White Paper

Improving Performance under Bundled Care

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Background

The field of medicine is changing rapidly due to two major disruptions – the application of artificial intelligence, such as machine and deep learning and the shift from fee-for-service to value-based payment models. These innovations, which are occurring simultaneously, are fundamentally altering how data are used and how care is provided. To survive in this new environment, health care organizations must adapt to these changes. To prosper, organizations must harness the potential of machine learning to improve performance under value-based payment models.

Machine learning refers to data analysis methods in which algorithms iteratively learn from data to find new insights. In medicine, machine learning can sort through enormous amounts of patient data to identify combinations that predict outcomes. These combinations typically involve far more variables than it would be possible to include in a traditional statistical model. While machine learning is widely used in other fields already, it is only now gaining ground in medicine as a result of the widespread implementation of electronic health records (EHRs) over the past decade. Implementation and use of EHRs has finally created the types of big data resources that are necessary to support machine learning.

Machine learning has the potential to change medicine fundamentally in three areas, as described by Obermeyer and Emanuel in *The New England Journal of Medicine*[1]. First, machine learning can assist with interpretation of digitized images, such as mammograms, and even replace a human reader in some cases. Second, machine learning can improve diagnostic accuracy by generating differential diagnoses and recommending follow-up tests. Lastly, machine learning can improve prognostication by considering thousands of potentially relevant variables rather than the small number of variables currently included in prognostic models.

The ability of machine learning to dramatically improve prognostication relates most directly to the other major change occurring in medicine – the shift to value-based care. Value-based care is care that emphasizes outcomes and value rather than simply the provision of services in the calculation of payments. Under value-based care payment models, the health outcomes of patients and the quality of the care provided are directly linked to the amount of payment received by the provider. Value-based payment models take many forms, ranging from requirements for specific conditions such as bundled payments to new organizational models, such as accountable care organizations (ACOs).

The move to value-based care is occurring rapidly. Under the Affordable Care Act, the Centers for Medicare & Medicaid Services (CMS) has developed several alternative payment models that emphasize value-based care, with the goal of having 50 percent of traditional Medicare payments flow through alternative models by 2018.[2]

Bundled Payment Models

Bundled payment models represent a major component of the shift to value-based care. Under bundled payment programs, payments for the multiple services received by beneficiaries during an episode of care are linked, and both financial and quality standards are considered when calculating payments.

Of particular importance for providers, participation in a bundled payment program can be mandatory for providers and institutions that accept Medicare. As of 2016, CMS required 800 hospitals in 67 metropolitan areas in the United States to participate in a bundled payment program for hip and knee replacements.[3]

Hip and knee replacements represent both a common and expensive procedure for Medicare. More than 400,000 Medicare beneficiaries received a hip or knee replacement in 2014, costing Medicare over $7 billion. However, costs, rates of complications, and patient outcomes vary widely across hospitals and geographic regions. The average total Medicare expenditure for surgery, hospitalization, and recovery ranges from $16,500 to $33,000.[4] The variations in cost and patient outcomes make hip and knee replacements well-suited to a bundled payment program, where providers are incentivized to coordinate care and avoid costly complications.

The goals of the bundled payment program for hip and knee replacements is to hold hospitals responsible financially for the quality and total costs of a hip or knee replacement and to incentivize coordination of care across hospitals, physicians, and other care providers. The model applies to patients who are ultimately discharged under MS-DRG 469 (Major joint replacement or reattachment of lower extremity with major complications or comorbidities) or 470 (Major joint replacement or reattachment of lower extremity without major complications or comorbidities). The episode of care begins when a patient is admitted to a participating hospital and ends 90 days post-discharge. All related items and services paid under Medicare Part A and Medicare Part B are included (see Figure 1).

At the beginning of the model year, hospitals receive target prices for the episodes of care. The target prices are determined based on historical hospital-specific spending and regional spending for hip and knee replacement episodes and typically include a discount over expected episode spending. Throughout the year, providers are paid under the usual payment system. At the end of the year, actual spending for the episode is compared to the target price. Hospitals that achieve both spending below the target price and a minimum composite quality score can earn a reconciliation payment that makes up the difference between the target price and the actual episode spending (up to a pre-determined cap), while hospitals that do not achieve those goals may be required to repay a portion of the episode cost to Medicare.

FIGURE 1.
ITEMS & SERVICES INCLUDED IN BUNDLED PAYMENTS

- Physicians' services
- Inpatient hospital services (including hospital readmissions)
- Inpatient psychiatric facility services
- Long-term care hospital services
- Inpatient rehabilitation facility services
- Skilled nursing facility services
- Home health agency services
- Hospital outpatient services
- Outpatient therapy services
- Clinical laboratory services
- Durable medical equipment
- Part B drugs
- Hospice
- Some per beneficiary per month (PBPM) care management payments under models tested under section 1115A of the Social Security Act

As an incentive to coordinate care, hospitals participating in the bundled payment program are able to share savings payments – and financial accountability for increased spending – with collaborating providers and suppliers.

A key component of the bundled payment program is quality of care. Under the hip and knee replacement bundle, hospital quality is evaluated using a composite quality score methodology. The composite quality score is a summary score reflecting performance and improvement on the two quality measures, as well as reporting of patient-reported outcomes (PROs) and limited risk variable data. The quality measures are described in Table 2.

Hospitals are not required to submit THA/TKA PROs and risk variable data. However, submission of these data can help hospitals earn two points toward the composite quality score, which may increase the financial benefit for the hospital. The eligible PROs, which must be collected both pre-operatively and post-operatively, are:

- Veterans RAND 12 Item Health Survey (VR-12) OR the Patient-Reported Outcomes Measurement Information System (PROMIS) Global-10 generic PRO survey

  AND

- Hip disability and Osteoarthritis Outcome Score (HOOS)/Knee injury and Osteoarthritis Outcome Score (KOOS) Jr. OR HOOS/KOOS subscales PRO survey for patients undergoing eligible elective primary THA/TKA procedures

Table 1 summarizes the voluntary variables that can be collected and submitted under the hip and knee replacement bundle.

TABLE 1.
VOLUNTARY DATA COLLECTION ELEMENTS FOR HIP AND KNEE REPLACEMENT BUNDLE[3]

<table>
<tr><th colspan="11">Data Collection Requirements</th></tr>
<tr><th colspan="5">Pre-Operative Data Collection</th><th colspan="6">Post-Operative Data Collection</th></tr>
<tr><td colspan="2">VR-12</td><td>OR</td><td colspan="2">PROMIS-Global</td><td colspan="2">VR-12</td><td>OR</td><td colspan="3">PROMIS-Global</td></tr>
<tr><td colspan="5">AND</td><td colspan="6">AND</td></tr>
<tr><td colspan="2">HOOS/KOOS Jr.</td><td>OR</td><td colspan="2">HOOS/KOOS subscales</td><td colspan="2">HOOS/KOOS Jr.</td><td>OR</td><td colspan="3">HOOS/KOOS subscales</td></tr>
<tr><td>HOOS Jr</td><td>KOOS Jr.</td><td></td><td>HOOS subscales</td><td>KOOS subscales</td><td>HOOS Jr</td><td>KOOS Jr.</td><td></td><td>HOOS subscales</td><td colspan="2">KOOS subscales</td></tr>
<tr><td>• Pain (2Qs)
• Function, daily living (4Qs)</td><td>• Stiffness (1Q)
• Pain (4Qs)
• Function, daily living (2Qs)</td><td></td><td>• Pain (10Qs)
• Function, daily living (17Qs)</td><td>• Stiffness (2Qs)
• Pain (9Qs)
• Function, daily living (17Qs)</td><td>• Pain (2Qs)
• Function, daily living (4Qs)</td><td>• Stiffness (1Q)
• Pain (4Qs)
• Function, daily living (2Qs)</td><td></td><td>• Pain (10Qs)
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• Pain (9Qs)
• Function, daily living (17Qs)</td></tr>
<tr><td colspan="5">AND</td><td colspan="6">AND</td></tr>
<tr><td colspan="2">Medicare Provider Number</td><td colspan="2">Mode of Collection</td><td>Body mass index (BMI) or height in cm and weight in kg</td><td colspan="2">Medicare Provider Number</td><td></td><td colspan="3">Mode of Collection</td></tr>
<tr><td colspan="2">Medicare Health Insurance Claim (HIC) number</td><td colspan="2">Person completing survey</td><td>Pre-operative Use of Narcotics</td><td colspan="2">Medicare Health Insurance Claim (HIC) number</td><td></td><td colspan="3">Person completing survey</td></tr>
<tr><td colspan="2">Date of Birth</td><td colspan="2">Patient-reported Pain in Non-operative Lower Extremity Joint(s)</td><td>Patient-reported Health Literacy Screening (SILS2) questionnaire</td><td colspan="2">Date of Birth</td><td></td><td colspan="3"></td></tr>
<tr><td colspan="2">Date of Collection</td><td colspan="2">Patient-reported Back Pain (Oswestry Index question)</td><td>Race and Ethnicity</td><td colspan="2">Date of Collection</td><td></td><td colspan="3"></td></tr>
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The first performance period for the hip and knee replacement bundle began on April 1, 2016, so results are not yet available. In the meantime, CMS is moving ahead with a cardiac bundled payment model, set to launch in July 2017. Under the proposed model, participating hospitals would be accountable for the cost and quality of care provided to Medicare beneficiaries who are admitted for myocardial infraction and coronary artery bypass graft (CABG); the model also builds on the hip and knee replacement bundle by adding hip/femur fractures.

Myocardial infarction and CABG are common in the Medicare population, and, like hip and knee replacements, there are large variations in spending. For example, costs to Medicare for treatment of myocardial infarction totaled over $6 billion in 2014, but costs varied by as much as 50 percent depending on region and provider.[5]

The new model would work in a similar manner to the orthopedic bundled payment model, with actual spending for the episode compared to a target price at the end of the model year. Target prices may be risk-adjusted depending on the complexity of care and type of treatment provided (e.g., medical versus surgical for myocardial infarction). Hospitals that achieve both lower costs and high quality can earn a reconciliation payment, while hospitals that do not meet those goals may have to repay a portion of the episode costs to CMS.

The proposed quality measures for myocardial infarction, CABG, and hip/femur fractures are described in Table 2.

TABLE 2.
QUALITY MEASURES INCLUDED IN BUNDLED PAYMENT MODELS

Measure Name	Description	Bundle(s)		
		Ortho*	AMI	CABG
Hospital-Level Risk-Standardized Complication Rate (RSCR) Following Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty (TKA) (NQF #1550)	This measure estimates a hospital-level risk-standardized complication rate (RSCR) associated with elective primary total hip arthroplasty (THA) and total knee arthroplasty (TKA) in patients 65 years and older. The measure uses Medicare claims data to identify complications occurring from the date of index admission to 90 days post date of the index admission.[6]	X		
Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) Survey measure (NQF #0166)	HCAHPS is a 32-item survey instrument that produces 11 publicly reported measures: 7 multi-item measures (communication with doctors, communication with nurses, responsiveness of hospital staff, pain control, communication about medicines, discharge information and care transition); and 4 single-item measures (cleanliness of the hospital environment, quietness of the hospital environment, overall rating of the hospital, and recommendation of hospital). HCAHPS is administered to a random sample of adult inpatients between 48 hours and six weeks after discharge.[7]	X	X	X
Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate Following Acute Myocardial Infarction (AMI) Hospitalization (NQF #0230)	This measure estimates a hospital-level, 30-day risk-standardized mortality rate (RSMR) for patients discharged from the hospital with a principal diagnosis of acute myocardial infarction. Mortality is defined as death for any cause within 30 days after the date of admission of the index admission.[8]		X	
Excess Days in Acute Care after Hospitalization for Acute Myocardial Infarction	Acute care days include emergency department, observation, and inpatient readmission days.[9]		X	
Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate Following Coronary Artery Bypass Graft (CABG) Surgery (NQF #2558)	The measure estimates a hospital-level, risk-standardized mortality rate (RSMR) for patients 18 years and older discharged from the hospital following a qualifying isolated coronary artery bypass graft (CABG) procedure. Mortality is defined as death from any cause within 30 days of the procedure date of an index CABG admission.[10]			X

**Required for hip and knee replacements as well as hip and femur fractures*

Like with the hip and knee replacement bundle, participation in the cardiac bundled payment program will be required for some hospitals – in this case, hospitals in 98 randomly-selected metropolitan statistical areas (the same areas participating in the hip and knee replacement bundle plus additional areas) will be required to participate.

In addition to these two bundled payment programs, CMS has indicated that they intend to develop a voluntary bundling program in 2018.

Machine Learning to Improve Performance under Bundled Payments

Given these developments, health care organizations and providers must consider what is necessary to be successful under bundled payment models. As noted by CMS, a key goal of the bundled payment models is to incentivize hospitals to 'avoid expensive and harmful events.'[3] To support that goal, the models force providers to assume greater risk for the cost of patient care. This assumption of risk makes it imperative for organizations to be able to identify patients at high risk for adverse outcomes and, whenever possible, avoid those complications.

For example, in the case of hip and knee replacements, non-routine discharges, complications, and readmissions account for $3,309 in excess costs on average for every patient or $3 billion dollars annually in the U.S.[11] Avoiding these complications even for a subset of patients can result in significant costs savings, as well as improved scores on quality measures. The same scenario applies to myocardial infarction, where reducing excess days (which could include longer hospital stays, readmissions, or emergency room visits) can result in costs savings as well as improved scores on the excess days quality measure.

Moving beyond avoiding complications, hospitals may also reduce costs through the choice of implant for hip and knee replacements. The cost of implants varies widely, from approximately $3,800 to $7,800, depending on manufacturer and type. If patient outcomes for a lower cost implant are shown to be equivalent to outcomes for a higher cost implant, it becomes possible to make an ethical decision to use the lower cost implant, thus generating further savings.

Implementing measures such these to reduce costs and improve performance under bundled care requires the prognostic ability of machine learning. Machine learning can shift through data from a specific hospital, as well as data from thousands – or even millions – of patients from other data sources, such as claims and electronic health records, to identify variables that predict both positive and negative patient outcomes. Providers can then implement targeted interventions in advance, with the goal of avoiding complications and improving patient outcomes.

Consider the case of myocardial infarction. In this condition area, machine learning can be used to develop predictive tools that identify patients at high risk for readmission. Hospitals can take steps, such as increased collaboration with post-acute care providers, to reduce the likelihood of readmission. In hip and knee replacement, discharges to skilled nursing facilities can result in much higher costs; predictive analytics can be used to identify which patients are most likely to experience complications leading to a non-routine discharge. As an example, patients with poorly controlled diabetes may receive pre-surgery care to manage their diabetes, with the goal of reducing the risk of adverse post-surgery outcomes.

To make effective use of machine learning tools, hospitals must be able to efficiently collect and report the data required for bundled payment programs. Increasingly, these data include PROs in addition to clinical variables (as outlined in Table 1). PRO data collection can be challenging, particularly during the post-surgery period when patients who are doing well may be less likely to respond to PRO surveys. But, while PROs are currently voluntary, submission of PRO data has the potential to increase the hospital's composite quality score, making it advantageous for hospitals to do so.

Once these data have been collected and combined with other data sources, hospitals can leverage the data for other purposes, such as benchmarking against national or regional samples. While much of the immediate focus in bundled payments is on reducing unnecessary complications and preventing costly events, longer-term success will depend on identifying and implementing the most effective care pathways for different condition areas. Care pathways may include, for example, pre-surgery counseling and risk mitigation for hip/knee replacement patients, combined with active collaboration with outpatient care providers to promptly identify and manage issues before they escalate into a readmission or serious complication. Benchmarking efforts will help hospitals to identify the most consistent, effective care pathways for patients. In addition, the sheer volume of patients that can be included in machine learning algorithms may make it possible to identify patterns in patient subgroups (e.g., younger patients, patients with specific comorbidities) and design pathways to maximize outcomes in those groups.

To achieve these goals, machine learning algorithms require a range of data sources – including clinical data, PROs, claims data, and potentially other sources of cost/resource utilization data – as well as large numbers of patients. Sophisticated models are needed to combine and organize these data so that machine learning algorithms can be applied.

As noted by Obermeyer and Emanuel, the most significant potential of the application of machine learning to medicine is the ability to reduce costs in a way that benefits patients, providers, and payers – by identifying adverse outcomes before they occur, when it is still possible for providers to take action to prevent that outcome.[1] Use of machine learning in this way has the potential to both improve patient outcomes and help organizations succeed in the new value-based care landscape.

While machine learning offers great possibilities, several barriers exist to its widespread adoption and use within medicine. Most significantly, there is discomfort among care providers about applying analytics that are not based on algorithms that

use accessible and widely understood clinical variables. Machine learning algorithms often use thousands of variables that are not readily understood, where the causal connection between the variable and the outcome is unclear. Providers may be hesitant to trust these 'black box' analytics. However, these types of analytics are widely used in other fields and have demonstrated the ability in medicine to help providers avoid complications, readmissions, and deaths.[12]

Adoption and use of these predictive analytic tools will require a culture change within medicine, where clinicians will need to become more comfortable with probabilities instead of certainties. This is a major change, but the shift in thinking is necessary for clinicians to be able to take full advantage of these new technologies. And, by embracing and using these technologies to their fullest potential, clinicians will benefit – both by improving performance under bundled payment programs and by providing better care at a lower cost to all patients.

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About the Author

Dr. Richard Gliklich is the CEO of OM1 (formerly Better Outcomes Corporation). Prior to founding OM1, Dr. Gliklich was President of the Outcome division of Quintiles, the largest provider of biopharmaceutical development and commercial outsourcing services, and he also served on its Executive Committee through its 2013 IPO. Prior to Quintiles, he was Founder, CEO and Chairman of Outcome, a health information and services company that served more than 2,500 healthcare organizations and a majority of the global top 30 life sciences companies. Dr. Gliklich led Outcome from its start as a spin-off from his Harvard affiliated research laboratory in 1998 through its acquisition by Quintiles in October 2011.

In addition to his experience as an entrepreneur and executive, Dr. Gliklich is well known in the areas of registries, outcomes and analytics. He is senior editor of the landmark publication by the U.S. Agency for Healthcare Research and Quality (AHRQ) handbook "Registries for Evaluating Patient Outcomes: A User's Guide" and the PI for the Outcomes Measures Framework, which focuses on standardization of outcomes measurement. He has led several key national and international efforts focused on evaluating the safety, effectiveness, value and quality of healthcare. Dr. Gliklich also holds several patents for both health outcomes systems and medical devices.

Dr. Gliklich is a graduate of Yale University and Harvard Medical School and a former Charles A. Dana Scholar at the University of Pennsylvania. He is also a surgeon and the Leffenfeld Professor at Harvard Medical School.

About OM1

OM1, Inc. is a digital health company focused on solving the problem of determining and understanding the true results of healthcare and offering a more complete view of patient outcomes than has been available until now. With specialized outcomes management and predictive analytics tools that leverage our own linked database of more than 180 million patients, OM1 takes big data and makes it meaningful and personalized - enabling informed decisions and actionable insights that consider the what if rather than just what was. OM1 partners with at risk providers and health care organizations to help them succeed with value-based care and bundled payments.

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