In recent years, the Centers for Medicare & Medicaid Services (CMS) has expanded its array of hospital quality measures in cardiovascular disease. In doing so, CMS has shifted its focus from process measures to outcome measures, increasingly using the measures in pay-for-reporting and performance programs. The emerging measures and their association with policy initiatives have changed over time and may be difficult to track for the casual observer, even as they increasingly influence payments to individuals and institutions.

This Perspective provides a primer on the CMS hospital cardiovascular outcome measures included in the Hospital Inpatient Quality Reporting Program (IQR), Hospital Readmissions Reduction Program (HRRP); and Hospital Value-Based Purchasing (HVBP) Program. We begin with a brief background on past and current CMS quality measurement efforts and then provide an overview of measure specifications for the current cardiovascular outcome measures used in these programs. We then summarize how the measures are currently used in the IQR, HRRP, and HVBP to assess hospital performance.

Background

CMS has a history of quality measurement dating back to its implementation of the Medicare Utilization and Quality Control Peer Review Program in the early 1980s. Initially, the Peer Review Program conducted implicit reviews of select cases, as suggested to them via beneficiaries, providers, or sampling.

In the early 1990s, the Peer Review Program and the Medicare Peer Review Organization review process were combined into the Medicare Peer Review Organization (MPS). In the late 1990s, the quality measurement activities and the potential for bias toward high-performing hospitals, which would be more likely to participate.

Partially in response to these concerns, CMS shifted its quality measurement activities away from individual Quality Improvement Organizations and toward centralized national programs. Starting in 2004, CMS introduced the Reporting Hospital Quality Data for Annual Payment Update as instructed by the Medicare Prescription Drug, Improvement, and Modernization Act of 2003. The program is a pay-for-reporting program that was enacted in order for hospitals participating in the Inpatient Prospective Payment System to publicly report their performance on the quality measures. More than 3,500 of the nation’s hospitals are reimbursed under the Inpatient Prospective Payment System, which prospectively sets rates for hospital reimbursement under Medicare Part A based on the condition and severity of the admission.

The first set of measures included in the Reporting Hospital Quality Data for Annual Payment Update were focused on process, such as providing aspirin on arrival for heart attack patients and angiotensin-converting enzyme inhibitors for heart failure patients. The full list of measures originally included in the Reporting Hospital Quality Data for Annual Payment Update is listed in Table 1. In August 2007 (fiscal year 2008), CMS introduced measures that focused on outcomes, starting with 30-day acute myocardial infarction (AMI) and heart failure mortality. While CMS attempted to monitor mortality rates for several conditions in the 1980s as part of the Peer Review Program, some experts criticized the measures and the effort was discontinued in the early 1990s. The critiques were largely based around the risk-adjustment methodology, which excluded many variables directly related to mortality and did not adequately adjust for patient severity. In response to these concerns, the current claims-based measures were validated with models developed with medical records. Over the next several years, CMS would rename the Reporting Hospital Quality Data for Annual Payment Update as the Hospital Inpatient Quality Reporting Program (IQR) and add other conditions in order to determine if appropriate care was provided. Over time, CMS reorganized the Peer Review Program into Quality Improvement Organizations, which, in addition to their quality improvement objectives, were charged with systematically gathering and reviewing data for the purpose of quality measurement. Concerns were raised surrounding the voluntary nature of participation in Quality Improvement Organization measurement activities and the potential for bias toward high-performing hospitals, which would be more likely to participate.

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(Circ Cardiovasc Qual Outcomes. 2014;7:00-00.)

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Circ Cardiovasc Qual Outcomes is available at http://circoutcomes.ahajournals.org
DOI: 10.1161/CIRCOUTCOMES.114.001364

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and outcomes (readmission, complication, and payment). By October 2016, CMS will include a total of 63 measures in the IQR, 10 of which will be outcome measures for 4 cardiovascular conditions.\textsuperscript{13}

With the passage of the Affordable Care Act, hospital quality measurement at CMS was linked to pay-for-performance. In particular, the Affordable Care Act introduced 3 programs that penalize or reward hospitals based on their performance on quality measures: 1) the Hospital Readmissions Reduction Program (HRRP); 2) the Hospital Value-Based Purchasing Program (HVBP); and 3) the Hospital Acquired Condition Reduction Program. We discuss only the HRRP and HVBP, because the Hospital Acquired Condition Reduction Program does not include cardiovascular outcome measures.

The HRRP took effect in October 2012 and originally included readmission measures for 3 conditions: AMI, heart failure, and pneumonia. As of October 2016, the expanded Program will include 6 conditions and procedures: AMI, heart failure, coronary artery bypass graft surgery, pneumonia, chronic obstructive pulmonary disease, and elective total hip or knee replacement.\textsuperscript{14} The HRRP applies to hospitals reimbursed under the Inpatient Prospective Payment System, reducing a portion of total payments for hospitals that experience higher than expected readmission rates, given their case mix, on any of the measures included in the Program.

The HVBP began in fiscal year 2013, with the goal of improving the value of care provided to Medicare beneficiaries. Unlike the HRRP, the HVBP is a composite score that includes 4 domains: patient experience of care, outcome, efficiency, and clinical process of care. Each domain has its own weight, with the outcome and patient experience domains accounting for 30% each and the efficiency and process of care domains accounting for 20% each.\textsuperscript{15} Over time, the weights of each domain are subject to change by CMS. The HVBP applies to hospitals in the Inpatient Prospective Payment System and provides payment incentives and payment penalties for high- and low-performing hospitals, respectively. By October 2014, the HVBP will include 12 process of care measures, 1 patient experience measure, 5 outcome measures, and 1 efficiency measure (Table 2).

The implementation of these programs is part of efforts at CMS to support the “Triple Aim” as described by then-CMS Administrator Dr. Donald Berwick.\textsuperscript{16} The Triple Aim’s goal is to improve healthcare quality and patient experience, while reducing healthcare costs. An integral aspect is the use of quality measurement to identify and learn from high-quality providers. The belief is that high performers set examples of achievable standards that others should be capable of replicating. For example, when discussing the HVBP, CMS mentions that, “when hospitals follow proven best practices, patients receive higher quality care and see better outcomes.”\textsuperscript{17} And recently, CMS has begun to see improvements in hospital performance in the areas in which these programs focus. For example, the current drop in readmission rates is cited as proof of high-quality care leading to reduced costs.\textsuperscript{18}

### Cardiovascular Outcome Measures

In Table 3, we list the cardiovascular outcome measures included in the IQR, HRRP, and HVBP and their implementation date. The sections below detail the major aspects of

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**Table 1. Original measures included in reporting hospital quality data for annual payment update**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Was aspirin given to the patient upon arrival to the hospital</td>
<td>AMI</td>
</tr>
<tr>
<td>Was aspirin prescribed when the patient was discharged</td>
<td>AMI</td>
</tr>
<tr>
<td>Was a β-blocker given to the patient upon arrival to the hospital</td>
<td>AMI</td>
</tr>
<tr>
<td>Was a β-blocker prescribed when the patient was discharged</td>
<td>AMI</td>
</tr>
<tr>
<td>Was an ACE inhibitor given for the heart failure</td>
<td>Heart failure</td>
</tr>
<tr>
<td>Did the patient get an assessment of his or her heart function</td>
<td>Heart failure</td>
</tr>
<tr>
<td>Was an ACE inhibitor given to the patient</td>
<td>Heart failure</td>
</tr>
<tr>
<td>Was an antibiotic given to the patient in a timely way</td>
<td>Pneumonia</td>
</tr>
<tr>
<td>Had the patient received a pneumococcal vaccination</td>
<td>Pneumonia</td>
</tr>
<tr>
<td>Was the patient’s oxygen level assessed</td>
<td>Pneumonia</td>
</tr>
</tbody>
</table>

*AMI, acute myocardial infarction; ACE, angiotensin-converting enzyme*
the measures; more comprehensive information is available in the technical reports. In general, the methodology used to create these measures is similar across conditions and outcomes.

**Data Sources Used to Calculate Measures**

All of the measures use 3 years of CMS administrative claims data to assess hospital performance. Specifically, the measures use Standard Analytic Files, which are identifiable data files that include patient demographic characteristics (e.g., age, race, zip code), diagnosis/procedure information, and limited hospital data (e.g., provider number). There are 7 Standard Analytic Files, each for specific care settings: Inpatient, Outpatient, Home Health Agency, Hospice, Skilled Nursing Facility, Durable Medical Equipment, and Physician/Carrier. The readmission and mortality measures only use the Inpatient and Outpatient Standard Analytic Files, while the payment measures use all seven.

**Measure Cohorts**

The measures used by CMS are limited to Medicare fee-for-service patients aged 65 years and older. Patients younger than 65 years who qualify for Medicare due to disability or end-stage renal disease are not included as they are deemed clinically distinct from the target population. Each measure uses primary International Classification of Diseases, Ninth Revision Clinical Modification discharge diagnosis codes to identify patients with a given condition or procedure to be included in the initial cohort. The measures then make additional minor exclusions in order to ensure that patients with missing data or atypical cases are not included (e.g., patients discharged against medical advice or patients without continuous enrollment data during the outcome window).

**Calculating Hospital-Level Measures**

The measures are calculated using hierarchical regression models in order to account for the clustering of patients within hospitals. The models generate a predicted over expected ratio for each hospital, including confidence intervals for each estimate. The expected rate for each hospital is estimated using that hospital’s patient mix and the average hospital intercept. Specifically, for each patient in the data set, the estimated regression coefficients are multiplied by the observed characteristics and the average of the hospital-specific intercepts are added to this quantity. Then, the quantity is transformed to the probability scale. For each patient within a hospital, these probabilities are summed. The predicted rate in each hospital uses a similar calculation. The

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**Table 3. Cardiovascular outcome measures and CMS implementation date in pay-for-reporting/performance programs**

<table>
<thead>
<tr>
<th>Measure</th>
<th>IQR</th>
<th>HRRP</th>
<th>HVBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMI</td>
<td>October 2007</td>
<td>N/A</td>
<td>October 2013</td>
</tr>
<tr>
<td>Heart failure</td>
<td>October 2007</td>
<td>N/A</td>
<td>October 2013</td>
</tr>
<tr>
<td>Stroke</td>
<td>October 2015</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>CABG</td>
<td>October 2016</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Readmission</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMI</td>
<td>October 2009</td>
<td>October 2012</td>
<td>N/A</td>
</tr>
<tr>
<td>Heart failure</td>
<td>October 2009</td>
<td>October 2012</td>
<td>N/A</td>
</tr>
<tr>
<td>Stroke</td>
<td>October 2015</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>CABG</td>
<td>October 2016</td>
<td>October 2016</td>
<td>N/A</td>
</tr>
<tr>
<td>Payment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMI</td>
<td>October 2015</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Heart failure</td>
<td>October 2016</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

AMI, acute myocardial infarction; CABG, coronary artery bypass graft surgery; CMS, Centers for Medicare & Medicaid Services; HRRP, Hospital Readmissions Reduction Program; HVBP, Hospital Value-Based Purchasing Program; IQR, Hospital Inpatient Quality Reporting Program.
predicted rate for each hospital is calculated by summing the predicted rates for all patients in the hospital. The predicted rate 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. The hospital-specific intercept is estimated by the model for each hospital based on the actual outcomes for its patients relative to hospitals with similar patients. A ratio of 1.0 is average performance, with anything below signifying better than expected performance and anything above signifying worse than expected performance. The exceptions to these performance categories are the payment measures that classify hospitals as lower, same as, or higher than the national average payment since lower or higher payment is not inherently good or bad. The reported measures multiply the ratio by the national rate of mortality, readmission, or average payment for that condition in order to produce a risk-standardized rate, making the ratios easier to interpret.

Implementation of Cardiovascular Outcome Measures in CMS Programs

IQR

The measures included in IQR are publicly reported on Hospital Compare for hospitals with at least 25 or more cases of a condition in the 3-year measurement period. All hospitals are included in the calculation. In order for a hospital to be classified as better as or worse than average, the entire 95% interval estimate for its rate must be below or above the national average. In the example shown in Figure 1 for AMI readmission, the hospital is classified as no different than the national average, as a portion of the yellow interval estimate overlaps with the national average readmission rate of 18.3%. Hospitals are not penalized or rewarded for their performance but if they choose to suppress their results, they receive a reduced Annual Payment Update. CMS also provides hospitals with an annual hospital-specific report (HSR), which includes all of a hospital’s patients in the measures along with their characteristics (eg, age, admission and discharge dates, health insurance claim number). The goal of these reports is to share information that will stimulate performance improvement activities. The HSRs, which include patient health information, are available to the hospital but not the general public. An example of the type of information included in an HSR is displayed in Figure 2. A full version of the HSR is located at the CMS Quality Net website.

HRRP

As with IQR, the results of the measures included in HRRP are also publicly reported on Hospital Compare. However, they are reported on a separate portion of the website, with results for all hospitals included in a downloadable spreadsheet. They are also used by CMS to determine which hospitals will receive a payment penalty. Similar to IQR, rates and associated penalties are only calculated for hospitals with 25 or more cases of a condition in the 3-year measurement period.

However, a key difference between the use of the readmission measures in HRRP versus IQR is that the point estimate, and not the entire confidence interval, is used to determine if a hospital’s rate is below or above the national average. Thus, the number of hospitals classified as having higher than expected readmissions in HRRP is far greater than the number in IQR. For example, in Figure 1, the hospital is classified as average in IQR but higher than average in HRRP since its point estimate (19.7%) is higher than the national average (18.3%). CMS has stated that the statutory language in the Affordable Care Act directs the use of the point estimate when calculating the excess readmission ratio. Specifically, the language states that the excess readmission ratio is “the ratio (but not less than 1.0) of… the risk adjusted readmissions based on actual readmissions… to the risk adjusted expected readmissions.”

Once CMS calculates a hospital’s penalty, it is then applied to the base operating Diagnosis-Related Group payments for all inpatient admissions, not just the measured conditions. Specifically, CMS reduces a hospital’s base operating Diagnosis-Related Group payments as determined by the hospital’s performance on the measures. As of the current fiscal year, this amount has reached its cap and cannot be higher than 3% of the total base operating Diagnosis-Related Group payment. The steps used to calculate payment penalties for each condition included in the HRRP are displayed in Figure 3.
Performance on each measure is treated independently, instead of as a composite score. Thus, performing better than expected on one measure will not “cancel out” performing worse than expected on another measure. For example, if a hospital were to have lower than expected readmission rates for AMI and heart failure but a higher than expected rate for coronary artery bypass graft surgery, it would still be penalized. The implication of this policy is that adding conditions to the HRRP will increase the number of hospitals performing worse than expected on at least one of the measures, leading to a rise in the number of penalized hospitals. As in IQR, hospitals also receive HSRs for their patients in the HRRP measures.

HVBP
In keeping with IQR and HRRP, the results of each of the domains included in HVBP are publicly reported on Hospital Compare. As with the HRRP, hospitals’ HVBP results are included in spreadsheets in a separate section of the Hospital Compare website. Of the 5 measures included in the outcome domain, 2 are for AMI and heart failure mortality. These mortality measures are the same as those included in IQR and are similarly limited to hospitals with 25 or more cases, but are distinct in their measurement period of 1 year rather than 3.37 As with the HRRP measures, CMS uses the point estimates, not the interval estimates, to determine hospitals’ performance on the AMI and heart failure mortality measures.

In order for hospitals to be included in the HVBP, they must meet the minimum number of cases for 2 of the 4 performance domains. The requirements for each domain are:

1. Calculate Excess Readmission Ratio = # of Predicted/Expected Readmissions
2. Calculate Aggregate Payments for Excess Readmissions = Base DRG Payment * # of Admissions for Measured Condition * (Excess Readmission Ratio – 1)
3. Payment Adjustment Factor = Aggregate Payments for Excess Readmissions/Aggregate Payments for All Discharges for All Conditions
4. Hospital Payment = Base Operating DRG * Payment Adjustment Factor

Figure 2. Example of information included in hospital-specific reports.
DOB, date of birth; HICNO, health insurance claim number; ID, identification

Figure 3. Steps for calculating payment penalty for conditions included in the hospital readmissions reduction program. DRG, diagnosis-related group

Sources of Funding
Dr. Krumholz is supported by grant U01 HL105270-05 (Center for Cardiovascular Outcomes Research at Yale University) from the National Heart, Lung, and Blood Institute.

Disclosures
Drs. Bernheim, Drye, and Krumholz work under contract with the Centers for Medicare & Medicaid Services to develop and maintain performance measures. Dr. Krumholz is the recipient of research grants from Medtronic and from Johnson & Johnson, through Yale University, to develop methods of clinical trial data sharing and chairs a cardiac scientific advisory board for United Healthcare.
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35. *The Patient Protection and Affordable Care Act*. 124 stat. 119, §3025. 2010

**Key Words:** Cardiovascular Outcomes ▪ CMS ▪ Pay-for-Reporting ▪ Pay-for-Performance ▪ Quality Reporting ▪ Readmission ▪ Value-Based Purchasing
Hospital Cardiovascular Outcome Measures in Federal Pay-for-Reporting and Pay-for-Performance Programs: A Brief Overview of Current Efforts
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Circ Cardiovasc Qual Outcomes. published online September 9, 2014;
Circulation: Cardiovascular Quality and Outcomes is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 1941-7705. Online ISSN: 1941-7713

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circoutcomes.ahajournals.org/content/early/2014/09/09/CIRCOUTCOMES.114.001364.citation

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