A SAS Solution for Arkansas Episode-Based Payment System RFI

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Executive Summary

Exceeding Arkansas’ Stated Goals

With SAS, Arkansas will exceed their goals of addressing 75% of medical spend over the next 3-4 years.

The commitment of the Arkansas Department of Human Services (DHS) Division of Medical Services (DMS) to improve the cost and quality of health care in Arkansas is highly commendable. The launch of five episodes of care across the state is a major accomplishment.

The State of Arkansas has a goal to address 75%+ of medical spend over the next 3-4 years. We would be honored to partner with the State of Arkansas to reach and exceed this goal. Our team has currently developed 21 episodes and are working toward the creation of 200.

A Proven Solution

SAS Analytics and HCI3’s PROMETHEUS Payment ECR (Evidence-informed Case Rate) Analytics enables health plans and providers to implement bundled payment and accountable care organization (ACO) shared savings models. Dynamic and scalable, our approach to analyzing health care data streamlines the planning and execution of a wide variety of value-driven payment contracts. An ECR is a budget for a comprehensive episode of medical care within a defined time period. The software will help health plans and providers control costs, while improving quality and health outcomes.

There are currently 16 active customers with four active PROMETHEUS pilot sites in Minnesota, Pennsylvania, Illinois, and Michigan with two other sites coming on board in Colorado and New York. Each site is working towards reducing the rate of potentially avoidable complications (PACs), promoting a patient-centered environment, and helping providers act as a team.

A Proven Team—SAS and HCI3

SAS and HCI3: A leader in health analytics and a pioneer in evidence-informed payment solutions.

SAS and HCI3 are willing to invest with Arkansas to make the nation’s first statewide payment reform initiative a success. We would be honored to be invited to provide a demonstration of our capabilities in August.
Solution Overview

SAS and the Health Care Incentives Improvement Institute (HCI3) are collaborating to help the health care industry address emerging provider reimbursement models through the use of advanced analytics. SAS is the leader in health analytics software and services and HCI3 is a pioneer in designing and executing evidence-informed payment solutions.

"In trying to control spiraling medical costs, value-driven payment models can mean the difference between being a market leader and lagging behind," said Jason Burke, Managing Director of the SAS Center for Health Analytics and Insights (CHAI). "Companies exclusively using conventional reimbursement models will miss emerging opportunities to profit from improved performance. Together with HCI3’s experience, we’ll help accelerate the change that will reward high-quality care."

SAS® Analytics and HCI3’s PROMETHEUS Payment® ECR (Evidence-informed Case Rate) Analytics® will enable health plans and providers to implement bundled payment and accountable care organization (ACO) shared savings models. Dynamic and scalable, this approach to analyzing health care data streamlines the planning and execution of a wide variety of value-driven payment contracts. An ECR is a budget for a comprehensive episode of medical care within a defined time period. The software will help health plans and providers control costs, while improving quality and health outcomes.

"Payment reform is sweeping the U.S. and the world as private and public sector employers grapple with the continued growth in health care spending in tightening fiscal environments," said Francois de Brantes, Executive Director of HCI3. "Our work has shown how bundled payments and other value-based incentives can move providers from simply producing more services to focusing on effectiveness and efficiency. SAS’ expertise can leverage that work and offer payers and providers the newest and most advanced solutions for this changing landscape."

This collaboration is sponsored and led by the SAS Center for Health Analytics and Insights (CHAI), a health industry think tank focused on identifying novel ways of applying advanced analytics to the challenges facing the health and life sciences industries. In the year since its inception, CHAI has published industry-leading research on the transformative opportunities for health analytics within both health plans and health care providers, as well as tackled industry collaborations in areas such as adaptive clinical trials, personalized health insurance, and now bundled payment analytics.

About HCI3

The Health Care Incentives Improvement Institute is a nonprofit organization guided by a Board of Directors that includes physicians, employers, health plans and other stakeholders. HCI3 has created a broad range of programs to measure outcomes, reduce care defects, promote a team approach to caring for patients, realign payment incentives around quality and reward excellence. HCI3 has implemented programs in communities across the country, working collaboratively with clinicians,
hospitals, employers, health plans and others, through their two branded programs: Bridges to Excellence® (BTE) and PROMETHEUS Payment®.

**SAS’ CHAI Team**

A new health care and life sciences research and incubation organization within SAS, the leader in business analytics software and services, will help organizations develop deeper insights into medical care, financial performance and their customers.

The SAS Center for Health Analytics and Insights (CHAI) will lead to a better, more cost-effective health delivery system by enabling collaboration on innovative uses of advanced analytics across health care and life sciences. Focus areas will include evidence-based medicine, adaptive clinical research, cost mitigation and many aspects of customer intelligence.

For more than 30 years, SAS® analytic software has been a vital instrument for the world's leading health care and life sciences companies as they have provided care and developed products. With its history in health analytics, SAS has brought together senior leaders and analysts from the health and life science industries to form CHAI.

"SAS understands that it has a special role in health and life sciences. As both an employer and consumers of health care we also well understand the struggles everyone is facing as health care delivery systems are under fundamental pressures," said Jim Goodnight, CEO and co-founder of SAS. "We are investing in CHAI because SAS recognizes the value of collaboration between all industries involved in health services and products."

**Why Now?**

The use of advanced analytics is critical to improving health outcomes with the ongoing US debate on health system reform, discussion in many countries of how best to care for an aging population and global concerns on containing the cost of care.

"Our industry is in the midst of a huge transformation," says Jason Burke, Managing Director and Chief Strategist for CHAI. "Despite years of operating in silos, the reality is today health plans, health care providers, life sciences firms and government organizations all face similar challenges in an unsustainable system. So the promise in health analytics to these organizations – better health outcomes at lower costs, and through better customer relationships – is tremendous."

Health reform has increased the adoption of electronic health information systems that offer potential for analysis, but the real opportunity is in bringing business and clinical insights together to drive decision making. Though many organizations have used analytics for years, an increased focus on advanced analytics and cross-market collaboration are new, reflecting a growing recognition that fundamental improvements are needed. All health industry segments require collaboration and more sophisticated uses of information.
How Will it Work?

CHAI industry experts will develop and propagate the use of advanced analytics across the health and life sciences ecosystem: conducting industry research; publishing best practice findings; engaging with industry executives and associations; establishing innovative advanced analytical applications; and helping organizations plan for ongoing change. Industry analytical topics include health outcomes, clinical trials, health care cost mitigation, data privacy and customer intelligence.

CHAI's goals center on creating opportunities for collaborative innovation in three ways:

- **Improving medical care.** "SAS has unmatched experience in applying advanced analytics to patient data," said CHAI Senior Manager of Analytical Consulting Dave Handelsman. "From driving new medical innovations through techniques such as adaptive clinical trials, all the way to improving patient health outcomes through evidence-based medicine programs, the role of advanced analytics is crucial." Handelsman has been with SAS for more than 10 years and served as Product Manager for SAS Drug Development. He was previously an executive at ClinTrials and worked earlier at Pharmaceutical Research Associates.

- **Strengthening financial performance.** "Nobody can discuss health care without talking about the financial implications," said CHAI Senior Health Plan Consultant Sarah Rittman, formerly Director of Business Transformation at Blue Cross Blue Shield of North Carolina. "These concerns include a health insurance industry moving from wholesale to retail business models, a pharmaceutical industry facing unprecedented levels of R&D costs and providers struggling to maintain profitability. There is simply no choice – we must become smarter. Analytics must be applied to information for better financial decisions. And it is not just about knowing the costs – it is about predicting and preventing them." Rittman, is a former director of business transformation at Blue Cross Blue Shield of North Carolina.

- **Deepening customer insights.** "Complexity has greatly increased," said CHAI Senior Pharmaceutical Consultant Brad Sitler, previously General Manager of a pharmaceutical marketing firm. "This industry transformation means that everyone is facing new customers. Who are they? What are they looking for? How should I interact with them? And how can I build a relationship that ultimately improves patients’ lives while protecting the privacy of their data? These questions are driving a new level of interest in applying advanced analytical techniques from other industries to life and health sciences."

History and Background

In 2006 the Prometheus Payment Design Team convened a series of meetings with practicing physicians who had been organized in Clinical Working Groups focused on Cancer, Cardiac, Chronic, Orthopedic and Preventive care. Their task was to select a starter set of clinical conditions around which episodes rates (Evidence-informed Case Rates or ECRs) could be constructed. Each condition would be fully defined by the each group, whose tasks included:

- Selecting clinical practice guidelines for those conditions;
- Analyzing the guidelines to determine the natural boundaries of the ECR (trigger and end);
- Providing a rigorous estimate of the scope of services of the ECR, including the total units of service and the type of provider responsible for delivering those services as outlined in the guidelines;
• Establishing a reasonable set of performance measures that should be used to evaluate the clinical performance of providers delivering the services included in the ECR;
• Identifying routine complications that are prevalent for patients that don’t receive optimal care;
• Participating in and supervising the data modeling of the ECR to determine the extent to which the results were valid; and
• Creating estimates for the warranted variation of services that should be added to the base.

The results of this work were summarized in a Commonwealth Fund report published in June 2007 and served as an input to the initial modeling work performed in 2007 and early 2008. Starting with AMI, Hip replacement, Knee replacement, and Diabetes, the objective was to analyze a large claims database in order to determine the amount of unexplainable variation in total costs of care that could be reasonably attributed to complications under the control of providers as opposed to complications caused by the natural progression of the illness or injury.

In its work on determining a framework for efficiency, the National Quality Forum also concluded that there are metabolic pathways for certain patients that will simply lead to increased severity of the condition caused by the progression of the disease while others will be stabilized. All these frameworks essentially acknowledge the same construct – there are typical sets of services that one expects to observe in the care of a patient at any given time, and these services will vary over time as the patient’s condition changes; however there are also non-typical services that occur as a result of quality “defects”. We initially termed the first type of variation warranted and the second unwarranted. Subsequently, and in deference to the model developed by Geisinger, we switched the terminology to typical services and services associated with potentially avoidable complications (PACs).

From the onset, the data modeling was build on SAS, mostly to enable the calculations of regression models for severity adjustments. As it started to yield outputs, it became clear that the current coding practices in hospitals and physician offices allowed us to identify claims and events within a claim that were associated to PACs.

At its core, the definition of a PAC is any event that negatively impacts the patient and is potentially controllable by all the physicians and hospitals that manage and co-manage the patient. In its seminal report, To Err is Human, the Institute of Medicine highlighted a significant number of these negative events, including a host of hospital-acquired conditions that have since become defined by the CMS and included as markers of quality. In addition, the AHRQ has used the same research to base its Patient Safety Indicators – any hit in the numerator of those measures is a negative event impacting a patient.

To Err is Human also pointed out that the lack of care coordination for patients with chronic conditions led to a significant number of unnecessary hospitalizations. Work by Wagner and colleagues showed how extensively these hospitalizations could be reduced when care for these patients was optimized. More recently, Jencks and colleagues highlighted the significant number of readmissions that occur post discharge that could be reduced with better post acute care transitions.

All these negative events are included in our definitions of Potentially Avoidable Complications. In fact, we have used the specific AHRQ and CMS definitions as well as others vetted by external clinical working groups. Readmissions are easy to account for in an episode when the window of that episode is appropriately set, and we count readmissions as PACs. We summarized our initial modeling work in a Commonwealth

In June 2009 we published a paper that showed how severity-adjusting ECRs and adding a PAC allowance (which is also severity-adjusted) creates an incentive to care for sicker patients and enables clinicians who reduce PACs (improve quality) to financially benefit from that improvement.

In 2012, HCI3 and the Brandeis team were awarded the contract by CMS to fully develop the CMS Grouper. That work will be on-going for several years. Our commitment to the ECR Analytics is to
incorporate as best we can the elements of the CMS Grouper that will help providers, payers, researchers and others gain insights into the costs of care and develop innovative payment models to reward providers that deliver high value.

Current and Future Versions

Current Version (v3.6)

The major components of the current production version of PROMETHEUS ECR Analytics (v3.6) are described in some detail in the next sections.

Future Version (v5.0 – SAS ECR Analytics)

The focus of SAS's collaboration with HCI3 is to substantially enhance and rearchitect the current version of ECR Analytics, to address enhancements requested by current customers, add new clinical episodes and new standard reports, add ability to apportion and roll up episode specific costs to higher levels of disease specific aggregation and to improve the performance and supportability of the application.

New episode definitions will continue to be added on a regular basis over the next 2-3 years, with a target of covering sufficient episodes to account for 80+% of Medicare.
Requirements

4.1 Component A: Episode Design

(a) Episode Definition Components:

The PROMETHEUS Payment model is an ambitious attempt at creating a patient-centered payment for health care services that would split apart technical and probability risks (currently compressed and indistinguishable in either fee for service or capitation payments) and assign responsibility for the former to providers and the latter to insurers. The payment model’s foundational element is an Evidence-informed Case Rate (ECR), which is a bundled price for a severity-adjusted, typical episode of care for any patient-provider-payer triad after an episode is triggered. Under grants from the Commonwealth Fund and the Robert Wood Johnson Foundation, we used a large national medical and pharmacy claims dataset consisting of over 4.5 million covered lives to model ECRs for 21 acute & chronic medical conditions and inpatient & outpatient procedures. Electronic medical records data or results of laboratory or radiology tests were not available to us.

What are ECRs?
ECRs are patient-centered episodes of care for the treatment of an illness or condition, or for an inpatient or outpatient procedural event, severity-adjusted to that patient. They include all covered services related to the care of the condition as determined by tested, medically accepted clinical practice guidelines or expert opinion. They are time-delimited and are built to identify “typical” services, from services associated with potentially avoidable complications (PACs). By separating base (typical) care from care of complications, we bifurcate the total variation in the price of care into the portion of that total variation that is caused by patient factors and typical care of the patient, and the portion that is caused by provider management failures leading to potentially avoidable complications. The base set reveals itself to be the appropriate one from which to develop the patient health status factors that require an adjustment in the intensity of services to care for that patient, as well as the base from which to create a risk-adjusted bundled price for an episode. The cost of caring for potentially avoidable complications forms the basis for the ECR-specific PAC allowance that is made available to all episodes, irrespective of occurrence of complications, creating a strong incentive for providers to decrease complications.

How are ECRs constructed?
For each ECR, the following steps are followed:
1. **Clinical Logic (Defining the boundaries of an ECR):**

   This step is developed initially using clinical guidelines or expert opinion. It is then validated using empirical data that is shared with the clinical working group. The definitions are further refined based on the outputs and clinical discussion and the final set of rules and definitions are created for the various components of an episode. In this step we define 1) the triggers for a condition or procedure, 2) the time windows for the episode including look-back and look-forward periods, 3) what claims and services are considered relevant for the episode, 4) what constitutes “typical” care that is routinely expected to be delivered to a patient with or without co-morbidities or other factors that naturally increase the intensity of services and are outside the control of the provider (e.g. admission of a patient for an AMI through the emergency room), 5) what patients should be excluded from the episode (denominator exclusions), 6) what claims should be excluded from the episodes (numerator exclusions), 7) what variables should be used for risk adjustment, and 8) what are standard complications to be expected and would be considered potentially avoidable for the condition / procedure under study.

   We consider PACs as indicators of health system failure that cause gaps in quality of care. We categorize them into three types:

   - **PACs related to the index condition.** This would include an adverse event directly related to the index medical condition or procedure either during the index stay or a subsequent ED visit or hospitalization. An example would be respiratory failure during the index stay in a patient admitted with pneumonia, or wound infection in a patient with hip replacement.
   
   - **PACs related to comorbidities.** If one of the patient’s controlled comorbid conditions is exacerbated during the episode time window or requires a subsequent ED visit or hospitalization. For example, an ED visit for an asthma attack in a patient with diabetes or one discharged for pneumonia.
   
   - **PACs related to patient safety failures.** Examples are bed sores, line sepsis, adverse drug events, drug interactions etc.

   The ABMS / Brookings have a strong process developed along with the PCPI Clinical Working Groups to define the clinical logic on an episode-by-episode basis. Clinical experts from various specialties who participate in the care of a condition / procedure are invited to the table to provide clinical guidance and input and to develop a consensus where published clinical guidelines are lacking. The Prometheus starter set of episodes will be vetted through this clinical logic process.

2. **Development of the SAS Metadata:** The clinical logic defined above is translated into code-sets for each ECR to convert the clinical definitions to a SAS metadata set that can be read into the SAS programs for episode construction.
We use the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes, and the American Medical Association’s Current Procedural Terminology (CPT®) codes for diagnoses and procedures for medical claims, and the National Drug Codes (NDC) for pharmacy claims. We heavily leverage the Agency for Healthcare Research and Quality (AHRQ)’s Clinical Classification Software (CCS) as a means of grouping ICD-9-CM diagnosis and procedure codes, and the CCS for CPT classification to group CPT codes into Prometheus defined super-categories. This helps group similar conditions and procedures into relatively homogenous meaningful, clinical categories to increase the strength of the variables for further analysis. Separate SAS Metadata sets exist for each ECR® that map the ICD-9 diagnosis codes, the procedure codes, the CPT codes, the revenue codes as well as the NDC codes to the triggers, the typical, PACs as well as exclusion codes within each ECR®. The code-sets are taken back to the clinical working group for a final review before implementing into the SAS programs. Steps 1 and 2 could be performed to some extent during the same clinical session and the code-sets verified separately.

3. Episode Construction (Grouping) Logic: In this step we define the analysis plan, the methods and parameters to build an episode and to create the analytical dataset for risk-adjustment. This step once finalized, should be consistent across all conditions within an episode type. This step uses a series of sub-steps:

a. Data Cleaning and Preparation: Here rules are defined to 1) determine how to treat claims that straddle the episode start or end date, 2) what claims are considered as cost outliers, 3) what claims are considered as invalid for the episode due to missing data elements e.g. missing gender, missing costs.

b. Enrollment / Eligibility criteria: For each episode type we define the enrollment and eligibility criteria, so if a member has enrollment gaps then they are considered as having incomplete data and are dropped from the analysis.

c. Trigger rules and other exclusion criteria: For each episode type we define what claim type would be a valid claim to have the trigger codes present, determine if there are any trigger exclusions, how to treat emergency room claims, hospital deaths, cases that left against medical advice, age criteria, multiple of bilateral procedure exclusions.

d. Building the episode: All claims during the episode time window, for members that meet the inclusion criteria, are aggregated together to create the complete set of services within the episode. This includes inpatient facility
claims and associated inpatient professional claims (linked as +/- 2 days from the date of admission and discharge of an inpatient stay claim), outpatient facility claims, outpatient professional services, as well as claims for laboratory, radiology, and other ancillary services. Readmissions as well as associated admissions (including skilled nursing facilities (SNF) and home health (HH) claims) during the episode time window are also aggregated with the episode. Pharmacy claims are identified using a unique member identifier and aggregated within an episode based on the prescription fill date and logic to verify that it is a valid pharmacy claim for the episode time window. Claims with medical diagnosis or procedural codes for services not directly related to care for the index condition are excluded, as are claims for majorsurgical procedures which suggest that the index condition is at a differentacuity level requiring surgical intervention (e.g., coronary artery bypass graft in a setting of CAD or AMI). In such cases a procedural episode starts to keep the index episode more homogenous with regards to clinical as well as financial risk. Pharmacy claims with NDC codes not relevant to the episode are also removed. The remaining claims are considered “relevant” – and are separated into claims related to (a) typical care or (b) potentially avoidable complications (PAC) depending on whether they carry a PAC code in any of the diagnosis fields or had a procedure code that was related to services provided for a complication.

e. **Validity Testing:** After the episodes are constructed, the SAS programs are run on the developmental database and the outputs are taken back to the Clinical Working Groups and studied for 1) the number of episodes that were triggered as compared to the prevalence of the condition or procedure in the literature, 2) drops in counts at every level of the episode construction to look for significant loss in episode counts and any need to refine the clinical codes or the logic, 3) average episode costs as compared to that in the literature, 4) the typical costs and the PAC costs, and 5) the types of PACs, their frequency of occurrence and the costs associated with them. This enables a validity testing with both empirical and clinical feedback into the clinical logic as well as the episode construction process to decide if any changes should be made to the trigger definitions, exclusion criteria, assignment of codes, or the episode construction architecture itself.

There are currently 21 episodes in version 3.6. They are indicated below:

<table>
<thead>
<tr>
<th>ECR® Category</th>
<th>ECR® Description</th>
<th>ECR® Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>ChronicMedical</td>
<td>Asthma</td>
<td>ASTHMA</td>
</tr>
<tr>
<td>ECR® (CH)</td>
<td>Chronic Obstructive Pulmonary Disease</td>
<td>COPD</td>
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<tr>
<td></td>
<td>Congestive Heart Failure</td>
<td>CHF</td>
</tr>
<tr>
<td></td>
<td>Coronary Artery Disease</td>
<td>CAD</td>
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<td>Diabetes</td>
<td>DM</td>
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### Requirements

<table>
<thead>
<tr>
<th>Inpatient Procedural ECR® (IPP)</th>
<th>Hypertension Gastro-esophageal Reflux Disease</th>
<th>HTN GERD</th>
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<tbody>
<tr>
<td>Hip Replacement</td>
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<td>HIPR KNEE</td>
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<tr>
<td>Knee Replacement</td>
<td></td>
<td>CABB BARI</td>
</tr>
<tr>
<td>Coronary Artery Bypass Graft</td>
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<td>COLON</td>
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<tr>
<td>Bariatric Surgery</td>
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<tr>
<td>Colon Resection</td>
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</tbody>
</table>

| Inpatient Medical ECR® (IM)    | Acute Myocardial Infarction                | AMI PNE STR|
| Acute Myocardial Infarction   |                                            |           |
| Pneumonia                     |                                            |           |
| Stroke                        |                                            |           |

| Outpatient Procedural ECR® (OPP) | Coronary Angioplasty | PCI GALL HYST KNRP COLOS PREG |
| Coronary Angioplasty           |                    |           |
| Cholecystectomy                |                    |           |
| Hysterectomy                   |                    |           |
| Knee Arthroscopy               |                    |           |
| Colonoscopy                    |                    |           |
| Pregnancy and Delivery         |                    |           |

In addition to the above, the following additional Episodes area already defined for next version of ECR Analytics, and more are bring added every month.

- Hip Revision
- Knee Revision
- Knee Arthroscopy w ligament repair
- Knee Arthroscopy w/o ligament repair
- Metastatic Cancer
- Dialysis
- Transplant
- Laparoscopic Gallbladder surgery
- Upper GI endoscopy
- Valve replacement
- Low risk pregnancy
- High risk pregnancy
- Vaginal delivery
- C-Section

### 4. Risk-Adjustment Logic:
The goal of the modeling effort is to determine the extent to which the different types of variation that are embedded into any episode of medical care – the risks inherent to the patient and the risks imputed by providers in the management of the patient’s care – could be
sufficiently segregated to create clear and unambiguous accountability for the effective and efficient management of a patient’s care. For each of the episodes, we use “allowed amounts” as the dependent variable to create the episode predicted price. These are the pre-adjudicated costs that account for the reimbursable amount (the reimbursed amount plus the patient portion of costs) for all the claims selected as “typical” for the episode. Only “typical” claims are used for the modeling exercise to adjust for the warranted variation in costs related to patient characteristics. We do not use PAC claims for risk-adjustment because these are events and services that are unwarranted and we do not want to adjust away costs associated with these services. We create separate risk-adjustment models for up to three separate components based on the episode type: 1) inpatient facility, 2) outpatient facility, and 3) professional & other claims (here all other services are aggregated together for the purposes of modeling into one dataset containing inpatient professional, outpatient professional, pharmacy, lab, radiology and other ancillary claims). The results of the three models are then brought together as a complete predicted episode price.

This approach removes the incentive to provide care in a given location (inpatient vs. outpatient) and lets the provider choose the type and place of services that would lead to the most cost-effective care. In addition, there may be comorbid conditions that modify the costs of care in the inpatient setting that are different than the risk modifiers in the outpatient setting, hence the need for separate models. Moreover, the inpatient facility claims have their own coding rules and a hospital confinement often comes with a bundled cost (allowed amount) on a single line item, but risk factors and services on separate line items that provide a different challenge for modeling. On the other hand, the professional claims are individually available with cost and services on a line-by-line basis and can be linked using the member ID. In addition, we chose to use pharmacy data to adjust for severity, since we found in the claims data, physicians do not use diagnosis codes completely, so pharmacy data helped enhance the risk-adjustment process and capture additional comorbidities.

**Unit of Analysis:** The unit of analysis is the component of episode being modeled e.g. inpatient facility (stay model), outpatient facility, or professional, pharmacy and other services (PFO) model. It contains all “typical” claims that are relevant to that component of the episode. It is important to exclude claims for potentially avoidable complications (PACs) since costs related to these services should not have occurred and we do not want to adjust away or justify the occurrence of complications.

**Dependent Variable:**
The dependent variable is cost. We use the “allowed amount” field for costs since it usually represents the reimbursed amount to the providers along with the patient portion of the costs and
does not vary with the members benefit design or utilization of services. We remove outlier ECRs by truncating the selected claims at the 1st and 99th percentile value for costs. The distribution of cost was examined, and was transformed using the log transformation (Ln) to reduce the skewness in cost data.

**Independent Variables:**
A separate list of independent variables is created for each ECR specific to the severity indicators and comorbidities for the condition under study. The list of “risk factors” or “cost modifiers” consists of patient demographic factors, hospital or provider characteristics, geographic area indicators, comorbidities, procedures or diagnostic tests performed, and pharmacy variables to the extent this information is available in the database. Variables are often grouped together into relatively homogenous risk categories. Frequency of occurrence of variables often determines if the variable needs to be entered alone or should be combined with other variables to ensure they are not lost from the modeling exercise. A difference in cost using univariate analysis (with or without a variable) often determines whether a given variable will be presented to the multivariable stepwise analysis. The variables selected in the inpatient model may be different from those used in the outpatient model depending on the implications of each variable to cost in various settings. The statistical modeling determines whether or not a variable should be included in the final models.

**Statistical Methods:**
To measure the association between each categorical independent variable and cost, a bivariate analysis using the t-test (or analysis of variance (ANOVA) if the independent variable has more than 2 levels) was performed on Ln cost. Means, standard deviations and other descriptive statistics was transformed back and reported on the original scale. For the “typical” cases and services analysis, we used the ordinary least squares regression (OLS; also known as multiple linear regression) analysis for developing the ECR multivariable models. Multiple linear regression is a statistical method for measuring associations between a set of independent variables and a continuous outcome such as cost. This method has the following advantages: (a) widely used and accepted, (b) easy to understand, (c) relatively easy to explain to non-statisticians, (d) transparent, and (e) several different model selection methods are available in SAS (e.g. Schwarz Criterion, automated variable selection procedures such as stepwise).

**Model Selection Criteria:**
The question of which model is the “best” is often not a straightforward one. Generally, the “best” model is the one that strikes a balance between being clinically plausible, fitting the data well, and yet not being overly complex (i.e. not having a large number of parameters in the model). An effective model selection process is one that combines both clinical input as well as statistical evidence (e.g.
model building statistics). The process described below used a combination of clinical review and model building statistics. Variables are first examined univariately. Variables which are clinically plausible, have a minimum number of 30 cases per category, and the t-test p-value for the association between the variable and Ln cost was <0.5 are placed in the pool of candidate independent variables. Some of these candidate variables are reclassified as “force” variables, i.e. variables that should be in all models due to their clinical importance. Multiple linear regression with the stepwise variable selection procedure is used to select from the remaining candidates. The p-values to enter and exit the model are set at 0.05. The stepwise procedure works by fitting a model with only the forced variable in the model. Then the procedure computes an F statistic for each candidate independent variable. The F statistic is the F statistic that would be obtained if only that variable were added to the model. The variable with the lowest F statistic p-value that is less than 0.05 is put in the model, and then the model is refit. New F statistics are computed for the remaining candidate variables, and again the one with the lowest F statistic p-value below 0.05 is added to the model. This process continues until no other candidates have F statistic p-values <0.05. If, at any time during the process, the p-value for the F statistic of any variable in the model goes above 0.05, that variable is removed from the model unless the variable is a force variable.

The resulting model is reviewed for clinical plausibility. Variables are selected if they were clinically important, their coefficients are in the right direction and magnitude, and their variance inflation factor (VIF) is low suggesting no evidence of multicollinearity. The models are re-run with the selected variables. This process of model fitting, clinical review, and refitting is continued until a clinically plausible model is identified.

**Regression Diagnostics:**

Once a model is selected, the assumptions of the linear regression model are verified. As mentioned above, this model assumes that the errors, εi, are independent, normally distributed random variables with mean 0 and constant variance. Residual analysis was performed to verify these assumptions. If the residual analysis does not meet the linear regression assumptions, a Box-Cox transformation is performed on the data and the lambda that has the best regressions diagnostics is selected.

**Bootstrap Validation:**

The above model is run using stepwise selection with SLE (significance level for model entry) = 0.05 and SLS (significance level for staying in model) = 0.05 on 200 bootstrap samples, and a record is kept of how many times each variable is selected in the 200 model runs. A bootstrap sample is created by sampling with replacement from the full dataset until a sample of the same size as the full dataset is drawn. Any variables that were forced into the model above are also forced in the 200 bootstrap models. Any variable that enters into less than 160 bootstrap models (80% of the
Final Model:
Variables which do not consistently perform as significant predictors in at least 75% of the 200 bootstrap validations are dropped. The final step is to run the model cleanup algorithm as in Step 4 one last time. The reason for doing this is that removal of some variables may cause perturbations in the sign of other variables, if there exists some correlation between these variables. The resulting model is the final model.

Retransformation Bias:
Because cost is log-transformed before it is modeled, there is a bias that occurs when one tries to back-transform predicted LN(ALLOW) into the original units. This results in systematic underpayment and the cumulative effect can be substantial. For this reason a Bias Correction Factor (BCF) is calculated as the ratio of the total actual costs in dollars (of all patients that went into the model) to their predicted costs. Multiplying the predicted cost by this BCF assures that there will be no systematic under or over-prediction of cost on the user’s data set.

5. Pricing the Base Services (Core Pricing):
A foundational element of Prometheus is that the base set of services should include all the services that are recommended by Clinical Practice Guidelines or expert opinion as laid out by the Clinical Working Groups. For chronic conditions, such core services were listed with input from Clinical Working Groups and their costs estimated. A “gaps-in-care” analysis is performed on a patient-by-patient basis to study the underuse of core services and to identify the gaps in care-coordination. This kind of analysis could be an add-on to the logic to understand variation in costs of “typical” care with regards to underuse.

6. Limitations of Episode Construction and Risk-adjustment analysis:
1. Models are only as good as the data.
2. We’re using claims data from specific populations to estimate costs which will possibly be used for other populations. These cost estimates may not apply to all populations.
3. Claims data are messy with incomplete or incorrect diagnosis codes being used an there is limited clinical information that can only be obtained through patient chart reviews such as information on body weight, BP, smoking status etc.
4. Socio-economic and other factors such as educational level, family support, access to healthcare etc., which may impact costs are not available in most administrative databases but are very important for severity adjustment.
5. Laboratory data is not available to us – it has been shown to add a lot of value to administrative data for risk-adjustment purposes to assess the severity of a patient’s disease.

7. Limitations of Clinical Guidelines:
Work to date suggests clinical guidelines are necessary, but not always sufficient, to create a base ECR. Guidelines can use language that defers to a doctor's discretion, such as, "Use treatment X, when appropriate." This can make it difficult to determine the resources necessary to provide recommended care. Where the best available evidence or expert consensus does not provide sufficient information, empirical data must be used to fill in knowledge gaps. In these cases, data modeling will help to determine where ECRs can provide sufficient flexibility to physicians without having significant impact on the final episode price. For example, clinical guidelines are often not specific in detailing the amount of case management and follow-up required to treat a given condition. However, if the final episode price is not sensitive to wide variation in follow-up time, this becomes much less of an issue. Alternatively, examining cost data with high compliance rates may show a more consistent approach to case management as done by best-practice providers.

8. SAS package (SAS software): The clinical logic as depicted by the SAS Metadata, the episode construction logic in the form of SAS programs and macros as well as the logic for risk-adjustment has been assembled in a SAS package that has been made available in part as a free-ware downloadable from the website www.hci3.org. The complete SAS packages are available on signing of a licensing agreement ensuring that data sharing happens among users.

(b) Willingness to publish the details of these episode to the provider community:

SAS agrees that all episode definitions and associated episode related logic will be published to support transparency of review by the provider community.

4.2 Component B: Administration/ infrastructure:

- Experience executing technical episode algorithms (designed internally and/ or by 3rd parties) and input results to payment system of record
  More than 5 years experience as national leader in piloting episode algorithms and inputing results into payment system of record.
Experience generating reports that highlight performance and define payment (batch / realtime)
Standard reports are provided with ECR Analytics and have been used by early adopters (commercial plans and the providers they are contracting with).

Integrating non-claims data into episode algorithms
All experience to this point has been based on using claims data in episode algorithms but we plan on supporting selected non-claims data in future releases.

Administering rewards payments and penalties
HCI3 have had more than five years experience working with Commercial Health Plans and Providers in administering shared savings payment incentive models. HCI3 will continue to provide guidance to ECR Analytics customers based on the experiences of best practices that they have seen at early adopter sites.

Please describe your proposed timeframe and capacity to scale up to reach 75%+ of medical spend within the next 3-4 years
New episode definitions will continue to be added on a regular basis over the next 2-3 years, with a target of covering sufficient episodes to account for 80%+ of Medicare. As a by-product of HCI3’s recently awarded contract with CMS for “Episode Grouping for Physician Fee Schedule Adjustment”, there is funding to develop sufficient episodes to cover 80%+ of Medicare spending. The funding to define these episodes is part of the contact awarded by CMS. We have a contractual agreement that HCI3 will provide those episodes to SAS on a timely basis as they are developed.

Number of Implementations of ECR Analytics v3.6
There are currently 16 active customers with four active PROMETHEUS pilot sites in Minnesota, Pennsylvania, Illinois, and Michigan with two other sites coming on board in Colorado and New York. Each site is working towards reducing the rate of potentially avoidable complications (PACs), promoting a patient-centered environment, and helping providers act as a team.

Although there are a number of flexible ways to implement the PROMETHEUS ECR methodology, in most sites, incentives are offered to providers and health systems in the form of bonuses paid at the end of the year to those clinicians who come under their ECR budgets and deliver quality care to
patients. **Bridges to Excellence** (BTE) Care Recognition Programs are an important aspect of PROMETHEUS implementations. Each implementation site selects one or more BTE Care Recognition Programs that support quality reporting for corresponding ECRs, and for which clinicians must submit clinical data.

**SAS ECR Analytics Functionality**

SAS ECR Analytics is founded on the PROMETHEUS Payment system. PROMETHEUS Payment is a package, or bundled fee payment system centered on a comprehensive episode of medical care that covers all patient services related to an illness, condition, or procedure. PROMETHEUS Payment addresses a full range of issues that can drive profound long-term, system-wide improvements including:

- Fair compensation of providers – and rewarding excellence by allowing top performers to earn more,
- Offering direct and powerful incentives for providers to deliver greater value and better outcomes,
- Encouraging caregivers to work in teams, share information, and take collective responsibility for a patient’s health,
- Providing a realistic framework to transform today’s fragmented and inefficient system into one that is far more integrated and accountable.
SAS Corporate Overview

Headquartered in Cary, North Carolina, SAS is the largest privately held software company in the world with record 2011 annual revenue of $2.725 billion. We have been in business for 36 years and our longevity is a testament to our superior software and customer service. Our mission is to deliver software and services that give people the power to make the right decisions.

As the leader in business analytics, SAS helps organizations understand their business drivers and create answers to complex problems. SAS eliminates the complexity of sharing data and applications across the organization. SAS goes beyond other vendors’ narrow definitions of business intelligence, offering business analytics—data management and predictive analytic capabilities that tell an organization not just where it has been, but where it should go next. SAS business analytics deliver the foresight and understanding that is required to meet and exceed goals.

Founded in 1976, SAS serves more than 55,000 government, university, and business sites in 129 countries. SAS solutions are used extensively by all 50 state governments, all 15 federal departments and approximately eighty-five percent (85%) of federal sub-agencies and quasi-governmental affiliates. Ninety percent (90%) of the overall Fortune 500 are SAS customers.

For more than three decades, SAS has delivered the latest technology to our government customers, taking their operations to new levels. Our U.S. state and local government practice helps state government agencies meet their missions and goals faster and more accurately than ever before. We want to be the most valued competitive weapon in government decision making.

The world’s largest privately held software company

Beyond business intelligence

Extensive government experience

Dedicated state and local practice