Patient-Centered Care: What Factors Drive Outcomes in the Hospital Setting?

Section 1: Specific Aims: It is essential that policymakers, hospital leaders, and hospital patients and providers understand the implications of patient centered care in the hospital setting. Current legislation dictates that hospital reimbursement, in part, will increasingly be driven by high performance results on patient satisfaction and patient process measures. However, there is little comprehensive data that allows the study of patient satisfaction and process measures in the hospital with other critical aspects of the hospital's market, structure, and outcomes and that controls for different patient characteristics.

Our project goals are to build a unique national hospital database centered on the patient's care experience for all acute hospitals in 14 states and evaluate the validity and strength of the relationships among hospital measures of patient-centered care (PCC), hospital processes, and various clinical and resource outcomes. We will approach the issue of PCC from a variety of disciplinary perspectives, represented among our research team, while simultaneously engaging stakeholders in the hospital sector. To accomplish this we have targeted several specific aims:

Specific Aim 1: Build a database that links, by hospital, two-years of patient data from multiple national datasets on a comprehensive mix of market, structure, process, patient satisfaction, and outcomes data. These datasets are: (1) H-CAHPS survey results on patient satisfaction scores, process measures, and 30-day mortality for AMI, heart failure (HF), pneumonia, and surgical care; (2) corresponding AHRQ-SID hospital treatment data for all the acute hospitals in 14 states and detailed information on the patient's outcomes and their race/ethnicity, age, gender, chronic conditions, and severity of illness; (3) American Hospital Association's (AHA) Annual Survey with details on the structural and process characteristics of study hospital; (4) AHA Survey of Electronic Health Record (EHR) Implementation reflecting the extent of hospital implementation of EHRs; and (5) data from the HRSA's Area Resource File (ARF) with hospital market data on the hospital's environment.

Specific Aim 2: Test the representativeness of the resulting database and report results on the PCC measures in relation to the hospital's structural, process, patient, and outcome measures.

Specific Aim 3: Use the data to evaluate four high priority areas of national interest:

Sub Aim 3a: How do hospital PCC measures correlate with hospital process measures and hospital costs and clinical outcomes?

Sub Aim 3b: How are hospital PCC measures influenced by the patient's race/ethnicity, age, gender, chronic conditions, and severity of illness?

Sub Aim 3c: What are the relationships between hospital PCC measures and the implementation of the electronic health record (EHR)?

Sub Aim 3d: What are the potential implications for PCC of the incentive payments in the Hospital Value-Based Purchasing legislation that is scheduled to begin in 2013?

The proposed study would create a research resource that could be used to test many different hypotheses related to measuring, monitoring and improving the patient centeredness of hospital care in this country. Such a dataset could be a powerful tool for policy makers and researchers as well as a data-driven source to inform diverse stakeholders and to organize and incorporate their feedback. To our knowledge, no such national database exists. In addition, we will facilitate an iterative 'share and revise' model of research where an established and engaged "roundtable" of 25 of the nation's thought leaders and organizational decision makers review our findings and provide feedback. This group of stakeholders, organized at Stanford University by our collaborator, Dr. Arnold Milstein, was created to accelerate the discovery of healthcare service innovation that improves the value of care via exceptional patient experience, transforming the human experience in healthcare. This iterative research approach will ultimately result in dissemination of our findings in a series of practitioner-professional meetings as well as peer-reviewed published articles, so that the PCC insights generated from our study can permeate both the practice and research world.

Section 2. Research Strategy

2a. Significance

The context in which hospitals provide high quality patient services is intense. In 2009, there were 35.5 million inpatient admissions to 5,008 community hospitals at a cost of $656 billion and the average profit margin was 5%.[1] However, many hospitals struggle to balance multiple missions including outstanding patient service, teaching, and community service.[2] A national survey of healthcare executives indicates that high on the list of problems facing hospitals are: financial challenges, healthcare reform implementation, government mandates, and patient satisfaction.[3] Faced with soaring costs and intense competitive pressures, hospitals are struggling to remain financially viable while providing high quality patient care.[4-7]

In an effort to attract patients through improved patient experiences many hospitals have been turning to patient centered care (PCC).[8-13] PCC has been broadly defined as "health care that establishes a partnership among delivery systems, practitioners, patients and their families to ensure, when appropriate, that decisions respect patients' wants, needs and preferences and the providers solicit patients' input on the education and support they need to make decisions and participate in their own care."[14] There is a growing body of research which has indicated that PCC has important benefits for patients through improved communication, more appropriate interventions, enhanced satisfaction, and better reported outcomes.[15-40]

However, to date, little research has focused on the hospital setting and hospital structural and process variables and linked them to PCC and the patients' care experiences.[41] Such research is critical to answering both PCORI's questions – "Given my personal characteristics, conditions, and preferences, what should I expect will happen to me?" And "How can the health care system improve my chances of achieving the outcomes I prefer?" Central to answering these questions is - how do our nation's 'health care system' leaders and decision makers evaluate and balance PCC initiatives with other critical aspects of running their organization. This dearth of PCC research at the macro hospital level stands in sharp contrast to a growing emphasis on patient-level research. This contrast is even sharper given the approaching deadline in The Patient Protection and Affordable Care Act of 2010 (PPACA) legislation that will start value-based reimbursement to hospitals in 2013, in part, tied to their scores for patient satisfaction and process measures for selected clinical measures.[42]

Key questions about the impact of PCC have not been sufficiently addressed to predict the success of the new legislation. Unanswered questions include: (1) Do hospitals with higher PCC scores have better objectively measured clinical outcomes than hospitals with lower PCC scores?; (2) If there is a concordance between PCC scores and clinical outcomes, to what extent does each PCC factor impact clinic outcomes on the margin? For example, which is more important, a good nursing PCC communication score or a good physician score, or are they complementary? (3) Is there a consistent relationship between good PCC scores and high evidence-based process measure scores? (4) To what extent do PCC scores vary by hospital ownership, religious affiliation, teaching status or level of market competition? and (5) What is the relationship between PCC and the nation's efforts to implement an electronic medical record? Moreover, while there has been research tying together perceptions of care to demographic factors, in particular, race,[43] to our knowledge, there are no major studies of PCC that link inpatient characteristics (e.g. - age, gender, race/ethnicity, insurance, chronic conditions, etc.) to PCC and hospital outcomes such as in-hospital mortality, 30-day mortality, hospital readmission, and resource use. Given wide disparities in health care outcomes, it is essential for clinicians, administrators, and policymakers to understand how the concordance (or discordance) between PCC measures and objective clinical outcomes differs by race and other patient related characteristics.

To model this 'broader context,' we rely on a well-established organizational framework that models a hospital's environment and market characteristics as influencing a hospital's structures and processes which, in turn, impact a patient's experiences and outcomes.[44-50] Each of the elements of this model can play an important role in influencing the patient's satisfaction and clinical outcome. By developing and linking critical variables for multiple dimensions of PCC across four clinical treatments (AMI, HF, pneumonia, and surgical care), we will describe the relationship among PCC indices and outcomes. Moreover, through an iterative stakeholder discussion process, we will test different hypotheses on how to measure, monitor, and improve the patient centeredness of hospital care.

We want to be clear, our intent is not to perform clinical effectiveness research (CER), but to build a national database that links PCC to real treatment patterns and outcomes and discusses with a group of active hospital stakeholders the resulting relationships in order to draw implications for the measurement of PCC and its use in their organizations. These four treatments are central to the national discussion about PPACA implementation but common in every hospital and very important to our stakeholders. We aim to bring together an outstanding research team with engaged stakeholders to build and evaluate a hospital PCC database that allows us to describe and evaluate key PPC relationships and inform the nation.

2b. Patient/Stakeholder Engagement

We will utilize a collaborative team of researchers and practitioners that represents a non-traditional group of partners to assist us in interpreting, translating, and disseminating our research findings into practice. One of our consultants, Dr. Arnold Milstein, has formed such a collaborative and recently hosted a meeting - 'Discovering Causes and Consequences of Exceptional Patient Experience of Care' - in September 2011 at Stanford University. This collaborative brings together more than 25 of the nation's leading Chief Experience Officers (CXO), researchers and others who are focused on transforming the human experience of health care. (The agenda and participants at the meeting are listed in Section 7 in the Resource Sharing Plan.) The meeting participants represented a mix of hospital stakeholders from different regions, types of health care facilities, and responsibilities. Many of the participants will have a role in understanding and improving PCC at their hospitals and especially the financial implications of the recently enacted value-based incentive reimbursement in PPACA.[42]

At our two-day meeting, specific concerns were raised about the role PCC would play in different types of hospitals and the relationship of PCC to other clinical processes and outcomes. Three broad questions were raised that warrant further research and collaboration with CXOs: (1) What is the relationship among hospital process, satisfaction, and clinical outcomes for different groups of patients and how are they linked especially to cost/resource use? (2) How is PCC impacted by Electronic Health Records (EHR) implementation? Several participants suggested that they thought EHR implementation might actually be a deterrent to patient satisfaction because it potentially limited the need for patient/provider communication. (3) How does PPACA, which includes the Hospital Consumer Assessment of Healthcare Providers and Hospital System Survey (H-CAHPS) in calculating value-based incentive payment impacts their organizations?

These questions go to the heart of the PCC implementation and the issues of concern to their hospital leaders and managers. Our collaboration of stakeholders represents a group of hospital leaders that will direct and manage the translation of federal mandates under PPACA into PCC practice in their organization(s). They are struggling to put their organization's efforts into the broader national context and to validate the importance of the measures in the final legislative rule.[42] Our project will build this 'broader context' and enlighten our stakeholder group but we also seek to translate our research and inform the broader hospital leadership community as well. To do this, we will engage in an iterative 'share and revise' model of research and

disseminate our findings in a series of practitioner/professional publications as well as peer-reviewed published manuscripts.

2c. Innovation

There are several innovative aspects in our proposal. First is the novel way in which we will aggregate patient specific data for two-years in a large national hospital database from different sources: H-CAPHS, AHRQ-SIDs, AHA Annual Survey, AHA EHR Implementation Survey, and HRSA-ARF - to link key indices of PCC with market, structural, process, patient, and clinical outcome measures at the hospital level (defined below). Specifically, we will link data from the 2009 and 2010 H-CAHPS data on patient satisfaction for four clinical treatments (AMI, HF, pneumonia, and surgical care) with corresponding clinical data on hospital evidence-based process measures, patient characteristics and clinical outcomes from the 2009 and 2010 HCUP-SID data. This will give us a unique and powerful database to assess relationships among key variables and test the consistency among our findings. To our knowledge no one has linked PCC and hospital level data on comprehensive set of process measures, electronic health records and patient clinical outcomes with accompanying patient characteristics like race/ethnicity, age, gender, chronic conditions, and severity of illness.

Another innovative aspect of our proposal is the ability, noted above, to engage a unique group of stakeholders who are national thought leaders as well as decision makers in their own organizations. Many of these stakeholders are on the frontline of the application of PCC ideas and processes in their organizations and are keenly interested in how the new PPACA legislation[42] will impact their organization(s). Their background and 'real world' experience to critically judge different aspects of PCC will provide invaluable feedback and help us blend 'academic rigor' with 'real world' experience.

Finally, a potentially important aspect of the database is that once it has been tested and evaluated, it can be expanded over time and as additional PCC, process, and outcome measures become available these can be added. Thus, we will be able to longitudinally analyze how changes in the variables and legislation potentially impact patient satisfaction and clinical outcomes for a broad range of medical and surgical conditions.

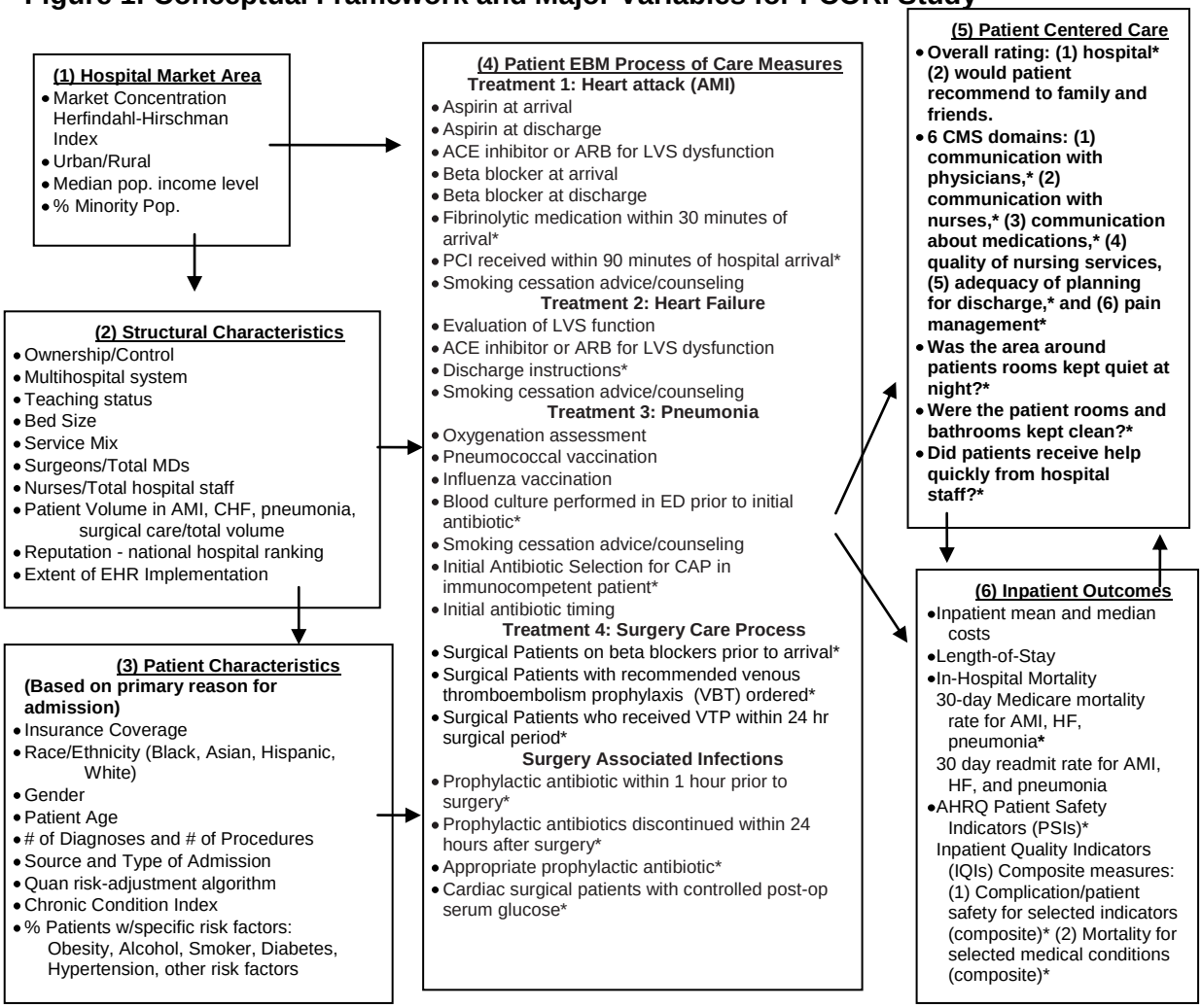
2d. Approach

2d.1 Overall Study Strategy: As outlined in our model below the causal pathway is from hospital's environment/market > structure and process > patient experiences > quality and cost of clinical treatments. Our strategy involves building a PCC database at the hospital level that represents important constructs of the model for each of four treatments. For each of these four treatments, as shown in Figure 1, we will include variables that reflect critical aspects of the hospital's environment or that control for important (confounding) aspects of the patient centered care experience in the hospital. The core of the data base, the PCC measures, is shown in Figure 1, section 5. These PCC reflect a range of patient satisfaction scores with different aspects of hospital treatment for each of the four study treatments and represent the actual patient satisfaction measures that will be used to determine hospital reimbursement under the PPACA.[42] Variables for other components of the model – are also shown in Figure 1, sections 1, 2, 3, 4, and 6, respectively.

For each study hospital, we will build a database around the hospital specific responses in the H-CAHPS data for each of the four treatment conditions. This will allow us to evaluate the consistency of patient satisfaction with hospital use of evidence–based processes for very different clinical conditions and, in turn, with the patients' outcomes within each treatment.

The sources of the data and variable descriptions in each aspect of the hospital are briefly described below.

Figure 1: Conceptual Framework and Major Variables for PCORI Study



* Measures are part of Hospital Inpatient Value-Based Purchasing Program Final Rule[42]

2d.2 Data Sources: The core of the database will be the inpatient data from the Hospital Quality Alliance (HQA) collaboration. HQA is a public and private partnership which includes CMS and the Joint Commission and is leading the effort in the hospital sector to monitor and report on hospital quality measures from the patient's perspective through the **CAHPS Hospital Survey (H-CAHPS)**. It is the first publicly available, standardized survey designed to gather information from adult inpatients about the degree of their inpatient centered care experiences. The National Quality Forum (NQF) formally endorsed the H-CAHPS survey in 2005, representing the consensus of many health care providers, consumer groups, professional associations, purchasers, federal agencies, and research and quality organizations.[51,52] The HCAHPS survey contains 18 patient perspectives on care and patient rating items that encompass eight key topics: 1) communication with doctors, 2) communication with nurses, 3) responsiveness of hospital staff, 4) pain management, 5) communication about medicines, 6) discharge information, 7) cleanliness of the hospital environment, and 8) quietness of the hospital environment. The H-CAHPS data also contains scores for the evidence-based process measures at each hospital. We will link the overall and treatment specific scores by hospital.

Table 1. Variation in 2009-2010 facility level HCAHPS (% of patients answering yes at the facility)

PCC Questions:	Mean	Min	Max	75th %tile	95th %tile	St dev	Count
YES' patients would definitely recommend the hospital	68.7	2.0	98.0	75.0	85.0	10.3	4,474
Doctors "always" communicated well	80.0	30.0	100.0	83.0	89.0	5.6	4,474
Nurses "always" communicated well	75.2	38.0	100.0	79.0	85.0	6.3	4,474
Pain was "always" well controlled	68.8	33.0	96.0	72.0	78.0	5.6	4,474
Patients "always" received help as soon as they wanted	63.2	18.0	98.0	69.0	79.0	9.2	4,474
Room was "always" clean	70.4	4.0	100.0	76.0	85.0	8.2	4,474
Staff "always" explained	59.6	15.0	89.0	63.0	71.0	6.5	4,474
Yes, staff "did" give patients this information	81.1	41.0	99.0	85.0	89.0	5.3	4,474
"Always" quiet at night	57.4	29.0	100.0	64.0	75.0	10.5	4,474

To augment the database, we will add data on the hospital's market area, structure, processes, and outcomes from the following data sources. The first, the **Healthcare Cost and Utilization Project (HCUP)** is a family of health care databases developed through a Federal-State-Industry partnership sponsored by the Agency for Healthcare Research and Quality (AHRQ). HCUP includes the largest collection of longitudinal hospital care data in the United States, with all-payer, encounter-level information beginning in 1988. We will use these databases to link in data on cost and quality of health services, medical practice patterns, access to health care programs, and outcomes of treatments at the local hospital market level. The **HCUP State Inpatient Databases (HCUP-SIDs**), a 100% discharge abstract data system, contains more than 100 clinical and nonclinical variables such as: principal and secondary diagnoses; principal and secondary procedures; admission and discharge status; patient demographics (e.g., gender, age, and, for some states, race); expected payment source (e.g., Medicare, Medicaid, private insurance, self-pay); total charges; and length-of-stay.[53,54]

The **2009 and 2010 AHA Annual Survey Databases** have more than 700 fields of data for over 6,000 hospitals representing 98% of all short-term general acute hospitals in the US. It includes demographic information, organizational structure, facilities and services, utilization data, community orientation indicators, physician arrangements, managed care relationships, expenses and staffing.[55,56] The **2007 and 2011 AHA Electronic Health Record Database** reports data on the 2006 and 2009 EHR implementation status, respectively, of the nation's hospitals and has data on dozens of indicators that illustrate the depth and level of technology integration. It documents the implementation of 4 subsystems: (1) electronic clinical documentation: physician & nurse notes, medication lists; (2) results viewing: lab & radiology reports, radiology images; (3) decision support: drug alerts, clinical reminders; and (4) bar coding: patient ID, lab specimens, and pharma tracking. AHA EHR data also notes the presence or absence of 32 clinical functionalities of an electronic record system, and whether the hospital: (1) had fully implemented these functionalities in all major clinical units,(2) had implemented them in one or more (but not all) major clinical units, 3) began implementation in at least one unit, 4) had resources for implementation in the next year, 5) did not have resources but was considering implementation, or 6) did not have resources and was not considering implementation.[57-59]

Two variables are critical for our study: (1) a hospital identifier which is needed to link the databases and (2) race/ethnicity. There are 14 states which have both a hospital identifier and race/ethnicity in 2009 and 2010 and will be included in our database. These states are: Arizona,

Arkansas, California, Colorado, Florida, Iowa, Maryland, Massachusetts, New Jersey, New York, North Carolina, Rhode Island, Utah, and Wisconsin. We can link all the variables in Figure 1 (discussed below) for the 1,595 hospitals in these 14 states. The resulting database would represent 31% of all hospitals nationally and 42% of inpatient discharges in 2009.[54]

Finally, we will use a non-hospital source, the **Area Resource File (ARF),** containing more than 6,000 variables for each of the nation's counties and available from the Health Resources and Services Administration (HRSA) to link data on health facilities, health professions, measures of resource scarcity, population health status, area economic activity, health training programs, and socioeconomic and environmental characteristics of the hospitals' county.[60] These data sources will be used to create the following variables discussed below.

2d.3 Variable Construction

2d.3.1 Hospital Environment/Market Area (Figure 1, Section 1): **Market Structure and Concentration:** An extensive empirical literature exists that examines the effects of hospital competition on the cost, access, patient satisfaction, and quality of hospital services. These studies typically find statistically significant effects.[61] We will use AHRQ's patient flow measure (patient's origin) to create our hospital markets because it lends itself to the idea that patients opt for the 'best' facility for their medical circumstances. We will use the Herfindahl-Hirschman Index (HHI), where the HHI is calculated as the sum of the squared market shares for all hospitals in the local market, as our market competition measure. E-mail correspondence with AHRQ (Drs. Irene Fraser and Herb Wong) indicates that the HHI will be available by the end of 2011 for the years 2006 and 2009. **Urban/Rural** is an area indicator reflecting population density. **Median Market Area Population Income:** Median population income levels provide an indicator, consistent with the competitive market model of how 'attractive' the population might be. Where hospital areas overlap various counties, we shall use the zip codes to weight median income by the population totals for the overlapping areas. **Percent Minority Population in Market Area:** We will use minority population as a share of the total population as another descriptor of the hospital's market area.

2d.3.2 Hospital Structural Characteristics (Figure 1, Section 2): **Hospital Ownership/Control:** Ownership/control definitions for short-term community hospitals will be consistent with AHA definitions[62] and we will use for-profit; private, not-for-profit, and government hospital designations. These distinctions represent important variations in Medicare costs, access, and outcomes. We will also note hospitals that are part of a **multihospital system. Teaching Status:** Hospital teaching status will be determined from AHA data and described by three binary variables: (1) hospitals with at least one approved residency program but no medical school affiliation; (2) hospitals with a medical school but not a member of the Council of Teaching Hospitals; and (3) hospitals that are members of the Council of Teaching Hospitals. This construction expresses teaching in terms of the level of teaching commitment and has been used extensively and effectively in our past research.[63-65] **Hospital Bedsize:** Hospital bedsize is a continuous variable and indicates the size of the hospital. We shall use bedsize categories to capture differences in hospital scale and the importance and complexity of size; this permits a nonlinear size effect on the dependent variables.[63,64] **Service Mix:** Typically, organizational studies differentiate hospitals based on their complexity and the degree to which they differentiate various products.[66-72] The AHA lists approximately 90 services staffed and supported by a hospital including: obstetrical care, cardiac intensive care, burn care, rehabilitation care, pediatric cardiac surgery, chiropractic services, dental services, and geriatric services, For each hospital, we will develop a service mix measure based on the number of services provided. Hospital staffing in the respective treatment area may be critical to different aspects of patient satisfaction and we will include measures of potential provider availability and accessibility for each hospital for the respective treatment: **percent MDs/total MDs** in the respective treatment area and **percent RNs/total medical staff** in the respective treatment area. **Patient Volume:** We will estimate for each hospital the mix of patients (and hospital

volume) that are AMI, HF, pneumonia, and surgical care inpatients to gauge the importance of each of the four treatments in the hospital's 'book of business.' We hypothesize that hospitals with higher volumes of patients in each of these respective treatments, all things being equal, would have higher levels of patient satisfaction, higher scores on patient process measures, and better outcomes. **Hospital Reputation**: Top ranking as a cardiovascular disease or surgical hospital by the 2009 *U.S. News and World Reports* or some such popular ranking will be used to reflect hospital quality. It could reflect what the 'public' or prospective inpatient might know about the hospital's quality before their treatment/surgery and be a guide to their selection of a particular hospital. **EHR Implementation**: The 2007 and 2009 EHR database would allow us to initially create an EHR Implementation variable based on the extent of implementation at the hospital in two different years – full implementation, partial implementation, etc. - and use these two points in our initial analysis. However, we would also evaluate other aspects of the EHR subsystems to see if their differentiation made a difference in PCC satisfaction.

2d.3.3 Inpatient Characteristics (Figure 1, Section 3): **Insurance Coverage**: Share of patients who are insured by Medicare, Medicaid, private/HMO insurance, self-pay, no insurance and other insurers (which include payers like worker's compensation, CHAMPUS, and other government payers). **Race/Ethnicity**: Six racial/ethnicity distinctions would be included: 1) white, 2) black, 3) Hispanic, 4) Asian or Pacific Islander, 5) Native American, and 6) other. Our previous research with HCUP has shown that the Native American and other variables are typically quite small so we would need to evaluate their cell sizes to ensure their inclusion would be meaningful.[73,74] **Gender:** Male and female inpatients will be distinguished. **Age:** Age is a continuous variable on the HCUP-SID files. **Number of Diagnoses and Procedures:** Numbers of diagnoses and procedures represent important information about the potential severity of the admission and the 'casemix' of the hospital. **Source and Type of Admission:** Source of admission - (1) emergency room, (2) another hospital, (3) long-term care facility and (4) routine, and the type of admission - (1) elective, (2) urgent, and (3) emergency and our prior research are significant predictors of costs and outcomes.[75] The ability of hospitals to differentiate these groups could be an important source for understanding the patients' AMI and HF experiences. **Inpatient Comorbidities:** ICD-9 coding permits the identification of a wide range of comorbid conditions. We have used a wide variety of these in our past HCUP-NIS investigations and we would potentially use these to identify major comorbidities in our HCUP-SID sample.[75,76] Comorbidities for each treatment condition – AMI, HF, pneumonia, and surgical care – would be included if they were either clinically relevant or represented some statistical minimum, perhaps 1% or 2% of the population. Inpatients that had major risk factors - obesity, alcohol dependence, smoker, diabetic (insulin and non-insulin diabetics), or hypertensive - would be included. In addition to these patient specific comorbidities, we shall add the **Quan risk-adjustment algorithm** for hospital patients[77] and the HCUP **Chronic Condition Indicator** (CCI) which allows users to categorize ICD-9-CM diagnosis codes into chronic or not chronic condition.[78,79] The CCI also groups all diagnoses into body systems so that users can create indicators listing which specific body systems are affected by a chronic condition. Both these approaches – Quan and CCI – are based on data available in HCUP - ICD-9 coding - and will be developed for each inpatient and tested for explanatory power, and other methodological issues like collinearity.

2d.3.4 Patient Process Measures (Figure 1, Section 4): HQA provides data on the compliance of hospitals with 24 patient measures of evidence-based processes of care for our four study conditions. These measures have been extensively described and refined in the literature[80] and we won't discuss them further here. The starred variables in Figure 1 are the PPACA final measures for fiscal year 2013 value-based purchasing (VBP) program.[42] As shown in Figure 1, there are several additional process measures that were developed and available from H-CAHPS but not used in the final rule. CMS explains that analysis that utilized both a truncated coefficient of variation approach and alternatively showing whether hospital performance was at the 75th and 90th percentiles was statistically indistinguishable led to

several measures meeting their definition for being topped-out. CMS felt their use might mask true performance differences among hospitals. We would propose to leave them in our analysis and compare their performance relative to the final process measures.[81]

2d.3.5 PCC-Patient Satisfaction Measures (Figure 1, Section 5): The H-CAHPS survey asks patients 27 questions about their experiences in the hospital and about their demographic characteristics. Responses to 14 of the questions (possible responses: always, usually, sometimes, and never) are summarized by CMS and reported in 6 domains in Figure 1 (section 6) as composites: (1) communication with physicians, (2) communication with nurses, (3) communication about medications, (4) quality of nursing services, (5) adequacy of planning for discharge, and (6) pain management. There are two questions about the overall rating of the (1) hospital and (2) whether the patient would recommend the hospital to family and friends. In addition, the H-CAHPS ask three questions about patient satisfaction with their stay: (1) How often was the area around patients' rooms kept quiet at night? (2) How often was the patients' room and bathroom kept clean? And (3) How often did patients' receive help quickly from hospital staff?[82]

We will use the 2009 and 2010 (8 quarters of data) H-CAHPS patient satisfaction scores for AMI, HF, pneumonia, and surgical care to build our dataset. This data is publically available on 3,827 community hospitals in 2009 (4,474 in 2010) and represents 2.7 million completed patient surveys from across the country in 2009. Table 1 contains the range of scores for some of the major satisfaction variables, which show significant variation for these measures across hospitals.

2d.3.6 Patient Outcome Variables (Figure 1, Section 6): The **inpatient median costs**, **30-day Medicare mortality rates** for AMI, HF, pneumonia, **30 day readmit rates** for AMI, HF, and pneumonia, **AHRQ Patient Safety Indicators** scores (PSIs), and the Inpatient Quality Indicators (IQIs) composite measure for (1) **Complication/patient safety** (composite). (2) **Mortality for selected medical conditions** (composite) are all aggregated from H-CAHPS data as reported in each quarter.[80,82] The inpatient mean costs for each treatment calculated from hospital charges (adjusted with the hospital's cost-charge ratio),[83,84] length of stay, and inpatient mortality rates for all four measures in our study come from aggregated AHRQ-SID hospitals.

All the variables in Figure 1 are readily available from their organizational sources and team members have used all these variables before with the exception of the HQA measures but we've never had the opportunity to study them in the proposed configuration. Greater detail on many of these variables are described in the HCUP-SID documentation and/or our previous HCUP, AHA, ARF studies.[63-65, 73-76, 85-97]

2d.3.7 Analytic Strategy: Our overall strategy will be a two-pronged approach, both a hospital and patient-based analysis, to address the concordance between objective clinical outcomes and PCC measures. Since the data listed in Figure 1 and described in detail above are mostly measured at the hospital level (sections 3 & parts of 6 excepted), our first approach will be to aggregate the HCUP-SID individual patient level data to the hospital level focusing on the specific patients being treated for each of the three conditions or undergoing surgery. We will then estimate equations of the following form:

$$PCC_{j,t} = \beta_0 + \beta_1 * C_{j,t} + \beta_2 * D_{j,t} + \beta_3 * H_j + \beta_4 * M_{j,t} + \varepsilon_{j,t} \quad (1)$$

Where PCC will be patient centered care outcomes (i.e. overall rating, or percentage of individuals who would recommend to family and friends) for the four specified patient sub-groups measured at hospital j in year t (or quarter for relevant analyses), C is a vector of objective clinical outcome measures at hospital j in time t (such as inpatient mortality, readmission, proportion admitted from home and discharged to places other than home, etc) **(see 2d.3.6),** D is a vector of the proportion of individuals treated at hospital j in year t who have certain characteristics (i.e. racial/ethnic composition, gender composition, age composition of patient population served), H is a vector of hospital characteristics as listed in Figure 1, section 2 (for example size, ownership status, freestanding or system linked, staffing, whether

they implemented EHR, financial health, etc), and importantly, whether they followed evidenced-based processes for each condition. Finally, M is a vector of market characteristics in which the hospital operates (HHI, rurality, population income levels, proportion of patients covered by public versus private insurance, etc).

This approach means HCUP-SID patient level data needs to be aggregated to the hospital level. To do this, we would select only those patients for a given condition based on their primary reason for admission during one of the eight quarters of 2009 and 2010 when they were surveyed by H-CAHPS and linked to the quarter when they were being treated in the hospital. This would insure that H-CAHPS data were linked appropriately with the corresponding treatment condition at the surveyed hospital. AHRQ has developed the clinical classification software (CCS) to facilitate the accurate identification of procedures and diagnoses and we would use their definitions of each of the four study treatments.[98]

While we are including a broad array of hospital and market characteristics, there could still be unobserved factors that drive any association between our clinical outcome covariates, denoted in equation 1 by C, and the PCC outcomes. As such, the above equation will be estimated using both hospital random effects models in an attempt to get estimates of the impact of clinical outcomes net of these unobserved characteristics. However, because random effects models make strong assumptions about the nature of these unobservables, we will also estimate hospital fixed effects models. The latter is not without some limitation though, as the factors in H and some in M are generally time invariant and will thus drop out of the fixed effects model. Estimating both models will provide insight into whether there is potentially unobserved heterogeneity driving any association (or lack thereof) between PCC outcomes and objective clinical outcomes at the hospital level. Since the processes are in the causal pathway we will estimate these equations with and without them in the D vector; we will also test the association of processes with patient outcomes as discussed below.

With respect to modeling PCCs as outcomes, most of these are measured in percentages. Papke and Wooldridge have shown that in these cases, the bounded nature of the data could provide misleading estimates of the effects of covariates of interest.[99] Papke and Wooldridge note that one way around this is to transform the outcome data to binary or multinomial response by setting a cutoff and modeling the outcome as 0/1 for whether an individual observation was above this cutoff.[99] They show that while appealing because it lends itself to established non-linear methods, this approach is by definition arbitrary. For instance, in the setting we are examining we could set a cutoff score for what we consider to be high enough levels of satisfaction (say a rating of 90), but this is arbitrary and may reveal nothing about the impact of, for example, adopting EHR, if the effect of adopting EHR is concentrated above or below this cutoff. Papke and Wooldridge detail fractional response models that are more appealing in these applications (so called fractional logit and fractional probit models).[99] We intend to use both linear and nonlinear methods, including these fractional response modeling techniques in estimating (1) above to provide the best possible estimates of the impacts of these various factors. These models are amenable to dealing with endogenous variables in a panel data setting as well.

Because HCUP-SIDs are based on patient level inpatient hospital discharges, they also provide a rich opportunity to examine organizational factors of the hospital, including summary PCC measures, and see how these impact *individual* patient level clinical outcomes and resource use during treatment. This is conceptually very important, because the proposed rules for PPACA-VBP[43] suggest that facility level measures of PCC somehow impact individual patient outcomes or resource use conditional on all other factors. If conditional on patient level risk and other system factors PCC does not impact outcomes or resource use, then there would be no purpose in including it in VBP rules. This is because the impact of PCC in aggregate models could be due to aggregation bias, or what has been termed ecological fallacy. Thus we

propose to examine this question by estimating the following equation using patient level HCUP-SID data:

$$C_{i,j,t} = \gamma_0 + \gamma_1 * R_{i,j,t} + \gamma_2 * PCC_{j,t} + \gamma_3 * S_{i,j,t} + \gamma_4 * D_{j,t} + \gamma_5 * H_{j,t} + \varepsilon_{j,t} \quad (2)$$

$$TC_{i,j,t} = \alpha_0 + \alpha_1 * R_{i,j,t} + \alpha_2 * PCC_{j,t} + \alpha_3 * C_{i,j,t} + \alpha_4 * D_{j,t} + \alpha_5 * H_{j,t} + \upsilon_{j,t} \quad (3)$$

Where C is again the objective clinical measures such as inpatient mortality, for patient i treated at hospital j in year t, R is the clinical risk adjustment for patient i, PCC is the vector of patient centered care measures for hospital j in year t, TC is the total cost for patient i in hospital j at time t, and D and H are defined as in (1) above. Most of the objective clinical outcomes represented by C are binary indicators, so these will be modeled using standard non-linear approaches. Since TC is likely skewed, standard health care cost estimation methods will be employed in estimating equation three.[99] We will also examine quantile regression approaches to examine whether improved PCC scores are impacting costs in a particular area of the cost distribution because it is important from a policy perspective to understand whether hospitals with better PCC have different costs across the full distribution, or whether it is concentrated in the tails of the distribution.

There are a number of specific hypotheses we will test with our two-pronged approach for each of our four treatment measures: H1: Higher scores on hospital PCC measures correlate with better outcomes; H2: Higher PCC nursing scores are more strongly associated with better hospital outcomes than physician scores; H3: Hospitals with a high proportion of racial/ethnic minorities will have PCC scores lower than those with small proportions of racial/ethnic minorities; H4: Hospitals with greater teaching commitment will have lower PCC scores; H5: Hospitals in more competitive markets have higher scores on PCC measures than those in less competitive markets; H6: Hospitals with higher evidenced-based process measure scores will have higher PCC scores. H7: Hospitals with more extensive EHR implementation will have better PCC scores; and H8: better EBM process measure scores result in higher PCC scores and better patient outcomes. We think these hypotheses reflect the broad potential of the database and the opportunity it affords to test other relevant hypotheses as we review results and refine methods with stakeholders.

Two methodological issues we need to evaluate are 1) factors that are potentially collinear and 2) repeated measures. Collinearity has implications for statistical inference because it could bias standard errors. We will be diligent in testing for collinearity among our measures, and in cases where two variables are collinear, use theory to drive our variable selection. Since all our models have repeated measures at the hospital level, which could also bias standard errors, we will adjust them for within hospital correlation.

Taken together, these analyses will provide powerful information relevant to both policy and managerial 'actionable' items. If, for example, there is strong concordance with PCC and both evidence-based processes and outcomes, policy-makers can continue to work with CXOs in disseminating and implementing AHRQ or other clinical guidelines in and across our nation's hospitals. If there is weak concordance, managers and decision makers will likely need to review the measurement of PCC at the hospital level. Even with concordance, given the nation's concern with soaring costs, hospitals must not only follow evidence based processes and achieve high levels of PCC and patient satisfaction but do so at lower costs. Our analysis will inform decision makers about the association of PCC and costs, whether or not it is enhanced by the degree of EHR implementation and what role market structure, hospital ownership and patient mix play in affecting this association. This will be critical information for any refinement of the Value-Based Purchasing that will begin in 2013 and the ability of our nation's hospital system to compete on the basis of both price and quality while simultaneously enhancing the patient-centered care experience.