notes

for the report on **Readmissions for the Same Condition**

in **PENNSYLVANIA**

Report Timeframe

Includes Discharges from January 2013 through August 2014

Report Release Date

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Pennsylvania Health Care Cost Containment Council

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1. OVERVIEW AND BACKGROUND

1.1 Description of Report

This document serves as the technical supplement to the new PHC4 report on Readmissions for the Same Condition in Pennsylvania. These Technical Notes describe the methodology used and outline the report format and presentation.

This report focused on rates of readmission for the same condition following a hospital stay in one of Pennsylvania's general and specialty acute care hospitals during the time period January 2013 through August 2014. The following conditions were studied in this report:

- Abnormal Heartbeat
- Chronic Obstructive Pulmonary Disease (COPD)
- Congestive Heart Failure (CHF)
- Diabetes – Medical Management

The following hospital-specific measures were included in this report:

- *Volume of cases* – For each hospital, the number of cases (index records) for each condition, after exclusions, was reported.
- *Risk-adjusted readmissions for the same condition rating* – For this measure, a readmission was defined as an acute care rehospitalization for the same condition, which occurred within 30 days of the discharge date of the original (index) hospitalization. The rating identified whether the hospital's observed readmission rate was significantly higher than, significantly lower than, or not significantly different than expected, based on patient risk factors. This measure was reported for each hospital.
- *Average hospital charge of readmissions for the same condition* – Hospital charge was the patient total charge of the readmission, excluding professional fees. Reported for each hospital, the average charge was based on readmissions to the original hospital only and was adjusted for the hospital's case mix.

Also included in the report was information about payments made by Medicare and Medicaid for readmissions for the same condition. The overall statewide average payment (unadjusted) was shown for three payer categories: Medicare fee-for-service, Medicaid fee-for-service, and Medicaid managed care. The average payment reflected the amount paid for the readmissions and was shown for each condition and each MS-DRG within a given condition—to account for variations in case mix. Payments were displayed at the statewide level only.

1.2 Description of Readmissions

This report describes readmission rates in Pennsylvania and includes statewide as well as hospital-specific results, with the purpose of identifying opportunities to reduce readmissions through the public reporting of readmission outcomes.

A new measure, "readmissions for the same condition," is the focus of the report and is particularly meaningful for chronic conditions for which patients are often readmitted multiple times for the same reason. In this analysis, PHC4 examines hospitalizations that resulted in readmissions for the same condition, where the patient returned to the hospital for the same type of condition (based on principal diagnosis and MS-DRG) as the initial (index) hospitalization.

2. GENERAL METHODOLOGY

2.1 Study Populations

Abnormal heartbeat, chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), and medically-managed diabetes (diabetes – medical management) were chosen for analysis in this report because they have one or more of the following qualities: 1) are high cost, high volume, and have a high rate of readmissions, 2) are the basis of the current and future readmission measures implemented by CMS in the Hospital Readmissions Reduction Program[1], and 3) are conditions for which hospitalization and readmission are often considered preventable. These conditions were defined based on specific MS-DRGs and ICD-9-CM (International Classification of Diseases, Ninth Revision, Clinical Modification) codes and were designed to represent clinically cohesive groups of patients. See Appendix A for definitions of these populations, which follow the approach used for PHC4's *Hospital Performance Report*.

The study populations for this report included all useable inpatient discharge records for adults (age 18 years and older), regardless of payer, from all Pennsylvania general and specialty acute care hospitals during the time period January 2013 through August 2014. Cases inappropriate for analysis were ultimately excluded as described in the "Exclusions" section below. Appendix B shows the statewide results for the hospital-specific measures and conditions displayed in this report after all exclusions.

2.2 Data Collection and Verification

The data for this analysis, obtained from the UB-04 (Uniform Billing) form, was submitted electronically to PHC4 by Pennsylvania general and specialty acute care 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, when available, were submitted by hospitals to the Council for the discharges included in this analysis. 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

[1] Centers for Medicare and Medicaid Services. 2013. "Medicare Program; Hospital Inpatient Prospective Payment Systems for Acute Care Hospitals and the Long-Term Care Hospital Prospective Payment System and Fiscal Year 2014 Rates; Quality Reporting Requirements for Specific Providers; Hospital Conditions of Participation; Payment Policies Related to Patient Status." Available at http://www.ofr.gov/OFRUpload/OFRData/2013-18956_PI.pdf

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 from the entire calendar date of Day 1 through the next calendar day (Day 2). Restricting the laboratory test collection timeframe to the initial segment of the hospitalization was important to assure that the laboratory data submitted to PHC4 reflected the severity of a patient's illness upon admission rather than after treatment or later in the hospital stay.

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.

2.2.1 Handling of Anomalous Laboratory Test Results

The calculation of hospital-specific risk-adjusted readmission outcomes relied heavily on the submission of valid and accurate laboratory test data. Hospitals were notified of anomalous laboratory data submissions (laboratory values so unreasonably high or low that that they were most plausibly representative of data errors) via specific feedback reports, provided on a quarterly basis, and were given the opportunity to correct the data. 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 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.

2.2.2 Hospitals Not Reported

During the study period there were 174 facilities in Pennsylvania. Results were not displayed for the following types of hospitals:

- Hospitals that closed or recently opened
- Pediatric hospitals
- Hospitals that did not treat any patients for the conditions in this report (no records were submitted to PHC4 for the four reported conditions)

See Appendix C for a listing of hospitals not displayed in this report.

2.3 Payment Data

Payment data for readmissions for the same condition was displayed at the statewide level for three payer categories: Medicare fee-for-service, Medicaid fee-for-service, and Medicaid managed care. Reported were the average, unadjusted readmission payments for each of the conditions overall as well as for the individual MS-DRGs within each of the conditions. "NR" was displayed in the average payment column whenever the number of readmissions within a single MS-DRG was ten or fewer. Also reported were the total payments for these readmissions.

Medicare fee-for-service payments were 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) were not included. Medicaid fee-for-service and managed care payments were based on the claim payment amounts obtained from the Pennsylvania Department of Human Services. The payment data displayed in this report corresponded to calendar years 2011 through 2012 as this was the most recent payment data available to PHC4. Patient liabilities (e.g., coinsurance and deductible dollar amounts) were not included in the average payment calculations but were included in the total payment figures.

2.4 Exclusions

Records excluded from the analyses are described below. See Appendix D for a full account of the cases excluded from the hospital level analyses.

2.4.1 Readmissions for the Same Condition: Exclusions

The following records (index hospitalizations) were excluded from the hospital-specific analysis of readmissions for same condition:

- 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 date not in study period
- Records with missing or invalid discharge status
- Non-adults (age < 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 (due to their clinical complexity)
- Patients who left against medical advice
- Patients transferred to acute care facilities (short-term care, federal, long-term care, or critical access facilities)
- Patients who died
- Records with an invalid length of stay
- Length of stay outliers. Outlier records were identified using the 99th percentile as the trim point. If the length of stay of a particular record was in

excess of the trim point for a given condition, that record was not used for the readmission analysis.
- Non-Pennsylvania residents
- Patients discharged to hospice
- Records with missing or invalid social security number

2.4.2 Average Hospital Charge of Readmissions for the Same Condition: Exclusions

Readmission records meeting any of the following criteria were excluded from the hospital-specific analysis of average charge of readmissions for the same condition:
- Patients readmitted to a different hospital (to ensure only charges relative to each specific hospital are represented, see Appendix E)
- Records with missing invalid discharge status
- Non-adults (age < 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 (due to their clinical complexity)
- Patients who left against medical advice
- Patients transferred to acute care facilities (short-term care, federal, long-term care, or critical access facilities)
- Records with missing or invalid charges
- Charge outliers (see "Trimming of Charges Outliers" section below)
- No reference data (When there were fewer than 20 readmission records in an MS-DRG and hospital region, such records were excluded from the analysis since a stable baseline for case mix adjustment could not be determined.)

2.4.2.1 Trimming of Charges Outliers

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 skewed the average results. Trim points for the 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; separate trim points were used for each individual MS-DRG in a condition. Since charges have the potential to vary 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 used in this report (see the "Determining Case Mix Adjusted Average Charge" section for more information about these regions).

Trim points for average charge were determined as follows:

Q1 = the first quartile (25th percentile charge value) of all patient readmission records for the same condition from the comparative database for a particular condition.

Q3 = the third quartile (75th percentile charge value) of all patient readmission records for the same condition from the comparative database for a particular condition.

IQR = Q3 – Q1

Lower Trim Point = Q1 – (3.0 x IQR)

Upper Trim Point = Q3 + (3.0 x IQR)

2.4.3 Payments: Exclusions

Payments were reported at the statewide level only for Medicare fee-for-service, Medicaid fee-for-service, and Medicaid managed care records. Readmission records not identified as having a payment from one of these payers were excluded. Both average and total payments for the readmissions for same condition were reported for this analysis. Readmission records meeting any of the following criteria were excluded from the average (but not totals) payment analysis to avoid skewing the results:

- Records with invalid discharge status
- Non-adults (age < 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 (due to their clinical complexity)
- Patients who left against medical advice
- Patients transferred to acute care facilities (short-term care, federal, long-term care, or critical access facilities)
- Records with very low payment (< $1,300) – to avoid including payments that were likely secondary.

3. METHODOLOGY FOR CALCULATING HOSPITAL LEVEL OUTCOMES

The readmission results in this report were displayed as hospital ratings. To determine a rating, a hospital's *actual* percent of readmissions for the same condition was compared to its *expected* percent of readmissions for the same condition. Each hospital's risk profile was used to calculate its expected value; this was done to adjust for the risk inherent to the hospital's specific patient population. Significance testing determined whether the difference between the actual and expected values was too large to be attributed solely to chance, which resulted in the rating.

For the average charge measure, each hospital's actual average charge for a given condition was adjusted to account for its assortment of cases across MS-DRGs (since charge values vary depending on MS-DRG assignment). In this way, the final results were displayed as case mix adjusted charges.

3.1 Determining Observed (Actual) Percent of Readmissions for the Same Condition

This percent was determined by dividing the number of discharges readmitted at least once, for the same condition, to any general or specialty acute care hospital in Pennsylvania within 30 days of discharge, by the total number of discharges included in the readmissions analysis for a particular condition. The readmission records in the numerator of this measure were required to have one of the principal diagnosis codes and one of the DRG codes that were used to identify records for the denominator. Further, planned readmissions, which were identified through a set of criteria used by the Centers for Medicare and Medicaid Services (CMS)—referred to as the "Planned Readmission Algorithm, Version 3.0"[2] were not included (see Appendix F). 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, and only the first readmission was considered. When the first readmission was identified as planned, no readmission was counted in the numerator. 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."[3] If the original hospitalization was not discharged to home, the same-day readmission was skipped over (not included) and if a second readmission occurred on a subsequent day but within 30 days, it was counted in the numerator as long as it was not identified as planned.

3.2 Determining Expected (Predicted) Percent of Readmissions for the Same Condition

Regression techniques were used to construct risk models for predicting the risk of readmission for the same condition. Each model was a mathematical formula used to ultimately predict a patient's probability of readmission for the same condition 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 readmission. A hospital's predicted rate was the average predicted probability across all its discharges in a given condition.

[2] Centers for Medicare and Medicaid Services. 2014. "2014 Measures and Specifications Report: Hospital-Level 30-Day Risk-Standardized Readmission Measures." Available at http://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HospitalQualityInits/Measure-Methodology.html

[3] "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 G for descriptions of discharge status codes.

3.3 Model Development

The first step in building the risk adjustment models was to prepare a reference database. UB-04 (administrative) data and laboratory test results from 2011 through 2013 adult (age ≥ 18 years) discharges from PA general and specialty 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 lower/higher than the statewide 5^{th}/95^{th} percentile value, respectively, the corresponding lab results were removed from the reference database, unless the hospital specifically indicated the results were not anomalous. 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, each condition was modeled separately using binary logistic regression. Model selection ultimately identified risk factors that were statistically significant predictors of the relevant event (i.e., readmission for same condition) for each condition. 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. 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 the remaining four 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 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.

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. Factors that failed this test were eliminated. This same approach was used to revise 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 "Calculating Expected Values" section below for a description of model coefficients. Factors that failed this test were either regrouped if possible or were eliminated. The final models developed for this report are detailed in Appendix H.

3.4 Calculating 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, i.e., yes/no, were coded as yes =1 and no = 0)

These models were then used to calculate the predicted values (i.e., predicted probability of readmission for the same condition) 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. See Appendix I for a sample calculation of the expected value.

3.5 Determining Statistical Ratings

Significance tests (using the binomial distribution, see below) were performed for the readmission measure. 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.

3.5.1 Binomial Distribution

The use of the binomial distribution required the following assumptions:

- Each observation included in the study had one of two observable events (i.e., readmission vs. no readmission). In other words, the response was dichotomous.
- The probability of the event (readmission for the same condition) for each observation studied within a given 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.

3.5.2 Calculation of p-values

The binomial distribution defined a probability of each potential outcome (e.g., the probability of observing exactly 3 readmissions 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 (i.e., readmissions for the same condition) that were observed (i.e., a = 1 readmission, a = 2 readmissions, 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 of readmission (for the same condition) for a particular hospital's condition

The rating process evaluated both fewer than expected as well as greater than expected readmissions for the same condition. Thus, a two-tailed test was used. In the example of 3 readmissions out of 40, the probability associated with the left-hand tail was the sum of the probability for 0, 1, 2 or 3 readmissions 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.

3.5.3 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 this report, a Type I error would have occurred when the difference between the actual and expected rates of readmission for the same condition 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.

3.5.4 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 readmission 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 readmission rate was less than expected, the hospital was assigned the symbol "○" to indicate that the readmission rate was significantly less than expected for a particular condition.
    - If the actual readmission rate was higher than expected, the hospital was assigned the symbol "●" to indicate that the readmission rate 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 readmission rate and the actual readmission rate was *not* statistically significant. It *could not be concluded* that the actual readmission rate for that particular hospital in that particular condition was different from the expected readmission rate derived from the particular hospital's risk profile. In this case the hospital was assigned the "⊙" symbol.

3.6 Determining Case Mix Adjusted Average Charge

As displayed in this report, the hospital-specific average readmission charge was based on readmissions to the original hospital only and was adjusted to account for each hospital's variation in the mix of cases across MS-DRGs. Since multiple MS-DRGs were used to define the study populations (see Appendix A) and therefore the readmissions analyzed in this report, case mix adjustment was used to calculate a composite average charge for the combined MS-DRGs representing the readmissions for each condition, for each hospital. This adjustment was made at the level of nine Pennsylvania regions (see below).

For example, the condition COPD was comprised of cases in MS-DRGs 190, 191 and 192. Therefore the average charge associated with any given hospital's COPD readmissions was adjusted to account for its own volume of readmissions in each of these MS-DRGs and the corresponding average regional charge for each MS-DRG. See Appendix J for a detailed example of a case mix adjustment calculation.

The nine PA regions were based on Pennsylvania's 67 counties as follows:

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

3.7 Minimum Cases Needed for Reporting

For hospital-specific reporting, 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.

4. APPENDICES

Appendix A. Definitions of Conditions

The following table defines the conditions included in this report. The ICD-9-CM codes (principal diagnosis) and MS-DRGs used to define each condition were applicable to CMS Grouper Versions 30.0 and 31.0.

Condition†	Principal Diagnosis Codes	MS-DRGs
Abnormal Heartbeat	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
Chronic Obstructive Pulmonary Disease (COPD)	491.20, 491.21, 491.22, 492.0, 492.8, 493.20, 493.21, 493.22, 496, 506.4	190, 191, 192
Congestive Heart Failure (CHF)	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	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

† Cases with HIV Infections (ICD-9-CM code 042, in any position) were excluded from all conditions.

Appendix B. Statewide Utilization and Outcome Data, by Condition

Condition	Total Number of Cases[1]	30-Day Readmissions for Same Condition[2] (%)	Average Hospital Charge[3] of Readmissions for Same Condition
Abnormal Heartbeat	62,235	3.6	$23,100
Chronic Obstructive Pulmonary Disease (COPD)	55,398	7.7	$31,568
Congestive Heart Failure (CHF)	63,140	7.7	$35,589
Diabetes – Medical Management	25,257	8.4	$28,072

[1] Number of index (initial) cases, after exclusions.
[2] Includes readmissions to any general or specialty acute care hospital in PA after all relevant exclusions were removed.
[3] Average charge is based on readmissions to the original hospital only. Value shown was based on records after all relevant exclusions were removed.

Appendix C. Hospitals Not Reported

The *Report on Readmissions for the Same Condition* included usable discharge records from all Pennsylvania general and specialty acute care facilities during the reported time period (January 2013 through August 2014). There were 174 facilities in Pennsylvania during the study period.

Hospital Name	Reason Hospital Not Reported
Facilities that Closed/Merged:	
Mid-Valley	Closed facility – effective 07/01/2014
Westfield	Closed facility – effective 12/12/2013
New Facilities:	
Einstein Montgomery	Opened 9/29/2012
Wills Eye	Opened 8/26/2013
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 No Records in the Report:	
The following facilities had no records in any of the four conditions in this report.	
Advanced Surgical	No records in report
Barix Clinics/PA	No records in report
Coordinated Health Ortho	No records in report
Edgewood Surgical	No records in report
OSS Orthopedic	No records in report
Rothman Specialty	No records in report
Physicians Care	No records in report
Surg Institute of Reading	No records in report
Surg Spec/Coordinated	No records in report
Wellspan Surgery & Rehab	No records in report

Appendix D. Statewide Exclusions, by Measure

Exclusions for each measure are listed below and displayed for all four conditions combined.

Table D1. Readmissions for the Same Condition: Exclusions

	Index Cases	
	Number	**Percent**
Total number of index cases before exclusions	235,709	100.0
Exclusions:		
• *Records with errors*	*0*	*0.0*
• *Duplicate records*	*15*	*<0.1*
• *Records with discharge date not in study period*	*1*	*<0.1*
• *Records with missing or invalid discharge status*	*22*	*<0.1*
• *Non-adults (age < 18 years) or invalid age*	*2,861*	*1.2*
• *Patients with HIV infection*	*331*	*0.1*
• *Patients who left against medical advice*	*3,020*	*1.3*
• *Patients transferred to acute care facilities*	*5,602*	*2.4*
• *Patients who died*	*3,086*	*1.3*
• *Invalid length of stay*	*0*	*0.0*
• *Length of stay outliers*	*1,951*	*0.8*
• *Non-Pennsylvania residents*	*7,710*	*3.3*
• *Patients discharged to hospice*	*3,673*	*1.6*
• *Records with missing or invalid social security number*	*1,407*	*0.6*
Total exclusions	*29,679*	*12.6*
Total cases in analysis	**206,030**	**87.4**

Table D2. Average Hospital Charge of Readmissions for the Same Condition: Exclusions

	Readmissions for Same Condition	
	Number	**Percent**
Total number of readmissions for the same condition before exclusions*	13,525	100.0
Exclusions:		
• *Patients readmitted to a different hospital*	*2,289*	*16.9*
• *Records with missing or invalid discharge status*	*0*	*0.0*
• *Non-adults (age < 18 years) or invalid age*	*0*	*0.0*
• *Patients with HIV infection*	*12*	*0.1*
• *Patients who left against medical advice*	*162*	*1.2*
• *Patients transferred to acute care facilities*	*286*	*2.1*
• *Records with missing or invalid charges*	*13*	*0.1*
• *Charge outliers*	*324*	*2.4*
• *No reference data*	*430*	*3.2*
Total exclusions	*3,516*	*26.0*
Total readmissions in analysis	**10,009**	**74.0**

* This total is an account of readmission records, ensuing from the index hospitalizations identified in Table D1 as "Total cases in analysis" (after exclusions).

Appendix E. Cases Readmitted to a Different Hospital: Exclusion from Analysis of Average Hospital Charge

Patients that were readmitted for the same condition but to a different hospital (not to the original hospital) were excluded from the hospital-specific analysis of average hospital charge of the readmissions. This was done to ensure the average charge reported for each hospital was specific to that hospital alone and did not reflect charges from other hospitals, which tended to be higher.

The following table provides the percent of readmissions for the same condition that returned to a different hospital. Since this is the first exclusion for the analysis of average hospital charge of readmissions for the same condition, the figures below are calculated before any of the further exclusions for that analysis.

Condition	% Readmissions for Same Condition that Returned to a Different Hospital
Abnormal Heartbeat	16.5%
Chronic Obstructive Pulmonary Disease (COPD)	13.7%
Congestive Heart Failure (CHF)	15.6%
Diabetes – Medical Management	26.7%

Appendix F. Planned Readmissions

Records identified as potentially planned readmissions were not included in the analyses.

Condition	Index Cases	Readmissions for the Same Condition		
	Total Number[1]	Total Number[2]	Number Planned	% Planned
Abnormal Heartbeat	62,235	2,892	645	22.3%
Chronic Obstructive Pulmonary Disease (COPD)	55,398	4,285	0	0.0%
Congestive Heart Failure (CHF)	63,140	4,871	11	0.2%
Diabetes – Medical Management	25,257	2,159	26	1.2%

[1] Number of index (initial) cases, after exclusions.
[2] Includes readmissions to any general or specialty acute care hospital in PA after exclusions were removed.

Appendix G. 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)
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 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 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 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*

* Valid beginning with 2013Q4.

Appendix H. PHC4 Models for Predicting Risk of Readmission for the Same Condition

Performance statistics for the models developed to predict the risk of readmission for the same condition (using a 2011-2013 model-building dataset) are shown in Table H1, and data definitions (Table H2) are provided to explain the model details shown in Tables H3-H6.

Table H1. Performance Statistics: Readmissions for Same Condition Models

Condition	c-statistic*
Abnormal Heartbeat	0.6199
Chronic Obstructive Pulmonary Disease	0.6221
Congestive Heart Failure	0.6178
Diabetes – Medical Management	0.7979

* The c-statistic is an indicator of a model's power to discriminate and has a lower bound of 0.5 and an upper bound of 1.

Table H2. Definitions of Column Labels

Indicator	Description
Predictor	Risk variable or covariate that is associated with an increased (or decreased) risk of readmission for the same condition. The predictors are listed in the order in which they entered the model.
Level	Indicates the subcategories for a given risk factor, if applicable.
Coefficient	The mathematical value (derived from the regression analysis) that corresponds to a given level of risk. The coefficient is used in the mathematical formula that calculates the patient's overall predicted risk of readmission for the same condition. Negative values indicate the variable is protective against readmission.
Odds Ratio	Odds ratios are the usual way coefficients are reported for logistic regression; they are used for interpreting the impact of the risk factors on the probability of readmission. The odds ratio is the ratio of the odds of an event (readmission for same condition) occurring in a risk group versus a group without that specific risk. An odds ratio greater than one implies that readmission is more likely in the group with the specific risk, whereas an odds ratio less than one indicates readmission is less likely in that group. Mathematically, the odds ratio is calculated by taking the inverse natural log of a given coefficient (i.e., Odds Ratio = $e^{coefficient}$). For example, a risk factor such as heart failure that has a coefficient of 0.3820 in a model predicting readmission would have an odds ratio of $e^{0.3820} = 1.465$. This means that patients with heart failure have 47% higher odds of readmission. The odds ratio for age is presented as the increase in odds corresponding to a ten year increase in age. For age over xx (where xx is a threshold such as 45, 50, etc.), the odds ratio is also presented as the increase in odds corresponding to a ten year increase in age over that threshold. The odds ratios for poverty rate, "Education Level – BS Degree or Higher" and "Percent Not Speaking English Very Well", which are all expressed as percentages, represent the increase in odds to a corresponding increase of 1 percentage point.
p-Value	Indicator of the degree of statistical significance.

Table H3. Abnormal Heartbeat – Readmissions for Same Condition Risk Model

Predictor	Level	Coefficient	Odds Ratio	p-Value
Intercept	NA	-5.4318	NA	NA
Race/Ethnicity	Hispanic/ Other	-0.2260	0.798	0.0141
Poverty Rate	NA	0.0090	1.009	<0.0001
Education Level - BS Degree or Higher	NA	0.0052	1.005	<0.0001
Age	NA	0.0855	1.089	0.0315
Age Over 55	NA	-0.1861	0.830	<0.0001
International Normalized Ratio[1]	1.11+	0.1558	1.169	<0.0001
Prothrombin Time (sec)[1]	13.1+	0.1558	1.169	
Beta Natriuretic Peptide (pg/mL)[2]	101+	0.1038	1.109	0.0062
pro-BNP (pg/mL)[2]	1001+	0.1038	1.109	
Creatine Kinase (U/L)	0-<36	0.2325	1.262	0.0005
Abnormal Heartbeat Type v2[3,4]	A	1.7286	5.633	<0.0001
	BD	0.7877	2.198	
	C	1.5222	4.582	
Atrial Fibrillation and Flutter (as secondary diagnosis)	NA	0.1721	1.188	<0.0001
History of Noncompliance with Medical Treatment	NA	0.3695	1.447	<0.0001
Mental Disorders	NA	0.1743	1.190	<0.0001
Kidney Disease Type v2[4,5]	A	0.4101	1.507	<0.0001
Cancer Type[6]	AB	0.2475	1.281	0.0002
Chronic Lung Disease v2[4]	NA	0.1372	1.147	0.0007

[1] The International Normalized Ratio and Prothrombin Time analytes were paired; the Prothrombin Time result was used for risk assignment only if the discharge did not have an International Normalized Ratio result.

[2] The Beta Natriuretic Peptide and pro-BNP (pro-Brain Natriuretic Peptide) analytes were paired; the pro-BNP result was used for risk assignment only if the discharge did not have a Beta Natriuretic Peptide result.

[3] Abnormal Heartbeat Type v2: A = paroxysmal tachycardia, B = sinoatrial node dysfunction and tachycardia-bradycardia syndrome, C = atrial dysrhythmia, D = premature beats, E = complete block and AV disassociation, F = AV block, G = bundle branch block

[4] This risk factor was redefined from an earlier version to enhance the risk model; this new version is labeled v2.

[5] Kidney Disease Type v2: A = chronic kidney disease stage V, B = chronic kidney disease stage I – IV or unspecified

[6] Cancer Type: A = metastatic, B = primary

NA = not applicable

Table H4. Chronic Obstructive Pulmonary Disease – Readmissions for Same Condition Risk Model

Predictor	Level	Coefficient	Odds Ratio	p-Value
Intercept	NA	-8.7436	NA	NA
Female	NA	-0.2696	0.764	<0.0001
Race/Ethnicity	Black	0.3404	1.406	<0.0001
Poverty Rate	NA	0.0068	1.007	<0.0001
Education Level – BS Degree or Higher	NA	0.0035	1.004	0.0003
Percent Not Speaking English Very Well	NA	0.0103	1.010	0.0003
Age	NA	1.8154	6.144	0.0215
Age Over 30	NA	-1.8213	0.162	0.0217
Age Over 65	NA	-0.1967	0.821	<0.0001
Bicarbonate (mEq/L)	31+	0.1993	1.221	<0.0001
Hemoglobin (g/dL)	0-<11.1	0.1341	1.144	<0.0001
Creatine Kinase (U/L)	0-<36	0.2653	1.304	<0.0001
Partial Thromboplastin Time (sec)	0-<22.1	0.4502	1.569	<0.0001
Glucose (mg/dL)	241+	0.1144	1.121	<0.0001
Platelet Count (10^9/L)	360.1+	0.1516	1.164	0.0005
Supplemental Oxygen	NA	0.4250	1.530	<0.0001
Mental Disorders	NA	0.2242	1.251	<0.0001
COPD Type v2[1,2]	A	0.5988	1.820	<0.0001
	B	0.3669	1.443	
History of Thrombosis or Embolism	NA	0.2636	1.302	<0.0001
History of Noncompliance with Medical Treatment	NA	0.2816	1.325	<0.0001
Long Term Steroid Use	NA	0.2712	1.312	<0.0001
Gastroesophageal Reflux Disease	NA	0.1134	1.120	<0.0001
Tracheostomy Status	NA	0.4577	1.580	0.0002
Osteoporosis	NA	0.1732	1.189	0.0001
Heart Failure Type v2[2,3]	ABC	0.0919	1.096	0.0006

[1] COPD Type: A = chronic obstructive pulmonary disease with (acute) exacerbation, B = chronic obstructive pulmonary disease with acute lower respiratory infection, C = chronic obstructive pulmonary disease, unspecified, D = emphysema, unspecified

[2] This risk factor was redefined from an earlier version to enhance the risk model; this new version is labeled v2.

[3] Heart Failure Type: A = hypertensive heart and chronic kidney disease with heart failure, B = hypertensive heart disease with heart failure, C = heart failure

NA = not applicable

Table H5. Congestive Heart Failure – Readmissions for Same Condition Risk Model

Predictor	Level	Coefficient	Odds Ratio	p-Value
Intercept	NA	-2.6920	NA	NA
Female	NA	-0.0147	0.985	0.5272
Race/Ethnicity	Black	0.1995	1.221	<0.0001
	Hispanic	0.1470	1.158	
Poverty Rate	NA	0.0035	1.004	0.0036
Age	NA	-0.1109	0.895	<0.0001
Age Over 80	NA	0.2867	1.332	<0.0001
Urea Nitrogen Blood (mg/dL)	26-<36	0.1955	1.216	<0.0001
	36+	0.3300	1.391	
Beta Natriuretic Peptide (pg/mL)[1]	0-<101	-0.4811	0.618	<0.0001
	1201-<2401	0.1223	1.130	
	2401+	0.1908	1.210	
pro-BNP (pg/mL)[1]	0-<1001	-0.4811	0.618	
	8001-<18001	0.1223	1.130	
	18001+	0.1908	1.210	
Sodium (mEq/L)	0-<131	0.3389	1.403	<0.0001
	131-<136	0.1608	1.174	
International Normalized Ratio[2]	1.31+	0.1139	1.121	<0.0001
Prothrombin Time (sec)[2]	15.1+	0.1139	1.121	
Hemoglobin (g/dL)	0-<11.1	0.1184	1.126	<0.0001

Predictor	Level	Coefficient	Odds Ratio	p-Value
Creatine Kinase (U/L)	0-<36	0.1342	1.144	0.0006
Defibrillator or Pacemaker v2[3]	NA	0.2857	1.331	<0.0001
Chronic Lung Disease v2[3]	NA	0.2214	1.248	<0.0001
CHF Type[4]	A	0.1419	1.152	<0.0001
Kidney Disease Type v2[3,5]	AB	0.1530	1.165	<0.0001
Drug Related Disorder Type[6]	ABC	0.4971	1.644	<0.0001
Coronary Artery Disease	NA	0.1291	1.138	<0.0001
Atrial Fibrillation and Flutter v2[3]	NA	0.1203	1.128	<0.0001
Diabetes Type[7]	AB	0.1312	1.140	<0.0001
Heart Valve Disorders	NA	0.1050	1.111	<0.0001
History of Noncompliance with Medical Treatment	NA	0.1717	1.187	<0.0001
Mental Disorders	NA	0.1100	1.116	0.0001
Removal of Fluid Procedure	NA	0.3544	1.425	0.0002
Cardiomyopathy v2[3]	NA	0.0999	1.105	0.0004
Gout	NA	0.1291	1.138	0.0016

[1] The Beta Natriuretic Peptide and pro-BNP (pro-Brain Natriuretic Peptide) analytes were paired; the pro-BNP result was used for risk assignment only if the discharge did not have a Beta Natriuretic Peptide result.
[2] The International Normalized Ratio and Prothrombin Time analytes were paired; the Prothrombin Time result was used for risk assignment only if the discharge did not have an International Normalized Ratio result.
[3] This risk factor was redefined from an earlier version to enhance the risk model; this new version is labeled v2.
[4] CHF Type: A = acute superimposed on chronic heart failure; B = all other CHF
[5] Kidney Disease Type v2: A = chronic kidney disease stage V, B = chronic kidney disease stage I – IV or unspecified
[6] Drug Related Disorder Type: A = drug dependence, B = drug induced mental disorders, C = nondependent drug abuse
[7] Diabetes Type: A = with complications, B = without complications
NA = not applicable

Table H6. Diabetes – Medical Management – Readmissions for Same Condition Risk Model

Predictor	Level	Coefficient	Odds Ratio	p-Value
Intercept	NA	-2.1422	NA	NA
Female	NA	0.0373	1.038	0.3081
Race/Ethnicity	Black	0.4204	1.523	<0.0001
	Hispanic	0.3192	1.376	
Percent Not Speaking English Very Well	NA	0.0141	1.014	0.0001
Age	NA	-0.3372	0.714	<0.0001
Age Over 70	NA	0.3351	1.398	<0.0001
Hemoglobin (g/dL)	0-<11.1	0.3205	1.378	<0.0001
Platelet Count (10^9/L)	360.1-<420.1	0.2065	1.229	<0.0001
	420.1+	0.4473	1.564	
Glucose (mg/dL)	0-<71	0.2187	1.244	<0.0001
	801+	0.3176	1.374	
White Blood Cell Count (10^9/L)	0-<4.4	0.3965	1.487	<0.0001
Gastroparesis	NA	1.2943	3.649	<0.0001
Potassium (mEq/L)	5.0-<5.4	0.0827	1.086	<0.0001
	5.4+	0.2136	1.238	
Aspartate Aminotransferase (U/L)	101+	0.3610	1.435	0.0005
Primary Diagnosis of Type I Diabetes	NA	0.5300	1.699	<0.0001
Mental Disorders	NA	0.3507	1.420	<0.0001
Long Term Insulin Use	NA	0.2713	1.312	<0.0001
History of Noncompliance with Medical Treatment	NA	0.2346	1.264	<0.0001
Drug Related Disorder Type[†]	A	0.4850	1.624	<0.0001
	BC	0.1869	1.206	
Malnutrition	NA	0.3546	1.426	<0.0001
Secondary Diagnosis of Diabetes with Renal Manifestation	NA	0.2320	1.261	0.0002
Coronary Artery Disease	NA	0.1980	1.219	0.0002

[†] Drug Related Disorder Type: A = drug dependence, B = drug induced mental disorders, C = nondependent drug abuse
NA = not applicable

Appendix I. Example of Expected Value Calculation

Calculations Used in Determining a Hospital's Expected Percent of Readmissions for the Same Condition
Medical Condition: Congestive Heart Failure (CHF)

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

Actual Percent of Readmissions: Total number of CHF cases readmitted for CHF divided by the total number of CHF hospitalizations for a hospital

Expected Percent of Readmissions: Mean of the predicted probabilities of readmission for CHF among all CHF hospitalizations for a hospital

Step 1: Calculate the predicted probability of readmission for CHF for each CHF hospitalization (PReadmSame):

$$\beta X = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots \beta_{31} x_{31}$$

$$= -2.6920 + (-0.0147)(x_1) + (0.1995)(x_2) + (0.1470)(x_3) + \ldots (0.1291)(x_{31})$$

where:

x_1 = Female (1 if true, 0 if false)
x_2 = Race/Ethnicity Black (1 if true, 0 if false)
x_3 = Race/Ethnicity Hispanic (1 if true, 0 if false)
…
X_{31} = Gout (1 if true, 0 if false)

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

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

where $e \approx 2.7182818285$

Step 2: Calculate the mean PReadmSame for a hospital (expected percent of readmissions for CHF):

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

Appendix J. Example of Case Mix Adjustment of Average Charge

Calculations Used in Determining a Hospital's Case Mix Adjusted Average Charge
Example Hospital: Hospital A in Southwestern PA, Region 1
Medical Condition: COPD

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

Actual Average Charge, Hospital: Mean of the charges among all COPD readmissions for a hospital.

Actual Average Charge, Region: Mean of the charges among all COPD readmissions for the hospital region.

Expected Average Charge: Mean of the predicted charges among all COPD readmissions for a hospital (equal to Mean PChg).

Step 1: Calculate the predicted charge (PChg) for each COPD readmission for a hospital:

The PChg for each COPD readmission record is based on the MS-DRG of the record and is equal to the average charge among all COPD readmissions (after exclusion) in the hospital's same region for the corresponding MS-DRG.

Region 1 - Southwestern PA, COPD, MS-DRG 190: $26,406
or
Region 1 - Southwestern PA, COPD, MS-DRG 191: $20,309
or
Region 1 - Southwestern PA, COPD, MS-DRG 192: $15,820

Step 2: Calculate the mean PChg for a hospital:

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

Case Mix Adjusted Average Charge:

$$\frac{\text{Actual Average Charge, Hospital A}}{\text{Expected Average Charge, Hospital A}}\text{(Actual Average Charge, Region 1)}$$