Title

The role of health information technology in early accountable care organizations in the United States

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The Role of Health Information Technology in Early Accountable Care Organizations in the United States

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Abstract

The Role of Health Information Technology in Early Accountable Care Organizations

in the United States by

Frances M. Wu

Doctor of Philosophy in Health Services and Policy Analysis

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Objective. To assess the role of health information technology (HIT) in advancing the care management implementation of Accountable Care Organizations (ACOs).

Data sources/study setting. Data from the National Survey of Accountable Care Organizations (NSACO), a web-based survey of ACOs in the United States administered from October 2012 to May 2013, which includes data from 173 ACOs with either public or private payer partners. In addition, semi-structured interviews lasting 45-60 minutes were conducted between December 2012 and February 2013 with 20 leaders of 11 ACOs.

Study design. Retrospective cross-sectional analysis. A measure of ACO care management implementation was created from seven survey questions related to the following care management capabilities: chronic care programs, care transitions programs, and patient engagement activities (Cronbach's alpha = 0.84). HIT capability was measured using nine questions which asked about functionalities such as the extent of the primary ACO organization's inpatient and outpatient data integration, degree of electronic referral information exchange, as well as various electronic health record capabilities. For the qualitative analysis, constant comparative method was used to identify and code comments related to how ACOs were using HIT to capture, provide, and exchange information in general and in the context of care management in particular.

Principal findings. Multivariate regression using multiple imputation to account for missing data showed that HIT was associated with a significant increase in ACO care management implementation, controlling for factors related to the ACO organization, contracts, and financial motivation (0.38, $p<0.001$ and 0.19, $p>0.001$ for ACOs with single and multiple contracts, respectively). The relationship was then assessed when HIT functionality was categorized by its coordination role – information capture, provision, and exchange. Information exchange activities were found to be more greatly associated with ACO care management implementation as compared to information capture and provision activities ($p<0.001$). In addition, in the interviews we saw several examples of information provision, capture, and exchange using health IT in the care management context.

Conclusion. The findings suggest that HIT is significantly and positively associated with the development of ACO care management capabilities. HIT may play an important coordination role given the given the different types of coordination needed in delivering various aspects of patient care. Conceptualization of HIT coordination in ACOs may be useful to increase understanding of the relationship between HIT and care management.

Keywords. Accountable care organizations; Medicare; health care reform; health policy; delivery of health care; health information technology.

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1 INTRODUCTION

Accountable Care Organizations (ACOs) are relatively new payment and delivery innovations that have emerged across the United States. These "organizations" may include networks of organizations or new organizations comprised of physicians, hospitals, and other health care providers willing to assume responsibility for the care of a defined patient population (Shortell and Casalino, 2007; Fisher and Shortell, 2010). An ACO is distinguished by several key features: 1) the organization is physician or hospital-led; 2) it is accountable for quality and total costs per patient across the full continuum of care for a population of patients; 3) payments to the organization are based on achieving quality and/or cost reduction thresholds; and 4) it is characterized by performance monitoring and measurement (Fisher and Shortell, 2010; McClellan et al, 2010).

In 2010, the Patient Protection Affordable Care Act (PPACA) granted the Centers for Medicare and Medicaid Services (CMS) the authority to create and administer a shared savings program, allowing provision of Medicare payments to ACO entities. In addition, the legislation outlined the general steps necessary for groups of clinicians, hospitals, and other healthcare providers to be recognized as ACOs in the shared savings program. It defined several structural requirements necessary for participation in a Medicare ACO incentive program: a mechanism for shared governance; a formal legal structure allowing the organization to receive and distribute payments and shared savings to participating service providers and suppliers; a minimum of 5,000 beneficiaries; full transparency with regard to quality; and inclusion criteria for eligible providers. ACOs are eligible to share in savings achieved when the total cost of care for its patient population is lower than the estimated amount based on prior expenditures. Other ACOs may also opt to take on additional financial responsibility for costs exceeding the expenditure target. The ACO is defined by a formal contractual agreement across participating organizations that may outline patient attribution to the system, quality goals, savings calculation method, and the savings distribution model, among other things.

Early critics of the ACO model claimed that it is no different from the push towards managed care and health maintenance organizations in the 1990s. However, there are a few key distinctions. Namely, providers within ACOs will be reimbursed for their services across a variety of payment mechanisms. Early-stage ACOs will continue to pay physicians primarily on a fee-for-service basis, with more mature ACOs using bundled or episode-based payments and more developed or experienced ACOs taking on capitated risk for patients in the ACO. In addition, as previously mentioned, there is a quality component to receiving payments, with organizations needing to reach a specified quality threshold to qualify for shared savings. Depending on the payment distribution model, ACOs may require that individual physicians meet pre-specified quality thresholds as well. Finally, unlike traditional health maintenance organizations, patients are not limited to physicians within the ACO network.

To encourage the development of ACOs, the Center for Medicare and Medicaid Innovation (CMMI) within CMS developed two ACO incentive programs: 1) the Medicare Shared Savings Program (MSSP) as a permanent program and 2) the Pioneer ACO program, considered a demonstration project to develop and test alternative

payment models. The latter model was intended for healthcare organizations experienced in care coordination that could move rapidly from a shared savings model to a population-based payment model while exposed to greater financial risk and potential reward through shared savings. By January 2014, the total number of participating Medicare ACOs was over 360 (Centers for Medicare and Medicaid Services, 2014).

The growth of the Medicare ACOs was not a surprise. The Medicare ACO incentive programs were expected to encourage the growth of the Medicare ACO model. However, whether private health plans would follow Medicare's lead and partner with health care providers to implement ACOs in the commercial sector was much less certain. Early commercial ACO and ACO-like models, many of which produced positive outcomes, generated substantial interest, which contributed to considerable growth of commercial ACOs (Song et al, 2011; Markowich, 2012). Leavitt Partners, an independent firm surveying ACOs identified 162 commercial payer ACO partnerships in 2012 (Muhlestein et al, 2012). The growth appears to be exponential, with the most recent national estimate from January 2014 at just over 600 ACOs (Muhlestein, 2014).

ACOs and the Need for Coordination in Care Transformation

The ACO delivery model appears to be diffusing nationwide; however it is too early to determine their impact on performance outcomes such as the Institute for Healthcare Improvement's Triple Aim of improving the patient experience of care, improving the health of the population, and reducing the per capita cost of health care. Some skeptics question whether the quality improvement and cost reduction mechanisms typically implemented by ACOs, such as disease management programs, patient centered medical homes, or financial and nonfinancial physician incentives, can achieve the changes expected of ACOs (Burns and Pauly, 2012). Touting limited evidence on the effectiveness of such strategies in the first place, they question whether these mechanisms really exist in the participating organizations and whether they can be implemented well in the scope of these new organizational models. The questions raised are important ones – can cost and quality targets at the inter-organizational level translate to changes in workflow processes on the frontline to show marked improvements?

In fact, as ACOs have developed their array of improvement processes has expanded, targeting important cost and quality challenges. For example, many ACOs have developed the capability to manage the care of their assigned patients, particularly those patients who have a high risk of using emergency rooms, being admitted to a hospital, or repeated use of ambulatory care services over a period of time. To achieve these goals, ACOs use programs such as chronic care programs, care transitions programs, and patient engagement activities. Chronic care programs may include one or more elements of the Chronic Care Model (Wagner, Austin, and Von Korff, 1996), such as delivery system design, decision support, or the broader health system or community. The model has become progressively important in light of the increasing prevalence of chronic disease and its associated cost (Paez, Zhao, and Hwang, 2009; Thorpe, Ogden, and Galactionova, 2010). Care transitions programs help manage healthcare across providers and care settings as patient conditions and treatments change. These programs are focused on the transition between inpatient and other care settings and often include patient education, medication management, and physician follow-up (Naylor et al, 2004;

Coleman et al, 2006). These programs have been shown to reduce costs associated with hospital readmissions or unnecessary emergency room visits (Feigenbaum et al, 2012). Finally, patient engagement involves patients, families, their representatives, and health professionals working in partnership to improve health and healthcare (Carman et al, 2013). Evidence suggests that patient engagement activities are effective in improving health outcomes and patient safety (Coulter and Ellins, 2007; Epstein and Street, 2008; Hibbard and Greene, 2013; Roseman et al, 2013).

Shared financial and clinical goals among participating ACO organizations result in increased interdependence and requires a greater degree of coordination. This is especially true at the frontline, among an ACO's physicians, nurses, behavioral health specialists, therapists and other care givers who deliver patient care, in order to develop and strengthen quality improvement and cost reduction capabilities within and between existing systems of care. For example, processes need to be put in place to ensure that a 55 year-old grandmother with a history of Type 2 diabetes, complicated with hypertension and recurrent episodes of depression, is able to see a psychiatrist after missing her last appointment (Improving Chronic Illness Care, 2010). Processes are also needed to ensure a 92 year-old woman with advanced Alzheimer's and living at an assisted living facility is provided treatment consistent with the wishes expressed in her advance health care directive when she is hospitalized for a broken hip and develops arrhythmia (Schumann, 2013). These types of care processes, especially those serving complex patients, may or may not already exist among participating organizations. Inter-organizational cooperation and collaboration is difficult but increasingly important; resources and planning are required to implement and execute these capabilities well within ACOs, in order to coordinate care to a higher degree and with greater reliability.

Early proponents of the ACO model highlighted its flexibility, since it does not require the level of financial and structural integration of a fully integrated delivery system (Fisher et al, 2007; Fisher and Shortell, 2010). Studies of early ACOs confirm that they do vary across numerous organizational characteristics, including structural characteristics such as organizational, legal, and governance structures as well as size in terms of number of attributed patients and participating physicians (Larson et al, 2012). They also differ in terms of cultural characteristics, such as history of physician engagement, which has been found to influence views of integration within ACOs (Kriendler et al, 2012). Across all ACO forms however, health information technology (hereafter referred to as HIT or health IT), such as electronic health records (EHR), clinical decision support systems (CDSS), and electronic registries, is widely considered to be a part of the organization's infrastructure that is critical to its implementation and ultimate success. ACOs require capabilities beyond current clinical and administrative workflow support tools in order to measure and monitor the care for a cohort of patients. These solutions, such as population management and predictive modeling capabilities, are HIT-based. As a result, many healthcare organizations feel that a robust level of HIT is necessary to survive in the evolving healthcare environment and undergo transformation toward accountable care (Larson et al, 2012).

Health Information Technology in ACOs

Supporters of HIT tout its potential benefits such as the use of EHRs to improve efficiency through clinical workflow standardization and reduced inpatient utilization, to improve safety through improved medication management and reduction of medical errors, and to improve health outcomes through chronic disease prevention and care management (Institute of Medicine, 2001; Hillestad et al, 2005). Others argue for the broad-based role of health IT as a foundation for current healthcare reform, including ACOs (Buntin and Blumenthal, 2010). However, the research evidence on health IT's benefits is limited in areas such as cost of care and is often assessed in specific care delivery models and contexts (e.g. large integrated delivery systems) and, hence, difficult to generalize (Chaudhry et al, 2006).

Studies of specific HIT systems have also shown mixed benefits. A recent review of EHRs found a positive relationship between EHR use and care efficacy and efficiency, replicating the methods and selection criteria of two earlier reviews which found mixed results (Chaudhry et al, 2006; Goldzweig et al, 2009; Buntin et al, 2011). CDSS have generally been associated with positive effects on practitioner performance, though generalizations across settings, interventions, and outcomes are difficult (Garg et al, 2005; Kawamoto et al, 2005; Bryan amd Boren, 2008). While evidence for clinical and economic outcomes are sparse, a recent review of CDSS found improved health care process outcomes across diverse settings (Bright et al, 2012). Finally, use of computerized physician order entry (CPOE) has been assocated with decreased medication and prescribing error rates (Kaushal et al, 2003; Gergiou, 2012). Though the potential for health IT is clear, there remains a gap between its potential and empirically demonstrated benefits (Black et al, 2011).

In the face of limited evidence on the benefits associated with HIT, the literature is relatively silent on its theoretical role in healthcare delivery. There have been a plethora of studies that assess the association between HIT and clinical process or outcome measures, yet few explore the coordinating role of HIT, which may shed light on the whether some functionality may prove more useful than others in terms of care management (Adler-Milstein and Jha, 2012). Given the concurrent government incentives underway through the PPACA as well as the Health Information Technology for Economic and Clinical Health (HITECH) Act (part of the American Recovery and Reinvestment Act of 2009), it is an interesting time to consider the relationship between HIT and ACO care management implementation. The HITECH Act provides HHS with the authority to establish programs to improve health care quality, safety, and efficiency through the promotion of HIT. One such program is the Medicare EHR Incentive Program established to promote the spread of "meaningful use" of EHRs. The program spans a five-year period from 2011 to 2016 and is designed to incentivize increasing use of HIT: stage one focuses on capturing patient information and limited data sharing; stage two focuses on more comprehensive data exchange across organizations and care settings; and stage three will focus on improved outcomes, patient engagement, and more advanced clinical process flows (Blumenthal and Tavenner, 2010).

While ACOs are a delivery system model that is quickly transforming the healthcare organizational landscape, there is uncertainty whether ACOs will be able to achieve comprehensive reform. It is relatively early in the innovation adoption process

and thus impossible to know the effect of ACOs on health provision and outcomes. Even still, it is critical to understand ACOs during this early implementation stage, to understand what factors aid in their transformation process, and to potentially inform ongoing ACO formation. This study seeks to: 1) assess the relationship between HIT and ACO care management implementation in early ACOs and 2) explore whether the effect of various HIT functionalities on ACO care management practices varies by the type of information coordination that the HIT facilitates. Despite the prevalence of both HIT and ACOs in the current health care reform activity underway among both public and private organizations across the country, it is not well understood how the two are related. This study is designed to provide a starting point.

2 THEORETICAL FRAMEWORK AND HYPOTHESES

Interdependence and the Need for Coordination

There is a national priority to increase coordination of healthcare delivery. The Institute of Medicine identified care coordination across functional areas as a national priority area for transforming healthcare (Institute of Medicine, 2003). Many factors such as the growing life expectancy and the increased prevalence of chronic disease suggest that individuals will see more specialists, increasing the need for care coordination and information sharing among clinicians (Anderson and Knickman, 2002). In addition many studies have shown that ineffective coordination can lead to misuse and overuse of care, as well as conflicting clinical advice and adverse drug events (Wolff, Starfield, and Anderson 2002). Lack of coordination and communication across healthcare settings can lead to significant patient complications including medication errors and preventable hospital readmissions and emergency department visits.

The need for organizational coordination within ACOs is particularly great. ACO formation creates increased interdependence, both within and between organizations along the care continuum, since member organizations share contractual responsibility for cost and quality targets. Depending on the financial risk arrangement, participating organizations may share in savings associated with lower costs incurred than expected for the attributed patient population but also in losses for care costs incurred over the expected amount. Savings may be used to reinvest in the ACO, but a portion may also be distributed to individual physicians who meet pre-established quality thresholds. Therefore, cost and quality matter at both the organizational and individual physician levels, requiring coordination among the various ACO participants at multiple levels.

There are several conceptualizations of coordination in the organizational theory literature (March and Simon, 1958; Van de Ven, 1976; Mintzberg, 1980). March and Simon (1958) suggest that organizational coordination occurs through both programming and feedback approaches. The former includes standardization of skills and coordination by plan, both of which constrain action to some degree. These are predefined and include the establishment of rules and routines and the establishment of schedules, respectively, and are used in situations of increasing interdependence. For situations requiring a greater degree of coordination, feedback approaches are appropriate and "mutual adjustment", an informal communication process between two parties is used. In feedback approaches, there is transmission of new information during the process. Van de Ven (1976) distinguishes between impersonal, personal, and group approaches for coordination, which are not fundamentally dissimilar to the March and Simon formulation. The first closely follows coordination by programming, whereas the latter two, personal and group, describe coordination by feedback. While individuals make mutual adjustments through vertical or horizontal communication in the personal mode, a greater degree of interdependence may require mutual adjustment by groups of individuals through formal or informal methods in the group mode. Though these models somewhat differ in their nomenclature and detail, there are general consistencies. Basic coordinating approaches call for standardization while more sophisticated coordination needs are addressed by a higher degree of interaction and iterative processing among participants.

Of particular interest to this research, Thompson (1976) distinguishes between three types of interdependence that require coordination: pooled, sequential, and reciprocal. Pooled interdependence occurs among related but not closely connected activities; for example, ambulatory visits made by a patient for different episodes of care. Activities used to coordinate pooled activities often involve standardization, such as the use of standardized forms to document each visit. Sequential interdependence is defined by a close and sequential ordering and often involves planning or establishing procedures: for example, the uni-directional process by which a patient is discharged from the hospital to be admitted to a post-acute care facility. Finally reciprocal interdependence is the most complex, in which interdependence flows in both directions. An example of reciprocal interdependence is the process by which a physician provides a diagnosis and discusses with the patient or caregiver end of life treatment goals to determine a course of action. The type of interdependence between activities determines the ideal coordination strategy to integrate organizational components. For example, increases in interdependence between pooled, sequential, and reciprocal activities are associated with an increased need for coordination. These coordinating requirements are additive and are associated with increasing costs.

Coordination of Health Care

In the health services literature, there have been a multitude of studies that examine coordination of healthcare (Bodenheimer, 2008; Schultz et al, 2013). Two areas of coordination most often explored are that between providers and that between providers and patients. Coordination in this body of literature does not utilize the previously described conceptualizations or frameworks. Instead, coordination of the former type is most often measured through process measures; coordination occurring between providers and patients are often evaluated by patient perceptions.

Past studies of provider coordination have looked at coordination in terms of referral information transfer between primary care and specialist physicians (Forrest et al, 2000; Gandhi et al, 2000; Stille et al, 2006). Evidence shows that information transfer in either direction – primary care physician (PCP) referral information to specialist or specialist follow-up information to PCP – is often absent or incomplete; for example, the primary care referral may contain little or no important information for the specialist or the PCP may not receive feedback or treatment recommendations from the specialist. Specific measures of coordination in these studies include: percent of specialists receiving information from referring physicians; percent of primary care physician receiving feedback from specialists; and provider satisfaction with the quality of information received. Studies also look at the impact of missing or absent information on care and provider satisfaction. In one particular study of an academic medical center, 28% and 43% of PCPs and specialists, respectively, were dissatisfied with the quality of information received from each other (Gandhi et al, 2000). In another study of 32 primary care clinics, PCPs reported missing information in 13.6% of visits, which contributed to care delays and lower provider satisfaction (Smith et al, 2005).

In addition to referral information, other studies have looked at communications associated with emergency room or inpatient admissions (Kripalani et al, 2007a). Several studies found low rates of timely availability of discharge summaries (Harding 1987;

Pantilat et al, 2001; Kripalani et al, 2007b; van Walraven et al, 2010). When available, discharge summaries often lacked important information such as diagnostic test results, inpatient treatment, discharge medication, test results pending at discharge, patient or caregiver counseling, and follow-up plans (Kripalani et al, 2007b). In a study of PCPs, 31% reported being unaware of patient hospitalization, which was associated with patients being twice as likely to report post-discharge problems (Arora et al, 2010). One study of patient experience post-hospital discharge found that nearly one in five patients experience an adverse event, many of which were preventable or whose severity could have decreased with system design changes (Forster et al, 2003).

For studies of coordination among providers, there is strong evidence that provider relationships often lack exchange of complete, accurate and timely information – both to understand the past care that a patient has received and to help care decision-making going forward. Studies that examined coordination between providers and patients or family caregivers also found that there were missing or conflicting information given to patients, and when relevant there was often missing transitional information (Schoen, 2004; Schoen, 2005). These studies also varied widely, across settings such as ambulatory and inpatient care and patient populations such as patients with specific chronic illness, pediatrics, etc. Similar to those of provider coordination, these studies utilized heterogeneous approaches to measuring coordination. Examples of specific measures include percent of people with chronic illness reported receiving contradictory information from different healthcare providers; percent of hospitalized patients reported receiving information about their care; and percent of patients and families feeling prepared for care transitions.

Some suggest that the literature on coordination in healthcare is limited by inconsistent conceptions of coordination (Stille et al, 2005; Uijen et al, 2012). For example, early conceptions of coordination were synonymous with integration, while later definitions in the 1990s included the patient's perception of the care provider's knowledge of their care. Coordination and case management were used interchangeably after the mid 1990s, and finally in the late 2000s, coordination was defined as "the delivery of services by different practitioners in a timely and complementary manner so that care is connected and cohesive for the patient" (Haggerty et al, 2008). It is clear that the literature is not governed by a single conceptualization of coordination and there does not exist standard frameworks by which to measure coordination (McDonald et al, 2007; Schultz et al, 2013).

One growing body of research related to coordination is that of relational coordination. Gittell and colleagues argue that dimensions of work relationships and of communication matter greatly in coordination. They define relational coordination as "a mutually reinforcing process of interaction between communication and relationships carried out for the purpose of task integration" (Gittell, 2002a). Relational coordination is measured by seven dimensions. Three of the dimensions describe work relationships: shared goals, shared knowledge, and mutual respect. The remaining four dimensions describe communication – timeliness, frequency, accuracy, and problem solving – that reinforce and are reinforced by the three relational dimensions (Gittell, 2002b). The theory suggests that these dimensions of work relationships and communication enhance and reinforce each other in a work process. In this way, the theory of relational

coordination uses interpersonal dimensions to operationalize conceptions of coordination. For example one might hypothesize that higher levels of relational coordination, that which includes more frequent and accurate communication and grounded by shared goals or mutual respect, are necessary for the reciprocally interdependent work processes as suggested by Thompson (1976) and as previously described. Relational coordination has been studied across several industries including healthcare and has been most typically measured using individuals' evaluations of their relationships with team members or other parties involved in a task process, along the seven dimensions (Gittell et al, 2000; Gittell, 2002b; Gittell et al, 2008; Gittell, Seidner, Wimbush, 2010).

Organizing various elements of work processes requires both technical and relational coordination. For example, organizations require technical coordination through processes and procedures to coordinate individuals across organizational structures such as teams and departments as well as functional areas. In addition, they may also require relational coordination between individuals by promoting work relationships and communication (Gittell, 2002). One facilitator for coordinating both technical and relational dimensions of an organization is health IT. HIT is "the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making" (Thompson and Brailer, 2004). HIT within a primary ACO organization promotes and supports communication and information exchange, include functionality such as secure messaging between patients and providers, patient portals, and maintenance of patient problem lists of current diagnoses. Besides functionality more commonly associated with an EHR, HIT can also include systems which support broader functionality such as data integration between inpatient and outpatient care settings or the ability to risk-stratify a patient population. Though not specific to ACOs, earlier studies have shown that HIT is associated with greater use of care management processes, tools such as disease registries, clinical practice guidelines, and nurse care managers used to improve the efficiency and quality of primary care delivery (Casalino et al, 2003; Rittenhouse et al, 2011) suggesting that HIT may facilitate coordination by supporting strategies such as care management processes or play a direct role in coordination itself.

Information Systems and Technology as Facilitators of Coordination

Theoretically, the benefits of information technology are achieved through information efficiencies, which decrease time or costs, as well as through information synergies, those "performance gains that result when IT helps two or more individuals or subunits to pool their resources and cooperate and collaborate across role or subunit boundaries" (Dewett and Jones, 2001). Positive organizational benefits resulting from these efficiencies and energies have been classified into five major outcomes: ability to connect employees, improved ability to codify organizational knowledge, improved boundary spanning capabilities, improved information processing leading to increased efficiency; and improved collaboration promoting innovation (Dewett and Jones, 2001).

Information technology has the ability to link individuals who work independently within teams or across functions. In order to produce efficiencies across these connections, it requires providing a consistent platform across users, including a

common language in order to promote shared meaning across users and a consistent interface so that users know when and where to input and locate information within the system (Melin and Axelson, 2005). If done well, IT has the potential to allow users to exchange information and communicate more efficiently, which may decrease the need for other forms of communication over time (Argyres, 1999). Linking users requires a degree of standardization and may represent a formalization of process. For example, prior authorization from payers is often required for medical, pharmacy, laboratory, radiology, or durable medical equipment. Using an electronic medical record to support this process allows for standardization of forms, which are healthcare service and payer agnostic; codification of data to facilitate timely responses from payers; and a standardized payer question response process through the electronic system. Setting up such as system requires a significant amount of upfront work to develop templates and standardize work procedures. However, it can ease the burden that the current prior authorization process places on physician practices. Through standardization and plans, information technology can enable work efficiencies and reinforces processes (Orlikowski, 1991; O'Malley et al, 2010).

In addition, information technology has the ability to produce information synergies through increased coordination. The role of HIT becomes more apparent at the boundaries – of teams, departments, and organizations – by supporting coordination activities such as routines (clinical pathways), boundary spanners (primary care nurses and case managers) and alignment across levels (Gittell and Weiss, 2004). HIT allows for individuals across boundaries to access information in a timely manner from other parts of the organization, which may not have been available before. Individuals can know what activities are underway in other parts of the patient care process, for example and understand how their actions fit in the overall process. They have an increased understanding of how their actions may influence and be influenced by others in the process. It can allow for increased exchange resulting from that information, enabling individuals to process a greater degree of complexity. Health IT and IT in general has the potential to enable these kind of new organizational activities to occur (Malone and Crowston, 1994).

The Role of Health Information Technology in Coordination

The role of IT is potentially very complex; there are multiple mechanisms by which it can create efficiencies and synergies as described by Dewitt and Jones. In order to understand the fundamental role of HIT in coordination, it may make sense to start with a simpler framework. If coordination is defined as managing dependencies, then identifying: 1) the different types of dependencies and 2) the appropriate coordination activities using HIT for managing them, can offer some insight to the role of health IT. Considering Thompson's (1976) three types of dependencies – pooled, sequential, and reciprocal – and the information needs for each of these three types, the coordination functions of HIT that match these interdependencies can be summarized as: information capture, provision, and exchange (for pooled, sequential, and reciprocal interdependencies, respectively). Pooled interdependence relies on capturing information, sequential interdependence requires both capturing and providing

information, and finally reciprocal interdependence requires capturing, providing, and exchanging information.

HIT captures information in a standard manner, for example, through pre-existing templates for progress notes or structured data for lab results. Capturing patient information reflects pooled interdependence between activities and a lower level of coordination. Providing information inherently involves both capturing and providing information to an intended audience, such as reminders to providers or information to patients, which explicitly link individuals in a task process and require a higher level of coordination. Finally, exchanging information (e.g. between primary care and specialty physicians) reflects reciprocal interdependence. Bi-directional exchange has the potential for problem solving or issue prevention/resolution and requires the highest level of coordination.

The relationship between interdependence and coordination described above suggests ways in which health information technology and systems may produce positive outcomes and play a coordination role. Health IT may play a key role in capturing, providing, and exchanging information for ACOs in their early implementation phase. As a result, the following hypothesis will be examined:

> H1: Health IT capability is positively associated with ACO care management implementation, measured as a composite index of chronic disease, care transitions, and patient engagement activities.

Information capture, provision, and exchange coordinate care under conditions of relatively increasing levels of interdependence. HIT functionality related to information capture, such as the ability to document patients' current and active diagnoses, coordinates activities that are less interdependent. Information provision functionality, for example the ability to provide clinical decision support at the time of care, coordinates activities that are relatively more interdependent. Finally information exchange functionality, such as the ability to exchange information between providers, coordinates activities that are relatively the most interdependent. It is likely that these three categories of information coordination are associated with ACO care management capabilities differentially. More mature care management, i.e. a greater degree of ACO care management implementation, likely requires greater information exchange capability. Since data exchange mechanisms coordinate higher levels of interdependence as compared to data provision mechanisms, it is hypothesized that:

> H2a: *Information exchange* activities are more positively associated with ACO care management implementation than *information provision* activities.

Furthermore, since information exchange and information provision mechanisms coordinate higher levels of interdependence as compared to information capture mechanisms, it is hypothesized that:

H2b: *Information exchange and information provision* activities are more positively associated with ACO care management implementation than *information capture* activities.

3 METHODS

The study uses both quantitative and qualitative approaches, described below.

3.1 QUANTITATIVE DATA AND DESIGN

The quantitative data are taken from the National Survey of Accountable Care Organizations (NSACO), an annual survey of ACOs across the U.S. that have signed or are actively pursing ACO contracts (Dartmouth/UC Berkeley). Launched in late 2012, it is the most comprehensive survey of ACOs formed as of August 2012 and includes those with private, public and multi-payer contracts. Survey questions asked about the ACO's general contract terms; local context; leadership; organizational structure; and capabilities such as care management, quality improvement, and health information technology (a copy of the survey may be obtained by request). The survey is primarily web-based (three respondents answered by phone) and administered by a third party survey firm. It is completed by an individual who is most knowledgeable about the ACO – typically the chief executive officer, chief medical officer, or President from the ACO's primary provider organization, either a physician organization or hospital.

Various sources were used to develop the sample for the survey, which included all known ACOs at the time of the survey launch. ACOs participating in CMS ACO initiatives (either the MSSP or Pioneer programs) or state Medicaid programs are publicly identified and were included in the sample. ACOs formed with commercial payers were also included and were identified through various sources including press releases; surveys of healthcare providers; and participation in ACO collaboratives such as the ACO Learning Network (facilitated by the Brookings Institution and The Dartmouth Institute for Health Policy and Clinical Practice) and the Partnership for Care Transformation (PACT) Implementation Collaborative (facilitated by Premier). The final sample included 292 eligible ACO organizations with one or more formal ACO contract – contractual responsibility for both total cost of care and quality performance. The survey was pilot tested with several ACOs before its launch in October 2012. The survey was in the field for eight months and closed in June 2013. There were 173 completed responses for a 70% response rate, using methodology adapted from the American Association for Public Opinion Research, which incorporates cases of unknown eligibility (AAPOR, 2011).

The following measures were used for the analysis:
Dependent Measure: ACO Care Management Implementation Index. This measure conceptualizes the degree to which an organization or organizations have moved toward an ACO model. The measure captures attributes of ACOs that allow them to achieve the Triple Aim. Three areas of care management which are highly intertwined, yet thought to each contribute separately to meeting the Triple Aim, are included in the measure: chronic care programs, care transitions programs, and patient engagement activities. Seven items from the Care Management and Quality and Process Improvement sections of the survey were chosen to reflect broad capabilities in these areas, including the extent to which:

- Providers are engaged in planned and continuous management of patient care (patient engagement)
- Chronic care management processes are in place to manage patients with high volume, high cost chronic illness (chronic care management)
- Systems are in place to assure smooth transitions of care across all practice settings (care transitions)
- Clinicians encourage ACO patients to be actively involved in decisions involving their care and self–management of their care (patient engagement)
- Processes and protocols are established for identifying, counseling, and planning for end of life care (chronic care management)
- Activities are directed toward reducing preventable hospital admissions (care transitions)
- Disease monitoring data, such as HbA1c testing, eye exams, and cholesterol levels for diabetics, are used to improve ambulatory care (chronic care management)

See Appendix A1 for a list of survey questions. Cronbach's alpha is 0.84 for the seven items. The response scale for each is 1 to 9; the index is constructed by summing the responses across the questions and ranged from 0 to 63.

Primary independent variable: HIT capabilities index. The HIT capabilities index measures the degree to which an ACO possess specific capabilities with regard to its information systems and technology: outpatient and inpatient data integration among ACO providers and those providers contractually outside of the ACO; systems designed to perform predictive risk assessment or to stratify patients by risk; referral information exchange with specialists; and provision of electronic health information to patients upon request. In addition the measure includes functionality specific to the organization's EHR system(s), including the use of patient registries to track chronic conditions and preventative measures; the implementation of clinical decision support rules and associated compliance tracking; problem lists of current and active diagnoses or medication lists; and patient reminders for preventative/follow-up care generated by the EHR (see Appendix A2 for survey questions).

Cronbach's alpha for these nine functionalities is 0.87. The index is constructed by summing the responses to the nine questions (response scale 1 to 9). The questions are classified in Table 1 using Thompson's interdependence types: pooled, sequential, and reciprocal which correspond to capturing, providing, and exchanging information among ACO participants. Classification of the functionalities is conceptually-based, taking into account the various activities and workflows that each functionality supports. In less clear instances, interviews with ACO leaders (see Section 3.2 for description) are used to inform the classification.

Patient registries, for example, are classified as information provision rather than information capture, as a result of how leaders described registries and their usage in various contexts:

- "One of the things that we did four years ago that predated any of this conversation was we put in a disease registry…[which] has been very powerful, very helpful for us to track the progress we're making on our patients. It's one of

the key elements that helps us to track the progress our doctors are making with these patients."

- "[The disease registry] is starting to identify patients that need to come in…most of them are usually because they have chronic disease data or multiple comorbidities...We can provide them feedback about how they are performing across their practice on the patients for their given specialty."
- "The disease registry is monitored really by two parties. One, by the office, the physician and the office staff, to see what are the requirements? What are the clinical pathways? What are the follow up items that need to occur for each one of those patients?...We are also looking at it from our side… to see how someone is progressing… One of the key components is how they're doing on their disease registry follow up of those patients. So they are checking it because they are responsible for it. But we're also looking over their shoulders to encourage them to do that follow up visit, to call these patients in, to get them in, to check on their progress, etcetera."

Table 1. Components of HIT capabilities index, by interdependence and coordination type.

HIT Capability	Interdependence Type	Information Coordination Type (Item Name)
Outpatient and inpatient data integration for ACO providers	Pooled	Information capture (capture1)
Outpatient and inpatient data integration for providers outside of the ACO	Pooled	Information capture (capture2)
Problem lists of current and active diagnoses/active medication lists within the EHR(s)	Pooled	Information capture (capture3)
Patient registries to track chronic conditions and preventative measures linked to EHR(s)	Sequential	Information provision (provision1)
Clinical decision support tools capable of being implemented and compliance tracking within the EHR(s)	Sequential	Information provision (provision2)
Patient reminders for preventive/follow-up care generated by the EHR(s)	Sequential	Information provision (provision3)
Patients provided an electronic copy of their health information/discharge instructions upon request	Sequential	Information provision (provision4)
System for predictive risk assessment/stratification	Reciprocal	Information exchange (exchange1)
Electronic referral information exchange between specialists	Reciprocal	Information exchange (exchange2)

Other Covariates
The following variables are included in the model as control variables:

Multi-payer ACO contracts. ACOs involving multiple payer contracts may either include both commercial and public payers or more than one commercial payer. A relatively greater patient population may be attributed to these models and may reflect a greater proportion of total revenue tied to ACO business. The development of ACOs with multiple contracts (i.e. multi-payer) may be different from those with a single ACO contract. Those ACOs with a relatively greater degree of revenue tied to their ACO business will invest more resources in the initiative. Multi-payer contract participation is coded as "1" for the binary variable.

Medicare ACO contract only. Payer type reflects differences in the patient populations for which healthcare is provided and potentially differences in the process by which the care is delivered. ACOs participating in a Medicare ACO program are held to specific requirements as part of that program and may develop differently than those with additional or only commercial payer contracts. Medicare ACO contract only is measured as a binary variable with "1" indicating that the ACO is only involved in a Medicare ACO program and "0" indicating that the ACO has other payer partners.

Ownership. This measure reflects the self-reported ownership status of the organization contributing the largest number of patients to the ACO. Ownership is measured as a three-category variable: physician-owned (the reference category), hospital-owned, or other, which may include responses of "publicly-owned entity", "privately-owned entity", or "other". Hospital ownership may reflect greater number of resources and also different financial incentives, both influencing the implementation of ACOs.

Size. Organizational size is a proxy for resources and has been found to be positively associated with the implementation of quality improvement interventions such as care management processes (Casalino et al, 2003; Rittenhouse et al, 2008). Larger ACOs and those with greater resources may exhibit different implementation patterns than their smaller counterparts and those with fewer resources to dedicate towards innovation adoption. Size is measured by the total number of primary care clinician full-time equivalents (FTEs). ACOs are centered around primary care so keeping the measure of size focused on the "technical core" of primary care (and not including the count of specialist FTEs) is likely a stronger indicator of ACO size. The correlation between the number of primary care clinician FTEs and specialty care clinician FTEs is 0.53.

Integrated delivery system. Integrated delivery systems (IDS) may experience ACO development differently as a result of greater existing integration between parts of the organization and resources. This measure reflects whether the organization self-identifies as an IDS (coded as "1"), while "0" indicates the organization does not self-identify as an IDS.

Financial motivation. Financial motivation reflects the perceived importance of the ACO initiative to the organization's financial viability. Five questions assess the importance, using a 1-9 scale, the following factors in making the decision to develop an ACO:

- Confidence in ability to meet spending and quality targets to achieve shared savings or bonuses,
- Current or anticipated limitations to fee–for–service reimbursements,
- To be competitive in the market,
- To gain experience working under new payment models, and
- To be perceived as a cost–conscious provider organization.

These questions are asked from the context of the responding organization's largest contract. Financial motivation is measured by the sum of these five questions. The measure captures an overall sense of how important financial factors were in pursuing an ACO.

The zero order correlation matrix for these seven items is shown in Appendix B, Table B1.

Multiple regression was used to investigate the association between HIT capability and ACO care management implementation. The model is represented by the following equation for each individual ACO organization i:

$$y_i = \alpha + \beta_1 x_{i1} + \beta_2 x_{i2} + \beta_3 x_{i3} + \beta_4 x_{i4} + \beta_5 x_{i5} + \beta_6 x_{i6} + \beta_7 x_{i7} + \varepsilon_i,$$

where $\varepsilon_i \sim N(0, \sigma)$
and

x_{i1} = HIT capabilities index
x_{i2} = Multi-payer ACO contracts
x_{i3} = Medicare ACO contract only
x_{i4} = Ownership
x_{i5} = Size
x_{i6} = Integrated delivery system
x_{i7} = Financial motivation
y_i = ACO care management implementation index for the ith ACO.

To examine the effect of missing data on the regression results, the regressions were estimated in two ways: with and without imputation of missing values. Multiple imputation is a technique which uses the distribution of the observed data to estimate values for missing data. In multiple imputation, multiple data sets are created, analyzed individually, and then combined to obtain the overall estimates, variances, and confidence intervals (Rubin, 1987; Schafer, 1997). Multiple imputation by chained equations (MICE) is a flexible approach which allows for a separate model to be specified for each variable with missing data (White et al, 2010). MICE is used to estimate regression coefficients for the model above, to account for missing data which may otherwise bias the estimates.

MICE allows for the inclusion of auxiliary variables, those which are not in the model but may be related and provide additional information on model variables. Since MICE allows for separate models for each imputed variable, auxiliary variables are included especially in the case where an auxiliary variable possesses more complete data than the imputed variable. A measure of perceived local market competition is included as an auxiliary variable for financial motivation; measures of scope of services and number of contracted services are included as auxiliary variables for the IDS measure; and a measure of self-reported organization type and the total number of provider organizations included in the ACO are used as auxiliary variables for the ownership variable. The auxiliary variables are conceptually related to the model variables. See Appendix C for detail on these measures. Included in the imputation model are six variables. The specific models used for each variable with missing data are shown in Appendix D.

Data analysis was performed with STATA 12 (StataCorp, College Station, TX, USA).

3.2 QUALITATIVE DATA AND DESIGN

The second part of the dissertation comprises an analysis of qualitative data from interviews with senior leaders of a select group of ACOs. Since ACO implementation is a dynamic process that may not be fully captured in a cross-sectional survey, the qualitative analysis is intended to: 1) provide detailed information on the EHRs and other health information systems currently in use or whose use is being planned, and 2) elucidate how ACOs use HIT to develop care management, including disease management and case management.

A semi-structured interview guide was developed to cover the areas of: leadership and governance; relationships with payers, physicians, and patients; health IT infrastructure; care management capabilities; multiple-payer contracts; and general questions, during a 45-60 minute interview (see Appendix E). The interview questions were designed so that a single respondent representing executive or senior leadership from each ACO could complete the interview.

A purposive sample of 28 organizations was selected, stratified across the following categories: organizational type (e.g., integrated delivery system, physician organization, physician hospital organization, other), payer type (public or commercial), Medicare ACO program type (where appropriate, MSSP or Pioneer), size (number of patients/beneficiaries covered), and geographic location. Using the same criteria, a diverse group of twelve of these 28 organizations was chosen for the first round of outreach in November 2012; three additional organizations from the remaining sixteen were contacted in mid-January 2013 in the second round of outreach. For these fifteen organizations an introductory email was sent on behalf of the lead investigators from University of California, Berkeley and Dartmouth College. Follow up emails and phone calls were conducted within a week of the initial email and continued until the research team was able to identify the appropriate contacts, confirm their participation in the study, and to schedule the interviews or confirm a refusal for participation.

Eleven telephone interviews, lasting approximately 60 minutes, were conducted between December 2012 and February 2013. See Table 2 below for characteristics of the 11 ACOs, which varied across geographic location, organizational type, and total number of attributed patients, among others. In all interviews, both a lead interviewer (TR, SS) and a note taker (FW) were present. In total, three of the fifteen organizations refused to participate – one due to lack of time, another due to lack of interest in participating in any ACO-related request, and finally the last due to uncertainty surrounding participation as part of the MSSP program. One organization did not respond during the recruiting period. All interviews were recorded following the participants' consent and sent to an external firm for transcription.

Table 2. Organizational characteristics of study ACOs.

ACO Name	Organization Type	Payer (Lives Covered)/ Start Date	Medicare ACO Type	Geographic Location	Titles of Interviewees
Park Nicollet Health Services	Integrated delivery system	Medicare (16,000) and additional risk-based commercial payer contract	Pioneer	Minneapolis, MN	Vice President, Government Relations Director, Pioneer ACO and Medicare Products Senior Medical Director
Triad Healthcare Network	Clinically integrated network of physicians affiliated with Cone Health	Medicare (38,000) with plans for contracts with commercial payers	MSSP	Greensboro, NC	Vice President and Executive Director Executive Medical Director
District Medical Group	Medical group affiliated with the University of Arizona College of Medicine - Phoenix	No formal ACO contract signed but targeting Medicaid and commercial payers		Phoenix, AZ	President and Chief Executive Officer
John Muir Health	Integrated delivery system	Blue Shield (16,000) and Medicare (7,000)	MSSP	Walnut Creek, CA	Vice President, Employer and Payor Relations Medical Director, Care Management Director, Physician Application Services
Atrius Health	Alliance of six medical groups	Medicare (25,000) and Blue Cross Blue Shield Alternative Quality Contract (106,000)	Pioneer	Boston, MA	Executive Director, Accountable Care Programs Chief Physician Executive
Carilion Clinic	Integrated delivery system	Aetna (50,000) and Medicare (not started at time of interview)	MSSP	Roanoke, VA	Senior Vice President, Physician Services
Methodist Patient Centered ACO	Hospital system with primary care clinics	Medicare (13,000)	MSSP	Dallas, TX	Vice President, Managed Care
Multicare Health System	Integrated delivery system	Medicaid managed care (20,000); contracts with Blue Cross planned		Tacoma, WA	Director, Payor Contracting Vice President, Revenue Cycle Senior Vice President, Strategy and Business Development Director, Ambulatory Accountable Care

Brown and Toland	Independent practice association	Blue Shield (21,000); Cigna (1,500); Aetna (1,500); Medicare (18,000)	Pioneer	San Francisco, CA	Vice President, Accountable Care and Public Policy
Coastal Medical	Medical group	Blue Cross Blue Shield of Rhode Island (33,000); Medicare (8,000); two other commercial contracts planned	MSSP	Providence, RI	Director, Data Analysis and Reporting
Advocate Health Care	Nine physician hospital organizations	Blue Cross Blue Shield (250,000) and Medicare (114,000)	MSSP	Oak Brook, IL	President

Analysis follows the constant comparative method (Strauss and Corbin, 1990). The interview transcripts were coded with Atlas.ti version 7 software to identify respondents' comments related to health IT systems, data capabilities, and care management capabilities (see Appendix F for list of codes and definitions). Coding was jointly completed by two researchers (TR, FW) to inductively develop a list of codes and concurrently assign them to relevant statements. Each coder independently coded the same interview, with 81% agreement on the assignment of codes, providing a measure of reliability. Coding differences were resolved through discussion and changes to codes and code definitions were adjudicated throughout the coding process.

In addition, codes were assigned to comments relating to the use of HIT to capture, provide, and exchange information. Information capture was used to code statements expressing the sharing or transferring of data and documentation of clinical activities, each for the purpose of measuring ACO performance. Information provision was used to code statements regarding HIT usage to provide feedback to physicians (including reports) or to provide clinical information or education to patients. Finally, information exchange was used to code statements which describe providers using HIT to exchange clinical information, such as between the inpatient or specialty care settings or within a health information exchange (HIE). Another common example of information exchange includes case managers using HIT to work with high-risk or high-utilization patients to improve their care.

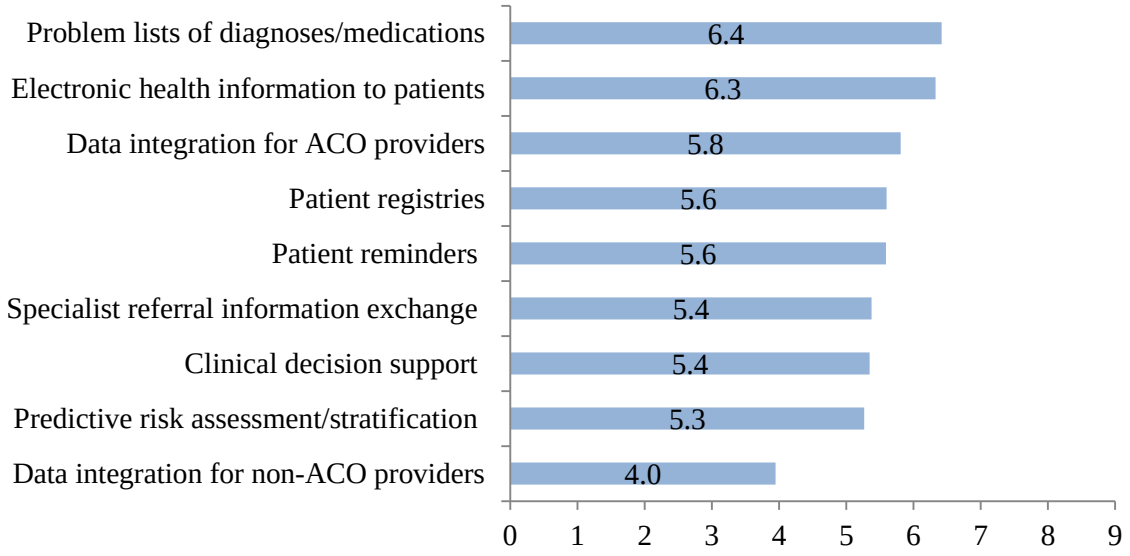
In the initial analysis, passages that represented both HIT and data analytics capabilities codes were identified to understand what systems are used and how these systems are used during the ACO development process. In the second stage, the information capture, information provision, and information exchange codes were queried to find additional examples of the ways in which HIT is used to support ACO activities. Finally, the codes representing the intersection of HIT and care management-related codes were explored to identify ways in which HIT is used specifically to support care management activities within the participating ACOs. Respondent ACOs were anonymized with a letter (ACO A through ACO K) for each quote identifying the site to give the reader a sense of the diversity of evidence.

4 RESULTS

4.1 QUANTITATIVE RESULTS

The mean scores for each of the nine HIT functionalities comprising the HIT capabilities index ranged from 3.95 (outpatient and inpatient integration for providers outside of the ACO) to 6.42 (problem lists of current and active diagnoses AND/OR active medication lists). Functionality such as provision of electronic health information to patients and data integration for providers within the ACO were also relatively high (6.33 and 5.81, respectively). Other functionality such as information exchange with specialists, clinical decision support, and predictive risk assessment for population health management were relatively low (5.38, 5.35, and 5.27, respectively). The mean response scores (out of a maximum of 9) for each HIT functionality are presented in Figure 1 below.

Figure 1. Mean survey scores of nine health IT functionalities.



Of the 173 responses, 172 were included in the analysis. Added-variable plots (or partial-regression leverage plots) for each of the variables were used to identify any problematic observations. They revealed one outlier in the data (see Appendix B, Figure B1). The ACO was a hospital-owned IDS with both Medicare and Medicaid contracts reporting a single primary care FTE physician. This observation was dropped from the analysis for a total of 172 observations included in the analysis.

Summary statistics for the model variables are shown in Table 2. The mean HIT capabilities index score across the 172 ACOs was 49.6 out of a total possible 81. Financial motivation scores (out of a possible 45) ranged from 19 to 45 with a mean of 35.6. ACOs reported between 11 and 1069 primary care physician FTEs, with an average of 180 FTEs. Over 40% of the study ACOs reported more than one formal ACO contract and 40% reported a Medicare ACO contract only. Over half, 78 of the ACOs

who responded, reported being an IDS. Finally in terms of ownership, the ACOs were distributed relatively evenly between being physician- or hospital-owned, with 60 (41%) and 57 (40%), respectively reported in each category.

Summary statistics are also shown by quartiles of the dependent variable, ACO care management implementation index. When grouped by quartiles of the dependent variable, ACOs varied significantly across the HIT capabilities index and participation in multiple ACO contracts. As shown below in Table 2, there was a monotonically increasing pattern for the mean HIT capabilities index as ACO care management implementation index increased by quartile.

Table 3. Summary ACO characteristics by quartiles of ACO care management implementation index.

ACO characteristic	ACO care management implementation index quartile				Total
	1	**2**	**3**	**4**	
Mean HIT capabilities index (0-81), mean (SD)*	40.6 (12.2)	48.9 (10.2)	51.1 (10.8)	59.5 (9.3)	49.6 (12.8)
Financial motivation (0-45), mean (SD)	33.8 (6.0)	35.4 (5.2)	34.9 (4.5)	37.5 (4.8)	35.6 (5.4)
Primary care clinician FTE, mean (SD)	138.8 (131.1)	144.5 (92.7)	166.1 (147.7)	289.3 (261.6)	180.2 (175.2)
Multi-payer**					
Yes, No. (%)	8 (18.6)	19 (44.2)	21 (63.6)	21 (53.9)	69 (43.7)
Medicare only					
Yes, No. (%)	24 (55.8)	16 (37.2)	10 (30.0)	13 (33.3)	63 (39.9)
IDS					
Yes, No. (%)	17 (44.7)	20 (47.6)	16 (53.3)	25 (67.6)	78 (53.1)
Ownership					
Physician, No. (%)	17 (46.0)	22 (55.0)	11 (34.4)	10 (27.0)	60 (41.1)
Hospital, No. (%)	16 (43.2)	14 (35.0)	12 (37.5)	15 (40.5)	57 (39.0)
Other, No. (%)	4 (10.8)	4 (10.0)	9 (28.1)	12 (32.4)	29 (19.9)

* significant at the 0.05 level; ** significant at the 0.01 level

Multiple regression results with standardized coefficients are reported in model 1 of Table 3 below. It appeared that one unit increase in the HIT capabilities index was associated with 0.38 increase in the ACO care management implementation index for ACOs with a single payer contract. The relationship between health IT and ACO capabilities was reduced to 0.19, with multiple payer contracts. Standardizing the HIT capabilities index to the mean yielded a difference of 3.8 units. The figure in Appendix B, Figure B2 shows plots of the predicted values of ACO care management implementation index versus HIT capabilities index, by multi-payer status. The slope of the line for the ACOs with multiple ACO contracts is smaller than that for the single payer ACOs, visually representing the relationship reflected in the regression results.

An interaction between the HIT capabilities index and multi-payer was significant in early analyses, while an interaction of the HIT capabilities index and IDS was borderline significant at the 0.05 level. When both interaction terms were included in the regression, the latter interaction became nonsignificant. As a result, the interaction between HIT capabilities index and multi-payer was included in the final model.

In the regression analysis above, 46 observations were excluded as a result of missing data. To account for these incomplete observations, eight imputations were run using MICE to impute missing fields for the model variables. These eight imputed datasets were used to estimate the regression model presented above. The results are shown in Table 3, model 2. The effect of HIT on ACO care management implementation was very similar between the two models. A unit increase in the HIT capabilities index was associated with a 0.37 increase ($p<0.001$) in the ACO care management implementation index. Other significant variables in the model included the ownership category, Other ($p<0.001$) and ACO size in terms of primary care physician FTE ($p<0.001$). These findings support H1 that health IT capability is positively associated with ACO care management implementation.

Table 4. Factors associated with the ACO care management implementation index.

	(1)		(2)*	
	Coeff (SE)	p-value	Coeff (SE)	p-value
HIT capabilities index	0.38 (0.05)	<0.001	0.37 (0.04)	<0.001
Multi-payer	11.77 (4.19)	0.01	9.92 (3.84)	0.01
HIT*Multi-payer	-0.19 (0.08)	0.02	-0.16 (0.07)	0.03
Medicare only	0.75 (1.18)	0.53	0.62 (1.08)	0.57
Ownership**				
Hospital-owned	-0.22 (1.15)	0.85	-0.20 (1.08)	0.86
Other	5.34 (1.38)	<0.001	5.41 (1.26)	<0.001
Primary care clinician FTE	0.01 (0.00)	<0.001	0.01 (0.00)	<0.001
IDS	0.46 (1.16)	0.69	0.17 (1.22)	0.89
Financial motivation	0.12 (0.09)	0.22	0.12 (0.09)	0.19
N	126		172	

* Model 2 uses imputed data.

** Reference category is physician-owned, "Other" category may include: publicly owned, privately owned, or other.

IDS stands for integrated delivery system; FTE stands for full-time equivalent

It was hypothesized in H2a and H2b that HIT functionality by coordination type (information capture, provision, and exchange) will be differentially associated with ACO care management implementation and in an increasing order. Prior to imputation, the mean scores of HIT functionality by these types of coordination were: information capture: 5.39 (SD: 1.54); information provision: 5.72 (SD: 1.68); information exchange: 5.32 (SD: 1.67), suggesting that functionality coordinating the simpler tasks of information capture and information provision were more prevalent than performing the more complex coordination of information exchange. Yet, the mean scores for functionality associated with information capture and information exchange were relatively similar.

Imputed datasets using MICE were also used to test the relative contributions of HIT functionality categorized into information capture, provision and exchange. In the multiple regression, information capture and provision functionality were not significantly associated with ACO care management implementation (see Table 5 below). However, information exchange functionality was significantly and positively associated, 0.86 ($p<0.001$). To test H2a and H2b, post-hoc estimation using linear combination of model coefficients was performed to assess differences between information capture, provision, and exchange in their association with ACO care management implementation. Information exchange showed a significantly stronger and more positive association with the dependent variable than information provision ($p<0.001$), consistent with H2a. Since conceptually both information exchange and information provision mechanisms coordinate higher levels of interdependence as compared to information capture mechanisms, it was hypothesized in H2b that both information exchange and provision activities would be more positively associated with ACO care management implementation than information capture activities. In the analysis, information exchange functionality was found to be significantly different from that of information capture in the expected direction ($p=0.01$). However, information provision was not found to be significantly different from information capture functionality. Thus, the results were inconsistent with H2b.

Table 5. Factors associated with the ACO care management implementation index, including HIT functionality by coordination type.*

	Coeff (SE)	p-value
Information capture functionality	0.22 (0.14)	0.11
Information provision functionality	0.14 (0.09)	0.15
Information exchange functionality	0.86 (0.17)	<0.001
Multi-payer	1.69 (1.04)	0.11
Medicare only	0.35 (1.03)	0.73
Ownership**		
Hospital-owned	-0.05 (1.10)	0.97
Other	5.28 (1.21)	0.00
Primary care clinician FTE	0.01 (0.00)	0.00
IDS	0.76 (1.06)	0.48
Financial motivation	0.15 (0.09)	0.08
N	172	

* The model uses imputed data.
** Reference category is physician-owned, "Other" category may include: publicly owned, privately owned, or other.
IDS stands for integrated delivery system; FTE stands for full-time equivalent

Logistic regression was used to assess the ACO characteristics associated with an ACO scoring in the top quartile of the ACO care management implementation index. There were three organizational characteristics that were significantly associated with the ACO possessing relatively greater care management. As shown in Table 6 below, the results suggested that a one unit increase in the HIT capabilities index was associated with a 18% increased odds of an ACO being in the top quartile for ACO care management implementation, holding all other variables constant ($p<0.001$). In addition, "Other" ownership, relative to the physician-owned category, was significantly and positively associated with an ACO being in the top quartile of ACO care management implementation (OR: 5.17, $p=0.02$). The number of primary care clinician FTEs was also significantly associated but had very little effect (OR: 1.01, $p<0.01$). There were no other characteristics that were significant in the model.

Table 6. Factors associated with an ACO scoring in the top quartile of the ACO care management implementation index.*

	Odds Ratio (SE)	p-value
HIT capabilities index	1.18 (0.04)	<0.001
Multi-payer	0.98 (0.59)	0.98
Medicare only	0.95 (0.60)	0.94
Ownership**		
Hospital-owned	1.59 (1.01)	0.47
Other	5.17 (3.66)	0.02
Primary care clinician FTE	1.01 (0.00)	<0.01
IDS	0.98 (0.61)	0.98
Financial motivation	1.06 (0.06)	0.25
N	172	

* The model uses imputed data.
** Reference category is physician-owned, "Other" category may include: publicly owned, privately owned, or other.
IDS stands for integrated delivery system; FTE stands for full-time equivalent

Health IT Functionality as a Guttman Scale

Finally, an analysis was conducted to determine whether the nine HIT functionality items formed a true Guttman scale (Guttman, 1950). For example, if the functionality were ordered by difficulty in terms of coordinating information activities, information capture functionality would be the least difficult, followed by information provision functionality, and then information exchange functionality would be the most difficult. A true Guttman scale would mean that these functionality were cumulative – that is, if an ACO responds positively that it has implemented a specific information exchange functionality, it would also respond positively to implementation of "less difficult" functionality, such as that associated with information capture and provision. If the items formed a Guttman scale then ACOs would accumulate positive "responses" (i.e. that they have implemented the specific functionality) in that order of difficulty.

The nine HIT functionality that comprise the HIT capabilities index were the items of interest. It was predicted that the three information capture items were relatively easiest to implement, the four information provision items were relatively more difficult, and the two information exchange items were relatively the most difficult. Standard methods to detect Guttman errors, to see how often the Guttman structure is violated, rely on a complete ordering of each item individually, not by group. In the following, basic descriptives were used to determine how well these items followed the predicted pattern by group (capture, provision, exchange). One item, the extent to which outpatient and inpatient data is integrated from providers with no formal relationship or contracted outside the ACO, was not included in the analysis. The reasons for its exclusion are explained at the end of this section.

For the first analysis, comparison of the groups by individual items was examined to see whether the comparisons followed the expected pattern. For example, the response

for each of the two information capture items was compared individually to the response for each of the four information provision items. An equal or higher response, or score, was expected for the information capture items compared to the information provision questions since the former are easier to implement. Similarly, each information capture item was also compared to each information exchange item, and finally, each information provision item was compared to each information exchange item. For each comparison, the count of observations where the expected pattern does not hold is divided by the total number of observations, to produce a percentage of "violations".

Table 7 below shows the counts and percentages for each individual item comparison. Across the comparisons, the percent of "violations" ranged from 12 to 48% with a mean of 28% violations. It appeared that generally the HIT items followed the expected pattern but not surprisingly, it varied by item. The mean of percent violations between information capture and provision was 29%; the mean between information capture and exchange was 25%. Between information provision and exchange items the mean percent violation was 30%.

Table 7. Violation counts and percentages for individual HIT functionality item comparisons.

Violation*	Count of Violations	Total Observations	Percent of Violations
provision1 > capture1	53	165	32
provision2 > capture1	52	163	32
provision3 > capture1	54	163	33
provision4 > capture1	78	161	48
provision1 > capture3	42	162	26
provision2 > capture3	19	162	12
provision3 > capture3	22	162	14
provision4 > capture3	55	161	34
exchange1 > capture1	51	166	31
exchange2 > capture1	48	165	29
exchange1 > capture3	43	162	27
exchange2 > capture3	20	162	12
exchange1 > provision1	43	165	26
exchange2 > provision1	45	165	27
exchange1 > provision2	62	163	38
exchange2 > provision2	55	163	34
exchange1 > provision3	56	163	34
exchange2 > provision3	45	163	28
exchange1 > provision4	46	161	29
exchange2 > provision4	35	161	22

* See Table 1 for item names for each HIT capability.

In addition, group-level comparisons were made. The mean of responses for each group were compared. It is expected that the mean for information capture items would be at least as large as the mean for information provision and information exchange items for an ACO – 99 observations followed this pattern. For information provision and exchange, it was expected that the mean of the former would be at least as large as the mean of the latter – 114 observations followed this pattern.

A final method was used to assess the group comparisons. The means for each group of items, which range between 0 and 9, were dichotomized such that the value "0" was coded for means with values less than or equal to 3, and the value "1" was coded for means greater than 3. This was a sensible cutoff since the 1, 2, and 3 responses in the web-based survey were also labeled "We do not have the ability"; for 4, 5, or 6 responses the description read: "We have some ability", and for 7, 8, 9: "We have complete or near complete ability". The values were then concatenated in a three-digit number to easily visualize the pattern in the order of information capture, provision, and exchange. The expected patterns were 000, 100, 110, or 111. The results are shown in column 1 of Table 8 below. Only eight of the 166 observations with non-missing values did not follow the pattern expected. The vast majority of ACOs (139) possessed some level of each group of health IT.

In addition, the dicohotimization was repeated further up the 1-9 scale such that means less than or equal to 6 were coded as "0" and all values greater coded as "1". This was more restrictive so that responses reflecting complete or near completed ability would be coded as yes. The results are shown in column 2 of Table 8. Many of the responses were shifted downward not surprisingly, with 64, or 37%, with a 000 pattern. Still using this dichotimization, there were few that did not follow the pattern expected. 27 out of the 166 did not follow the expected pattern.

Table 8. Frequencies of dichotomized HIT functionality group means.

	(1)*		(2)**	
Pattern	Frequency	Percent	Frequency	Percent
...	7	4.05	7	4.05
000	4	2.31	64	36.99
001	2	1.16	6	3.47
010	0	0.00	10	5.78
011	1	0.58	2	1.16
100	1	0.58	16	9.25
101	5	2.89	9	5.2
110	14	8.09	25	14.45
111	139	80.35	34	19.65

Bold represents unexpected patterns.

* Reported frequencies and percentages are based on dichotomizing group means at 3.

** Reported frequencies and percentages are based on dichotomizing group means at 6.

Most of the nine items comprising the HIT capabilities index focused on capabilities internal to the ACO, such as the extent of various EHR functionality. One item which measured the extent to which inpatient and outpatient data from providers

outside of the ACOs were integrated is unlike the others in that it is asks about connectivity *outside* of the ACO. It was excluded from the analysis since the outward facing nature of the capability makes it inherently different from the remaining items.

4.2 QUALITATIVE RESULTS

While it is relatively undisputed that information and data are important to ACOs, less clear are how they are utilized during the various stages of ACO formation and how health IT promotes such utilization. Recent work suggests the importance of work relationships and communication aspects to meet the need for increased coordination within ACOs (Rundall et al, under review). In this analysis, the more formalized methods of coordination using technology, within and among ACO organizations, are explored.

The analysis focused on the diverse roles of health IT in ACO development. During our interviews we were able to gain an understanding of the process by which ACOs develop and how health IT supports these fundamental activities. These findings are presented first, followed by the frequencies with which HIT were mentioned in the context of facilitating information capture, provision, and exchange in the interviews. The various ways in which ACO leaders talk about how health IT facilitates or enables ACO development are described next, and in the final section, the close relation of HIT to care management is discussed.

HIT Capabilities of Early ACOs

ACOs in this early stage of development were characterized by highly varying health IT capabilities. The table below summarizes the current or ongoing health IT investments of the 11 ACOs.

Table 9. Health IT systems and capabilities of study ACOs.

ACO	EHR	Includes inpatient?	Data Warehouse	Decision Support	Registries	Predictive Modeling	Patient Portal	Data Analytics (measurement/ monitoring)
A	Yes	No	No	Yes	Yes	Yes	Yes	Yes
B	Yes	No, but have two-way EMR access	Yes	No mention	Yes	In process	Yes	case mix costs/variation reduction
C	No	No	No	No	No	No	No	Limited
D	Yes, including case managers, coordinators	Yes	In process	Yes	Yes	In process	Yes	In process
E	Yes	Yes	In process	Yes	Yes	In process (risk stratification)	Yes	In process
F	Yes, not yet including case managers, coordinators	Yes	No mention	In process	Yes	Yes	In process	Yes
G	No	Partial	No, but HIE	In process	In process	In process	No	In process
H	Yes	Yes	No	In process	No	No	In process	In process
I	No	No	No	Yes	Yes	Yes	No	Yes
J	No	No	In process	No mention	Yes	Yes	In process	Yes
K	In process	Yes	No	No mention	In process	In process	Yes	In process

Stages of ACO Development Involving HIT

From our conversations, it appeared that there was a general process by which ACOs manage a population of patients:

1. Integrate data from various sources
2. Establish and validate measures/metrics and standards
3. Identify focus areas for improvement
4. Implement improvement interventions
5. Evaluate impact of interventions

This process was not linear but rather it was often iterative. For example, an ACO involving both a medical group and a hospital may have initially integrated their data across both inpatient and ambulatory care settings. Clinical leadership from the two organizations established measures relevant to both, such as the inpatient discharge process involving care transitions or the overall readmission rate, and agreed on acceptable standards or goals of care. Based on these goals and current performance, areas for improvement might be defined and interventions designed and implemented while monitoring the same or additional measures to evaluate the intervention effectiveness. Concurrently or perhaps following these activities, ACO leaders may have sought to partner with post-acute care facilities or additional provider groups in the community such as specialty practices. Similar steps might have ensued to integrate the data, create measures and standards, and improve care or efficiency for a specific care process or sub-population of patients.

Though development paths varied by ACO, health IT helped to coordinate people or information in each part of the process. As previously described, health IT tools coordinated often complex activities by capturing information for pooled activities, providing information for sequential activities, and exchanging information for reciprocal activities. Information capture was the most basic and was related to activities 1, 2 and 5 in the above; both information provision and information exchange facilitated activities 3 and 4. While data analysis was fundamental to many data-related activities it did not describe a coordinating role of health IT and thus it was not included as a separate activity above. However, it was often the precursor to information provision activities.

Health IT and Coordination

In our 11 interviews, there were 87 total comments describing the ways in which HIT is used to coordinate ACO activities through information capture, provision, and exchange. Of these, 72 statements expressed the positive instance of health IT performing coordination activities while 15 expressed limited ability or lack of existing HIT to carry out those specific competencies. Across ACOs, the number of statements varied from 12 in ACO J to one in ACO G.

It appeared that information exchange, describing the most complex coordination activities, was the most frequently mentioned with 37 total mentions during the interviews. Information provision was the next most frequently mentioned with 30 instances, and finally information capture with 20 mentions. Table 9 summarizes the number of comments for each HIT coordination type per participating ACO. These frequencies do not reflect the relative frequency of HIT used in each capacity. Instead,

the numbers may reflect what was most salient to respondent at the time of the interview or what the interviewee considered most important or interesting to report.

Table 10. Code frequencies for comments related to information capture, provision and exchange, by ACO.

	Accountable Care Organization											
Code	A	B	C	D	E	F	G	H	I	J	K	Total
Info Capture Limited	1	0	1	3	0	0	0	0	1	1	0	7
Info Capture	0	0	1	2	2	0	0	4	1	2	1	13
Info Provision Limited	1	0	0	1	0	0	0	0	0	0	0	2
Info Provision	0	3	5	0	6	2	1	3	2	3	3	28
Info Exchange Limited	2	0	1	0	0	1	0	1	0	1	0	6
Info Exchange	2	7	3	5	2	1	0	1	3	5	2	31
Total	6	10	11	11	10	4	1	9	7	12	6	87

Information Capture

Information capture activities took many forms, including activities to capture clinical data within one or more EHR systems or activities to capture the total care for a patient, by integrating data across the care continuum and using both administrative claims and clinical data. Over half of the 11 ACOs we spoke to had fully-integrated EHRs across their providers, meaning that their providers were on a single, common system. However in one ACO (ACO C) there were over 15 disparate clinical information systems. Though a single system made for relatively easier data integration and sharing among providers, many respondents described the need for additional health IT, such as a clinical data warehouse, to aggregate data from various sources in order to capture a more comprehensive picture of patient care. For example, one respondent from ACO E said:

> "Well, one thing about the IT part is that we're actually building an enterprise data warehouse to house claims data that we then will merge with clinical data and in that way be able to see the whole picture of our patient when they go to providers that aren't on EPIC. Their claims data will come through, and we'll actually know at least something about the visit. We'll also have pharmacy data. We'll know when our patients fill their prescriptions and when they don't, which is a big deal because right now you know you prescribe it, but you have no clue if the patient is taking it. So that is information that we're trying to bring in now…"

As shown in this example, information capture entailed the aggregation of multiple data types, including administrative, specialty, pharmacy, post-acute, or behavioral health care data. It involved both technical, and depending on history or culture, perhaps political challenges as well.

The same respondent described the need for flexibility within a data warehouse – to not only integrate different data types but also data from multiple organizations of the same type: "…we've tried to structure it agnostic to payer, so it could easily be expanded as we move forward. We also have 120 or so metrics that payers have given us or the quality metrics required by the MSSP that we are also building into our data warehouse

and our monitoring processes so that we can kind of focus on the things that payers have said they believe are important for the better care of their beneficiaries, or Medicare has said." In this example, it was important that the design of the tool accommodate data from multiple payers. For the most part it appeared that ACOs were designing and developing their infrastructure with future ACO partners in mind.

Establishing metrics and determining standards were closely related to information capture and data aggregation efforts. These activities involved some degree of discussion and exchange between ACO partners in order to come to agreement. This step was considered to be closely related to information capture as it involved preparing the raw data in some useable and interpretable form. One respondent from ACO B described these types of activities further along the care continuum, involving new partnerships and requiring access to data: "There was work done in the post-acute facility group that focused on skilled nursing facilities. They developed a limited network of skilled nursing facilities, and developed standards for both the facilities, and the providers who care for patients in those facilities…and there's work being done now to develop a scorecard to track quality and utilization metrics for those facilities." The example above implicitly described the use of health IT to monitor performance at both the organizational and provider levels for partner organizations.

While health IT such as EHRs and data warehouses were critical to information capture, ACOs faced considerable IT challenges that may have hindered their progress in such activities. Recognizing that information capture is only one piece along the development process one respondent (ACO A) confided:

> "One of the biggest factors that we have realized, we realized it going in to the ACO, but we didn't realize the scope or the importance of it until we got deeper into it. And that is that our medical records, as much as they allow us unprecedented ability to file data and retrieve data and even report on data, they are first and foremost meant for documentation of clinically relevant matters. And they're not data analysis tools… so getting data, but data that is a combination of claims data as well as patient specific data entered into the electronic record has been critical to us in terms of our ability to find actionable areas where we can put our clinical resources to achieve the goals of the ACO. And getting that data has been much more difficult than we thought. Getting that data in a clean, meaningful, actionable way, and also as expeditiously as possible, because when you think about what we need to change, three years sounds like a long time. But in the context of the change necessary, three years is almost the blink of an eye. So we need data feedback much faster than we typically get."

This individual described the need for information capture that is comprehensive, timely, and accurate in order to support more sophisticated information provision and information exchange activities required of ACOs. Not surprisingly, this was a challenge for all of the ACOs we interviewed.

Information Provision

Information provision activities were those in which information was provided from one party to the other as part of the larger process of patient care. Examples of information provision included a central team providing a patient list for care manager follow-up or electronic alerts provided to physicians to signal an overdue screening or test. Information provision in the interviews were described most often as occurring at two levels of the organization: at the central team level, which spanned across the different physician practices, and at the frontline level, which occurred where the care team and patients and their caregivers interact. Many respondents discussed the ability to provide performance feedback to physicians. For example, one respondent from ACO J was very explicit about how comprehensive information capture enabled the provision of new information to physicians: "I think the aha for us is now that we have stood up a data warehouse, it will allow us to aggregate even more information, have a repository so we can have more of a profile of our patients. I talked to you about being able to produce report cards on a quarterly basis. Our goal is by the beginning of next year is that will be able to update all of our information nightly, and our physicians will understand how they are progressing." The performance feedback provided to physicians and near real-time data of their patients allowed physicians themselves the ability to monitor the care they deliver.

Respondents not only spoke of more frequent feedback to clinicians, but access to new types of information. One individual described the newly acquired ability for physicians to understand their performance in non-traditional ways, such as "performance on a cost basis or cost efficiency and looking at things like what drugs are they prescribing…what is the rate of their high tech imaging…where are they doing their procedures…and so they can start to understand how their practice patterns are impacting the cost of care and not just the quality." In this particular ACO (ACO G), health IT enabled physicians to understand their prescribing patterns and their relative cost efficiency, measures that they previously did not have access to but which could potentially motivate behavior change. ACO themselves were evaluated by cost and efficiency, making these measures increasingly important.

Most often, respondents mentioned information provision in the form of performance feedback and patient lists. While it was often implied that information provision to clinicians was important, the following quote from one ACO leader in ACO F pinpointed why it is critical to quality improvement: "I think that infrastructure build is really around our business intelligence capabilities of not only reporting the quality measures at the end of the year but if we want to actively improve them and get our care teams to improve them we have to have regular daily, weekly, monthly performance reports and patient panel registries in order to put them into our care team processes. They know who these patients are and make sure that they're engaged with their quality in diabetes or depression or vascular disease, hypertension and all of that so the infrastructure and data analytics is huge…" For this respondent, timely information provision was at the core of focusing and improving care delivery within care teams.

At the frontline level, there were several responses regarding decision support tools that provided information to physicians through alerts and real-time data. One leader from ACO G described a vendor-supported tool:

> "…this point of care tool is basically a patient summary that is presented for every single patient they see, whether or not they are Medicare Shared Savings or one of our contracted commercial payers. It's for literally every patient they see and that gives them really clinical decisions for point of care. So if someone came in for a sore knee this particular document will tell them all their actionable--their last labs and what risks they have and what outstanding recommendations they have whether it be immunizations, vaccinations, whatever screening, preventive care. It just raises awareness with the physician at that time that that patient is in need of additional services. And that works great for patients that are in front of them."

Other respondents spoke of decision support tools provided through their electronic records – for primary care or subspecialist physicians, and also for medical assistants or nurses who use the system – to identify standards or elements of care which are not met, at the point of care.

Finally, only one or two respondents mentioned the use of health IT such as patient portals to provide information to patients. One interviewee from ACO E described patient alerts in MyChart, a patient portal available in a widely used EHR:

> "If you haven't had something done, and based upon your age or whatever, it appears you ought to have it, you will receive an alert in My Chart telling you that you should have it…So MyChart is a communication tool, and we send medical information to patients through it. But we don't really let them give us anything back."

Electronic information provision to patients through patient portals appeared still to be in the infancy stages.

Information Exchange

Information exchanges activities were characterized by bi-directional access to information from a different part of the care process, which may have directly informed and influenced clinical decision-making. In our interviews, there were some instances where respondents described initiatives that revealed the close relationship between information provision and information exchange activities. In ACO F, the central ACO team was able to "risk stratify patients based on claims and put that in front of a physician at a care conference to talk about these patients". These care conferences were a care delivery innovation where a physician coach facilitated discussion of a high-risk patient with a primary care physician and medical home team including a social worker, pharmacist, and care manager. Risk stratification and the resulting patient list enabled the care team, during the 30-minute care conferences, to focus on potentially vulnerable patients. They allowed for a quick exchange of patient information and status as well as discussion on appropriate next steps.

Information exchange was by far the most sophisticated type of activity facilitated by health IT. The following two examples show how EHRs have enabled the exchange of information in a way such that different care providers had access to specific patient information at the right time. In the first from one leader at ACO D, simple data sharing allowed for case managers and care coordinators to understand what each other were doing across the inpatient and outpatient settings.

> "We're all integrated. The case managers also document in EPIC. And in fact, if a patient is admitted, so one of the patients on the ACO is admitted, case managers document just like everybody else, you know, the integrated model in EPIC. And the care coordinators on the outpatient side are able to see exactly what happened and the care coordination that took place on the inpatient side. So there is absolutely no lag as far as how things are viewed."

In this system, all individuals involved in patient care were on the same system and were able to share the same view of a patient's record. It allowed care providers to understand what needed to be done, how the care they provided impacted the care for a patient during a different part of the care delivery process, or vice versa. The following second example, from ACO E, showed how information exchange results in more efficient care:

> "And so they've been working really well on how to create kind of like a seamless continuum for the patients, so that everything the orthopedic surgeon would want to have seen done ahead of time has already been done, and because we have an electronic medical record, it's now all available to the orthopedist when the patient arrives. And so it's far more seamless and efficient for the patient. We have less duplication of tests and in more proper timeframe. You get from identification of symptoms to treatment of diagnoses."

In this example, not only was data exchange occurring to document clinical activities, it was used to inform the information needs of other actors further along in the care process and also to prevent duplication of activities.

Care Management and Health IT

In the above, we have explored the various ways in which health IT has enabled information capture, provision, and exchange activities within developing ACOs. While presented relatively independently, these activities were actually tightly coupled and helped focus, measure, and improve care management capabilities in areas such as care coordination and patient engagement. The following illustrated how information provision closely followed information capture in ACO A, then translated to targeted care by case managers:

> "And then other programs like orthopedics for instance, we've identified through data analysis, cost analysis, that total joint replacement is a major expense for us that really does bear some consideration in terms of care coordination and specialist engagement. Colorectal cancer screening and those sorts of things. So we've identified all of these programs, and then our nurse case managers apply the pre-visit planning process to patients who are included in these lists of patients per provider who have a need for that. So that's how the care coordination goes."

In this example, the information provided to nurse case managers helped prioritize patients and inform them of special needs or extra attention that patients may have needed during their next exchange.

The following quote illustrated the portfolio of health IT capabilities to understand the totality of patient care, as it is happening, to improve care transitions in ACO J:

> "We've invested significantly in technology to use registries, predictive modeling, care management tools. We've redesigned, or are in the process of redesigning our care management model within the hospital. Our goal is not a discharge but we really want coordination of care. We want a clean handoff. We want to know where the patient is going. We want to know that the patient had outstanding reconciliation on their meds, that they have an appointment with their physician, that we can track that follow up."

In this ACO, investment in health IT and care process redesign activities were closely related to improving care coordination.

Finally, the following respondent described system triggers for patients at risk for readmission, its effects on increased patient outreach, and its measureable impact on readmissions in ACO K:

> "I would just say keeping in contact with the patients after they've left the inpatient venue has really been the most effective. We have a tool that we use for our inpatients that tries to risk adjust our inpatient population to identify those patients at high risk for readmission within 30 days. It's called the LACE tool. This tool identifies those patients. And what we've done, if any patient who has a score of 10 or greater gets sort of full court press on discharge, which means they get a care transition visit. They get a follow up appointment scheduled for them. They get referred to the case management departments. And we've seen that our readmission rate of that population since we've implemented this tool is constantly coming down. It's come down considerably, and it's continuing to decrease. And it's again because the patients are engaged."

This example highlighted the use of information, generated by technology-enabled tools, to measurably improve care outcomes.

The findings presented above reveal the breadth of health IT capabilities that ACOs possess and illustrate the ways various tools are used in coordination activities through information capture, provision, and exchange.

5 DISCUSSION

The analysis demonstrated that health IT is positively and significantly associated with ACO care management implementation. It appears that HIT such as data integration, predictive risk assessment, and various functionality typically found in EHRs are positively associated with care management capabilities in the areas of chronic disease management, care transitions, and patient engagement. The causal direction of the relationship is not able to be determined from the current study, but it is possible that HIT both strengthens and is strengthened by care management capabilities. If both are true, then these have a mutually reinforcing relationship. For example, health IT may be implemented to support care delivery workflow, but also the care delivery needs identified through quality and process improvement may also highlight additional areas for HIT development. Robust health IT infrastructure is not only important in itself, for example to achieve workflow efficiencies and improve safety in areas like medication management, but also as a facilitator of care management processes and practices within an ACO.

Evaluating health IT by their coordination levels may be a useful way of conceptualizing these systems and system functionality. The results suggest that information capture and provision are not significantly associated with ACO care management implementation but information exchange, involving the most interdependent activities, is positively and significantly associated with ACO care management implementation. This may not necessarily suggest that simpler forms of coordination do not have meaningful contribution to the development of care management, especially if these activities lay the foundation for higher-level coordination to occur. Instead the findings may suggest that health IT designed to support more complex forms of coordination has the greatest impact on ACO care management activities and has the potential to support care for the most complex patients.

In addition, our analysis comparing the relative impacts of HIT functionality in their association with ACO care management implementation revealed that the difference between information capture and provision is not significant, whereas information exchange is significantly different from both information capture and provision. This verifies our findings using multiple regression and distinguished the impact of information exchange functionality relative to the two other types. Again it is not to say that information capture and provision are less important since conceptually the coordination levels are cumulative, i.e. information exchange inherently includes both capture and provision as well (and our analysis showed support for this), but to emphasize the role of coordinating reciprocally dependent activities in ACO care management.

The findings using a muti-payer contract interaction term also suggest that the presence of more than one ACO contract diminishes the strength of the relationship between HIT and care management. This is an interesting and unexpected finding if one considers the number of payer contracts to be correlated with the total amount of risk an ACO is taking on. For example, if an ACO is exposed to greater risk as a result of a greater proportion of its patients or patient revenue tied to risk-based contracts, one might guess that it would also make greater HIT investments in order to manage the care for

those patient populations more closely. However, it may be that health IT in organizations with multiple ACO contracts make a small marginal contribution to care management implementation efforts with each additional contract and in these instances other factors are relatively more important. In our interviews, many respondents felt that multiple ACO contracts would not require substantial additional infrastructure development. Yet, for ACOs with a single ACO contract, it appears that HIT is fundamental to development of care management within that ACO.

The current study includes ACOs representing the early adopters of the payment and delivery system innovation. These organizations are still new and dynamic, especially as ongoing efforts to promote the model may likely target increasingly diverse healthcare organizations. The significant interaction between the presence of multiple ACO contracts and health IT may change, and may be also become more relevant as ACOs continue to increase their attributed number of patients either through existing or new contracts. As a result, it is important for future studies to examine whether these relationships change or remain consistent as ACOs develop and evolve.

From our interviews we reported the frequencies with which ACO leaders mentioned information capture, provision, and exchange processes when describing their health IT systems and capabilities. The interviews supported the categorization of HIT functionality used in the earlier quantitative analysis. We found that leaders most frequently spoke of their HIT in an information exchange capacity and less so in terms of information capture. This does not necessarily mean that they possess these capacities to a greater degree but rather that they may have found data exchange to be most relevant to their work. We find that often it is the increased ability to share and exchange information that distinguishes an ACO development effort from others. In addition, information capture, while mentioned least frequently when described in the positive sense, was mentioned most frequently among instances describing limited or nonexistent HIT capabilities. It seems that one challenge our study ACOs universally faced is integrating multiple types of data from various sources.

Many examples showed how health IT underlies key care management processes within an ACO, and there were several instances where health IT and care management capabilities were described as intricately related. As one individual remarked "care management – setting up the best way to re-stratify our patients, to reach out to our patients, and to keep them as healthy a we can keep them while at the same time creating the infrastructure to actually monitor that and recognize who they are – that is a lot of IT infrastructure" (ACO E). We provided striking examples of how health IT captures, provides, and exchanges data in the context of ACOs. Using this framework we observed how ACOs in their early stages use and develop IT to support their formation.

In our interviews, we also found that HIT systems varied widely. Some ACOs were completely integrated on their clinical systems, a couple others had a single system for the majority but not all of their physicians, and some faced the challenge of several disparate systems. Even among those with fully integrated EHRs, some respondents did not have access to inpatient data for their ACO members and yet others had not fully developed the functionality built-in to such large investments. ACOs realize the necessity for robust data analytics, yet the ACOs we spoke to have gone about this differently – some have achieve integration and reporting through a data warehouse and

yet others have sought vendor-sponsored systems to meet their needs. While ACO leaders we spoke to had a clear conception of what and how such data were to be used, it is clear that there are many paths leading toward the same destination.

Furthermore, it appeared that relationships drive the extent of the activities in which an ACO is engaged. This observation appears to follow closely with Gittell's theory of relational coordination, which describes interpersonal dimensions of relationships as the means by which coordination can be achieved (Gittell, 2002b). For example, several respondents reported a uni-directional flow of claims data feeds from their payer partner. However, only in select ACOs, those with a close working partnership with the payer, did activities beyond information capture occur. For example, two respondents in ACO D described working with their payers in case management – to not only identify high-risk patients or those needing follow-up, but also to use utilize case management resources from the payer to accomplish these tasks. On the opposite end of the spectrum, one leader from ACO K described the disappointing lack of analytic support from their payer when a more complementary relationship was expected.

A similar pattern was observed for acute and post-acute care organizations. For example, two ACOs mentioned their involvement with skilled nursing facilities in an effort to track the care of their patients across care settings; yet in only one of these were plans discussed to integrate clinical systems in an effort to more comprehensively capture patient care information. The degree to which an ACO is involved in coordination through health IT is likely driven but also limited by relationships among internal and external ACO partners. The relationship between relational coordination and health IT is an area that should be explored in future studies.

In this study we included structural and organizational characteristics of the ACO as covariates in our quantitative analysis. Other recent studies of HIT use have looked at characteristics of the HIT users themselves, such as the use of mid-level providers and provider communication patterns, which may be relevant to understanding the relationship between HIT and care management (Lanham, Leykum, and McDaniel, 2012; Milstein and Jha, 2012; Graetz et al, 2014). These studies of health HIT suggest that team design and communication may influence the use of health IT and related processes and outcomes. Future studies should examine the role of intra-organizational factors, including team-level characteristics, in the relationship between HIT and care management capabilities.

5.1 LIMITATIONS

The study has several limitations. First, the survey questions were answered by a single respondent from the ACO, who may or may not have been the most knowledgeable of the health IT or care management capabilities of the ACO. These topic areas were only two of many covered by the NSACO. Relatedly, questions were asked in the context of the largest organization in the ACO, so the ability to measure the capabilities of the entire ACO was limited since ACOs can include multiple organizations. Despite this however, we are fairly confident that through the sample development and introductory emails we identified the most capable respondents, those in a position to answer questions across the breadth of dimensions related to the ACO.

In addition, many of the HIT-related questions were multi-part questions; for example one question asked "To what extent are clinical decision support rules able to be implemented and is compliance with the rule capable of being tracked within the EHR(s) used by your ACO?" The response may have been subjected to a great degree of variation in interpretation by respondents depending on how they evaluated their organization's ability on the various components of a question along a single nine-point response scale.

Third, categorization of health IT functionality into information capture, provision, and exchange presented a challenge in a few instances where the multiple parts of a survey question reflected different coordination levels; for example, one question stated "To what extent are PCPs able to provide relevant referral information electronically to specialists AND obtain relevant and timely feedback electronically?" The first part of the question (PCPs providing relevant referral information electronically) refers to information provision, while the second part (obtaining relevant and timely feedback electronically) in combination with the first part represents information exchange. There were only a couple questions of this type but in such instances it was difficult to make one categorization for the range of HIT functionality. Still, to the extent possible we used the qualitative data to inform our categorization of functionality asked about in the survey questions.

Fourth, substantial missing data were present. In the non-imputed model, only 128 of 173 were included. Through MICE the missing data was addressed and the estimates using the imputed data were found to follow closely with that using the non-imputed data. Though there was no way to verify the ability of the multiple imputation approach to generate valid estimates, it has been found helpful in other empirical studies (van Buuren et al, 2006; van Buuren, 2007).

Finally, one can argue that since the dependent and primary independent measures were derived from the same source, the measure of ACO care management may have included some measurement of HIT capability, confounding the results. However, we do not believe the potential for this is great given that the questions related to care management asked about more general processes or programs in place, such as the extent to which chronic care management processes and programs are in place or the extent to which the ACO has established processes and protocols related to end of life care. The respondent would likely have answered these questions in the broader context of current clinical workflow practices. In contrast, the HIT related questions asked about specific functionality, many of which are specific to the EHR system(s).

There are also limitations to report in our qualitative analysis. There were one to four respondents in each interview we conducted. Given that we asked about a variety of topics similar to the survey, it is unclear whether the individual(s) to which we spoke were the most knowledgeable in a given area and provided complete and accurate responses. The findings were from the perspective of leader(s) of the focal provider organization though they may not be the individuals who directly and routinely used health IT systems in the manners they report. However, given the introductory email describing the project and interview objectives, as well as various communication related to planning and scheduling for the interview, it is likely that these leaders were indeed the individuals best able to comment about many different areas across the organization.

Eleven ACOs comprised our study, which is insufficient to make generalizations about the existing universe of ACOs. Still, we intentionally sampled ACOs across a variety of organizational characteristics in order to represent a range of ACO experiences. In most cases we were able to distinguish what has occurred as a result of the ACO, though in some cases it is less clear. We reported the extent to which HIT systems exist or were in development within current ACOs, independent of whether the HIT initiatives were conceived prior to or as a result of the decision to become an ACO.

6 CONCLUSIONS

While ACOs are a payment and delivery system model that is quickly transforming the healthcare organizational landscape, there is uncertainty whether they are able to achieve the Triple Aim goals of improving patient experience, reducing costs, and improving quality. It is relatively early in their implementation and future research is needed to assess their impact on the Triple Aim. In the meantime, it is important to understand their early implementation and to identify the factors associated with their transformation and ongoing evolution.

The ACO model distinguishes itself from earlier payment reform initiatives by holding member organizations responsible for the overall quality and cost for a defined population of patients. Many respondents described how data are necessary to be able to take risks, both clinical and financial, which are inherent to the design of the ACO model. According to one ACO leader, "You've got to have the data…You can't be accountable without the information that you need, and we have that, but it brings home all the time for us when there were delays in getting the data…how important that data is. I don't think you can take risks without it." Increased risk is attenuated by increased measurement and monitoring ability. As another respondent reflected: "As we're really trying new things and as we try new things we're trying them on this population because we have such rich data for this population. We really have an ability to measure whether or not we're having an impact and if we can prove on this population that you can really have a substantial impact on the Triple Aim, then we can take initiatives and resources like this to scale and I think that has helped us somewhat." From these leaders, it is clear that what is new and what is enabling the movement toward accountable care is data. In this way, health IT, which supports information processes, is central to ACO development.

This study has shown health IT to be positively associated with care management capabilities in the ACO context. We characterize these HIT capabilities based on the level of coordination that they provide and find some evidence for its usefulness. In our interviews we saw several examples of information provision, capture, and exchange using health IT in the care management context, showing that this conceptualization of HIT coordination in ACOs appears to be useful. In addition, through the interviews, we found that all the ACOs we spoke to were challenged with obtaining a more comprehensive picture of patient care for their patients. They used health IT in varying and differing ways but the goals remain the same.

It is likely that many healthcare organizations undergoing ACO development are concurrently building one of more aspects of their HIT infrastructure. For example, there may be a great degree of overlap between physicians participating in ACOs and those participating in the Medicare EHR Incentive Program established through the HITECH Act, which promotes the spread of "meaningful use" of EHRs. In the light of the fact that billions of federal dollars have been dedicated to establish programs through both HITECH and PPACA to improve healthcare quality, safety, and efficiency, future research should seek to further identify specific HIT areas most critical to care management development within ACOs to inform these concurrent programs.

Given health IT's potentially multi-faceted contribution to ACO development, additional assistance may be targeted to specific ACOs. Among physicians, it appears that primary care specialties and those in larger practices are more likely to use EHRs and meet criteria for meaningful use (DesRoches et al, 2008; Bruen et al, 2011). Small physician practices may be unable or unwilling to take on the resource-intensive EHR implementation work, though those who join ACOs may find additional support. Smaller physician led ACOs may be one group that would benefit from additional assistance in developing health IT and related infrastructure (Shortell et al, under review). Given the tight coupling of health IT and care management capabilities found in the current study, assistance to organizations with little resources for HIT or care management support may be a good investment.

The ability to better care for patients with chronic illness will be central to ACO success in meeting cost, quality and population health goals. The effective use of HIT will be one of the key capabilities needed for enhanced care management. The current study has shed light on this relationship by specifying the specific coordination roles the HIT plays in the care process and, in particular the importance of the information exchange role in coordinating highly interdependent activities associated with providing patient care.

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APPENDICES

APPENDIX A1. NSACO SURVEY QUESTIONS USED FOR ACO CARE MANAGEMENT IMPLEMENTATION INDEX

Survey questions used for ACO Care Management Implementation Index (7 questions, 1-9 response scale):

Q75: To what extent are chronic care management processes and programs in place to manage patients with high volume, high cost chronic illnesses – including mental illness?
Q88: To what extent is the ACO actively engaged in improving ambulatory care by using disease monitoring data, such as HbA1c testing, eye exams, and cholesterol levels for diabetics?
Q74: To what extent are providers engaged in and compensated for planning and continuous management of patient care?
Q76: To what extent are systems in place to assure smooth transitions of care across all practice settings including hospitals, long-term care, home care, adult day care, and community-based health and social services as needed?
Q85: To what extent is the organization engaged in reducing preventable hospital readmissions?
Q79: To what extent do clinicians encourage ACO patients to be actively involved in decisions involving their care and self-management of their care?
Q80: To what extent does your ACO have established processes and protocols for identifying, counseling and planning for end of life care?

APPENDIX A2. NSACO SURVEY QUESTIONS USED FOR HIT CAPABILITIES INDEX

Survey questions used for HIT Capabilities Index (9 questions, 1-9 response scale):

Q62: To what extent are you able to integrate outpatient and inpatient data from providers within the ACO (including medication data, lab results, and health status appraisals)?
Q63: To what extent are you able to integrate outpatient and inpatient data from providers with no formal relationship or contracted outside the ACO (including medication data, lab results, and health status appraisals)?
Q64: To what extent is a sophisticated system in place for predictive risk assessment AND risk stratification of the ACO patient populations?
Q65: To what extent are registries used for all ACO patients to track chronic conditions and preventative measures, and can be linked to the EHR(s) used by your ACO?
Q66: To what extent are PCPs able to provide relevant referral information electronically to specialists AND obtain relevant and timely feedback electronically?
Q68: To what extent are clinical decision support tools able to be implemented and is compliance with the rule capable of being tracked within the EHR(s) used by your ACO?
Q69: To what extent are up-to-date problem lists of current and active diagnoses AND/OR active medication lists maintained within the EHR(s) used by your ACO?
Q72: To what extent are patient reminders for preventive/follow-up care generated by the EHR(s) used by your ACO?
Q73: To what extent are patients provided an electronic copy of their health information AND/OR discharge instructions upon request?

APPENDIX B. IN-DEPTH RESULTS FROM QUANTITATIVE ANALYSIS

Table B1. Correlation matrix of model variables

	ACO Index	HIT Index	Total FTE	Financial Motivation	Multi-payer	Ownership	Medicare Only	IDS
ACO Index	1.00							
HIT Index	0.59	1.00						
Total FTE	0.24	0.00	1.00					
Financial Motivation	0.27	0.19	0.10	1.00				
Multi-payer	0.28	0.13	0.34	0.14	1.00			
Ownership	0.28	0.09	0.14	0.04	0.04	1.00		
Medicare Only	-0.13	-0.08	-0.31	-0.08	-0.55	-0.10	1.00	
IDS	0.16	0.13	0.40	-0.15	0.16	0.27	-0.29	1.00

Figure B1. Added variable plots to determine outliers.

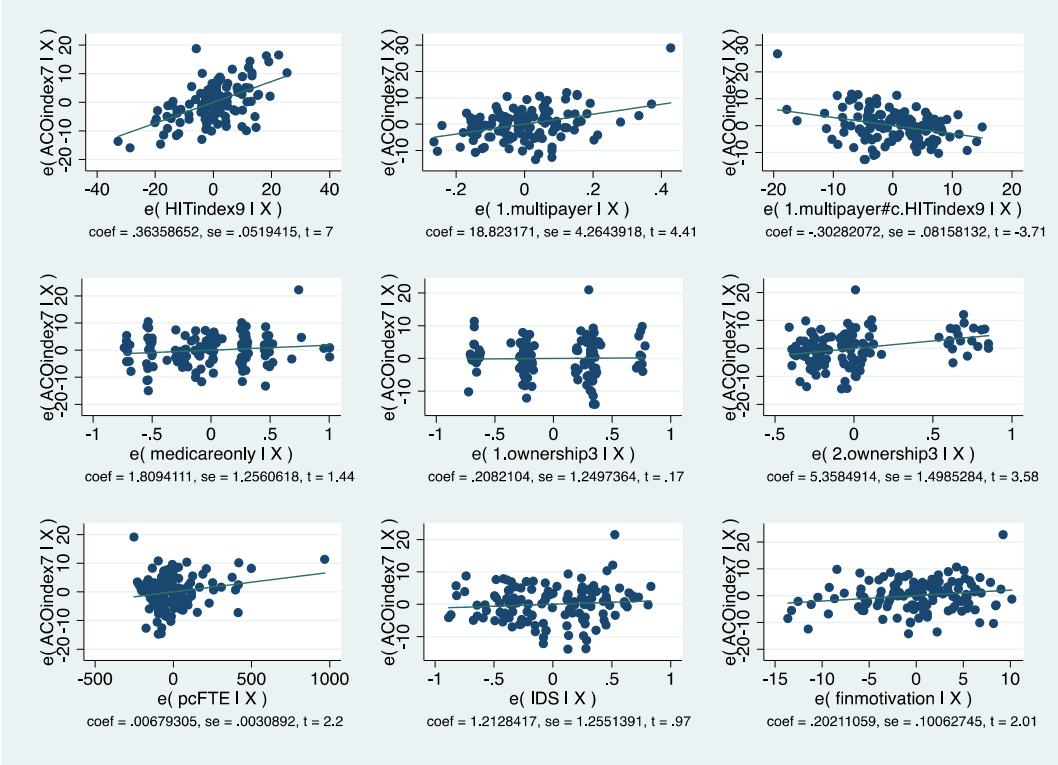
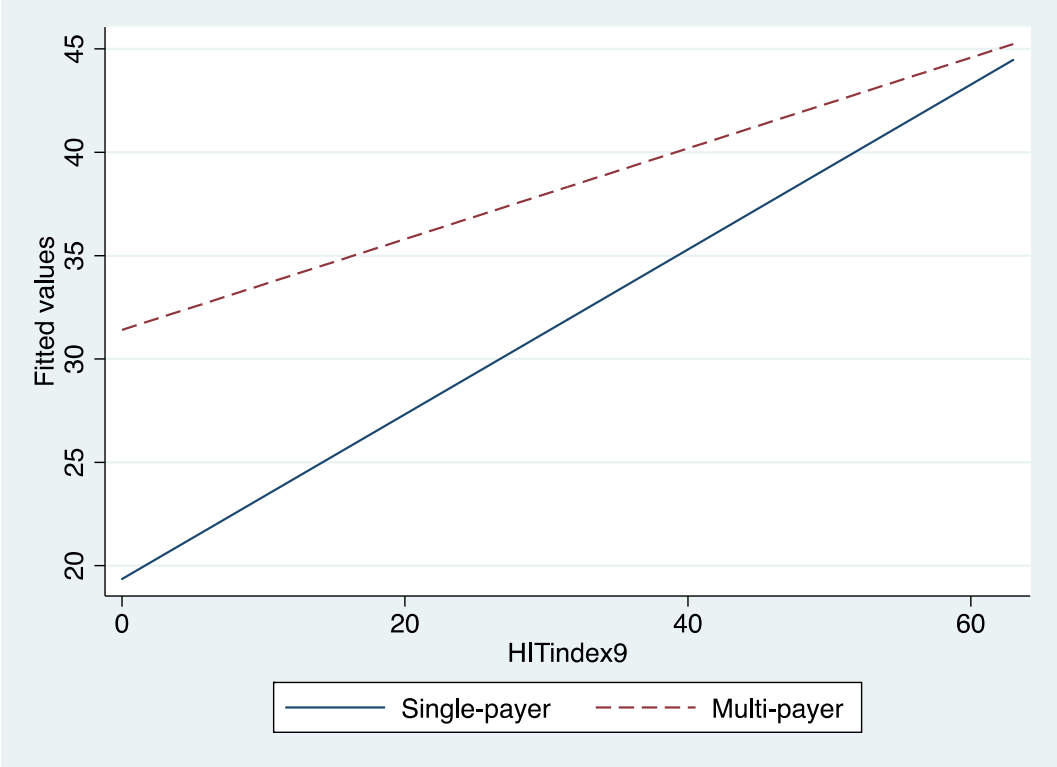


Figure B2. Plot of predicted values vs. HIT capabilities index, by multi-payer status.



APPENDIX C. AUXILIARY VARIABLES USED FOR IMPUTATION MODEL.

Model Variable	Auxiliary Variables
Ownership	**Number of provider groups** – sum of responses for the following survey questions: For each type of provider organization, please identify how many are participating (i.e. have members attributed) in the ACO for which you completed this survey: Hospital, Nursing Facility, Federally Qualified Health Center or rural health center, Medical Group, Specialist Group **Organization type** – response for the survey question: Which of the following best describes the organization of your ACO? Response options: Physician-led; Hospital-led; Jointly led by physicians and hospitals; Coalition-led; State, region, or county-led; Some other arrangement
IDS	**Scope of services** – one point assigned for each "Yes" response for the following survey questions: For your largest commercial ACO contract, which of the following services are included in the total cost of care for the ACO budget calculation? (This is the target on which the shared savings will be determined): Inpatient, Emergency Room, Outpatient, Lab/X-ray, Advanced Imaging, Professional Services, Pharmacy, Mental health/Substance Abuse, Durable Medical Equipment, Vision hearing and speech services, Dental, Other). Response options: Yes, No, Don't know **Contracted services** – one point assigned for each "Within the ACO" response for the survey questions: Please indicate the highest level of engagement that the following provider groups have with the ACO: Primary care, Routine specialty care (e.g. orthopedics), Specialized care, such as transplants, Hospital inpatient care, Emergency care, Non-emergency urgent care, In-patient rehabilitation services, Out-patient rehabilitation services, Behavioral health, Skilled nursing facility, Pediatric health, Palliative/hospice, Home health/visiting nurse, Outpatient pharmacy, Other. Response options: Within the ACO, Contracted outside, No formal relationship, Don't know
Financial motivation	**Local market** – response to the survey question: On a scale of 1-5 where 1=not at all competitive and 5=very competitive, how intense is the competition for patients in your market?

APPENDIX D. IMPUTATION MODEL USED FOR EACH IMPUTED VARIABLE.

Model Variable	Method	Variables Included in Imputation
Financial motivation	linear regression	financial motivation, primary care physician FTE, ACO care management implementation index, HIT capabilities index, IDS, ownership, local market, Medicare only, multi-payer
Primary care physician FTE	predictive mean matching	primary care physician FTE, financial motivation, ACO care management implementation index, HIT capabilities index, IDS, ownership, Medicare only, multi-payer
ACO care management implementation index	linear regression	ACO care management implementation index, financial motivation, primary care physician FTE, HIT capabilities index, IDS, ownership, Medicare only, multi-payer
HIT capabilities index	linear regression	HIT capabilities index, financial motivation, primary care physician FTE, ACO care management implementation index, IDS, ownership, Medicare only, multi-payer
Integrated delivery system	logistic regression	IDS, financial motivation, primary care physician FTE, ACO care management implementation index, HIT capabilities index, ownership, scope of services, contracted services, Medicare only, multi-payer
Ownership	multinomial logistic regression	ownership, financial motivation, primary care physician FTE, ACO care management implementation index, HIT capabilities index, IDS, number of provider groups, organization type, Medicare only, multi-payer

APPENDIX E. NSACO IN-DEPTH INTERVIEW GUIDE

ACCOUNTABLE CARE ORGANIZATIONS INTERVIEW DATE _____
Name, Title, and Organization of Interviewee:

_____

Thank you for agreeing to speak with us today. As mentioned in our email introduction letter, our conversation will focus on different aspects of ACO formation and development.

Over the next few weeks, we will be speaking with individuals at approximately 10 ACOs across the country. The goal of these interviews is to identify strategies that organizations have used to successfully implement ACOs in diverse settings.

We expect that our discussion will take about 45 minutes. The name of your organization will be included as a participating organization and linked to your responses in project reports. Prior to submission, you will have an opportunity to review the report and correct any factual errors. May we have your permission to record this conversation so that we can transcribe your responses? Before we begin, do you have any questions for us?

We will start by asking you some background questions about you and some general questions about the ACO.

Respondent and ACO Background

1. Can you briefly describe your role in regards to the ACO? At what point did you become involved in the ACO? (*If needed, probe: When was this?)*
2. What are the most important goals the organization's leadership has set for the ACO?

Overview

3. From your perspective, what is the greatest accomplishment the ACO has achieved?
4. To what would you credit your successes thus far?

Relationships among Participating Organizations

In the next set of questions, I will ask you about various relationships among the organizations participating in the ACO.

Health Plan Engagement

5. Can you describe the ACO's relationship with the payer or health plan supporting the ACO? (*Probes: Was this a prior experience or a new relationship? Did the health plan initiate the ACO planning and discussions or did you and the providers? How would you describe the communication between the providers and plan?)*

Hospital Engagement [only relevant for ACOs that include a hospital partner]

6. How important was it to include a hospital partner in the ACO?
7. How has hospital management justified the business case for entering into an ACO contract?
8. How has the hospital changed its business model to adapt to ACO participation?

Physician Engagement

There is great interest in strategies used to engage both physicians and patients within new ACO models. The next set of questions focus on your ACO's approach in these two areas. First, regarding physicians:

9. To what extent has ACO formation created new organizational ties, interdependency and coordination among ACO physicians? *Probe for specific examples if needed.*
10. What is the role of physician leadership in ACO development?
11. In what ways have clinicians been involved in ACO discussions and decision-making?
12. Can you describe the strategies that you have used to engage clinicians in these activities?
    a. How successful have these strategies been?
    b. What are the barriers to such patient engagement?
    c. How have you been able to overcome those barriers?

Patient Engagement and Participation

With regard to patients:

13. Can you describe the strategies that you have used to engage patients in ACO programs designed to promote health and prevent disease? *(If needed, probe for a specific example of an action or a program they have implemented?)*
    a. How successful have these strategies been?
    b. What are the barriers to such patient engagement?
    c. How have you been able to overcome those barriers?
14. Can you describe the strategies that you have used to engage patients and their caregivers in non-clinical activities, such as advisory panels, Town Hall meetings, or informational surveys?
    a. How successful have these strategies been?
    b. What are the barriers to such patient engagement?
    c. How have you been able to overcome those barriers?

Capabilities of the ACO

The next few questions are related to the capabilities of your ACO. I will ask you questions related to health information technology infrastructure, care management programs, and finally quality and process improvement activities.

Health Information Technology

With regard to health information technology, such as electronic health records, health information exchanges, disease registries, and data sharing:

15. In what ways do you use health IT in your ACO?
16. Does your ACO use health IT for disease management? If so, how is this done? Which specific diseases is your ACO focused on currently?
17. Does your ACO use health IT fir case management? If so, how is this done?
18. What are the barriers to effective use of health IT in your ACO?
    a. How have you overcome those barriers?
19. Does your ACO or its participating organizations have plans to further develop health IT? If so, can you describe these plans?

Care Management

The next set of questions is related to your care management programs, such as chronic disease management, pre-visit planning, medication management, discharge planning, etc.

20. Can you describe the ways your ACO has tried to increase coordination of patient care?
    a. What has been your most effective program or activity to increase care coordination?
21. What have been the biggest barriers to implementing care management programs in your ACO?
    a. What were the specific policies and practices your ACO employed to overcome these barriers?
    b. Which of these policies and practices were most effective?

Quality and Process Improvement

In regards to quality improvement:

22. Does your ACO have a quality and patient safety committee?
    a. Can you describe how the committee works?
    b. What are the committee's most important quality improvement and patient safety priorities?
    c. Can you describe an example of an effective effort to improve the quality of care for patients in the ACO?
23. Can you describe an example of an effective initiative to reduce waste or inefficiency?
    a. Why do you think this effort was able to achieve its objectives?

Multiple Payer Contracts [only relevant for ACOs with contracts with multiple payers]

We are interested in the rationale and specific processes associated with pursuing ACO contracts with a single payer compared to with multiple payers.

24. What, if any, additions in infrastructure are needed to pursue a multi-payer ACO?
25. At what point did you decide to pursue an ACO with multiple payers?
26. What were the driving forces behind your decision to pursue a multi-payer ACO?

a. What were the primary challenges and what strategies were used to overcome them?

27. Have you identified any unintended benefits/consequences of multi-payer arrangements?

Concluding Questions

We would like to conclude our discussion with three capstone questions.

28. As you think about your ACO formation and performance to date, what are you most proud of?
29. What are your biggest concerns for the ACO?
    a. How do you plan to address these concerns as you move forward?
30. Finally, what advice do you have for others who are implementing the ACO model?

Thank you for taking the time to speak with us today. We very much value the opportunity to learn from your experiences. In the coming weeks, we will send you a summary of our discussion and will plan to share with you any documents that we produce as a result of this work. Once again, thank you for your time today.

APPENDIX F. CODES AND DEFINITIONS

Code	Definition
Accountability Methods	Plans or procedures followed to promote accountability within the ACO, at both the intra- and inter-organizational levels
Benchmarks	Standards of performance achieved by high performing organizations in the comparison group. In addition benchmarks can be quality or cost thresholds used to determine whether an organization is eligible to share in savings
Care Coordination	Alignment of care across multiple providers, settings, and/or specialties. Care coordination involves the marshaling of personnel and other resources in order to carry out all required patient care activities. Initiation often requires system redesign and improvements to the process, content, or frequency of sharing information among participants responsible for different aspects of care.
Care Coordination - Navigator	A specific intervention used to improve care coordination is the use of care navigators, which may be nurses or case managers whose goal is to help patients formulate or follow a care plan.
Care Management	Set of programs and systems aimed to help manage patients' health and medical conditions (i.e. disease registries, disease management programs, medication management, telephonic care management such as nurse call lines, patient self-management, etc.)
Care Process Redesign	A set of activities aimed at improving the healthcare delivery process. This might include improving access or quality of care and efforts to improve the patient experience of care by providing seamless and efficient care. In addition, this includes the development of Centers of Excellence
Care Transitions	The movement of patients between healthcare providers and settings as patient conditions and subsequent care needs change over the course of an acute or chronic illness.
Data	Of or relating to the collection or analysis of clinical or administrative facts or statistics
Data Warehouse	A large store of data aggregating a wide range of sources, potentially from more than one organization
Disease Management Methods	Plans or procedures followed to improve the management of patients with chronic diseases. This may include resources such as nurse care managers or the use of patient registries.
EHR	A systematic collection of electronic health information about individual patients or populations. It is a digital record that is theoretically capable of being shared across different health settings. EHRs can include a range of data, including demographics, medical history, medications and allergies, immunization status, laboratory test results, billing information,

	etc.
EHR - Universal Shared	Electronic health records that are offered on the same technological platform across offices or care settings (i.e. ambulatory, specialists, inpatient, etc.)
Health Information System	Refers to the various types of health information across computerized systems. The main types of information system support the following functions: administration/finance (billing, patient registration), clinical (electronic health records, clinical decision support, e-prescribing), and infrastructure (IT security, servers and networks, data warehouses).
HIE/Interoperability	Refers to the secure exchange of health information across systems and between providers, consumers, government and quality entities, and insurers.
High Risk Patients	Patients who are at high risk for high utilization of healthcare services, (i.e. inpatient and emergency room usage), due to their complex conditions. Includes codes related to these patients such as identification, coaching, etc.
High Utilizer/High Cost Patient	Patients who, for clinical (e.g., comorbidities) and/or social (e.g., language/economic barriers) reasons, consume a disproportionate amount of care at the expense of the health care system or tax payers. Targeted interventions aimed at high utilizers hold the promise to drastically reduce health care spending.
HIS Capabilities - Data Analytics	Refers to a specific health information technology capability related to the use and analysis of data to inform planning and decision-making of the ACO
HIS Capabilities - Decision Support	Refers to a specific health information technology capability related to the real-time use of data and technology to support guideline-based clinical workflows
HIS Capabilities - Other	Refers to other issues related to the ability or capacity of health information systems within an ACO
HIS Capabilities - Planned	Refers to intended initiatives to develop the abilities or capacities of the health information systems within an ACO
HIS Capabilities - Registry	Refers to a specific health information technology capability related to the development and use of patient lists to identify and coordinate care for a specific patient population
Improvement Method - Cost	Plans or procedures followed to improve the cost associated with the delivery of health services.
Improvement Method - Priorities	A specific order or preference to execute plans or procedures followed to improve the delivery of health services, whether cost or quality improvements
Improvement Method - Quality	Plans or procedures followed to improve the quality associated with the delivery of health services.
Information Sharing	Of or relating to the sharing of clinical or administrative information among ACO participating entities
Infrastructure Building	The development of organizational structure such as personnel, IT

	systems, etc. This includes creation of new ties to external organizations such as home health, behavioral health, etc.
Measures - Cost	Quantification of the cost of a selected aspect of care, allowing relative comparison or comparison to an evidence-based criterion
Measures - Patient Experience	Quantification of the experience of a patient undergoing care, allowing relative comparison or comparison to an evidence-based criterion
Measures - Quality	Quantification of the quality of a selected aspect of care, allowing relative comparison or comparison to an evidence-based criterion; for example, measures for health maintenance activities such as routine mammography or colorectal cancer screening
Measure - Utilization	Quantification of the use (i.e. volume) of a selected aspect of care, allowing relative comparison or comparison to an evidence-based criterion
Patient Engagement	The active involvement of patients in their own care. Patient engagement is influenced by the behaviors of individual patients relative to their health care in addition to the actions of professionals and the policies of institutions. Patient engagement ensures individuals obtain the greatest benefit from the health care services available to them. Examples of engagement include shared decision-making, patient participation on the Board, etc.
Patient Experience	Measure of quality from the patient's perspective which can include access, communication, service, helpfulness and information resources.
Patient Portal	Secure website that allows patients to view their health information. Patient portals vary in functionality and can include access to medical information, lab results, and physician messaging.
Performance Monitoring	A formalized system for collecting and reporting information regarding the performance of an individual, group or organization.
Physician Performance Feedback	An approach used to provide physicians with information with regards to their individual performance in a routine manner - this can include feedback on clinical and service quality, utilization, costs, etc.
Standards	Established and quantifiable measures relating to some aspect of care
Team-based Care	Healthcare delivered by a group of health care providers and supported by staff, including physicians, nurses, case managers, social workers, and medical assistants. The concept behind team-based care is to increase coordination and communication among all individuals who touch the patient at the point of care.
Triple Aim	Of or relating to Institute of Healthcare Improvement's Triple Aim of improving the health of a population of patients, improving the patient experience of care, and to reduce the per capita cost of care