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# Surgical Mortality as a Measure of Hospital Quality


**3M Clinical and Economic Research**

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## Executive Summary

While there is increasing consensus that comparative mortality data should be included in hospital payment incentive systems, attempts to develop clinically credible and unbiased measure of mortality have proved challenging. The primary intent of mortality measurement is to provide hospitals the incentive and the information to improve mortality performance through quality improvement initiatives. To be effective for quality improvement, the measure of mortality should be limited to patients for whom a hospital is reasonably responsible for the patient outcome and thereby amenable to quality improvement efforts.

A comprehensive method of measuring and comparing surgical mortality was developed for this report. This measure was based on a 30-day post-procedure time period and included extensive exclusions for patients for whom a hospital was not considered reasonably responsible for the patient outcome, such as patients who left against medical advice, were transferred in, were in critical condition at the time of admission or had a clinically unrelated readmission during the 30-day post-procedure period. However, hospitals were considered responsible for mortality during any clinically related readmissions in the 30-day post-procedure period. Using a categorical model for risk adjustment, a national 30-day post-procedure norm was created by computing the 30-day post-procedure mortality rate for each risk class. To avoid having post-surgery complications impact the assignment of risk classes, the patient's condition at admission was used to assign the risk classes.

Using Medicare data from FY 2018, 1,972,743 hospital surgical admissions with a 30-day post-procedure mortality rate of 2.41 percent were analyzed.

- 14.0 percent of surgical admissions were excluded because the hospital was not considered reasonably responsible for the patient outcome
- Of the total number of 30-day post-procedure deaths:
  - 39.5 percent occured during the during the in-hospital surgical admission
  - 49.9 percent occured in the community
  - 10.6 percent occured during a clinically related readmission
- Patients who died during a clinically related readmission on average were readmitted in 7.2 days
- 11.1 percent of admissions would be assigned to a higher risk class if the condition of the patient at the time of discharge had been used to assign the risk class

Extensive variation in 30-day post-procedure mortality performance across geographic regions was found, ranging from 37.2 percent below expected for Hawaii to 36.2 percent above expected for Mississippi. In general, the southern states tended to have above expected 30-day post-procedure mortality. Extensive variation in 30-day post-procedure mortality performance was also found by type of hospital with major teaching hospitals, high disproportionate share hospitals, large urban hospitals and the largest size hospitals having 30-day post-procedure mortality of 21.2, 5.9, 5.6, and 10.7 percent below expected, respectively. When hospitals were divided into deciles based on surgical volume, 30-day post-procedure mortality performance steadily improved with increasing volume, ranging from 11.0 percent above expected to 12.0 percent below expected for the top volume decile. This result suggests surgical volume is directly related to 30-day surgical mortality performance.

Comparing mortality performance based on in-hospital mortality to mortality performance based on 30-day post-procedure mortality produces dramatically different results by type of hospital. A national in-hospital mortality norm was created by computing the in-hospital mortality rate for each risk class. Compared to 30-day post-procedure mortality, in-hospital mortality performance for major teaching hospitals and large urban hospitals dropped from 21.2 to 2.6 percent and from 5.6 to 3.9 percent below expected, respectively. Compared to 30-day post-procedure mortality, in-hospital mortality performance for high disproportionate share and the largest size hospitals changed from 5.9 percent below expected to 4.4 above expected and from 10.7 percent below expected to 0.5 percent above expected, respectively. Thus, in-hospital mortality results in a bias against major teaching hospitals, high disproportionate share hospitals, large urban hospitals, and the largest size hospitals.

> Any use of in-hospital mortality as an alternative to 30-day post-procedure mortality would create a bias against major teaching hospitals, high disproportionate share hospitals, large urban hospitals and the largest size hospitals.

If the intent of mortality measurement is to provide hospitals the incentive and the information needed to improve mortality performance, it is essential that any effective measure of mortality be clinically credible and unbiased. The mortality measure developed in this report focused on surgical mortality, excludes patients for whom a hospital is not reasonably responsible for the patient outcome, uses the condition of the patient at admission for risk adjustment and includes death during the 30-day post-procedure period. Significant variation in 30-day post-procedure performance was found across geographic areas and types of hospitals.

The measure of hospital 30-day post-procedure surgical mortality identifies patients who are amenable to quality improvement efforts and makes it possible to credibly include surgical mortality in pay for performance systems and public reporting systems.

## Background

Mortality is increasingly used as a component in hospital payment incentive systems based on quality of care. The Medicare Payment Advisory Commission (MedPAC) has advocated the consolidation of hospital pay-for-performance programs with a greater emphasis on hospital mortality rates.[1] The Government Accounting Office (GAO) concurs with MedPAC and recommends an expanded use of mortality as a measure of inpatient quality.[2]

There are a wide variety of mortality models in use. CMS publishes annual hospital mortality rates through the Hospital Compare Website[3]. These mortality rates are a key component of a hospital's total performance score in the Medicare value-based purchasing (VBP) initiative intended to reward high quality care. The CMS regression-based mortality risk model looks back a year for patient level risk factors and is based upon a standard 30-day post-procedure or post-discharge window. The Agency for Healthcare Research and Quality (AHRQ) calculates mortality rates as part of their series of inpatient quality indicators[4]

In addition to government agencies, private entities are also disseminating comparative mortality data. The American College of Surgeons provides a Surgical Risk Calculator as part of its national surgical quality improvement program[5] *US News & World Report* incorporates mortality ratios as part of their "Best Hospitals" ranking algorithm.[6] Healthgrades publishes an annual ranking of hospitals using a regression-based risk adjustment model with varying risk factors for defined cohorts of surgical and medical admissions for in-hospital and hospital 30-day mortality.[7] Vizient produces a widely used mortality index for its member hospitals to report comparative mortality results to third parties. Although there are few details in the published literature describing the Vizient model, it appears to be a regression-based risk adjustment model for in-hospital mortality.[8]

Despite the myriad of comparative mortality measures, health policy researchers generally agree that existing quality pay for performance systems fail to adequately recognize the importance of mortality as a measure of inpatient quality[9] and that existing mortality measures may be both limited and misleading.[10] The lack of a standard approach to measuring mortality performance and the questionable validity of existing approaches has resulted in limited use of mortality in most quality-based payment incentive systems.

## Focusing on Surgical Mortality

The underlying objective for the use of mortality in hospital quality-based payment incentive systems is to provide a financial incentive for hospitals to improve mortality performance. The ultimate measure of success of any incentive-based system is whether providers responded to the incentives and improved performance. To be effective in health care, the incentive must be clinically credible. While this attribute seems obvious, it has often not been achieved. At a minimum, clinical credibility requires that performance evaluation be limited to patients for whom the hospital is reasonably responsible for the outcome and is therefore amenable to quality improvement efforts by the hospital. Essentially, this means that clinical outliers for which hospital responsibility is questionable should not be included in the mortality performance evaluation of a hospital. Inclusion of a patient in the assessment of the hospital's mortality performance means that the hospital is judged to be responsible for the outcome of that patient. Typically, the quality improvement process involves pulling patient charts to understand the reasons that led to the patient outcome. If that process yields patients for whom the hospital has no reasonable way to influence the outcome, clinical credibility is lost, and the quality improvement process breaks down.

There are many factors that can impact mortality rates including availability of hospice care, hospital policies and community attitudes regarding do-not-resuscitate orders, the availability of skilled nursing facility beds and admitting and discharging practices related to end-of-life care, especially admissions for palliative care. These discharge issues present serious challenges for the determination and comparison of hospital mortality rates because they are highly variable across geographic regions, represent factors that are not necessarily under the control of the hospital and do not directly relate to the clinical care provided by the hospital.

Discharge issues present serious challenges for the determination and comparison of hospital mortality rates because they are highly variable across geographic regions, represent factors that are not necessarily under the control of the hospital and do not directly relate to the clinical care provided by the hospital.

These factors are most significant for patients treated medically who may be admitted to the hospital for end-of-life care when no further medical interventions may be warranted. In contrast, except for critically ill patients admitted with serious illness or injury, a patient undergoing a surgical procedure will be expected in all likelihood to survive the procedure. However, a surgical mortality rate that only includes patients who died during the hospitalization in which the surgical procedure was performed is impacted by the same discharge timing issues that impact medical patients. As a result, in-hospital surgical mortality rates can be misleading and not comparable across hospitals. Studies that compared in-hospital and 30-day mortality measures have shown differences in hospital relative performance[11, 12, 13, 14] and national quality measurement guidelines have advocated the use of a standardized time period for evaluating outcomes such as mortality.[15] Because of these discharge issues and the observed bias of in-hospital mortality measures, this study focused on hospital 30-day post-procedure surgical mortality.

Evaluating hospital 30-day post-procedure mortality requires that events that occur post discharge be evaluated to determine if they are related to the surgical procedure. For example, if a surgical patient dies during a readmission for sepsis from a post-operative wound infection, that death should be attributed to the hospital that performed the original surgery and not the hospital that treated the patient for the post-op wound infection. Conversely, if a patient who had orthopedic surgery is readmitted for appendicitis and dies during the readmission, that death should not be attributed to the hospital that performed the original orthopedic surgery. Surgical patients with significant post-procedure events like a readmission should be excluded as a clinical outlier if the readmission is unrelated to the original surgery.

In-hospital post-procedure complications can significantly impact the risk of mortality. The risk adjustment method used to risk adjust 30-day post-procedure surgical mortality rates across hospitals must exclude in-hospital post-procedure complications (e.g., internal hemorrhage) and be based on the patient's condition at the time of admission for the procedure. Otherwise, poor performance in preventing in-hospital post-op complications would lead to bias in favor of hospitals with poor complication performance.

Beyond the basic requirement that the mortality measure be clinically credible, an effective measure of hospital 30-day post-procedure surgical mortality should meet the following requirements:

- Any surgical deaths for which the hospital is reasonably responsible should be included in the mortality measure
- Any surgical deaths for which the hospital is not reasonably responsible should be excluded from the mortality measure
- The measure of mortality should not be susceptible to distortions caused by hospital discharge practices and policies
- The measure of mortality should not be susceptible to biases due to hospital inpatient complication performance

By meeting these requirements, the measure of hospital 30-day post-procedure surgical mortality can identify patients who are amenable to quality improvement efforts, making it possible to credibly include surgical mortality in pay for performance systems and public reporting systems.

## Defining 30-Day Post-Procedure Surgical Episodes

The definition of 30-day post-procedure surgical episodes requires rules for evaluating readmissions and transfers, a method of risk adjusting mortality rates, selection of the surgical procedures included, rules for excluding patients from mortality comparisons, development of a national 30-day post-procedure surgical mortality norm and a method for computing expected mortality rates using the national norm.

### Readmissions During the 30-Day Surgical Episode

Using a 30-day post-procedure surgical episode as the basis for determining surgical mortality requires that any readmissions that occur in the 30-day post-procedure episode must be evaluated to determine if they are clinically related to the original surgery. The Potentially Preventable Readmissions (PPRs) methodology was used to determine whether a readmission was clinically related to the prior surgical procedure.[16] A readmission is considered a PPR if the reason for the readmission is clinically related to a prior hospitalization and the readmission is potentially preventable. A PPR may result from deficiencies in the process of care (readmission for a surgical wound infection) or inadequate post-discharge follow-up rather than unrelated events that occur post discharge (broken leg due to trauma). Readmissions may result from actions taken or omitted during the initial hospital stay, such as incomplete treatment or poor care of the underlying problem, or from poor coordination of services at the time of discharge and afterwards, such as incomplete discharge planning or inadequate access to care. The PPRs were used to evaluate readmissions that occurred during the 30-day post-procedure episode. The PPRs, a transparent system with a definition manual available for inspection,[17] are used for readmission performance reporting in 12 states and as the basis of quality-based payment incentive systems in seven states.

### Transfers

If the admission that initiates a 30-day post-procedure surgical episode results in a transfer to another hospital and the admission to the other hospital occurs on either the day of discharge or the day after discharge from the hospital that initiated the surgical episode, the transfer is considered a continuation of the surgical episode and a clinically related transfer. However, if the transfer to another hospital occurs two or more days after discharge from the hospital that initiated the surgical episode, the transfer is treated as a readmission and is evaluated with PPRs to determine if it is clinically related to the admission that initiated the surgical episode.

**Risk Adjustment**

In order to compare 30-day post-procedure surgical mortality rates, the mortality rates must be risk adjusted. The All Patient Refined Diagnosis Related Groups (APR DRGs) methodology was used to risk adjust mortality rates.[18] APR DRGs are a categorical clinical model composed of base categories (base APR DRGs) that are subdivided into four severity of illness subclasses. These subclasses are unique to each base APR DRG and are based on the extent of physiologic decompensation or organ system loss of function. The APR DRG methodology also includes four risk of mortality (ROM) subclasses based on the likelihood of dying. The combination of the base APR DRGs and the four ROM subclasses constitute a system of patient risk classes. The APR DRG based risk classes are exhaustive and mutually exclusive resulting in a patient being assigned to one and only one risk class.

In APR-DRGs, high risk of mortality is primarily determined by the interaction of multiple diseases. Patients with multiple comorbid conditions involving multiple organ systems represent difficult-to-treat patients who tend to have poor outcomes and are at a higher risk of dying.

APR DRG assignment is computed both at the time of admission and at the time of discharge. At the time of admission, the Present on Admission (POA) indicator field on the UB04 is used to exclude complications and other conditions that arise after admission from the APR DRG assignment. The POA indicator became a required reporting element for both principal and secondary diagnoses on hospital claims submitted for payment after October 1, 2007.[19] For risk adjusting hospital mortality rates the APR DRGs with the ROM subclasses assigned at the time of admission were used. The four ROM subclasses are numbered sequentially from 1 to 4 indicating respectively, minor, moderate, major and extreme risk of mortality.

In determining a patient's ROM subclass, the APR DRG methodology's underlying clinical principles consider that a patient's risk of dying is highly dependent on the patient's underlying clinical problems, and that patients with a high risk of dying are usually characterized by multiple serious diseases. In the APR-DRGs, the assessment of a patient's risk of mortality is specific to the base APR-DRG to which a patient is assigned. In other words, the determination of the risk of mortality is disease specific. Thus, the significance attributed to complicating or comorbid conditions is dependent on the underlying problem. For example, certain types of infections are considered a more significant problem in a patient who is hospitalized for an immunodeficiency disorder than in a patient hospitalized a fractured leg. In APR-DRGs, high risk of mortality is primarily determined by the interaction of multiple diseases. Patients with multiple comorbid conditions involving multiple organ systems represent difficult-to-treat patients who tend to have poor outcomes and are at a higher risk of dying. The APR DRGs and severity of illness subclasses are used for performance reporting in five states and as the basis of payment adjustments in 30 states. The APR DRGs are a transparent system with a definition manual available for inspection.[20]

## Selection of Surgical Procedures

There are 330 base APR DRGs, of which 139 are considered surgical. For this study, the surgical base APR DRGs were reviewed to exclude those that are generally not applicable to the Medicare population (obstetrics, newborns, pediatrics), transplant surgery, surgery for major trauma and surgery unrelated to the principal diagnosis, resulting in 36 surgically based APR DRGs being excluded from the analysis (listed in Appendix A). After these exclusions, there were 103 surgical base APR DRGs included in the analysis. These 103 surgical base APR DRGs encompass 82.2 percent of all Medicare inpatient surgical procedures.

## Patient Exclusions

In order to identify patients for whom it is reasonable to consider a hospital responsible for the outcome of the surgical episode, the following exclusions were used:

- ***Patients discharged agianst medical advise***
  It is not reasonable to consider a hospital responsible for the outcome of the surgical episode when a patient leaves the hospital against medical advice.
- ***Patients at extreme risk of mortality at the time of admission***
  Patients with an admission APR DRG with a ROM subclass of 4 (e.g., in cardiac arrest) are patients who may be unstable and need life-saving interventions requiring immediate surgery. In such emergency situations it may be difficult to assess surgical risk, making it difficult to assess hospital responsibilty for the outcome of the surgical episode.
- ***Patients transferred in from another hospital***
  Patients who receive their initial care at another hospital and are transferred to a hospital for the surgical procedure may have the outcome of the surgical episode influenced by the care given in the initial hospital, making it difficult to assess responsibility for the outcome of the surgical episode.
- ***Patients with an unrelated readmission during the post-procedure 30-day episode***
  If a patient has a clinically related readmission occur during the post-procedure 30-day episode, the hospital that performed the procedure is considered responsible for the outcome during the readmission even if the readmission is to a different hospital. While patients admitted at ROM subclass 4 at the time of the procedure are excluded, clinically related readmissions at a ROM subclass 4 are included because the readmission is associated with the care given during the initial admission in which the procedure was performed and is therefore a continuation of the surgical episode. However, if a clinically unrelated readmission occurs, the patient is being treated for two separate conditions, making it difficult to assess hospital responsibility for the outcome of the surgical episode.
- ***Patients with a non immediate and unrelated transfer out during the post-procedure 30-day episode***
  If a transfer to another hospital occurs two or more days after discharge from the hospital that initiated the surgical episode, the transfer is treated as a readmission and if the transfer is clinically unrelated to the admission that initiated the surgical episode, the patient is excluded.

These exclusions essentially identify clinical outliers. The subset of patients remaining are those for whom the hospital has relatively clear responsibility for the outcome of the surgical episode; they are referred to as eligible admissions and constitute the “at-risk” population (denominator) for 30-day post-procedure surgical mortality. Since the objective of the mortality comparisons is to provide comparative performance information that can be used for quality improvement, it is essential that determination of responsibility for the outcome of the surgical episode be clinically credible. If responsibility for the outcome of the surgical episode is questionable, the focus becomes the credibility of the data and not the performance differences being observed in the data, thereby undermining quality improvement efforts.

### National Norm

Each patient is assigned to a mortality risk class defined by the base APR DRG and ROM subclass assigned at admission. For each type of surgical procedure, the national average 30-day post-procedure surgical mortality rate for all at-risk patients is computed for each risk class (referred to as the national 30-day post-procedure surgical mortality norm value).

### Expected Values

The expected value (E) for a hospital or geographic region is the number of at-risk admissions in each risk category times the national 30-day post-procedure surgical mortality norm value (rate) for the risk category summed over all risk categories (indirect rate standardization). The difference between the actual number of deaths (A) and the expected number of deaths (E) represents good performance if (A-E) is negative (A<E) and poor performance if (A-E) is positive (A>E). The %(A-E)/E is the percent that actual performance is below expected (%(A-E)/E is negative) or above expected (%(A-E)/E is positive).

## Data

The data used in this report is the FY18 Medicare Fee-For-Service data (FFS). The first 11 months of data was used to determine mortality performance and the twelfth month was used to complete the 30-day surgical episode and identify any readmissions or transfers. Eligible admissions were identified from the 3,315 hospitals paid under the Medicare Inpatient Prospective Payment System (IPPS). Readmissions and transfers were identified using the IPPS hospitals and non-IPPS hospitals (critical access hospitals and free-standing psychiatric hospitals). The discharge disposition field on the UB04 was used to determine patients who died in the hospital (discharge disposition = 20) and patients who left against medical advice (discharge disposition = 07). The point of origin field on the UB04 was used to determine patients who were transferred in from another hospital (point of origin = 4). The Master Beneficiary Summary File (MBSF) contains enrollment data on all Medicare beneficiaries enrolled in or entitled to Medicare. The date of death in the MBSF was used to determine deaths in the community. If there was a conflict between the date of death in the MBSF and the hospital reported date of death, the hospital reported date of death was used. When multiple procedures are performed during a hospitalization, the APR DRGs use surgical hierarchies to select the procedure that assigns the APR DRG. The date of the procedure that is used to assign the APR DRG initiates the 30-day surgical episode. If an in-hospital death has a length of stay greater than 30 days, the patient is not considered to have died during the 30-day post-procedure surgical episode.

## Results

In the eleven months of data analyzed, there were 2,294,766 admissions that were assigned one of the 103 surgical APR DRGs. These admissions are referred to as “candidate admissions,” which may be eligible to be included in the denominator of the mortality rate. The following exclusions were applied to the candidate admissions to determine the subset of candidate admissions that are eligible admissions to be included in the denominator of the mortality rate:

- **97,993** candidate admissions were excluded because the admission APR DRG ROM was subclass 4
- **4,208** candidate admissions were excluded because the discharge status was left against medical advice

- **128,897** candidate admissions were excluded because the admission had a point of origin of transfer in
- **31,738** candidate admissions were excluded because they occurred within the 30-day post-procedure period following another candidate admission. Because these candidate admissions follow a prior candidate admission, they are not eligible to initiate a surgical episode and are instead treated as readmissions following the prior candidate admission
- **1,520** candidate admissions were excluded because a readmission with a discharge status of left against medical advice occurred within the 30-day post-procedure period
- **55,811** candidate admissions were excluded because a clinically unrelated readmission occurred within the 30-day post-procedure period
- **1,856** candidate admissions were excluded because a clinically unrelated transfer to another hospital occurred two or more days after discharge from the hospital that initiated the surgical episode and within the 30-day post-procedure period

A total of 322,023 candidate admissions were excluded (14.0 percent), resulting in 1,972,743 candidate admission being eligible to be included in the denominator of the mortality rate.
Of the 1,972,743 eligible admissions, 154,517 eligible admissions (7.8 percent) had a clinically related readmission within the 30-day post-procedure period. 72.8 percent of the readmissions that occurred within the 30-day post-procedure episode were clinically related (154,517) and 27.2 percent were clinically unrelated (57,667). Of the 154,744 clinically related readmissions 72.5 percent returned to the same hospital as their eligible admission.

The 30-day post-procedure deaths in the 1,978,560 eligible admissions were as follows:

- **18,721** in-hospital deaths during an eligible admission
- **5,041** deaths during a clinically related readmission of an eligible admission
- **23,685** post-discharge community deaths during the 30-day post-procedure period of an eligible admission

A total of 47,447 deaths among eligible admissions occurred during the 30-day post-procedure period of an eligible admission, resulting in an overall 30-day post-procedure mortality rate of 2.41 percent (47,447/ 1,972,743). Only 39.5 percent of the deaths occurred during the initial eligible surgical admission and the majority of deaths (60.5 percent) occurred in the community or during a clinically related readmission.

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The mortality rate for the 154,571 eligible admissions with a clinically related readmissions was 3.26 percent (5,041 deaths). The average time between discharge from an eligible admission to a clinically related readmission was 10.5 days. Of the eligible admissions with a clinically related readmission who died, the average number of days between discharge from the eligible admission to a clinically related readmission was 7.2 days with 62.9 percent of those readmission (3,171) admitted at ROM subclass 4.

Using the 1,972,743 eligible admissions, the mortality rate was computed for each of the 103 base surgical APR DRGs and ROM subclasses creating a national 30-day post-procedure surgical mortality norm. For base APR DRGs that had 10 or less deaths, each of the three ROM subclasses were assigned the average mortality rate for the base APR DRG (base APR DRGs 232, 510, 514 and 519). The mortality rates across the three ROM subclasses almost always increased monotonically. There were three exceptions in which two of the ROM subclasses did not increase monotonically (base APR DRGs 162, 303 and 511). For these three APR DRGs, the average mortality rate across the two ROM subclasses was assigned to both ROM subclasses. The national 30-day post-procedure surgical mortality norm is contained in Appendix B.

## Geographic Variation

Table 1 contains the %(A-E)/E for the 30-day post-procedure mortality for the nine census regions. New England and the Pacific census regions have the best performance at 12.1 and 13.7 percent below expected, respectively. The East South Central region has the poorest performance at 18.7 percent above expected. The South Atlantic, East South Central and West South Central regions all have higher than expected 30-day post-procedure mortality.

***Table 1: %(A-E)/E for 30-Day Post-Procedure Mortality by Census Region***

| Census Region | States | Eligible Discharges | 30-day Post-Procedure Deaths | %(A-E)/E |
|---|---|---|---|---|
| New England | ME, VT, NH, CT, MA, RI | 99,243 | 1,944 | -12.1 |
| Middle Atlantic | NY, NJ, PA | 242,852 | 5,795 | -2.9 |
| South Atlantic | FL, GA, SC, NC, VA, WV, DC, MD, DE | 430,538 | 11,163 | 4.8 |
| E North Central | IL, WI. MI, IN. OH | 297,607 | 7,065 | -4.0 |
| E South Central | KY, TN, AL, MS | 141,390 | 4,039 | 18.7 |
| W South Central | TX, OK, AR, LA | 212,035 | 5,605 | 4.6 |
| W North Central | MN, IA, MO, KS, NE, SD, ND | 173,654 | 3,642 | -3.3 |
| Mountain | AZ, NM, UT, CO, NV, WY, ID, MT | 134,431 | 2,935 | 2.9 |
| Pacific | CA, OR, WA, HI, AK | 221,554 | 4,746 | -13.7 |

Table 2 contains the the %(A-E)/E for the 30-day post-procedure mortality by states. The states range from 37.2 percent below expected for Hawaii to 36.2 percent above expected for Mississippi. Consistent with the census region results, the southern states tend to have higher than expected 30-day post-procedure mortality.

***Table 2: %(A-E)/E for 30-Day Post-Procedure Mortality by State***

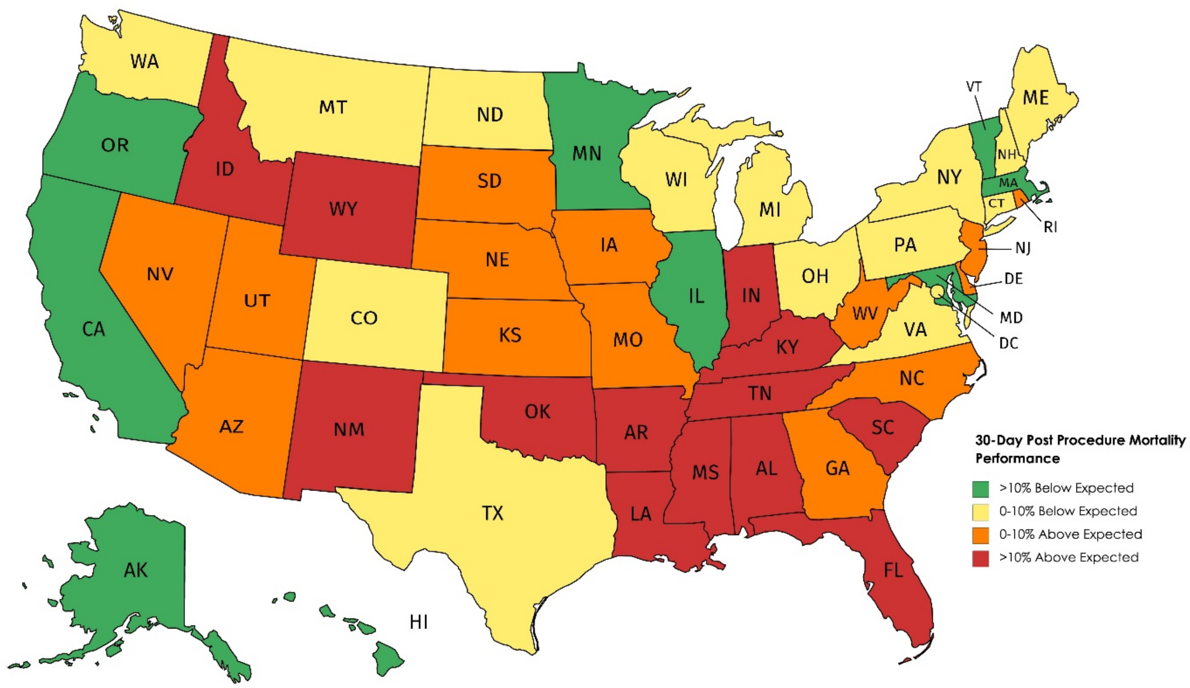
| State | Eligible Discharges | 30-Day Post-Procedure deaths | %(A-E)/E |
|---|---|---|---|
| Alabama | 35,930 | 1,053 | 22.6 |
| Alaska | 3,831 | 60 | -26.8 |
| Arizona | 42,038 | 934 | 3.8 |
| Arkansas | 25,762 | 704 | 17.8 |
| California | 153,052 | 3,354 | -15.2 |
| Colorado | 31,897 | 613 | -7.3 |
| Connecticut | 21,528 | 473 | -7.1 |
| Delaware | 9,380 | 221 | 7.8 |
| DC | 7,291 | 173 | -7.6 |
| Florida | 148,146 | 4,220 | 15.1 |
| Georgia | 51,462 | 1,459 | 6.3 |
| Hawaii | 4,384 | 80 | -37.2 |
| Idaho | 9,834 | 215 | 13.5 |
| Illinois | 79,665 | 1,804 | -10.5 |
| Indiana | 46,939 | 1,234 | 10.1 |
| Iowa | 21,715 | 490 | 8.3 |
| Kansas | 25,578 | 552 | 6.8 |
| Kentucky | 31,340 | 883 | 13.4 |
| Louisiana | 30,547 | 868 | 12.5 |
| Maine | 8,303 | 185 | -2.3 |
| Maryland | 38,743 | 838 | -17.7 |
| Massachusetts | 50,752 | 907 | -19.0 |
| Michigan | 64,652 | 1,581 | -5.8 |
| Minnesota | 46,284 | 688 | -28.4 |
| Mississippi | 23,212 | 790 | 36.2 |
| Missouri | 46,310 | 1,208 | 5.8 |
| Montana | 8,798 | 177 | -0.4 |
| Nebraska | 16,367 | 355 | 1.5 |
| Nevada | 14,984 | 389 | 3.6 |
| New Hampshire | 10,146 | 212 | -1.0 |
| New Jersey | 53,094 | 1,526 | 8.2 |
| New Mexico | 9,102 | 234 | 11.5 |
| New York | 104,112 | 2,301 | -7.9 |
| North Carolina | 65,488 | 1,556 | 1.1 |
| North Dakota | 7,182 | 159 | -2.6 |
| Ohio | 73,794 | 1,756 | -1.3 |
| Oklahoma | 32,361 | 853 | 17.9 |
| Oregon | 20,007 | 367 | -12.1 |
| Pennsylvania | 85,646 | 1,968 | -4.3 |
| Rhode Island | 5,243 | 119 | 4.0 |
| South Carolina | 35,619 | 955 | 11.7 |
| South Dakota | 10,218 | 190 | 4.6 |
| Tennessee | 50,908 | 1,313 | 10.7 |
| Texas | 123,365 | 3,180 | -2.7 |
| Utah | 14,958 | 304 | 8.0 |

| State | Eligible Discharges | 30-Day Post-Procedure deaths | %(A-E)/E |
|---|---|---|---|
| Vermont | 3,271 | 48 | -26.9 |
| Virginia | 59,644 | 1,330 | -6.1 |
| Washington | 40,280 | 885 | -3.2 |
| West Virginia | 14,765 | 411 | 5.5 |
| Wisconsin | 32,557 | 690 | -9.7 |
| Wyoming | 2,820 | 69 | 21.5 |

Figure 1 is a U.S. map with the states color coded as follows:

**Green:** %(A-E)/E >10% below expected – 9 states
**Yellow:** %(A-E)/E 0-10% below expected – 15 states
**Orange:** %(A-E)/E 0-10% above expected – 14 states
**Red:** %(A-E)/E >10% above expected – 13 states

***Figure 1: %(A-E)/E for 30-Day Post-Procedure Mortality by State***



## Variation by Type of Hospital

Table 3 contains the %(A-E)/E for 30-day post-procedure mortality for categories of hospitals based on teaching status (IPPS Indirect Medical Education (IME) payment adjustment), proportion of low income patients (IPPS Disproportionate Share Hospital (DSH) payment adjustment), location and size. Major teaching hospitals (the 10 percent of hospitals with the largest IME payment adjustment) have a 30-day post-procedure mortality rate 21.2 percent lower than expected. The hospitals with the largest DSH payment adjustment, large urban hospitals and the largest size hospitals all have lower than expected 30-day post-procedure mortality. Even though high DSH hospitals face challenges because of the populations they serve, they achieved good (5.9 percent below expected) 30-day post-procedure mortality performance.

***Table 3: %(A-E)/E for 30-Day Post-Procedure Mortality by Type of Hospital***

| | | Hospitals | Eligible Admissions | Deaths | %(A-E)/E |
|---|---|---|---|---|---|
| IME | Top 10% | 330 | 396,037 | 8,124 | -21.2 |
| | All Other | 2,817 | 1,576,706 | 39,323 | 5.9 |
| | | | | | |
| DSH | DSH Top 20% | 617 | 298,245 | 7,743 | -5.9 |
| | DSH Middle 60% | 1,923 | 1,337,577 | 33,592 | 1.8 |
| | DSH Bottom 20% | 607 | 336,921 | 6,112 | -2.0 |
| | | | | | |
| Location | Large Urban | 1,272 | 859,527 | 19,933 | -5.6 |
| | Other Urban | 872 | 612,065 | 14,934 | 5.4 |
| | Rural | 1,003 | 501,151 | 12,580 | 3.5 |
| | | | | | |
| Size | Top 10% | 331 | 682,173 | 15,734 | -10.7 |
| | All Other | 2,816 | 1,290,570 | 31,713 | 6.3 |

## 30-Day Versus In-Hospital Mortality

Prior research has found that in-hospital mortality and 30-day mortality can produce different performance evaluations of hospitals.[11, 12, 13, 14] 30-day post-procedure mortality and in-hospital mortality were analyzed with and without exclusions for each category of hospital and is contained in Table 4. To compute %(A-E)/E, three additional national norms were created: 30-day post-procedure mortality without exclusions, in-hospital mortality with exclusions and in-hospital mortality without exclusions.

In table 4 the %(A-E)/E for in-hospital mortality without exclusions is considered the baseline mortality result. The %(A-E)/E was recomputed for in-hospital with exclusions, 30-day post-procedure without exclusions and 30-day post-procedure with exclusions. Relative to in-hospital mortality without exclusions, red cells mean the change in the mortality measure decreased mortality performance (less negative or more positive) and green cells mean the change in the mortality measure improved mortality performance (more negative or less positive). So, for the top 10 percent IME hospitals with a %(A-E)/E of 2.6 percent below expected for in-hospital mortality without exclusions, changing to 30-day post-procedure without exclusions improved performance to 12.7 percent below expected. Changing to in-hospital with exclusions improved performance to 10.6 percent below expected. Changing to 30-day post-procedure with exclusions improved performance to 21.1 percent below expected. Thus, the combined effect of changing to 30-day post-procedure mortality and adding the exclusions had a dramatic impact on the %(A-E)/E for the top 10 percent IME hospitals with a performance improvement change from 2.6 percent below expected to 21.1 percent below expected.

> Surgical mortality based on in-hospital mortality without clinical outliers removed is extremely biased against high IME hospitals, high DSH hospitals and large hospitals and would not be an appropriate basis for use in any hospital payment incentive system.

The impact on the top and bottom DSH hospitals was also dramatic. The combined impact of changing from in-hospital mortality with no exclusion to 30-day post-procedure mortality with exclusions improved performance for the 20 percent top DSH hospitals from 4.4 percent above expected to -5.9 percent below expected, and lowered performance for the 20 percent bottom DSH hospitals from 12.9 percent below expected to 2.0 percent below expected. Table 5 demonstrates that a surgical mortality based on in-hospital mortality without clinical outliers removed is extremely biased against high IME hospitals, high DSH hospital and large hospitals and would not be an appropriate basis for use in any hospital payment incentive system.

Some hospital payment incentive systems separate hospitals into percentiles of performance for the purpose of determining incentive payments. For example, the mortality component of the Medicare hospital Value Based Purchasing system determines incentive payments in 10 increments based on hospital performance percentile in the 50th to 100$^{th}$ percentile range.[21] In order to evaluate the impact of different mortality measures on hospital percentiles, the in-hospital mortality measure with no exclusions and a 30-day post-procedure mortality measure with exclusions were compared. Because the percentile assignment of hospitals with a very low volume of surgical patients can result in extreme percentile values, hospitals with less than 100 at risk surgical patients were excluded. A hospital was assigned to a decile based on its mortality performance ((A-E)/E). Across the two measures of mortality, 79.6 percent of hospitals were assigned to a different decile with an average change of 2.2 deciles.

Within categories of hospitals, the extent of the difference in decile assignment was even greater. For example, across the two measures of mortality 88.8 percent of the top 10 percent of IME hospitals were assigned to a different decile with an average change of 2.6 deciles with the 30-day post-procedure with exclusions mortality measure resulting 70.1 percent of the hospitals being assigned a higher decile. Thus, for payment adjustments based on performance percentile, there can be substantial differences in percentile assignment potentially resulting in substantive payment differences and biases for mortality measures that do not include deaths during the post-procedure period or fail to exclude admission for which hospital responsibility is questionable.

***Table 4: %(A-E)/E for 30-Day Post-Procedure Mortality and In-Hospital Mortality by Type of Hospital***

| | | Hospitals | Admissions | In-Hospital | 30-Day Post-Procedure | Exclusions |
|---|---|---|---|---|---|---|
| IME | Top 10% | 330 | 486,350 | -2.6 | -12.7 | No Exclusions |
| | | | 396,037 | -10.6 | -21.2 | With Exclusions |
| | All Other | 2,817 | 1,808,415 | 0.9 | 4.1 | No Exclusions |
| | | | 1,576,706 | 3.1 | 5.9 | With Exclusions |
| | | | | | | |
| DSH | DSH Top 20% | 617 | 359,547 | 4.4 | -3.6 | No Exclusions |
| | | | 298,245 | 4.7 | -5.9 | With Exclusions |
| | DSH Mid 60% | 1,923 | 1,561,128 | 0.9 | 1.4 | No Exclusions |
| | | | 1,337,577 | 1.2 | 1.8 | With Exclusions |
| | DSH Bot 20% | 607 | 374,090 | -12.9 | -2.2 | No Exclusions |
| | | | 336,921 | -12.9 | -2.0 | With Exclusions |
| | | | | | | |
| Location | Large Urban | 1,272 | 1,001,089 | -3.9 | -4.6 | No Exclusions |
| | | | 859,527 | -4.6 | -5.6 | With Exclusions |
| | Other Urban | 872 | 712,218 | 4.4 | 4.6 | No Exclusions |
| | | | 612,065 | 4.3 | 5.4 | With Exclusions |
| | Rural | 1,003 | 581,458 | 1.9 | 2.7 | No Exclusions |
| | | | 501,151 | 3.1 | 3.5 | With Exclusions |
| | | | | | | |
| Size | Top 10% | 331 | 827,465 | 0.5 | -6.4 | No Exclusions |
| | | | 682,173 | -3.7 | -10.7 | With Exclusions |
| | All Other | 2,816 | 1,467,300 | -0.4 | 4.3 | No Exclusions |
| | | | 1,290,570 | 2.4 | 6.3 | With Exclusions |

## Surgical Volume

There has long been an observed link between hospital volume and the quality of healthcare outcomes. Specifically, the adage that "practice makes perfect" applies to hospital surgical procedures, in that hospitals with larger volumes of patients achieve better outcomes (even if this does not extend to medical admissions).[22] In recent years this linkage has been debated by researchers positing that improved safety standards and protocols have eroded the dependency of outcomes upon volume. Other recent studies have shown that, if anything, this volume related gap has increased.[23] This is an important issue as it can impact the minimum standards that should be met by hospitals.

To examine the impact of surgical volume on surgical mortality, the 1,972,743 eligible admissions were used to rank hospitals based on their surgical volume. Hospitals were assigned to surgical volume deciles with approximately 245 hospitals in each decile. Because the percentile assignment of hospitals with a very low volume of surgical patients can result in extreme percentile values, hospitals with less than 100 at risk surgical patients were excluded from the hospital ranking. The %(A-E)/E for 30-day post-procedure mortality was computed and is contained in Table 5.

***Table 5: 30-day Post-Procedure and In-Hospital Mortality Performance by Surgical Volume Decile***

| Percentile | Eligible Admissions per Hospital | 30-day Deaths per Hospital | 30-day Mortality %(A-E)/E |
|---|---|---|---|
| 1-5 | 272.1 | 7.3 | 11.0 |
| 6 | 596.5 | 15.2 | 7.9 |
| 7 | 789.6 | 20.5 | 7.3 |
| 8 | 1049.3 | 26.5 | 3.4 |
| 9 | 1471.2 | 35.4 | -0.3 |
| 10 | 2647.4 | 55.7 | -12.0 |

In Table 5 the 50 percent of hospitals with the lowest volume of surgical procedures were combined (i.e, the bottom five volume deciles). The 30-day post-procedure mortality performance (%(A-E)/E) steadily improves from 11.0 percent above expected for the bottom five volume deciles to 12.0 percent below expected for the top volume decile. Table 5 also indicates there is dramatic improvement in mortality performance between hospitals in the top (highest volume) decile and the second highest volume decile (-0.3% to -12%) These results suggest surgical volume is directly related to 30-day surgical mortality performance.

## Extreme Risk of Mortality Patients

There are 97,993 candidate surgical admissions (4.3 percent of candidate admissions) that had an admission APR DRG ROM 4 and were excluded from the measure of 30-day post-procedure mortality. While the exclusion of the ROM 4 admissions is based on the difficulty in assessing surgical risk and assigning responsibility for the surgical episode to a hospital, it is still important to understand the impact of this exclusion. Applying the exclusion rules (left against medical advice, clinically unrelated readmission, etc.) to the ROM 4 admissions excludes 26,742 admissions (27.3 percent) resulting in 71,251 ROM 4 eligible admissions. 72.6 percent of the 26,742 ROM 4 exclusions were transfer-in exclusions (19,412). A total of 18,351 deaths occurred during the 30-day post-procedure period of an eligible ROM 4 admission, resulting in a 30-day post-procedure mortality rate of 25.8 percent. The majority of deaths (65.9 percent) occurred during the eligible admission in which the surgical procedure was performed. Thus, the eligible ROM 4 admissions have a mortality rate that is more than 10 times higher than the ROM 1-3 admissions (25.8 vs 2.4 percent) and these patients were much more likely to have died during the initial eligible admission in which the surgery was performed. (65.5 vs 39.5 percent). These results are consistent with the assumption that ROM 4 admissions are patients who may be unstable and require life saving interventions and immediate surgery, making it difficult to assess surgical risk.

To assess hospital performance for ROM subclass 4 admissions, the 71,251 ROM 4 eligible admissions were used to create a national norm. The %(A-E)/E for the ROM subclass 4 admissions is contained in Table 6. In general, the pattern observed for ROM 4 admissions is the same as for ROM 1-3 admissions: Hospitals with the largest IME payment adjustment, hospitals with the largest DSH payment adjustment, large urban hospitals and the largest size hospitals all have lower than expected 30-day post-procedure mortality. However, the magnitude of the %(A-E)/E for the ROM 4 admissions is less than the ROM 1-3 admissions. In the case of high IME hospitals, for example, the %(A-E)/E drops from 21.2 percent below expected for ROM 1-3 patients to 6.0 percent below expected for ROM 4 patients. The substantial difference for hospitals with the largest IME payment adjustment, hospitals with the largest DSH payment adjustment, large urban hospitals and the largest size hospitals may be due to the inherent difficulty in preventing death in ROM 4 admissions, thereby reducing performance differences across types of hospitals.

***Table 6: %(A-E)/E for 30-Day Post-Procedure Mortality for ROM Subclass 4 Admissions by Type of Hospital***

| | | Hospitals | Eligible Admissions | %(A-E)/E Post-Proc Mortality ROM 1-3 | %(A-E)/E Post-Proc Mortality ROM 4 |
|---|---|---|---|---|---|
| IME | Top 10% | 330 | 15,269 | -21.2 | -6.0 |
| | All Other | 2,817 | 55,982 | 5.9 | 1.7 |
| | | | | | |
| DSH | DSH Top 20% | 617 | 14,619 | -5.9 | -2.1 |
| | DSH Middle 60% | 1,923 | 48,986 | 1.8 | 0.5 |
| | DSH Bottom 20% | 607 | 7,646 | -2.0 | 0.9 |
| | | | | | |
| Location | Large Urban | 1,272 | 33,039 | -5.6 | -1.8 |
| | Other Urban | 872 | 21,015 | 5.4 | 1.8 |
| | Rural | 1,003 | 17,197 | 3.5 | 1.2 |
| | | | | | |
| Size | Top 10% | 331 | 26,202 | -10.7 | -2.6 |
| | All Other | 2,816 | 45,049 | 6.3 | 1.5 |

Extremes of age also create a higher risk of surgical mortality. Across states the average age of eligible surgical admissions varied from 69.9 (Kentucky) to 73.3 (New Jersey). However, the percent of eligible surgical admissions who were age 85 or over varied from 8.0 percent (Idaho) to 14.6 percent (New Jersey). Thus, there is significant practice pattern variation across states in the rate that surgery is performed on the extreme elderly. Since the extreme elderly have an inherently higher risk of mortality, the decision to perform relatively elective surgery on the extreme elderly is a clinical decision that must be carefully evaluated. The 82 percent variation across states in the rate that surgery is performed on the extreme elderly represents a substantial practice pattern difference. No explicit adjustment for extremes of age in the 30-day post-procedure mortality measure was added to compensate for this practice pattern difference. One of the key objectives of the 30-day post-procedure mortality measure is to identify performance issues that are amenable to quality improvement. The rate at which relatively elective surgery is performed on the extreme elderly is a practice pattern that is amenable to change and should be identified and evaluated.

### Impact of Risk of Mortality Assignment at Time of Admission

For risk adjusting hospital mortality rates the APR DRGs with the ROM subclasses assigned at the time of admission were used, thereby excluding the impact of complications and other conditions that arise after admission. If the APR DRG and ROM subclass had been assigned based on discharge information, 218,829 eligible admissions would have been assigned to a higher risk of mortality APR DRG (11.1 percent). Of the 218,829 admissions that were assigned to a higher risk of mortality APR DRG, 4,304 would have their ROM subclass increased to ROM subclass 4 (2.0 percent). Any assignment of risk of mortality based on discharge information would create a bias in favor of hospitals with poor inpatient complication performance.

## Summary of Results

The measure of surgical mortality developed in this report was designed to meet six essential requirements necessary for mortality-based pay for performance systems and public reporting systems to be an effective incentive for quality improvement.

- Surgical mortality should not be limited to in-hospital deaths during the surgical admission and should encompass the 30-day post-procedure period
    - *Only 39.5 percent of surgical deaths within 30-days of the procedure occur during the in-hospital surgical admission*
- Any surgical deaths for which the hospital is reasonably responsible should be included in the mortality measure
    - Include community deaths during a 30-day post-procedure period
        - *49.9 percent of 30-day post-procedure deaths occur in the community*
    - Include deaths during clinically related readmissions including readmissions to a different hospital
        - *10.6 percent of 30-day post-procedure deaths occur during a clinically related readmission*
        - *Clinically related readmissions who died (5,041), on average were readmitted in 7.2 days with 62.9 percent of those readmission (3,171) admitted at ROM subclass 4*
- Any surgical deaths for which the hospital is not reasonably responsible should be excluded in the mortality measure

- Extensive exclusions for clinically unrelated readmissions, transfer-ins, left against medical advise and critical high risk of mortiality admissions
  - *Hospitals should not be considered reasonably responsible for mortality in 14.0 percent of surgical admissions*

- The measure of mortality should not be susceptible to distortions caused by hospital discharge practices and policies
  - Includes community deaths, deaths in SNFs and other facilities and death in a clinically related readmission during the 30-day post-procedure period
    - *60.5 percent of all 30-day post-procedure deaths occur in the community, post-acute facility or during a clinically related readmission*
- The measure of mortality should not be susceptible to biases due to hospital complication performance
  - Risk adjustment based on the condition of the patient at the time of admission
    - *Risk adjustment based on the condition of the patient at the time of discharge would increase the ROM subclass* in *11.1 percent admissions*
- The measure of mortality should be transparent and understandable
  - Risk adjustment is expressed using exhaustive and mutaly exclusive clinically credible risk categories

By meeting these requirements, the measure of surgical mortality can be used in pay for performance systems and public reporting systems because it identifies patients who are amenable to hospital quality improvement efforts, thereby increasing the effectiveness of the incentives in any pay for performance incentive system.

Using the hospital 30-day post-procedure measure with exclusions, the following results were found:

- The 30-day post-procedure mortality rate was 2.41 percent
- 30-day post-procedure mortality ranged from 37.2 percent below expected for Hawaii to 36.2 percent above expected for Mississippi. The southern states tended to have higher than expected 30-day post-procedure mortality.
- Major teaching hospitals, high DSH hospitals, large urban hospitals and the largest size hospitals all have lower than expected 30-day post-procedure mortality with a %(A-E)/E of 21.2, 5.9, 5.6, and 10.7 percent below expected, respectively
- Any mortality measure that is based on in-hospital mortality or fails to exclude clinical outlliers is biased against major teaching hospitals, high DSH hospitals, large urban hospitals and the largest size hospitals
- Surgical volume is related to 30-day surgical mortality performance with the 10 percent of hospitals with the highest volume of surgical patients having a 30-day post-procedure mortality performance that is 12.0 percent below expected

These results show a significant variation in 30-day post-procedure mortality performance across geographic regions and types of hospitals. The results illustrate that any mortality measure based on in-hospital mortality will be biased against certain classes of hospitals.

## Discussion

Existing measures of mortality performance typically are expressed in the context of a complex mathematical formula (usually a regression model) that produces a measure of relative mortality risk, which in turn is translated into the number of expected deaths. Expected deaths computed in this way constitute a "black box"—a methodology with clinical logic that cannot be readily understood, essentially requiring a "trust me" leap of faith regarding the validity of the clinical logic. The logic of a mortality measure must be transparent (meaning its logic is open for evaluation) and it must be expressed in a clinically credible and understandable manner that communicates actionable information. Only then can the mortality measure be used effectively as the basis of quality improvement initiatives. Overly complex mathematical models tend to have the sole objective of attempting to explain differences in mortality performance as opposed to supporting the dual objective of explaining mortality performance differences and identifying patients where real quality improvement is possible. All the various mathematical formula-based mortality models use different variables with different weighting factors, which makes comparisons of the clinical logic in these models almost impossible. Some models become almost circular when using palliative care or do-not-resuscitate orders as a variable to explain mortality differences— essentially using mortality to explain mortality.

The logic of a mortality measure must be transparent (meaning its logic is open for evaluation) and it must be expressed in a clinically credible and understandable manner that communicates actionable information. Only then can the mortality measure be used effectively as the basis of quality improvement initiatives.

The most comprehensive hospital quality-based payment incentive systems is the Medicare Hospital Value Based Purchasing (HVBP). A major component of HVBP is mortality performance for patients admitted for acute myocardial infarction (AMI), heart failure, pneumonia, chronic obstructive pulmonary disease (COPD) and stroke. The U.S. Government Accountability Office (GAO) found no apparent improvement in hospital performance for the mortality measures in the HVBP during the initial years of implementation.[24] With the exception of mortality for pneumonia patients, other researchers have found no improvement in hospital performance for the mortality measures in the HVBP.[25] Despite the financial incentives in HVBP, hospitals do not appear to be responding to the incentives.

For each of the five conditions, HVBP mortality performance is determined based on a regression equation. Each variable in the regression can either increase or decrease predicted mortality. In a mathematical context the pluses and minuses may work out, but from a quality improvement perspective, the variables can be counterintuitive and undermine the quality improvement process. From the 2020 HVBP mortality measures[26] for a COPD patient, both diabetes and morbid obesity lower the risk of mortality. So, for two patients who are otherwise identical except that one has diabetes and morbid obesity, the patient with diabetes and morbid obesity is considered to have a lower risk of mortality. Diabetes increases the risk of mortality for acute myocardial infarction (AMI) patients but lowers the risk of mortality for heart failure patients. For heart failure patients, dementia results in a bigger increase in heart failure risk of mortality than cardio-respiratory failure and shock. For pneumonia patients, septicemia lowers the risk of mortality.

Such counterintuitive clinical relationships abound in the HVBP regression equations. Similar problems can be found in virtually all mortality regression-based systems.

The quality improvement process fundamentally involves an in-depth review of actual versus expected performance. Encountering a COPD patient with reduced risk of mortality due to diabetes and morbid obesity undermines clinical credibility and results in the breakdown of the quality improvement process. Attempts to provide a mathematical justification for the reduction in risk of mortality due to diabetes and morbid obesity tend to be futile and come down to a “trust me” leap of faith that physicians are unlikely to accept. While technically the logic in HVBP is transparent, from a practical perspective it is a black box. Essentially in HVBP, the attempt to measure risk of mortality has become lost in overly complex mathematical models that attempt to explain mortality differences. Beyond clinical credibility, what HVBP fails to do is identify mortality performance differences where real quality improvement is possible. Without such a focus, hospitals will find it difficult to respond to the incentives in a quality-based payment incentive system.

Essentially in HVBP, the attempt to measure risk of mortality has become lost in overly complex mathematical models that attempt to explain mortality differences. Beyond clinical credibility, what HVBP fails to do is identify mortality performance differences where real quality improvement is possible.

Contrast the HVBP approach to the IPPS DRG based payment system in which the DRG categories are the method of risk adjustment (the risk categories) as well as the unit of payment. Each DRG has an expected value (the DRG payment amount) and hospitals and clinicians can precisely understand the reason a patient was assigned to a DRG as well as the financial expectation. Patients with extreme patterns of resource use are considered outliers and are not paid the standard DRG payment amount. This straightforward, easily understood categorical approach (a product with a price) provides hospitals with actionable information. A fundamental reason why the DRG IPPS resulted in dramatic efficiency improvements in the years following its implementation was that the DRGs were clinically credible and readily understood. Similarly, the 30-day post-procedure mortality measure developed in this report is based on an easily understood categorical method of risk adjustment with expected mortality rates for each risk category and the exclusion of clinical outliers. Fundamentally, HVBP has failed to adhere to the core requirements for any payment incentive system and ignored the lessons from the successful DRG IPPS.

## Conclusions

While there is an increasing consensus that comparative mortality data should be included in hospital payment incentive systems, attempts to develop clinically credible and unbiased measures of mortality have proved challenging. The primary intent of mortality measurement is to provide hospitals the incentive and the information to improve mortality performance through quality improvement initiatives. To be effective for quality improvement, the measure of mortality should be limited to patients for whom a hospital is reasonably responsible for the patient outcome and thereby amenable to quality improvement efforts.

In order to achieve real quality improvement, it is essential that any effective measure of mortality be clinically credible and unbiased. If responsibility for the outcome is questionable, the focus becomes the credibility of the data and not the performance differences being observed in the data, thereby undermining quality improvement initiatives. The mortality measure developed in this report focused on surgical mortality, excluded patients for whom a hospital is not reasonably responsible for the patient outcome, used the condition of the patient at admission for risk adjustment and included death during the 30-day post-procedure period. Significant variation in 30-day post-procedure performance was found across geographic area and types of hospitals. Any use of in-hospital mortality as an alternative to 30-day post-procedure mortality would create a bias against major teaching hospitals, high disproportionate share hospitals, large urban hospitals and the largest size hospitals.

The surgical mortality measure developed in this report identifies patients who are amenable to quality improvement efforts and makes it possible to credibly include surgical mortality in pay for performance systems and public reporting systems.

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## Appendix A: Procedures Excluded

| | |
|---|---|
| 001 | LIVER TRANSPLANT &/OR INTESTINAL TRANSPLANT |
| 002 | HEART &/OR LUNG TRANSPLANT |
| 004 | TRACHEOSTOMY W MV 96+ HOURS W EXTENSIVE PROCEDURE |
| 005 | TRACHEOSTOMY W MV 96+ HOURS W/O EXTENSIVE PROCEDURE |
| 006 | PANCREAS TRANSPLANT |
| 007 | ALLOGENEIC BONE MARROW TRANSPLANT |
| 008 | AUTOLOGOUS BONE MARROW TRANSPLANT OR T-CELL IMMUNOTHERAPY |
| 009 | EXTRACORPOREAL MEMBRANE OXYGENATION (ECMO) |
| 020 | OPEN CRANIOTOMY FOR TRAUMA |
| 095 | CLEFT LIP & PALATE REPAIR |
| 097 | TONSIL & ADENOID PROCEDURES |
| 160 | MAJOR CARDIOTHORACIC REPAIR OF HEART ANOMALY |
| 161 | IMPLANTABLE HEART ASSIST SYSTEMS |
| 178 | EXTERNAL HEART ASSIST SYSTEMS |
| 440 | KIDNEY TRANSPLANT |
| 539 | CESAREAN SECTION W STERILIZATION |
| 540 | CESAREAN SECTION W/O STERILIZATION |
| 541 | VAGINAL DELIVERY W STERILIZATION &/OR D&C |
| 542 | VAGINAL DELIVERY W O.R. PROCEDURE EXCEPT STERILIZATION &/OR D&C |
| 543 | ABORTION W D&C, ASPIRATION CURETTAGE OR HYSTEROTOMY |
| 547 | ANTEPARTUM W O.R. PROCEDURE |
| 548 | POSTPARTUM & POST ABORTION DIAGNOSIS W O.R. PROCEDURE |
| 583 | NEONATE W ECMO |
| 588 | NEONATE BWT <1500G W MAJOR PROCEDURE |
| 609 | NEONATE BWT 1500-2499G W MAJOR PROCEDURE |
| 630 | NEONATE BIRTHWT >2499G W MAJOR CARDIOVASCULAR PROCEDURE |
| 631 | NEONATE BIRTHWT >2499G W OTHER MAJOR PROCEDURE |
| 740 | MENTAL ILLNESS DIAGNOSIS W O.R. PROCEDURE |
| 841 | EXTENSIVE 3RD DEGREE BURNS W SKIN GRAFT |
| 842 | BURNS W SKIN GRAFT EXCEPT EXTENSIVE 3RD DEGREE BURNS |
| 910 | CRANIOTOMY FOR MULTIPLE SIGNIFICANT TRAUMA |
| 911 | EXTENSIVE ABDOMINAL/THORACIC PROCEDURES FOR MULT SIGNIFICANT TRAUMA |
| 912 | MUSCULOSKELETAL & OTHER PROCEDURES FOR MULTIPLE SIGNIFICANT TRAUMA |
| 950 | EXTENSIVE PROCEDURE UNRELATED TO PRINCIPAL DIAGNOSIS |
| 951 | MODERATELY EXTENSIVE PROCEDURE UNRELATED TO PRINCIPAL DIAGNOSIS |
| 952 | NONEXTENSIVE PROCEDURE UNRELATED TO PRINCIPAL DIAGNOSIS |

## Appendix B: National 30-Day Post-procedure Mortality Norm

| APR DRG | ROM | Eligible Admissions | 30-Day Deaths | Mortality Rate | Description |
|---|---|---|---|---|---|
| 21 | 1 | 5,406 | 111 | 2.05 | OPEN CRANIOTOMY EXCEPT TRAUMA |
| 21 | 2 | 5,302 | 242 | 4.56 | OPEN CRANIOTOMY EXCEPT TRAUMA |
| 21 | 3 | 5,972 | 848 | 14.20 | OPEN CRANIOTOMY EXCEPT TRAUMA |
| 22 | 1 | 3,983 | 39 | 0.98 | VENTRICULAR SHUNT PROCEDURES |
| 22 | 2 | 489 | 19 | 3.89 | VENTRICULAR SHUNT PROCEDURES |
| 22 | 3 | 228 | 22 | 9.65 | VENTRICULAR SHUNT PROCEDURES |
| 23 | 1 | 2,755 | 19 | 0.69 | SPINAL PROCEDURES |
| 23 | 2 | 1,640 | 60 | 3.66 | SPINAL PROCEDURES |
| 23 | 3 | 649 | 86 | 13.25 | SPINAL PROCEDURES |
| 24 | 1 | 22,972 | 97 | 0.42 | OPEN EXTRACRANIAL VASCULAR PROCEDURES |
| 24 | 2 | 9,252 | 151 | 1.63 | OPEN EXTRACRANIAL VASCULAR PROCEDURES |
| 24 | 3 | 1,257 | 64 | 5.09 | OPEN EXTRACRANIAL VASCULAR PROCEDURES |
| 26 | 1 | 1,245 | 14 | 1.12 | OTHER NERVOUS SYSTEM & RELATED PROCEDURES |
| 26 | 2 | 1,287 | 49 | 3.81 | OTHER NERVOUS SYSTEM & RELATED PROCEDURES |
| 26 | 3 | 996 | 102 | 10.24 | OTHER NERVOUS SYSTEM & RELATED PROCEDURES |
| 27 | 1 | 1,003 | 5 | 0.50 | OTHER OPEN CRANIOTOMY |
| 27 | 2 | 230 | 8 | 3.48 | OTHER OPEN CRANIOTOMY |
| 27 | 3 | 131 | 23 | 17.56 | OTHER OPEN CRANIOTOMY |
| 29 | 1 | 3,025 | 21 | 0.69 | OTHER PERCUTANEOUS INTRACRANIAL PROCEDURES |
| 29 | 2 | 934 | 55 | 5.89 | OTHER PERCUTANEOUS INTRACRANIAL PROCEDURES |
| 29 | 3 | 690 | 86 | 12.46 | OTHER PERCUTANEOUS INTRACRANIAL PROCEDURES |
| 30 | 1 | 8,972 | 144 | 1.60 | PERCUTANEOUS INTRA & EXTRACRANIAL VASCULAR PROCS |
| 30 | 2 | 5,193 | 448 | 8.63 | PERCUTANEOUS INTRA & EXTRACRANIAL VASCULAR PROCS |
| 30 | 3 | 2,193 | 505 | 23.03 | PERCUTANEOUS INTRA & EXTRACRANIAL VASCULAR PROCS |
| 73 | 1 | 894 | 9 | 1.01 | ORBIT & EYE PROCEDURES |
| 73 | 2 | 302 | 8 | 2.65 | ORBIT & EYE PROCEDURES |
| 73 | 3 | 48 | 5 | 10.42 | ORBIT & EYE PROCEDURES |
| 89 | 1 | 1,388 | 12 | 0.86 | MAJOR CRANIAL/FACIAL BONE PROCEDURES |
| 89 | 2 | 1,117 | 25 | 2.24 | MAJOR CRANIAL/FACIAL BONE PROCEDURES |
| 89 | 3 | 270 | 14 | 5.19 | MAJOR CRANIAL/FACIAL BONE PROCEDURES |
| 91 | 1 | 1,300 | 6 | 0.46 | OTHER MAJOR HEAD & NECK PROCEDURES |
| 91 | 2 | 1,640 | 18 | 1.10 | OTHER MAJOR HEAD & NECK PROCEDURES |
| 91 | 3 | 212 | 9 | 4.25 | OTHER MAJOR HEAD & NECK PROCEDURES |
| 92 | 1 | 812 | 3 | 0.37 | FACIAL BONE EXCEPT MAJOR CRANIAL/FACIAL BONE PROCS |
| 92 | 2 | 333 | 5 | 1.50 | FACIAL BONE EXCEPT MAJOR CRANIAL/FACIAL BONE PROCS |
| 92 | 3 | 95 | 10 | 10.53 | FACIAL BONE EXCEPT MAJOR CRANIAL/FACIAL BONE PROCS |
| 98 | 1 | 2,527 | 23 | 0.91 | OTHER EAR, NOSE, MOUTH & THROAT PROCEDURES |
| 98 | 2 | 1,686 | 62 | 3.68 | OTHER EAR, NOSE, MOUTH & THROAT PROCEDURES |
| 98 | 3 | 777 | 96 | 12.36 | OTHER EAR, NOSE, MOUTH & THROAT PROCEDURES |
| 120 | 1 | 7,690 | 77 | 1.00 | MAJOR RESPIRATORY & CHEST PROCEDURES |
| 120 | 2 | 5,108 | 121 | 2.37 | MAJOR RESPIRATORY & CHEST PROCEDURES |
| 120 | 3 | 1,091 | 117 | 10.72 | MAJOR RESPIRATORY & CHEST PROCEDURES |

| APR DRG | ROM | Eligible Admissions | 30-Day Deaths | Mortality Rate | Description |
|---|---|---|---|---|---|
| 121 | 1 | 10,565 | 109 | 1.03 | OTHER RESPIRATORY & CHEST PROCEDURES |
| 121 | 2 | 6,337 | 282 | 4.45 | OTHER RESPIRATORY & CHEST PROCEDURES |
| 121 | 3 | 5,414 | 956 | 17.66 | OTHER RESPIRATORY & CHEST PROCEDURES |
| 162 | 1 | 191 | 8 | 4.19 | CARDIAC VALVE PROCEDURES W AMI OR COMPLEX PDX |
| 162 | 2 | 1,101 | 42 | 3.81 | CARDIAC VALVE PROCEDURES W AMI OR COMPLEX PDX |
| 162 | 3 | 1,188 | 131 | 11.03 | CARDIAC VALVE PROCEDURES W AMI OR COMPLEX PDX |
| 163 | 1 | 6,281 | 37 | 0.59 | CARDIAC VALVE PROCEDURES W/O AMI OR COMPLEX PDX |
| 163 | 2 | 16,616 | 449 | 2.70 | CARDIAC VALVE PROCEDURES W/O AMI OR COMPLEX PDX |
| 163 | 3 | 4,854 | 393 | 8.10 | CARDIAC VALVE PROCEDURES W/O AMI OR COMPLEX PDX |
| 165 | 1 | 212 | 3 | 1.42 | CORONARY BYPASS W AMI OR COMPLEX PDX |
| 165 | 2 | 6,534 | 144 | 2.20 | CORONARY BYPASS W AMI OR COMPLEX PDX |
| 165 | 3 | 3,587 | 252 | 7.03 | CORONARY BYPASS W AMI OR COMPLEX PDX |
| 166 | 1 | 15,518 | 127 | 0.82 | CORONARY BYPASS W/O AMI OR COMPLEX PDX |
| 166 | 2 | 14,008 | 243 | 1.73 | CORONARY BYPASS W/O AMI OR COMPLEX PDX |
| 166 | 3 | 4,835 | 248 | 5.13 | CORONARY BYPASS W/O AMI OR COMPLEX PDX |
| 167 | 1 | 1,342 | 24 | 1.79 | OTHER CARDIOTHORACIC & THORACIC VASCULAR PROCS |
| 167 | 2 | 1,816 | 81 | 4.46 | OTHER CARDIOTHORACIC & THORACIC VASCULAR PROCS |
| 167 | 3 | 1,576 | 174 | 11.04 | OTHER CARDIOTHORACIC & THORACIC VASCULAR PROCS |
| 169 | 1 | 3,384 | 70 | 2.07 | MAJOR ABDOMINAL VASCULAR PROCEDURES |
| 169 | 2 | 5,133 | 269 | 5.24 | MAJOR ABDOMINAL VASCULAR PROCEDURES |
| 169 | 3 | 2,480 | 337 | 13.59 | MAJOR ABDOMINAL VASCULAR PROCEDURES |
| 170 | 1 | 53 | 1 | 1.89 | PERM CARDIAC PACEMAKER IMPLANT W AMI, HF, SHOCK |
| 170 | 2 | 176 | 13 | 7.39 | PERM CARDIAC PACEMAKER IMPLANT W AMI, HF, SHOCK |
| 170 | 3 | 360 | 46 | 12.78 | PERM CARDIAC PACEMAKER IMPLANT W AMI, HF, SHOCK |
| 171 | 1 | 14,465 | 53 | 0.37 | PERM CARDIAC PACEMAKER IMPLANT W/O AMI, HF, SHOCK |
| 171 | 2 | 15,651 | 212 | 1.35 | PERM CARDIAC PACEMAKER IMPLANT W/O AMI, HF, SHOCK |
| 171 | 3 | 9,758 | 430 | 4.41 | PERM CARDIAC PACEMAKER IMPLANT W/O AMI, HF, SHOCK |
| 174 | 1 | 26,690 | 212 | 0.79 | PERCUTANEOUS CARDIAC INTERVENTION W AMI |
| 174 | 2 | 25,673 | 768 | 2.99 | PERCUTANEOUS CARDIAC INTERVENTION W AMI |
| 174 | 3 | 12,175 | 1,045 | 8.58 | PERCUTANEOUS CARDIAC INTERVENTION W AMI |
| 175 | 1 | 26,662 | 84 | 0.32 | PERCUTANEOUS CARDIAC INTERVENTION W/O AMI |
| 175 | 2 | 26,991 | 373 | 1.38 | PERCUTANEOUS CARDIAC INTERVENTION W/O AMI |
| 175 | 3 | 15,132 | 729 | 4.82 | PERCUTANEOUS CARDIAC INTERVENTION W/O AMI |
| 176 | 1 | 634 | 6 | 0.95 | INSERTION, REVISION & REPLACEMENT OF CARDIAC DEVICES |
| 176 | 2 | 1,809 | 44 | 2.43 | INSERTION, REVISION & REPLACEMENT OF CARDIAC DEVICES |
| 176 | 3 | 1,742 | 83 | 4.76 | INSERTION, REVISION & REPLACEMENT OFCARDIAC DEVICES |

| APR DRG | ROM | Eligible Admissions | 30-Day Deaths | Mortality Rate | Description |
|---|---|---|---|---|---|
| 177 | 1 | 291 | 2 | 0.69 | CARDIAC PACEMAKER & DEFIBRILLATOR REVISION |
| 177 | 2 | 614 | 6 | 0.98 | CARDIAC PACEMAKER & DEFIBRILLATOR REVISION |
| 177 | 3 | 492 | 36 | 7.32 | CARDIAC PACEMAKER & DEFIBRILLATOR REVISION |
| 179 | 1 | 1,321 | 3 | 0.23 | DEFIBRILLATOR IMPLANTS |
| 179 | 2 | 4,830 | 87 | 1.80 | DEFIBRILLATOR IMPLANTS |
| 179 | 3 | 4,988 | 200 | 4.01 | DEFIBRILLATOR IMPLANTS |
| 180 | 1 | 1,117 | 16 | 1.43 | OTHER CIRCULATORY SYSTEM PROCEDURES |
| 180 | 2 | 3,075 | 109 | 3.54 | OTHER CIRCULATORY SYSTEM PROCEDURES |
| 180 | 3 | 3,981 | 377 | 9.47 | OTHER CIRCULATORY SYSTEM PROCEDURES |
| 181 | 1 | 12,315 | 122 | 0.99 | LOWER EXTREMITY ARTERIAL PROCEDURES |
| 181 | 2 | 9,609 | 346 | 3.60 | LOWER EXTREMITY ARTERIAL PROCEDURES |
| 181 | 3 | 3,505 | 390 | 11.13 | LOWER EXTREMITY ARTERIAL PROCEDURES |
| 182 | 1 | 18,931 | 168 | 0.89 | OTHER PERIPHERAL VASCULAR PROCEDURES |
| 182 | 2 | 22,205 | 718 | 3.23 | OTHER PERIPHERAL VASCULAR PROCEDURES |
| 182 | 3 | 14,707 | 1,274 | 8.66 | OTHER PERIPHERAL VASCULAR PROCEDURES |
| 183 | 1 | 5,571 | 55 | 0.99 | PERCUTANEOUS STRUCTURAL CARDIAC PROCEDURES |
| 183 | 2 | 20,623 | 247 | 1.20 | PERCUTANEOUS STRUCTURAL CARDIAC PROCEDURES |
| 183 | 3 | 8,140 | 295 | 3.62 | PERCUTANEOUS STRUCTURAL CARDIAC PROCEDURES |
| 220 | 1 | 12,179 | 137 | 1.12 | MAJOR STOMACH, ESOPHAGEAL & DUODENAL PROCEDURES |
| 220 | 2 | 4,926 | 270 | 5.48 | MAJOR STOMACH, ESOPHAGEAL & DUODENAL PROCEDURES |
| 220 | 3 | 2,309 | 366 | 15.85 | MAJOR STOMACH, ESOPHAGEAL & DUODENAL PROCEDURES |
| 222 | 1 | 1,234 | 20 | 1.62 | OTHER STOMACH, ESOPHAGEAL & DUODENAL PROCEDURES |
| 222 | 2 | 999 | 77 | 7.71 | OTHER STOMACH, ESOPHAGEAL & DUODENAL PROCEDURES |
| 222 | 3 | 797 | 165 | 20.70 | OTHER STOMACH, ESOPHAGEAL & DUODENAL PROCEDURES |
| 223 | 1 | 3,699 | 21 | 0.57 | OTHER SMALL & LARGE BOWEL PROCEDURES |
| 223 | 2 | 2,101 | 80 | 3.81 | OTHER SMALL & LARGE BOWEL PROCEDURES |
| 223 | 3 | 1,023 | 134 | 13.10 | OTHER SMALL & LARGE BOWEL PROCEDURES |
| 224 | 1 | 4,916 | 45 | 0.92 | PERITONEAL ADHESIOLYSIS |
| 224 | 2 | 3,394 | 134 | 3.95 | PERITONEAL ADHESIOLYSIS |
| 224 | 3 | 1,652 | 197 | 11.92 | PERITONEAL ADHESIOLYSIS |
| 226 | 1 | 1,811 | 10 | 0.55 | ANAL PROCEDURES |
| 226 | 2 | 965 | 27 | 2.80 | ANAL PROCEDURES |
| 226 | 3 | 380 | 28 | 7.37 | ANAL PROCEDURES |
| 227 | 1 | 14,881 | 88 | 0.59 | HERNIA PROCS EXCEPT INGUINAL, FEMORAL & UMBILICAL |
| 227 | 2 | 3,794 | 119 | 3.14 | HERNIA PROCS EXCEPT INGUINAL, FEMORAL & UMBILICAL |
| 227 | 3 | 583 | 65 | 11.15 | HERNIA PROCS EXCEPT INGUINAL, FEMORAL & UMBILICAL |
| 228 | 1 | 5,517 | 56 | 1.02 | INGUINAL, FEMORAL & UMBILICAL HERNIA PROCEDURES |
| 228 | 2 | 2,462 | 83 | 3.37 | INGUINAL, FEMORAL & UMBILICAL HERNIA PROCEDURES |
| 228 | 3 | 441 | 38 | 8.62 | INGUINAL, FEMORAL & UMBILICAL HERNIA PROCEDURES |

| APR DRG | ROM | Eligible Admissions | 30-Day Deaths | Mortality Rate | Description |
|---|---|---|---|---|---|
| 229 | 1 | 2,333 | 31 | 1.33 | OTHER DIGESTIVE SYSTEM & ABDOMINAL PROCEDURES |
| 229 | 2 | 2,839 | 184 | 6.48 | OTHER DIGESTIVE SYSTEM & ABDOMINAL PROCEDURES |
| 229 | 3 | 2,554 | 479 | 18.75 | OTHER DIGESTIVE SYSTEM & ABDOMINAL PROCEDURES |
| 230 | 1 | 16,029 | 260 | 1.62 | MAJOR SMALL BOWEL PROCEDURES |
| 230 | 2 | 12,451 | 721 | 5.79 | MAJOR SMALL BOWEL PROCEDURES |
| 230 | 3 | 7,690 | 1,281 | 16.66 | MAJOR SMALL BOWEL PROCEDURES |
| 231 | 1 | 36,067 | 289 | 0.80 | MAJOR LARGE BOWEL PROCEDURES |
| 231 | 2 | 19,277 | 770 | 3.99 | MAJOR LARGE BOWEL PROCEDURES |
| 231 | 3 | 6,728 | 884 | 13.14 | MAJOR LARGE BOWEL PROCEDURES |
| 232 | 1 | 432 | 2 | 0.46 | GASTRIC FUNDOPLICATION |
| 232 | 2 | 92 | 0 | 0.00 | GASTRIC FUNDOPLICATION |
| 232 | 3 | 12 | 3 | 25.00 | GASTRIC FUNDOPLICATION |
| 233 | 1 | 3,764 | 8 | 0.21 | APPENDECTOMY WITH COMPLEX PRINCIPAL DIAGNOSIS |
| 233 | 2 | 1,140 | 9 | 0.79 | APPENDECTOMY WITH COMPLEX PRINCIPAL DIAGNOSIS |
| 233 | 3 | 298 | 10 | 3.36 | APPENDECTOMY WITH COMPLEX PRINCIPAL DIAGNOSIS |
| 234 | 1 | 3,089 | 2 | 0.06 | APPENDECTOMY WITHOUT COMPLEX PRINCIPAL DIAGNOSIS |
| 234 | 2 | 888 | 10 | 1.13 | APPENDECTOMY WITHOUT COMPLEX PRINCIPAL DIAGNOSIS |
| 234 | 3 | 207 | 7 | 3.38 | APPENDECTOMY WITHOUT COMPLEX PRINCIPAL DIAGNOSIS |
| 260 | 1 | 3,648 | 74 | 2.03 | MAJOR PANCREAS, LIVER & SHUNT PROCEDURES |
| 260 | 2 | 3,337 | 94 | 2.82 | MAJOR PANCREAS, LIVER & SHUNT PROCEDURES |
| 260 | 3 | 870 | 86 | 9.89 | MAJOR PANCREAS, LIVER & SHUNT PROCEDURES |
| 261 | 1 | 499 | 5 | 1.00 | MAJOR BILIARY TRACT PROCEDURES |
| 261 | 2 | 476 | 25 | 5.25 | MAJOR BILIARY TRACT PROCEDURES |
| 261 | 3 | 216 | 41 | 18.98 | MAJOR BILIARY TRACT PROCEDURES |
| 263 | 1 | 27,570 | 113 | 0.41 | CHOLECYSTECTOMY |
| 263 | 2 | 15,091 | 242 | 1.60 | CHOLECYSTECTOMY |
| 263 | 3 | 5,288 | 277 | 5.24 | CHOLECYSTECTOMY |
| 264 | 1 | 627 | 15 | 2.39 | OTHER HEPATOBILIARY, PANCREAS & ABDOMINAL PROCS |
| 264 | 2 | 971 | 86 | 8.86 | OTHER HEPATOBILIARY, PANCREAS & ABDOMINAL PROCS |
| 264 | 3 | 629 | 160 | 25.44 | OTHER HEPATOBILIARY, PANCREAS & ABDOMINAL PROCS |
| 301 | 1 | 170,548 | 706 | 0.41 | HIP JOINT REPLACEMENT |
| 301 | 2 | 46,368 | 1,777 | 3.83 | HIP JOINT REPLACEMENT |
| 301 | 3 | 9,124 | 1,165 | 12.77 | HIP JOINT REPLACEMENT |
| 302 | 1 | 224,375 | 199 | 0.09 | KNEE JOINT REPLACEMENT |
| 302 | 2 | 35,164 | 180 | 0.51 | KNEE JOINT REPLACEMENT |
| 302 | 3 | 2,181 | 80 | 3.67 | KNEE JOINT REPLACEMENT |
| 303 | 1 | 3,453 | 16 | 0.46 | DORSAL & LUMBAR FUSION PROC FOR CURVATURE OF BACK |
| 303 | 2 | 791 | 19 | 2.40 | DORSAL & LUMBAR FUSION PROC FOR CURVATURE OF BACK |
| 303 | 3 | 98 | 2 | 2.04 | DORSAL & LUMBAR FUSION PROC FOR CURVATURE OF BACK |

| APR DRG | ROM | Eligible Admissions | 30-Day Deaths | Mortality Rate | Description |
|---|---|---|---|---|---|
| 304 | 1 | 72,713 | 159 | 0.22 | DORSAL & LUMBAR FUSION PROC EXCEPT CURVATURE BACK |
| 304 | 2 | 13,923 | 147 | 1.06 | DORSAL & LUMBAR FUSION PROC EXCEPT CURVATURE BACK |
| 304 | 3 | 1,674 | 104 | 6.21 | DORSAL & LUMBAR FUSION PROC EXCEPT CURVATURE BACK |
| 305 | 1 | 3,681 | 31 | 0.84 | AMPUTATION OF LOWER LIMB EXCEPT TOES |
| 305 | 2 | 12,414 | 490 | 3.95 | AMPUTATION OF LOWER LIMB EXCEPT TOES |
| 305 | 3 | 9,814 | 913 | 9.30 | AMPUTATION OF LOWER LIMB EXCEPT TOES |
| 308 | 1 | 46,720 | 977 | 2.09 | HIP & FEMUR FRACTURE REPAIR |
| 308 | 2 | 41,242 | 2,825 | 6.85 | HIP & FEMUR FRACTURE REPAIR |
| 308 | 3 | 13,815 | 2,041 | 14.77 | HIP & FEMUR FRACTURE REPAIR |
| 309 | 1 | 4,605 | 38 | 0.83 | OTHER SIGNIFICANT HIP & FEMUR SURGERY |
| 309 | 2 | 3,237 | 103 | 3.18 | OTHER SIGNIFICANT HIP & FEMUR SURGERY |
| 309 | 3 | 1,361 | 150 | 11.02 | OTHER SIGNIFICANT HIP & FEMUR SURGERY |
| 310 | 1 | 12,494 | 45 | 0.36 | INTERVERTEBRAL DISC EXCISION & DECOMPRESSION |
| 310 | 2 | 3,546 | 69 | 1.95 | INTERVERTEBRAL DISC EXCISION & DECOMPRESSION |
| 310 | 3 | 720 | 57 | 7.92 | INTERVERTEBRAL DISC EXCISION & DECOMPRESSION |
| 312 | 1 | 692 | 5 | 0.72 | SKIN GRAFT, EX HAND, FOR MUSCULOSKEL & CONN TISSUE |
| 312 | 2 | 804 | 18 | 2.24 | SKIN GRAFT, EX HAND, FOR MUSCULOSKEL & CONN TISSUE |
| 312 | 3 | 456 | 29 | 6.36 | SKIN GRAFT, EX HAND, FOR MUSCULOSKEL & CONN TISSUE |
| 313 | 1 | 20,589 | 79 | 0.38 | KNEE & LOWER LEG PROCEDURES EXCEPT FOOT |
| 313 | 2 | 9,624 | 210 | 2.18 | KNEE & LOWER LEG PROCEDURES EXCEPT FOOT |
| 313 | 3 | 3,152 | 152 | 4.82 | KNEE & LOWER LEG PROCEDURES EXCEPT FOOT |
| 314 | 1 | 6,118 | 27 | 0.44 | FOOT & TOE PROCEDURES |
| 314 | 2 | 9,451 | 123 | 1.30 | FOOT & TOE PROCEDURES |
| 314 | 3 | 5,822 | 222 | 3.81 | FOOT & TOE PROCEDURES |
| 315 | 1 | 10,324 | 38 | 0.37 | SHOULDER, ARM PROCS EXCEPT JOINT REPLACEMENT |
| 315 | 2 | 5,232 | 151 | 2.89 | SHOULDER, ARM PROCS EXCEPT JOINT REPLACEMENT |
| 315 | 3 | 1,509 | 119 | 7.89 | SHOULDER, ARM PROS EXCEPT JOINT REPLACEMENT |
| 316 | 1 | 1,819 | 6 | 0.33 | HAND & WRIST PROCEDURES |
| 316 | 2 | 884 | 14 | 1.58 | HAND & WRIST PROCEDURES |
| 316 | 3 | 352 | 12 | 3.41 | HAND & WRIST PROCEDURES |
| 317 | 1 | 4,143 | 19 | 0.46 | TENDON, MUSCLE & OTHER SOFT TISSUE PROCEDURES |
| 317 | 2 | 2,965 | 60 | 2.02 | TENDON, MUSCLE & OTHER SOFT TISSUE PROCEDURES |
| 317 | 3 | 1,503 | 112 | 7.45 | TENDON, MUSCLE & OTHER SOFT TISSUE PROCEDURES |
| 320 | 1 | 15,053 | 44 | 0.29 | OTHER MUSCULOSKELETAL SYSTEM & CONN TISSUE PROCS |
| 320 | 2 | 4,780 | 48 | 1.00 | OTHER MUSCULOSKELETAL SYSTEM & CONN TISSUE PROCS |
| 320 | 3 | 1,292 | 92 | 7.12 | OTHER MUSCULOSKELETAL SYSTEM & CONN TISSUE PROCS |

| APR DRG | ROM | Eligible Admissions | 30-Day Deaths | Mortality Rate | Description |
|---|---|---|---|---|---|
| 321 | 1 | 31,802 | 135 | 0.42 | CERV SPINAL FUSION & BACK/NECK PROC EX DISC EXCIS |
| 321 | 2 | 11,297 | 282 | 2.50 | CERV SPINAL FUSION & BACK/NECK PROC EX DISC EXCIS |
| 321 | 3 | 2,647 | 258 | 9.75 | CERV SPINAL FUSION & BACK/NECK PROC EX DISC EXCIS |
| 322 | 1 | 51,264 | 53 | 0.10 | SHOULDER & ELBOW JOINT REPLACEMENT |
| 322 | 2 | 9,108 | 52 | 0.57 | SHOULDER & ELBOW JOINT REPLACEMENT |
| 322 | 3 | 614 | 21 | 3.42 | SHOULDER & ELBOW JOINT REPLACEMENT |
| 361 | 1 | 2,909 | 19 | 0.65 | SKIN GRAFT FOR SKIN & SUBCUTANEOUS TISSUE DIAGNOSES |
| 361 | 2 | 3,274 | 79 | 2.41 | SKIN GRAFT FOR SKIN & SUBCUTANEOUS TISSUE DIAGNOSES |
| 361 | 3 | 1,387 | 69 | 4.97 | SKIN GRAFT FOR SKIN & SUBCUTANEOUS TISSUE DIAGNOSES |
| 362 | 1 | 2,605 | 2 | 0.08 | MASTECTOMY PROCEDURES |
| 362 | 2 | 1,484 | 13 | 0.88 | MASTECTOMY PROCEDURES |
| 362 | 3 | 94 | 5 | 5.32 | MASTECTOMY PROCEDURES |
| 363 | 1 | 1,756 | 5 | 0.28 | BREAST PROCEDURES EXCEPT MASTECTOMY |
| 363 | 2 | 259 | 6 | 2.32 | BREAST PROCEDURES EXCEPT MASTECTOMY |
| 363 | 3 | 53 | 8 | 15.09 | BREAST PROCEDURES EXCEPT MASTECTOMY |
| 364 | 1 | 6,626 | 45 | 0.68 | OTHER SKIN, SUBCUTANEOUS TISSUE & RELATED PROCS |
| 364 | 2 | 6,696 | 172 | 2.57 | OTHER SKIN, SUBCUTANEOUS TISSUE & RELATED PROCS |
| 364 | 3 | 3,289 | 314 | 9.55 | OTHER SKIN, SUBCUTANEOUS TISSUE & RELATED PROCS |
| 401 | 1 | 754 | 2 | 0.27 | ADRENAL PROCEDURES |
| 401 | 2 | 345 | 3 | 0.87 | ADRENAL PROCEDURES |
| 401 | 3 | 62 | 6 | 9.68 | ADRENAL PROCEDURES |
| 403 | 1 | 13,289 | 27 | 0.20 | PROCEDURES FOR OBESITY |
| 403 | 2 | 3,094 | 13 | 0.42 | PROCEDURES FOR OBESITY |
| 403 | 3 | 213 | 11 | 5.16 | PROCEDURES FOR OBESITY |
| 404 | 1 | 2,085 | 7 | 0.34 | THYROID, PARATHYROID & THYROGLOSSAL PROCEDURES |
| 404 | 2 | 1,328 | 15 | 1.13 | THYROID, PARATHYROID & THYROGLOSSAL PROCEDURES |
| 404 | 3 | 293 | 19 | 6.48 | THYROID, PARATHYROID & THYROGLOSSAL PROCEDURES |
| 405 | 1 | 304 | 2 | 0.66 | PROCS FOR ENDO, NUTRITIONAL & METABOLIC DISORDER |
| 405 | 2 | 920 | 52 | 5.65 | PROCS FOR ENDO, NUTRITIONAL & METABOLIC DISORDERS |
| 405 | 3 | 1,170 | 108 | 9.23 | PROCS FOR ENDO, NUTRITIONAL & METABOLIC DISORDERS |
| 441 | 1 | 2,199 | 31 | 1.41 | MAJOR BLADDER PROCEDURES |
| 441 | 2 | 2,072 | 78 | 3.76 | MAJOR BLADDER PROCEDURES |
| 441 | 3 | 432 | 40 | 9.26 | MAJOR BLADDER PROCEDURES |
| 442 | 1 | 7,731 | 31 | 0.40 | KIDNEY & URINARY TRACT PROCEDURES FOR MALIGNANCY |
| 442 | 2 | 4,590 | 60 | 1.31 | KIDNEY & URINARY TRACT PROCEDURES FOR MALIGNANCY |
| 442 | 3 | 955 | 59 | 6.18 | KIDNEY & URINARY TRACT PROCEDURES FOR MALIGNANCY |

| APR DRG | ROM | Eligible Admissions | 30-Day Deaths | Mortality Rate | Description |
|---|---|---|---|---|---|
| 443 | 1 | 6,573 | 17 | 0.26 | KIDNEY & URINARY TRACT PROCEDURES FOR NONMALIG |
| 443 | 2 | 3,713 | 61 | 1.64 | KIDNEY & URINARY TRACT PROCEDURES FOR NONMALIG |
| 443 | 3 | 1,715 | 108 | 6.30 | KIDNEY & URINARY TRACT PROCEDURES FOR NONMALIG |
| 444 | 1 | 252 | 0 | 0.00 | RENAL DIALYSIS ACCESS DEVICE PROCS & VESSEL REPAIR |
| 444 | 2 | 2,008 | 23 | 1.15 | RENAL DIALYSIS ACCESS DEVICE PROCS & VESSEL REPAIR |
| 444 | 3 | 1,639 | 88 | 5.37 | RENAL DIALYSIS ACCESS DEVICE PROCS & VESSEL REPAIR |
| 445 | 1 | 2,045 | 25 | 1.22 | OTHER BLADDER PROCEDURES |
| 445 | 2 | 1,104 | 55 | 4.98 | OTHER BLADDER PROCEDURES |
| 445 | 3 | 292 | 40 | 13.70 | OTHER BLADDER PROCEDURES |
| 446 | 1 | 7,444 | 86 | 1.16 | URETHRAL & TRANSURETHRAL PROCEDURES |
| 446 | 2 | 6,209 | 253 | 4.07 | URETHRAL & TRANSURETHRAL PROCEDURES |
| 446 | 3 | 1,376 | 159 | 11.56 | URETHRAL & TRANSURETHRAL PROCEDURES |
| 447 | 1 | 364 | 6 | 1.65 | OTHER KIDNEY, URINARY TRACT & RELATED PROCEDURES |
| 447 | 2 | 1,634 | 63 | 3.86 | OTHER KIDNEY, URINARY TRACT & RELATED PROCEDURES |
| 447 | 3 | 1,183 | 111 | 9.38 | OTHER KIDNEY, URINARY TRACT & RELATED PROCEDURES |
| 480 | 1 | 6,374 | 20 | 0.31 | MAJOR MALE PELVIC PROCEDURES |
| 480 | 2 | 955 | 9 | 0.94 | MAJOR MALE PELVIC PROCEDURES |
| 480 | 3 | 74 | 1 | 1.35 | MAJOR MALE PELVIC PROCEDURES |
| 482 | 1 | 4,336 | 16 | 0.37 | TRANSURETHRAL PROSTATECTOMY |
| 482 | 2 | 2,058 | 30 | 1.46 | TRANSURETHRAL PROSTATECTOMY |
| 482 | 3 | 581 | 39 | 6.71 | TRANSURETHRAL PROSTATECTOMY |
| 483 | 1 | 1,202 | 7 | 0.58 | PENIS, TESTES & SCROTAL PROCEDURES |
| 483 | 2 | 362 | 13 | 3.59 | PENIS, TESTES & SCROTAL PROCEDURES |
| 483 | 3 | 87 | 6 | 6.90 | PENIS, TESTES & SCROTAL PROCEDURES |
| 484 | 1 | 4,313 | 7 | 0.16 | OTHER MALE REPRODUCTIVE SYSTEM & RELATED PROCS |
| 484 | 2 | 775 | 13 | 1.68 | OTHER MALE REPRODUCTIVE SYSTEM & RELATED PROCS |
| 484 | 3 | 166 | 17 | 10.24 | OTHER MALE REPRODUCTIVE SYSTEM & RELATED PROCS |
| 510 | 1 | 765 | 0 | 0.00 | PELVIC EVISC, RADICAL HYSTERECT & RADICAL GYN PROCS |
| 510 | 2 | 477 | 1 | 0.21 | PELVIC EVISC, RADICAL HYSTERECT & RADICAL GYN PROCS |
| 510 | 3 | 87 | 3 | 3.45 | PELVIC EVISC, RADICAL HYSTERECT & RADICAL GYN PROCS |
| 511 | 1 | 860 | 6 | 0.70 | UTERINE & ADNEXA PROCS FOR OVARIAN & ADNEXAL MALIG |
| 511 | 2 | 1,582 | 11 | 0.70 | UTERINE & ADNEXA PROCS FOR OVARIAN & ADNEXAL MALIG |
| 511 | 3 | 673 | 30 | 4.46 | UTERINE & ADNEXA PROCS FOR OVARIAN & ADNEXAL MALIG |
| 512 | 1 | 2,685 | 12 | 0.45 | UTERINE & ADNEXA PROCS EX OVARIAN & ADNEXAL MALIG |

| APR DRG | ROM | Eligible Admissions | 30-Day Deaths | Mortality Rate | Description |
|---|---|---|---|---|---|
| 512 | 2 | 1,271 | 25 | 1.97 | UTERINE & ADNEXA PROCS EX OVARIAN & ADNEXAL MALIG |
| 512 | 3 | 270 | 18 | 6.67 | UTERINE & ADNEXA PROCS EX OVARIAN & ADNEXAL MALIG |
| 513 | 1 | 7,208 | 9 | 0.12 | UTERINE & ADNEXA PROCS FOR NON-MALIG EX LEIOMYOMA |
| 513 | 2 | 1,026 | 9 | 0.88 | UTERINE & ADNEXA PROCS FOR NON-MALIG EX LEIOMYOMA |
| 513 | 3 | 182 | 7 | 3.85 | UTERINE & ADNEXA PROCS FOR NON-MALIG EX LEIOMYOMA |
| 514 | 1 | 2,225 | 4 | 0.18 | FEMALE REPRODUCTIVE SYSTEM RECONSTRUCTIVE PROCS |
| 514 | 2 | 241 | 1 | 0.41 | FEMALE REPRODUCTIVE SYSTEM RECONSTRUCTIVE PROCS |
| 514 | 3 | 26 | 0 | 0.00 | FEMALE REPRODUCTIVE SYSTEM RECONSTRUCTIVE PROCS |
| 517 | 1 | 399 | 5 | 1.25 | DILATION & CURETTAGE FOR NON-OBSTETRIC DIAGNOSES |
| 517 | 2 | 312 | 17 | 5.45 | DILATION & CURETTAGE FOR NON-OBSTETRIC DIAGNOSES |
| 517 | 3 | 80 | 6 | 7.50 | DILATION & CURETTAGE FOR NON-OBSTETRIC DIAGNOSES |
| 518 | 1 | 1,284 | 6 | 0.47 | OTHER FEMALE REPRODUCTIVE SYSTEM & RELATED PROCS |
| 518 | 2 | 763 | 11 | 1.44 | OTHER FEMALE REPRODUCTIVE SYSTEM & RELATED PROCS |
| 518 | 3 | 212 | 26 | 12.26 | OTHER FEMALE REPRODUCTIVE SYSTEM & RELATED PROCS |
| 519 | 1 | 1,779 | 4 | 0.22 | UTERINE & ADNEXA PROCEDURES FOR LEIOMYOMA |
| 519 | 2 | 209 | 1 | 0.48 | UTERINE & ADNEXA PROCEDURES FOR LEIOMYOMA |
| 519 | 3 | 38 | 0 | 0.00 | UTERINE & ADNEXA PROCEDURES FOR LEIOMYOMA |
| 650 | 1 | 273 | 3 | 1.10 | SPLENECTOMY |
| 650 | 2 | 195 | 8 | 4.10 | SPLENECTOMY |
| 650 | 3 | 143 | 19 | 13.29 | SPLENECTOMY |
| 651 | 1 | 503 | 3 | 0.60 | OTHER PROCS OF BLOOD & BLOOD-FORMING ORGANS |
| 651 | 2 | 291 | 6 | 2.06 | OTHER PROCS OF BLOOD & BLOOD-FORMING ORGANS |
| 651 | 3 | 115 | 13 | 11.30 | OTHER PROCS OF BLOOD & BLOOD-FORMING ORGANS |
| 680 | 1 | 1,431 | 24 | 1.68 | MAJOR PROCS LYMPHATIC/HEMATOPOIETIC/OTH NEOPL |
| 680 | 2 | 1,349 | 61 | 4.52 | MAJOR PROCS LYMPHATIC/HEMATOPOIETIC/OTH NEOPL |
| 680 | 3 | 607 | 101 | 16.64 | MAJOR PROCS LYMPHATIC/HEMATOPOIETIC/OTH NEOPL |
| 681 | 1 | 1,610 | 32 | 1.99 | OTHER PROCS LYMPHATIC/HEMATOPOIETIC/OTH NEOPL |
| 681 | 2 | 2,040 | 138 | 6.76 | OTHER PROCS LYMPHATIC/HEMATOPOIETIC/OTH NEOPL |
| 681 | 3 | 1,034 | 310 | 29.98 | OTHER PROCS LYMPHATIC/HEMATOPOIETIC/OTH NEOPL |
| 710 | 1 | 913 | 5 | 0.55 | INFECTIOUS & PARASITIC DISEASES INCLUDING HIV W PROC |

| APR DRG | ROM | Eligible Admissions | 30-Day Deaths | Mortality Rate | Description |
|---|---|---|---|---|---|
| 710 | 2 | 16,143 | 436 | 2.70 | INFECTIOUS & PARASITIC DISEASES INCLUDING HIV W PROC |
| 710 | 3 | 24,724 | 3,031 | 12.26 | INFECTIOUS & PARASITIC DISEASES INCLUDING HIV W PROC |
| 711 | 1 | 4,157 | 15 | 0.36 | POST-OP, POST-TRAUMA, DEVICE INFECTIONS W PROCS |
| 711 | 2 | 4,131 | 67 | 1.62 | POST-OP, POST-TRAUMA, DEVICE INFECTIONS W PROCS |
| 711 | 3 | 3,566 | 192 | 5.38 | POST-OP, POST-TRAUMA, DEVICE INFECTIONS W PROCS |
| 792 | 1 | 1,803 | 18 | 1.00 | EXTENSIVE PROCS FOR COMPLICATION OF TREATMENT |
| 792 | 2 | 1,496 | 35 | 2.34 | EXTENSIVE PROCS FOR COMPLICATION OF TREATMENT |
| 792 | 3 | 1,259 | 109 | 8.66 | EXTENSIVE PROCS FOR COMPLICATION OF TREATMENT |
| 793 | 1 | 3,027 | 8 | 0.26 | MOD EXTENSIVE PROCS FOR COMPLICATION OF TREATMENT |
| 793 | 2 | 2,399 | 46 | 1.92 | MOD EXTENSIVE PROCS FOR COMPLICATION OF TREATMENT |
| 793 | 3 | 1,389 | 83 | 5.98 | MOD EXTENSIVE PROCS FOR COMPLICATION OF TREATMENT |
| 794 | 1 | 568 | 2 | 0.35 | NON-EXTENSIVE PROCS FOR COMPLICATION OF TREATMENT |
| 794 | 2 | 440 | 5 | 1.14 | NON-EXTENSIVE PROCS FOR COMPLICATION OF TREATMENT |
| 794 | 3 | 233 | 13 | 5.58 | NON-EXTENSIVE PROCS FOR COMPLICATION OF TREATMENT |
| 850 | 1 | 5,844 | 15 | 0.26 | PROCEDURE FOR REHAB, AFTERCARE OR OTH CONTACTS |
| 850 | 2 | 1,887 | 39 | 2.07 | PROCEDURE FOR REHAB, AFTERCARE OR OTH CONTACTS |
| 850 | 3 | 533 | 55 | 10.32 | PROCEDURE FOR REHAB, AFTERCARE OR OTH CONTACTS |

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