

Measure Information Form
Collected For: CMS Efficiency Measures (Claims Based)

Measure Set: CMS Payment Measures

Set Measure ID#: MSPB-1

Performance Measure Name: Medicare Spending Per Beneficiary (MSPB)

Description: The *Medicare Spending per Beneficiary (MSPB) Measure* evaluates hospitals' efficiency relative to the efficiency of the median hospital. Specifically, the *MSPB Measure* assesses the cost to Medicare of services performed by hospitals and other healthcare providers during an MSPB episode, which comprises the period immediately prior to, during, and following a patient's hospital stay.

Rationale: In the U.S., healthcare costs consume an ever-increasing amount of our Nation's resources. One source of these rising healthcare costs is payment systems that reward medical inputs rather than outcomes. Medicare is transforming from a system that rewards volume of service to one that rewards efficient, effective care and reduces delivery system fragmentation. To advance this transformation, CMS provides financial incentives to hospitals based on their performance on selected quality measures. These measures include evaluations of hospitals' clinical process of care, patient perspective of care, outcomes, and efficiency. By measuring the cost of care through the *MSPB Measure*, CMS aims to reward hospitals that can provide efficient care at a lower cost to Medicare. The FY 2012 and FY 2013 Inpatient Prospective Payment System (IPPS) Final Rules contains additional discussion of the *MSPB Measure*.

Type of Measure: Cost/Resource Use

Improvement Noted As: Improvement on this measure for a hospital would be observed as a lower MSPB Measure value across subsequent performance periods. A lower MSPB Measure value indicates that a given hospital spends less, relative to the national median *MSPB Amount* across all hospitals, during a given performance period. We note that results of the MSPB Measure alone do not necessarily reflect the quality of care provided by hospitals. Accordingly, lower MSPB Measures (i.e., lower Medicare spending per beneficiary) should not be interpreted as better care. The MSPB Measure is most meaningful when presented in the context of other quality measures part of the Hospital Value-Based Purchasing (HVBP) Program. As part of the HVBP Program, the MSPB Measure is aligned with current quality of care measures to facilitate profiling hospital value (payments and quality).

Numerator Statement: A hospital's average *MSPB Amount*, defined as the sum of standardized, risk-adjusted spending across all of a hospital's eligible episodes divided by the number of episodes for that hospital.

Denominator Statement: The median *MSPB Amount* across all episodes nationally.

Episode Definition:

An MSPB episode will include all claims with start date falling between 3 days prior to an inpatient PPS hospital admission (index admission) through 30 days post-hospital discharge. An episode includes the time period 30 days post-hospital discharge in order to emphasize the importance of care transitions and care coordination in improving patient care. Only discharges occurring prior to 30 days before the end of the measurement period are counted as index admissions. Admissions which occur within 30 days of discharge from another index admission are not considered to be index admissions.

Payments made by Medicare and the beneficiary (i.e., allowed charges) are counted in the MSPB episode as long as the start of the claim falls within the 30-day threshold. IPPS outlier payments (and outlier payments in other provider settings) are also included in the calculation of the *MSPB Measure*.

Included Populations:

Beneficiary populations eligible for the MSPB calculation include Medicare beneficiaries enrolled in Medicare Parts A and B who were discharged from short-term acute hospitals during the period of performance. Specifically, Medicare Part A and Medicare Part B claims from beneficiaries with an index admission within a subsection (d) hospital¹ are included in the MSPB episode if the beneficiary has been enrolled in Medicare Part A and Part B for the period 90 days prior to the start of an episode (i.e., 93 days prior to the date of the index admission) until the 30 days after discharge. Defining the population in this manner ensures that each beneficiary's claims record contains sufficient fee-for-service data both for measuring spending levels and for risk adjustment purposes.

Only claims for beneficiaries admitted to subsection (d) hospitals during the period of performance are included in the calculation of the *MSPB Measure*. Subsection (d) hospitals are hospitals in the 50 States and D.C. other than: psychiatric hospitals, rehabilitation hospitals, hospitals whose inpatients are predominantly under 18 years old, hospitals whose average inpatient length of stay exceeds 25 days, and hospitals involved extensively in treatment for or research on cancer. The claims for inpatient

¹ Claims reported by hospitals participating in the Medicare Acute Care Episode (ACE) Demonstration are also included in the *MSPB Measure* calculation. In ACE Demonstration hospitals, physicians submit claims as usual, but ACE claims are categorized as "no pay." As a result, they show up in the standardized payment; consequently, ACE demonstration episodes are included in the *MSPB Measure*.

admissions to subsection (d) hospitals are grouped into “stays” by beneficiary, admission date, and provider.

Excluded Populations:

Populations excluded from the MSPB calculation include any episodes where at any time during the episode, the beneficiary is enrolled in a Medicare Advantage plan; the beneficiary becomes deceased; the beneficiary is covered by the Railroad Retirement Board; or Medicare is the secondary payer. Regarding beneficiaries whose primary insurance becomes Medicaid during an episode due to exhaustion of Medicare Part A benefits, Medicaid payments made for services rendered to these beneficiaries are excluded; however, all Medicare Part A payments made before benefits are exhausted and all Medicare Part B payments made during the episode are included.

In addition, acute-to-acute transfers (where a transfer is defined based on the claim discharge or source code) will not be considered index admissions. In other words, these cases will not generate new MSPB episodes; neither the hospital which transfers a patient to another subsection (d) hospital, nor the receiving subsection (d) hospital will have an index admission attributed to them. Further, any episode in which the index admission inpatient claim has a \$0 actual payment or a \$0 standardized payment is excluded.

Index admissions to hospitals that Medicare does not reimburse through the IPPS system (e.g., cancer hospitals, critical access hospitals, hospitals in Maryland) are not eligible to begin an MSPB episode.

Price Standardization:

To capture differences in beneficiary resource use that a hospital can influence through appropriate practices and care coordination, the *MSPB Measure* removes sources of variation which are not directly related to decisions to utilize care, such as local or regional price differences. The *MSPB Measure* relies on a detailed price standardization methodology to exclude geographic payment rate differences; in other words, the *MSPB Measure* adjusts observed payments for Medicare geographic adjustment factors, such as the hospital wage index and geographic practice cost index (GPCI). Specifically, the price standardization methodology:

- Eliminates adjustments made to national payment amounts to reflect differences in regional labor costs and practice expenses (measured by hospital wage indexes and geographic practice cost indexes);
- Substitutes a national amount in the case of services paid on the basis of state fee schedules;
- Eliminates payments to hospitals for graduate indirect medical education (IME) and for serving a disproportionate population of poor and uninsured (i.e., disproportionate share payments (DSH));

- Maintains differences that exist in actual payments resulting from:
 - the choice of setting in which a services is provided,
 - the choice about who provides the service,
 - the choice as to whether to provide multiple services in the same encounter, and
 - differences in provider experience with regard to outlier cases; and
- Treats outlier payments as a given rather than trying to determine what outlier payment would have been in a standardized world. Actual outlier payments are adjusted for differences in wages using the wage index.

Full details of the price standardization methodology for the *MSPB Measure* are available at:

<http://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier4&cid=1228772057350>.

Risk Adjustment:

To account for case-mix variation and other factors, the MSPB risk adjustment methodology adjusts the *MSPB Measure* for age and severity of illness. The model broadly follows the CMS-HCC risk adjustment methodology, which is derived from Medicare Part A and B claims and is used in the Medicare Advantage (MA) program.² Although the MA risk adjustment model includes 24 age/sex variables, the MSPB methodology does not adjust for sex, and only includes 12 age categorical variables in the risk adjustment methodology. Severity of illness is measured using 70 hierarchical condition category (HCC) indicators derived from the beneficiary's claims during the period 90 days prior to the start of the episode, an indicator of whether the beneficiary recently required long-term care, as well as the MS-DRG of the index hospitalization. As described above, episodes where the beneficiary is not enrolled in both Medicare Part A and Medicare Part B for the 90 days prior to the episode are excluded. This "look back period" captures beneficiaries' comorbidities in the risk adjustment. The MSPB risk adjustment methodology also includes status indicator variables for whether the beneficiary qualifies for Medicare through Disability or End-Stage Renal Disease (ESRD) and whether a beneficiary resides in a long-term care facility as non-diagnostic measures of severity of illness. Because the relationship between comorbidities' episode cost may be non-linear in some cases (i.e., beneficiaries may also have more than one disease during a hospitalization episode), the model also takes into account interactions between HCCs and/or enrollment status variables that are included in the MA model. The MSPB risk adjustment method does not control for the beneficiary's sex

² Centers for Medicare and Medicaid Services, Office of the Actuary. "Announcement of Calendar Year (CY) 2009 Medicare Advantage Capitation Rates and Medicare Advantage and Part D Payment Policies." April 2008. <http://www.cms.gov/MedicareAdvtgSpecRateStats/Downloads/Announcement2009.pdf>

and race. For a complete description of MSPB risk adjustment methodology, see the “Measure Calculation” section below.

Tables 1 through 6 present the final set of risk-adjustment variables:

Table 1: Age Variables

Indicator Variable	Description Label
0-34	Age between 0 and 34 years old
35-44	Age between 35 and 44 years old
45-54	Age between 45 and 54 years old
55-59	Age between 55 and 59 years old
60-64	Age between 60 and 64 years old
65-69	Age between 65 and 69 years old (reference category) ³
70-74	Age between 70 and 74 years old
75-79	Age between 75 and 79 years old
80-84	Age between 80 and 84 years old
85-89	Age between 85 and 89 years old
90-94	Age between 90 and 94 years old
95+	Age greater than or equal to 95 years old

Table 2: Severity of Illness Measures

Indicator Variable	Description Label
HCC1	HIV/AIDS
HCC2	Septicemia/Shock
HCC5	Opportunistic Infections
HCC7	Metastatic Cancer and Acute Leukemia
HCC8	Lung, Upper Digestive, and Other Severe Cancers
HCC9	Lymphatic, Head and Neck, Brain, and Other Cancers
HCC10	Breast, Prostate, Colorectal, and Other Cancers and Tumors
HCC15	Diabetes with Renal or Peripheral Circulatory Manifestation
HCC16	Diabetes with Neurologic or Other Specified Manifestation
HCC17	Diabetes with Acute Complications
HCC18	Diabetes with Ophthalmologic or Unspecified Manifestation
HCC19	Diabetes without Complication
HCC21	Protein-Calorie Malnutrition
HCC25	End-Stage Liver Disease
HCC26	Cirrhosis of Liver
HCC27	Chronic Hepatitis
HCC31	Intestinal Obstruction/Perforation
HCC32	Pancreatic Disease
HCC33	Inflammatory Bowel Disease

³ To prevent collinearity in the case of mutually exclusive, exhaustive categorical variables when an intercept term is present, the 65-69 age indicator variable is omitted from the regression.

Indicator Variable	Description Label
HCC37	Bone/Joint/Muscle Infections/Necrosis
HCC38	Rheumatoid Arthritis and Inflammatory Connective Tissue Disease
HCC44	Severe Hematological Disorders
HCC45	Disorders of Immunity
HCC51	Drug/Alcohol Psychosis
HCC52	Drug/Alcohol Dependence
HCC54	Schizophrenia
HCC55	Major Depressive, Bipolar, and Paranoid Disorders
HCC67	Quadriplegia, Other Extensive Paralysis
HCC68	Paraplegia
HCC69	Spinal Cord Disorders/Injuries
HCC70	Muscular Dystrophy
HCC71	Polyneuropathy
HCC72	Multiple Sclerosis
HCC73	Parkinson's and Huntington's Diseases
HCC74	Seizure Disorders and Convulsions
HCC75	Coma, Brain Compression/Anoxic Damage
HCC77	Respirator Dependence/Tracheostomy Status
HCC78	Respiratory Arrest
HCC79	Cardio-Respiratory Failure and Shock
HCC80	Congestive Heart Failure
HCC81	Acute Myocardial Infarction
HCC82	Unstable Angina and Other Acute Ischemic Heart Disease
HCC83	Angina Pectoris/Old Myocardial Infarction
HCC92	Specified Heart Arrhythmias
HCC95	Cerebral Hemorrhage
HCC96	Ischemic or Unspecified Stroke
HCC100	Hemiplegia/Hemiparesis
HCC101	Cerebral Palsy and Other Paralytic Syndromes
HCC104	Vascular Disease with Complications
HCC105	Vascular Disease
HCC107	Cystic Fibrosis
HCC108	Chronic Obstructive Pulmonary Disease
HCC111	Aspiration and Specified Bacterial Pneumonias
HCC112	Pneumococcal Pneumonia, Empyema, Lung Abscess
HCC119	Proliferative Diabetic Retinopathy and Vitreous Hemorrhage
HCC130	Dialysis Status
HCC131	Renal Failure
HCC132	Nephritis
HCC148	Decubitus Ulcer of Skin
HCC149	Chronic Ulcer of Skin, Except Decubitus
HCC150	Extensive Third-Degree Burns
HCC154	Severe Head Injury

Indicator Variable	Description Label
HCC155	Major Head Injury
HCC157	Vertebral Fractures without Spinal Cord Injury
HCC158	Hip Fracture/Dislocation
HCC161	Traumatic Amputations
HCC164	Major Complications of Medical Care and Trauma
HCC174	Major Organ Transplant Status
HCC176	Artificial Openings for Feeding or Elimination
HCC177	Amputation Status, Lower Limb/Amputation Complications

Table 3: Enrollment Status Variables

Indicator Variable	Description Label
DISABLED	Originally Disabled.
ESRD	End-Stage Renal Disease

Table 4: Long-Term Care Variables

Indicator Variable	Description Label
LTC	Long-Term Care

Table 5: Variable Interaction Terms

Indicator Variable	Description Label
HCCs 15-19_HCC80	Diabetes Mellitus*Congestive Heart Failure
HCCs 15-19_HCCs 95-96, 100-101	Diabetes Mellitus*Cerebrovascular Disease
HCC80_HCCs 108	Congestive Heart Failure*Chronic Obstructive Pulmonary Disease
HCC108_HCCs 95-96, 100-101_HCCs 81-83	Chronic Obstructive Pulmonary Disease*Cerebrovascular Disease*Coronary Artery Disease
HCC131_HCC80	Renal Failure*Congestive Heart Failure
HCC131_HCC80_HCCs 15-19	Renal Failure*Congestive Heart Failure*Diabetes Mellitus
DISABLED_HCC5	Disabled, Opportunistic Infections
DISABLED_HCC44	Disabled, Severe Hematological Disorders
DISABLED_HCC51	Disabled, Drug/Alcohol Psychosis
DISABLED_HCC52	Disabled, Drug/Alcohol Dependence
DISABLED_HCC107	Disabled, Cystic Fibrosis

Table 6: Indicator Variable

Indicator Variable	Description Label
MS-DRGs	For a complete list of all MS-DRGs, see: https://www.cms.gov/acuteinpatientpps/downloads/FY_12_NPRM_Table_5.zip

Data Collection Approach: Medicare claims data

Data Accuracy: The claims data used to calculate the *MSPB Measure* are maintained by CMS's Office of Information System. These data undergo additional quality assurance checks during measure development and maintenance.

Measure Analysis Suggestions: None

Sampling: No

Data Reported As: Ratio of standardized, risk-adjusted *MSPB Amount* for each hospital divided by the median *MSPB Amount* across all hospitals.

Measure Calculation:

The *MSPB Measure* is calculated according to the following nine steps:

Step 1: Standardize Claims Payments. To eliminate payment variation due to Medicare geographic adjustment factors, standardized payments for each claim are calculated using the methodology described above.

Step 2: Calculate Standardized Episode Spending. Standardized spending during an episode is calculated as the sum of all the standardized Medicare claims payments made during the MSPB episode (i.e., between 3 days prior to the hospital admission until 30 days after discharge).

Step 3: Calculate Expected Episode Spending. To estimate the relationship between the independent variables described above (i.e., age, HCC, enrollment status, comorbidity interactions, long-term care, MS-DRG) and standardized episode cost, the MSPB methodology uses an ordinary least squares (OLS) regression. Using a separate model for episodes within each major diagnostic category (MDC), these variables are regressed on standardized episode cost. The MDC is determined by the MS-DRG of the index hospital stay. The predicted values from this regression are used to measure expected spending for each episode.

Step 4: Truncate Predicted Values. Although including a large number of variables in the regression more accurately captures beneficiary case mix, including a larger number of variables can produce some extreme predicted values due to having only a

few outlier episodes in a given cell. To prevent creating extreme predicted values, this step truncates (a.k.a. ‘bottom-codes’) predicted values at the 0.5th percentile.^{4, 5} This step also renormalizes the predicted values to ensure that the average expected episode spending level for each MDC is the same before and after truncating. This normalization occurs by multiplying the truncated predicted values by the ratio of the average predicted spending levels and the average truncated predicted spending levels.

Step 5: Calculate Residuals. The residuals for each episode are calculated as the difference between the standardized episode spending level in Step 2 and the truncated predicted value of spending for that episode calculated Y_{ijm} in Step 4. If the variable represents standardized spending levels for episode i for \hat{Y}_{ijm} hospital j of MS-DRG type m , and equals the predicted spending levels from Step 4, then one can calculate the residual mathematically as:

$$Residual_{ijm} = Y_{ijm} - \hat{Y}_{ijm}$$

Step 6: Exclude Outliers. To mitigate the effect of high-cost and low-cost outliers on each hospital’s *MSPB Measure* score, MSPB episodes whose residuals fall above the 99th percentile or below the 1st percentile of the distribution of residuals are excluded from the MSPB calculation. Excluding outliers based on residuals eliminates the episodes that deviate most from their predicted values in absolute terms. This step also renormalizes the predicted values to ensure that the average expected episode spending levels are the same as average standardized spending levels after outlier exclusions. This renormalization multiplies the predicted values after excluding outliers by the ratio of the average standardized spending levels and the average truncated predicted spending levels after excluding outliers.

Step 7: Calculate the MSPB Amount for Each Hospital. The *MSPB Amount* for each hospital depends on three factors: i) the ratio of the average standardized episode spending level from Step 2, ii) the average expected episode spending for each hospital calculated after Step 6, and iii) the average standardized episode spending across all hospitals. To calculate the *MSPB Amount* for each hospital, one simply finds the ratio of the average standardized episode spending over the average expected episode spending, and then multiplies this ratio by the average episode spending level across all hospitals. Mathematically, the *MSPB Amount* is calculated as:

⁴ In this memorandum, “truncate” is equivalent to “Winsorize.” Winsorization is a statistical transformation that limits extreme values in data to reduce the effect of possibly spurious outliers. Thus, all predicted values below the 0.5th percentile are assigned the value of the 0.5th percentile.

⁵ To ensure that the lowest predicted values within an MDC are adjusted even for MDCs with few episodes, this methodology first sets the lowest predicted value within the MDC to the second lowest predicted value within the MDC before truncating at the 0.5th percentile.

$$MSPB\ Amount_j = \frac{\frac{1}{n_j} \sum_{i \in \{I_j\}} Y_{ij}}{\frac{1}{n_j} \sum_{i \in \{I_j\}} \hat{Y}_{ij}} \cdot \left(\frac{1}{n} \sum_i Y_{ij} \right)$$

where

- Y_{ij} is the standardized spending for episode i in hospital j ,
- \hat{Y}_{ij} is the spending for episode i in hospital j , using the truncated, renormalized predicted values from the risk adjustment regression after Step 6,
- n_j is the number of episodes for hospital j
- n is the number of episodes across all hospitals in the U.S.
- $i \in \{I_j\}$ indicates all episodes i in the set of episodes attributed to hospital j

In words, this equation defines the *MSPB Amount* for hospital j as the average spending level for a hospital divided by the expected episode spending level for that hospital, multiplied by the average spending over all episodes across all hospitals. Defining a hospital's *MSPB Amount* by calculating the ratio of the hospital's standardized payment total to its expected payment total is a familiar methodology for implementing risk adjustment. The *MSPB Amount* represents the per-episode spending level for a hospital j assuming its composition of episodes matches that of the national average.

Step 8: Calculate the MSPB Measure. The *MSPB Measure* for hospital j is calculated as the ratio of the *MSPB Amount* for a hospital (calculated in Step 7) divided by the median *MSPB Amount* across all hospitals:

$$MSPB\ Measure_j = \frac{MSPB\ Amount_j}{med(MSPB\ Amount_j)}$$

The median *MSPB Amount* for hospital j is a weighted median, where the weights are the number of episodes in each hospital.⁶

Step 9: Use MSPB Measure Amount for Open Hospitals with More than 25 Episodes. Although the methodology calculates an *MSPB Measure* for each hospital with an episode during the period of performance, the methodology only uses the *MSPB Measures* for open hospitals for payment purposes. Further, to reduce the likelihood

⁶ For example, if there are 2 hospitals and one hospital had an MSPB of 1.5 and another had one of 0.5 but the first had 4 episodes and the second only 1, then the median would be 1.5 (i.e., 1.5, 1.5, **1.5**, 1.5, 0.5).

that a hospital's MSPB Measure would be affected by only a few high-cost outliers, hospitals with fewer than 25 episodes will not have their *MSPB Measure* used.

Model Validation: In the development and validation of the MSPB Measure, we assessed reliability by considering the extent to which assessments of a hospital using different but randomly selected subsets of patients produces similar measures of hospital performance. That is, we took a "test-retest" approach in which hospital performance in measured once using a random subset of patients, then measured again using a second subset (over the same time period) that excludes the MSPB episodes chosen for the first sample. By comparing the correlation of a hospital's MSPB Measure calculated using the two mutually exclusive samples, one can identify the relationship of a hospital's score across multiple samples. The Spearman rank correlation for a hospital across samples is 0.835. Using these samples, we additionally calculated quintile rank stability across samples, where quintile ranks were calculated by randomly dividing hospitals with greater than or equal to 50 observations into equal halves and calculating each hospital's MSPB quintile rank within each half. Ranks across halves were then compared. 72 percent of hospitals in the bottom quintile in one sample are in the bottom quintile in the next; similarly, 73 percent of hospitals in the top quintile in one sample are in the top quintile in the next, suggesting high reliability. Further, 90 percent of the hospitals in the top quintile in one sample remain in the top two quintiles in the other sample. In sum, these results indicate a stable, precise measure.

Selected References:

- CMS (Centers for Medicare and Medicaid Services). "Medicare Program; Hospital Inpatient Value-Based Purchasing Program." *Federal Register* 76 (88).