Hospital-Level, Risk-Standardized Payment Associated with a 30-Day Episode of Care for AMI (Version 1.0)

2012 Measure Methodology Report

Submitted By

Yale New Haven Health Services Corporation – Center for Outcomes Research & Evaluation (YNHHSC/CORE):

Nancy Kim, M.D., Ph.D.*– Project Lead
Lesli S. Ott, M.A., M.A. – Lead Analyst
Steven Spivack, M.P.H. – Project Coordinator
Xiao Xu, M.A., Ph.D.* – Consulting Health Economist
Mark Volpe, B.S. – Research Assistant
Alex Liu, B.S. – Research Assistant
Kanchana R. Bhat, M.P.H. – Project Manager
Marissa Lee, M.P.H. – Project Coordinator
Carol Oladele, Ph.D. – Research Assistant
Susannah M. Bernheim, M.D., M.H.S.* – Project Director
Harlan M. Krumholz, M.D., S.M.* – Principal Investigator

*Yale School of Medicine

Prepared For:

Centers for Medicare & Medicaid Services (CMS)

September 2012

ACKNOWLEDGEMENTS

This study is a collaborative effort, and the study authors gratefully acknowledge and thank Zhenqiu Lin, Elizabeth Drye, and Lori Geary from Yale New Haven Health Services Corporation-Center for Outcomes Research & Evaluation; Sharon-Lise Normand from Harvard School of Public Health; and Lein Han, Karen Nakano, Michael Rapp, and Kate Goodrich at the Centers for Medicare & Medicaid Services for their contributions to this work.

We also thank the Technical Expert Panel members, who provided helpful insight on key measure decisions. These members include:

Amanda Kowalski, PhD
Assistant Professor of Economics, Yale University

Anne-Marie Audet, MD, MSc, SM
Vice President, Health System Quality and Efficiency, Commonwealth Fund

David Dunn, MD
AAPC and Zhealth Publishing, President-elect AAPC and Vice President of Zhealth Publishing

David S. P. Hopkins, PhD
Senior Advisor, Pacific Business Group on Health

Donald Casey MD, MPH, MBA
Vice President and Medical Director, NYU Langone Medical Center

Kavita Patel, MD, MS
Managing Director for Clinical Transformation and Delivery, Engelberg Center for Healthcare Reform, Brookings Institution

Lesley Curtis, PhD, MS
Associate Professor in Medicine, Duke University

Peter Bach, MD, MAPP
Director, Center for Health Policy and Outcomes, Memorial Sloan-Kettering Cancer Center

Richard Bankowitz, MD, MBA
Chief Medical Officer, Premier Inc.

Stephen Schmaltz, PhD, MS, MPH
Associate Director, Center for Database Management and Analysis, Joint Commission

Terry Golash, MD
Senior Medical Director, Aetna

Vivian Ho, PhD
James A. Baker III Institute Chair in Health Economics and Professor of Economics, Rice University

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

This technical report describes the hospital-level, risk-standardized 30-day episode-of-care payment measure for acute myocardial infarction (AMI) developed by Yale New Haven Health Services Corporation – Center for Outcomes Research & Evaluation (YNHHSC/CORE) under contract with the Centers for Medicare & Medicaid Services (CMS). A risk-standardized payment measure for an AMI episode of care that spans from admission through 30 days post-admission provides information that will support hospital efforts to optimize and coordinate care.

Context of Medicare Spending and Value Assessments

Medicare spending is estimated to have been $525.0 billion in 2010 with annual growth rates projected to be 6.3% for 2013 through 2020. This growth in spending is unsustainable and highlights the need to understand the value of care Medicare buys with every dollar spent. High-value care can be illuminated by assessing hospitals on both cost and quality measures. In this report, we describe the development of a "cost" measure that evaluates the cost of care for Medicare patients from the CMS perspective. We developed this measure to align with current quality of care measures to facilitate the profiling of hospital value.

Using Payments for Medicare Patients

Costs are often approximated using hospital charges, converting hospital charges to costs based on cost-to-charge ratios, or estimated based on Medicare payments. Because we are interested in measuring costs from Medicare's perspective, we focused on payments made for Medicare patients for a 30-day episode of care for AMI. Payments for Medicare patients are calculated from a combination of Medicare claims and CMS data. Using CMS's clearly defined Prospective Payment Systems and Fee Schedules in combination with Medicare claims allows for the removal of payment adjustments that are not directly related to care (e.g., geographic factors and policy adjustments) across all care settings, services, and supplies.

Measuring AMI

By focusing on one specific condition, value assessments may provide actionable feedback to hospitals and incentivize targeted improvements in care. AMI is a common condition in the elderly with substantial variability in payments due to different practice patterns. Quality measures for AMI such as 30-day AMI risk-standardized mortality (RSMR) are already publicly reported. In the context of its publicly reported quality measures, AMI is an ideal condition in which to assess payments for Medicare patients and relative hospital value.

30-Day Episode of Care

When considering hospital payments, we focused on an "episode of care" triggered by admission for several key reasons. First, hospitalizations represent brief periods of illness that require ongoing management post-discharge. Second, decisions made at the admitting hospital affect payments for care in the immediate post-discharge period. Third, attributing payments for a continuous episode of care to admitting hospitals may reveal practice variations in the full care of the illness that can result in increased payments**.** Fourth, a 30-day preset window provides a standard observation period by which to compare all hospitals. Lastly, we designed the AMI payment measure to be aligned with AMI quality measures, i.e. CMS's publicly reported AMI mortality measure, which is reported 30 days after admission. The AMI payment measure captures payments for Medicare patients across multiple care settings, services, and supplies (i.e., inpatient, outpatient, skilled nursing facility, home health, hospice,

physician/clinical laboratory/ambulance services, and durable medical equipment, prosthetics/orthotics, and supplies).

Payment Calculation
The overarching goal of the measure is to calculate payments that reflect differences in the care provided for patients with AMI rather than differences based on geography or policy adjustments. In order to remove payment adjustments unrelated to clinical care we developed the measure by "stripping" or "standardizing" payments as detailed below:

- Stripping refers to removing geographic differences and policy adjustments in payment rates for individual services.
- Standardizing refers to averaging payments across geographic areas for those services where geographic differences in payment cannot be stripped.

By removing payment adjustments unrelated to clinical care, our measure reflects differences in payment due to practice variation at the hospital level. The body of the report presents the current measure specifications, methodology, and results in detail. Although the methodology of this payment measure is developed for AMI, it can be applied to other disease conditions such as heart failure and pneumonia.

Statistical Model
To calculate hospital-specific risk-standardized payments, we estimated hierarchical generalized linear models. This strategy accounts for within-hospital correlation of the observed outcomes and accommodates the assumption that underlying differences in quality across hospitals lead to systematic differences in outcomes.

Findings
Wide variation in payments for an AMI episode of care persists after considering transfers, removing Medicare payment adjustments that are not related to clinical care (e.g., geographic factors and policy adjustments), and adjusting for case mix.

1. INTRODUCTION

1.1. Background

Medicare spending is estimated to have been $525.0 billion in 2010 with annual growth rates projected to be 6.3% for 2013 through 2020 due to both an increase in the Medicare population as well as Medicare spending on each beneficiary.[1] Further projections anticipate an exhaustion of Medicare's Hospital Insurance Trust Fund (Part A) by 2024.[2] The growth in spending is unsustainable and highlights the need to understand the value of care Medicare buys with every dollar spent.

Given the urgency of the Medicare Hospital Insurance Trust Fund and the fact that Medicare pays for 40-50% of hospitalizations nationally,[3] hospital costs are a natural venue in which to deconstruct payments for Medicare patients. Yet payments to hospitals are difficult to interpret in isolation. Some high-payment hospitals may have better clinical outcomes when compared with low-payment hospitals; other-high payment hospitals may not. For this reason, the value of hospital care is more clearly assessed when pairing hospital payments with hospital quality.

A measure of payments for Medicare patients to hospitals that is aligned with current quality of care measures will facilitate profiling hospital value (payments and quality). Under contract with CMS, we developed a measure of payments for Medicare patients that reflects differences in the management of care for patients with acute myocardial infarction (AMI) both during hospitalization and immediately post-discharge. AMI is a condition with substantial variation in costs of care and for which there are well-established publicly reported quality measures, and is therefore an ideal condition for assessing relative value for an episode of care that begins with an acute hospitalization. By focusing on one specific condition, value assessments may provide actionable feedback to hospitals and incentivize targeted improvements in care.

Understanding both inpatient and post-discharge costs will become increasingly important with the push toward Accountable Care Organizations (ACOs).[4] These ACOs are intended to create financial incentives for providers to work together to treat an individual patient across care settings, including in doctor's offices, hospitals, and long-term care facilities. The Medicare Shared Savings Program will reward ACOs that lower growth in health care costs while meeting quality metrics. Participation in ACOs is currently voluntary, but the growing interest in ACOs emphasizes the importance of characterizing the association between quality of care and payments for Medicare patients for an episode of care triggered by hospitalization.

1.2. Assessing Cost of Care by Measuring Payments for Medicare Patients

There are many different ways to measure cost including, but not limited to, approximations using hospital charges, conversions of charges to costs using cost-to-charge ratios, and estimations based on Medicare payments.

Hospital charges are the prices a hospital sets for its services. Hospital costs – the fixed and variable expenses incurred by the hospital in providing the services – are just one of many factors that influence the amount a hospital charges for services. Other factors may include: input prices, target profit

margins, competition, and the necessity of recouping the costs of uncompensated care. Hospital charges often do not accurately reflect true costs of care.

Cost-to-charge ratios help translate hospital charges into cost. Cost-to-charge ratios are defined as a hospital's total expenses divided by the sum of the hospital's gross patient revenue and other operating revenue. In order to apply a hospital's cost-to-charge ratio, researchers must use the Medicare hospital cost reports in combination with Medicare claims data. Inherent in this process are problems with the data, which are magnified when trying to use more than one data source. Specifically, cost centers identified in the cost reports may not match revenue centers in the claims files, making the payment calculation via this method impossible for some hospitals.[5]

Payments for Medicare patients are generated from a combination of Medicare claims and CMS data. Using CMS's clearly defined Prospective Payment Systems and Fee Schedules in combination with Medicare claims, allows for the removal of payment adjustments that are not directly related to care (e.g., geographic factors and policy adjustments) across all care settings, services, and supplies. **For this task, we have defined the "cost" of care as payments made for Medicare patients for an AMI episode of care.**

1.3. Measuring AMI Payments

By focusing on one specific condition, value assessments may provide actionable feedback to hospitals and incentivize targeted improvements in care. AMI is a common condition in the elderly with a substantial range in payments due to different practice patterns. Furthermore, because 30-day all-cause mortality and readmission measures for AMI are already publicly reported, AMI serves as a model condition for examining the association of payments for an episode of care with the quality of a hospital's care.

Additionally, AMI is clinically complex, commonly requiring the coordination of care between two or more hospitals for the acute admission. These transfer scenarios may be less important in other disease processes, but require the consideration of Medicare's transfer payment policies for the development of this payment measure. Thus, applying this methodology to other clinical conditions could be facilitated by beginning with AMI.

1.4. Episode of Care

When considering payments to hospitals, we focused on a 30-day "episode of care" triggered by admission for several key reasons. First, hospitalizations represent a brief period of acute illness that requires ongoing management post-discharge. Second, decisions made at the admitting hospital affect not only the hospitalization payments, but payments for care in the immediate post-discharge period. Third, assessing payments for a continuous episode of care may reveal practice variations in the full care of the illness that triggered admission**.** For instance, lower inpatient payments may be counterbalanced by greater dependence on post-acute care, such as skilled nursing, in some regions. Such patterns would not be visible in an inpatient-only measure. Fourth, a 30-day preset window provides a standard observation period by which to compare all hospitals. Lastly, when pairing payments with quality, measures should be aligned as much as possible. Most publicly reported quality measures are reported for a 30-day period after admission or discharge (e.g. RSMR rate and risk-standardized readmission rate).

Using the Chronic Condition Warehouse (CCW) data, we can track payments for Medicare patients through the post-discharge period. The CCW data are derived from Medicare claims in the Standard Analytic Files and contain payments for all care settings, services, and supplies. The CCW data provide a unique opportunity to gain insight into a cascade of medical events triggered by AMI hospitalization and the payments associated with those events. The specific goal of this task is to sum payments for Medicare patients, including index admission as well as post-discharge payments, for: readmission or other post-discharge inpatient care, skilled nursing facilities, outpatient providers, home health agencies, hospice care, physician/clinical laboratory/ambulance services, and durable medical equipment, prosthetics/orthotics, and supplies. This work will be used to better understand differences in the patterns of post-discharge care and associated payments made for Medicare patients across a continuum of care beginning with a hospitalization for AMI and following patients 30 days after hospital admission.

Please note that for easy reference, we sometimes refer to the hospital-level, risk-standardized payment measure for a 30-day episode of care for AMI simply as the AMI payment measure in this document.

1.5. Approach to Measure Development

We developed this measure in accordance with national guidelines and in consultation with clinical and measurement experts, key stakeholders, and the public. The proposed measure is consistent with the technical approach to outcomes measurement set forth in the National Quality Forum (NQF) guidance for outcomes measures,[6] CMS's Measure Management System (MMS),[7] and the guidance articulated in the American Heart Association's scientific statements, "Standards for Statistical Models Used for Public Reporting of Health Outcomes"[8] and "Standards for Measures Used for Public Reporting of Efficiency in Health Care."[9] During the measure development process, we obtained expert and stakeholder input via two mechanisms: first, through regular discussions with an advisory working group, and second, through meetings with a national Technical Expert Panel (TEP).

We held regular conference calls with our working group throughout the measure development phase. The working group included clinicians and other professionals with expertise in cardiology, biostatistics, health economics, measure development, and quality improvement. The working group meetings addressed key issues surrounding measure development, including detailed discussions regarding specific decisions (e.g., defining the appropriate measure cohort) to ensure the methodological rigor of the measure.

In addition to the working group and in alignment with the CMS's MMS, we convened a TEP consisting of a group of recognized experts and stakeholders in relevant fields to provide input and feedback during measure development. To form the TEP, we posted a public call for nominations and selected individuals representing a range of perspectives including those of physicians, health economists, consumers, hospitals, and purchasers. In contrast to the working group meetings, the TEP meetings followed a more structured format consisting of the presentation of key issues, relevant data, and our proposed approach. This presentation was followed by open discussion of these issues with TEP members.

We posted the measure specifications and a summary of the TEP discussions publicly, after which we underwent a 30-day public comment period. We collected these comments through the MMS website and summarized them for CMS. We also posted the comments verbatim on the MMS website. We considered all submitted comments during the final stages of measure development.

1.6. Aims of the Measure

The primary objective of this work is to develop a 30-day episode-of-care AMI payment measure that:

1. captures differences in the care provided by hospitals for patients with an AMI,
2. accounts for differences in the care coordinated by hospitals immediately post-discharge,
3. removes variation in payments due to payment adjustments that are not directly related to clinical care (e.g., geography and policy adjustments),
4. adjusts for hospital case-mix,
5. assesses relative performance of hospitals, and
6. aligns with AMI quality measures.

Using administrative claims data, we measure risk-standardized payments for Medicare patients for an episode of care that begins with an index admission for AMI and ends 30 days after the index admission. The AMI payment measure captures payments for Medicare patients across multiple care settings, services, and supplies (i.e., inpatient, outpatient, skilled nursing facility, home health, hospice, physician/clinical laboratory/ambulance services, and durable medical equipment, prosthetics/orthotics, and supplies). We remove payment adjustments unrelated to clinical care decisions. By risk-standardizing the payment measure, we are able to adjust for the case mix at any given hospital and compare a specific hospital's AMI payment to an average hospital with a similar case mix. Key decisions in the development of the AMI payment measure are aligned with key decisions in CMS's 30-day AMI RSMR measure.

Our methodology is developed in accordance with accepted standards for outcomes measure development, including appropriate risk adjustment to allow for fair profiling of institutions and transparency of specifications.

2. METHODS

2.1. Overview of Measure Methodology

We developed a hospital-level, risk-standardized payment measure for a 30-day episode of care for AMI. The measure comprises a single summary payment and uses index admissions from one year of CCW data (2008) to assess hospital performance. This measure is intended to capture differences in payment for a 30-day episode of care for AMI at the hospital level. Payments for Medicare patients can vary for a number of reasons, including:

1. hospital practice patterns,
2. payment adjustments that reflect geography (e.g., paying different amounts for the same service in different parts of the country),
3. payment adjustments that reflect policies (e.g., indirect medical education and disproportionate share adjustments) that serve a broader mission of CMS, but do not reflect medical care, and
4. case mix.

To isolate payment variation that reflects practice patterns rather than CMS payment adjustments, we "strip" or "standardize" payments for each care setting. Stripping refers to removing geographic differences and policy adjustments in payment rates for individual services from the total payment for that service. Standardizing refers to averaging payments across geographic areas for those services where geographic differences in payment cannot be stripped. Stripping and standardizing the payment amounts allows for a fair comparison across hospitals based solely on payments for decisions related to clinical care of AMI.

We adjust for case mix differences across hospitals by risk adjusting for patients' comorbid conditions identified in claims for acute inpatient hospital stays, hospital outpatient care, and physician, radiology, and laboratory services for the 12 months prior to the index admission as well as select conditions indicated by secondary diagnoses codes on index admission. We do not risk adjust for diagnoses that may be complications of care during the index admission (Appendix A). We used CMS Condition Category groups (CCs) to define the comorbid risk adjustment variables. Additionally, we risk adjust for the patients' age and a history of percutaneous coronary intervention (PCI) and/or coronary artery bypass graft surgery (CABG).

We use generalized linear modeling to estimate the risk adjustment model and validate the model via a split sample process. We then use hierarchical generalized linear regression to isolate a hospital-specific payment signal and to account for the clustering of admissions within each hospital. Finally, we calculate predicted and expected payments (as defined in Section 2.8) for each hospital.

2.2. Dataset

The CCW data are derived from the Medicare claims in the Standard Analytic Files. The CCW data contain data from the Medicare fee-for-service (FFS) institutional and non-institutional claims, enrollment and eligibility information, and assessment data for up to 100% of the Medicare beneficiary population for particular conditions. The data are organized by predefined chronic conditions including AMI, but can also be used to define individualized patient cohorts as described below. The annual CCW datasets include claims data from all seven standard files (inpatient, skilled nursing facility, outpatient,

home health agency, hospice, carrier, and durable medical equipment) that can be linked across care settings, services, supplies, and years using a unique patient identifier. Specific information available in the CCW data includes diagnosis codes, procedure codes, quantity/units of services used, and payments made by CMS, patients, and other insurers to care providers. We describe our methodology for estimating payments for an AMI episode of care below.

2.3. Cohort

Although the CCW data make a pre-defined cohort of AMI available, **we created our own AMI cohort from the CCW 2008 100% sample to be aligned with CMS's publicly reported 30-day AMI mortality measure**. Consistent with the AMI mortality measure, we included hospitalizations with a principal discharge diagnosis of AMI as classified by the International Classification of Diseases, Ninth revision, Clinical Modification (ICD-9-CM) code 410.xx, excluding those with 410.x2 (AMI, subsequent episode of care). A full list of ICD-9-CM codes included in our final cohort can be found in Appendix B. An **index hospitalization** is the initial AMI admission that triggers the 30-day episode of care for this payment measure. We included only those hospitalizations in 2008 from short-stay acute care hospitals in the index cohort. We restricted the cohort to patients enrolled in FFS Medicare Parts A and B (with no Medicare Advantage coverage).

If a patient had more than one eligible index AMI admission in 2008, we randomly selected one AMI admission for three reasons. First, repeated AMI hospitalizations for the same patient are not independent events. Including all AMI admissions from the same patient would introduce additional clustering of data within patients which can further complicate the analytic model. Second, because treatment patterns may differ when caring for a patient with a subsequent AMI, particularly if the event occurred within months of a "first" AMI, payments for repeated AMI admissions may not be as costly. The alternative approach of selecting only the "first" AMI admission could overestimate payments, while selecting only the subsequent AMI admission(s) may underestimate payments. Third, this strategy is consistent with CMS's publicly reported AMI 30-day mortality measure.

When using more than one year of data, we do not consider AMI admissions within 30 days of an index AMI admission as a new "index" admission. This situation arises when a patient has two or more qualifying index admissions within 30 days of the end of one calendar year and the beginning of the next (i.e., a patient is admitted for AMI on both December 15, 2008 and January 5, 2009). In this situation, the first admission is considered the index admission and payments for additional AMI admissions falling within 30 days of the index admission are captured as part of the first admission's episode of care.

Consistent with CMS's publicly reported measure for AMI RSMR, we consider admissions with transfers as a single inpatient hospitalization. To confirm the diagnosis, patients with AMI who transferred from one facility to another are required to have a principal discharge diagnosis of AMI at both hospitals. We do not include transfers directly from the emergency department (ED) to a second hospital in our transfer scenario because the CMS payment structure does not classify ED care as an admission. In these cases, the episode of care begins with an inpatient admission at the receiving hospital.

2.3.1. Index Cohort Exclusions

We applied several exclusion criteria to the cohort of index admissions as delineated below and in Figure 1:

- Admissions for patients with fewer than 30 days of post-admission enrollment in FFS Medicare Parts A and B
  Rationale**:** This is necessary in order to identify the outcome (payments) in the sample over our analytic period.

- Admissions for AMI patients who were admitted and discharged on the same- or next-day (and did not die or get transferred)
  Rationale**:** These patients likely did not suffer a clinically significant AMI.

- Admissions for patients transferred into the hospital
  Rationale: The acute episode is included in the measure but episode-of-care payments are assigned to the hospital where the patient was initially admitted rather than the hospital receiving the transferred patient.

- Admissions with inconsistent or unknown patient vital status
  Rationale: We exclude stays for patients that include inconsistent data (e.g., date of death precedes date of admission).

- Admissions with unreliable data
  Rationale: We exclude stays for patients that include unreliable data (e.g., age is greater than 115 or gender is discordant on the index admission claim and the denominator file).

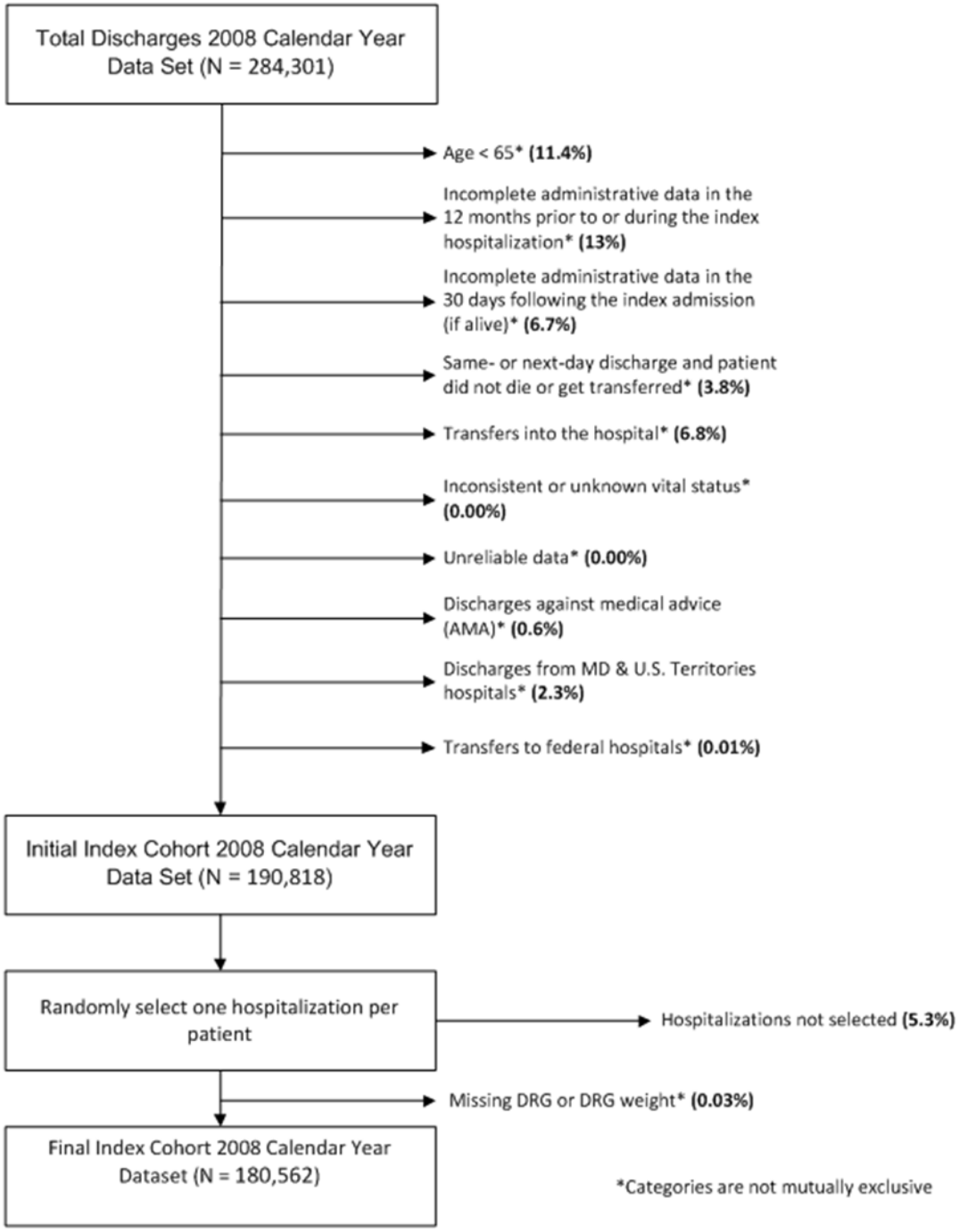
- Admissions where patients are discharged against medical advice
  Rationale**:** Hospitals had limited opportunity to implement high quality care.

- Discharges from Maryland and U.S. Territories Hospitals
  Rationale: These hospitals are not paid under the IPPS.

- Patients transferred to federal hospitals
  Rationale**:** We do not have claims data for these hospitals; therefore, including these patients would systematically underestimate payments.

- Admissions without a diagnosis-related group (DRG) or DRG weight for the index hospitalization
  Rationale: We cannot calculate a payment for these patients' index admission using the Inpatient Prospective Payment System (IPPS). Lack of payment estimates for these hospitalizations would result in underestimated payments for the entire episode of care.

Figure 1. Index AMI Cohort for the 2008 Calendar Year Sample



2.4. Outcome

The primary outcome of this measure is the hospital-level, risk-standardized payment for an AMI episode of care. The AMI payment measure captures payments for Medicare patients across multiple care settings, services, and supplies (i.e. inpatient, outpatient, skilled nursing facility, home health, hospice, physician/clinical laboratory/ambulance services, and durable medical equipment, prosthetics/orthotics, and supplies). We remove payment adjustments unrelated to clinical care decisions. By risk standardizing the payment measure, we are able to adjust for case mix at any given hospital and compare a specific hospital's AMI payment to an average hospital with a similar case mix. We define our analytic timeframe as beginning with the index admission for AMI to 30 days post-admission.

2.4.1. 30-day Timeframe

We considered 30 days post-admission as a clinically reasonable time frame for multiple reasons:

a. Within a 30-day time frame, payments are more likely attributable to care received during the index hospitalization and during the transition to the post-discharge setting.

b. The 30-day preset window provides a standard observation period by which to compare all hospitals.

c. The 30-day post-admission time frame is consistent with the other CMS measures endorsed by the NQF and publicly reported by CMS, including CMS's 30-day AMI mortality measure. We designed the AMI payment measure to align with CMS's publicly reported AMI mortality measure to facilitate assessments of health care value.

2.4.2 Prorating Payments

Some claims overlap the beginning or end date of the analytic timeframe. If a claim for payment began prior to the index admission, but ended in the analytic timeframe, it was excluded from our calculation. If a claim for payment began within the analytic timeframe, but ended after the last date of our 30-day post-admission period, we prorated the payment for the claim over the days in the analytic timeframe (Appendix C).

2.4.3 Transfer Scenarios

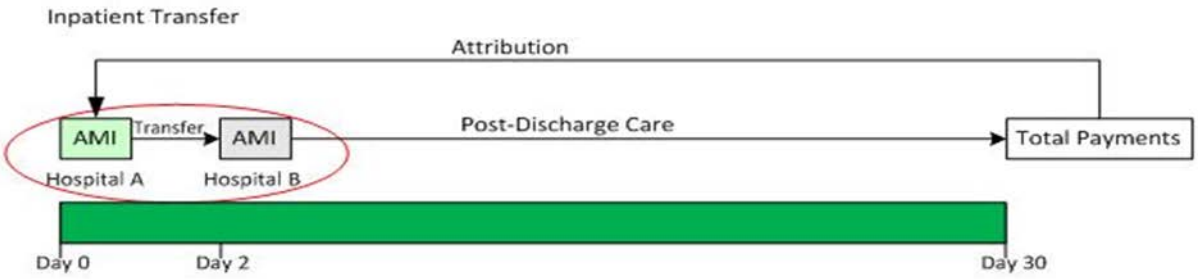
Because acute-to-acute hospital transfers are common among Medicare FFS beneficiaries age 65 or older hospitalized with AMI (8% of all index hospitalizations in internal analyses from 2008, data not shown), we included hospitalizations involving transfers in our payment calculation.

Medicare reduces payments when patients are transferred to another IPPS hospital and have a length of stay at least one day less than the geometric mean length of stay for the DRG. Under this policy, transferring hospitals are paid a per diem rate. For stays at the transferring hospital

that are equal to or greater than the geometric mean length of stay for the DRG, transferring hospitals receive a full DRG payment.[10] We assign the per diem rate or the full DRG rate to the transferring hospital where applicable and then add it to the payment for the hospital that received the transfer patient to calculate the payment for the index admission. We then aggregate total patient-level payments for each post-discharge care setting over the defined time period.

Because the episode of care begins at the time of index admission, we attribute this combined inpatient payment along with any payments made for post-discharge care to the transferring hospital Figure 2. This approach aligns with CMS's publicly reported measure for AMI RSMR.

Figure 2. Episode of Care for Transfer Patient



2.4.4 Removing Payment Adjustments

The overarching goal of the measure is to calculate payments that reflect differences in the care provided for patients with AMI rather than differences in payments based on geography (e.g., cost of living and wage index) or policy adjustments (e.g., indirect medical education and disproportionate share). Because these payment adjustments do not reflect the care delivered by hospitals, we remove geography and policy adjustments when calculating payments for each care setting, service, and supply by stripping or standardizing as described below.

2.5. Calculating Payments for Different Care Settings, Services, and Supplies

Medicare pays for health care services using a number of different payment systems that are generally organized by delivery setting (Appendix D). These payment systems consider not only the products the Medicare patient is buying in each setting, but also the characteristics of the care provider, the extent to which the same product may be furnished in different settings, and the market circumstances that affect providers' costs. Payment amounts within each payment system are usually updated annually (e.g., the IPPS) with some fee schedules having quarterly updates (e.g., Durable Medical Equipment/Prosthetics and Orthotics [DME/POS]). Information on CMS reimbursement rates for each care setting are made publicly available through either final rules published in the Federal Register, or fee schedules provided on the CMS website. A summary of Medicare's reimbursement system for most care settings is publicly available at the Medicare Payment Advisory Committee (MedPAC) website.[10] Below, we describe the key features of these payment systems and how we use these CMS payment algorithms to determine an

episode-of-care payment for AMI that isolates clinical care decisions. Appendix D provides payment diagrams for all care settings along with our approach to stripping or standardizing payments.

2.5.1. Inpatient Care Settings

2.5.1.1. Acute Inpatient Hospitals

Medicare beneficiaries sometimes require hospitalization for an acute illness.

How Medicare Reimburses Acute Inpatient Hospitals

Medicare pays most acute inpatient hospitals through a prospective payment system (PPS). This system uses DRG-specific weights to calculate a payment above or below the fixed payment, known as the base payment rate (operating and capital), which reflects the cost (labor and non-labor) to deliver care to a patient for an average Medicare hospitalization. The DRG payment covers routine operating costs attributable to patient care, including nursing services, room and board, and diagnostic and ancillary services. In addition to the primary discharge diagnosis, DRGs account for up to eight secondary diagnoses and up to six procedures (e.g. percutaneous cardiovascular procedure with or without intervention or coronary artery bypass grafting) performed during the stay. Other factors that inform DRG assignment are age, gender, and discharge destination. CMS assigns a unique weight to each DRG indicating the relative costliness of inpatient treatment for patients in a given DRG. Conditions that involve greater resource utilization (usually associated with procedures, comorbidities, or complications) are assigned higher DRG weights.

Table 1 demonstrates the calculation of payments for the most frequent DRGs in our 2008 cohort. These DRGs are ordered by the amount of the DRG payment made to hospitals rather than by the frequency in our cohort.

Table 1. Most Frequent DRGs in AMI Patients in 2008

DRG	MS-DRG Title	Surgical	DRG Weight	Payment*	% of Index Admissions
233	Coronary bypass w cardiac cath w MCC	Yes	6.4496	$34,935.81	3%
234	Coronary bypass w cardiac cath w/o MCC	Yes	4.9216	$26,659.03	3%
246	Perc cardiovasc proc w drug-eluting stent w MCC or 4+ vessels/stents	Yes	2.9046	$15,733.46	4%
248	Perc cardiovasc proc w non-drug-eluting stent w MCC or 4+ ves/stents	Yes	2.5180	$13,639.35	4%
247	Perc cardiovasc proc w drug-eluting stent w/o MCC	Yes	2.1255	$11,513.28	11%
249	Perc cardiovasc proc w non-drug-eluting stent w/o MCC	Yes	1.8124	$9,817.30	8%
280	Acute myocardial infarction, discharged alive w MCC	No	1.7391	$9,420.25	25%
283	Acute myocardial infarction, expired w MCC	No	1.5787	$8,551.41	6%
281	Acute myocardial infarction, discharged alive w CC	No	1.3126	$7,110.01	15%
282	Acute myocardial infarction, discharged alive w/o CC/MCC	No	1.0617	$5,750.95	9%

* This amount is arrived at by multiplying the FY 2008 operating and capital base payment amounts by the DRG weight

Medicare makes a number of payment adjustments which affect the total payment for an inpatient stay. Three major categories of adjustments include geography, policy, and outlier payments. Medicare adjusts for differences across hospitals in cost of living (geographic factor) and labor costs (wage index). Policy adjustments can result in additional payments to reflect the cost of teaching medical trainees (indirect medical education) and providing care to low-income patients (disproportionate share). Finally, Medicare makes "outlier payments" for admissions when the hospital's gross costs exceed a threshold amount that includes the DRG rate plus the amount payable for indirect medical education, disproportionate share payments, and a fixed dollar amount set annually by CMS. Outlier payments are not automatic: a hospital must make a specific request and must identify the actual cost associated with each outlier case.

Approach to Stripping Payments

In our calculation of payments for the index AMI hospitalization, we omit geographic factors and policy adjustments. We first multiply the operating and capital base payment rates by the DRG weight for each claim to arrive at our stripped payment. Medicare reduces payments when patients are transferred to another IPPS hospital and have a length of stay at least one day less than the geometric mean length of stay for the DRG. Under this policy, transferring hospitals are paid either a per diem rate or, for stays that are equal or greater than the geometric mean length of stay for the DRG, a full DRG payment. When applicable, we include this rule in our payment calculation. We then add any applicable outlier payments (after removing any wage index adjustment) that hospitals receive for unusually high-cost claims where applicable.

2.5.1.2. Inpatient Psychiatric Facilities (IPFs)

Medicare beneficiaries sometimes require hospitalization for an acute psychiatric illness.

How Medicare Reimburses IPFs

Medicare pays IPFs through a PPS. Under the IPF PPS, Federal per diem base rates are adjusted for geographic factors, patient characteristics (psychiatric DRG, age, comorbidities, length of stay), and facility characteristics (urban/rural, indirect medical education). Additional payments are made to IPFs based on the presence of a qualifying emergency department, the number of electroconvulsive therapy (ECT) treatments furnished, and outlier payments for cases with very high costs.

Approach to Stripping Payments

We multiply the base payment by adjustments for the patients' psychiatric DRG, age, and comorbidities and omit any adjustments for wage index, cost of living, or facility characteristics. We then account for length of stay and any ECT treatments to arrive at our stripped payment. We add outlier payments but remove the wage index adjustment for these payments where applicable. For model development, we did not adjust for the

presence of a qualifying emergency department because we did not have access to those data; however, this adjustment will be made when the measure incorporates additional years of data.

2.5.1.3. Inpatient Rehabilitation Facilities (IRFs)

After a hospitalization, some patients need intensive inpatient rehabilitation services such as physical, occupational, or speech therapy. To qualify for treatment in an inpatient rehabilitation setting, patients must be able to tolerate and benefit from three hours of therapy per day. These settings may be freestanding hospitals or specialized, hospital-based units.

How Medicare Reimburses IRFs

Medicare pays IRFs through a PPS. Under the IRF PPS, the IRF base rate is adjusted for geographic factors, patient characteristics (case mix group), facility characteristics (urban/rural, disproportionate share, indirect medical education), length of stay, and outlier payments. Case mix groups are informed primarily by the patient's condition (age, comorbidities, functional and cognitive statuses, and diagnoses requiring rehabilitation). Each case mix group has a national relative weight reflecting the expected relative costliness of treatment for patients in that specific case mix group compared with the average Medicare inpatient rehabilitation patient.

Approach to Stripping Payments

We multiply the base payment rate by the case mix group weight and omit any adjustments for wage index or facility characteristics. We then adjust for length of stay to arrive at our stripped payment. Where applicable, we add outlier payments but remove the wage index adjustment for these payments.

2.5.1.4. Long Term Care Hospitals (LTCHs)

Patients with clinically complex problems, such as multiple acute or chronic conditions, may need hospital care for extended periods of time. LTCHs must have an average Medicare length of stay greater than 25 days.

How Medicare Reimburses LTCHs

Medicare pays LTCHs through a PPS. Under the LTCH PPS, the LTCH base rate is adjusted for geographic factors, patient characteristics (Medicare severity long-term care [MS-LTC]-DRG), length of stay, and outlier payments. MS-LTC-DRGs are informed primarily by the patient's condition (age, gender, principal and secondary diagnoses, procedures, and discharge status). Each MS-LTC-DRG has a national relative weight reflecting the expected relative costliness of treatment for patients in that specific LTC-DRG compared with the average Medicare LTC patient.

Approach to Stripping Payments

We multiply the base payment rate by the MS-LTC-DRG weight and omit any adjustments for wage index. We then adjust for length of stay to arrive at our stripped payment. Where applicable, we add outlier payments but remove the wage index adjustment for these payments.

2.5.2. Outpatient Care Settings

Medicare pays for some outpatient services under the Outpatient Prospective Payment System (OPPS), including most hospital-based outpatient services. Outpatient services that do not fall under the OPPS are reimbursed using other fee schedules or payment systems (e.g., Medicare Clinical Diagnostic Laboratory Fee Schedule) as detailed later in this document.

2.5.2.1. Hospital Outpatient Services and Community Mental Health Centers (CMHCs)

Medicare beneficiaries receive a wide range of services in hospital outpatient departments. These vary from simple injections to complex procedures requiring anesthesia and can include emergency room visits as well as observation stays. CMHCs provide outpatient as well as partial hospitalization services to Medicare beneficiaries, including physician services, psychiatric nursing, counseling, and social services.

How Medicare Reimburses Hospital Outpatient Services and CMHCs

Medicare pays for most hospital outpatient services provided to Medicare beneficiaries using the OPPS. Partial hospitalization services furnished by CMHCs are also reimbursed under the OPPS. All services are paid according to ambulatory payment classifications (APCs), which group services according to similar clinical characteristics and in terms of resources required. Healthcare common procedure coding system (HCPCS) codes are grouped into over 500 APCs. Each APC is weighted and has a prospective payment amount associated with it. APC payments may be discounted when certain services or procedures, such as bilateral procedures, are provided.

A conversion factor (similar to a base payment) is multiplied by a wage index to account for geographic variations in hospitals' labor costs. This number is then multiplied by the APC relative weight. In addition, add-ons such as pass-through payments for new drugs and technical devices, outlier payments for high-cost services, and hold harmless payments for certain hospitals are applied.

Approach to Stripping Payments

We multiply the conversion factor by the APC weight and omit any adjustments for wage index. We then account for reduced or discontinued procedures, where applicable, as well as unit count to arrive at our OPPS stripped payment. We do not include pass-through payments for new drugs and technical devices or hold harmless payments for certain hospitals. For outpatient hospital services not paid under the OPPS, we apply the clinical lab fee schedule, ambulance fee schedule, physician fee schedule,

DME/POS/PEN fee schedule, and Part B drug fee schedule where applicable. Also, where applicable, we add outlier payments but remove the wage index adjustment for the payments.

2.5.2.2. Comprehensive Outpatient Rehabilitation Facilities (CORFs) and Outpatient Rehabilitation Facilities (ORFs)

Outpatient therapy services include physical therapy, occupational therapy, and speech-language pathology services. Medicare covers these services if they are furnished by a skilled professional, are appropriate and effective for a patient's condition, and are reasonable in terms of frequency and duration. The beneficiary must be under the care of a physician, have a treatable condition, and be improving.

How Medicare Reimburses CORFs and ORFs

Medicare pays for outpatient rehabilitation therapy according to fees established in the physician fee schedule. Under this fee schedule, a conversion factor set by Medicare is adjusted for complexity of service/expense as well as geographic factors. The unit of payment is each individual service. All services are classified and reported to CMS according to their HCPCS code. Payment rates are based on relative values units (RVUs) which account for the relative costliness of the following components of the service provided: clinician's work, practice expenses, and malpractice insurance. A separate geographic practice cost index (GPCI) for each of these work components reflects geographic differences in these costs in the market where the service is rendered.

Approach to Stripping Payments

We multiply the conversion factor by the work RVU, transitioned non-facility practice expense RVU, and malpractice insurance RVU weights and omit any adjustments for work GPCI, non-facility practice expertise GPCI, and/or malpractice insurance GPCI to arrive at our stripped payment.

2.5.2.3. Renal Dialysis Facilities (RDFs)

Individuals with end-stage renal disease require dialysis or renal transplant to survive. Medicare pays for both hemodialysis and peritoneal dialysis.

How Medicare Reimburses RDFs

Medicare pays dialysis providers a predetermined composite rate that is intended to cover the bundle of services, tests, certain drugs, and supplies required for either facility-based or home-based dialysis treatments. The composite rate is then adjusted for geographic factors. A drug add-on further supplements the payment, and CMS provides an additional adjustment for case mix using a patient's age, body surface area, and body mass index. Facility-based payments are capped at an amount equal to three

dialysis sessions per week; however, home-based dialysis may be provided more frequently.

Approach to Stripping Payments

Given that renal dialysis payment rates are adjusted by patient-specific body measurements that are not available in our data, we begin with the actual payment made to an RDF for patient care (including patient out-of-pocket payments) and remove payment adjustment attributable to wages using the RDF wage index published by CMS.

2.5.2.4. Rural Health Clinics (RHCs)

RHCs are clinics that are located in areas designated by the Bureau of the Census as rural and by the Secretary of the Department of Health and Human Services as underserved. Services rendered by approved RHCs to Medicare beneficiaries are covered under Medicare.

How Medicare Reimburses RHCs

Payments to RHCs for covered services furnished to Medicare patients is made by an all-inclusive rate for each visit. The encounter rate includes services from providers as well as supplies. Each year Congress determines this RHC per visit payment limit.

Approach to Stripping Payments

We begin with the actual payment made to an RHC for patient care and remove payment adjustment attributable to wages using the skilled nursing facility (SNF) state-specific rural wage index published by CMS.

2.5.2.5. Federally Qualified Health Clinics (FQHCs)

FQHCs provide access to primary care in areas where primary care resources are constrained. FQHCs are required to be community-centered and either not-for-profit or public organizations that emphasize coordination of care.

How Medicare Reimburses FQHCs

Payments are made much like they are made to RHCs. FQHC payments are an all-inclusive per visit amount based on reasonable costs. The FQHC payment methodology includes one urban and one rural payment limit.

Approach to Payments

Given the resources necessary to determine whether each FQHC is located in a rural or urban area, we did not adjust for wages in the current data. We use the total payment received by the FQHC as the payment for a FQHC claim.

2.5.2.6. Ambulatory Surgical Centers (ASCs)

ASCs are distinct facilities that furnish only ambulatory surgery.

How Medicare Reimburses ASCs

Medicare pays ASCs through a PPS. The unit of service is the individual surgical procedure. All services are paid according to APCs, which group services according to similar clinical characteristics and in terms of resources required. Each APC is weighted and has a prospective payment amount associated with it. APC payments may be discounted when certain services or procedures, such as bilateral procedures, are provided.

A conversion factor (similar to a base payment) is multiplied by a wage index to account for geographic variations in ASCs' labor costs. This number is then multiplied by the APC relative weight.

Approach to Stripping Payments

We begin with the conversion factor, omit any adjustments for wage index, multiply by the APC weight, multiply by the unit count, and make adjustments for multiple, reduced, or continued procedures where applicable.

2.5.2.7. Laboratory Services

Clinical lab services are tests on specimens taken from the human body (e.g., blood or urine) and used to help physicians diagnose or assess health.

How Medicare Reimburses Laboratory Services

Medicare pays for laboratory services using state-specific fee schedules. Individual lab services are identified by a HCPCS code.

Approach to Standardizing Payments

For each lab service on the clinical diagnostic laboratory fee schedule, we calculate the standard unit payment by taking the average of the payments across all states. We then multiply the average payment for a particular service by the unit count for that service. For lab services reimbursed under the automated multi-channel chemistry code, we use the total payment received by the lab.

2.5.2.8. Ambulance Services

Medicare beneficiaries sometimes require ambulance services for transportation.

How Medicare Reimburses Ambulance Services

Medicare pays for ambulance services using a fee schedule that pays separately for type of mileage (ground or air) and level of support (based on RVUs) provided during the trip. Reimbursements are also adjusted for geographic differences in labor cost as well as for service within urban or rural locations. Mileage type and level of support are indicated on the ambulance fee schedule by HCPCS code.

Approach to Standardizing Payments

We first calculate the average of the urban and rural mileage rates for each type of mileage at each level of ambulance service support for each state, and use these average state mileage and service rates to calculate a national average mileage and service rate for each HCPCS code. We then multiply this national average rate by the unit count.

2.5.2.9. Part B Drugs

Medicare makes payments to physicians for drugs or biologicals that are administered by infusion or injection and not usually self-administered.

How Medicare Reimburses Part B Drugs

Medicare pays for Part B prescription drugs using a national fee schedule (i.e., there is no variation from state to state).

Approach to Payments

We assign the national fee schedule amount to all Part B Drug claims and multiply this amount by the unit count.

2.5.3. Other Care Settings

2.5.3.1. Skilled Nursing Facilities (SNFs)

Beneficiaries who need short-term skilled care on an inpatient basis following a hospital stay of at least three days are eligible to receive covered services in a SNF.

How Medicare Reimburses SNFs

Medicare pays for SNFs through a PPS. Under the SNF PPS, Medicare assigns a different per diem base payment rate to SNFs based on their urban or rural status for each of three components of care: a nursing component, a therapy component, and a non-case mix-adjusted component reflecting the costs of room and board and administrative services. Daily payments to SNFs are then determined by adjusting the base payment rates for geographic differences in labor cost and by adjusting the nursing component and therapy components of the base payment rates by patient characteristics (resource

utilization groups [RUG]). RUGs are informed primarily by the patient's condition (comorbidities, activities of daily living score, therapy and service use) and are intended to group patients with similar expected service needs. Each RUG has a nursing relative weight and a therapy relative weight reflecting the expected relative costliness of treatment for patients in that specific RUG compared with the average Medicare beneficiary in a SNF. In addition, SNFs receive a 128% increase in the Medicare PPS per diem payment for patients with acquired immunodeficiency syndrome (AIDS).

Approach to Standardizing Payments

We average the urban and rural SNF per diem base rates, multiply by the RUG weights, and omit adjustment factors for the wage index. We then multiply this number by the number of days the patient is in a SNF and add a 128% AIDS adjustment if applicable. For critical access hospitals' swing-bed SNF claims, we use the total payment received by the SNF and remove the portion of the payment attributable to wage differences across geographic locations using the SNF state-specific rural wage index published by CMS.

2.5.3.2. Home Health Agencies (HHAs)

Beneficiaries who are generally confined to their homes and need skilled care from a nurse, physical therapist, or speech therapist on a part-time or intermittent basis are eligible to receive certain medical services at home. Covered services delivered by HHAs include: skilled nursing care, physical, occupational, and speech therapy, medical social work, and home health aide services.

How Medicare Reimburses HHAs

Medicare pays HHAs using a PPS and purchases home health services in units of 60-day episodes. Under the HHA PPS, Medicare assigns a base payment rate which is first adjusted for geographic factors and then adjusted for patient characteristics (by assigning each patient to a home health resource group [HHRG]). HHRG assignments are based on clinical and functional status as well as service use, and have a national relative weight reflecting the costliness of patients in that group compared with the average Medicare home health patient. Adjustments are also made for patients who receive fewer than five home health visits, are transferred to another HHA, or are discharged and readmitted to the same HHA within the 60-day time frame. Further adjustments are made for outlier payments and non-routine medical supplies. When there are fewer than five home health visits in the 60-day time frame, Medicare pays HHAs using the Low Utilization Payment Adjustment (LUPA) per visit rate, which is discipline-specific and depends on whether the visit was for home health aide, medical social services, occupational therapy, physical therapy, skilled nursing, or speech language pathology therapy. HHAs receive an add-on for LUPA episodes that occur as initial episodes in a sequence of adjacent episodes, or as the only episode.

Approach to Stripping Payments

We multiply the base payment by the HHRG weight and omit adjustment factors for the wage index. We then modify this total if the patient is transferred to another HHA or discharged and readmitted to the same HHA before 60 days. We then add any DME/POS/Oxygen add-ons or outlier payments (after removing the wage index adjustment) when applicable. For patients with fewer than five home health visits in the 60-day time frame, we apply the LUPA per visit payment rates with LUPA add-ons when applicable.

2.5.3.3. Hospice

Terminally ill beneficiaries, defined as having a life expectancy of six months or less, may receive hospice care. Hospice benefits cover a wide range of services including: physicians, skilled nursing, counseling, medical social services, drugs for pain control and symptom management, physical, occupational, and speech therapy, home health aides, and inpatient respite care.

How Medicare Reimburses Hospice

Medicare pays hospices for each day a beneficiary is eligible and under hospice care regardless of the amount of services provided on any given day. Payments are made according to a fee schedule that has individual base payment amounts for four categories of care: routine home care, continuous home care, inpatient respite care, and general inpatient care. Each hospice payment rate is then adjusted for geographic factors. Routine home care, inpatient respite care, and general inpatient care are paid the geographically-adjusted daily rate. Continuous home care is paid a geographically-adjusted hourly rate when care is delivered during a period of crisis and is provided in the home for eight or more hours in a 24-hour period beginning at midnight. Any applicable physician fees are added to the total hospice payment.

Approach to Stripping Payments

For continuous home care, we divide the base payment by 24 hours and multiply it by the number of hours of care and add any physician fees where applicable. For routine home care, inpatient respite care, and general inpatient care, we multiply the base payment by the number of days of care and add any applicable physician fees.

2.5.4 Physicians, Physician Extenders, Social Work Services

Medicare beneficiaries sometimes require the care of physicians or physician extenders for a number of different clinical services.

How Medicare Reimburses Physician, Physician Extenders, Social Work Services

Medicare uses a fee schedule based on a list of services and their corresponding payment rates to compensate individual providers. Medicare pays a higher physician fee for services provided in non-facility settings, such as physicians' offices, and a lower physician fee for services

furnished in facilities, such as hospitals. Physician fees are lower in facility settings because physicians' practice costs are generally lower in facilities. Also, in this case, Medicare pays both the facility and the physician. Each service has a weight, or RVU, that measures the relative costliness of three components of resources used to provide physician services: physician work, practice expenses, and malpractice insurance.

Medicare also uses three GPCIs to adjust for geographic factors related to physician work, practice expenses, and malpractice insurance, respectively. To arrive at the payment amount a conversion factor is multiplied by the total of the RVU weight multiplied by the GPCI weight for each type of resource. Adjustments are then made for certain circumstances such as multiple surgical procedures performed on the same day for the same patient, preoperative and postoperative management without surgical care, or bilateral surgery. Adjustments in payment are also made for care given by non-physicians such as physician assistants and clinical social workers.

Approach to Stripping Payments

For services provided in a facility setting (e.g., the hospital outpatient department), we multiply the conversion factor by the work RVU, transitioned facility practice expense RVU, and malpractice insurance RVU weights, and omit any adjustments for work GPCI, facility practice expertise GPCI, and/or malpractice insurance GPCI. For services provided in a non-facility setting (e.g. a physician's office), we multiply the conversion factor by the work RVU, transitioned non-facility practice expense RVU, and malpractice insurance RVU weights, and omit any adjustments for work GPCI, non-facility practice expertise GPCI, and/or malpractice insurance GPCI. We then adjust this total for the circumstances listed in the paragraph above and make any adjustments for care given by non-physicians. This adjusted payment amount is then multiplied by the unit count of the service provided.

2.5.5 Durable Medical Equipment/Prosthetics and Orthotics/Parenteral and Enteral Nutrition (DME/POS/PEN)

Beneficiaries who require medical equipment, prosthetics, orthotics, other supplies, or parenteral and enteral nutrition to treat their illness receive it under DME/POS/PEN.

How Medicare Reimburses DME

Medicare pays for DME/POS/PEN using a combination of state-specific fee schedules (for DME/POS) and a national fee schedule (for PEN).

Approach to Standardizing Payments

For DME/POS claims, we average the payment rate across the state for each item (identified by HCPCS code) on the fee schedule. Where applicable, we adjust the payment rates for new, used, or rental equipment. We then multiply by the unit count. If a patient receives Part B drugs in conjunction with DME, we add the Part B drug payment.

For PEN claims, we assign items the amounts specified in the national fee schedule.

2.6. Model Development and Validation Samples

For model development, we used the full 2008 calendar year 100% sample of AMI patients to derive the cohort (Sample A). To define the outcome, we used the full calendar year of 2008 as well as January 2009 data to cover the 30 day episode-of-care period for index admissions in December 2008. All final model results presented in Sections 3.2 and 3.3 were produced using this sample. To determine variables for inclusion in the model (variable selection), we used a randomly selected 50% sample of the full 2008 sample (Sample A1). We used Sample A1 plus the other half of the full 2008 sample (Sample A2) to assess model validity. Table 2 summarizes the different data samples and their purposes.

Table 2. 2008 AMI Payment Model Development and Validation Sample

Sample	% of Total Sample	Purpose
Sample A (Full Sample)	100%	Development (cohort, outcome definition, and determination of functional form of risk-adjustment model)
Sample A1 (Development)	50% (randomly selected)	Development (variable selection; validity testing)
Sample A2 (Validation)	50% (remaining 50%)	Development (validity testing)

2.7. Approach to Risk Adjustment

The goal of risk adjustment for this measure is to account for patient age, prior procedures (e.g., PCI and/or CABG), and comorbid conditions that are clinically relevant and have strong relationships with the outcome, while illuminating important quality differences between hospitals.

Comorbidities for inclusion in risk adjustment are identified in administrative claims during the 12 months prior to and including the index admission. To assemble the more than 15,000 ICD-9 codes into clinically coherent variables for risk-adjustment, the measure employs the publicly available CMS condition categories (CCs) to group ICD-9 codes into CCs,[11] and selects comorbidities on the basis of clinical relevance and statistical significance.

The measure does not adjust for the patient's admission source or discharge disposition (e.g., a skilled nursing facility) because these factors are associated with the structure of the health care system and the different care patterns the measure seeks to illuminate. Because hospitals should not be held to different standards of care based on the demographics of their patients, the measure also does not adjust for socioeconomic status (SES), gender, race, or ethnicity. Variation in payments associated with these characteristics may indicate differences in the care provided to vulnerable populations, and adjusting for these factors would obscure these disparities. The measure does not adjust for hospital characteristics either (e.g., teaching status), since this would hold different types of hospitals to different standards, and because such characteristics may exist on a causal pathway to the outcome rather than act as confounders. This approach is consistent with NQF guidelines.[12]

2.7.1. Complications of Hospitalization

Complications occurring during hospitalization are not comorbid illnesses and may reflect hospital quality of care; therefore, they should not be used for risk adjustment. Although adverse events during hospitalization may increase the payments for an AMI episode of care, including them as covariates in a risk-adjusted model could obscure payment differentials related to the quality of care delivered by hospitals. YNNHSC/CORE has previously reviewed every CMS-CC and identified those which, if they only occur during the index hospitalization, would be considered potential complications rather than comorbidities. For example, fluid, electrolyte or base disorders; sepsis; and acute liver failure are CMS-CCs that could potentially be complications of care (Appendix A).

2.7.2. Case Mix Adjustment: Candidate Comorbid Risk Variables

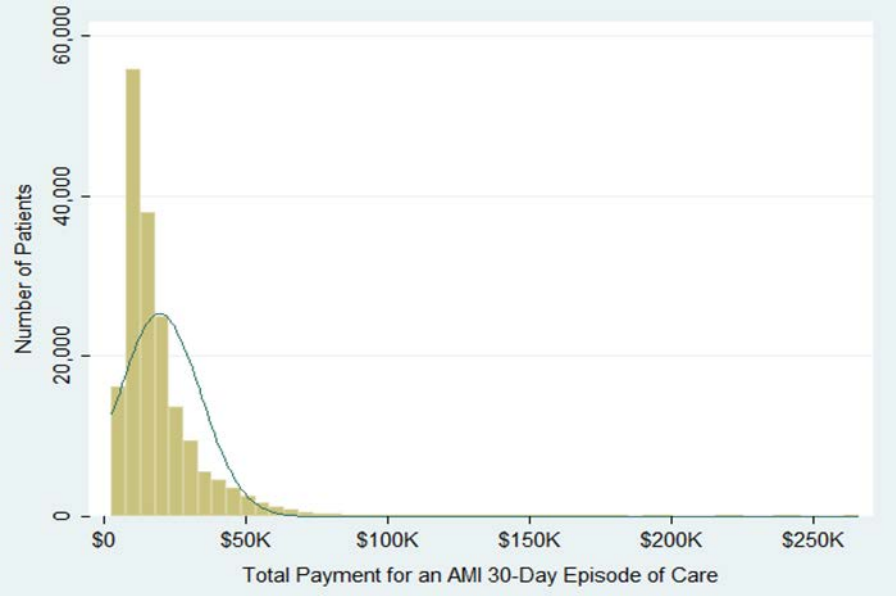
Our goal was to develop a parsimonious model that accounted for differences in patient case mix at the time of index admission that were strongly associated with total payment for an AMI 30-day episode of care. The candidate variables for the model were derived from secondary diagnoses of the index hospital stay (excluding potential complications), inpatient data, outpatient hospital data, and carrier files for physician, radiology and laboratory services during the 12 months prior to the index hospital stay.

To select candidate variables, we started with the 189 Condition Categories (CCs). We used the ICD-9-to-CC assignment map, which is maintained by CMS and posted on the QualityNet website. A team of clinicians reviewed all 189 CCs and excluded those that were not relevant to the Medicare population or not clinically relevant to the AMI payment outcome (e.g., attention deficit disorder, female infertility). Some of these CCs were combined into clinically coherent groups. The remaining clinically relevant CCs, along with several other adjustment variables including age, history of PCI, and history of CABG, were selected as candidate comorbid risk variables. A complete list of candidate variables is presented in Table 3.

2.7.3 Case Mix Adjustment: Choice of Functional Form

As is typical with data for healthcare payments, our dependent variable – total payment for an AMI 30-day episode of care – is both right-skewed and leptokurtotic (skewness= 2.7; kurtosis = 15.4). This is illustrated in Figure 3. To address estimation problems that can arise with non-normally distributed data, we employed the algorithm suggested by Manning & Mullahy (2001).[13] Using this algorithm and Sample A, we compared several alternative models in order to determine the best estimation approach. Based on these assessments, we chose to estimate a generalized linear model with a log link and an inverse Gaussian distribution.

Figure 3. Distribution of Unadjusted Patient-Level Total Payments for an AMI 30-Day Episode of Care (2008 Sample A; N=180,562 Patients)



2.7.4. Final Variable Selection

To inform variable selection, we performed a modified approach to stepwise generalized linear model regression. We used Sample A1 to create 1,000 bootstrap samples. For each sample, we ran a generalized linear model that included all candidate variables. Specifically, let Y_{ij} denote the outcome (i.e., total payment for an AMI 30-day episode of care) for the j^{th} patient admitted to the i^{th} hospital; and Z_{ij} denotes the candidate risk factors where $\mathbf{Z}_{ij} = (Z_{1ij}, Z_{2ij}, \ldots, Z_{pij})$ is a set of *p* patient-specific variables (e.g., age, prior PCI, comorbid conditions). Let I denote the total number of hospitals and n_i the number of index patient stays in hospital i. We assume the outcome is related linearly to the risk factors via a known link function, h(·), as follows:

$$h(Y_{ij}) = \alpha + \beta \mathbf{Z}_{ij} \quad (1)$$

In our case, h(·) is the log link and we assumed an inverse Gaussian error distribution. We estimated these generalized linear models using the SAS software system (SAS 9.3 GENMOD procedure).

The results were summarized to show the percentage of times that each of the candidate variables was significantly associated with AMI payment (at the $p<0.05$ level) in the 1,000 bootstrap samples (e.g., 70% would mean that the candidate variable was significant at $p<0.05$ in 70% of the bootstrap samples). We also assessed the direction and magnitude of the regression coefficients.

The working group reviewed these results and decided to retain all risk-adjustment variables above a 90% cutoff (i.e., to retain variables that were significant at the 0.05 level in at least 90% of the bootstrap samples). We chose the 90% cutoff because variables above this threshold demonstrated a relatively robust association with AMI payment and were clinically relevant. The final risk-adjusted AMI payment model included 32 variables (Table 4).

Table 3. 2008 AMI Payment Model Candidate Variables

Risk Adjustment Category	Risk Adjustment Variable	CC
Demographics	Age (65 – 74)	N/A
Demographics	Age (75 – 84)	N/A
Demographics	Age (>=85)	N/A
Cardiovascular	History of PCI	N/A
Cardiovascular	History of CABG	N/A
Cardiovascular	Respirator Dependence/Respiratory Arrest/Cardiorespiratory Failure	CC 77-79
Cardiovascular	Congestive Heart Failure	CC 80
Cardiovascular	Acute Coronary Syndrome	CC 81, 82
Cardiovascular	Angina Pectoris/Old Myocardial Infarction	CC 83
Cardiovascular	Coronary Atherosclerosis/Other Chronic Ischemic Heart Disease	CC 84
Cardiovascular	Heart Infection/Inflammation, Except Rheumatic	CC 85
Cardiovascular	Valvular and Rheumatic Heart Disease	CC 86
Cardiovascular	Congenital cardiac/circulatory defect	CC 87, 88
Cardiovascular	Hypertension and Hypertension Complications	CC 89-91
Other Comorbidity	History of Infection	CC 1, 3-5
Other Comorbidity	Septicemia/Shock	CC 2
Other Comorbidity	Other Infectious Diseases	CC 6
Other Comorbidity	Metastatic Cancer and Acute Leukemia and Other Major Cancers	CC 7, 8
Other Comorbidity	Other Major Cancers	CC 9, 11, 12
Other Comorbidity	Breast, Prostate, Colorectal, and Other Cancers and Tumors	CC 10
Other Comorbidity	Other Neoplasms	CC 13
Other Comorbidity	Benign Neoplasms of Skin, Breast, Eye	CC 14
Other Comorbidity	Diabetes and Diabetes Complications	CC 15-19, 119-120
Other Comorbidity	Protein-Calorie Malnutrition	CC 21
Other Comorbidity	Other Significant Endocrine and Metabolic Disorders	CC 22
Other Comorbidity	Disorders of Fluid/Electrolyte/Acid-Base	CC 23
Other Comorbidity	Obesity/Disorders of Thyroid, Cholesterol, Lipids	CC 24
Other Comorbidity	Liver and Biliary Disease	CC 25-30
Other Comorbidity	Pancreatic Disease	CC 32
Other Comorbidity	Inflammatory Bowel Disease	CC 33
Other Comorbidity	Peptic Ulcer, Hemorrhage, Other Specified Gastrointestinal Disorders	CC 34
Other Comorbidity	Appendicitis	CC 35
Other Comorbidity	Other Gastrointestinal Disorders	CC 36
Other Comorbidity	Bone/Joint/Muscle Infections/Necrosis	CC 37
Other Comorbidity	Rheumatoid Arthritis and Inflammatory Connective Tissue Disease	CC 38
Other Comorbidity	Disorders of the Vertebrae and Spinal Discs	CC 39
Other Comorbidity	Osteoarthritis of Hip or Knee	CC 40
Other Comorbidity	Osteoporosis and Other Bone/Cartilage Disorders	CC 41

Risk Adjustment Category	Risk Adjustment Variable	CC
Other Comorbidity	Congenital/Developmental Skeletal and Connective Tissue Disorders	CC 42
Other Comorbidity	Other Musculoskeletal and Connective Tissue Disorders	CC 43
Other Comorbidity	Severe Hematological Disorders	CC 44
Other Comorbidity	Disorders of Immunity	CC 45
Other Comorbidity	Coagulation Defects and Other Specified Hematological Disorders	CC 46
Other Comorbidity	Iron Deficiency and Other/Unspecified Anemias and Blood Disease	CC 47
Other Comorbidity	Delirium and Encephalopathy	CC 48
Other Comorbidity	Dementia	CC 49
Other Comorbidity	Senility, Nonpsychotic Organic Brain Syndromes/Conditions	CC 50
Other Comorbidity	Drug/Alcohol Psychosis	CC 51
Other Comorbidity	Drug/Alcohol Abuse/Dependence	CC 52, 53
Other Comorbidity	Severe Mental Illness	CC 54, 55
Other Comorbidity	Reactive and Unspecified Psychosis	CC 56
Other Comorbidity	Personality Disorders	CC 57
Other Comorbidity	Depression/Anxiety	CC 58, 59
Other Comorbidity	Other psychiatric disorders	CC 60
Other Comorbidity	Mental retardation or developmental disability	CC 61-65
Other Comorbidity	Plegia, Paralysis, Spinal Cord Disorder and Amputation	CC 67-69, 100, 101, 177, 178
Other Comorbidity	Muscular Dystrophy	CC 70
Other Comorbidity	Polyneuropathy	CC 71
Other Comorbidity	Multiple Sclerosis	CC 72
Other Comorbidity	Parkinson's and Huntington's Diseases	CC 73
Other Comorbidity	Seizure Disorders and Convulsions	CC 74
Other Comorbidity	Coma, Brain Compression/Anoxic Damage	CC 75
Other Comorbidity	Mononeuropathy, Other Neurological Conditions/Injuries	CC 76
Other Comorbidity	Arrhythmias	CC 92, 93
Other Comorbidity	Other and Unspecified Heart Disease	CC 94
Other Comorbidity	Stroke	CC 95, 96
Other Comorbidity	Precerebral Arterial Occlusion and Transient Cerebral Ischemia	CC 97
Other Comorbidity	Cerebrovascular Disease and Aneurysm	CC 98, 99
Other Comorbidity	Cerebrovascular Disease and Late Effects	CC 102, 103
Other Comorbidity	Vascular Disease and Complications	CC 104, 105
Other Comorbidity	Other Circulatory Disease	CC 106
Other Comorbidity	Cystic fibrosis	CC 107
Other Comorbidity	COPD	CC 108
Other Comorbidity	Fibrosis of lung or other chronic lung disorder	CC 109
Other Comorbidity	Asthma	CC 110
Other Comorbidity	History of Pneumonia	CC 111-113
Other Comorbidity	Pleural Effusion/Pneumothorax	CC 114
Other Comorbidity	Other Lung Disorders	CC 115
Other Comorbidity	Legally Blind	CC 116
Other Comorbidity	Major Eye Infections/Inflammations	CC 117
Other Comorbidity	Retinal Detachment	CC 118
Other Comorbidity	Retinal Disorders, Except Detachment and Vascular Retinopathies	CC 121
Other Comorbidity	Glaucoma	CC 122
Other Comorbidity	Other Eye Disorders	CC 124

Risk Adjustment Category	Risk Adjustment Variable	CC
Other Comorbidity	Significant Ear, Nose, and Throat Disorders	CC 125
Other Comorbidity	Hearing Loss	CC 1126
Other Comorbidity	Other Ear, Nose, Throat, and Mouth Disorders	CC 127
Other Comorbidity	Kidney Transplant Status	CC 128
Other Comorbidity	Dialysis Status	CC 130
Other Comorbidity	Renal Failure	CC 131
Other Comorbidity	Nephritis	CC 132
Other Comorbidity	Urinary Obstruction and Retention	CC 133
Other Comorbidity	Incontinence	CC 134
Other Comorbidity	Urinary Tract Infection	CC 135
Other Comorbidity	Other urinary tract disorders	CC 136
Other Comorbidity	Female Genital Disorders	CC 138, 139
Other Comorbidity	Male genital disorders	CC 140
Other Comorbidity	Decubitus Ulcer of Skin	CC 148
Other Comorbidity	Chronic Ulcer of Skin, Except Decubitus	CC 149
Other Comorbidity	Extensive Third-Degree Burns	CC 150
Other Comorbidity	Other Third-Degree and Extensive Burns	CC 151
Other Comorbidity	Cellulitis, Local Skin Infection	CC 152
Other Comorbidity	Other Dermatological Disorders	CC 153
Other Comorbidity	Head Injury	CC 154-156
Other Comorbidity	Vertebral Fractures	CC 157
Other Comorbidity	Hip Fracture/Dislocation	CC 158
Other Comorbidity	Major Fracture, Except of Skull, Vertebrae, or Hip	CC 159
Other Comorbidity	Internal Injuries	CC 160
Other Comorbidity	Traumatic Amputation	CC 161
Other Comorbidity	Other Injuries	CC 162
Other Comorbidity	Poisonings and Allergic Reactions	CC163
Other Comorbidity	Major Complications of Medical Care and Trauma	CC 164
Other Comorbidity	Other Complications of Medical Care	CC 165
Other Comorbidity	Major Symptoms, Abnormalities	CC 166
Other Comorbidity	Minor Symptoms, Signs, Findings	CC 167
Other Comorbidity	Major Organ Transplant Status	CC 174
Other Comorbidity	Other organ transplant/replacement	CC 175

Table 4. 2008 AMI Payment Model Final Variables

Category	Variable	CC
Demographics	Age (65 – 74)	N/A
Demographics	Age (75 – 84)	N/A
Demographics	Age (>=85)	N/A
Cardiovascular	History of PCI	N/A
Cardiovascular	History of CABG	N/A
Cardiovascular	Congestive Heart Failure	CC 80
Cardiovascular	Angina Pectoris/Old Myocardial Infarction	CC 83
Cardiovascular	Heart Infection/Inflammation, Except Rheumatic	CC 85
Cardiovascular	Valvular and Rheumatic Heart Disease	CC 86

Category	Variable	CC
Cardiovascular	Congenital cardiac/circulatory defect	CC 87, 88
Cardiovascular	Hypertension and Hypertension Complications	CC 89-91
Other Comorbidity	Metastatic Cancer and Acute Leukemia and Other Major Cancers	CC 7, 8
Other Comorbidity	Diabetes and Diabetes Complications	CC 15-19, 119-120
Other Comorbidity	Protein-Calorie Malnutrition	CC 21
Other Comorbidity	Other Significant Endocrine and Metabolic Disorders	CC 22
Other Comorbidity	Obesity/Disorders of Thyroid, Cholesterol, Lipids	CC 24
Other Comorbidity	Other Gastrointestinal Disorders	CC 36
Other Comorbidity	Osteoporosis and Other Bone/Cartilage Disorders	CC 41
Other Comorbidity	Iron Deficiency and Other/Unspecified Anemias and Blood Disease	CC 47
Other Comorbidity	Delirium and Encephalopathy	CC 48
Other Comorbidity	Dementia	CC 49
Other Comorbidity	Drug/Alcohol Psychosis	CC 51
Other Comorbidity	Drug/Alcohol Abuse/Dependence	CC 52, 53
Other Comorbidity	Severe Mental Illness	CC 54, 55
Other Comorbidity	Reactive and Unspecified Psychosis	CC 56
Other Comorbidity	Depression/Anxiety	CC 58, 59
Other Comorbidity	Precerebral Arterial Occlusion and Transient Cerebral Ischemia	CC 97
Other Comorbidity	Vascular Disease and Complications	CC 104, 105
Other Comorbidity	Other Lung Disorders	CC 115
Other Comorbidity	Legally Blind	CC 116
Other Comorbidity	Dialysis Status	CC 130
Other Comorbidity	Internal Injuries	CC 160

2.8. Statistical Approach to Risk-Standardized Payment (RSP)

To calculate hospital-specific RSPs, we estimate hierarchical generalized linear models using Sample A. This strategy accounts for within-hospital correlation of the observed outcomes and accommodates the assumption that underlying differences in quality across hospitals lead to systematic differences in outcomes. We model the total payment as a function of patient age, select comorbidities, and history of PCI and/or CABG with a hospital-specific random effect.

We use the following strategy to calculate the hospital-specific RSPs. We calculate these payments as the ratio of "predicted" AMI payment to expected AMI payment, and multiply by the national unadjusted average AMI payment. The predicted AMI payment for each hospital is estimated using its patient mix and an estimated hospital-specific intercept. The expected AMI payment for each hospital is estimated given the same patient mix but the average intercept among all hospitals in the sample.

Operationally, the expected AMI payment for each hospital is obtained by summing the expected AMI payments for all patients in the hospital. The expected AMI payment for each patient is calculated via the hierarchical model by applying the estimated regression coefficients to the observed patient characteristics and adding the average intercept. The predicted AMI payment for each hospital is calculated by summing the predicted AMI payments for all patients in the hospital. The predicted AMI payment for each patient is calculated through the hierarchical model by applying the estimated regression coefficients to the patient characteristics observed and adding the hospital-specific intercept.

More specifically, we use a hierarchical generalized linear model to account for the natural clustering of observations within hospitals and adjust for the selected risk factors. The model employs a log link and an inverse Gaussian error distribution with a hospital-specific random effect as follows:

$$h(Y_{ij}) = \alpha_i + \beta \mathbf{Z}_{ij} \quad (2)$$

$$\alpha_i = \mu + \omega_i; \qquad \omega_i \sim N(0, \tau^2) \quad (3)$$

where α_i represents the hospital-specific intercept, $\mathbf{Z}_{ij}$ is defined the same as in equation (1), μ is the average intercept across all hospitals in the sample, and τ^2 is the between-hospital variance component.[14] This model separates within-hospital variation from between-hospital variation. The hierarchical generalized linear models are estimated using the SAS software system (SAS 9.3 GLIMMIX procedure).

2.8.1 Hospital Performance Reporting

Using the selected set of risk factors, we fit the hierarchical generalized linear model defined by Equations (2) - (3) and estimate the parameters, $\hat{\mu}$, $\{\alpha_i, \alpha_2, \ldots, \alpha_I\}$, $\hat{\beta}$, and $\hat{\tau}^2$. We calculate a standardized outcome measure, RSP_i, for each hospital by computing the ratio of the predicted AMI payment to the expected AMI payment, and multiplying by the national unadjusted average AMI payment, $\bar{y}$. Specifically, we calculate

Predicted $$\hat{y}_{ij}(Z_{ij}) = h^{-1}(\hat{a}_i + \hat{\beta}\mathbf{Z}_{ij}) \quad (4)$$

Expected $$\hat{e}_{ij}(Z_{ij}) = h^{-1}(\hat{\mu} + \hat{\beta}\mathbf{Z}_{ij}) \quad (5)$$

$$\widehat{RSP}_i(Z_{ij}) = \frac{\sum_{j=1}^{n_i} \hat{y}_{ij}(Z)}{\sum_{j=1}^{n_i} \hat{e}_{ij}(Z)} \times \bar{y} \quad (6)$$

Again, i indexes hospitals, j indexes patients within hospitals, and n_i is the number of patients within hospital i. If "predicted" total payment is higher (or lower) than "expected" total payment for a given hospital, then its $\widehat{RSP}_i$ will be higher (or lower) than the national unadjusted average payment. For each hospital, we can compute an interval estimate of RSP_i to characterize the level of uncertainty around the point estimate using bootstrapping simulations. The point estimate and interval estimate can be used to characterize and compare hospital performance (e.g., higher than expected, as expected, or lower than expected). See Figure 4 for our overall analysis steps.

2.8.2 Creating Interval Estimates

Because the statistic described in Equation 6 (Section 2.8.1), i.e., $\widehat{RSP}_i$, is a complex function of parameter estimates, we use the re-sampling technique – bootstrapping – to derive an interval estimate. Bootstrapping has the advantage of avoiding unnecessary distributional assumptions.

Algorithm:

Let *I* denote the total number of hospitals in the sample. We repeat steps 1-4 below for B times, where *B* is the number of bootstrap samples desired (with b indexes the *b*th bootstrap sample):

1. Sample *I* hospitals with replacement.

2. Fit the hierarchical generalized linear model using all patients within each sampled hospital. If some hospitals are selected more than once in a bootstrapped sample, we treat them as distinct so that we have *I* random effects to estimate the variance components. At the conclusion of Step 2, we have:
   a. $\hat{\beta}^{(b)}$ (estimated regression coefficients of the risk factors)

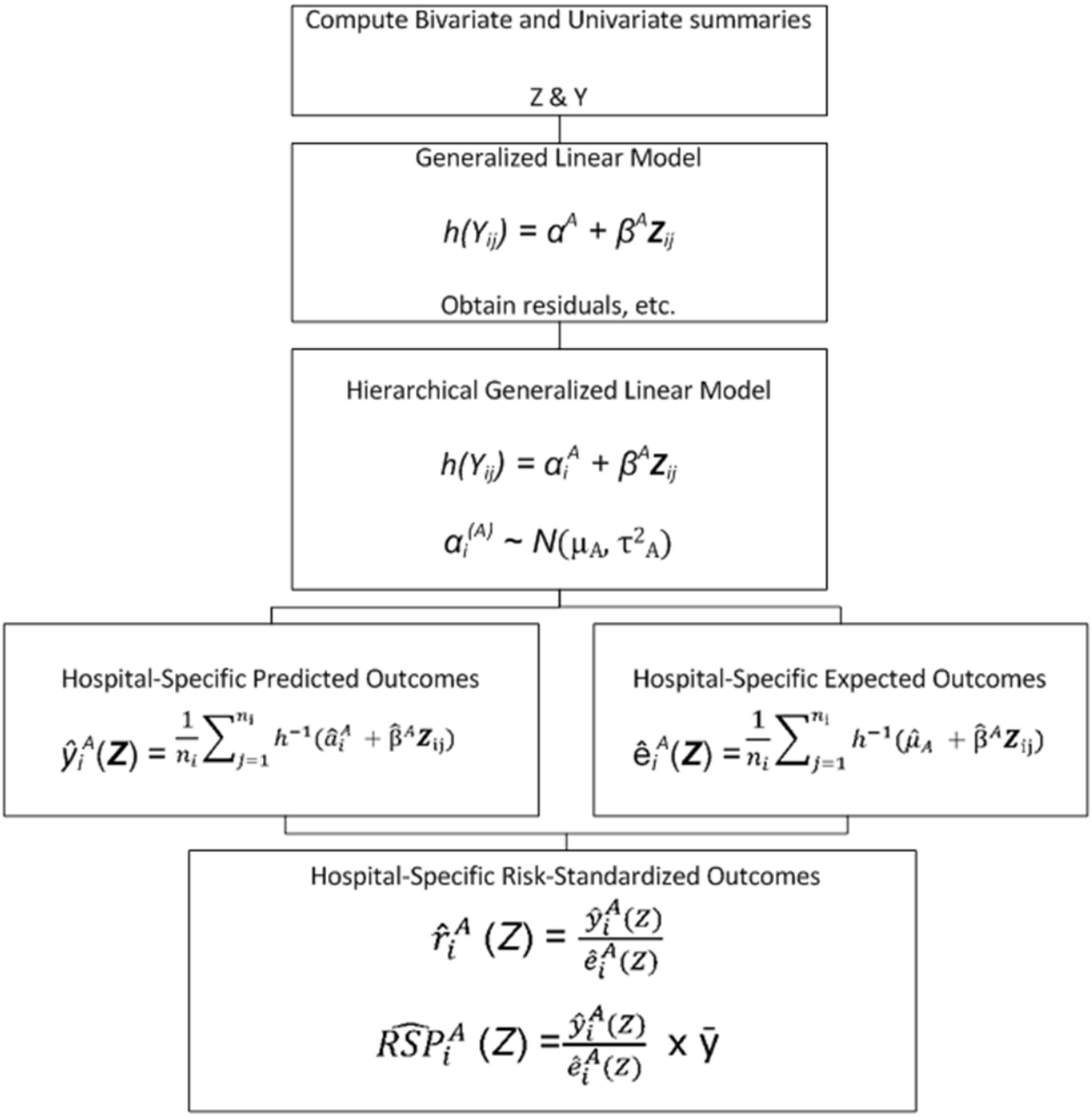
   b. The parameters governing the random effects, hospital adjusted outcomes, distribution, $\hat{\mu}^{(b)}$ and $\hat{\tau}^{2(b)}$
   c. The set of hospital-specific intercepts and corresponding variances, $\{\hat{\alpha}_i{}^{(b)}, \widehat{var}(\alpha_i{}^{(b)}); i = 1,2, \dots, I\}$

3. We generate a hospital random effect by sampling from the distribution of the hospital-specific distribution obtained in Step 2c. We approximate the distribution for each random effect by a normal distribution. Thus, we draw $\alpha_i{}^{(b*)} \sim N(\hat{\alpha}_i{}^{(b)}, \widehat{var}(\hat{\alpha}_i{}^{(b)}))$ for the unique set of hospitals sampled in Step 1.

4. Within each unique hospital *i* sampled in Step 1, and for each patient *j* in that hospital, we calculate $\hat{y}_{ij}{}^{(b)}$, $\hat{e}_{ij}{}^{(b)}$, and $\widehat{RSP}_i(Z)^{(b)}$ where $\hat{\beta}^{(b)}$ and $\hat{\mu}^{(b)}$ are obtained from Step 2 and $\hat{\alpha}_i{}^{(b*)}$ is obtained from Step 3.

Ninety-five percent interval estimates (or alternative interval estimates) for the hospital-standardized outcome can be computed by identifying the 2.5th and 97.5th percentiles of the B estimates (or the percentiles corresponding to the alternative desired intervals).[15]

Figure 4. Analysis Steps



3. RESULTS

3.1. Model Development and Validation Results

Table 5 shows the number of index admissions and number of hospitals associated with each of the samples used for measure development and validation as outlined in Section 2.6.

Table 5. Description of 2008 Development and Validation Samples

Sample	% of Total Sample	Purpose	Number of Index Admissions	Number of Hospitals
Sample A (Full Sample)	100%	Development (cohort, outcome definition, determination of functional form of risk-adjustment model)	180,562	4,151
Sample A1 (Development)	50% (randomly selected)	Development (variable selection; validity testing)	90,281	3,904
Sample A2 (Validation)	50% (remaining 50%)	Development (validity testing)	90,281	3,873

The frequencies of final selected risk factors for all samples, as shown in Table 6, are consistent across the development and validation samples.

Table 6. 2008 AMI Payment Model Risk Factor Frequencies in Development, Validation, and Full Samples

Risk Adjustment Category	Risk Adjustment Variable	2008 Sample A1 (%)	2008 Sample A2 (%)	2008 Sample A (%)
Demographics	Age (65 – 74)	31.09	31.13	31.11
Demographics	Age (75 – 84)	39.34	39.12	39.23
Demographics	Age (>=85)	29.57	29.75	29.66
Cardiovascular	History of PCI	7.64	7.73	7.69
Cardiovascular	History of CABG	6.01	5.99	6.00
Cardiovascular	Congestive Heart Failure (CC 80)	31.21	31.41	31.31
Cardiovascular	Angina Pectoris/Old Myocardial Infarction (CC 83)	21.16	21.21	21.18
Cardiovascular	Heart Infection/Inflammation, Except Rheumatic (CC 85)	1.82	1.77	1.80
Cardiovascular	Valvular and Rheumatic Heart Disease (CC 86)	27.06	27.43	27.24
Cardiovascular	Congenital cardiac/circulatory defect (CC 87-88)	0.94	0.94	0.94
Cardiovascular	Hypertension and Hypertension Complications (CC 89-91)	83.87	83.64	83.75
Other Comorbidity	Metastatic Cancer and Acute Leukemia and Other Major Cancers (CC 7-8)	3.95	4.01	3.98
Other Comorbidity	Diabetes and Diabetes Complications (CC 15-19,	41.83	41.87	41.85

Risk Adjustment Category	Risk Adjustment Variable	2008 Sample A1 (%)	2008 Sample A2 (%)	2008 Sample A (%)
	119-120)			
Other Comorbidity	Protein-Calorie Malnutrition (CC 21)	5.01	4.94	4.97
Other Comorbidity	Other Significant Endocrine and Metabolic Disorders (CC 22)	6.23	6.24	6.23
Other Comorbidity	Obesity/Disorders of Thyroid, Cholesterol, Lipids (CC 24)	72.16	72.41	72.28
Other Comorbidity	Other Gastrointestinal Disorders (CC 36)	44.93	45.30	45.11
Other Comorbidity	Osteoporosis and Other Bone/Cartilage Disorders (CC 41)	14.53	14.78	14.66
Other Comorbidity	Iron Deficiency and Other/Unspecified Anemias and Blood Disease (CC 47)	38.46	38.75	38.60
Other Comorbidity	Delirium and Encephalopathy (CC 48)	3.74	3.72	3.73
Other Comorbidity	Dementia (CC 49)	17.39	17.59	17.49
Other Comorbidity	Drug/Alcohol Psychosis (CC 51)	1.11	1.22	1.17
Other Comorbidity	Drug/Alcohol Abuse/Dependence (CC 52-53)	9.86	9.91	9.89
Other Comorbidity	Severe Mental Illness (CC 54-55)	4.40	4.42	4.41
Other Comorbidity	Reactive and Unspecified Psychosis (CC 56)	3.04	3.06	3.05
Other Comorbidity	Depression/Anxiety (CC 58-59)	10.42	10.70	10.56
Other Comorbidity	Precerebral Arterial Occlusion and Transient Cerebral Ischemia (CC 97)	15.30	15.26	15.28
Other Comorbidity	Vascular Disease and Complications (CC 104-105)	25.00	25.25	25.12
Other Comorbidity	Other Lung Disorders (CC 115)	26.87	27.03	26.95
Other Comorbidity	Legally Blind (CC 116)	0.72	0.77	0.75
Other Comorbidity	Dialysis Status (CC 130)	2.21	2.27	2.24
Other Comorbidity	Internal Injuries (CC 160)	0.91	0.94	0.93

3.1.1. Results of Risk-Adjustment Model in Development and Validation Samples

Table 7 reports the estimated coefficients, standard errors, payment ratios (PR) (i.e., exponentiated coefficient estimate), and 95% confidence intervals for the PR associated with each risk factor generated from the 2008 development sample and Table 8 presents the same information for the validation sample. PRs are similar in both samples.

Table 7. Generalized Linear Model Results for 2008 Development Sample A1
(N=90,281 at 3,904 hospitals)

Risk Adjustment Category	Risk Adjustment Variable	Estimate	Standard Error	Payment Ratio (PR)	95% Confidence Interval for PR
Intercept	N/A	9.839	0.007	-	-
Demographics	Age (65 – 74)	0.217	0.006	1.242	(1.229-1.256)
Demographics	Age (75 – 84)	0.188	0.005	1.207	(1.196-1.219)
Demographics	Age (>=85) (reference group)	0.000	-	1.000	-
Cardiovascular	History of PCI	-0.062	0.008	0.940	(0.926-0.954)
Cardiovascular	History of CABG	-0.220	0.008	0.802	(0.790-0.815)
Cardiovascular	Congestive Heart Failure (CC 80)	-0.053	0.005	0.949	(0.940-0.958)
Cardiovascular	Angina Pectoris/Old Myocardial Infarction (CC 83)	-0.043	0.005	0.958	(0.948-0.967)
Cardiovascular	Heart Infection/Inflammation, Except Rheumatic (CC 85)	0.205	0.017	1.228	(1.188-1.269)
Cardiovascular	Valvular and Rheumatic Heart Disease (CC 86)	0.025	0.005	1.025	(1.015-1.034)
Cardiovascular	Congenital cardiac/circulatory defect (CC 87-88)	0.102	0.022	1.108	(1.061-1.157)
Cardiovascular	Hypertension and Hypertension Complications (CC 89-91)	-0.047	0.006	0.954	(0.943-0.965)
Other Comorbidity	Metastatic Cancer and Acute Leukemia and Other Major Cancers (CC 7-8)	-0.098	0.010	0.907	(0.889-0.925)
Other Comorbidity	Diabetes and Diabetes Complications (CC 15-19, 119-120)	0.047	0.004	1.048	(1.039-1.057)
Other Comorbidity	Protein-Calorie Malnutrition (CC 21)	0.099	0.010	1.104	(1.083-1.125)
Other Comorbidity	Other Significant Endocrine and Metabolic Disorders (CC 22)	0.039	0.010	1.040	(1.020-1.060)
Other Comorbidity	Obesity/Disorders of Thyroid, Cholesterol, Lipids (CC 24)	-0.060	0.005	0.942	(0.933-0.950)
Other Comorbidity	Other Gastrointestinal Disorders (CC 36)	-0.042	0.004	0.958	(0.951-0.966)
Other Comorbidity	Osteoporosis and Other Bone/Cartilage Disorders (CC 41)	-0.027	0.006	0.973	(0.962- 0.984)
Other Comorbidity	Iron Deficiency and Other/Unspecified Anemias and Blood Disease (CC 47)	0.049	0.004	1.050	(1.041-1.059)
Other Comorbidity	Delirium and Encephalopathy (CC 48)	0.035	0.011	1.035	(1.013-1.058)
Other Comorbidity	Dementia (CC 49)	-0.112	0.006	0.894	(0.884-0.904)
Other Comorbidity	Drug/Alcohol Psychosis (CC 51)	0.108	0.020	1.114	(1.071-1.159)
Other Comorbidity	Drug/Alcohol Abuse/Dependence (CC 52-53)	-0.073	0.007	0.929	(0.917-0.942)
Other Comorbidity	Severe Mental Illness (CC 54-55)	0.045	0.010	1.046	(1.025-1.067)
Other Comorbidity	Reactive and Unspecified Psychosis (CC 56)	-0.050	0.012	0.951	(0.930-0.973)
Other Comorbidity	Depression/Anxiety (CC 58-59)	-0.040	0.007	0.961	(0.948-0.974)
Other Comorbidity	Precerebral Arterial Occlusion and Transient Cerebral Ischemia (CC 97)	0.046	0.006	1.047	(1.036-1.059)
Other Comorbidity	Vascular Disease and Complications (CC 104-105)	0.019	0.005	1.019	(1.009-1.029)
Other Comorbidity	Other Lung Disorders (CC 115)	0.048	0.005	1.049	(1.040-1.059)
Other Comorbidity	Legally Blind (CC 116)	-0.084	0.022	0.920	(0.880-0.961)
Other Comorbidity	Dialysis Status (CC 130)	0.122	0.017	1.130	(1.093-1.168)
Other Comorbidity	Internal Injuries (CC 160)	0.118	0.022	1.125	(1.077-1.176)

Table 8. Generalized Linear Model Results for 2008 Validation Sample A2
(N=90,281 at 3,873 hospitals)

Risk Adjustment Category	Risk Adjustment Variable	Estimate	Standard Error	Payment Ratio (PR)	95% Confidence Interval for PR
Intercept	N/A	9.834	0.007	-	-
Demographics	Age (65 – 74)	0.242	0.006	1.274	(1.260-1.288)
Demographics	Age (75 – 84)	0.200	0.005	1.221	(1.209-1.233)
Demographics	Age (>=85) (reference group)	0.000	-	1.000	-
Cardiovascular	History of PCI	-0.068	0.008	0.934	(0.921-0.948)
Cardiovascular	History of CABG	-0.196	0.008	0.822	(0.809-0.834)
Cardiovascular	Congestive Heart Failure (CC 80)	-0.040	0.005	0.961	(0.952-0.970)
Cardiovascular	Angina Pectoris/Old Myocardial Infarction (CC 83)	-0.042	0.005	0.959	(0.949-0.968)
Cardiovascular	Heart Infection/Inflammation, Except Rheumatic (CC 85)	0.205	0.017	1.227	(1.187-1.269)
Cardiovascular	Valvular and Rheumatic Heart Disease (CC 86)	0.025	0.005	1.026	(1.016-1.035)
Cardiovascular	Congenital cardiac/circulatory defect (CC 87-88)	0.104	0.022	1.110	(1.063-1.159)
Cardiovascular	Hypertension and Hypertension Complications (CC 89-91)	-0.052	0.006	0.949	(0.939-0.960)
Other Comorbidity	Metastatic Cancer and Acute Leukemia and Other Major Cancers (CC 7-8)	-0.093	0.010	0.911	(0.893-0.929)
Other Comorbidity	Diabetes and Diabetes Complications (CC 15-19, 119-120)	0.042	0.004	1.043	(1.035-1.052)
Other Comorbidity	Protein-Calorie Malnutrition (CC 21)	0.116	0.010	1.123	(1.102-1.145)
Other Comorbidity	Other Significant Endocrine and Metabolic Disorders (CC 22)	0.046	0.010	1.047	(1.027-1.067)
Other Comorbidity	Obesity/Disorders of Thyroid, Cholesterol, Lipids (CC 24)	-0.067	0.005	0.935	(0.926-0.943)
Other Comorbidity	Other Gastrointestinal Disorders (CC 36)	-0.046	0.004	0.955	(0.947-0.963)
Other Comorbidity	Osteoporosis and Other Bone/Cartilage Disorders (CC 41)	-0.034	0.006	0.966	(0.956-0.977)
Other Comorbidity	Iron Deficiency and Other/Unspecified Anemias and Blood Disease (CC 47)	0.057	0.004	1.059	(1.050-1.068)
Other Comorbidity	Delirium and Encephalopathy (CC 48)	0.024	0.011	1.025	(1.003-1.047)
Other Comorbidity	Dementia (CC 49)	-0.112	0.005	0.894	(0.885-0.904)
Other Comorbidity	Drug/Alcohol Psychosis (CC 51)	0.094	0.019	1.098	(1.058-1.140)
Other Comorbidity	Drug/Alcohol Abuse/Dependence (CC 52-53)	-0.071	0.007	0.932	(0.919-0.944)
Other Comorbidity	Severe Mental Illness (CC 54-55)	0.014	0.010	1.015	(0.995-1.035)
Other Comorbidity	Reactive and Unspecified Psychosis (CC 56)	-0.045	0.012	0.956	(0.935-0.978)
Other Comorbidity	Depression/Anxiety (CC 58-59)	-0.038	0.007	0.963	(0.951-0.976)
Other Comorbidity	Precerebral Arterial Occlusion and Transient Cerebral Ischemia (CC 97)	0.045	0.006	1.046	(1.034-1.058)
Other Comorbidity	Vascular Disease and Complications (CC 104-105)	0.020	0.005	1.021	(1.011-1.030)
Other Comorbidity	Other Lung Disorders (CC 115)	0.044	0.005	1.045	(1.036-1.055)
Other Comorbidity	Legally Blind (CC 116)	-0.060	0.022	0.942	(0.903-0.983)
Other Comorbidity	Dialysis Status (CC 130)	0.110	0.017	1.116	(1.080-1.153)
Other Comorbidity	Internal Injuries (CC 160)	0.171	0.022	1.186	(1.135-1.239)

For each generalized linear model, we compute seven summary statistics to assess model performance: calibration (a measure of over-fitting)*, predictive ratios by deciles and top 1% of predicted payment, distribution of residuals, mean absolute prediction error (MAPE), root–mean-square error (RMSE), R^2, and model chi-square. Model performance results are summarized in Table 9.

Over-fitting can result in the phenomenon in which a model describes the relationship between predictive variables and the outcome well in the development sample, but fails to provide valid predictions in new patients. Since the γ_0 in the validation sample is close to zero and the γ_1 is close to one, there is little evidence of over-fitting.

A predictive ratio is an estimator's ratio of predicted outcome to observed outcome (Ash & Byrne-Logan 1998).[1] A predictive ratio of 1.0 indicates an accurate prediction. A ratio greater than 1.0 indicates overprediction, and a ratio less than 1.0 indicates underprediction.

R^2 is the R-squared from a regression of observed outcome on the predicted outcome (Jones 2010).[16]

Table 9. Generalized Linear Model Performance for 2008 Development and Validation Samples

Indices	2008 Development Sample A1	2008 Validation Sample A2
Number of hospital stays	90,281	90,281
Number of hospitals	3,904	3,872
Unadjusted mean payment	$19,879	$19,911
Calibration (γ0, γ1)	(0,1)	(-0.226,1.023)
Discrimination – Predictive Ratios First Decile (lowest)	0.96	0.95
Discrimination – Predictive Ratios Second Decile	1.01	1.01
Discrimination – Predictive Ratios Third Decile	1.02	1.03
Discrimination – Predictive Ratios Fourth Decile	1.03	1.03
Discrimination – Predictive Ratios Fifth Decile	1.02	1.04
Discrimination – Predictive Ratios Sixth Decile	1.04	1.03
Discrimination – Predictive Ratios Seventh Decile	1.03	1.02
Discrimination – Predictive Ratios Eighth Decile	0.99	1.01
Discrimination – Predictive Ratios Ninth Decile	0.97	0.96
Discrimination – Predictive Ratios Tenth Decile (highest)	0.93	0.93
Discrimination – Predictive Ratios Top 1%	0.96	0.93
Residuals Lack of Fit (Pearson Residual Fall %) <-2	0.00	0.00
Residuals Lack of Fit (Pearson Residual Fall %) [-2, 0)	64.66	64.43
Residuals Lack of Fit (Pearson Residual Fall %) [0, 2)	29.54	29.80

* Over-Fitting Indices (γ_0, γ_1) provide evidence of over-fitting and require several steps to calculate. Let *b* denote the *estimated vector* of regression coefficients. *Predicted Payment* ($\hat{p}$) = exp{Xb}), and *Z* = *Xb* (e.g., the linear predictor that is a scalar value for everyone). A new generalized linear model that includes only an intercept and a slope by regressing the log of Y on Z is fitted in the validation sample; e.g., Ln (E(Y|Z))= $\gamma_0 + \gamma_1 Z$. Estimated values of γ_0 far from 0 and estimated values of γ_1 far from 1 provide evidence of over-fitting.

Residuals Lack of Fit (Pearson Residual Fall %) [2+	5.80	5.76
MAPE	9711	9661
RMSE	14060	13984
R^2	0.050	0.055
Model χ^2 (DF)	2.117 (30)	2.065 (30)

3.2. Final Model Results

The final hierarchical generalized linear regression model was created using the full 2008 sample (i.e., Sample A). The list of covariates and estimates of coefficients, standard errors, and payment ratios are shown in Table 10.

Table 10. Hierarchical Generalized Linear Model Results for Full 2008 Sample

Risk Adjustment Category	Risk Adjustment Variable	Coefficient Estimate	Standard Error	Payment Ratio (PR)	95% Confidence Interval for PR
Intercept	N/A	9.807	0.006	-	-
Demographics	Age (65 – 74)	0.231	0.004	1.260	(1.249 – 1.270)
Demographics	Age (75 – 84)	0.193	0.004	1.212	(1.203 – 1.221)
Demographics	Age (>=85)	0.000	-	1.000	-
Cardiovascular	History of PCI	-0.071	0.006	0.932	(0.921 – 0.942)
Cardiovascular	History of CABG	-0.207	0.006	0.813	(0.804 – 0.823)
Cardiovascular	Congestive Heart Failure (CC 80)	-0.045	0.004	0.956	(0.949 – 0.963)
Cardiovascular	Angina Pectoris/Old Myocardial Infarction (CC 83)	-0.041	0.004	0.960	(0.952 – 0.967)
Cardiovascular	Heart Infection/Inflammation, Except Rheumatic (CC 85)	0.195	0.013	1.215	(1.184 – 1.247)
Cardiovascular	Valvular and Rheumatic Heart Disease (CC 86)	0.019	0.004	1.019	(1.012 – 1.027)
Cardiovascular	Congenital cardiac/circulatory defect (CC 87-88)	0.092	0.017	1.096	(1.060 – 1.134)
Cardiovascular	Hypertension and Hypertension Complications (CC 89-91)	-0.048	0.004	0.954	(0.945 – 0.962)
Other Comorbidity	Metastatic Cancer and Acute Leukemia and Other Major Cancers (CC 7-8)	-0.096	0.008	0.909	(0.895 – 0.923)
Other Comorbidity	Diabetes and Diabetes Complications (CC 15-19, 119-120)	0.046	0.003	1.047	(1.040 – 1.054)
Other Comorbidity	Protein-Calorie Malnutrition (CC 21)	0.105	0.008	1.111	(1.094 – 1.128)
Other Comorbidity	Other Significant Endocrine and Metabolic Disorders (CC 22)	0.041	0.008	1.042	(1.027 – 1.057)
Other Comorbidity	Obesity/Disorders of Thyroid, Cholesterol, Lipids (CC 24)	-0.063	0.004	0.939	(0.932 – 0.946)
Other Comorbidity	Other Gastrointestinal Disorders (CC 36)	-0.040	0.003	0.961	(0.954 – 0.967)
Other Comorbidity	Osteoporosis and Other Bone/Cartilage Disorders (CC 41)	-0.030	0.004	0.970	(0.962 – 0.978)
Other Comorbidity	Iron Deficiency and Other/Unspecified Anemias	0.051	0.003	1.053	(1.046 – 1.060)

Risk Adjustment Category	Risk Adjustment Variable	Coefficient Estimate	Standard Error	Payment Ratio (PR)	95% Confidence Interval for PR
	and Blood Disease (CC 47)				
Other Comorbidity	Delirium and Encephalopathy (CC 48)	0.022	0.009	1.022	(1.005 – 1.039)
Other Comorbidity	Dementia (CC 49)	-0.107	0.004	0.898	(0.891 – 0.906)
Other Comorbidity	Drug/Alcohol Psychosis (CC 51)	0.101	0.015	1.106	(1.074 – 1.140)
Other Comorbidity	Drug/Alcohol Abuse/Dependence (CC 52-53)	-0.066	0.005	0.936	(0.926 – 0.946)
Other Comorbidity	Severe Mental Illness (CC 54-55)	0.022	0.008	1.022	(1.006 – 1.038)
Other Comorbidity	Reactive and Unspecified Psychosis (CC 56)	-0.037	0.009	0.964	(0.947 – 0.981)
Other Comorbidity	Depression/Anxiety (CC 58-59)	-0.035	0.005	0.966	(0.956 – 0.976)
Other Comorbidity	Precerebral Arterial Occlusion and Transient Cerebral Ischemia (CC 97)	0.040	0.005	1.041	(1.032 – 1.050)
Other Comorbidity	Vascular Disease and Complications (CC 104-105)	0.015	0.004	1.015	(1.007 – 1.022)
Other Comorbidity	Other Lung Disorders (CC 115)	0.045	0.004	1.046	(1.039 – 1.054)
Other Comorbidity	Legally Blind (CC 116)	-0.073	0.017	0.930	(0.899 – 0.961)
Other Comorbidity	Dialysis Status (CC 130)	0.119	0.013	1.126	(1.098 – 1.156)
Other Comorbidity	Internal Injuries (CC 160)	0.141	0.017	1.151	(1.113 – 1.191)

3.2.1. Distribution of Unadjusted and Adjusted Hospital-Specific AMI 30-Day Episode-of-Care Payment

Both unadjusted and adjusted payments from AMI admission to 30 days post-admission vary considerably across hospitals (Table 11). For hospitals with at least 25 cases, the hospital unadjusted AMI 30-day episode-of-care payment ranges from $12,282 to $37,482 across 1,846 hospitals with a median (interquartile range) of $19,683 ($17,880, $21,585). The mean ± SD hospital unadjusted payment is $19,799 ± $2,829 (Figure 5). After adjusting for patient case mix, the risk-standardized payment at the hospital-level has a median (interquartile range) of $20,152 ($19,191, $21,211) (Figure 6). The mean ± SD risk-standardized hospital payment is $20,207 ± $1,478, ranging from $15,251 to $27,317 across 1,846 hospitals.

While we include all hospitals when estimating the risk-adjustment model, we exclude hospitals with fewer than 25 cases total from the summary statistics below, since estimates for hospitals with fewer cases are less reliable, and CMS's past approach to public reporting has been not to report these results. The volume of AMI hospitalizations among the included hospitals ranges from 25 to 474 index AMI admissions, with a mean of 88 index admissions and a median of 66 index admissions.

Table 11. Distribution of Unadjusted and Risk-Standardized Payments for Hospitals with a Minimum of 25 AMI Index Admissions

Summary Statistic	AMI Episode-of-Care Payment (Unadjusted)	AMI Episode-of-Care Payment (Risk-Standardized)
Mean	$19,799	$20,207
SD	$2,829	$1,478
Min	$12,282	$15,251
10th Percentile	$16,232	$18,323
25th Percentile	$17,880	$19,191
Median	$19,683	$20,152
75th Percentile	$21,585	$21,211
90th Percentile	$23,378	$22,114
Max	$37,482	$27,317

Figure 5. Distribution of AMI Episode-of-Care Unadjusted Payment for Hospitals with a Minimum of 25 AMI Index Admissions

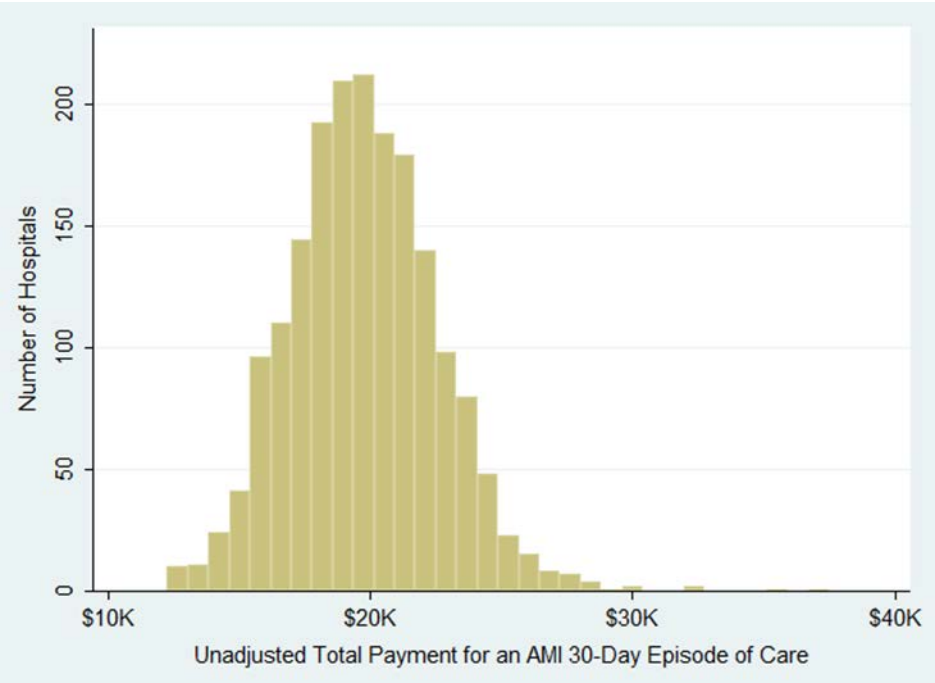
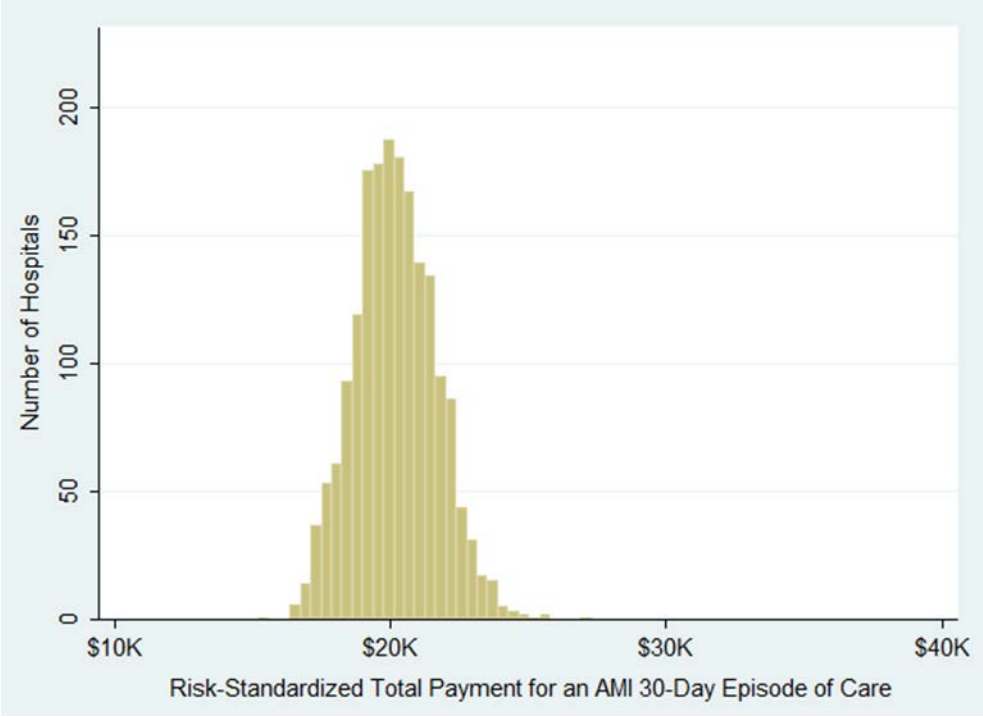


Figure 6. Distribution of AMI Episode-of-Care RSP for Hospitals with a Minimum of 25 AMI Index Admissions



3.3. Measure Testing

3.3.1. Reliability Testing

Below we discuss data element reliability. Measure reliability testing will be completed with a second year of data to compare risk factor frequencies and to measure results.

3.3.1.1. Data Element Reliability

In constructing the AMI payment measure we aim to utilize only those data elements from the claims that have both face validity and reliability. We avoid the use of fields that are coded inconsistently across hospitals or providers. Additionally, CMS has several hospital auditing programs in place to assess overall claims code accuracy, to ensure appropriate billing, and to recoup overpayment. CMS routinely conducts data analyses to identify potential problem areas and detect fraud, and audits important data fields used in our measures, including diagnosis and procedure codes and other elements that are consequential to payment.[17]

3.3.2. Validity Testing

3.3.2.1. Validity of Claims-based Measures

Our team has demonstrated the validity of claims-based measures for profiling hospitals for a number of prior measures by comparing either the measure results or the individual data elements against medical records. CMS validated the six NQF-endorsed claims-based measures currently in public reporting (i.e., mortality and readmission measures for AMI, heart failure, and pneumonia) with models that used medical record-abstracted data for risk adjustment. Specifically, claims model validation was conducted by building comparable models using abstracted medical record data for risk adjustment for heart failure patients (National Heart Failure data), AMI patients (Cooperative Cardiovascular Project data) and pneumonia patients (National Pneumonia Project dataset). When both models were applied to the same patient population, the hospital risk-standardized mortality and readmission rates estimated using the claims-based risk-adjustment models had a high level of agreement with the results based on the medical record model, thus supporting the use of the claims-based models for public reporting.

We have also completed two national, multi-site validation efforts for two procedure-based complications measures: primary elective hip/knee arthroplasty and implantable cardioverter defibrillator (ICD). Both projects demonstrated strong agreement between complications coded in claims and abstracted from medical record data. These validation efforts suggest that such claims data variables are valid across a variety of conditions.

3.3.2.2. Validity of Development Process

We are developing this measure in consultation with national guidelines for publicly reported outcomes measures, with outside experts, and with the public. The measure is

consistent with the technical approach to outcomes measurement set forth in National Quality Forum (NQF) guidance for outcomes measures,[18] CMS Measure Management System guidance, and the guidance articulated in the American Heart Association scientific statement, "Standards for Statistical Models Used for Public Reporting of Health Outcomes.[19]

In order to examine the face validity of our methods for estimating payments for an AMI episode of care, we compared our approach with two other measures that estimate payments for episodes of care. Specifically, we compared our methods with the:

- **American Board of Medical Specialties (ABMS) Acute Myocardial Infarction Episode of Care**, which estimates the cost of an episode of care for AMI at the hospital-level from the date of admission through 30 days post-admission for patients > 18 years. They use claims data from all payers, including Medicare and private insurance. They standardize prices across three components of care: inpatient facility, ambulatory pharmacy, and "all other" (e.g. evaluation and management, procedures, imaging, tests, DME). Costs at the inpatient facility level are calculated based on DRG-level information and length of stay. Total inpatient costs are divided by inpatient days to arrive at a per diem multiplier. This per diem multiplier is used to calculate the inpatient facility cost for each unique episode of care. A similar strategy is applied to ambulatory pharmacy and "all other" costs. Risk adjustment includes comorbid conditions identified in the 12 months preceding the index AMI admission using both inpatient and outpatient claims. The hospital is the unit of reporting.
- **CMS Medicare Spending per Beneficiary (MSPB) measure**, which estimates the cost of an episode of care for all inpatient diagnoses at the hospital-level from 3 days prior to admission through 30 days post-discharge for Medicare FFS beneficiaries 18 years and older. Their cost outcome includes patient copayments and excludes geographic and policy adjustments. Risk adjustment includes age, hierarchical condition categories, enrollment status, long-term care variables, variable interaction terms, and MS-DRGs present 90 days prior to index admission. The hospital is the unit of reporting.

Although our measure is being developed independently of those above, we share several key decisions:

1. *Include episode of care*: Like ours, both measures begin with a hospitalization and end 30 days after admission (ours, ABMS) or discharge (MSPB). Conceptually, this strategy groups together those medical transactions that are temporally related to a hospitalization. In this way, the care provided during hospitalization as well as the transition of care to post-discharge settings is attributed to the provider or hospital of the index admission.
2. *Isolate resource utilization:* Like ours, both measures attempt to isolate payment differentials due to resource utilization by removing payment adjustments that do not reflect the clinical care delivered, such as geographic factors and policy

adjustments (ours, MSPB), or standardizing payment amounts for isolated services, labs, or supplies (ABMS).

3. *Perform risk adjustment*: Like ours, both measures employ a thorough and transparent approach to risk adjustment, although the specific risk adjustment strategies differ technically.

In addition, we surveyed the TEP and asked each member to assess the face validity of our measure by rating the following statement using a six-point scale (1=Strongly Disagree, 2=Moderately Disagree, 3=Somewhat Disagree, 4=Somewhat Agree, 5=Moderately Agree, and 6=Strongly Agree):

> "This is a measure of payments for Medicare patients for a 30-day AMI episode-of-care. The measure removes policy adjustments that are independent of care decisions and risk-adjusts based on case mix. The measure is intended to provide CMS a tool to compare payments across hospitals nationally to identify hospitals that have notably higher or lower payments associated with AMI care. To what extent does the committee agree that this measure accomplishes this purpose?"

Among the 8 TEP members who provided a response, 3 responded "Moderately Agree" and 5 reported "Strongly Agree".

4. MAIN FINDINGS / SUMMARY

We present a hierarchical generalized linear regression model for assessing hospital-level, risk-standardized payments for a 30-day episode of care associated with an index admission for AMI. Our approach to model development and risk adjustment is consistent with quality measure methods recommendations for publicly reported outcomes measures from NQF, CMS, and the American Heart Association scientific statement.[6,7,8,9] This proposed measure is based on administrative claims data for FFS Medicare beneficiaries 65 years and older, and is being developed with extensive input from clinical and methodological experts with knowledge and experience relevant to quality measurement.

The study sample is appropriately defined, consisting of patients having an inpatient stay with a primary discharge diagnosis of AMI. The outcome is measured using stripped or standardized payments for Medicare patients starting with the index admission and continuing 30 days post-admission across all care settings, services, and supplies. The risk-adjustment process accounts for patient age, history of PCI and/or CABG, and comorbid conditions identified from: secondary diagnoses of the index hospital stay (excluding potential complications), inpatient data, outpatient hospital data, and carrier files for physician, radiology, and laboratory services during the 12 months prior to the index admission. The hierarchical modeling accounts for hospital case mix and the clustering of patients within hospitals, thereby making the measure suitable for public reporting.

We find substantial variation in risk-standardized payments for an AMI episode of care across hospitals. Implementation of this measure in conjunction with the publicly reported AMI mortality measure has the potential to improve the efficiency of care for patients with AMI. Although the payment methodology is developed in an AMI cohort, it can easily be applied to other disease conditions such as heart failure and pneumonia.

5. REFERENCES

1. Ash AS, Byrne-Logan S. How Well Do Models Work? Predicting Health Care Costs. *Proceedings of the Section on Statistics in Epidemiology. American Statistical Association.* 1998.
2. Medpac. *Report to the Congress: Medicare Payment Policy* 9/17/12 2012.
3. National Hospital Discharge Survey. http://www.cdc.gov/nchs/nhds.htm. Accessed 08/07/2012.
4. Affordable Care Act to improve quality of care for people with Medicare. 2011. http://www.hhs.gov/news/press/2011pres/03/20110331a.html. Accessed 08/07/2012.
5. *Using Medicare Hospital Cost Reports Cost-to-charge Ratios in Research*: Research Data Assistance Center, University of Minnesota;Nov. 2005, updated Aug. 2009.
6. National Voluntary Consensus Standards for Patient Outcomes: Phases I and II. http://www.qualityforum.org/projects/Patient_Outcome_Measures_Phases1-2.aspx.
7. Measures Management System Overview. 2012. https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/MMS/index.html?redirect=/MMS/19_MeasuresManagementSystemBlueprint.asp. Accessed 09/27/2012.
8. Krumholz HM, Brindis RG, Brush JE, et al. Standards for statistical models used for public reporting of health outcomes: an American Heart Association Scientific Statement from the Quality of Care and Outcomes Research Interdisciplinary Writing Group: cosponsored by the Council on Epidemiology and Prevention and the Stroke Council. Endorsed by the American College of Cardiology Foundation. *Circulation.* Jan 24 2006;113(3):456-462.
9. Krumholz HM, Keenan PS, Brush JE, Jr., et al. Standards for measures used for public reporting of efficiency in health care: a scientific statement from the American Heart Association Interdisciplinary Council on Quality of Care and Outcomes Research and the American College of Cardiology Foundation. *Circulation.* Oct 28 2008;118(18):1885-1893.
10. Medpac. Medicare Background. 2011; http://www.medpac.gov/payment_basics.cfm. Accessed 09/27/2012.
11. Pope G, Ellis R, Ash A, et al. Principal Inpatient Diagnostic Cost Group Models for Medicare Risk Adjustment. *Health Care Financing Review.* 2000;21(3):26.
12. Measure Evaluation Criteria. 2011; http://www.qualityforum.org/docs/measure_evaluation_criteria.aspx. Accessed 09/26/2012.
13. Manning WG, Mullahy J. Estimating log models: to transform or not to transform? *Journal of health economics.* Jul 2001;20(4):461-494.
14. Gatsonia C. Hierarchical Generalized Linear Models in the Analysis of Variations in Health Care Utilization. *Journal of the American Statistical Association.* 1999;94(445):29-42.
15. Normand S-L, Wang Y, Krumholz H. Assessing surrogacy of data sources for institutional comparisons. *Health Services and Outcomes Research Methodology.* 2007;7(1):79-96.
16. Jones AM. Models for Health Care. *Health, Econometrics and Data Group (HEDG) Working Papers.* 2010.
17. *Recovery Auditing in the Medicare and Medicaid Programs for Fiscal Year 2011*: Centers for Medicare and Medicaid Services;2011.

18. National Quality Forum. National voluntary consensus standards for patient outcomes, first report for phases 1 and 2: A consensus report http://www.nysna.org/images/pdfs/practice/nqf_ana_outcomes_draft10.pdf. Accessed August 19, 2010.
19. Krumholz HM, Brindis RG, Brush JE, et al. Standards for statistical models used for public reporting of health outcomes - An American Heart Association scientific statement from the quality of care and outcomes research interdisciplinary writing group - Cosponsored by the Council on Epidemiology and Prevention and the Stroke Council - Endorsed by the American College of Cardiology Foundation. *Circulation.* Jan 24 2006;113(3):456-462.

6. APPENDICES

Appendix A. Potential Complications in the Index Admission for AMI Payment Model

CC #	Description	Potential Complication in Index Admission
CC 1	HIV/AIDS	No
CC 2	Septicemia/Shock	Yes
CC 3	Central Nervous System Infection	No
CC 4	Tuberculosis	No
CC 5	Opportunistic Infections	No
CC 6	Other Infectious Diseases	Yes
CC 7	Metastatic Cancer and Acute Leukemia	No
CC 8	Lung, Upper Digestive Tract, and Other Severe Cancers	No
CC 9	Lymphatic, Head and Neck, Brain, and Other Major Cancers	No
CC 10	Breast, Prostate, Colorectal and Other Cancers and Tumors	No
CC 11	Other Respiratory and Heart Neoplasms	No
CC 12	Other Digestive and Urinary Neoplasms	No
CC 13	Other Neoplasms	No
CC 14	Benign Neoplasms of Skin, Breast, Eye	No
CC 15	Diabetes with Renal Manifestation	No
CC 16	Diabetes with Neurologic or Peripheral Circulatory Manifestation	No
CC 17	Diabetes with Acute Complications	Yes
CC 18	Diabetes with Ophthalmologic Manifestation	No
CC 19	Diabetes with No or Unspecified Complications	No
CC 20	Type I Diabetes Mellitus	No
CC 21	Protein-Calorie Malnutrition	No
CC 22	Other Significant Endocrine and Metabolic Disorders	No
CC 23	Disorders of Fluid/Electrolyte/Acid-Base	Yes
CC 24	Other Endocrine/Metabolic/Nutritional Disorders	No
CC 25	End-Stage Liver Disease	No
CC 26	Cirrhosis of Liver	No
CC 27	Chronic Hepatitis	No
CC 28	Acute Liver Failure/Disease	Yes
CC 29	Other Hepatitis and Liver Disease	No
CC 30	Gallbladder and Biliary Tract Disorders	No
CC 31	Intestinal Obstruction/Perforation	Yes
CC 32	Pancreatic Disease	No
CC 33	Inflammatory Bowel Disease	No
CC 34	Peptic Ulcer, Hemorrhage, Other Specified Gastrointestinal Disorders	Yes
CC 35	Appendicitis	No
CC 36	Other Gastrointestinal Disorders	No
CC 37	Bone/Joint/Muscle Infections/Necrosis	No
CC 38	Rheumatoid Arthritis and Inflammatory Connective Tissue Disease	No
CC 39	Disorders of the Vertebrae and Spinal Discs	No
CC 40	Osteoarthritis of Hip or Knee	No
CC 41	Osteoporosis and Other Bone/Cartilage Disorders	No

CC #	Description	Potential Complication in Index Admission
CC 42	Congenital/Developmental Skeletal and Connective Tissue Disorders	No
CC 43	Other Musculoskeletal and Connective Tissue Disorders	No
CC 44	Severe Hematological Disorders	No
CC 45	Disorders of Immunity	No
CC 46	Coagulation Defects and Other Specified Hematological Disorders	Yes
CC 47	Iron Deficiency and Other/Unspecified Anemias and Blood Disease	No
CC 48	Delirium and Encephalopathy	Yes
CC 49	Dementia	No
CC 50	Senility, Nonpsychotic Organic Brain Syndromes/Conditions	No
CC 51	Drug/Alcohol Psychosis	No
CC 52	Drug/Alcohol Dependence	No
CC 53	Drug/Alcohol Abuse, Without Dependence	No
CC 54	Schizophrenia	No
CC 55	Major Depressive, Bipolar, and Paranoid Disorders	No
CC 56	Reactive and Unspecified Psychosis	No
CC 57	Personality Disorders	No
CC 58	Depression	No
CC 59	Anxiety Disorders	No
CC 60	Other Psychiatric Disorders	No
CC 61	Profound Mental Retardation/Developmental Disability	No
CC 62	Severe Mental Retardation/Developmental Disability	No
CC 63	Moderate Mental Retardation/Developmental Disability	No
CC 64	Mild/Unspecified Mental Retardation/Developmental Disability	No
CC 65	Other Developmental Disability	No
CC 66	Attention Deficit Disorder	No
CC 67	Quadriplegia, Other Extensive Paralysis	No
CC 68	Paraplegia	No
CC 69	Spinal Cord Disorders/Injuries	No
CC 70	Muscular Dystrophy	No
CC 71	Polyneuropathy	No
CC 72	Multiple Sclerosis	No
CC 73	Parkinson's and Huntington's Diseases	No
CC 74	Seizure Disorders and Convulsions	No
CC 75	Coma, Brain Compression/Anoxic Damage	Yes
CC 76	Mononeuropathy, Other Neurological Conditions/Injuries	No
CC 77	Respirator Dependence/Tracheostomy Status	Yes
CC 78	Respiratory Arrest	Yes
CC 79	Cardio-Respiratory Failure and Shock	Yes
CC 80	Congestive Heart Failure	Yes
CC 81	Acute Myocardial Infarction	Yes
CC 82	Unstable Angina and Other Acute Ischemic Heart Disease	Yes
CC 83	Angina Pectoris/Old Myocardial Infarction	No
CC 84	Coronary Atherosclerosis/Other Chronic Ischemic Heart Disease	No
CC 85	Heart Infection/Inflammation, Except Rheumatic	No
CC 86	Valvular and Rheumatic Heart Disease	No
CC 87	Major Congenital Cardiac/Circulatory Defect	No

CC #	Description	Potential Complication in Index Admission
CC 88	Other Congenital Heart/Circulatory Disease	No
CC 89	Hypertensive Heart and Renal Disease or Encephalopathy	No
CC 90	Hypertensive Heart Disease	No
CC 91	Hypertension	No
CC 92	Specified Heart Arrhythmias	Yes
CC 93	Other Heart Rhythm and Conduction Disorders	Yes
CC 94	Other and Unspecified Heart Disease	Yes
CC 95	Cerebral Hemorrhage	Yes
CC 96	Ischemic or Unspecified Stroke	Yes
CC 97	Precerebral Arterial Occlusion and Transient Cerebral Ischemia	Yes
CC 98	Cerebral Atherosclerosis and Aneurysm	No
CC 99	Cerebrovascular Disease, Unspecified	No
CC 100	Hemiplegia/Hemiparesis	Yes
CC 101	Diplegia (Upper), Monoplegia, and Other Paralytic Syndromes	Yes
CC 102	Speech, Language, Cognitive, Perceptual	Yes
CC 103	Cerebrovascular Disease Late Effects, Unspecified	
CC 104	Vascular Disease with Complications	Yes
CC 105	Vascular Disease	Yes
CC 106	Other Circulatory Disease	Yes
CC 107	Cystic Fibrosis	No
CC 108	Chronic Obstructive Pulmonary Disease	No
CC 109	Fibrosis of Lung and Other Chronic Lung Disorders	No
CC 110	Asthma	No
CC 111	Aspiration and Specified Bacterial Pneumonias	Yes
CC 112	Pneumococcal Pneumonia, Emphysema, Lung Abscess	Yes
CC 113	Viral and Unspecified Pneumonia, Pleurisy	No
CC 114	Pleural Effusion/Pneumothorax	Yes
CC 115	Other Lung Disorders	No
CC 116	Legally Blind	No
CC 117	Major Eye Infections/Inflammations	No
CC 118	Retinal Detachment	No
CC 119	Proliferative Diabetic Retinopathy and Vitreous Hemorrhage	No
CC 120	Diabetic and Other Vascular Retinopathies	No
CC 121	Retinal Disorders, Except Detachment and Vascular Retinopathies	No
CC 122	Glaucoma	No
CC 123	Cataract	No
CC 124	Other Eye Disorders	No
CC 125	Significant Ear, Nose, and Throat Disorders	No
CC 126	Hearing Loss	No
CC 127	Other Ear, Nose, Throat, and Mouth Disorders	No
CC 128	Kidney Transplant Status	No
CC 129	End Stage Renal Disease	Yes
CC 130	Dialysis Status	Yes
CC 131	Renal Failure	Yes
CC 132	Nephritis	Yes
CC 133	Urinary Obstruction and Retention	Yes

CC #	Description	Potential Complication in Index Admission
CC 134	Incontinence	No
CC 135	Urinary Tract Infection	Yes
CC 136	Other Urinary Tract Disorders	No
CC 137	Female Infertility	No
CC 138	Pelvic Inflammatory Disease and Other Specified Female Genital Disorders	No
CC 139	Other Female Genital Disorders	No
CC 140	Male Genital Disorders	No
CC 141	Ectopic Pregnancy	No
CC 142	Miscarriage/Abortion	No
CC 143	Completed Pregnancy With Major Complications	No
CC 144	Completed Pregnancy With Complications	No
CC 145	Completed Pregnancy Without Complication	No
CC 146	Uncompleted Pregnancy With Complications	No
CC 147	Uncompleted Pregnancy With No or Minor Complications	No
CC 148	Decubitus Ulcer of Skin	Yes
CC 149	Chronic Ulcer of Skin, Except Decubitus	No
CC 150	Extensive Third-Degree Burns	No
CC 151	Other Third-Degree and Extensive Burns	No
CC 152	Cellulitis, Local Skin Infection	Yes
CC 153	Other Dermatological Disorders	No
CC 154	Severe Head Injury	Yes
CC 155	Major Head Injury	Yes
CC 156	Concussion or Unspecified Head Injury	Yes
CC 157	Vertebral Fractures	No
CC 158	Hip Fracture/Dislocation	Yes
CC 159	Major Fracture, Except of Skull, Vertebrae, or Hip	Yes
CC 160	Internal Injuries	No
CC 161	Traumatic Amputation	No
CC 162	Other Injuries	No
CC 163	Poisonings and Allergic Reactions	Yes
CC 164	Major Complications of Medical Care and Trauma	No
CC 165	Other Complications of Medical Care	Yes
CC 166	Major Symptoms, Abnormalities	No
CC 167	Minor Symptoms, Signs, Findings	No
CC 168	Extremely Low Birth weight Neonates	No
CC 169	Very Low Birth weight Neonates	No
CC 170	Serious Perinatal Problem Affecting Newborn	No
CC 171	Other Perinatal Problems Affecting Newborn	No
CC 172	Normal, Single Birth	No
CC 173	Major Organ Transplant	No
CC 174	Major Organ Transplant Status	Yes
CC 175	Other Organ Transplant/Replacement	Yes
CC 176	Artificial Openings for Feeding or Elimination	Yes
CC 177	Amputation Status, Lower Limb/Amputation	Yes
CC 178	Amputation Status, Upper Limb	Yes
CC 179	Post-Surgical States/Aftercare/Elective	Yes

CC #	Description	Potential Complication in Index Admission
CC 180	Radiation Therapy	No
CC 181	Chemotherapy	No
CC 182	Rehabilitation	No
CC 183	Screening/Observation/Special Exams	No
CC 184	History of Disease	No
CC 185	Oxygen	No
CC 186	CPAP/IPPB/Nebulizers	No
CC 187	Patient Lifts, Power Operated Vehicles, Beds	No
CC 188	Wheelchairs, Commodes	No
CC 189	Walkers	No

Appendix B. ICD-9-CM Codes Included in Final Cohort

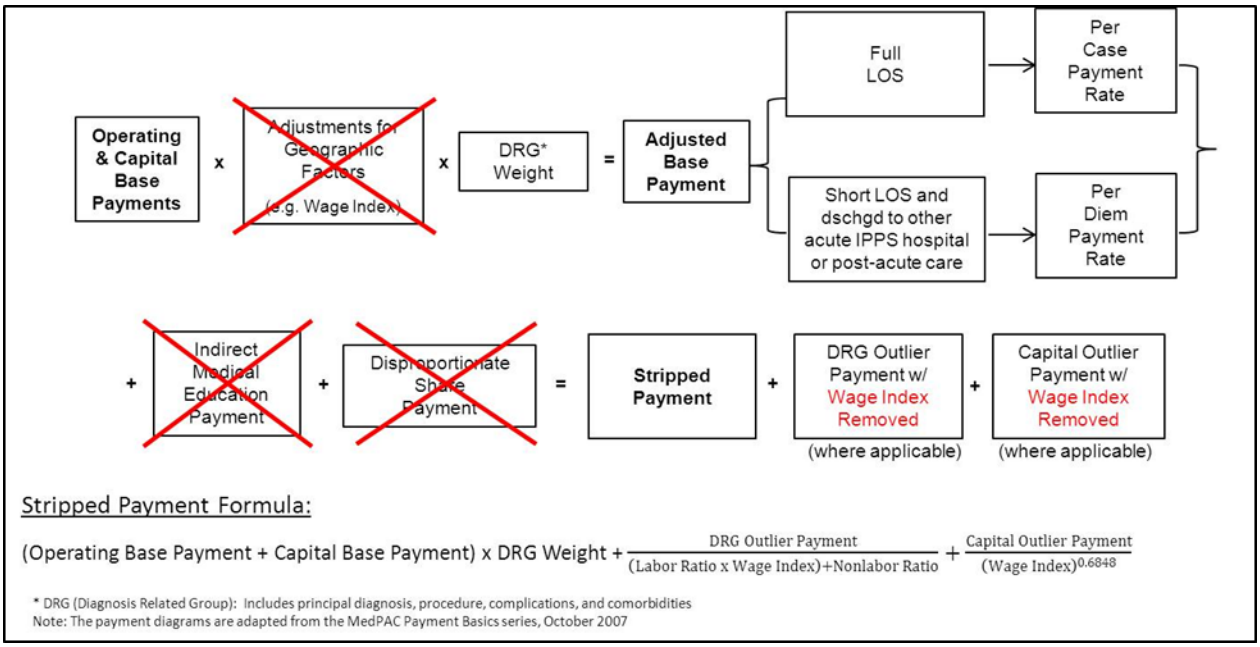
ICD-9-CM	Description
410.00	AMI (anterolateral wall) – episode-of-care unspecified
410.01	AMI (anterolateral wall) – initial episode-of-care
410.10	AMI (other anterior wall) – episode-of-care unspecified
410.11	AMI (other anterior wall) – initial episode-of-care
410.20	AMI (inferolateral wall) – episode-of-care unspecified
410.21	AMI (inferolateral wall) – initial episode-of-care
410.30	AMI (inferoposterior wall) – episode-of-care unspecified
410.31	AMI (inferoposterior wall) – initial episode-of-care
410.40	AMI (other inferior wall) – episode-of-care unspecified
410.41	AMI (other inferior wall) – initial episode-of-care
410.50	AMI (other lateral wall) – episode-of-care unspecified
410.51	AMI (other lateral wall) – initial episode-of-care
410.60	AMI (true posterior wall) – episode-of-care unspecified
410.61	AMI (true posterior wall) – initial episode-of-care
410.70	AMI (subendocardial) – episode-of-care unspecified
410.71	AMI (subendocardial) – initial episode-of-care
410.80	AMI (other specified site) – episode-of-care unspecified
410.81	AMI (other specified site) – initial episode-of-care
410.90	AMI (unspecified site) – episode-of-care unspecified
410.91	AMI (unspecified site) – initial episode-of-care

Appendix C. Example of Included and Excluded Payments for a Patient Admitted on May 3 and Discharged on May 8

Claim Type	Provider ID	Claim Date	Admission Type	Primary ICD-9	Payment	Included in Model?	Payment Included in Model	Comments
Carrier	123456	2 May-3 May	N/A	410.91	$255.61	N	$0.00	Starts prior to the index admission and ends within the analytic period.
Inpatient	234567	3 May-4 May	Admission	410.71	$1,109.49	Y	$1,109.49	This inpatient AMI (410.71) admission defines the index admission date (5/3).
Inpatient	345678	4 May-8 May	Transfer	410.71	$8,008.15	Y	$8,008.15	This inpatient AMI (410.71) discharge defines the discharge date (5/8).
Carrier	567891	3 May-3 May	N/A	785.0	$367.20	Y	$367.20	N/A
Carrier	678910	3 May-3 May	N/A	428.0	$6.59	Y	$6.59	N/A
Carrier	789101	3 May-8 May	N/A	410.71	$350.52	Y	$350.52	N/A
Carrier	456789	5 May-5 May	N/A	414.01	$225.75	Y	$225.75	N/A
Carrier	345678	7 May-7 May	N/A	296.30	$148.39	Y	$148.39	N/A
Inpatient	910112	30May-3 Jun	Readmission	410.71	$4,262.13	Y (prorated)	$3,409.70	Payment is prorated, based only on days in the 30-day post-admission period. The amount includes: ($4262.13/5)*4 = $3409.70. This second AMI (410.71) admission does not count as an index admission, but as a readmission.
Skilled Nursing Facility	891011	3Jun-21Jun	Transfer	428.0	$1,652.28	N	$0.00	Starts after the 30-day post-admission period.
N/A	N/A	N/A	N/A	TOTAL	$16,386.11	N/A	$13,625.79	N/A

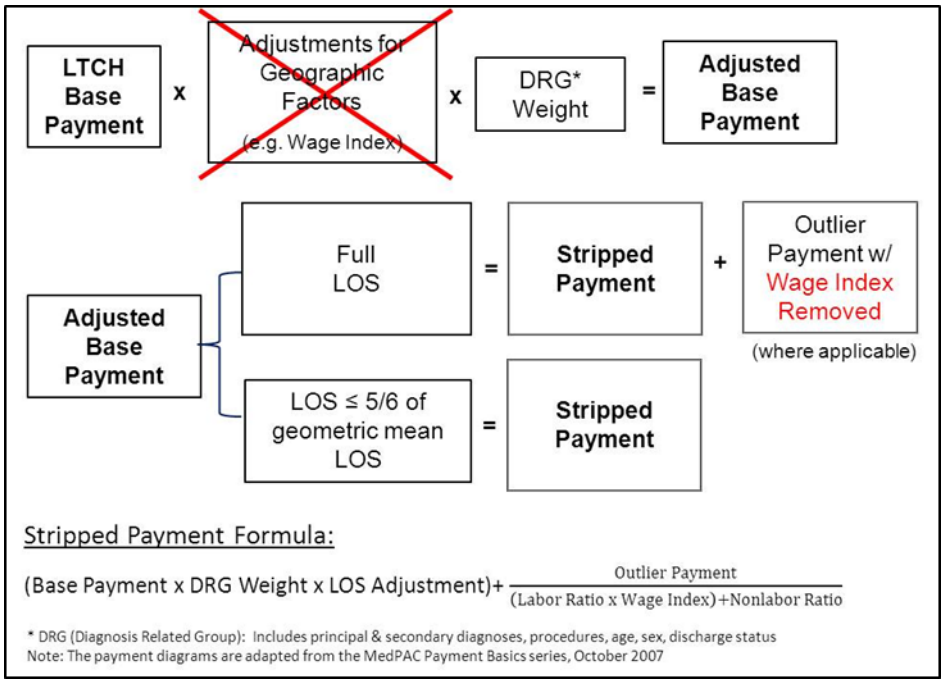
Appendix D. Stripped/Standardized Payment Diagrams

Inpatient Prospective Payment Setting: Stripped Payment

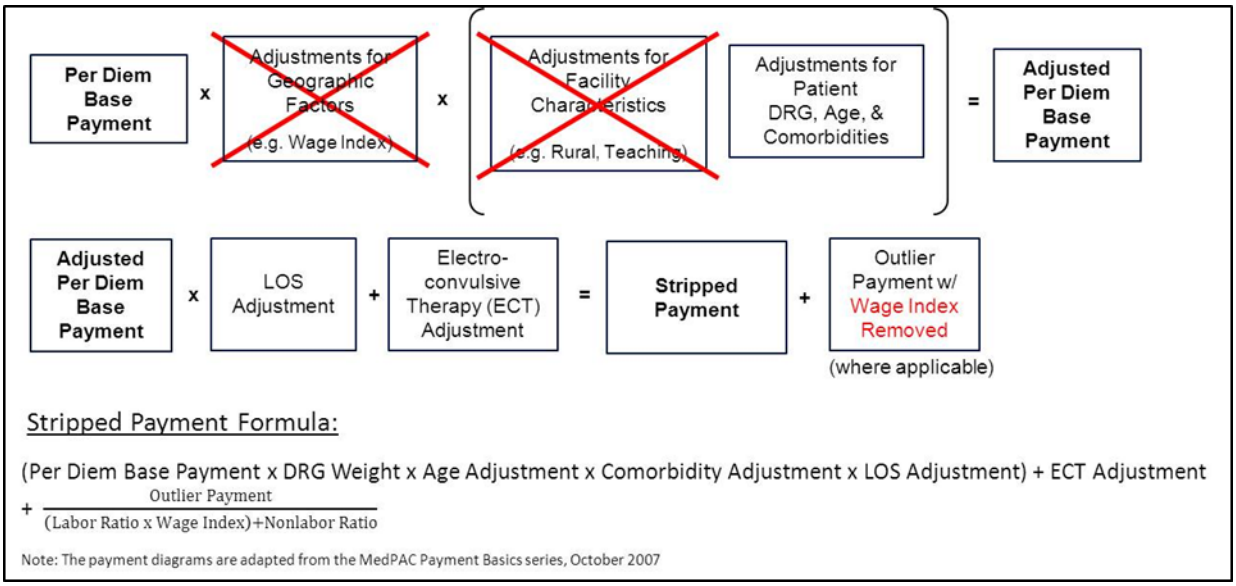


Note: Payments to critical access hospitals (CAHs) were calculated using the IPPS stripped payment formula.

Long Term Care Hospitals: Stripped Payment



Inpatient Psychiatric Facility: Stripped Payment

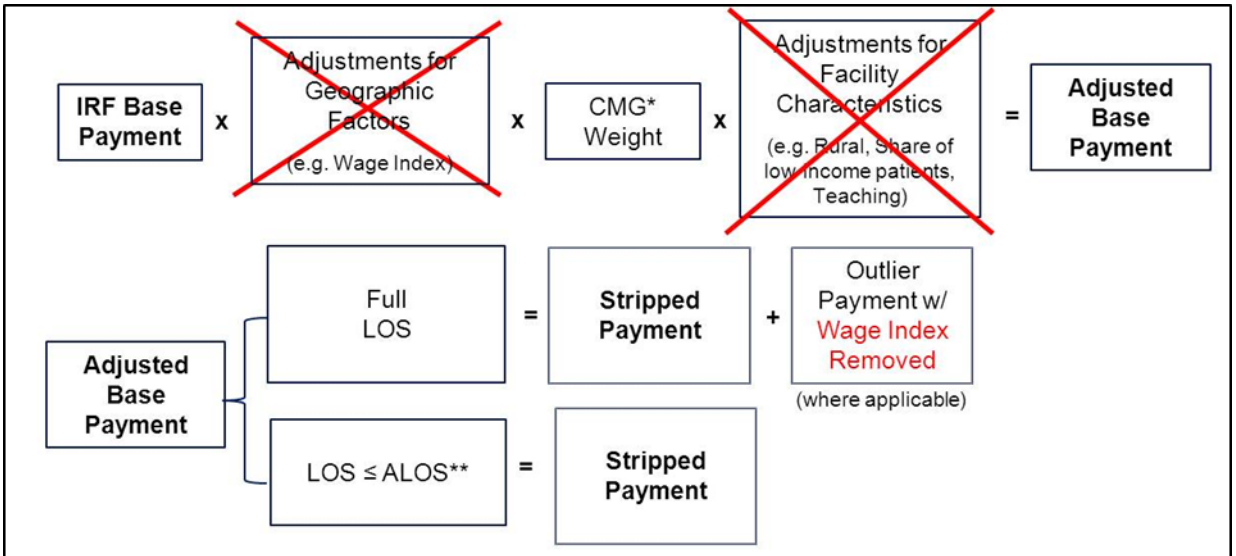


Stripped Payment Formula:

$$\text{(Per Diem Base Payment x DRG Weight x Age Adjustment x Comorbidity Adjustment x LOS Adjustment)} + \text{ECT Adjustment} + \frac{\text{Outlier Payment}}{\text{(Labor Ratio x Wage Index)+Nonlabor Ratio}}$$

Note: The payment diagrams are adapted from the MedPAC Payment Basics series, October 2007

Inpatient Rehabilitation Facility: Stripped Payment



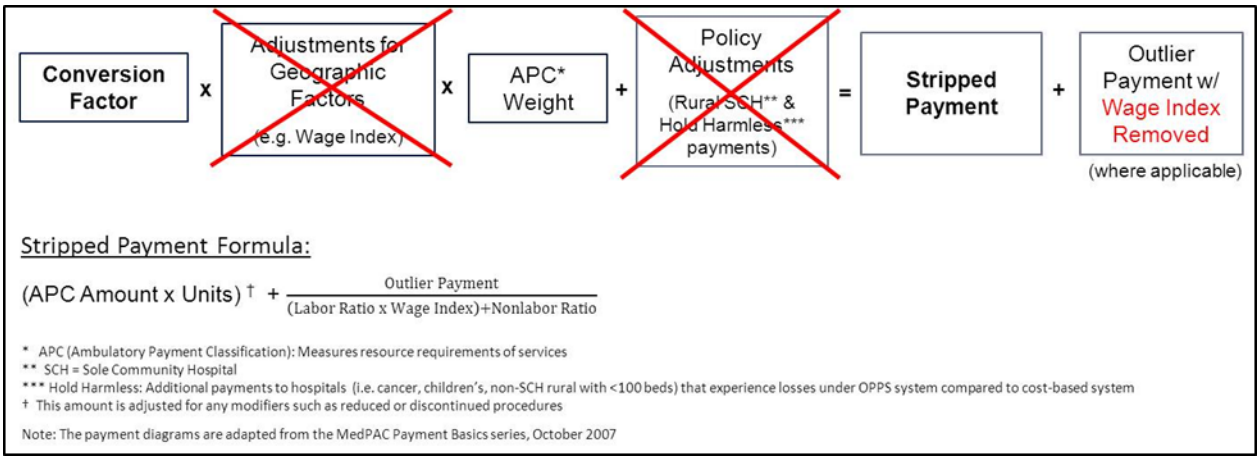
Stripped Payment Formula:

$$\text{(IRF Base Payment x CMG Weight x LOS Adjustment)} + \frac{\text{Outlier Payment}}{\text{(Labor Ratio x Wage Index)+Nonlabor Ratio}}$$

* CMG (Case-Mix Group): Includes diagnoses requiring rehabilitation, functional status, cognitive status, age, and comorbidities
** ALOS = Average Length of Stay for CMG

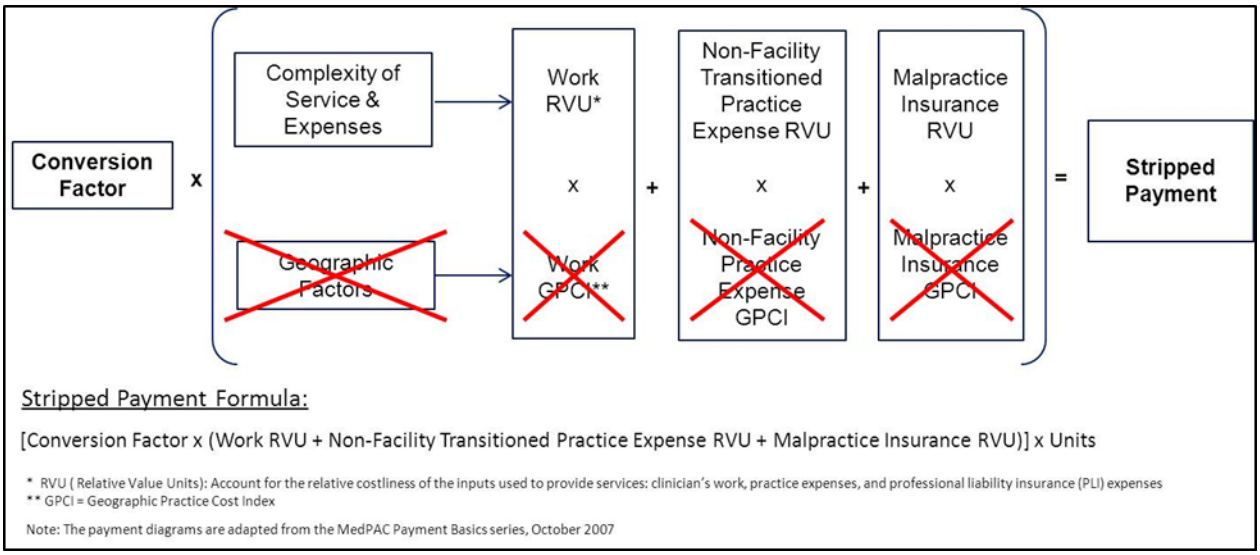
Note: The payment diagrams are adapted from the MedPAC Payment Basics series, October 2007

Hospital Outpatient and Community Mental Health Centers (CMHCs): Stripped Payment

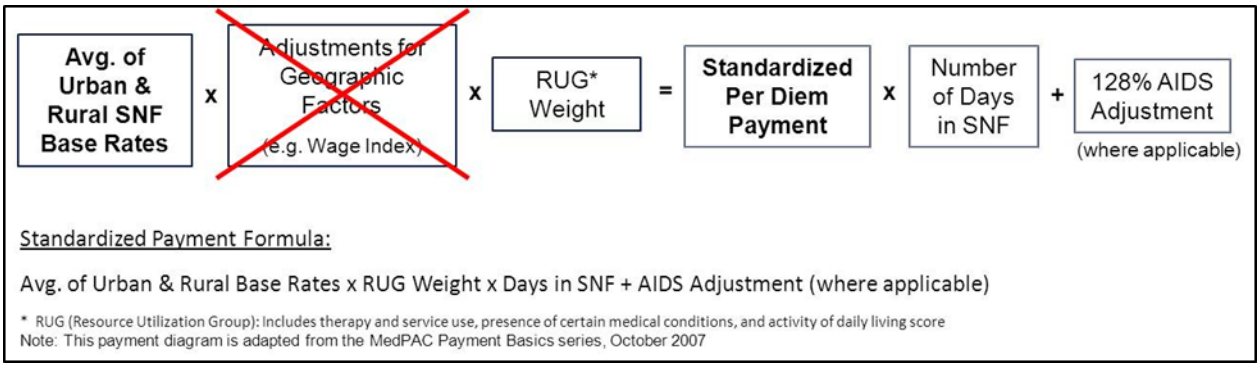


Note: Outpatient hospital claims can include services paid under the clinical lab, ambulance, physician, DME/POS/PEN, and Part B drugs fee schedules as well. Payments for those services are calculated according to the applicable payment formula.

Comprehensive Outpatient Rehabilitation Facilities (CORFs) and Outpatient Rehabilitation Facilities (ORFs): Stripped Payment



PPS SNF Claims: Standardized Payment



Standardized Payment Formula:

Avg. of Urban & Rural Base Rates x RUG Weight x Days in SNF + AIDS Adjustment (where applicable)

* RUG (Resource Utilization Group): Includes therapy and service use, presence of certain medical conditions, and activity of daily living score
Note: This payment diagram is adapted from the MedPAC Payment Basics series, October 2007

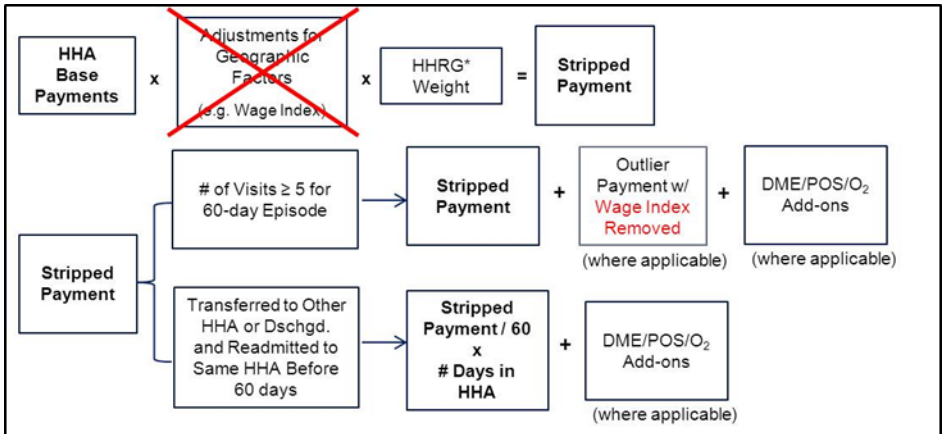
CAH Swing-Bed SNF Claims: Standardized Payment

Standardized Payment Formula†:

$$\frac{\text{Actual Payment} + \text{Co} - \text{Insurance}}{(\text{SNF Labor Ratio x Wage Index}) + (1 - \text{SNF Labor Ratio})}$$

† CAH-Swing Bed SNF Claims are not given a RUG weight
Note: The payment diagrams are adapted from the MedPAC Payment Basics series, October 2007

Home Health Agency (HHA): Stripped Payment



Low Utilization Payment Adjustment (LUPA) HHA Claims:

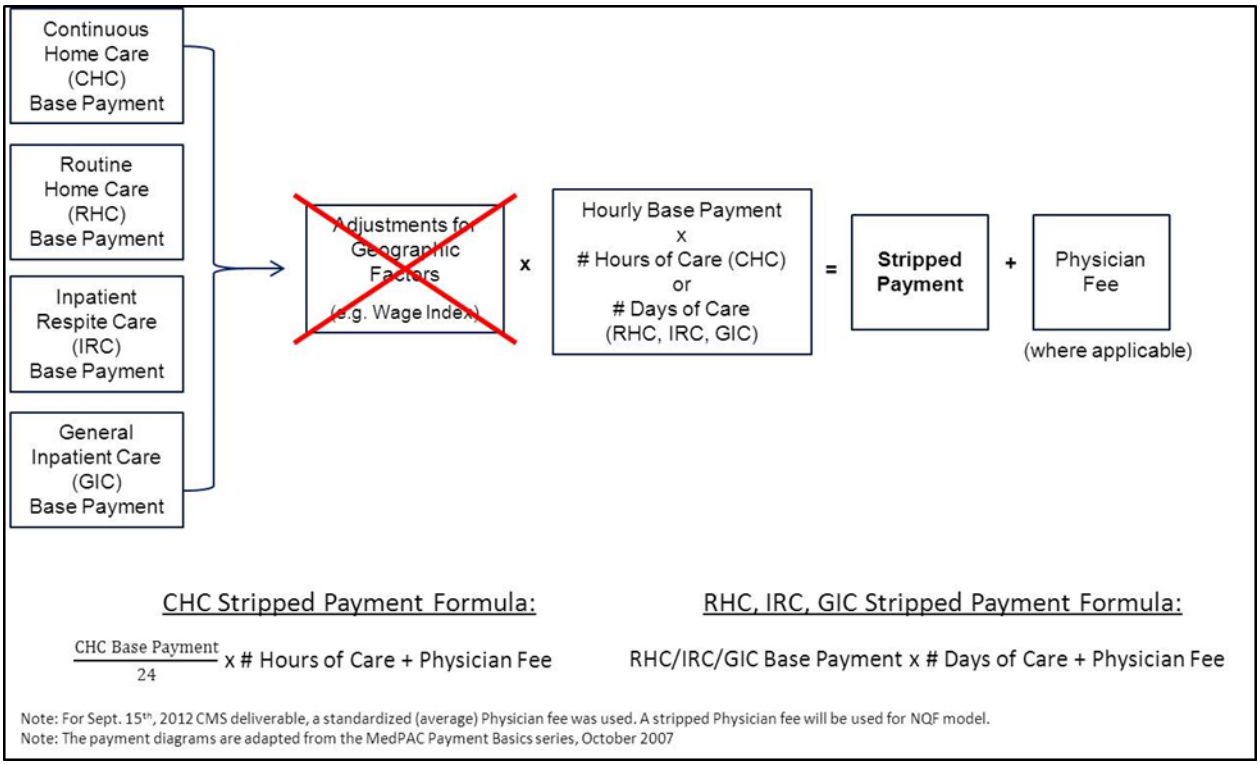
If HHA Claim has 4 or less visits in entire 60-day episode, the standardized LUPA per visit payment rate is applied. Standardized LUPA payment rate is published each year in the HHA PPS Final Rule.

Stripped Payment Formula:

$$\text{HHA Base Rate x HHRG Weight} + \frac{\text{Outlier Payment}}{(\text{Labor Ratio x Wage Index}) + \text{Nonlabor Ratio}} + \text{DME/POS/O}_2\text{ Add-ons}$$

* HHRG (Home Health Resource Group): Comprised of clinical, functional, and service utilization scores based on patient characteristics.
Note: HHA claims can include DME/Prosthetics/O_2 as well. Payment for those claim lines are calculated according to the DME/POS payment formula.
Note: The payment diagrams are adapted from the MedPAC Payment Basics series, October 2007

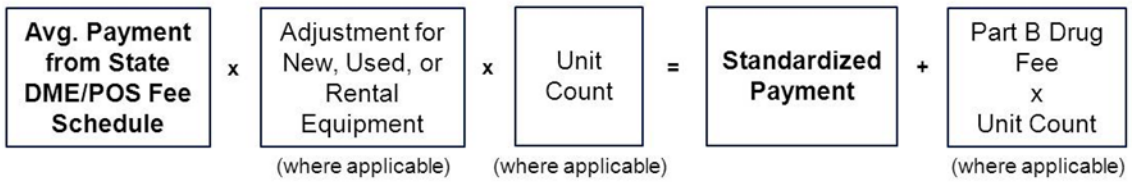
Hospice: Stripped Payment



Note: For Sept. 15th, 2012 CMS deliverable, a standardized (average) Physician fee was used. A stripped Physician fee will be used for NQF model.
Note: The payment diagrams are adapted from the MedPAC Payment Basics series, October 2007

Durable Medical Equipment (DME)/Prosthetics, Orthotics, and Surgical Supplies (POS)/Parenteral and Enteral Nutrition (PEN) Claims: Standardized Payment

DME/POS Claims:



DME/POS Standardized Payment:

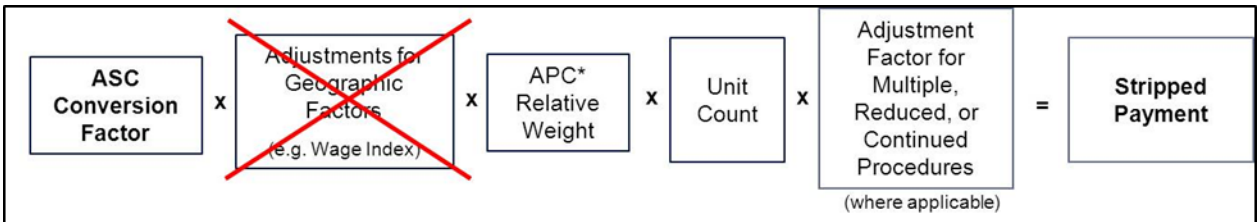
Avg. Payment from State DME/POS Fee Schedule x Adjustment for New, Used, or Rental Equipment x Unit Count + (Part B Drug Fee x Unit Count)

PEN Claims:

The PEN fee schedule is a national fee schedule (i.e. there is no variation from state to state). Thus, all PEN claims were assigned the PEN fee schedule amount.

Note: Where applicable, Part B Drugs associated with DME claims were assigned the DME infusion limit amount from the Part B Drugs fee schedule.
Note: The payment diagrams are adapted from the MedPAC Payment Basics series, October 2007

Ambulatory Surgical Center (ASC): Stripped Payment



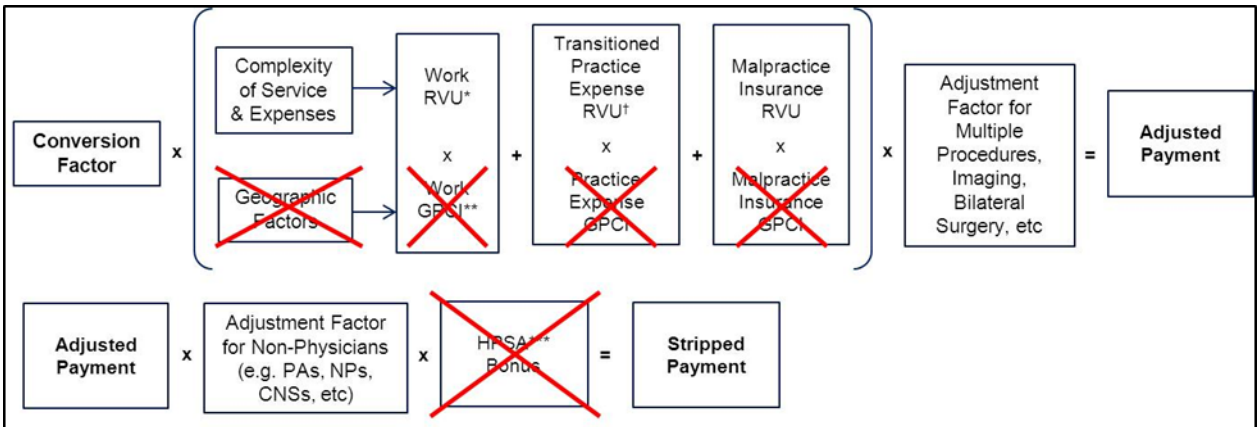
Stripped Payment Formula:

The amount equal to (ASC Conversion Factor x APC Relative Weight) is given on the ASC fee schedule.

(APC Fee Schedule Amount) x Unit Count x Adjustment Factor for Multiple, Reduced, or Continued Procedures

* APC = Ambulatory Payment Classification
Note: The payment diagrams are adapted from the MedPAC Payment Basics series, October 2007

Physician Services: Stripped Payment



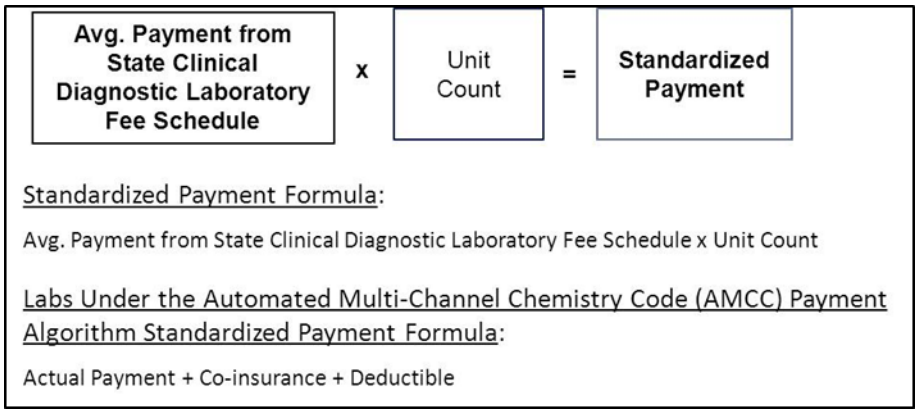
Stripped Payment Formula:

[Conversion Factor x (Work RVU + Transitioned Practice Expense RVU + Malpractice Insurance RVU)] x Adjustment Factor Related to Procedures x Adjustment Factor for Non-Physicians x Units

* RVU (Relative Value Units): Account for the relative costliness of the inputs used to provide services: clinician's work, practice expenses, and professional liability insurance (PLI) expenses
** GPCI = Geographic Practice Cost Index
*** HPSA = Health Professional Shortage Area
† The physician fee schedule lists separate PE RVUs for facility and non-facility settings.

Note: The payment diagrams are adapted from the MedPAC Payment Basics series, October 2007

Clinical Labs: Standardized Payment



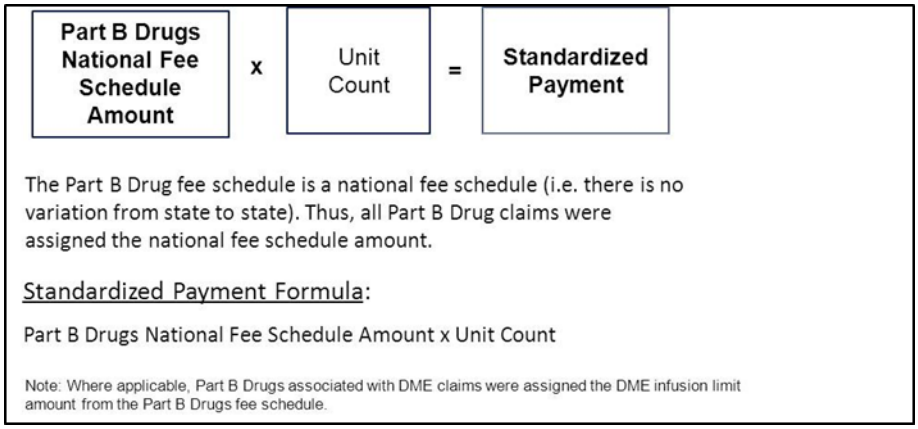
Standardized Payment Formula:

Avg. Payment from State Clinical Diagnostic Laboratory Fee Schedule x Unit Count

Labs Under the Automated Multi-Channel Chemistry Code (AMCC) Payment Algorithm Standardized Payment Formula:

Actual Payment + Co-insurance + Deductible

Part B Drugs: Standardized Payment



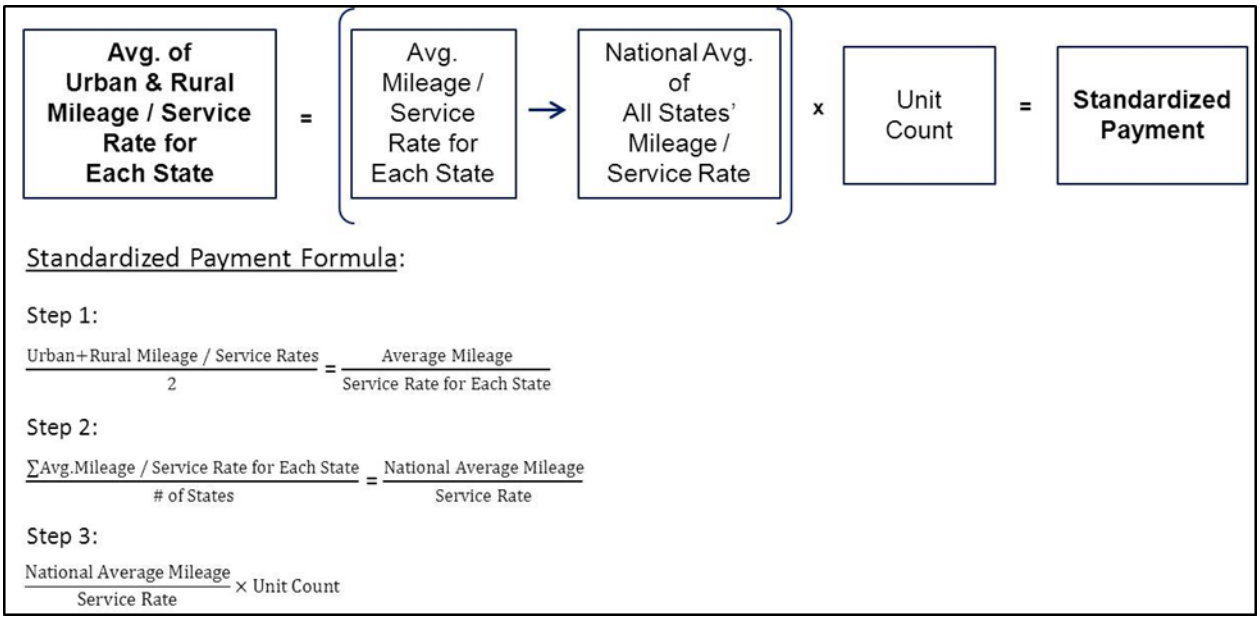
The Part B Drug fee schedule is a national fee schedule (i.e. there is no variation from state to state). Thus, all Part B Drug claims were assigned the national fee schedule amount.

Standardized Payment Formula:

Part B Drugs National Fee Schedule Amount x Unit Count

Note: Where applicable, Part B Drugs associated with DME claims were assigned the DME infusion limit amount from the Part B Drugs fee schedule.

Ambulance: Standardized Payment



Standardized Payment Formula:

Step 1:

$$\frac{\text{Urban+Rural Mileage / Service Rates}}{2} = \frac{\text{Average Mileage}}{\text{Service Rate for Each State}}$$

Step 2:

$$\frac{\sum \text{Avg.Mileage / Service Rate for Each State}}{\text{\# of States}} = \frac{\text{National Average Mileage}}{\text{Service Rate}}$$

Step 3:

$$\frac{\text{National Average Mileage}}{\text{Service Rate}} \times \text{Unit Count}$$

Rural Health Clinics (RHCs) and Federally Qualified Health Clinics (FQHCs): Standardized Payment

RHCs:

Each year Congress determines a RHC per visit payment limit. We remove the portion of the payment likely attributable to wages using the SNF state rural wage index.

Stripped Payment Formula:

$$\frac{\text{Actual Payment} + \text{Co} - \text{Insurance} + \text{Deductible}}{(\text{Outpatient Labor Ratio x Wage Index}) + (1 - \text{Outpatient Labor Ratio})}$$

FQHCs:

FQHC payments are an all-inclusive per visit amount based on reasonable costs. Given the resources necessary to determine whether the FQHC is located in a rural or urban area, we did not adjust for wages in the current data.

Standardized Payment Formula:

Actual Payment + Co-insurance

Note: A FQHC PPS is scheduled to be implemented in 2014.

Renal Dialysis Facilities (RDFs): Stripped Payment

Given that the 2008/2009 Renal Dialysis payment rates are adjusted by patient-specific body measurements which we do not have in our data, as well as capped at an amount equal to 3 dialysis sessions per week, we chose to remove the portion of the payment likely attributable to wages using the RDF wage index.

Stripped Payment Formula:

$$\frac{\text{Actual Payment} + \text{Co} - \text{Insurance} + \text{Deductible}}{(\text{Outpatient Labor Ratio x Wage Index}) + (1 - \text{Outpatient Labor Ratio})}$$

Note: A Renal Dialysis PPS was implemented in 2011.

Appendix E. Technical Expert Panel Member Roster

Name	Title	Organization	Area of Expertise
Amanda Kowalski, PhD	Assistant Professor of Economics	Yale University	Topic Knowledge
Anne-Marie Audet, MD, MSc, SM	Vice President, Health System Quality and Efficiency	Commonwealth Fund	Quality Improvement and Performance Measurement
David Dunn, MD	President-elect AAPC and Vice President of Zhealth Publishing	AAPC and Zhealth Publishing	Topic Knowledge
David S. P. Hopkins, PhD	Senior Advisor	Pacific Business Group on Health	Consumer, Quality Improvement, Performance Measurement
Donald Casey, MD, MPH, MBA	Vice President and Medical Director	NYU Langone Medical Center	Quality Improvement and Performance Measurement
Kavita Patel, MD, MS	Brookings Institution, Managing Director for Clinical Transformation and Delivery	Engelberg Center for Health Care Reform	Topic Knowledge
Lesley Curtis, PhD, MS	Associate Professor in Medicine	Duke University	Topic Knowledge and Performance Measurement
Peter Bach, MD, MAPP	Director, Center for Health Policy and Outcomes	Memorial Sloan-Kettering Cancer Center	Quality Improvement, Topic Knowledge, Health Care Disparities
Richard Bankowitz, MD, MBA	Chief Medical Officer	Premier Inc.	Quality Improvement, Topic Knowledge
Stephen Schmaltz, PhD, MS, MPH	Associate Director, Center for Database Management and Analysis	Joint Commission	Quality Improvement and Performance Measurement
Terry Golash, MD	Senior Medical Director	Aetna	Purchaser perspective
Vivian Ho, PhD	James A. Baker III Institute Chair in Health Economics and Professor of Economics	Rice University	Topic Knowledge