HOSPITAL PERFORMANCE REPORT
49 COMMON MEDICAL PROCEDURES AND TREATMENTS

Report Period: Federal Fiscal Year 2008
(October 1, 2007 through September 30, 2008)

Technical Notes

for

Western Pennsylvania

Central and Northeastern Pennsylvania

Southeastern Pennsylvania

Includes Methodology for Procedure and Treatment Groups in the Printed Report and on the Council's Web Site

The Pennsylvania Health Care Cost Containment Council
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Technical Notes
FFY 2008 Hospital Performance Report

OVERVIEW

This document serves as a technical supplement to the *FFY 2008 Hospital Performance Report* (HPR). The Technical Notes describe the methodology of the analyses and outline the development of the report format and presentation. This document also includes data tables containing information about the statewide results and cases excluded from analysis.

The current report presents the following quality measures for adult (≥ 18 years of age) cases in 49 procedure and treatment groups (see Appendix Tables C1 and C2 for statewide results):

- ***Risk-adjusted Mortality Rating*** — In-hospital Mortality was identified in the patient discharge record as a discharge status of "20."
- ***Risk-adjusted Length of Stay*** — Length of Stay was calculated by subtracting the admit date from the discharge date.
- ***Risk-adjusted Length of Stay Outlier Rates and Ratings*** — Length of stay outliers (short/long) were those hospitalizations with a residual length of stay (defined as the difference between the actual and expected length of stays) that was below the 5th or above the 95th percentile of all statewide hospitalizations.
- ***Risk-adjusted Readmissions for Any Reason Rating*** — A hospital readmission was defined as an acute care rehospitalization, for any reason, which occurred within 30 days of the discharge date of the original hospitalization.
- ***Risk-adjusted Readmissions for Complication or Infection Rating*** — A readmission for complication or infection was defined as a rehospitalization with a principal diagnosis of a complication or infection, which occurred within 30 days of the discharge date of the original hospitalization. See Tables D1 and D2 in the Appendix for detail on cases readmitted for complication or infection, by reason for readmission.
- ***Average Hospital Charge (adjusted by case-mix at the regional level)*** — Hospital charge was the patient total charge excluding professional fees.
- ***Transfer to Acute Care*** — Percent of cases that were transferred to another acute care facility. Transfer cases were identified as a discharge status of "02" (short term general hospital), "43" (federal health care facility), "63" (long term care hospital), or "66" (critical access hospital) in the discharge records of patients admitted for Heart Attack – Medical Management.

It should be noted that not all of these outcome measures were appropriate for all procedure or treatment groups. Those measures not suitable for a particular procedure or treatment group were not analyzed and therefore were not reported.

The printed report includes 31 code-based conditions/procedures (19 medical conditions and 12 surgical procedures). Each condition/procedure is defined by a particular set of ICD-9-CM codes and limited to certain MS-DRGs. The Council's Web site reports utilization and outcome information for adult cases in the 31 code-based conditions/procedures and in 18 DRG-based conditions/procedures, for a total of 49 different procedure and treatment groups. Beginning with the FFY2008 report, a new DRG-based condition, *Liver Disease except Cancer, Cirrhosis or Alcoholic Hepatitis*, was added to the PHC4 Web site.

The printed report is comprised of three separate "area" reports, which include summaries by procedure and treatment groups for the state, area, and individual hospitals in the area. The three areas allow a broader range of comparison among acute care facilities. These areas are divided into 9 regions.

Subdivision of 3 Pennsylvania Areas into 9 Regions:

Western Pennsylvania

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

Central and Northeastern Pennsylvania

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

Southeastern Pennsylvania

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

DATA COLLECTION AND VERIFICATION

The data for the FFY 2008 Hospital Performance Report, obtained from the UB-04 (Uniform Billing Form), was submitted electronically on a quarterly basis to the Pennsylvania Health Care Cost Containment Council by Pennsylvania general acute care (GAC) and specialty GAC hospitals. Federal hospitals were not included. The data included demographic information, hospital charges, and diagnosis and procedure codes (ICD-9-CM; International Classification of Diseases, Ninth Revision, Clinical Modification).

Additionally, patient severity information was abstracted by hospitals using MediQual Systems, Inc.® *Atlas Outcomes*™ Severity of Illness System. The admission severity scores, the predicted probability of death (MQPredDeath), and the predicted length of stay (MQPredLOS) values generated by this system were submitted to the Council for a select group of acute care inpatient records. For the period of this report (Q4-2007 through Q3-2008) these submissions covered approximately 50 percent of acute care hospital discharges.

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, media verification was performed to assure data were submitted in a readable format. Extensive quality assurance checks were completed and *Atlas Outcomes*™-derived records were matched to inpatient records. Error reports were then generated and returned to each facility with an opportunity to correct any problems.

Hospitals Not Reported

Utilization and outcome data was not reported for closed and pediatric hospitals as well as hospitals with missing/unusable data (see Table F in the Appendix of this document for details). Although data and analyses specific to these facilities were not displayed in the printed or Web site release editions of the *Hospital Performance Report*, their valid, adult (≥ 18 years of age) records were retained in the reference database (unless noted otherwise) for statistical analyses of mortality, length of stay, length of stay outliers, readmissions for any reason, readmissions for complication or infection, and average charge.

PROCEDURE AND TREATMENT GROUPS

Rationale for Including "Code-Based" Conditions

The 49 procedure and treatment groups included in the current *Hospital Performance Report* were comprised of both ICD-9-CM code-based conditions and MS-DRG-based conditions. While MS-DRGs typically represent a subset of all patients with a specific diagnosis or surgical treatment that are homogeneous with regard to resource use, the code-based conditions were designed to represent a more clinically cohesive group of patients.

Development of more clinically cohesive groups was accomplished by defining code-based conditions by specific ICD-9-CM codes—as the principal diagnosis or principal procedure—and restricting them to select MS-DRGs. For example, Chronic Obstructive Pulmonary Disease (COPD) was defined as cases with a principal diagnosis of 491.20, 491.21, 491.22, 492.0, 492.8, 496 or 506.4 and restricted to MS-DRGs 190, 191, and 192. In addition, cases that were deemed to be clinically complex were excluded. For example, HIV infection (ICD-9-CM code 042, in any position) was excluded from all code-based conditions.

Selection of Code-Based Conditions and DRG-Based Conditions

The procedure and treatment groups included in the *Hospital Performance Report* were selected primarily because 1) they were high in volume or mortality, 2) they showed high variability in mortality among hospitals, 3) they were described in the literature as high cost, high mortality conditions, or 4) the transfer rate (i.e., transfer to another acute care facility) was typically less than 5 percent (so that a complete picture of the care delivered could be obtained by examining a single discharge record). In addition, since the report included data from acute care facilities regardless of bed size, procedure and treatment groups were selected that were prevalent at smaller facilities as well as at larger facilities. A broad range of both medical and surgical hospitalizations are represented.

STUDY POPULATION

Inclusion Criteria

The study population for the *Hospital Performance Report* (printed and Web site) included usable records from all Pennsylvania general acute care (GAC) and specialty GAC hospitals in FFY 2008. All records that met the definition criteria outlined in the "Procedure and Treatment Groups" section were included. During the study period there were 176 facilities in Pennsylvania.

Exclusion Criteria

The number of cases included in any single type of analysis varies because each area of analysis has its own unique set of exclusion criteria (see "Records Excluded from Analyses" section). However, the following exclusions were common to all procedure and treatment groups:

- Duplicate records
- Missing or invalid discharge status (see Appendix Table G for valid codes)
- Non-adult (< 18 years) or invalid age (e.g., data not available for calculation of age, or > 120 years)
- Patients who left against medical advice (LAMA, discharge status code—07)

- Patients transferred to acute care facilities (short-term care, federal, long-term care, or critical access hospital; discharge status codes—02, 43, 63, 66)
  Exception: discharge status codes 02, 43, 63 and 66 were not excluded from the Heart Attack – Medical Management population for analysis of the transfer to acute care percent

Clinically complex cases were removed from the code-based conditions. That is, records with an HIV infection code (ICD-9-CM code 042, in any position) were excluded from all of the code-based diagnoses and procedures. Also, cases with abdominal trauma codes[1], in any position, were excluded from the Colorectal Procedures study population.

Exclusions from Readmission Analyses: Special Case of Intermediary Hospitalizations

For the readmission rate calculation, the numerator was based on *the number of hospitalizations that resulted in at least one readmission* within 30 days. This number was divided by the total number of records in the procedure or treatment group to determine the readmission rate. 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. However, readmissions themselves were evaluated for their own readmissions. "Intermediary hospitalizations" were excluded from the readmissions analyses. These hospitalizations were readmissions to the *same* hospital, for the *same* medical condition, that *preceded* another readmission that was specifically for a complication or infection (occurring within 30 days of the initial hospitalization). That is, intermediary hospitalizations were those readmissions that were embedded between an initial hospitalization and a readmission for a complication or infection. They were excluded so the readmission for complication or infection was not attributed back to more than one hospitalization.

UTILIZATION AND OUTCOME MEASURE ANALYSES

Exclusions from Analyses

Procedure and Treatment Groups Excluded from Analyses

Outcomes were reported for a given condition or procedure based on the appropriateness of the measure to that condition or procedure. The following guidelines were used to determine which procedure and treatment groups were to be excluded from a particular analysis:

- Length of stay outlier rates and ratings (short and long) were not analyzed for a particular procedure or treatment group when less than 95% of the cases in that condition or procedure fell into a single MediQual Disease Group.[2]
- Mortality ratings were not reported for conditions or procedures with low statewide mortality (i.e., less than 10 mortalities, after exclusions). Additionally, mortality ratings for conditions or procedures with statewide mortalities of 10-29 were calculated using only one risk variable (i.e., *Atlas Outcomes*™ predicted probability of death). See the "Risk Adjustment Procedures" section for a description of the risk variables.

[1] ICD-9-CM diagnosis codes 863.0 to 864.19, 868.0 to 869.1, 879.2 to 879.9, 902.0 to 902.9, 908.1, 908.2, 908.4, 908.6, 908.9, 922.2, 935.2, 936, 937, 938, 947.3.

[2] Because Length of Stay Outlier Rate and Ratings were based on *Atlas Outcomes*™ Predicted Length of Stay (MQPredLOS) values, these measures were not reported for those procedure and treatment groups for which the *Atlas Outcomes*™ algorithms (used to calculate the MQPredLOS) could not be suitably applied.

- Readmissions (for any reason and for complication or infection) were not analyzed for a particular procedure or treatment group when 10% or more of the cases were cancer-related. In addition, readmissions were not analyzed for Heart Attack – Medical Management because rehospitalizations were an expected part of the treatment process. To maintain consistency within the Heart Attack conditions, Heart Attack – Angioplasty/Stent was also excluded from the readmissions analyses.
- Transfer to acute care percents were calculated for Heart Attack – Medical Management only.

Note that length of stay and average charge were analyzed and reported for all procedure and treatment groups.

Records Excluded from Analyses

In addition to the cases excluded from the general study population (see "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, records missing the *Atlas Outcomes*™ MQPredDeath (a risk factor for mortality) were excluded from the mortality analyses because these cases could not be properly risk adjusted. For complete detail of all record exclusions (type and number), see Table E in the Appendix of this report.

Trimming

Outlier cases were trimmed (deleted) from the length stay and average charge analyses. 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). For the current *Hospital Performance Report,* the mean was the primary descriptive measure for length of stay and average charge. The trimming of individual records from the database was performed after all other exclusions were satisfied.

For length of stay, the 99th percentile was used as the trim point. If the length of stay of a particular record was in excess of the trim point, that record was removed from the database and thus from the length of stay analyses. (Length of stay outliers were also excluded from the readmissions analyses.)

Trim points for average charge for each procedure or treatment group 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 code-based condition. Since charges varied dramatically among 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. Hospitals were consolidated into the three Pennsylvania areas after the trimming of outlier charges was performed.

Trim points for average charge were determined as follows:

Q1 = the first quartile (25th percentile length of stay value) of all patient records from the comparative database in a particular category
Q3 = the third quartile (75th percentile length of stay value) of all patient records from the comparative database in a particular category

IQR = Q3 – Q1

Lower Trim Point = Q1 – (3.0 x IQR)
Upper Trim Point = Q3 + (3.0 x IQR)

Determination of Utilization and Outcome Values

Separate analyses were performed to determine *actual* mortality percents, length of stay in days, short length of stay outlier percents, long length of stay outlier percents, readmissions for any reason percents, readmissions for complication or infection percents, and average charge. Except for the calculation of average charge[1], actual results were then adjusted for the risk inherent in a particular hospital's population. The hospital's risk profile was used to calculate *expected* values, which were then the basis of the *risk-adjusted* values that were displayed in the printed and Web site reports for length of stay and length of stay outliers (short/long). For mortality, length of stay outliers (short/long) and readmissions (any reason and for complication or infection), significance tests were conducted to determine if 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.*

Determining Actual (Observed) Values

Mortality	This percent was determined by dividing the total number of hospitalizations ending in death by the number of hospitalizations in the mortality analysis for that particular procedure or treatment group.
Average Length of Stay	The length of stay for a hospitalization was determined by subtracting the admit date from the discharge date. The average length of stay was determined as the arithmetic mean length of stay for the hospitalizations included in the length of stay analysis for a particular procedure or treatment group.
Length of Stay Outliers (Short and Long)	This percent was determined by dividing the total number of short/long length of stay outlier hospitalizations by the number of hospitalizations in the length of stay outlier analysis for that particular procedure or treatment group.
Readmissions for Any Reason	This percent was determined by dividing the number of discharges readmitted at least once for an acute care condition[2] to any GAC or specialty GAC hospital within 30 days of discharge by the total number of discharges included in the readmissions analysis for that particular procedure or treatment group. If, over the study period, a patient had multiple discharges in the same procedure or treatment group, each discharge was independently investigated to determine whether it had a readmission within 30 days of that discharge. Thus, 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 procedure or treatment group). Same day readmissions were included only if the original hospitalization resulted in a discharge to "home."[3]

[1] Average charge for the code-based conditions was adjusted to account for variations in case-mix because these conditions included more than one MS-DRG in their definition. See "Special Considerations for Average Charge" section.

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

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

Readmissions for Complication or Infection	Similar to readmissions for any reason, except the number of discharges readmitted to any GAC or specialty GAC hospital within 30 days was limited to only those readmissions with a principal diagnosis that indicated a complication or infection. (See Table B of the Appendix for the ICD-9-CM codes that defined readmissions for complication or infection.) NEW codes were used to define the complication/infection categories beginning with the FFY2008 Hospital Performance Report. As a result, readmission rates generally increased.
Average Charge	This value was determined as the arithmetic mean average charge for the hospitalizations included in the charge analysis for a particular procedure or treatment group.

Determining Expected (Predicted) Values

Risk Adjustment Procedures

Regression techniques were used to construct "risk-adjustment models" for mortality, length of stay, and readmissions (for any reason and for complication or infection). The models used three risk factors to calculate expected, or predicted, results. Hospitals whose discharges were characterized by a greater number of risk factors (e.g., severity of illness, comorbidity, demographic and/or socioeconomic factors) were given "credit" in the system; hospitalizations with more risk factors were expected to have longer lengths of stay, and a greater probability of death, and/or readmission.

The first step in building the risk adjustment models for mortality, length of stay, and readmissions was to identify possible risk-adjustment factors—those factors that potentially contribute to a particular event for the conditions/procedures in the current report. In doing so, clinical, demographic, and socioeconomic factors identified in the literature were considered. The *Atlas Outcomes*™ predicted probability of death and predicted length of stay scores were also considered. The processes for 1) gathering and reporting the Atlas information and 2) building the PHC4 risk-adjustment models are explained in the following sections.

Atlas Outcomes™ Approach for Risk Adjustment

Acute care hospitals used MediQual's *Atlas Outcomes*™ Severity of Illness System to assess each patient's condition from date of admission through the first two days of the hospital stay (or a maximum of 30 hours, based on when the patient was admitted to the hospital). This system summarizes the overall risk/severity and calculates the patient's predicted probability of death (MQPredDeath) and predicted length of stay (MQPredLOS). The MQPredDeath was derived from a logistic regression model and had a value from 0.000 to 1.000. The MQPredLOS was derived from a linear regression model and had no bounds.

Atlas Scoring: Focus on Laboratory Data. The *Atlas Outcomes*™ system is based on diagnosis and procedure codes, age, sex, and clinical laboratory data. The clinical laboratory data is collected during specified timeframes in the hospitalization. The results are entered into algorithms that calculate the overall predicted probability of death or the predicted length of stay.

PHC4 Model Selection

Model selection identified three risk factors that were statistically significant predictors of the relevant event (i.e., mortality, length of stay, or readmission) in the highest number of procedure and treatment groups. Each medical condition and surgical procedure was modeled separately, and only those receiving that analysis were included (e.g., only

conditions/procedures included in the readmissions analysis were used to select the best risk variables for the readmissions models).

Linear regression models were used for length of stay, while binary logistic regression models were used for mortality and readmissions outcomes. Risk factors were considered significant in a condition/procedure if they met the $p < 0.10$ significance criteria.

To determine the first risk factor, individual models were run for each procedure and treatment group that received that analysis. The candidate variable that was significant ($p < 0.10$) in the most models was chosen to be the first risk factor.

The second risk factor was determined by running a similar set of models for each procedure and treatment group with the first risk factor already entered into the models. The candidate variable that was significant in the most models (after taking into account the effect of the first risk factor) was selected to be the second risk factor.

Similarly, the third risk factor was determined by running the models for each procedure and treatment group with the first and second risk factors already entered into the models. The candidate variable that was significant in the most models (after taking into account the effect of the first and second risk factors) was selected to be the third risk factor.

The linear and logistic regression models used to calculate risk-adjusted results were limited to three risk factors in order to avoid over specification. The following table summarizes the risk factors found to be significant for each of the three models:

			Readmissions:	
Rank	**Mortality**	**Length of Stay**	**Any Reason**	**Complication or Infection**
1st	MQPredDeath	MQPredLOS	MQPredLOS or MQPredDeath*	MQPredLOS or MQPredDeath†
2nd	Age&Age^2	Age&Age^2	Diabetes§	Age&Age^2
3rd	Cancer Type‡	Poverty Rate	Cancer Type‡	Diabetes§

* In the readmissions for any reason analyses, MQPredDeath was used in the models for the following conditions/procedures: Diabetes with Amputation; Respiratory Failure with Mechanical Ventilation; Respiratory Failure without Mechanical Ventilation; Abdominal Aortic Aneurysm Repair - Endovascular; Abdominal Aortic Aneurysm Repair - Open; Hip Fracture - Surgical Repair; Cirrhosis and Alcoholic Hepatitis; Hypotension and Fainting; Liver Disease except Cancer, Cirrhosis, and Alcoholic Hepatitis. MQPredLOS was used in all other conditions/procedures.

† In the readmissions for complication or infection analyses, MQPredDeath was used in the models for the following conditions/procedures: Chronic Obstructive Pulmonary Disease (COPD), Congestive Heart Failure (CHF), Diabetes - Medical Management, Kidney Failure - Acute, Pneumonia - Infectious, Stomach and Intestinal Bleeding, Stroke - Non-Hemorrhagic, Abdominal Aortic Aneurysm Repair - Endovascular, Gallbladder Removal - Open, Hip Fracture - Surgical Repair, Cirrhosis and Alcoholic Hepatitis, and Hypotension and Fainting. MQPredLOS was used in all other conditions/procedures.

‡ Cancer was defined by the following ICD-9-CM codes: Malignant Neoplasm and Carcinoma in situ = 140.0-195.8, 200.00-208.91, 230.0-239.9; Secondary Neoplasm (Metastatic) = 196.0-199.1

§ Diabetes was defined by the following ICD-9-CM codes: 250.01-250.93

Calculation of Expected Values

Once the three risk factors were identified for each measure, separate models were run for each procedure and treatment group using the three risk factors. These models estimated the relative effects (β_n) that the risk factors had on the relevant outcome value for each hospitalization, and generated model equations of the 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 are binary, e.g., yes/no, were coded as yes = 1 and no = 0)

These models were then used to provide the predicted values (e.g., predicted probability of death, predicted length of stay) 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.

For linear models, this value βX is the final predicted value. For logistic models, 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) within that procedure or treatment group. See Appendix Tables H and I for examples of risk-adjustment calculations.

Determining Risk-Adjusted Values

Risk adjusted values for mortality, length of stay, and readmissions (for any reason and for complication or infection) were calculated for each hospital by dividing the hospital's actual value by its expected value and then multiplying that result by the statewide average.

Special Considerations for Length of Stay Outlier Measures

The variable of analysis for the calculation of the length of stay outlier rates was the residual length of stay (ResLOS). This value was calculated for each record as the difference between the actual length of stay and MQPredLOS. Length of stay outliers were identified as those hospitalizations (for a given procedure or treatment group) in which the ResLOS was below the 5th percentile (short length of stay outliers) or above the 95th percentile (long length of stay outliers) of the statewide distribution of ResLOS.

The "expected" percent of short/long length of stay outliers for each hospital within each procedure or treatment group was equal to the statewide percent—near 5%—of short (or long) length of stay outliers. (Note that since outliers were defined as being strictly less than the 5th percentile or greater than the 95th percentile, the statewide rates of outliers will be near, but less than, 5%.) Since length of stay outlier rates were based on the MQPredLOS, the actual percent of outliers for each facility was already "risk-adjusted" and additional adjustments were not necessary. While lower-than-expected and higher-than-expected ratings for mortality or readmissions may suggest good performance or opportunities for improvement, respectively, similar ratings for the short or long length of stay outlier measures are meant to be a tool to help hospitals identify variation in utilization patterns.

Special Considerations for Average Charge

Average charge was reported without adjustment for each procedure or treatment group that contained cases from a single MS-DRG. For the conditions and procedures that included more

than one MS-DRG in their definition, case-mix adjustment was used to calculate a composite average charge for the combined MS-DRGs representing the condition. This adjustment was made at the level of the nine Pennsylvania regions and was used to account for hospital variation in the mix of cases across MS-DRGs. See Appendix Table J for an example of a case-mix adjustment calculation.

For example, Chronic Obstructive Pulmonary Disease was comprised of a subset of cases in MS-DRGs 190, 191 and 192. The charges associated with MS-DRGs 190, 191 and 192 were adjusted according to the number of patients and the average charge associated with treating patients in each of these three MS-DRGs within a particular Pennsylvania region.

Determining Statistical Ratings

Significance tests (using the binomial distribution) were performed for mortality, length of stay outliers (short/long), and readmissions (for any reason or for complication or infection). 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 procedure or treatment group was equal to the probability provided by the risk models.
- The result for any one observation in the analyses had no impact on the result of another observation. In other words, the observations were independent.

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

Calculation of p-values

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

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

where:

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

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

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

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

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

The two-tailed p-value was calculated for each hospital within each procedure or treatment group analyzed.

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 *Hospital Performance Report*, a Type I error occurred when the difference between the observed 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 procedure or treatment group, 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 clinical 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 greater than or equal to 0.05, then the conclusion was made that the difference between what was expected and what was observed was *not* statistically significant. It *cannot be concluded* that the actual mortality percent for that that particular hospital in that particular procedure or treatment group was different from the expected mortality percent derived from that particular hospital's risk profile.

- 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 observed mortality percent was less than expected, the hospital was assigned the symbol "○" (as shown in the *Hospital Performance Report*) to indicate that the mortality percent was significantly less than expected for a particular procedure or treatment group.

    - If the observed mortality percent was higher than expected, the hospital was assigned the symbol "●" (as shown in the *Hospital Performance Report*) to indicate that the mortality percent was significantly greater than expected for a particular procedure or treatment group.

MINIMUM CASES NEEDED FOR REPORTING

In the printed report, "NR" (not reported) was displayed in place of a particular result whenever the number of cases analyzed for that particular measure (after exclusions) was less than five. However, if there were less than five cases (identified in the report in the column named "cases") in the mortality analysis (or length of stay analysis for conditions/procedures for which mortality was not reported), NR appears in place of *all* results. Note that for Abdominal Aortic Aneurysm Repair - Open and Endovascular, as well as Heart Attack – Angioplasty/Stent there was a high percentage of hospitals with zero cases; for practical reasons these hospitals were not displayed for these particular procedures.

Results presented on the Web site were similar to the printed report, with one exception: when there were less than 5 cases in the "cases" column, the hospital was not displayed for that particular procedure or treatment group.

"NA" (not available) was displayed in the average charge column of the printed and Web site reports for facilities that submitted records with errors in revenue data. These records were removed from the statewide dataset used for the average charge analysis.

APPENDIX

TABLE A
The 49 Medical Conditions and Surgical Procedures in the *FFY 2008 Hospital Performance Report*

The following table defines the 31 code-based and 18 DRG-based conditions and procedures included in this report. The ICD-9-CM codes and MS-DRGs used to define each condition/procedure are applicable to CMS Grouper Version 25.0. Additional exclusions (clinically complex cases) are identified as footnotes.

The 31 Code-Based Conditions/Procedures

Each category includes records with the listed principal diagnosis and/or procedure and the listed MS-DRG(s).

*Medical Condition**	*Principal Diagnosis Codes (ICD-9-CM)*	*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
Blood Clot in Extremities	451.0, 451.11, 451.19, 451.2, 451.81, 451.82, 451.83, 451.84, 451.89, 451.9, 453.40, 453.41, 453.42, 453.8, 453.9	294, 295, 299, 300, 301
Blood Clot in Lung	415.11, 415.12, 415.19	175, 176
Chronic Obstructive Pulmonary Disease	491.20, 491.21, 491.22, 492.0, 492.8, 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 with Amputation	250.0x, 250.1x, 250.2x, 250.3x, 250.7x, 250.8x, 250.9x (x=0-3)	239, 240, 241, 255, 256, 257, 616, 617, 618
Diabetes – Medical Management	250.0x, 250.1x, 250.2x, 250.3x, 250.4x, 250.6x, 250.7x, 250.8x, 250.9x (x=0-3)	073, 074, 299, 300, 301, 637, 638, 639, 698, 699, 700
Heart Attack – Medical Management	410.01, 410.11, 410.21, 410.31, 410.41, 410.51, 410.61, 410.71, 410.81, 410.91	280, 281, 282, 283, 284, 285
Intestinal Obstruction	560.0, 560.2, 560.30, 560.31, 560.39, 560.81, 560.89, 560.9	388, 389, 390
Kidney Failure – Acute	584.5, 584.6, 584.7, 584.8, 584.9	682, 683, 684
Kidney and Urinary Tract Infections	590.00, 590.01, 590.10, 590.11, 590.2, 590.3, 590.80, 590.9, 595.x (x = 0-3), 595.81, 595.89, 595.9, 599.0	689, 690
Pneumonia – Aspiration	507.0	177, 178, 179
Pneumonia – Infectious	480.0, 480.1, 480.2, 480.3, 480.8, 480.9, 481, 482.0, 482.1, 482.2, 482.30, 482.31, 482.32, 482.39, 482.40, 482.41, 482.49, 482.81, 482.82, 482.83, 482.84, 482.89, 482.9, 483.0, 483.1, 483.8, 485, 486, 487.0	177, 178, 179, 193, 194, 195
Respiratory Failure with Mechanical Ventilation	506.1, 518.5, 518.81, 518.83, 518.84	207, 208
Respiratory Failure without Mechanical Ventilation	506.1, 518.5, 518.81, 518.83, 518.84	189
Septicemia	038.0, 038.10, 038.11, 038.19, 038.2, 038.3, 038.40, 038.41, 038.42, 038.43, 038.44, 038.49, 038.8, 038.9, 995.90, 995.91, 995.92	870, 871, 872
Stomach and Intestinal Bleeding	456.0, 530.7, 530.82, 531.00, 531.01, 531.20, 531.21, 531.40, 531.41, 531.60, 531.61, 532.00, 532.01, 532.20, 532.21, 532.40, 532.41, 532.60, 532.61, 533.00, 533.01, 533.20, 533.21, 533.40, 533.41, 533.60, 533.61, 534.00, 534.01, 534.20, 534.21, 534.40, 534.41, 534.60, 534.61, 535.01, 535.11, 535.21, 535.31, 535.41, 535.51, 535.61, 537.83, 537.84, 562.02, 562.03, 562.12, 562.13, 569.3, 569.85, 578.9	368, 369, 370, 377, 378, 379
Stroke – Hemorrhagic	430, 431, 432.0, 432.1, 432.9	064, 065, 066
Stroke – Non-Hemorrhagic	433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91	061, 062, 063, 064, 065, 066

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

TABLE A CONTINUED

***The 31 Code-Based Conditions/Procedures* CONTINUED**

***Surgical Procedure*[1]**	***Principal Procedure Codes (ICD-9-CM)***	***MS-DRGs***
Abdominal Aortic Aneurysm Repair - Endovascular	39.71 With principal diagnosis (PDx) of 441.4	237, 238
Abdominal Aortic Aneurysm Repair - Open	38.44, 38.64, 38.84 With PDx of 441.4	237, 238
Colorectal Procedures[2]	45.71, 45.72, 45.73, 45.74, 45.75, 45.76, 45.79, 45.8, 45.92, 45.94, 46.03, 46.10, 46.11, 46.13, 46.42, 46.43, 46.52, 46.76, 46.94, 48.49, 48.5, 48.62, 48.63, 48.69, 48.75, 48.76, 70.72	329, 330, 331, 332, 333, 334
Gallbladder Removal - Laparoscopic	51.23, 51.24	411, 412, 413, 417, 418, 419
Gallbladder Removal - Open	51.21, 51.22	411, 412, 413, 414, 415, 416
Heart Attack - Angioplasty/Stent	00.66, 36.06, 36.07 With PDx of 410.01, 410.11, 410.21, 410.31, 410.41, 410.51, 410.61, 410.71, 410.81, or 410.91	246, 247, 248, 249
Hip Fracture - Surgical Repair	78.55, 79.15, 79.25, 79.35, 79.55, 81.51, 81.52 With PDx of 820.0x (x = 0–3,9), 820.1x (x = 0–3,9), 820.2x (x = 0–2), 820.3x (x = 0–2), 820.8, or 820.9	469, 470, 480, 481, 482
Hysterectomy - Abdominal	68.31, 68.39, 68.41, 68.49, 68.61, 68.69, 68.9	734, 735, 736, 737, 738, 739, 740, 741, 742, 743
Hysterectomy - Vaginal	68.51, 68.59, 68.71, 68.79	734, 735, 736, 737, 738, 739, 740, 741, 742, 743
Prostatectomy - Radical	60.3, 60.4, 60.5, 60.62, 60.69	665, 666, 667, 707, 708
Prostatectomy - Transurethral	60.21, 60.29	665, 666, 667, 713, 714
Removal of Blockage of Neck Vessels	38.12	037, 038, 039

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

TABLE A CONTINUED

The 18 DRG-Based Conditions/Procedures

Each category includes records with the listed MS-DRG(s).

Condition	*MS-DRGs*
Brain Surgery	025, 026, 027
Bronchitis and Asthma	202, 203
Chest Pain	313
Cirrhosis and Alcoholic Hepatitis	432, 433, 434
Hypotension and Fainting	312
Infectious and Parasitic Diseases with Surgery	853, 854, 855
Liver, Gallbladder or Pancreatic Cancer	435, 436, 437
Liver Disease except Cancer, Cirrhosis or Alcoholic Hepatitis	441, 442, 443
Major Lung Surgery	163, 164, 165
Medical Back Problems	551, 552
Miscellaneous Lung Surgery	166, 167, 168
Miscellaneous Vascular Surgery	252, 253, 254
Noncancerous Pancreatic Disorders	438, 439, 440
Postoperative and Posttraumatic Infections with Surgery	856, 857, 858
Postoperative and Posttraumatic Infections without Surgery	862, 863
Stomach and Intestinal Complications and Disorders	393, 394, 395
Stomach and Intestinal Infections and Disorders	391, 392
Stomach and Small Intestine Surgery	326, 327, 328

TABLE B

ICD-9-CM Codes Used to Define Readmissions for Complication or Infection

Readmissions with one of the following ICD-9-CM codes listed as the principal diagnosis were included in this measure. These codes are applicable to CMS Grouper Versions 25 and 26.

Stroke/Anoxic Brain Damage

348.1	432.9	433.81	997.00
430	433.01	433.91	997.01
431	433.11	434.01	997.02
432.0	433.21	434.11	997.09
432.1	433.31	434.91	

Acute Myocardial Infarction

410.01	410.31	410.61	410.91
410.11	410.41	410.71	997.1
410.21	410.51	410.81	

Hypertension and Hypotension

458.29	997.91

Shock

785.50	785.51	785.59	998.0

Vascular Complications

415.11	444.89	451.82	453.8
415.12	444.9	451.83	453.9
415.19	449	451.84	997.2
444.0	451.0	451.89	997.71
444.1	451.11	451.9	997.72
444.21	451.19	453.40	997.79
444.22	451.2	453.41	999.1
444.81	451.81	453.42	999.2

Respiratory Complications

511.0	511.9	518.4	518.84
511.1	512.1	518.5	997.3†
511.8†	514	518.81	997.39‡
511.89‡	518.0	518.82	

Digestive Complications

531.00	532.20	533.50	535.01
531.01	532.21	533.51	535.41
531.10	532.40	533.60	535.51
531.11	532.41	533.61	535.61
531.20	532.50	534.00	537.84
531.21	532.51	534.01	557.0
531.40	532.60	534.10	560.81
531.41	532.61	534.11	564.2
531.50	533.00	534.20	564.3
531.51	533.01	534.21	564.4
531.60	533.10	534.40	568.81
531.61	533.11	534.41	569.83
532.00	533.20	534.50	578.9
532.01	533.21	534.51	997.4
532.10	533.40	534.60	
532.11	533.41	534.61	

Infection

008.45	038.44	567.39	996.60
038.0	038.49	567.81	996.61
038.10	038.8	567.89	996.62
038.11	038.9	567.9	996.64
038.12‡	530.86	569.61	996.65
038.19	536.41	590.10	996.66
038.2	567.1	590.11	996.67
038.3	567.21	599.0	996.69
038.40	567.22	790.7	998.51
038.41	567.29	995.90	998.59
038.42	567.31	995.91	999.31
038.43	567.38	995.92	999.39

Pneumonia

481	482.39	482.82	483.1
482.0	482.40	482.83	483.8
482.1	482.41	482.84	485
482.2	482.42‡	482.89	486
482.30	482.49	482.9	507.0
482.31	482.81	483.0	997.31‡
482.32			

Device, Implant or Graft Complications

530.87	996.04	996.42	996.59
536.40	996.09	996.43	996.70
536.42	996.1	996.44	996.72
536.49	996.30	996.45	996.74
569.60	996.31	996.46	996.76
569.62	996.39	996.47	996.77
569.69	996.40	996.49	996.78
996.01	996.41	996.52	996.79

Procedure and Medical Care Complications

349.31‡	995.93	998.30‡	998.83
584.5	995.94	998.31	998.89
584.6	997.5	998.32	998.9
584.7	998.11	998.33‡	
584.8	998.12	998.4	
584.9	998.13	998.6	
909.3	998.2	998.7	

† Invalid as of 10/1/2008. ‡ Valid beginning 10/1/2008.

TABLE C1

Statewide Utilization and Outcome Data for Code-Based Conditions/Procedures

Medical Conditions

Description	# of Cases[1]	% Mortality[2]	Length of Stay[2]	Readmissions % Any Reason[2]	Readmissions % Comp/ Infec[2]	Average Charge[2]
Abnormal Heartbeat	44,947	0.8	3.5	14.8	3.4	$32,586
Blood Clot in Extremities	7,741	0.4	4.2	NR	NR	$18,496
Blood Clot in Lung	6,937	1.9	5.3	NR	NR	$28,880
Chronic Obstructive Pulmonary Disease (COPD)	32,007	1.0	4.5	22.9	6.8	$22,517
Congestive Heart Failure (CHF)	48,294	2.6	5.0	27.1	7.7	$27,600
Diabetes with Amputation	2,015	1.2	9.5	21.3	6.6	$68,378
Diabetes - Medical Management	17,278	0.6	3.7	21.3	4.3	$21,463
Heart Attack - Medical Management	12,941	10.6	5.3	NR	NR	$34,378
Intestinal Obstruction	9,357	1.7	4.3	NR	NR	$21,216
Kidney Failure - Acute	20,371	5.1	5.6	23.9	11.5	$29,457
Kidney and Urinary Tract Infections	23,419	0.8	4.2	17.5	8.3	$20,730
Pneumonia - Aspiration	9,442	10.2	6.8	24.6	17.3	$34,248
Pneumonia - Infectious	39,707	2.5	4.9	16.8	8.0	$24,313
Respiratory Failure with Mechanical Ventilation	6,122	29.5	9.4	27.6	15.5	$79,603
Respiratory Failure without Mechanical Ventilation	9,884	10.1	6.0	26.4	15.3	$28,676
Septicemia	26,171	18.5	7.2	NR	NR	$43,160
Stomach and Intestinal Bleeding	19,810	2.0	4.4	17.0	6.5	$26,111
Stroke - Hemorrhagic	3,634	26.2	5.9	18.6	9.5	$44,142
Stroke - Non-Hemorrhagic	18,770	4.9	4.9	14.5	6.9	$34,134

Surgical Procedures

Abdominal Aortic Aneurysm Repair - Endovascular	1,682	0.7	2.8	11.8	6.7	$95,135
Abdominal Aortic Aneurysm Repair - Open	485	3.9	8.0	13.4	6.8	$88,988
Colorectal Procedures	14,418	2.8	8.6	NR	NR	$65,597
Gallbladder Removal - Laparoscopic	13,636	0.2	3.6	7.2	2.7	$32,671
Gallbladder Removal - Open	2,365	1.5	6.7	10.8	5.9	$54,051
Heart Attack - Angioplasty/Stent	11,314	1.4	3.7	NR	NR	$71,601
Hip Fracture - Surgical Repair	12,926	2.0	5.9	14.9	8.6	$43,929
Hysterectomy - Abdominal	15,323	0.1	2.6	NR	NR	$26,125
Hysterectomy - Vaginal	6,158	NR	1.6	3.0	2.1	$19,766
Prostatectomy - Radical	3,979	NR	2.3	NR	NR	$41,968
Prostatectomy - Transurethral	3,446	0.4	2.6	NR	NR	$18,499
Removal of Blockage of Neck Vessels	4,823	0.2	2.3	9.4	2.7	$28,652

[1]Number of cases after mortality exclusions (or length of stay exclusions for procedures in which mortality is not reported).
[2]Value shown is based on records after all relevant exclusions are removed.
NR: Not Reported

TABLE C2

Statewide Utilization and Outcome Data for DRG-Based Conditions/Procedures

Description	*# of Cases*[1]	*% Mortality*[2]	*Length of Stay*[2]	*Readmissions*		*Average Charge*[2]
				% Any Reason[2]	*% Comp/ Infec*[2]	
Brain Surgery	5,617	4.3	5.8	NR	NR	$102,480
Bronchitis and Asthma	13,580	0.2	3.3	11.7	2.7	$18,267
Chest Pain	33,396	<0.1	1.7	11.4	1.8	$17,433
Cirrhosis and Alcoholic Hepatitis	4,153	5.8	5.5	34.4	6.4	$39,458
Hypotension and Fainting	19,671	0.2	2.8	12.0	2.7	$19,967
Infectious and Parasitic Diseases with Surgery	4,112	14.7	13.6	NR	NR	$109,781
Liver, Gallbladder or Pancreatic Cancer	3,393	9.8	5.6	NR	NR	$38,698
Liver Disease except Cancer, Cirrhosis, or Alcoholic Hepatitis	4,674	5.4	5.0	34.8	6.8	$36,643
Major Lung Surgery	5,806	3.0	7.2	NR	NR	$76,297
Medical Back Problems	12,290	0.6	3.8	16.3	3.8	$22,199
Miscellaneous Lung Surgery	5,674	6.1	8.2	NR	NR	$66,398
Miscellaneous Vascular Surgery	11,710	1.6	5.2	NR	NR	$63,203
Noncancerous Pancreatic Disorders	9,278	1.0	4.7	19.2	2.7	$25,816
Postoperative and Posttraumatic Infections with Surgery	2,882	1.5	7.9	18.9	11.4	$64,011
Postoperative and Posttraumatic Infections without Surgery	4,847	0.6	4.8	NR	NR	$27,699
Stomach and Intestinal Complications and Disorders	11,164	2.2	4.2	NR	NR	$24,945
Stomach and Intestinal Infections and Disorders	44,451	0.3	3.2	NR	NR	$19,543
Stomach and Small Intestine Surgery	4,141	4.3	8.5	NR	NR	$91,336

[1]Number of cases after mortality exclusions (or length of stay exclusions for conditions in which mortality was not reported).
[2]Value shown was based on records after all relevant exclusions were removed.
NR: Not Reported

TABLE D1

Statewide Cases Readmitted for Complication or Infection, by Reason for Readmission
Code-Based Conditions/Procedures

Code-Based Condition/Procedure	# of Cases Meeting Readmissions Criteria	Total # of Cases Readmitted for Complication or Infection	% of Cases Readmitted for Complication or Infection	*Reason for Readmission*										
				Stroke/Anoxic Brain Damage	Acute Myocardial Infarction	Hypertension and Hypotension	Shock	Vascular Complications	Respiratory Complications	Digestive Complications	Infection	Pneumonia	Device, Implant or Graft Complications	Procedure and Medical Care Complications
Medical Conditions														
Abnormal Heartbeat	41,248	1,416	3.4	107	114	13	1	118	129	106	324	225	109	170
Chronic Obstructive Pulmonary Disease	30,299	2,070	6.8	49	101	4	0	95	594	93	365	634	26	109
Congestive Heart Failure	44,090	3,374	7.7	154	317	16	1	93	542	151	799	554	76	671
Diabetes with Amputation	1,889	124	6.6	6	6	0	0	3	4	4	49	12	6	34
Diabetes - Medical Management	16,271	705	4.3	37	38	3	0	22	49	40	242	110	22	142
Kidney Failure - Acute	17,796	2,052	11.5	51	73	4	0	91	136	119	613	172	45	748
Kidney and Urinary Tract Infections	22,039	1,830	8.3	59	57	1	1	66	74	73	1,048	251	36	164
Pneumonia - Aspiration	7,578	1,314	17.3	18	22	2	0	30	116	35	316	698	19	58
Pneumonia - Infectious	36,694	2,951	8.0	79	105	8	1	137	387	110	641	1,299	25	159
Respiratory Failure with Mechanical Ventilation	3,813	591	15.5	8	32	0	0	22	274	13	104	95	11	32
Respiratory Failure without Mechanical Ventilation	8,127	1,244	15.3	17	31	2	1	29	704	20	198	188	5	49
Stomach and Intestinal Bleeding	18,365	1,200	6.5	64	48	1	1	76	67	379	266	161	29	108
Stroke - Hemorrhagic	2,154	204	9.5	85	6	1	0	18	5	4	39	20	0	26
Stroke - Non-Hemorrhagic	16,307	1,132	6.9	453	49	6	1	47	48	63	226	152	15	72
Surgical Procedures														
Abdominal Aortic Aneurysm Repair - Endovascular	1,472	98	6.7	2	6	0	0	10	4	8	33	5	9	21
Abdominal Aortic Aneurysm Repair - Open	424	29	6.8	0	1	0	0	2	1	5	12	1	1	6
Gallbladder Removal - Laparoscopic	12,838	342	2.7	5	9	1	0	35	13	88	112	32	6	41
Gallbladder Removal - Open	2,171	129	5.9	1	1	0	0	14	4	24	53	8	4	20
Hip Fracture - Surgical Repair	12,032	1,040	8.6	35	55	2	0	72	61	76	350	167	136	86
Hysterectomy - Vaginal	5,927	127	2.1	1	0	0	0	11	4	9	63	4	0	35
Removal of Blockage of Neck Vessels	4,549	122	2.7	25	15	1	0	3	9	7	20	13	2	27

TABLE D2

Statewide Cases Readmitted for Complication or Infection, by Reason for Readmission
DRG-Based Conditions/Procedures

DRG-Based Condition/Procedure	# of Cases Meeting Readmissions Criteria	Total # of Cases Readmitted for Complication or Infection	% of Cases Readmitted for Complication or Infection	*Reason for Readmission*										
				Stroke/Anoxic Brain Damage	Acute Myocardial Infarction	Hypertension and Hypotension	Shock	Vascular Complications	Respiratory Complications	Digestive Complications	Infection	Pneumonia	Device, Implant or Graft Complications	Procedure and Medical Care Complications
Bronchitis and Asthma	13,033	353	2.7	12	9	4	1	25	62	9	79	118	8	26
Chest Pain	31,651	577	1.8	40	83	11	0	59	38	33	128	93	34	58
Cirrhosis and Alcoholic Hepatitis	3,484	222	6.4	4	5	0	0	3	25	36	91	15	0	43
Hypotension and Fainting	18,584	498	2.7	47	42	8	1	39	37	24	141	93	11	55
Liver Disease except Cancer, Cirrhosis, or Alcoholic Hepatitis	3,810	258	6.8	7	2	0	1	10	23	23	102	32	4	54
Medical Back Problems	11,509	440	3.8	23	34	0	0	34	22	34	142	79	12	60
Noncancerous Pancreatic Disorders	8,595	233	2.7	8	12	1	1	16	13	28	80	29	15	30
Postoperative and Posttraumatic Infections with Surgery	2,528	287	11.4	3	3	0	0	12	7	7	201	4	12	38

TABLE E1

Statewide Exclusions from Analyses, by Measure
Code-Based Conditions/Procedures

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

	Mortality		***Length of Stay***		***Length of Stay Outliers: Short and Long***		***Readmissions: Any Reason and Complication or Infection***		***Average Charge***		***Transfer to Acute Care[5]***	
	#	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**
Total Cases Before Exclusions	475,426	100.0	485,839	100.0	421,295	100.0	365,125	100.0	485,839	100.0	16,545	100.0
Exclusions:												
Records with errors	0	0.0	0	0.0	0	0.0	0	0.0	189	<0.1	0	0.0
Duplicate records	88	<0.1	88	<0.1	76	<0.1	69	<0.1	82	<0.1	3	<0.1
Discharge date not in time period	27	<0.1	29	<0.1	24	<0.1	24	<0.1	16	<0.1	1	<0.1
Missing or invalid discharge status	180	<0.1	180	<0.1	153	<0.1	158	<0.1	179	<0.1	1	<0.1
Non-adult (< 18) or invalid age	9,914	2.1	9,914	2.0	9,369	2.2	9,029	2.5	9,911	2.0	5	<0.1
Patients with HIV Infection[1]	628	0.1	629	0.1	588	0.1	550	0.2	629	0.1	9	0.1
Patients with abdominal trauma[2]	122	<0.1	122	<0.1	NA	NA	NA	NA	122	<0.1	NA	NA
Patients who left against medical advice	3,418	0.7	3,419	0.7	3,361	0.8	2,836	0.8	3,419	0.7	142	0.9
Patients transferred to GAC facilities	13,787	2.9	13,790	2.8	13,222	3.1	8,255	2.3	13,776	2.8	NA	NA
Patients who died	NA	NA	18,514	3.8	17,693	4.2	11,219	3.1	NA	NA	1,401	8.5
Missing Atlas Outcomes™ data[3]	7,997	1.7	7,517	1.5	6,366	1.5	5,896	1.6	NA	NA	NA	NA
Invalid length of stay	NA	NA	12	<0.1	3	<0.1	6	<0.1	NA	NA	NA	NA
Length of stay outliers	NA	NA	3,902	0.8	NA	NA	2,936	0.8	NA	NA	NA	NA
Non-Pennsylvania residents	NA	NA	NA	NA	NA	NA	9,900	2.7	NA	NA	NA	NA
Patients discharged to hospice	NA	NA	NA	NA	NA	NA	5,426	1.5	NA	NA	NA	NA
Missing or inconsistent patient identifiers[4]	NA	NA	NA	NA	NA	NA	2,153	0.6	NA	NA	NA	NA
Admit, discharge, readmission date discrepancies	NA	NA	NA	NA	NA	NA	249	0.1	NA	NA	NA	NA
Invalid charges	NA	NA	NA	NA	NA	NA	NA	NA	596	0.1	NA	NA
Charge outliers	NA	NA	NA	NA	NA	NA	NA	NA	8,380	1.7	NA	NA
No reference data	NA	NA	NA	NA	NA	NA	NA	NA	2,503	0.5	NA	NA
Intermediary Hospitalization	NA	NA	NA	NA	NA	NA	336	0.1	NA	NA	NA	NA
Total Exclusions	36,161	7.6	58,116	12.0	50,855	12.1	59,042	16.2	39,802	8.2	1,562	9.4
Total Cases in Analysis	439,265	92.4	427,723	88.0	370,440	87.9	306,083	83.8	446,037	91.8	14,983	90.6

[1]This exclusion is only applicable to the code-based conditions/procedures.
[2]This exclusion is only applicable to the Colorectal Procedures study population.
[3]Either Missing MQPredDeath or MQPredLOS, depending on which one was used as a risk adjustor.
[4]Social Security Number, Date of Birth, Sex
[5]This measure is reported only for Heart Attack – Medical Management
NA: Not Applicable

TABLE E2

Statewide Exclusions from Analyses, by Measure
DRG-Based Conditions/Procedures

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

	Mortality		***Length of Stay***		***Length of Stay Outliers: Short and Long***		***Readmissions: Any Reason and Complication or Infection***		***Average Charge***	
	#	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**
Total Cases Before Exclusions	233,384	100.0	233,384	100.0	78,097	100.0	120,303	100.0	233,384	100.0
Exclusions:										
Records with errors	0	0.0	0	0.0	0	0.0	0	0.0	32	<0.1
Duplicate records	113	<0.1	113	<0.1	7	<0.1	82	0.1	113	<0.1
Discharge date not in time period	6	<0.1	6	<0.1	2	<0.1	5	<0.1	3	<0.1
Missing or invalid discharge status	40	<0.1	40	<0.1	15	<0.1	22	<0.1	40	<0.1
Non-adult (< 18) or invalid age	19,087	8.2	19,087	8.2	635	0.8	12,524	10.4	19,087	8.2
Patients who left against medical advice	3,603	1.5	3,603	1.5	2,161	2.8	2,606	2.2	3,603	1.5
Patients transferred to GAC facilities	4,848	2.1	4,848	2.1	2,064	2.6	2,645	2.2	4,848	2.1
Patients who died	NA	NA	3,342	1.4	420	0.5	799	0.7	NA	NA
Missing Atlas Outcomes™ data[1]	4,848	2.1	4,746	2.0	1,857	2.4	2,465	2.0	NA	NA
Invalid length of stay	NA	NA	2	<0.1	0	0.0	1	<0.1	NA	NA
Length of stay outliers	NA	NA	1,824	0.8	NA	NA	872	0.7	NA	NA
Non-Pennsylvania residents	NA	NA	NA	NA	NA	NA	3,428	2.8	NA	NA
Patients discharged to hospice	NA	NA	NA	NA	NA	NA	407	0.3	NA	NA
Missing or inconsistent patient identifiers[2]	NA	NA	NA	NA	NA	NA	1,113	0.9	NA	NA
Admit, discharge, readmission date discrepancies	NA	NA	NA	NA	NA	NA	58	<0.1	NA	NA
Invalid charges	NA	NA	NA	NA	NA	NA	NA	NA	183	0.1
Charge outliers	NA	NA	NA	NA	NA	NA	NA	NA	3,719	1.6
No reference data	NA	NA	NA	NA	NA	NA	NA	NA	201	0.1
Intermediary Hospitalization	NA	NA	NA	NA	NA	NA	82	0.1	NA	NA
Total Exclusions	32,545	13.9	37,611	16.1	7,161	9.2	27,109	22.5	31,829	13.6
Total Cases in Analysis	200,839	86.1	195,773	83.9	70,936	90.8	93,194	77.5	201,555	86.4

[1]Either Missing MQPredDeath or MQPredLOS, depending on which one is used as a risk adjustor.
[2]Social Security Number, Date of Birth, Sex
NA: Not Applicable

TABLE F

Hospitals Not Reported in the *Hospital Performance Report – FFY 2008*

The study population for the FFY2008 *Hospital Performance Report* included useable discharge records from all GAC/SGAC Pennsylvania facilities abstracting clinical data (Atlas) in the reported time period. There were 176 facilities in Pennsylvania during the study period.

Hospital Name	Reason for Not Reporting
Facilities currently in operation with unavailable data[1]:	
Central and Northeastern Pennsylvania	
Bucktail	*Records with data errors*
Mid-Valley	*Severity data needed for risk adjustment not available*
Montrose General	*Severity data needed for risk adjustment not available*
Southeastern Pennsylvania	
Abington	*UB and severity data not available*
Coordinated Health Orthopedic	*Severity data needed for risk adjustment not available*
Thomas Jefferson	*Severity data needed for risk adjustment not available*
Western Pennsylvania	
Brookville	*Severity data needed for risk adjustment not available*
Facilities for which average charge will not be reported[2]:	
Central and Northeastern Pennsylvania	
Jersey Shore	*Records with data errors*
Facilities that closed/merged:	
Southeastern Pennsylvania	
DSI of Bucks County	*Closed facility – effective 02/04/09*
Temple University Children's	*Closed facility – effective 12/01/07*
Warminster	*Closed facility – effective 10/01/07*
Western Pennsylvania	
Commonwealth Medical Center (formerly Aliquippa)	*Closed facility – effective 12/12/08*
Mercy Jeannette	*Merged with Excela Hlth Westmoreland – effective 05/01/08*
Other facilities not reported:	
Southeastern Pennsylvania	
Children's Hospital Philadelphia	*Children's hospital[3]*
St. Christopher's Children's	*Children's hospital[3]*
Surgical Institute of Reading	*New facility Q1, 2008 – not enough data for analysis*
Westfield	*New facility Q2, 2008 – not enough data for analysis*
Western Pennsylvania	
Children's Hospital Pittsburgh	*Children's hospital[3]*
Edgewood	*Specialized hospital: number of records available for analysis in HPR was negligible[4]*

[1]Hospitals with ≥ 10% missing *Atlas Outcomes™* severity scores (based on all records in the list of 35 diseases, procedures, and medical conditions that need to be abstracted) or facilities that submitted incomplete/unusable UB data for one or more quarters.
[2]Discharges relevant to the charge analysis were excluded from the statewide dataset.
[3]Pediatric cases were excluded from the *Hospital Performance Report* study populations. Therefore, data for children's hospitals were not reported. Adult discharges from pediatric hospitals were retained in the statewide dataset.
[4]Discharges relevant to the HPR were retained in the statewide dataset.

TABLE 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 an intermediate care facility (ICF)
05[1]	*Q3, 2007 to Q1, 2008*: Discharged/transferred to another type of institution not defined elsewhere in this code list *Q2, 2008*: 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
43	Discharged/transferred to a federal health care facility
50	Discharged to hospice—home
51	Discharged to hospice—medical facility (certified) providing hospice level of care
61	Discharged/transferred to a hospital-based Medicare approved swing bed
62	Discharged/transferred to an inpatient rehabilitation facility (IRF) including rehabilitation distinct part units of a hospital
63	Discharged/transferred to a Medicare certified long term care hospital (LTCH)
64	Discharged/transferred to a nursing facility certified under Medicaid but not certified under Medicare
65	Discharged/transferred to a psychiatric hospital or psychiatric distinct part unit of a hospital
66	Discharged/transferred to a critical access hospital (CAH)
70[2]	Discharged/transferred to another type of health care institution not defined elsewhere in this code list

[1] Name change effective Q2, 2008
[2] New code effective Q2, 2008

TABLE H

Linear Regression Example

Calculations Used in Determining Length of Stay for a Hospital
Medical Condition: Heart Attack – Medical Management

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

Actual Length of Stay: Mean of the length of stay for each hospitalization.

Expected Length of Stay: Mean of the predicted length of stay for each hospitalization.

Step 1: Calculate each hospitalization's predicted length of stay (PLOS):

$$PLOS = \beta X$$

$$= \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4$$

$$= -1.3861 + (0.4669)(x_1) + (0.0659)(x_2) + (-0.2936)(x_3) + (1.9187)(x_4)$$

where:

- x_1 = MQPredLOS value
- x_2 = Age
- x_3 = Age-squared/1000
- x_4 = Poverty Rate

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

Step 2: Calculate the mean PLOS for a hospital (expected length of stay):

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

Risk-Adjusted Length of Stay:

$$\frac{\text{Mean Actual LOS}}{\text{Mean PLOS}} (\text{Statewide Mean Actual LOS})$$

TABLE I

Logistic Regression Example

Calculations Used in Determining Readmissions for Any Reason for a Hospital
Medical Condition: Chronic Obstructive Pulmonary Disease

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

Actual Percent Readmitted for Any Reason: Total number of cases readmitted for any reason / total number of hospitalizations.

Expected Percent Readmitted for Any Reason: Mean of the predicted probability of readmission for any reason for each hospitalization.

Step 1: Calculate the predicted probability of readmission for any reason for each hospitalization (PReAny):

$$\beta X = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5$$

$$= -2.3082 + (0.1988)(x_1) + (0.1823)(x_2) + (0.2832)(x_3) + (0.4358)(x_4)$$

where:

x_1 = MQPredLOS
x_2 = Diabetes (1 if true, 0 if false)
x_3 = Malignant/In Situ Cancer (1 if true, 0 if false)
x_4 = Metastatic Cancer (1 if true, 0 if false)

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

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

where $e \approx 2.7182818285$

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

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

Risk-Adjusted Percent Readmitted for Any Reason:

$$\frac{\text{Mean Actual Percent Readmitted for Any Reason}}{\text{Mean PReAny}} \left(\text{Statewide Mean Actual Percent Readmitted for Any Reason} \right)$$

TABLE J

Case-Mix Adjustment Example

Calculations Used in Determining Average Charge for a Hospital

Region: Southwestern PA
Medical Condition: Kidney Failure - Acute

Total Cases:	Number of hospitalizations for a hospital after exclusions (equal to n).
Actual Charge:	Mean of the charges for each hospitalization.
Expected Charge:	Mean of the predicted charges for each hospitalization.

Step 1: Calculate each hospitalization's predicted charge (PChg):

The PChg for each record is equal to the average charge for all hospitalizations (after exclusion) in the hospital's same region, condition, and MS-DRG within the condition.

Region 1 - Southwestern PA, Kidney Failure - Acute, MS-DRG 682: $25,591
or
Region 1 - Southwestern PA, Kidney Failure - Acute, MS-DRG 683: $17,439
or
Region 1 - Southwestern PA, Kidney Failure - Acute, MS-DRG 684: $11,323

Step 2: Calculate the mean PChg for a hospital (expected charge):

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

Risk-Adjusted Charge: $\frac{\text{Mean Actual Chg}}{\text{Mean PChg}}$ (Region 1 Actual Charge)

GLOSSARY OF ABBREVIATED TERMS

FFY	Federal Fiscal Year
GAC	General Acute Care Hospital
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
IQR	Interquartile Range
KCF	Key Clinical Findings
MQPredDeath	*Atlas Outcomes*™ Predicted Probability of Death
MQPredLOS	*Atlas Outcomes*™ Predicted Length of Stay
MS-DRG	Medicare Severity - Diagnosis Related Group
NA	Not Applicable/Available
NR	Not Reported
PDx	Principal Diagnosis
Q	Quarter
SGAC	Specialty General Acute Care Hospital
UB-04	Uniform Billing Form