HOSPITAL PERFORMANCE REPORT
51 COMMON MEDICAL PROCEDURES AND TREATMENTS

Report Period: Federal Fiscal Year 2007
(October 1, 2006 through September 30, 2007)

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

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September 2008

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Technical Notes
FFY 2007 Hospital Performance Report

OVERVIEW

This document serves as a technical supplement to the *FFY 2007 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 51 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 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 (19 medical conditions and 12 surgical procedures). Each condition is defined by a particular set of ICD-9-CM codes and limited to certain DRGs. The Council's Web site reports utilization and outcome information for adult cases in the 31 code-based conditions and in 20 DRGs, for a total of 51 different procedure and treatment groups.

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 2007 Hospital Performance Report, obtained from the UB-92/04 (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 using the 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 (Q4-2006 through Q3-2007) 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 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 51 procedure and treatment groups included in the current *Hospital Performance Report* were comprised of both ICD-9-CM code-based conditions and DRGs. While 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 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 DRG 088. 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 DRGs

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 by these conditions and DRGs.

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 hospital discharges in FFY 2007. All records that met the definition criteria outlined in the "Procedure and Treatment Groups" section were included. During the study period there were 177 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 study populations. 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 procedure conditions. 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 code-based conditions and DRGs based on the appropriateness of the measure to the code-based condition or DRG. 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 code-based condition or DRG when less than 95% of the cases in that condition fell into a single MediQual Disease Group.[2]
- Mortality Ratings were not reported for code-based conditions or DRGs with low statewide mortality (i.e., less than 10 mortalities, after exclusions). Additionally, mortality ratings for code-based conditions or DRGs 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 code-based condition or DRG 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 code-based conditions and DRGs.

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 DRG; therefore, separate trim points were used for each individual DRG in a code-based condition. Since charges varied dramatically among regions for the same DRG, trim points were calculated at the regional level for each DRG. Nine different sets of upper and lower trim points were used for each individual 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 contribute more than one readmission to the numerator count (i.e., one for each of the multiple discharges that are 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 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 is limited to only those readmissions with a principal diagnosis or principal procedure that indicates a complication or infection. (See Table B of the Appendix for the ICD-9-CM codes that defined readmissions for complication or infection.)
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 and DRGs 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 summarized the overall risk/severity and calculated 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.

The *Atlas Outcomes*™ system is based on the examination of numerous Key Clinical Findings (KCFs) such as lab tests, EKG readings, vital signs, the patient's medical history, imaging results, pathology, age, sex, and operative/endoscopy findings. Hospital personnel abstract these KCFs during specified timeframes in the hospitalization. Some pre-admission data are also captured (e.g., cardiac catheterization findings) as are some history findings. The KCF results are entered into algorithms that calculate the overall predicted probability of death or the predicted length of stay. The FFY 2007 Hospital Performance Report utilizes *Atlas Outcomes*™ version 4.0 scoring algorithms.

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 code-based conditions and DRGs. Each code-based condition and DRG was modeled separately, and only the code-based conditions and DRGs that received that analysis were included

(e.g., only conditions 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 code-based condition or DRG if they met the $p < 0.10$ significance criteria.

To determine the first risk factor, individual models were run for each code-based condition and DRG 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 code-based condition and DRG 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 code-based condition and DRG 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	MQPredLOS
2nd	Age/Age^2	Age/Age^2	Cancer Type*	Age/Age^2
3rd	Female	Poverty Rate	Age/Age^2	Cancer Type*

*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

Calculation of Expected Values

Once the three risk factors were identified for each measure, separate models were run for each code-based condition and DRG 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 code-based condition or DRG. 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 code-based condition or DRG 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 DRG. For the code-based conditions that included more than one DRG in their definition, case-mix adjustment was used to calculate a composite average charge for the combined 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 DRGs. See Appendix Table J for an example of a case-mix adjustment calculation.

For example, Heart Attack – Medical Management was comprised of a subset of cases in DRGs 121, 122, and 123. The charges associated with DRGs 121, 122, and 123 were adjusted according to the number of patients and the average charge associated with treating patients in each of these three 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 condition/DRG 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/DRG.

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

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 and code-based condition or DRG 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 code-based condition or DRG, 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 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 particular clinical condition in that particular hospital 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 clinical condition.

    - 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 clinical condition.

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/DRGs 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 condition or DRG.

"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, if the errors could have potentially biased other hospitals' outcomes (average charge). All records from these hospitals were removed from the statewide dataset used for the average charge analysis.

APPENDIX

TABLE A

The 31 Code-Based Conditions/Procedures and 20 DRGs in the *FFY 2007 Hospital Performance Report*

The following table outlines the code-based conditions and procedures (the ICD-9-CM codes and DRGs used to define each medical condition or surgical procedure) and the DRGs included in this report (inpatient discharges from October 1, 2006 through September 30, 2007). These codes and DRGs are applicable to CMS Grouper Version 24. Additional exclusions (clinically complex cases) are identified as footnotes.

The 19 code-based medical conditions are:

*Medical Condition**	*Principal Diagnosis Codes (ICD-9-CM)*	*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	117, 118, 124, 125, 138, 139, 518, 552, 556, 558
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	128,130,131
Blood Clot in Lung	415.11, 415.19	078
Chronic Obstructive Pulmonary Disease	491.20, 491.21, 491.22, 492.0, 492.8, 496, 506.4	088
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	124, 127
Diabetes with Amputation	250.xy (x = 0-9, y = 0-3)	113, 114, 285
Diabetes – Medical Management	250.xy (x = 0-9, y = 0-3)	018, 019, 130, 131, 294, 295, 331, 332
Heart Attack – Medical Management	410.01, 410.11, 410.21, 410.31, 410.41, 410.51, 410.61, 410.71, 410.81, 410.91	121,122,123
Intestinal Obstruction	560.0, 560.2, 560.30, 560.31, 560.39, 560.81, 560.89, 560.9	180, 181
Kidney Failure – Acute	584.5, 584.6, 584.7, 584.8, 584.9	316
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	320, 321
Pneumonia – Aspiration	507.0	079, 080
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	079, 080, 089, 090
Respiratory Failure with Mechanical Ventilation	506.1, 518.5, 518.81, 518.83, 518.84	565, 566
Respiratory Failure without Mechanical Ventilation	506.1, 518.5, 518.81, 518.83, 518.84	087
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, 995.93, 995.94	575, 576
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	174, 175, 571
Stroke – Hemorrhagic	430, 431, 432.0, 432.1, 432.9	014
Stroke – Non-Hemorrhagic	433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, 436	014, 015, 559

*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 12 code-based surgical procedures are:

Surgical Procedures[1]	*Principal Procedure Codes (ICD-9-CM)*	*DRGs*
Abdominal Aortic Aneurysm Repair - Endovascular	39.71 With principal diagnosis (PDx) of 441.4	110, 111
Abdominal Aortic Aneurysm Repair - Open	38.44, 38.64, 38.84 With PDx of 441.4	110, 111
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	146, 147, 149, 569, 570
Gallbladder Removal - Laparoscopic	51.23, 51.24	195, 196, 493, 494
Gallbladder Removal - Open	51.21, 51.22	195, 196, 197, 198
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	555, 557
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	210, 211, 544
Hysterectomy - Abdominal	68.31, 68.39, 68.41, 68.49, 68.61, 68.69, 68.9	353, 354, 355, 357, 358, 359
Hysterectomy - Vaginal	68.51, 68.59, 68.71, 68.79	353, 354, 355, 357, 358, 359
Prostatectomy - Radical	60.3, 60.4, 60.5, 60.62, 60.69	306, 307, 334, 335
Prostatectomy - Transurethral	60.21, 60.29	306, 307, 334, 335, 336, 337
Removal of Blockage of Neck Vessels	38.12	533, 534

The 20 DRGs reported are:

DRG	*Common Names*
001	Brain Surgery, complicated
075	Major Lung Operations
076	Miscellaneous Lung Procedures, complicated
096	Bronchitis and Asthma, complicated
097	Bronchitis and Asthma, uncomplicated
141	Hypotension and Fainting, complicated
143	Chest Pain
182	Stomach and Intestinal Infections and Disorders, complicated
183	Stomach and Intestinal Infections and Disorders, uncomplicated
188	Stomach and Intestinal Complications and Disorders
202	Cirrhosis and Alcoholic Hepatitis
203	Liver, Gallbladder or Pancreatic Cancer
204	Noncancerous Pancreatic Disorders
205	Liver Disease Except Cancer, Cirrhosis, Alcoholic Hepatitis, complicated
243	Medical Back Problems
418	Infection after Surgery or Trauma
553	Vascular Operations Excluding Heart, complicated, with Major Cardiovascular Condition
554	Vascular Operations Excluding Heart, complicated, without Major Cardiovascular Condition
567/568	Stomach and Small Intestinal Operations, complicated
578/579	Surgery for Infectious or Parasitic Disease

[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 B

ICD-9-CM Codes Used to Define Readmissions for Complications or Infections

Readmissions with one of the following ICD-9-CM codes listed as the principal diagnosis or principal procedure were included in this measure. These codes are applicable to CMS Grouper Versions 24 and 25.

ICD-9-CM Codes
Diagnosis/Procedure

Procedure/Medical Care Related Events

54.61 (procedure)	998.7	
909.3	998.83	
995.4	998.89	
995.86	998.9	
995.89	999.2	
997.5	999.4	
998.0	999.5	
998.2	999.6	
998.31	999.7	
998.32	999.8	
998.4	999.9	
998.6		

Digestive System Complications

560.81	564.4	
564.2	997.4	
564.3		

Pulmonary Compromise

31.1 (procedure)	518.5	
31.21 (procedure)	518.81	
31.29 (procedure)	518.82	
512.1	518.84	
514	997.3	
518.4	998.81	

Hemorrhage

39.41 (procedure)	998.11	
39.98 (procedure)	998.12	
57.93 (procedure)	998.13	

Infection

038.0	567.1	996.60
038.10	567.21	996.61
038.11	567.22	996.62
038.19	567.29	996.64
038.2	567.31	996.65
038.3	567.38	996.66
038.40	567.39	996.67
038.41	567.81	996.69
038.42	567.89	998.51
038.43	567.9	998.59
038.44	569.61	999.3†
038.49	995.90	999.31‡
038.8	995.91	999.39‡
038.9	995.92	
530.86	995.93	
536.41	995.94	

Pneumonia (coded by causative organism)

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

ICD-9-CM Codes
Diagnosis/Procedure

Cardiac Complications

410.01	410.61
410.11	410.71
410.21	410.81
410.31	410.91
410.41	997.1
410.51	

Venous Thrombosis/Pulmonary Embolism

415.11	451.19	453.42
415.12‡	451.81	453.8
415.19	453.40	997.2
451.11	453.41	999.1

Hypo/Hypertension

458.21	997.91
458.29	

Stroke/Anoxic Brain Damage

348.1	433.81
430	433.91
431	434.01
432.0	434.11
432.1	434.91
432.9	436
433.01	997.00
433.11	997.01
433.21	997.02
433.31	997.09

Device, Implant or Graft Complications

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

Gastric/Intestinal Hemorrhage or Ulceration

49.95 (procedure)	533.01
531.00	533.10
531.01	533.11
531.10	533.20
531.11	533.21
531.20	533.40
531.21	533.41
531.40	533.60
531.41	533.61
531.60	534.00
531.61	534.01
532.00	534.10
532.01	534.11
532.10	534.20
532.11	534.21
532.20	534.40
532.21	534.41
532.40	534.60
532.41	534.61
532.60	537.84
532.61	578.9
533.00	

† No longer effective as of 10/1/2007. ‡ Effective beginning 10/1/2007.

TABLE C1

Statewide Utilization and Outcome Data for Code-Based Conditions

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	39,330	0.8	3.3	14.4	2.3	$27,634
Blood Clot in Extremities	7,324	0.8	4.3	NR	NR	$16,725
Blood Clot in Lung	6,987	1.8	5.4	NR	NR	$28,207
Chronic Obstructive Pulmonary Disease	27,715	1.0	4.5	23.6	5.8	$21,410
Congestive Heart Failure	51,898	2.8	5.0	26.9	4.8	$25,808
Diabetes with Amputation	2,138	1.7	9.8	21.6	5.7	$62,963
Diabetes - Medical Management	17,166	0.6	3.8	21.1	3.0	$20,477
Heart Attack - Medical Management	12,570	11.0	5.4	NR	NR	$32,314
Intestinal Obstruction	8,715	1.9	4.3	NR	NR	$20,164
Kidney Failure – Acute	19,577	5.4	5.8	24.1	5.9	$28,199
Kidney and Urinary Tract Infections	22,659	1.0	4.2	17.5	4.1	$19,934
Pneumonia - Aspiration	9,216	9.8	6.8	24.5	8.2	$31,924
Pneumonia - Infectious	41,543	2.6	5.0	17.4	6.0	$23,630
Respiratory Failure with Mechanical Ventilation	6,153	29.3	9.7	27.5	12.6	$76,003
Respiratory Failure without Mechanical Ventilation	8,607	11.7	6.3	27.3	13.9	$28,904
Septicemia	23,630	18.1	7.3	NR	NR	$40,710
Stomach and Intestinal Bleeding	20,411	2.0	4.3	16.6	5.0	$23,802
Stroke - Hemorrhagic	3,652	28.1	6.0	18.7	8.5	$41,250
Stroke - Non-Hemorrhagic	19,450	5.0	4.9	15.1	5.8	$30,595

Surgical Procedures

Abdominal Aortic Aneurysm Repair-Endovascular	1,567	0.7	3.0	12.4	4.6	$89,282
Abdominal Aortic Aneurysm Repair-Open	548	1.8	7.6	11.6	3.3	$80,857
Colorectal Procedures	14,676	3.3	8.7	NR	NR	$63,084
Gallbladder Removal - Laparoscopic	13,962	0.2	3.6	7.3	2.2	$30,823
Gallbladder Removal - Open	2,470	1.7	6.7	10.8	4.5	$50,753
Heart Attack - Angioplasty/Stent	12,240	1.4	3.8	NR	NR	$67,429
Hip Fracture - Surgical Repair	13,231	1.9	5.9	15.1	6.5	$40,507
Hysterectomy - Abdominal	15,703	0.1	2.7	NR	NR	$24,200
Hysterectomy - Vaginal	6,824	NR	1.6	3.3	2.0	$18,071
Prostatectomy - Radical	3,830	NR	2.5	NR	NR	$38,684
Prostatectomy - Transurethral	3,776	NR	2.6	NR	NR	$17,918
Removal of Blockage of Neck Vessels	5,206	0.3	2.4	8.4	2.5	$27,882

[1]Number of cases after mortality exclusions (or LOS exclusions for conditions 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 DRGs

DRG	Description	# of Cases[1]	% Mortality[2]	Length of Stay[2]	Readmissions: % Any Reason[2]	Readmissions: % Comp/ Infec[2]	Average Charge[2]
001	Brain Surgery, complicated	3,545	6.2	7.8	NR	NR	$112,171
075	Major Lung Operations	5,979	3.2	7.5	NR	NR	$71,315
076	Miscellaneous Lung Procedures, complicated	4,818	6.0	8.8	NR	NR	$64,499
096	Bronchitis and Asthma, complicated	6,963	NR	3.8	15.0	3.3	$19,401
097	Bronchitis and Asthma, uncomplicated	5,789	NR	2.7	8.9	1.0	$15,065
141	Hypotension and Fainting, complicated	13,471	0.3	3.1	14.2	2.4	$19,952
143	Chest Pain	38,347	<0.1	1.7	10.7	1.4	$16,949
182	Stomach and Intestinal Infections and Disorders, complicated	30,758	0.4	3.6	NR	NR	$19,395
183	Stomach and Intestinal Infections and Disorders, uncomplicated	17,132	NR	2.6	NR	NR	$16,130
188	Stomach and Intestinal Complications and Disorders	8,849	2.9	4.6	NR	NR	$24,146
202	Cirrhosis and Alcoholic Hepatitis	4,365	7.3	5.6	34.2	3.4	$36,184
203	Liver, Gallbladder or Pancreatic Cancer	3,497	10.7	5.6	NR	NR	$37,876
204	Noncancerous Pancreatic Disorders	9,569	1.0	4.7	20.3	2.1	$23,287
205	Liver Disease Except Cancer, Cirrhosis, Alcoholic Hepatitis, complicated	4,055	6.0	5.2	33.5	4.2	$34,483
243	Medical Back Problems	12,213	0.6	3.9	16.9	2.6	$19,646
418	Infection after Surgery or Trauma	4,551	0.5	4.8	NR	NR	$24,828
553	Vascular Operations Excluding Heart, complicated, with Major Cardiovascular Condition	3,539	5.9	8.5	NR	NR	$82,887
554	Vascular Operations Excluding Heart, complicated, with Major Cardiovascular Condition	6,288	0.7	4.9	NR	NR	$54,090
567, 568	Stomach and Small Intestinal Operations, complicated	3,132	6.4	10.6	NR	NR	$103,432
578, 579	Surgery for Infectious or Parasitic Disease	6,803	9.5	11.2	24.0	11.7	$81,375

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

TABLE D1

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

Code-Based Condition	# of Cases Meeting Readmissions Criteria	Total # of Cases Readmitted for Complication or Infection	% of Cases Readmitted for Complication or Infection	*Reason for Readmission*											
				Procedure/Medical Care Related Events	Digestive System Complications	Pulmonary Compromise	Hemorrhage	Infection	Pneumonia	Cardiac Complications	Venous Thrombosis/ Pulmonary Embolism	Hypo/Hypertension	Stroke/Anoxic Brain Damage	Device, Implant or Graft Complications	Gastric/Intestinal Hemorrhage or Ulceration
Medical Conditions															
Abnormal Heartbeat	36,321	846	2.3	6	8	93	25	177	151	75	75	12	106	61	58
Chronic Obstructive Pulmonary Disease	26,265	1,516	5.8	1	8	506	4	157	555	87	67	4	49	18	67
Congestive Heart Failure	47,548	2,268	4.8	11	8	509	15	448	426	328	108	28	195	57	140
Diabetes with Amputation	1,997	113	5.7	8	0	8	2	60	7	11	7	0	4	3	4
Diabetes - Medical Management	16,167	478	3.0	4	5	57	7	148	70	56	31	6	57	11	26
Kidney Failure – Acute	17,142	1,019	5.9	11	6	135	9	368	119	94	93	15	55	32	85
Kidney and Urinary Tract Infections	21,304	872	4.1	19	10	71	10	342	156	48	67	8	66	36	44
Pneumonia - Aspiration	7,470	612	8.2	1	5	144	1	207	127	24	30	1	28	29	20
Pneumonia - Infectious	38,369	2,307	6.0	4	14	352	9	361	1,103	119	147	7	73	31	91
Respiratory Failure with Mechanical Ventilation	3,862	486	12.6	1	0	267	3	90	67	24	18	1	8	4	7
Respiratory Failure without Mechanical Ventilation	6,943	962	13.9	3	1	635	0	114	138	24	22	1	9	7	17
Stomach and Intestinal Bleeding	18,944	954	5.0	7	18	55	20	173	115	72	67	4	51	24	351
Stroke - Hemorrhagic	2,082	177	8.5	0	0	15	1	22	8	3	31	1	97	0	1
Stroke - Non-Hemorrhagic	16,912	985	5.8	8	0	56	3	160	70	63	61	4	504	18	42
Surgical Procedures															
Abdominal Aortic Aneurysm Repair-Endovascular	1,363	63	4.6	5	1	0	4	25	6	3	4	0	1	10	4
Abdominal Aortic Aneurysm Repair-Open	491	16	3.3	3	0	0	1	9	1	0	0	0	1	0	1
Gallbladder Removal - Laparoscopic	13,169	293	2.2	18	90	12	25	66	24	12	21	1	13	3	9
Gallbladder Removal - Open	2,281	103	4.5	5	20	8	3	51	2	4	4	1	0	2	3
Hip Fracture - Surgical Repair	12,342	800	6.5	14	17	58	34	223	105	67	77	1	33	120	51
Hysterectomy - Vaginal	6,520	132	2.0	15	11	0	32	58	1	3	9	0	1	1	1
Removal of Blockage of Neck Vessels	4,867	120	2.5	4	2	4	14	13	12	18	8	0	40	2	4

Note: For some code-based conditions, the sum of the readmissions for complication or infection may have been higher than the total because some records could have had both a principal diagnosis and a principal procedure that met the criteria for being captured in this analysis. If this occurred, the record was displayed in each readmission category above; however, the record was counted only once in determining the percent of readmissions for complication or infection.

TABLE D2

Statewide Cases Readmitted for Complication or Infection, by Reason for Readmission DRGs

DRG		# of Cases Meeting Readmissions Criteria	Total # of Cases Readmitted for Complication or Infection	% of Cases Readmitted for Complication or Infection	*Reason for Readmission*											
					Procedure/Medical Care Related Events	Digestive System Complications	Pulmonary Compromise	Hemorrhage	Infection	Pneumonia	Cardiac Complications	Venous Thrombosis/ Pulmonary Embolism	Hypo/Hypertension	Stroke/Anoxic Brain Damage	Device, Implant or Graft Complications	Gastric/Intestinal Hemorrhage or Ulceration
096	Bronchitis and Asthma, complicated	6,737	220	3.3	1	1	40	1	35	85	14	26	1	10	2	6
097	Bronchitis and Asthma, uncomplicated	5,602	56	1.0	1	0	12	0	3	27	1	5	1	5	1	0
141	Hypotension and Fainting, complicated	12,717	301	2.4	4	4	31	4	66	47	32	36	10	37	12	18
143	Chest Pain	36,326	497	1.4	6	5	37	7	87	100	104	48	3	43	29	28
202	Cirrhosis and Alcoholic Hepatitis	3,627	123	3.4	4	1	13	2	53	10	6	3	0	6	6	19
204	Noncancerous Pancreatic Disorders	8,956	189	2.1	6	22	9	3	60	26	12	19	2	8	9	13
205	Liver Disease Except Cancer, Cirrhosis and Alcoholic Hepatitis, complicated	3,335	139	4.2	2	8	11	2	73	18	2	5	0	3	6	10
243	Medical Back Problems	11,434	302	2.6	0	2	21	4	77	58	29	45	1	31	21	14
578, 579	Surgery for Infectious or Parasitic Disease	5,574	654	11.7	54	12	26	15	425	30	5	31	1	11	35	15

Note: For some DRGs, the sum of the readmissions for complication or infection may have been higher than the total because some records could have had both a principal diagnosis *and* a principal procedure that met the criteria for being captured in this analysis. If this occurred, the record was displayed in each readmission category above; however, the record was counted only once in determining the percent of readmissions for complication or infection.

TABLE E1

Statewide Exclusions from Analyses, by Measure
Code-Based Conditions

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	454,322	100.0	468,989	100.0	402,693	100.0	351,379	100.0	468,989	100.0	16,307	100.0
Exclusions:												
Records with errors	0	0.0	0	0.0	0	0.0	0	0.0	4	<0.1	0	0.0
Duplicate records	212	<0.1	216	<0.1	184	<0.1	171	<0.1	216	<0.1	6	<0.1
Discharge date not in time period	15	<0.1	17	<0.1	13	<0.1	11	<0.1	17	<0.1	1	<0.1
Missing or invalid discharge status	34	<0.1	34	<0.1	29	<0.1	26	<0.1	34	<0.1	1	<0.1
Non-adult (< 18) or invalid age	3,035	0.7	3,035	0.6	2,610	0.6	2,538	0.7	3,035	0.6	4	<0.1
Patients with HIV Infection[1]	519	0.1	522	0.1	492	0.1	446	0.1	522	0.1	9	0.1
Patients with abdominal trauma[2]	53	<0.1	53	<0.1	NA	NA	NA	NA	53	<0.1	NA	NA
Patients who left against medical advice	3,197	0.7	3,200	0.7	3,152	0.8	2,673	0.8	3,200	0.7	145	0.9
Patients transferred to GAC facilities	13,932	3.1	13,947	3.0	13,369	3.3	8,414	2.4	13,947	3.0	NA	NA
Patients who died	NA	NA	18,129	3.9	17,237	4.3	11,291	3.2	NA	NA	1,413	8.7
Missing Atlas Outcomes™ data[3]	4,981	1.1	4,601	1.0	3,973	1.0	3,423	1.0	NA	NA	NA	NA
Invalid length of stay	NA	NA	3	<0.1	2	<0.1	2	<0.1	NA	NA	NA	NA
Length of stay outliers	NA	NA	3,790	0.8	NA	NA	2,867	0.8	NA	NA	NA	NA
Non-Pennsylvania residents	NA	NA	NA	NA	NA	NA	9,564	2.7	NA	NA	NA	NA
Patients discharged to hospice	NA	NA	NA	NA	NA	NA	4,901	1.4	NA	NA	NA	NA
Missing or inconsistent patient identifiers[4]	NA	NA	NA	NA	NA	NA	1,894	0.5	NA	NA	NA	NA
Admit, discharge, readmission date discrepancies	NA	NA	NA	NA	NA	NA	500	0.1	NA	NA	NA	NA
Invalid charges	NA	NA	NA	NA	NA	NA	NA	NA	231	<0.1	NA	NA
Charge outliers	NA	NA	NA	NA	NA	NA	NA	NA	9,810	2.1	NA	NA
No reference data	NA	NA	NA	NA	NA	NA	NA	NA	1,130	0.2	NA	NA
Intermediary Hospitalization	NA	NA	NA	NA	NA	NA	299	0.1	NA	NA	NA	NA
Total Exclusions	25,978	5.7	47,547	10.1	41,061	10.2	49,020	14.0	32,199	6.9	1,579	9.7
Total Cases in Analysis	428,344	94.3	421,442	89.9	361,632	89.8	302,359	86.0	436,790	93.1	14,728	90.3

[1]This exclusion is only applicable to the code-based conditions.
[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 (see the "PHC4 Model Selection" section for details).
[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
DRGs

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	174,869	100.0	206,094	100.0	75,990	100.0	109,419	100.0	206,094	100.0
Exclusions:										
Records with errors	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Duplicate records	159	0.1	182	0.1	84	0.1	109	0.1	182	0.1
Discharge date not in time period	8	<0.1	8	<0.1	2	<0.1	4	<0.1	8	<0.1
Missing or invalid discharge status	4	<0.1	5	<0.1	1	<0.1	1	<0.1	5	<0.1
Non-adult (< 18) or invalid age	1,527	0.9	1,527	0.7	558	0.7	889	0.8	1,527	0.7
Patients who left against medical advice	2,897	1.7	3,475	1.7	2,079	2.7	2,518	2.3	3,475	1.7
Patients transferred to GAC facilities	4,371	2.5	4,544	2.2	2,054	2.7	2,924	2.7	4,544	2.2
Patients who died	NA	NA	3,477	1.7	508	0.7	1,476	1.3	NA	NA
Missing Atlas Outcomes™ data[1]	2,124	1.2	2,363	1.1	885	1.2	1,256	1.1	NA	NA
Invalid length of stay	NA	NA	1	<0.1	1	<0.1	1	<0.1	NA	NA
Length of stay outliers	NA	NA	1,624	0.8	NA	NA	842	0.8	NA	NA
Non-Pennsylvania residents	NA	NA	NA	NA	NA	NA	3,343	3.1	NA	NA
Patients discharged to hospice	NA	NA	NA	NA	NA	NA	472	0.4	NA	NA
Missing or inconsistent patient identifiers[2]	NA	NA	NA	NA	NA	NA	1,053	1.0	NA	NA
Admit, discharge, readmission date discrepancies	NA	NA	NA	NA	NA	NA	174	0.2	NA	NA
Invalid charges	NA	NA	NA	NA	NA	NA	NA	NA	138	0.1
Charge outliers	NA	NA	NA	NA	NA	NA	NA	NA	4,147	2.0
No reference data	NA	NA	NA	NA	NA	NA	NA	NA	0	0.0
Intermediary Hospitalization	NA	NA	NA	NA	NA	NA	49	<0.1	NA	NA
Total Exclusions	11,090	6.3	17,206	8.3	6,172	8.1	15,111	13.8	14,026	6.8
Total Cases in Analysis	163,779	93.7	188,888	91.7	69,818	91.9	94,308	86.2	192,068	93.2

[1]Either Missing MQPredDeath or MQPredLOS, depending on which one is used as a risk adjustor (see the "PHC4 Model Selection" section for details).
[2]Social Security Number, Date of Birth, Sex
NA: Not Applicable

TABLE F

Hospitals Not Reported in the *Hospital Performance Report – FFY 2007*

The study population for the *Hospital Performance Report – FFY 2007* included useable discharge records from all GAC/SGAC Pennsylvania facilities abstracting clinical data (Atlas) in the reported time period. During the study period there were 177 facilities in Pennsylvania.

Hospital Name	Reason for Not Reporting
Facilities currently in operation that submitted incomplete data[1]:	
Central and Northeastern Pennsylvania	
Montrose General	*Missing one quarter (Q3, 2007) of UB data*
Wayne Memorial	*Missing severity = 11.4%*
Southeastern Pennsylvania	
Lower Bucks	*Missing severity = 10.8%*
Western Pennsylvania	
Brookville	*Missing severity = 31.7%*
Facilities for which average charge will not be reported[2]:	
Southeastern Pennsylvania	
Bucktail	*Records with data errors*
Facilities that closed:	
Southeastern Pennsylvania	
Graduate	*Closed facility – effective 03/31/07*
Temple University Children's	*Closed facility – effective 12/01/07*
Warminster	*Closed facility – effective 10/01/07*
Other facilities not reported:	
Southeastern Pennsylvania	
Children's Hospital Philadelphia	*Children's hospital[3]*
Coordinated Health Orthopedic	*New facility – UB and Atlas data submission began 10/01/07 – not enough data for analysis*
DSI of Bucks County	*New facility – UB and Atlas data submission began 01/01/08 – not enough data for analysis*
St. Christopher's Children's	*Children's hospital[3]*
Surgical Institute of Reading	*New facility – UB and Atlas data submission began 01/01/08 – not enough data for analysis*
Westfield	*New facility – UB and Atlas data submission began 04/01/08 – 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, effective 10/01/06) 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 – FFY 2007* 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 another short-term general hospital for inpatient care
03	Discharged/transferred to a skilled nursing facility (SNF) with Medicare certification
04	Discharged/transferred to an intermediate care facility (ICF)
05	Discharged/transferred to another type of institution not defined elsewhere in this code list
06	Discharged/transferred to home under care of organized Home Health Service Organization in anticipation of covered skilled care
07	Left against medical advice (AMA) or discontinued care
20	Expired
43	Discharged/Transferred to a Federal health care facility
50	Discharged to Hospice—home
51	Discharged to Hospice—medical facility
61	Discharged/transferred to hospital-based Medicare approved swing bed
62	Discharged/transferred to an inpatient rehabilitation facility 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

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):

$$PLOS = \beta X$$

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

$$= -0.9827 + (0.4675)(x_1) + (0.0662)(x_2) + (-0.3364)(x_3) + (1.2994)(x_4)$$

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):

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

$$= -2.7124 + (0.2351)(x_1) + (0.2761)(x_2) + (0.4285)(x_3) + (0.0145)(x_4) + (-0.1366)(x_5)$$

where:

x_1 = MQPredLOS
x_2 = Malignant/In Situ Cancer (1 if true, 0 if false)
x_3 = Metastatic Cancer (1 if true, 0 if false)
x_4 = Age
x_5 = Age-squared/1000

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
Surgical Procedure*:* Diabetes with Amputation

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 DRG within the condition. Region 1 - Southwestern PA, Diabetes with Amputation, DRG 113:$40,717 or Region 1 - Southwestern PA, Diabetes with Amputation, DRG 114:$24,690 or Region 1 - Southwestern PA, Diabetes with Amputation, DRG 285:$26,952 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

DRG	Diagnosis Related Group
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
NA	Not Applicable/Available
NR	Not Reported
PDx	Principal Diagnosis
Q	Quarter
SGAC	Specialty General Acute Care Hospital
UB-92/04	Uniform Billing Form