MIS Quarterly

RESEARCH ARTICLE

CPOE-ENABLED COORDINATION: APPROPRIATION FOR DEEP STRUCTURE USE AND IMPACTS ON PATIENT OUTCOMES[1]

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In the United States, the Centers for Medicare & Medicaid Services (CMS) has begun instituting pay-for-performance incentives that reward hospitals based on patient-centric outcomes such as patient satisfaction. Further, to promote the "meaningful use" of health information technology (HIT), CMS has been prompting hospitals to adopt and use HITs. Computerized provider order entry (CPOE) is one such HIT and is designed to improve coordination in patient care teams and consequently patient outcomes. We explore the impact of CPOE-enabled coordination on patient satisfaction with the care team. In a departure from prior research that has tended to treat the team as all clinicians within a hospital unit/clinic, we conceptualize (and operationalize) patient care teams as ad hoc and patient-specific and thus comprised of those clinicians having direct contact with the patient. In a further departure from prior research that has employed lean measures of IS use (e.g., use intentions, duration, or frequency of use), we respond to the call for rich measures of IS use by conceptualizing deep structure use (DSU) of CPOE as patient care team-level usage of CPOE features.

We draw upon adaptive structuration theory (AST) to identify faithfulness of appropriation (FOA) and consensus on appropriation (COA) as two related, but distinct, aspects of CPOE appropriation by patient care teams that affect DSU. We also draw on relational coordination theory to conceptualize communicative coordination (CC) as team communication for coordination purposes and theorize that DSU affects patient satisfaction through CC and informating the patient differentially across high/low patient mortality risk conditions.

Based on data from 224 patient care teams caring for both low and high patient mortality risk conditions, our results indicate that FOA and COA are salient predictors of DSU, and that the effect of COA on DSU is mediated by FOA. We also observed a significant indirect effect of DSU on patient satisfaction (as mediated by communicative coordination and patient informating), but only for high patient mortality risk conditions. Our findings are important because they show that by using CPOE in a comprehensive manner, patient care team members are better able to coordinate patient care and are able to better inform the patient about their care, ultimately leading to improved patient satisfaction. Additional implications for HIT research and practice are discussed.

Keywords: CPOE adoption, adaptive structuration theory, deep structure use, relational coordination, patient satisfaction

[1]James J. Jiang was the accepting senior editor for this paper. Guodong Gao served as the associate editor.

The appendices for this paper are located in the "Online Supplements" section of the *MIS Quarterly*'s website (http://www.misq.org).

Introduction

Computerized provider order entry (CPOE) has the potential to improve coordination in patient care teams leading to improved patient outcomes, yet until recently its use in the United States has remained limited (Harle et al. 2013). To stimulate economic growth, Congress passed the 2009 American Recovery and Reinvestment Act (ARRA), which included $27 billion in funding to spur "meaningful use" of health information technology (HIT) (Buntin et al. 2011). Yet, of the 2,475 U.S. hospitals seeking reimbursement from the Centers for Medicare & Medicaid Services (CMS) through demonstration of meaningful use, only 313 were able meet the guidelines (Harle et al. 2013), largely due to CPOE use limitations.

Patients purchase care and advice from physicians, but the context in which they do so is one that is fraught with uncertainty and high knowledge asymmetries between patients and providers (Arrow 1963). These characteristics of the healthcare service context make patients' satisfaction with the care they receive and the value of information shared with them particularly important in assessing the impact of HIT. PATSAT (patient satisfaction) has historically been considered to be an important outcome for hospitals (Jha et al. 2008; Kazley et al. 2015; Manary et al. 2013; Sitzia and Wood 1997) and is routinely reported by hospitals to CMS (Blumenthal et al. 2015). Over time, CMS hospital reimbursements began to be tied to overall PATSAT ratings, with higher scoring hospitals receiving higher payment (Long 2012; Tsai et al. 2015). Starting in 2013, to stimulate a pay-for-performance healthcare environment and to improve patient-centric outcomes, CMS put at risk 1% of hospital reimbursements based on PATSAT scores, with this figure rising to 2% by 2017 (Petrullo et al. 2012; Tsai et al. 2015). Given that CMS expenditures were $1.1 trillion in 2014 and rising quickly, the relevance of PATSAT to hospital administrators has grown considerably. Yet we find that the literature is silent on the relationship that might exist between the "meaningful use" of CPOE and PATSAT.

While some have questioned PATSAT as a measure of *quality* of care (Fenton et al. 2012; Manary et al. 2013), PATSAT has been found to be positively associated with various clinical outcomes (Boulding et al. 2011; Jha et al. 2008). Arguably, customer satisfaction in a medical context is quite unique, as under some circumstances high PATSAT scores could be elevated by negative patient behavior (e.g., opioid prescription abuse). Yet as medical care becomes increasingly patient centric, patients' perceptions of their care is "the bottom line" (Jha et al. 2008), and is a key outcome of interest in relation to HIT initiatives by hospitals. It has been used as a dependent variable in studies on HIT (Queenan et al. 2011; Sykes et al. 2011; Venkatesh et al. 2011) and clinician coordination studies (e.g., Gittell 2002; Gittell et al. 2010), and we too select it as our ultimate dependent variable.

In contrast to prior research that has treated the team as *all* clinicians working within a hospital unit such as orthopedics (Gittell 2002; Gittell et al. 2010) or emergency (Argote 1982) and in contrast to research that has conceptualized teams as *all* clinicians working at a medical clinic (Kane and Alavi 2008; Kane and Labianca 2011), we conceptualize (and operationalize) patient care teams as *ad hoc* and *patient* specific and thus comprised of those clinicians having direct contact with the patient.

Recent work has empirically examined the impact of the use of CPOE features by clinicians and others involved in patient care on patient length of stay (Romanow et al. 2017). However, surprisingly little is known about how patient care teams appropriate CPOE features, how this appropriation influences team use of CPOE, and how such use affects coordination of the care team, keeping the patient informed about their care or what we call informating the patient, and ultimately PATSAT. Given our focus on understanding how teams use CPOE to coordinate care, we adopt a deep structure use (DSU) perspective to conceptualize team level CPOE use, in contrast to past studies that have adopted lean measures for HIT use such as availability, duration, or frequency of use. Indeed, few studies have conceptualized IS use in a "rich" manner to account for the technology, task, and user in a team context (Burton-Jones and Straub 2006; Rai and Hornyak 2013). We focus on DSU as it provides a rich use perspective, allowing us to tap into the volitional use of advanced CPOE features across patient care teams. Further, we conceptualize team CPOE DSU as an IT-enabled coordination mechanism for patient care teams that can help explain variations in patient centric outcomes like PATSAT (Agarwal et al. 2010).

Given our interest in understanding DSU, we draw on the concept of appropriation from adaptive structuration theory (AST) (DeSanctis and Poole 1994). Informed by work on resistance (Lapointe and Rivard 2005), we assume that low appropriation of CPOE features emanates from apathy and/or passive resistance when it comes to the use of advanced features. Drawing on AST, we examine how two aspects of appropriation—consensus on appropriation (COA) and faithfulness of appropriation (FOA) (Chin et al. 1997; Salisbury et al. 2002)—impact patient care teams' use of CPOE. Thus, our first research question (**RQ1**) is: **How does a patient care team's appropriation of CPOE system features affect DSU?**

We also examine the impact of DSU on communicative coordination (CC) and consequently patient outcomes, conditional on patient mortality risk. Patient care teams have traditionally relied on paper-based patient records and relationships among care providers to coordinate patient care. Under this approach, the patient's record resides in one location and can be accessed by one clinician at a time, with no affordance for remote access. With the introduction of systems such as CPOE, multiple clinicians, situated at different locations, can access patient records at the same time. Such systems should improve coordination among members of a patient care team and thereby improve patient outcomes, particularly when coordination requirements are extensive as in the case of high patient mortality risk conditions. Past research has found the impact of use of CPOE features by members of a patient care team on patient length of stay to be conditional on the mortality risk of the patient condition (Romanow et al. 2017). It has also revealed increased PATSAT to result from HIT use and has suggested that increases may be due to improved team coordination (Queenan et al. 2011). Moreover, PATSAT is strongly and positively influenced by clinician–patient communication regarding the patient's health status (Boulding et al. 2011; Heidegger et al. 2006; Manary et al. 2013; Street et al. 2009).

As patients purchase information and medical care from providers to understand and improve their health (Arrow 1963), it is not surprising that clinician–to–patient communication is an important predictor of PATSAT (Boulding et al. 2011; Fitzpatrick 1991; Manary et al. 2013; Street et al. 2009). According to Zuboff (1988), IT systems can be used not only to automate processes but also to generate information that enables learning and empowers individuals (i.e., to "informate"). We suggest that CPOE plays a critical role not only in automating coordination processes of care providers, but also in providing a legible, timely, and widely accessible repository of patient data that can be used for *informating* patients (IP) and that use of a care coordination system like CPOE occurs at the patient care team level. We find no prior studies to have examined the association of team CPOE use with coordination among patient care team members, and the consequent impact on two key patient outcomes: IP and PATSAT.

We consider the role of differing levels of patient mortality risk as we conjecture that past work overlooking this contextual factor may be a reason for the mixed evidence concerning the impact of the use of HIT such as electronic health records (EHRs) and CPOE on patient outcomes (Agarwal et al. 2010). Teams caring for high mortality risk patients (e.g., organ transplant cases) may have a greater need for coordination than teams caring for low mortality risk patients (e.g., vaginal birth cases) due to the inherently higher levels of uncertainty that are associated with higher mortality risk conditions. Thus, for high mortality risk conditions, the advanced features of CPOE (i.e., those accessed through DSU) may prove more beneficial and have a greater impact on CC and patient outcomes, than for low mortality risk conditions where care processes are likely to be more routinized and require less coordination among team members. Thus, our second research question (**RQ2**) is: **How does CC enabled by DSU affect patient outcomes (IP and PATSAT) under differing levels of patient mortality risk?**

We focus on the post-adoption stage when CPOE use in clinical teams is stable. We make this choice as we are interested in understanding variations in DSU well after the shakedown phase in which learning occurs, work processes are redefined, and active resistance is likely to be expressed (Hsieh and Wang 2007; Kane and Labianca 2011). This choice enables us to focus on the differences across teams in the use of advanced CPOE features, such as alerts or decision support, once use has stabilized and is not subject to the variances that are characteristic of the shakedown phase (Jasperson et al. 2005; Morris and Venkatesh 2010).

Conceptual Background

In this section, we (1) discuss the nature of patient care teams and explain why coordination is essential to their success, (2) draw on the group-level IS use literature to conceptualize DSU in patient care teams, (3) draw on AST to introduce the concept of technology appropriation and identify predictors of DSU, (4) draw on relational coordination theory to identify how DSU enables coordination in patient care teams, (5) discuss clinician-to-patient communication and the role of DSU for IP, and (6) define PATSAT and discuss its meaningfulness in assessing care team performance.

Patient Care Teams and the Need for Coordination

Our unit of analysis is an *ad hoc* patient care team that provides care for a patient during a hospitalization encounter. Each hospitalization encounter involves the time from preadmission testing to discharge. The care team that interacts with a patient includes an assigned physician and other clinicians such as nurses and physician assistants. Team members can interact directly with a patient by checking vitals and communicating with the patient or by administering drugs, tests, or procedures.

Drawing upon the literature on coordination in organizations (Malone and Crowston 1994; Thompson 1967) and clinical environments (Argote 1982; Faraj and Xiao 2006; Gittell et al. 2010), we define coordination as the integration of work under conditions of task interdependence and uncertainty (Faraj and Xiao 2006). Patient care involves interdependencies (Kane and Alavi 2008), requiring that team members coordinate in uncertain and time-sensitive environments (Faraj and Sproull 2000; Faraj and Xiao 2006; Gittell 2002). Such settings with high task interdependence and uncertainty require mutual adjustment between team members (Thompson 1967). Consequently, clinical processes need to rely not only on the error reducing mechanisms inherent to formal coordination, but also on flexible informal structures (Faraj and Xiao 2006). Given the multiple clinician roles in a team, we posit that CPOE provides coordinating features central to the effective functioning of the team and the delivery of quality care.

CPOE Deep Structure Use: An IT Enabler of Coordination in Patient Care Teams

CPOE is a computer-based system that enables clinicians to directly enter medical orders (Ash et al. 2007; Cutler et al. 2005). Common examples of *medical orders* are diagnostic tests, medications, and nursing orders (Doolan and Bates 2002). Upon order entry, CPOE systems provide an error checking mechanism (Queenan et al. 2011) by highlighting potential drug-to-drug interaction, and drug-to-allergy alerts based on information in the patient's EHR (Hillestad et al. 2005). Many CPOE systems provide decision support features, such as informing the clinician of alternative medications and appropriate dosages (Garg et al. 2005). Since CPOE incorporates standard treatment protocols based on best practices, as well as access to related systems containing clinical results and progress notes captured during the hospital stay, we consider CPOE as an *IT-enabled coordinating mechanism* for patient care.

Although an IT-enabled coordination mechanism implies system use by groups who appropriate IS features to enact work processes, few studies have focused on group level analysis of IS use (Kane and Labianca 2011; Burton-Jones and Gallivan 2008). Moreover, system use can range from cursory baseline feature use to extensive utilization of advanced features. Although there can be significant differences in how a system's features are used by groups in general and by patient care teams in our context, most IS studies have not considered such differences (Burton-Jones and Straub 2006). Consistent with Romanow et al. (2017), we adopt a DSU conceptualization of CPOE use. We argue that patient care teams can exhibit significant differences in the use of CPOE features ranging from only the use of baseline features such as order entry that can be mandated (as at our empirical site) to extensive volitional use of advanced features.

As summarized in Table 1, we identify CPOE features as supportive of four overarching tasks in clinician teams' coordinating patient care: (1) *standardizing treatment plans* based on the use of best practices that are codified as order sets in the CPOE system and that are selected and executed when orders are submitted through the system, (ii) *preventing errors* based on the use of decision support systems and the triggering of alerts when standardized treatment plans may require modification relative to a specific patient, (3) *achieving integrated and timely access of clinical results to clinicians* based on the use of real-time unified views of clinical information related to the patient and remote access to it, and (4) *maintaining an assessment of a patient's progress relative to expectations* based on the use of digital progress notes. While order sets, alerts, and decision support are widely regarded as CPOE features, integration of clinical results and digital progress notes involve closely affiliated documentation and EHR systems and are extensions of CPOE that are integral to the coordination of patient care teams. Accordingly, we focus on both the core CPOE features (i.e., order sets, decision support) and the extended features (i.e., clinical results, progress notes) that represent extended CPOE (hereafter referred to as CPOE for convenience).

Team Appropriation Predictors of DSU in Patient Care Teams

Prior *group* level research has revealed that adaptive structuration theory (AST) is an important theoretical lens to understand how features of an IS are appropriated and then used (DeSanctis and Poole 1994; Jones and Karsten 2008). The conceptual basis of AST lies in the notions of appropriation and spirit (DeSanctis and Poole 1994). The theory suggests that, over time, humans interact with features embedded in the IS, thereby reshaping both human behavior and the IS itself (DeSanctis and Poole 1994; Im 2014). The system features, together with its *spirit* or general intent, form the structural potential of an IT (DeSanctis and Poole 1994). Groups may select features and then adapt them to meet their specific needs, and as a result features in use (appropriation) may vary across groups, even though the structural potential of the IT remains constant (Poole and DeSanctis 1990, 1992).

The use of AST to understand the predictors of DSU is appealing, as some physicians resist adopting the spirit of "cookbook medicine" inherent in environments that incorporate CPOE order sets (Gittell 2002; Wright et al. 2009). Consistent with AST, we suggest that different patient care teams will use baseline CPOE features (e.g., order entry) in an identical fashion especially as the use of these features is more readily mandated, while exhibiting variation in the use of advanced CPOE features (e.g., decision support, progress notes).

There are two key AST constructs—namely, faithfulness of appropriation (FOA) and consensus on appropriation (COA)—that are especially relevant to us. FOA refers to the

Table 1. Clinician Teams' Deep Structure Use of CPOE Features and Effects on Patient Care Coordination

Use of CPOE Technology Features by Clinician Teams	Task Supported	Impact on Patient Care Coordination
Baseline features involving order sets that represent best practices and order entry through the CPOE system	Clinical order entry with the objective of standardizing patient care (Kohn et al. 2000)	Team members have access to real-time, legible orders that have been placed on behalf of a patient, thus incorporating best clinical practices, while reducing duplicate or conflicting orders as well as the potential for error.
Decision support systems and alerts	Error prevention (Garg et al. 2005; Queenan et al. 2011)	Team members are alerted to the need for changes in standard care protocols and can determine why such changes are necessary.
Hospital wide and remote access to up-to-date patient information including lab results, vital signs, imaging, and medication	Clinical results integration and access (Niazkhani et al. 2009)	Team members have remote and up-to-the-minute access to patient status, thus allowing more informed and better coordinated decision making with respect to patient care.
Digital progress notes (i.e., clinical notes typically written by a hospital physician that provide an overview of the patient's status as well as the physician's assessment and projected care plan for the patient (Wilcox et al. 2010))	Maintaining a record of how a patient is responding to a treatment protocol.	Digital progress notes are considered superior to paper-based assessments due to shared access to legible clinicians' notes regarding patient status of a patient. It has been suggested that digital progress notes may lead to improved team collaboration and coordination when implementing the projected patient care plan (Weir et al. 2003).

degree to which users in a group adopt an IS for use in a manner that is consistent with its general intent (i.e., in accordance with how the system was designed to be used). In contrast to FOA, ironic appropriation involves use of the IS that is inconsistent with its spirit, or general intent. Ironic use is not *always* considered suboptimal, yet over time the internal contradictions that can arise from ironic use may lead to escalating tension among team members (Poole and DeSanctis 1992). Teams that exhibit ironic use are more likely to report lower satisfaction and group outcomes than teams that exhibit high FOA (Poole and DeSanctis 1992).

One could argue that FOA predicting DSU is axiomatic. Yet FOA is the degree to which users judge the overall use of the technology to be consistent with the spirit of the IS as intended by the designers (Schwarz and Chin 2007). FOA is an overall *evaluation* of the consistency of use of the IS relative to design intent and does not capture the actual or perceived use behavior (Burton-Jones and Straub 2006). In contrast to FOA, DSU captures the degree to which users apply the individual features that the IS affords the user for a given set of tasks, and assesses the comprehensiveness of the use of features for the underlying tasks (Burton-Jones and Straub 2006).

The second construct, COA, refers to within-team agreement on how the IS features should be applied to the work process (DeSanctis and Poole 1994; Salisbury et al. 2002). Teams that exhibit high COA have less uncertainty regarding which IS features should be applied (Salisbury et al. 2002) to the tasks involved in coordinating patient care. Conversely, teams that exhibit low COA will have low agreement on which IS features should be applied, thus impeding effective coordination of clinicians and potentially hindering the quality of care.

Enabling Communicative Coordination in Patient Care Teams with DSU

Our conceptualization thus far has been that the use of CPOE enables patient care teams to incorporate standardized, formal coordination. As a patient care team involves interdependent and uncertain tasks, there is also a need for it to achieve mutual adjustment among members and to be able to coordinate spontaneously (Gittell 2002). To conceptualize this, we draw on Gittell et al.'s (2010) notion of relational coordination as "a mutually reinforcing process of interaction between communication and relationships carried out for the purpose of task integration" (p. 492). Prior research suggests that teams with higher relational coordination achieve better outcomes (e.g., reduced length of stay, improved PATSAT) (Gittell 2002; Gittell et al. 2010).

Central to relational coordination is the notion that effective coordination relies on four aspects of communication (Gittell 2002): *timeliness* (Waller 1999), *frequency* (Ancona and Caldwell 1992; Tushman 1979), *accuracy* (O'Reilly and

Roberts 1977; Tushman 1979), and *the problem solving nature of the communication* (Rubinstein 2000; Stevenson and Gilly 1993). Coordination work is carried out through groups of individuals who leverage relationships to perform tasks; thus, communication and coordination occur within the structure of these relationships (Gittell 2002). Gittell (2002) suggests that three dimensions of relationships are also salient to coordination: shared goals (March and Simon 1958; Saavedra et al. 1993; Wageman 1995), shared knowledge (Dougherty 1992; Weick and Roberts 1993), and mutual respect (Eisenberg 1990).

While Gittell (2002) conceptualizes relational coordination as an aggregate of communication and relationship attributes, we differentiate between communication in a team and the relationships among clinicians in a team. Indeed, relational capital has been differentiated from processes of coordination in other team work contexts such as software development (Tiwana and McLean 2005). This differentiation is important in our study, as we are interested in the facets of relational coordination that are enabled by DSU. To this end, we focus on team communicative coordination (CC) and define it as the quality of communication in a patient care team for purposes of managing its interdependencies in providing patient care. The separation of the relationship and communicative components of relational coordination enables us to understand the impact of DSU on CC and consequently IP and PATSAT, while controlling for the team's shared knowledge, mutual respect, and shared goals.

Enabling Informating the Patient with DSU

The term informating, first coined by Zuboff (1988), refers to the duality of IT in not only automating processes but in generating information that enables learning and can empower individuals. While prior research has examined how IT can informate physicians (Kohli and Kettinger 2004), the impact of system use and the communicative coordination it fosters on informating patients has not been investigated. We define informating the patient (IP) as in-patient perceptions of the quality of communication regarding the patient's health status and treatment as provided by their patient care team during a hospitalization encounter (Boulding et al. 2011; Manary et al. 2013). Through third-party providers, U.S. hospitals routinely ask patients for their perceptions of IP by responding to items like (1) how well did the nurses keep you informed and (2) how well did the physician keep you informed. Previous research has found that patient perceptions of IP are highly associated with overall PATSAT (Boulding et al. 2011; Fitzpatrick 1991; Manary et al. 2013; Street et al. 2009). Recent primary care research has reinforced the importance of sharing digital physician notes with patients (Delbanco et al. 2012). We suggest that CPOE-enabled coordination (e.g., sharing the contents of digital notes with patients) can enhance IP through CC.

Patient Satisfaction: An Evaluation of Patient Informating and Team Coordination

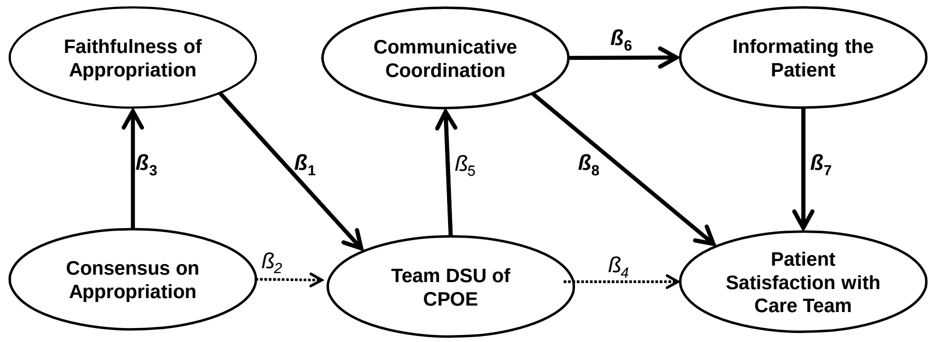
PATSAT has been tracked for decades in hospitals in the United States and other countries and is widely recognized as an important outcome (Bombardier 2000; Heidegger et al. 2006; Jackson et al. 2001; Jha et al. 2008; Kazley et al. 2015; Manary et al. 2013; Sitzia and Wood 1997). We define PATSAT as overall inpatient perceptions of the quality of care provided by their patient care team during a hospitalization encounter (Gittell 2002; Gittell et al. 2010; Queenan et al. 2011; Sykes et al. 2011). PATSAT is a composite score for each patient derived from the following three items: (1) overall rating of your care at the hospital, (2) how well staff *worked together* to care for you, and (3) likelihood of you recommending the hospital to others. We posit that an IT-enabled environment can positively impact a patient's perceptions of how well the care team worked together and how well the care team kept the patient informed. Thus, we suggest that overall PATSAT is a particularly appropriate dependent variable in this context.

Research Model and Hypotheses

Our model (Figure 1) explicates (1) how DSU is affected by a team's appropriation of the system and (2) how CC enabled by DSU affects patient outcomes (IP and PATSAT) under differing levels of patient mortality risk. Table 2 defines our constructs.

Hypotheses

We expect that patient care teams will appropriate CPOE features to varying degrees, which is consistent with AST (DeSanctis and Poole 1994). Specifically, teams that consider their appropriation to be faithful will report higher levels of DSU. FOA captures the extent to which a team *evaluates* its use of a CPOE system to be consistent with the spirit or general intent of the system (Burton-Jones and Straub 2006; Chin et al. 1997). When FOA is high, the patient care team evaluates its CPOE use to be compliant with the spirit of the system, and the team is less likely to engage in ironic use and the deployment of workaround or *shadow* systems (DeSanctis and Poole 1994; Salisbury et al. 2002). As an example, to con-



H1: FOA→DSU; $ß_1 > 0$
H2: COA→FOA→DSU; $ß_3 * ß_1 > 0$; COA→DSU ($ß_2$) included to evaluate partial vs. full mediation of COA→FOA→DSU
H3: DSU→CC→IP stronger for high risk than low risk group: $ß_5 * ß_{6(High\ Risk)} > ß_5 * ß_{6(Low\ Risk)}$
H4: CC→IP→PATSAT stronger for high risk than low risk group due to 1st stage moderation; $ß_{6(High\ Risk)} > ß_{6(Low\ Risk)}$
H5: DSU→CC→PATSAT stronger for high risk than low risk group; $ß_5 * ß_{8(High\ Risk)} > ß_5 * ß_{8(Low\ Risk)}$;
DSU→PATSAT ($ß_4$) included to evaluate partial vs. full mediation of DSU→CC→PATSAT

Figure 1. Research Model and Hypotheses

Table 2. Constructs and Definitions

Construct	Acronym	Definition
Faithfulness of Appropriation	FOA	The degree to which CPOE is used by the patient care team in a manner consistent with its general design intent (Chin et al. 1997; DeSanctis and Poole 1994; Salisbury et al. 2002)
Consensus on Appropriation	COA	The extent to which patient care team members who use CPOE jointly agree on how to apply the technology to their work (DeSanctis and Poole 1994; Salisbury et al. 2002)
Deep Structure Use	DSU	Patient care teams' use of features of the CPOE system that support the underlying structure of the task (Burton-Jones and Straub 2006; DeSanctis and Poole 1994). These features include standardized order sets, decisions support and alerts, clinical results integration, and progress notes
Communicative Coordination	CC	Patient care team coordination through communicative means, carried out for the purpose of task integration (Gittell 2002; Gittell et al. 2010)
Informating the Patient	IP	Inpatient perceptions of the quality of communication regarding the patients' ongoing health status and treatment as provided by their patient care team during a hospitalization encounter (Boulding et al. 2011; Manary et al. 2013)
Patient Satisfaction With Care team	PATSAT	Overall assessment of patients associated with a patient care team of the quality of care provided by the patient care team during their hospitalization encounter (Gittell 2002; Gittell et al. 2010; Queenan et al. 2011; Sykes et al. 2011)
Patient Condition Mortality Risk		An estimate of the likelihood of an in-hospital death of a patient, with risk adjusted mortality rate as the most commonly used measure to account for variance in patient characteristics (Boyd and Jackson 2005; Iezzoni et al. 1996; Thomas and Hoffer 1999)

textualize intent from a clinical IT perspective, the general intent behind CPOE is for vital signs to be entered into the system at the time they are generated and for alerts to always be acknowledged. When a team evaluates its overall use of CPOE to be consistent with these intentions, the team is likely to exhibit greater use of specific features, thereby increasing DSU. In contrast, when a team exhibits low FOA, the patient care team evaluates its overall CPOE use to deviate from the general intent of the system. Continuing with our example, while the general intent behind CPOE may be for vital signs to be entered into the system at the time they are generated and alerts to always be acknowledged, a team may find response time of the system and time demands as compelling reasons to deviate from these intentions. The patient care team may establish workarounds to enter vital signs into the system during certain hours of the day when response time or system availability are better and they may use their discretion to determine when to acknowledge an alert. In these circumstances when a team evaluates its use of CPOE to deviate from the spirit of the system, the structural features of the system will be less extensively used, thereby lowering DSU. Based on the above arguments, we expect FOA to positively affect DSU for both low and high mortality risk patients, leading us to hypothesize:

H1: *Team faithfulness of appropriation is positively associated with DSU for (a) low mortality risk patients and (b) high mortality risk patients.*

We draw on and extend research that has suggested that COA promotes team system usage (DeSanctis and Poole 1994; Im 2014) by elaborating the mechanism through which this effect is channeled. Specifically, we suggest that the effect of COA on DSU is mediated through FOA in the case of both low and high mortality risk patients for two reasons. First, COA creates social pressure for team members to use system features in a consistent manner, thereby promoting DSU (Salisbury et al. 2002). Prior research has suggested that the influence of COA on team system use manifests through internalization and compliance (Im 2014). Internalization refers to individual clinicians' perceptions of patient care team messages, and the incorporation of these messages and team attitudes into their own constructions of reality, whereas compliance refers to individual clinicians' behavior as they conform to group pressures (Im 2014). We argue that the social pressure to comply with consistent DSU across members of a team is mediated through FOA when the use being pressed for is consistent with the spirit of the CPOE system. We acknowledge that social pressure for consistent use across members may not be mediated through FOA and can affect DSU directly, as some of the use being pressed for by the team can be ironic or deviant from the general intentions underlying the system (DeSanctis and Poole 1994; Salisbury et al. 2002). As an example, clinicians on a cardiovascular critical care unit may perceive that system availability is unreliable, and agree that their unit will maintain only paper-based records of vital signs rather than risking a temporary lack of access at a critical time.

Second, the process of developing COA promotes shared understanding among team members on the meaning of CPOE use within the clinical context. This process of developing shared understanding promotes the use of advanced features, thereby expanding DSU in the team. As an example, COA can promote shared understanding on the benefits of acknowledging alerts when they occur despite the extra effort that may be required to do so. The process of developing shared understanding should promote DSU through FOA when the shared understanding is consistent with the general intent of the system but COA should promote DSU directly when it is not. We expect this positive effect emanating from COA and mediated through FOA to DSU to hold for both low and high mortality risk patients, leading us to the following hypothesis:

H2: *The positive impact of COA on DSU will be mediated through FOA for (a) low mortality risk patients and (b) high mortality risk patients.*

Previous research has found CPOE use to be positively associated with PATSAT (Queenan et al. 2011) and has found team relational coordination to be positively associated with PATSAT (Gittell 2002; Gittell et al. 2010). Extending this reasoning, we posit that together the four constitutive aspects (i.e., timeliness, frequency, accuracy, and problem solving nature of communication) of CC are augmented by the DSU and that CC enabled by DSU will improve clinician-to-patient communication, thus informating the patient.

Compared to paper records, CPOE benefits include remote access to clinical results and patient status, improved order turnaround on laboratory results and prescriptions, and clinical decision support (Niazkhani et al. 2009). Remote and simultaneous access to the latest patient data by all team members arguably enhances the accuracy and timeliness of communication. Physicians can remotely access a patient's records and render a more informed decision regarding how to respond to changes in the patient's condition. Alerts and clinical decision support speak directly to the problem-solving nature of communication, as clinicians can assimilate the decision support recommendations, and can immediately inform each team member of the amendments to the treatment protocols through the release of new CPOE orders. Based on an alert trigger, clinicians can discuss the alerts with patients for clarification, and these discussions can be documented in CPOE through an alert disposition.

Finally, we expect higher mortality risk across patient conditions to increase the IP benefits that accrue from DSU through CC. This is consistent with recent research that has found that HIT adoption reduces mortality rates for the most complex patients, but does not impact mortality outcomes for the average patient (McCullough et al. 2016). While McCullough et al. (2016) suggest that HIT use benefits accrue to patients whose providers require cross-specialty information and care coordination, the mechanisms through which this occurs have not been empirically tested. By capturing DSU and CC and considering the nature of the coordination tasks that the care team has to address, we elaborate the use-to-performance pathway. Specifically, we expect teams caring for higher mortality risk patient conditions will exhibit greater utility of DSU for CC and subsequently of CC for IP due to the uncertain and frequently changing circumstances inherent to the care of high mortality risk patients. Thus, we state the following hypothesis:

H3: *The positive mediation effect of DSU on IP through CC will be moderated by patient mortality risk such that the mediation effect will be stronger for high than low mortality risk patients.*

Prior research has shown that clinician–patient communication regarding the patient's status is positively associated with PATSAT (Boulding et al. 2011; Manary et al. 2013; Street et al. 2009). It has also shown that when primary care physicians share their progress notes with patients this helps patients to feel informed and in control of their care (Delbanco et al. 2012). We argue that teams that display higher CC and thus have higher quality of communication for coordinating patient care will also do a better job of informating the patient and that higher IP will increase PATSAT. Consistent with recent research (McCullough et al. 2016), we expect differences in mortality risk across patient conditions to *change* the PATSAT benefits that accrue from CC through IP. We suggest that these expected differential improvements in PATSAT through IP resulting from CC will arise because increases in CC enable the spontaneous coordination required by the uncertain and frequently changing circumstances inherent to high risk patient care (Gittell 2002). We also suggest that all patients will place high value on being informed, leading to a strong impact of IP on PATSAT for both low and high mortality risk patients. Thus, we state the following hypothesis:

H4: *The positive mediation effect of CC on PATSAT through IP will be moderated by patient mortality risk such that the influence of CC on IP will be stronger for high mortality risk patients.*

Prior research has found that the impact of health IT on patient mortality favors complex, high severity patients, and suggests that these benefits result from improved coordination and communication (McCullough et al. 2016). We argue that the mediation of DSU on PATSAT by CC is moderated by the mortality risk associated with a patient's condition. We posit that differences in mortality risk across patient conditions lead to CPOE-enabled CC playing a greater or lesser role in affecting PATSAT. Patient care teams caring for high mortality risk patients such as those having cardiovascular surgery require greater CC for effective functioning as they are confronted with more unpredictable situations that can lead to sudden changes in a patient's condition. Thus, high mortality risk patients require more intense monitoring, and their treatment protocols may need more frequent adjustment in comparison to low mortality risk patients. Therefore, patient care teams caring for low mortality risk patients may require less in the way of use of system features for CC, as compared to teams caring for high mortality risk patients. As such, we expect differences in mortality risk across patient conditions to *change* the team effectiveness benefits that accrue from DSU by improving the timeliness, frequency, accuracy, and problem solving orientation of communication in a patient care team. Improvements in communication will be more salient to patient care teams caring for high mortality risk patients, who will in turn receive higher overall PATSAT scores. Accordingly, we hypothesize that patient mortality risk will moderate the positive mediation of DSU on PATSAT through CC:

H5: *The positive mediation effect of DSU on PATSAT through CC will be moderated by patient mortality risk such that the mediation effect will be stronger for high mortality risk patients.*

The Empirical Study

Context

We collected data at two hospitals of a private five hospital not-for-profit group in the southeastern United States. Hospital A is an urban acute care hospital with 480 beds and had implemented CPOE in 2003, and Hospital B is a community hospital with 150 beds that had implemented CPOE in 2007.[2] We concentrated on these two hospitals, as they both had considerable experience with the identical CPOE system. Also, both had achieved universal adoption in that active order sets covered virtually every patient condition and medical orders were entered electronically for 100% of patients by all in-patient units. As use of advanced features of CPOE and related systems beyond order entry (e.g., alerts, clinical decision support, or progress notes) was volitional to the patient care team, there was variance in DSU across teams. During the study period, the CPOE software and supporting infrastructure at both hospitals were maintained without substantial modifications.

[2]The remaining three hospitals in this hospital group had either not yet implemented CPOE, or were recent users of the system when data collection commenced.

Cardiologists were predominantly employed by the hospitals, while high volume specialties such as obstetrics and orthopedic surgery relied on independent physicians. This distinction is important as hospitalists and residents (as hospital employees) have been found to be more engaged with HIT implemented by their hospitals (Davidson and Chismar 2007). At both hospitals, many of the independent physicians in specialties such as orthopedics relied on mid-levels (e.g., physician assistants) to enter orders into the CPOE system.

To develop a rich understanding of the context in which CPOE is used, one of the authors closely engaged with the Chief Medical Information Officer (CMIO) over a three-year period. Discussions were also held with the executive VP and Chief Medical Officer (CMO) of the hospital group as well as the respective CMOs, Chief Nursing Officers (CNOs), and nurse managers at each hospital. During data collection, face-to-face meetings occurred with over 550 of the clinical staff identified as part of the study.

Study Design

We collected data from multiple sources. For all of our independent variables, we collected data using a survey that we developed. For our dependent variable, we used PATSAT data that was routinely collected by a third-party provider at Hospital A and Hospital B. We were granted access to 2,475 PATSAT surveys collected by the third-party provider, which represented 100% of the completed surveys captured from patients discharged from Hospital A and Hospital B between December 1, 2011, and August 31, 2012. Given our interest in contrasting low and high mortality risk patient groups, we selected the following patient conditions in consultation with the CMIO and other clinical staff: organ transplant, cardiovascular surgery, and pneumonia as representing high mortality risk, and knee/hip replacement and vaginal birth as representing low mortality risk. Table 3 compares mortality risk assessments across these patient conditions, supporting our categorization. We provide risk-adjusted statistics when available through established U.S. government sources, as they take into account factors such as age and comorbidities. There was a total of 440 PATSAT surveys associated with these patient conditions. As teams form during the process of care for a patient and are not predefined fixed entities, we used a systematic multistep process to determine the responsible physician and other core clinicians who had cared for the 440 patients in the selected patient conditions for whom we had PATSAT data. Through the process of team formation and survey data collection described later, we developed team-level data for 224 patient care teams (126 low mortality risk, 98 high mortality risk).

Team Formation

Prior research has typically conceptualized the patient care team as the members of a hospital unit such as a specialty ward or an outpatient care clinic (e.g., Argote 1982; Kane and Alavi 2008; Kane and Borgatti 2011; Kane and Labianca 2011). The net result of such an approach is that *all* clinicians associated with a hospital unit or clinic are considered part of the patient care team, even though many of them have not had contact with the particular patient whose outcomes are being studied. Such an approach overlooks the *ad hoc* nature of patient care teams in hospitals.

Gittell and her colleagues (Gittell 2002; Gittell et al. 2010) have followed a relational coordination approach, which conceptualizes coordination as a network of cross-functional ties. In some cases, this relational coordination approach has been used to conceptualize the patient care team as only those clinicians who have cared for the patient (Gittell et al. 2008; Weinberg et al. 2007). Building on this approach, we followed a team formation process where the patient care team involved only those clinicians that cared for the patient; in addition, we required that the responsible physician's perspective be obtained for each patient care team. We operationalize the ad hoc team as consisting of only those clinicians who are involved in the direct provisioning of care for a patient. Team membership begins with a responsible physician, an assigned day and night shift nurse, and as patients are moved between hospital units they are reassigned to a new nurse. Thus, clinicians are routinely associated with multiple *ad hoc* teams, and the composition of these teams varies both within and across patient conditions (e.g., pneumonia, heart surgery).

We constructed the *ad hoc* patient care teams using an iterative, structured process, which required roughly 450 hours of systematic analysis over a six-week period. Our intent was to identify each patient's core team members (i.e., those who had direct contact with the patient), and to avoid the mostly uninvolved support staff (i.e., those who with a limited data entry role on behalf of the core team but with little or no patient contact). We considered the core team to include the responsible physician, the assigned day and night shift nurses, and the mid-level clinicians such as Physician Assistants (PA), Nurse Practitioners (NP), and Certified Nurse Midwives (CNM) who were associated with the patient. Unlike earlier work, we also include among core team members those clinicians from other hospital units who joined the care team as the patient was moved, as these patient–provider encounters may impact the patient's perceptions of the care provided. Additionally, we attempted to capture all the *part time* float pool nurses identified as involved in a patient's care, even

Table 3. Mortality Risk by Patient Condition

	High Mortality Risk Patients n = 98			Low Mortality Risk Patients n = 126	
Mortality Risk Measure	Organ Transplant	Cardiovascular Surgery	Pneumonia	Knee/Hip Replacement	Vaginal Birth
30-day Risk Adjusted		(a) CABG 2.2% AVR 4.2% MVR 4.84%	(b) 11.6%	(c) Hip .52% Knee .27%	
Unadjusted 3-month Graft	(d) Liver 8.8%				
Unstandardized Mortality Rates					(e) 0.015% 1 year

(a) 30-day risk adjusted mortality rates for Coronary Artery Bypass Graft (CABG), Aortic Valve Replacement (AVR), Mitral Valve Replacement (MVR) (Puskas et al. 2012).
(b) From CMS Medicare Hospital Quality Chart Book for U.S. patients (Suter et al. 2014),
(c) 30-day risk adjusted mortality rates for Total Hip Arthroplasty (THA) and Total Knee Arthroplasty (TKA) (Singh et al. 2011).
(d) Based on Scientific Registry of Transplant Recipients data (Thuluvath et al. 2010).
(e) U.S. maternity related deaths within one year of end of pregnancy 15 per 100,000 live births (King 2012).

though they may only work occasionally at the hospital and may float between numerous specialty units in the hospital.

Each patient survey included a unique patient visit ID, which was used to map to the following information from archival sources: the complete CPOE order set detail, clinical documentation, and discharge diagnosis. From the CPOE order set detail, the responsible physician was identified as a team member. The documentation system contained entries by clinicians recording the patient care process, including patient vital signs, medication administration, and progress notes. We used role-based transaction thresholds to identify clinicians with a significant involvement in the patient care process. Documentation entries often require a bedside visit, which implies some level of direct patient contact. Additional physicians and mid-level clinicians (PA, NP, and CNM) who made any documentation entries on behalf of a patient were added to the patient care team. Compared to physicians or mid-levels, nurses (RN, LPN) are more likely to make proxy entries (i.e., on behalf of other clinicians) that do not involve direct patient contact. We know this as physicians and mid-levels combined accounted for just 4% of all documentation entries, while nurses made over 80% of the documentation entries at our two sites. To minimize the inclusion of nurses who had no direct role in a patient's care, nurses were included on a team only if they made at least one documentation entry and two or more additional order or documentation entries. Patient care teams for 440 unique patient visits were constructed across the five patient conditions, representing low or high mortality risk. Team membership assumptions and patient conditions were validated and endorsed by both the CMIO and nursing management. We consider the team formation process in our research design as a significant improvement in the conceptualization and operationalization of an *ad hoc* patient care team. For a more detailed description of the team formation and patient condition selection process, please refer to Appendix A.

Measures

The constructs in our model are at the level of the care team for a patient. We used a clinician survey to collect data from clinicians on FOA, COA, DSU, and CC, and obtained data for IP and PATSAT from a third-party provider survey that was used by the hospitals to collect data from patients post-hospitalization. Data collected from clinicians were aggregated to the team level for a patient following Chan's (1998) guidelines (see Table 4). Specifically, we used a referent-shift consensus approach to measure a patient care team's FOA, COA, DSU, and CC. The survey items corresponding to each of these constructs were framed to capture a clinician's perspective about their team. For example, the FOA items were formulated as "Our clinical team used the system properly," rather than "I used the system properly." As explained later, we assessed consensus in responses among individuals in a team prior to aggregating individual level measures to compute team-level scores. IP and PATSAT with the care team were measured using the survey items administered by a third-party provider that conducts patient surveys on behalf of the hospitals. The measurement items that were used to capture data from individual clinicians for FOA, COA, DSU, and CC and for patients for IP and PATSAT are shown in Appendix F.

We used a number of controls for our mediation and dependent variables. For DSU, we controlled for the following: the team's average perceived ease of use of the CPOE system, the

Table 4. Patient Care Team Constructs and Measurement Approach

Construct	Acronym	Measurement Approach	Scale Type, Informing Sources and Reliabilities in Informing Sources
Faithfulness of Appropriation	FOA	• Clinician survey • Aggregation through referent- shift consensus	Five-item reflective measure adapted from Salisbury et al. (2002) who report α = .91
Consensus on Appropriation	COA	• Clinician survey • Aggregation through referent- shift consensus	Five-item reflective measure adapted from Salisbury et al. (2002) who report α = .85
Deep Structure Use	DSU	• Clinician survey • Aggregation through referent- shift consensus	Composite index of eight items based on Garg et al. (2005), Kohn et al. (2000), Niazkhani et al. (2009), Weir et al. (2003), and CMS meaningful use guidelines (Blumenthal and Tavenner 2010).
Communicative Coordination	CC	• Clinician survey • Aggregation through referent- shift consensus	Composite index of four items adapted from Gittell et al. (2010) who report α = .86
Informating the Patient	IP	• Third-party administered patient survey • Measured with respect to overall patient care team	Composite index of two items from proprietary measure used by a leading national vendor for patient satisfaction assessment
Patient Satisfaction With Care team	PATSAT	• Third-party administered patient survey • Measured with respect to overall patient care team	Three-item reflective measure; proprietary measure used by a leading national vendor for patient satisfaction assessment
Patient Condition Mortality Risk		• Binary measure, 0 for low mortality risk and 1 for high mortality risk	Groupings into low and high mortality risk levels based on King (2012), Puskas et al. (2012), Singh et al. (2011), and Suter et al. (2014)

team's average perceived usefulness of the CPOE system, the average clinician age on the team, the average CPOE experience among team members, and team physician proportion (i.e., proportion of physicians to other clinicians on the team) in a manner that was consistent with prior work (Davis 1989; Venkatesh et al. 2003). For IP, we controlled for team size as number of clinicians on the team and team physician proportion. With respect to the dependent variable PATSAT, we controlled for hospital, average length of stay of patients associated with the team, patient care team size, as well as the three relational coordination relationship factors (shared knowledge, mutual respect, shared goals) (see Appendix B for details).

Survey Data Collection

We surveyed clinicians on teams caring for five unique patient conditions. For instance, orthopedic surgeons and nurses who had recently cared for *knee/hip replacement* surgery patients were asked to complete their survey in the context of the knee/hip replacement teams in which they were involved. Team eligibility had two prerequisites: (1) a responsible physician respondent, and (2) an 80% response rate by the patient care team. Although an ideal response rate by a team has not been firmly established in team-level research, recent publications have reported response rates ranging from 72.8% (Maruping et al. 2009) to 91.3% (Kang et al. 2012). Accordingly, we deemed an 80% minimum response rate to be a good target. For a 10-member patient care team, responses from the responsible physician, plus 7 of the 9 nurses/mid-levels involved in patient care would be acceptable. Pretests of the instruments were conducted with clinicians and based on their feedback changes were made to improve clarity. A total of 52 clinicians participated in the pretest of the survey, allowing us to evaluate the reliability, content validity and construct validity, of the measures prior to data collection (Straub 1989).

Final survey data collection was conducted over a 12-week period and achieving the targeted 80% team level response rate required an on-site presence by one of the authors that exceeded 850 hours. Clinicians first received an email from their unit managers directing them to visit the appropriate sur-

Table 5. Patient Care Team Descriptive Statistics

	High Mortality Risk Patients (n = 98)				Low Mortality Risk Patients (n = 126)		
	Organ Transplant	Cardiovascular Surgery	Pneumonia	Mean	Knee/Hip Replacement	Vaginal Birth	Mean
# of Qualifying Teams (Total = 224)	34	43	21	32.7	74	52	63
# of Respondents (Total = 506)	79	162	121	120.7	63	85	74
Mean Team Size (Number of clinicians)	10.4	14	8.8	11.7	7.5	5.6	6.7
Mean Length of Stay (Days)	5.8	8.4	4.9	6.7	3.1	2.1	2.7
Mean Clinician Age (Years)	43.5	38.8	38.9	40.4	46	41.7	44.2
Team (Female) Proportionality†	75%	80%	86%	80%	84%	89%	85.7%
Team CPOE Experience (Years)	6.0	5.2	3.9	5.23	5.4	4.2	4.9

†We captured team gender proportion and team physician proportion (ratio of physicians to other clinicians). These two constructs were highly correlated, and gender proportion was dropped at the analysis phase.

vey URL, which resulted in initial response rates of 8% to 10%. To boost response rates, we obtained permission to enter the nursing units outside of shift change hours (7 a.m. to 10 a.m.; 7 p.m. to 10 p.m.) in order to meet face-to-face with potential respondents and provide a brief overview of the study. While we were unable to meet with all identified clinicians during the data collection period, this process resulted in an overall response rate for nurses and mid-levels of 90.5% at Hospital B, and 87.5% at Hospital A. The physician response rate at Hospital B was 66%, and at Hospital A was 60.5%. Table 5 presents the profiles of patient care teams for the different patient conditions.

Team Level Aggregation and Validation of Measures

Team Level Aggregation of Individual Level Measures

We used recommended procedures to evaluate if individual-level measures can be aggregated to compute team-level scores (Chan, 1998). We had two types of individual level measures for which we conducted this assessment: those with a clinical team frame of reference and those with the individual respondent's frame of reference (see Table 4 and Appendix B). Prior to aggregating individual-level measures to create team-level measures, we evaluated r_{wg}, the degree of consensus among clinicians in a team on (1) each individual item for a reflectively measured construct (i.e., FOA, COA, and the two control variables, perceived usefulness (USFL) and ease of use (EOU) of CPOE) and (2) the composite index, which was computed as a unit mean of the items, for a formatively measured construct (i.e., CC, DSU, and IP) (R Development Core Team 2013). The median r_{wg} scores range from 0.872 to 0.967 and exceed the .70 threshold considered suitable for within-group agreement and aggregating individual level measures to the team level (Klein and Kozlowski 2000).

Measurement Validation

We used PLS (specifically SmartPLS; Ringle et al. 2005) for our analysis for three reasons: (1) PLS enabled us to estimate the measurement model and the structural model simultaneously, (2) it is suitable for exploratory models involving newly created measures or constructs, such as DSU, and (3) PLS has fewer distributional assumptions (Gefen et al. 2011). Assessment of reliability, construct validity, and measurement invariance across the low and high mortality risk conditions was conducted using a multistep, iterative process. As noted in Appendices F and G, we deleted some items to achieve configural and metric invariance. After these adjustments, the remaining items loaded on the same factors, with very similar magnitude of loadings across both patient mortality risk conditions, with a 0.038 average discrepancy in all factor loadings across the two patient mortality risk conditions. The final factor pattern matrix is shown in Appendix D. The reliability of the reflective measures was assessed

Table 6. Descriptive Statistics and Construct Reliability for Low Mortality Group (n = 126)

Construct[a]	Mean	Standard Deviation	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation (4)	5.897	0.303	0.923	0.888	0.752
Consensus on Appropriation (3)	5.734	0.327	0.961	0.940	0.892
Patient Satisfaction with Team (3)	4.690	0.586	0.934	0.895	0.825
Informating the Patient (1)[b]	4.567	.596	NA	NA	NA
Communicative Coordination (1)[b]	4.118	0.217	NA	NA	NA
Deep Structure Use (1)[b]	5.635	0.314	NA	NA	NA
Perceived Usefulness (4)	5.857	0.386	0.963	0.949	0.867
Perceived Ease of Use (3)	5.421	0.413	0.949	0.920	0.860
Team Physician Proportion	1.819	.068	NA	NA	NA
Team Mean CPOE Experience (YRS)	4.899	1.090	NA	NA	NA
Team Average Age (YRS)	44.179	6.189	NA	NA	NA
Length of Stay (Days)	2.698	1.803	NA	NA	NA

Notes: (a) The number in the parenthesis represents the number of items in the scale after dropping certain measurement items in order to achieve measurement invariance across the low and high patient mortality risk conditions.
(b) Communicative Coordination, Deep Structure Use, and Informating the Patient are formative constructs. They were measured using 4, 8, and 2 items respectively that were converted to composite indexes computed as unit means of the items.

Table 7. Descriptive Statistics and Construct Reliability for High Mortality Group (n = 98)

Construct[a]	Mean	Standard Deviation	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation (4)	6.062	0.290	.962	.947	0.863
Consensus on Appropriation (3)	5.839	0.310	.966	.947	0.904
Patient Satisfaction with Team (3)	4.738	0.550	.936	.903	.831
Informating the Patient (1)[b]	4.61	0.592	NA	NA	NA
Communicative Coordination (1)[b]	4.249	0.174	NA	NA	NA
Deep Structure Use (1)[b]	6.061	0.309	NA	NA	NA
Perceived Usefulness (4)	5.950	0.441	.977	.969	0.914
Perceived Ease of Use (3)	5.404	0.441	.971	.956	0.919
Team Physician Proportion	1.848	.102	NA	NA	NA
Team Mean CPOE Experience (YRS)	5.231	1.093	NA	NA	NA
Team Average Age (YRS)	40.4	5.705	NA	NA	NA
Length of Stay (Days)	6.684	4.078	NA	NA	NA

Notes: (a) The number in the parenthesis represents the number of items in the scale after dropping certain measurement items in order to achieve measurement invariance across the low and high mortality risk conditions.
(b) Communicative Coordination, Deep Structure Use, and Informating the Patient are formative constructs. They were measured using 4, 8, and 2 items respectively that were converted to composite indexes computed as unit means of the items.

using Cronbach's alphas (Nunnally 1967). The lowest Cronbach's alpha (.888) and composite reliability (.923) scores exceeded the .80 thresholds for each construct (see Tables 6 and 7). The lowest item-to-construct loading is 0.796, and all loadings had a significant t value, thus indicating adequate convergent validity (see Appendix C).

To establish discriminant validity, we conducted two tests. First, we compared an indicator's loadings on its intended construct with cross-loadings on other constructs. All items loaded higher on their intended construct (0.796 or higher) than on other constructs. Second, we compared whether the square root of the average variance extracted (AVE) of the constructs was greater than the correlations among all other constructs (Gefen and Straub 2005). We find for both patient mortality risk groups that greater variance is shared between a construct and its indicators than between constructs, providing additional evidence of discriminant validity (see Appendix E). Our research design, which involves data from multiple sources, mitigates common method bias; tests also suggest that common method bias is not an issue (see Appendix D). Finally, we did not detect any multicollinearity issues in our analysis (variance inflation factor: average = 1.59, max = 6.03).

Hypotheses Testing

We conducted a multigroup PLS analysis for the low and high mortality risk patient groups using 1,000 bootstrap samples. The standardized path coefficients, standard errors, and significance of the paths are reported in Table 8 and Figure 2. Most of the controls associated with PATSAT (length of stay, and the following team variables: team size, shared knowledge, mutual respect, and shared goals) were nonsignificant; only hospital was significant. The following controls associated with DSU were significant: perceived usefulness, CPOE experience, and team physician proportion. Patient care teams for high mortality risk patients with higher team physician proportion were associated with higher DSU; conversely, low mortality risk patient care teams with a *lower* physician proportion were associated with higher DSU. Perceived ease of use was not significant in either the low or high patient mortality risk groups, consistent with previous HIT research (Hu et al. 1999) and with Hsieh et al. (2008) who find EOU to diminish in importance over time as a predictor of use.

From the structural model results (Figure 2 and Table 8), we find that FOA is positively associated with DSU for both low and high patient mortality risk groups (β1 = .442, p < .01 for low mortality risk group; β1 = .349, p <. 01 for high patient mortality risk group), thereby supporting H1a and H1b. To test the mediation of COA on DSU through FOA (H2a, H2b), we conducted a product-of-coefficients test using bootstrapping to estimate the standard error as prescribed by Preacher et al. (2007) as this approach does not require distributional assumptions.

We generated 1,000 bootstrap samples for each of the low and high patient mortality risk groups. We computed the indirect effect (z'= β1× β3, with β1 being the effect of FOA on DSU and β3 being the effect of COA on FOA) and its standard error (σ). The mediation effect was significant for the low mortality risk group (σ = .065, z' = .29, p < .01) and for the high mortality risk group (σ = .094, z' = .28, p < .01), thereby supporting H2a and H2b.

To test that the mediation DSU→CC→IP is conditional on patient mortality risk group (H3), we followed Preacher et al. First, for each patient mortality risk group, we computed the indirect effect (z' = β5 × β6, with β5 being the direct effect of DSU on CC and β6 being the direct effect of CC on IP) and its standard error (σ). The mediation effect was nonsignificant for the low patient mortality risk group (σ = .032, z' = .010, p > .1) and significant for the high patient mortality risk group (σ = .081, z' = .131, p < .1). Second, we computed the mean of the 1,000 pairwise differences in the bootstrap estimates for z' for the low and high mortality risk groups ($z'_{High\_risk} - z'_{Low\_risk}$) and the standard error of the differences. To test the conditional indirect effect, we calculated the t-value using the multigroup path comparison approach suggested by (Chin 2004) and applied in past work (e.g., Hsieh et al. 2008).[3] We found that the mediation effect was stronger in the high risk mortality group than in the low risk mortality group ($z'_{High\_risk} - z'_{Low\_risk}$ = .121 and its standard error σ = .08, t = 1.52, p <.10).

To test that the mediation CC→IP→PATSAT is conditional on patient mortality risk (H4), we replicated the procedure used to test H3. First, for each mortality risk group, we computed the indirect effect (z' = β6 × β7, with β6 being the direct effect of CC on IP, and β7 being the direct effect of IP on PATSAT) and its standard error (σ). The mediated effect was nonsignificant for the low mortality group (σ = .053, z' = .016, p > .1) and was significant for the high mortality group (σ = .098, z' = .155, p < .1). Second, to test the conditional indirect effect, we calculated the t-value to assess the significance of $z'_{High\_risk} - z'_{Low\_risk}$ using the same approach as H3. We found that the mediation was stronger in the high mortality group than in the low mortality group ($z'_{High\_risk} - z'_{Low\_risk}$ = .139, standard error σ = .105, t = 1.33, p < .10).

To test that the mediation DSU→CC→PATSAT is conditional on patient mortality risk (H5), we replicated the procedure used to test H3 and H4. First, for each mortality risk group, we computed the indirect effect (z' = β5 × β8, with β5 being the direct effect of DSU on CC, and β8 being the direct effect of CC on PATSAT) and its standard error (σ). The mediated effect was nonsignificant for the low mortality group (σ = .041, z' = .015, p > .1) and was significant for the

[3] $t = \frac{Path\ Coefficient_{Sample_1} - Path\ Coefficient_{Sample_2}}{\sqrt{\frac{(m-1)^2}{(m+n-2)} * S.E^2_{Sample_1} + \frac{(n-1)^2}{(m+n-2)} * S.E^2_{Sample_2}} * \left(\sqrt{\frac{1}{m} + \frac{1}{n}}\right)}$, where m and n are the sample sizes in groups 1 and 2, respectively.

Table 8. Multigroup Structural Model Estimation Results

Main Effects			Low Mortality Risk	High Mortality Risk
β1: FOA	→	DSU	.442 (.088)***	.349 (.112)***
β2: COA	→	DSU	.151 (.090)*	.027 (.122) NS
β3: COA	→	FOA	.649 (.052)***	.801(.031)***
β4: DSU	→	PATSAT	-.025 (.072) NS	.061 (.102) NS
β5: DSU	→	CC	.453 (.071)***	.622 (.064)***
β6: CC	→	IP	.018 (.071) NS	.213 (.128)**
β7: IP	→	PATSAT	.754(.066)***	.720 (.070)***
β8: CC	→	PATSAT	.017(.083) NS	.178(.105)**
FOA R^2			.421	.641
DSU R^2			.632	.557
CC R^2			.205	.387
IP R^2			.112	.039
PATSAT R^2			.562	.583
Controls			**Low Mortality Risk**	**High Mortality Risk**
AGE	→	DSU	-.125 (.078) NS	.022 (.060) NS
EXP	→	DSU	-.186 (.069)***	.272 (.078)***
TPP	→	DSU	.249 (.072)***	-.155 (.091)*
EOU	→	DSU	-.095 (.065) NS	.024 (.094) NS
USFL	→	DSU	.373 (.084)***	.267 (.109)***
TPP	→	IP	-.190 (.060)***	.098 (.145) NS
SIZE	→	IP	-.178 (.095)**	-.008 (.135) NS
SIZE	→	PATSAT	.092 (.105) NS	-.060 (.163) NS
LOS	→	PATSAT	-.054 (.086) NS	-.07 (.164) NS
RC5	→	PATSAT	-.038 (.071) NS	.079(.095) NS
RC6	→	PATSAT	-.011 (.096) NS	-.026 (.122) NS
RC7	→	PATSAT	-.036 (.105) NS	-.213 (.163) NS
HOSP	→	PATSAT	NA	.155(.092)*

Notes: (a) Standardized coefficients are reported; standard errors in parentheses.
(b) ***p < .01, **p < .05, *p < .10, NS: Not significant.
(c) One-tailed tests for relationships among constructs in the model as direction of relationships are theorized, two-tailed tests for controls.
(d) COA = Consensus on Appropriation; FOA = Faithfulness of Appropriation; DSU = Deep Structure Use; IP =Informating the Patient; PATSAT = Patient Satisfaction; AGE = average age of team members; EXP = average experience using CPOE; TPP = Team Physician Proportion; EOU =Team Perceived Ease of Use; USFL = Team Perceived Usefulness; SIZE = Team size (number of members); LOS = average length of stay of patients associated with the team; RC5=Shared Knowledge; RC6 =Mutual Respect, RC7 = Shared Goals; HOSP = Grand mean of PATSAT for patient care teams at a hospital.

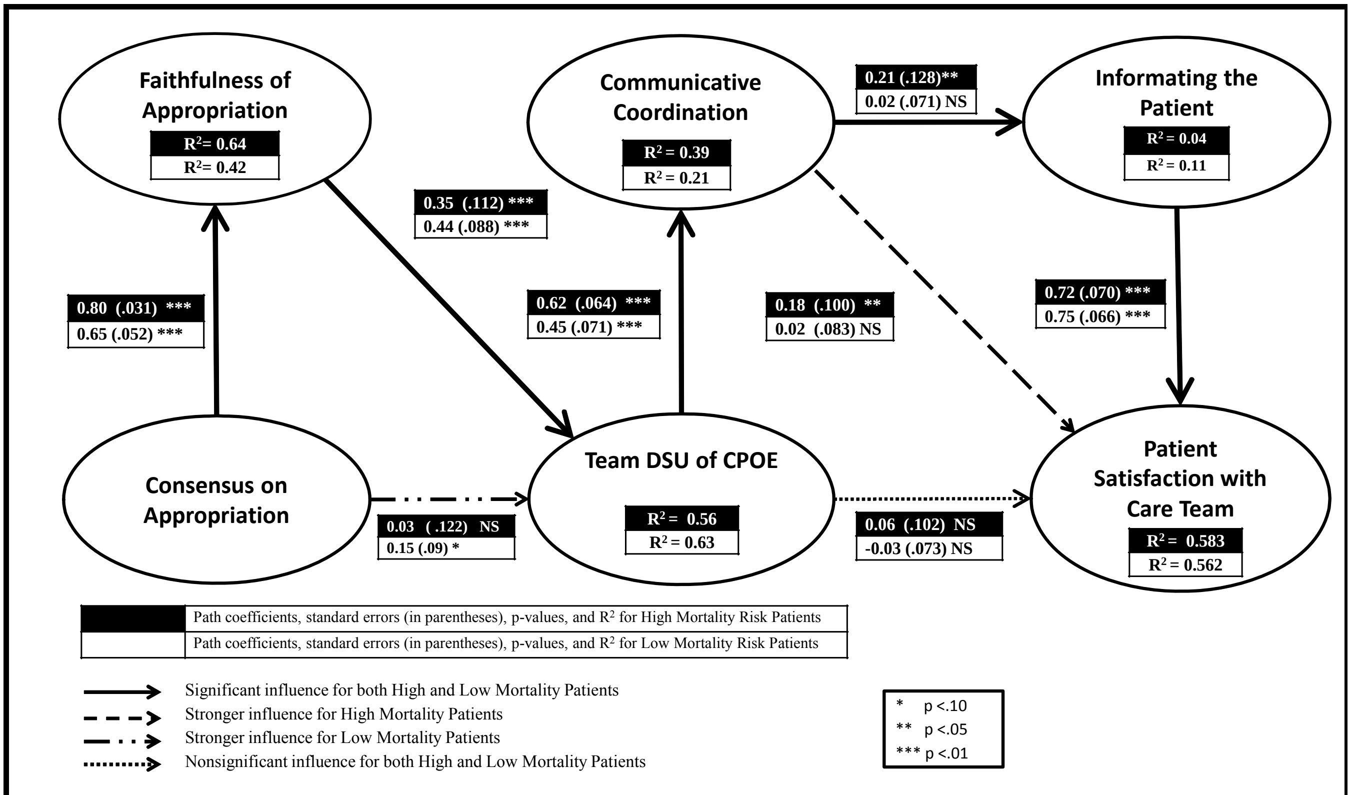


Figure 2. Structured Model Estimation Results for High and Low Patient Mortality Risk Group

high mortality group ($\sigma = .081$, $z' = .204$, $p < .01$). Second, to test the conditional indirect effect, we calculated the t-value to assess the significance of $z'_{High\_risk} - z'_{Low\_risk}$ using the same approach as H3 and H4. We found that the mediation was stronger in the high mortality risk group than in the low one ($z'_{High\_risk} - z'_{Low\_risk} = .189$, standard error $\sigma = .085$, $t = 2.22$, $p < .05$).

For H3, H4, and H5 (the conditional indirect effect hypotheses) we also evaluated if both stages of the mediation were moderated by patient mortality risk. We found that both stages were moderated for H3 (DSU→CC→IP) and H5 (DSU→CC→PATSAT) and that the first stage was moderated for H4 (CC→IP→PATSAT).

Cross-Nesting Assessment and Robustness Analysis

Our unit of analysis is a patient care team for a specific patient, with the patient outcomes (PATSAT and IP) corresponding to the care team. Accordingly, our model, measures (including the composite measures), and analysis are at the level of a care team for a patient. As *ad hoc* patient care teams can be cross-nested and clinicians can serve on multiple patient care teams, we took several steps to assess the robustness of our results to cross-nesting. We computed a cross-nesting index for a team as follows: We calculated the number of other patient teams that each member of a given patient team had been part of and computed the average number of other teams that members of the patient's team had been part of. For cross-nesting index, the mean was 8.66, the median was 8.47, and the standard deviation was 3.84. We did the following to evaluate and safeguard against biased estimates because of cross-nesting: (1) included a team cross-nesting index as an additional control on all mediating and dependent variables, (2) examined the behavior of the error terms of all the mediating and dependent variables, and (3) used PLS bootstrapping (as reported earlier) to test our hypotheses. Elaborating, first, we controlled for the impact of the cross-nesting index on PATSAT as well as all other mediating constructs (see Appendix H). We find all hypotheses to be supported and only nominal changes to the path coefficients and standard errors. We also interacted the cross-nesting index with each of the predictors. Here again, we found all hypotheses to be supported and only nominal changes to the

Table 9. Summary of Hypotheses Testing Results

		Hypothesis	Findings
RQ1: Appropriation Impact on DSU	H1 ✔	FOA is positively associated with DSU of CPOE for (a) low mortality risk patients and (b) high mortality risk patients.	FOA→DSU was significant for both high and low patient mortality risk groups.
	H2 ✔	The positive impact of COA on DSU of CPOE will be mediated through FOA for (a) low mortality risk patients and (b) high mortality risk patients.	FOA fully mediated the relationship between COA and DSU (COA→FOA→DSU) for high and low patient mortality risk groups.
RQ2: Impact of CC Enabled by DSU on Patient Outcomes (IP, PATSAT) for Low/High Patient Mortality Risk Groups	H3 ✔	The positive mediation of DSU of CPOE on IP through CC will be moderated by patient mortality risk such that the effect will be stronger for high than low mortality risk patients.	The mediation (DSU→CC→ IP) was moderated by patient mortality risk; *both* stages moderated. DSU had no direct or indirect effect on IP for the low mortality risk group. CC fully mediated the relationship between DSU and IP for the high mortality risk group.
	H4 ✔	The positive mediation of CC on PATSAT through IP will be moderated by patient mortality such that the effect from CC to IP will be stronger for high mortality risk patients.	The first stage (CC→IP→PATSAT) was moderated by patient mortality risk (significant only for high mortality risk group). IP fully mediated the CC→PATSAT relationship, but only for the high mortality risk group. IP had a strong direct effect on PATSAT for both the high *and* low mortality risk groups.
	H5 ✔	The positive mediation of DSU of CPOE on PATSAT through CC will be moderated by patient mortality such that the effect will be stronger for high risk patients.	Both stages of the mediation (DSU→CC→PATSAT) were moderated by patient mortality risk. CC fully mediated the DSU→PATSAT relationship, but only for the high mortality risk group. CC had no direct or indirect effect on PATSAT for low mortality risk group.

path coefficients and standard errors. Second, for all the mediating and dependent variables, we examined the residual plots, univariate statistics of the residuals, the difference in the variance of residuals across teams with different levels of cross-nesting (above the median and below the median), and the correlation between the studentized residuals and the predicted values. We found (1) the residuals behave normally, (2) no significant differences in the variance of the residuals across teams that were high (above the median) and low (at or below the median) in cross-nesting (Levene's test for equality of variance was nonsignificant for all constructs at $p > .23$ or more), and (3) no significant correlation between the studentized residuals and the predicted values of constructs ($r < .001$, $p > .99$ in all cases). Third, we used PLS bootstrapping for our hypotheses testing—approaches like pair-bootstrapping which are similar to PLS bootstrapping have been shown to perform as well as asymptotical corrections of the error term, like the Huber-White-Correction commonly used in regression analysis (Flachaire 2005). Overall, our results indicate that the results were robust to the cross-nesting across teams.

Discussion

Our results support our hypotheses as summarized in Table 9. We now discuss the theoretical implications of our results.

Implications for Theory

We contribute to the growing HIT literature (Chiasson and Davidson 2004; Romanow et al. 2012) by elaborating our understanding about HIT as an enabler of patient care team coordination. We conceptualize and operationalize DSU of CPOE, assess the role of appropriation in affecting DSU, and evaluate how CC enabled by DSU impacts two key patient outcomes, IP and PATSAT, under different levels of patient mortality risk. Our findings contribute to our understanding about how CPOE-enabled coordination and its consequences and, more broadly, HIT use for clinical care coordination, as we now elaborate.

First, our findings pertaining to H1 and H2 (which correspond to RQ1) extend our understanding about the predictors of DSU by surfacing the impact of appropriation constructs (i.e., FOA and COA) on DSU above and beyond technology acceptance factors. In our research context involving a comprehensive and mature HIT implementation well past the shakedown period, we found that COA and FOA explained significant variance in DSU for both high and low risk patient mortality groups after considering the influence of team members' perceptions of ease of use and usefulness. We contribute to theory by showing that consensus on how team members appropriate the technology promotes their overall appropriation of the technology to be consistent with the overall design spirit, or faithful, thereby enhancing clinicians' utilization of advanced features of the technology to support their tasks.

Second, our findings pertaining to H3, H4, and H5 (corresponding to RQ2) contribute to our understanding of the mechanisms through which HIT use affects patient outcomes when patient mortality risk is high. Our findings show that CC enabled by HIT use, in this case CPOE, affects key patient outcomes. Specifically, to our knowledge, ours is the first study to (1) disentangle the composite relational coordination construct introduced by Gittell (2002) and Gittell et al. (2010) by separating CC, which focuses on a team's communication activities, from its intangible resources (i.e., shared knowledge about individuals' roles, mutual respect, and shared goals), and (2) show that DSU has an indirect effect on IP and PATSAT that is mediated by CC. Thus, we advance our understanding about CPOE impacts by surfacing that DSU has a positive influence on CC for high mortality risk patients and through CC impacts patient outcomes.

By incorporating a DSU lens, we captured volitional use by clinicians of advanced features such as digital progress notes and decision support. Prior research has suggested that increased PATSAT resulting from CPOE use is potentially influenced by improved team coordination (Queenan et al. 2011). By conceptualizing and measuring DSU and CC across the team members who provided care to the patient, we advance our understanding of *how* the use of features embedded in systems like CPOE can influence PATSAT.

Through the integration of IP in our model, we develop an even clearer link between HIT use and PATSAT. Extending research that has focused on how HIT use can informate clinicians (Kohli and Kettinger 2004), our study illuminates the dual role of HIT use for clinicians and patients. The role of IP for PATSAT is especially salient, as a core output in healthcare is the transfer of patient-related information from clinicians to patients (Arrow 1963). The inclusion of IP in our model greatly increases the explained variance in PATSAT. As such, we extend prior research that has shown clinician-to-patient communication and PATSAT to be positively associated (Boulding et al. 2011; Manary et al. 2013; Street et al. 2009) by elaborating the process through which this impact can be achieved: DSU of an HIT positively impacts PATSAT through CC and/or IP.

Third, our study extends our understanding about patient care team coordination and its impact on patient outcomes by considering the contextual role of the nature of the task. We find that DSU significantly increases PATSAT through CC for high mortality risk patients, but not for low mortality risk patients. This suggests that it is when the complexity and uncertainty associated with a patient condition increases that CPOE enablement of coordination and the consequent impacts on patient outcomes materialize. This represents a significant contribution to theory in that it may help to explain why prior research on the impact of HIT has been somewhat mixed (Agarwal et al. 2010). Specifically, it suggests by integrating the clinical context of use—such as low and high mortality risk conditions for which care is coordinated—we can develop a better understanding of the impact of HIT systems.

Fourth, our conceptualization and operationalization of the patient care team that is patient specific embraces the nature of these teams, and contributes to our understanding of teams in an *ad hoc* environment. Unlike previous research that considers all clinicians on a specific specialty unit (Argote 1982; Gittell 2002; Gittell et al. 2010) or clinic (Kane and Alavi 2008; Kane and Borgatti 2011; Kane and Labianca 2011) as team members, we considered only those clinicians that came in direct contact with the patient. By taking this approach, we captured responses from all involved clinicians throughout the patient's hospital stay, including part time nurses loosely affiliated with the hospital but influential to patient care.

Fifth, to the best of our knowledge, ours is the first study to explore how DSU by a patient care team affects PATSAT. Our DSU construct can help researchers to understand how the use of advanced features such as decision support and alerts, progress notes, and clinical results integration differs across patient care teams when use behaviors have progressed well past the shakedown phase of IS implementation and have become stable. Our results suggest that DSU impacts CC in patient care teams not only through standardized order sets, but through volitional use of advanced features, thus leading to improved PATSAT outcomes for patients with high mortality risk.

Implications for Practice

Our study has several important implications for hospital administrators and clinical IT practitioners. First, our results suggest that hospitals can improve CC within patient care teams by promoting DSU. By using CPOE in a comprehensive manner, patient care team members are better able to coordinate patient care, ultimately leading to improved PATSAT. Hospital administrators and their IT staff often hear that the increased data entry associated with CPOE detracts from face-to-face interaction with patients, and clinicians anecdotally suggest that the impact of the additional time at the computer leads to lower patient outcomes like PATSAT. Our results suggest quite the opposite. Based on our findings, hospitals would be well advised to be patient with CPOE implementations under the knowledge that benefits will eventually accrue in the form of improved CC once they are past the shakedown phase and *if* clinicians use features beyond the ones that are likely to be mandated such as order entry through a system. Hospitals should also be aware that the impact of DSU on PATSAT does not appear to be significant for low mortality risk patients, and they should not necessarily expect that the use of features beyond baseline order entry and order sets will increase PATSAT for these types of patients. The real payoff from DSU appears to be in the improvements it affords in managing the care process for high mortality risk patients.

Second, clinicians need to recognize the important role of IP for PATSAT in both high and low mortality risk conditions. Specifically, DSU can improve CC and in turn enable clinicians to better informate the patient. Generally, clinicians can leverage HIT not just to automate care processes but to informate the patient. Recent research suggests that open notes, or the sharing of progress notes with patients, can be an important mechanism to informate patients and that producing open notes is not burdensome for clinicians (Delbanco et al. 2012). As such, patients can be informated not only indirectly through the sharing of notes internally between clinical team members but also directly through the purposeful sharing of notes with the patient during their stay and after discharge through their patient portal. Given the increased emphasis of PATSAT on CMS reimbursements in 2017, HIT practices that informate the patient and consequently increase PATSAT may also yield higher revenues for hospitals.

Third, our study suggests that IT professionals implementing CPOE should work closely with patient care teams to help them develop a consensus on how they wish to use the technology. This will help to drive more faithful appropriation and ultimately lead to greater DSU. Many hospitals implementing CPOE emphasize the development of order sets to serve the needs of different care teams. While this is important to obtain the most from the baseline features that CPOE provides, we believe that it is also important for IT professionals to work more closely with patient care teams to establish COA on the many other features that CPOE affords (e.g., decision support and alerts, clinical results integration, and progress notes).

Limitations and Future Research

Although our study was carefully theorized and designed, it is not without limitations. First, our study focused on two hospitals that were part of a not-for-profit organization. These hospitals had implemented a commercially available CPOE system years ago and were well past the shakedown phase. Thus, it is difficult to know the extent to which our results can be generalized to other settings (e.g., for-profit hospitals, hospitals using an alternative software vendor, or hospitals that have implemented CPOE recently and are still in the shakedown phase).

Second, our study design captures all patients discharged from the two focal hospitals between December 1, 2011, and August 31, 2012, who had completed a patient satisfaction survey. Our clinician survey was administered to the patient care team members between October 17, 2012, and January 25, 2013, resulting in a time lag between the time of patient care and the completion date of the clinician surveys. Clinician perceptions regarding the focal constructs such as DSU may have shifted during the time lag. Since the CPOE system had been implemented for more than 7 years at these two hospitals, stable use patterns had emerged across patient conditions, thereby minimizing the risks associated with the time lag. Had this design been conducted in a hospital CPOE implementation site during or immediately after shakedown phase, this limitation would have posed a more serious threat to the validity of the results.

Third, our study relied on PATSAT as our ultimate dependent variable. While PATSAT is a quality metric of considerable concern to hospital administrators, other more objective metrics might have been used for assessing the outcome of DSU on the quality of care that was provided. Unfortunately, we did not have access to these other outcome measures. One direction for future research would be to determine if our model is able to explain or predict alternative measures related to the quality of care (e.g., readmission rates, medical errors, etc.).

Fourth, we constructed an index to account for cross-nesting of clinicians in patient care teams and conducted multiple robustness tests that suggested the results are robust to cross-nesting. Future research can address cross-membership across patient care teams by using multi-level approaches. Future research may also employ a social network perspective to evaluate how different types of ties among clinicians influence DSU and how different types of ties among clinicians interact with DSU to affect coordination in patient care teams.

Another avenue for future research is to examine the impacts of the use of specific CPOE features on CC or patient care outcomes. For example, given the need to elaborate our understanding on effective mechanisms to informate the patient, researchers can evaluate how and when open progress notes should be shared with patients. Finally, it may be useful to evaluate facets beyond IP and CC that mediate the impact of DSU on PATSAT.

Conclusions

Our study shows that the impact of DSU of CPOE on PATSAT is mediated by CC and IP, but only for patients with high mortality risk conditions. We also found that FOA and COA are strong predictors of DSU, and that the effects of COA on DSU are mediated by FOA, for both high and low patient mortality risk groups. The results contribute to our understanding of *how* DSU influences PATSAT and *when* DSU is likely to be most impactful. We hope that our study will encourage further research that leverages the coordination lens and the DSU and CC constructs that we developed to examine the impact of HIT use on clinical outcomes.

Acknowledgments

The authors gratefully acknowledge the assistance of Dr. Steven Luxenberg, who was instrumental in providing access to the data and the hospital organization in which this research was conducted. We would like to thank the *MIS Quarterly* editors and reviewers who handled our manuscript and provided such constructive feedback. We would also like to thank Jan DeGross for her help in the production process of our paper.

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MIS Quarterly

RESEARCH ARTICLE

CPOE-ENABLED COORDINATION: APPROPRIATION FOR DEEP STRUCTURE USE AND IMPACTS ON PATIENT OUTCOMES

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Appendix A

Formulating Patient Care Teams and Managing the Survey Process

We followed a systematic and rigorous procedure as described below to meaningfully map the care team for each patient and to administer the surveys to the clinicians.

Step 1: Obtaining Patient Satisfaction Survey for a Visit to the Hospital
We obtained a total of 2,475 patient satisfaction surveys, with each survey having a unique visit ID. These data were provided to us by the third-party administrator of patient satisfaction surveys for the hospitals.

Step 2: Extracting CPOE Order Data to Match the Patient Satisfaction Surveys
Using the unique patient visit ID contained in the patient satisfaction survey, the Chief Medical Information Officer (CMIO) retrieved from the clinical archival data all CPOE orders placed on behalf of the patient during their stay, resulting in a total of 370,000 unique orders. Data elements included date timed stamped description of the order, the clinician name and occupation code (MD, RN, PA), and the responsible physician.

Step 3: Extracting Documentation and Diagnosis Codes
For each patient visit ID, the CMIO extracted all nursing and physician documentation entries, resulting in a total of 300,000 unique records. These data included vital signs, medication orders, progress notes, and discharge orders, as well as admitting, secondary, and discharge diagnosis codes (problem lists).

Step 4: Associating and Validating a Patient Record with a Medical Condition
Order set and documentation entries were organized by patient visit IDs which were then counted according to order sets for conditions. Final confirmation of the patient condition was determined by the admitting and discharge diagnosis codes.

Step 5: Selecting Patient Conditions
Our sampling included both high and low patient mortality risk conditions. We focused on patient conditions in which there would be maximal variance in the composition of the teams caring for such patients. This was done in order to avoid having to ask clinicians to complete multiple surveys. We ultimately selected the following patient conditions: high mortality risk (organ transplant, cardiovascular surgery, and pneumonia); low mortality risk (knee/hip replacement and vaginal birth).

Step 6: Determining Clinicians with Direct Contact with a Patient and Consequently Members of the Patient Care Team

Our objective was to include those clinicians on a patient care team who had direct contact with the patient during their hospitalization. The likelihood of direct contact was assessed using appropriate role-based criteria that were determined in consultation with hospital representatives. This assessment procedure, as described below, was identically implemented across each patient condition.

All orders and documentation entries were summarized by patient, and then by clinician associated with the patient.

From the CPOE order set detail, the identified responsible physician was included as a team member.

Other clinicians associated with a patient care team were determined based on documentation entries made by a clinician. We considered documentation entries made by a clinician as more indicative of direct contact of the clinician with a patient in the patient's care process, compared to a clinician simply entering an order into the CPOE system on behalf of the responsible physician. We use this heuristic as documentation entries by the clinician were more apt to require a bedside visit, thus additional physicians, as well as mid-level clinicians (PA, NP, CNM) who made documentation entries were included as clinicians in the patient care team. Nurses (RN, LPN), who are more apt to make routine entries on behalf of other team members than an MD or PA, were included on a team with a documentation entry, and any combination of entries to the documentation and CPOE order system exceeding two entries.

Other clinicians, such as pharmacists, anesthesiologists, and dieticians, who provided services across a broad range of patient conditions were also identified through the order and documentation entries. However, these clinicians were only identified in a few instances and were not included in a patient care team.

Therefore, the care team that was identified for a patient was comprised of the responsible physician, and other physicians, mid-levels, and nurses that would have most likely presented themselves at the patient bedside throughout the patient stay.

Step 7: Assigning a Clinician to a Survey for One of the Patient Conditions

This step focused on ensuring that a clinician was assigned to complete a survey for one patient condition. Although most clinicians mapped to one patient condition, there were clinicians who cared for multiple patient conditions. This was especially true for float pool, pre-admission testing, and pre-op/post-anesthetic care unit (PACU) nurses. Nurses that had cared for patients in multiple conditions were assigned to complete a survey for one condition based on a careful consideration of the volume of patients and the patient condition.

Step 8: Validation Process

Throughout the team formation process, input was sought from the CMIO, Chief Medical Officers, Chief Nursing Officers, and Nursing Management. A final review of the team creation process was completed with the CMIO, and cross-validation using separate archival data was performed on a sample of teams. Through the cross-validation, the CMIO was satisfied with the representation of the patient care teams and the rigor associated with the process. While nurses such as RN's and LPN's were included as team members, the inclusion of clinical partners whose role on the units were more administrative than fully trained nurses, required additional discussion with nurse management. Through the discussion, the nurse managers felt strongly that the role of clinical partners should be excluded from the study, as they were not sufficiently trained to understand the features embedded in the system, or make alterations to the clinical care processes.

Step 9: Managing the Survey Process

Once each clinician was assigned to one patient condition, additional information for each clinician and patient team (e.g., clinician hospital unit assignment, patient team size, number of patient care teams for each clinician, date of first survey request, survey completion date, date that the clinician was excluded from the study for reasons such as the clinician not being employed at the hospital anymore) was integrated to facilitate the progression of survey data collection process. This additional information was useful in tracking overall response rates and progress towards obtaining at or above an 80% response rate for each team. The survey collection process began in the third week of October 2012 after the pre-tests and the team formation process.

Appendix B

Control Variables

Construct	Definition And Informing Sources	Measurement Approach
Team Average Age	Average age of individuals in a patient care team (Morris and Venkatesh 2000; Venkatesh et al. 2003)	• Clinician survey (single-item measure) • Mean of age of team members
Perceived Usefulness	The degree to which a patient care team believes that system use would enhance team performance (Davis 1989; Salisbury et al. 2002; Venkatesh et al. 2003)	• Clinician survey (three-item reflective measure) • Aggregation through direct consensus
Perceived Ease of Use	The degree to which a patient care team believes that use of a system will be free of effort (Davis 1989; Salisbury et al. 2002; Venkatesh et al. 2003)	• Clinician survey (six-item reflective measure) • Aggregation through direct consensus
Hospital PATSAT	Mean of PATSAT across patient care teams at hospital	• Third-party administered patient survey (three-item reflective measure)
Length of Stay	Length of stay for a patient associated with a care team; *length of stay = actual inpatient length of stay in relation to the standard protocols for the patient condition*	• Archival data from hospital (patient length of stay)
Team Size	Number of clinicians, including physicians and nursing staff that are part of the patient care team	• Computed using archival data from hospital
Team Physician Proportion	Ratio of physicians to other clinicians (e.g., nurse, mid-level) on a team	• Computed using archival data from hospital
Cross-Nesting Index	For each individual clinician in our sample, we calculated the number of teams (patients) that they represented. Then, for each team we calculated the average number of teams that its team members were part of.	• Computed using archival data from hospital

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Appendix C

Loadings and Cross-Loadings of Multi-Item Measures

		High Mortality Risk Patients					Low Mortality Risk Patients				
Construct	**Item**	**COA**	**EOU**	**FOA**	**PATSAT**	**USFL**	**COA**	**EOU**	**FOA**	**PATSAT**	**USFL**
COA	COA3	**0.944**	0.520	0.749	0.056	0.669	**0.936**	0.325	0.604	-0.177	0.234
	COA4	**0.970**	0.469	0.738	0.003	0.633	**0.964**	0.327	0.626	-0.126	0.272
	COA5	**0.938**	0.409	0.794	0.030	0.589	**0.933**	0.303	0.608	-0.195	0.261
EOU	EOU2	0.432	**0.949**	0.362	-0.144	0.615	0.287	**0.915**	0.314	-0.079	0.607
	EOU3	0.523	**0.971**	0.451	-0.126	0.579	0.309	**0.931**	0.353	-0.114	0.676
	EOU4	0.449	**0.956**	0.374	-0.107	0.528	0.334	**0.937**	0.407	-0.085	0.646
FOA	FOA2	0.700	0.301	**0.904**	0.011	0.518	0.595	0.282	**0.920**	-0.079	0.349
	FOA3	0.727	0.410	**0.916**	0.041	0.630	0.427	0.402	**0.808**	-0.131	0.427
	FOA4	0.727	0.385	**0.953**	-0.018	0.537	0.596	0.396	**0.935**	-0.131	0.408
	FOA5	0.814	0.438	**0.941**	0.044	0.616	0.646	0.267	**0.796**	-0.058	0.289
PATSAT	OA2	0.053	-0.17	-0.03	**0.827**	-0.08	-0.09	-0.086	-0.05	**0.897**	-0.16
	OA3	0.020	-0.11	0.005	**0.955**	-0.07	-0.18	-0.09	-0.01	**0.914**	-0.14
	OA4	0.027	-0.10	0.066	**0.953**	0.010	-0.22	-0.096	-0.18	**0.913**	-0.16
USFL	USFL1	0.595	0.526	0.586	-0.084	**0.950**	0.255	0.630	0.453	-0.144	**0.935**
	USFL2	0.627	0.482	0.568	0.031	**0.964**	0.259	0.698	0.364	-0.135	**0.932**
	USFL3	0.676	0.582	0.647	-0.020	**0.971**	0.262	0.640	0.409	-0.196	**0.932**
	USFL4	0.637	0.703	0.577	-0.115	**0.939**	0.231	0.623	0.360	-0.164	**0.925**

Notes:

1. COA = Consensus on Appropriation; EOU = Team Perceived Ease of Use; FOA = Faithfulness of Appropriation; PATSAT = Patient Satisfaction with Care Team; USFL= Team Perceived Usefulness.
2. Communicative Coordination, Team Deep Structure Use, and Informating the Patient are formative constructs that were measured as composite indexes of their respective measurement items. Accordingly, the measurement items of these constructs are not included in this analysis.

Appendix D

Measurement Invariance and Common Method Bias Analysis

Measurement Invariance: In order to compare low and high mortality risk patient condition groups, it was necessary to drop certain items to establish measurement invariance. For the perceived usefulness and perceived ease of use constructs, we deleted the problematic items which included productivity and mental effort in their stem. Similarly, some of the appropriation measures, including "The developers would agree with how our team used the system" and "There was no conflict on our team with respect to the CPOE system," accentuated measurement variance, and were subsequently deleted. The trimmed measures resulted in improved construct validity, higher AVE scores, and improved measurement invariance, without substantially changing content validity of the affected constructs. The loadings of these measures across groups are shown in the table below.

Measure	Low Mortality Risk	High Mortality Risk
FOA2	.920	.904
FOA3	.808	.916
FOA4	.935	.953
FOA5	.796	.941
COA3	.936	.944
COA4	.964	.969
COA5	.933	.938
EOU2	.915	.949
EOU3	.931	.971
EOU4	.937	.956
USFL1	.935	.950
USFL2	.932	.964
USFL3	.932	.970
USFL4	.925	.939
PATSAT1	.897	.827
PATSAT2	.914	.955
PATSAT3	.913	.952

Common Method Bias Analysis: Common method bias is considered a significant threat to construct validity, resulting from the simultaneous measurement of the dependent and independent variables with the same instrument (Podsakoff et al. 2003). We rely on clinician surveys for the independent variables and a third-party patient satisfaction survey for the dependent variable. Therefore, the independent and dependent variables are collected separately from two instruments, as well as from a completely different set of respondents, thereby eliminating the principal source of common method bias. Additionally, as per recommended procedures, we evaluated the correlations among the study constructs by conducting a marker variable analysis (Malhotra et al. 2006). We identified the lowest and second lowest correlation variables that were collected during the survey process. Adjusting for and , the correlations among the study variables did not change at the second decimal level, nor was there a change in significance level. The average correlation change for was -.00110, and for .00116, indicating that common method bias is not a concern with our data.

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Appendix E

Correlation Matrix by Patient Mortality Risk Group

	AGE	COA	EOU	EXP	FOA	HOSP	LOS	IP	PATSAT	RC5	RC6	RC7	CC	TPP	DSU	SIZE	USFL
AGE	**1\1**	0.11	0.10	0.38	0.19	NA	0.03	-.06	0.00	-0.13	0.10	0.04	0.10	0.19	0.04	0.11	0.28
COA	0.2	**0.95\ 0.89**	0.34	0.08	0.65	NA	-0.02	-.17	-0.18	0.27	0.29	0.26	0.37	0.05	0.49	0.00	0.27
EOU	0.07	0.49	**0.96\ 0.86**	0.21	0.39	NA	0.12	-.05	-0.10	-0.01	0.05	-0.07	0.06	0.36	0.43	0.23	0.69
EXP	0.33	0.11	-0.20	**1\1**	-0.04	NA	0.14	-.10	-0.02	-0.09	0.08	0.05	-0.11	0.25	-0.08	0.24	0.33
FOA	0.18	0.80	0.42	0.09	**0.93\ 0.75**	NA	0.08	-.06	-0.12	0.47	0.36	0.29	0.51	0.20	0.70	0.15	0.43
HOSP	0.15	-0.16	-0.43	0.63	-0.18	**1\NA**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LOS	-0.07	-0.28	-0.21	0.06	-0.21	0.28	**1.00**	-.29	-0.20	-0.08	-0.07	-0.10	-0.05	0.36	0.05	0.74	0.16
IP	-.00	.09	-.12	.05	.04	.06	-.03	**1\1**	.74	-.05	.06	.04	.02	-.31	-.09	-.30	-.09
PATSAT	0.03	0.04	-0.14	0.04	0.02	0.12	-0.12	**.73**	**0.91\ 0.83**	-0.10	0.00	-0.03	-0.02	-0.21	-0.11	-0.18	-0.17
RC5	0.00	0.41	0.18	-0.02	0.43	-0.22	-0.17	.07	0.09	**1\1**	0.58	0.53	0.46	-0.04	0.42	0.00	0.11
RC6	0.10	0.46	0.22	0.16	0.51	0.03	-0.23	.13	0.14	0.61	**1\1**	0.67	0.60	-0.08	0.21	-0.04	0.22
RC7	0.15	0.48	0.04	0.31	0.48	0.21	-0.24	.21	0.16	0.41	0.73	**1\1**	0.61	-0.11	0.21	-0.08	0.12
CC	0.07	0.38	0.31	0.19	0.36	0.09	-0.27	.18	0.28	0.30	0.61	0.56	**1\1**	0.01	0.45	-0.04	0.17
TPP	-0.08	-0.44	-0.21	0.16	-0.43	0.36	0.44	.01	0.04	-0.39	-0.50	-0.46	-0.39	**1\1**	0.36	0.64	0.30
DSU	0.28	0.60	0.32	0.30	0.64	0.09	-0.23	.11	0.17	0.33	0.58	0.63	0.62	-0.39	**1\1**	0.14	0.52
SIZE	-0.08	-0.30	-0.10	0.10	-0.26	0.27	0.89	-.00	-0.08	-0.25	-0.33	-0.34	-0.25	0.60	-0.27	**1\1**	0.22
USFL	0.31	0.66	0.60	0.06	0.62	-0.15	-0.21	-.04	-0.05	0.23	0.42	0.31	0.41	-0.40	0.60	-0.21	**0.96\ 0.87**

Notes

1. Above diagonal represents Low Mortality Risk group (n = 126); below diagonal represents High Mortality Risk group (n = 98).
2. Square root of AVE on diagonal for high\low mortality group; AVE (high group)\AVE(low risk group).
3. Age = Team members' average age (in years); COA = Consensus on Appropriation; EOU = Team Perceived Ease of Use; EXP = Team Average Experience with CPOE; FOA = Faithfulness of Appropriation; HOSP = Hospital Control; LOS = Patient Length of Stay; IP = Informating the Patient; PATSAT = Patient Satisfaction with Care Team; RC5 = Clinician Shared Knowledge; RC6 = Clinician Mutual Respect ; RC7 = Clinician Shared Goals; CC = Team Communicative Coordination; TPP = Team Physician Proportion; DSU = Team Deep Structure Use of CPOE; Size =Patient Care Team Size; USFL = Team Perceived Usefulness

Appendix F

Measurement Items for Constructs

Construct/ Type of Scale Used	Measurement Items	Informing Sources
Faithfulness of Appropriation 7-point Likert scale: 1 = Extremely unlikely 7 = Extremely Likely	(1) The developers of the CPOE system would agree with how our patient care team used the system.* (2) Our patient care team used the CPOE system properly. (3) The original developers of the CPOE system would view our patient care team's use of the system as appropriate. (4) Our patient care team used the CPOE system as it should have been used. (5) Our patient care team used the CPOE system in the most appropriate fashion.	Chin et al. 1997 DeSanctis and Poole 1994 Salisbury et al. 2002
Consensus on Appropriation 7-point Likert scale: 1 = Strongly disagree 7 = Strongly Agree	(1) Our patient care team was able to reach consensus on how to apply CPOE to coordinate patient care.* (2) There was no conflict in our patient care team regarding how we should incorporate the CPOE system to coordinate care.* (3) Our patient care team reached mutual understanding on how we should use CPOE to coordinate care. (4) Our patient care team was able to reach consensus on how we should use CPOE to coordinate care. (5) Overall, our patient care team agreed on how we should use CPOE to coordinate patient care.	DeSanctis and Poole 1994 Salisbury et al. 2002
Deep Structure Use 7-Point Likert scale: 1 = Strongly Disagree 7 = Strongly Agree	(1) <u>Including the responsible physician</u>, our patient care team directly entered CPOE medication orders for ___percent of unique patients. (2) Our patient care team ensures that ____ percent of all patients had at least one diagnosis entry. (3) <u>Including the responsible physician</u>, our patient care team consistently utilized the <u>drug-drug</u> interaction alerts provided by the CPOE system as a prompt to find safer alternatives. (4) Including the responsible physician, our patient care team consistently utilized <u>drug-allergy</u> interaction alerts provided by the CPOE system as a prompt to find safer alternatives. (5) Including the responsible physician, our patient care team consistently used CPOE to update and monitor real time patient status such as vital signs, medication orders, and lab results. (6) Including the responsible physician, our patient care team consistently used CPOE for clinical decision support—such as advice on medical conditions like sepsis, or for drug prescribing. (7) Including the responsible physician, our patient care team consistently used progress notes to update other team members on the care of our patients. (8) Our patient care team consistently used the standard CPOE order sets in the care of our patients, unless patient conditions prompted changes to standard protocols.	Burton-Jones and Straub 2006 DeSanctis and Poole 1994
Communicative Coordination 5 point Likert scale: 1 = Never 5 = Always	(1) How <u>frequently</u> do the following types of care providers on your team communicate with you about patients? Physicians, Nurses (2) Do the following types of care providers on your team communicate with you in a <u>timely</u> way about patients? Physicians, Nurses (3) Do the following types of care providers on your team communicate with you <u>accurately</u> about patients? Physicians, Nurses (4) When problems arise regarding the care of patients, do the following types of care providers on your team work with you <u>*to solve the problem*</u>? Physicians, Nurses	Gittell 2002 Gittell et al. 2010
Informating the Patient 5 Point Likert scale: 1 = Very Poor 5 = Very Good	(1) How well did the nurses keep you informed? (2) How well did the physician keep you informed?	Third-party provider patient survey
Patient Satisfaction 5 Point Likert scale: 1 = Very Poor 5 = Very Good	(1) Overall rating of your care at the hospital. (2) How well did the staff *work together* to care for you? (3) Likelihood of you recommending the hospital to others.	Third-party provider patient survey

*Denotes items that were dropped.

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Appendix G

Measurement Items for Controls

Construct/ Type of Scale Used	Measurement Items	Informing Sources
Perceived Usefulness 7 point Likert where: 1 = Extremely likely 7 = Extremely unlikely	(1) Using CPOE enables me to improve patient care and management. (2) Using CPOE improves my performance with respect to patient care. (3) Using CPOE enhances my effectiveness with respect to patient care. (4) Using CPOE makes it easier to carry out patient care. (5) I find CPOE useful for coordinating patient care* (6) Using CPOE increases my productivity with respect to patient care*	Davis 1989 Salisbury et al. 2002 Venkatesh et al. 2003
Perceived Ease of Use 7 point Likert where: 1 = Extremely likely 7 = Extremely unlikely	(1) Interacting with the CPOE system does not require a lot of my mental effort.* (2) I *find* it easy to get the CPOE system to do what I *want* it to do. (3) I *find* interaction with the CPOE system clear and understandable. (4) I *find the CPOE system* easy to use.	Davis 1989 Salisbury et al. 2002 Venkatesh et al. 2003
Age	In what year were you born? (enter 4-digit birth year; for example, 1976)	Morris and Venkatesh 2000 Venkatesh et al. 2003
Gender	Are you male or female?	Venkatesh et al. 2003 Venkatesh et al. 2000
Experience	The go-live date for CPOE at Hospital A was 11/01/2003 and at Hospital B was 02/01/2007. I have been using CPOE since ________	Davis et al. 1989 Venkatesh et al. 2003
Team Physician Proportion	Which best describes your role at the hospital? Nurse, Nurse Practitioner, Physician Assistant, Physician Computed based on the survey item above as the ratio of physicians to other clinicians (e.g., nurse, mid-level) on a team	
Shared Knowledge 5 point Likert where: 1 = Nothing 5 = Everything	How much do the following types of care providers on your team <u>know about your role</u> in caring for patients? Physicians: Nurses:	Gittell 2002 Gittell et al. 2010
Mutual Respect 5 point Likert where: 1 = Not at all 5 = Completely	How much do the following types of care providers on your team <u>respect the role you play</u> in caring for patients? Physicians: Nurses:	Gittell 2002 Gittell et al. 2010
Shared Goals 5 point Likert where: 1 = Not at all 5 = Completely	How much do the following types of care providers on your team <u>share your goals</u> for the care of patients? Physicians: Nurse:	Gittell 2002 Gittell et al. 2010

*Denotes items that were dropped

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Appendix H

Robustness Analysis with Inclusion of Cross-Nesting Index

Main Effects			Low Mortality Risk Without CNI	Low Mortality Risk with CNI	High Mortality Risk Without CNI	High Mortality Risk with CNI
β1: FOA	→	DSU	.442 (.088) ***	.409 (.085) ***	.349 (.112) ***	.389 (.10) ***
β2: COA	→	DSU	.151 (.090) *	.161 (.086) *	.027 (.122) NS	-.022 (.116) NS
β3: COA	→	FOA	.649 (.052)***	.651 (.050)***	.801(.031) ***	.797 (.032) ***
β4: DSU	→	PATSAT	-.025 (.072) NS	-.024 (.072) NS	.061 (.102) NS	.049 (.102) NS
β5: DSU	→	CC	.453 (.071) ***	.438 (.069) ***	.622 (.064) ***	.629 (.067) ***
β6: CC	→	IP	.018 (.071) NS	.085 (.080) NS	.213 (.128) **	.210(.13) *
β7: IP	→	PATSAT	.754(.066) ***	.755(.067) ***	.720 (.070)***	.719(.07)***
β8: CC	→	PATSAT	.017(.083) NS	.015 (.083) NS	.178(.105)**	.189 (.108) **
FOA R^2			.421	.422	.641	.644
DUS R^2			.632	.666	.557	.603
CC R^2			.205	.286	.387	.388
IP R^2			.112	.143	.039	.039
PATSAT R^2			.562	.562	.583	.585
Controls						
AGE	→	DSU	-.125 (.078) NS	-.097 (.077) NS	.022 (.060) NS	.006 (.06) NS
EXP	→	DSU	-.186 (.069) ***	-.091 (.069) NS	.272 (.078) ***	.141 (.085) NS
TPP	→	DSU	.249 (.072) ***	.331(.074) ***	-.155 (.091) *	-.208 (.078) **
EOU	→	DSU	-.095 (.065) NS	.004 (.080) NS	.024 (.094) NS	.151 (.099) NS
USFL	→	DSU	.373 (.084) ***	.324 (.091) ***	.267 (.109) ***	.220 (.097) **
SIZE	→	PATSAT	.092 (.127) NS	.099 (.103) NS	-.060 (.163) NS	.-.049 (.161) NS
LOS	→	PATSAT	-.054 (.104) NS	-.086 (.093) NS	-.07 (.164) NS	-.067 (.157) NS
RC5	→	PATSAT	-.038 (.071) NS	-.041 (.075) NS	.079 (.095) NS	.077 (.092) NS
RC6	→	PATSAT	-.011 (.096) NS	-.011 (.102) NS	-.026 (.119) NS	-.024 (.117) NS
RC7	→	PATSAT	-.036 (.105) NS	-.038 (.110) NS	-.213 (.163) NS	-.214 (.155) NS
HOSP	→	PATSAT	NA	NA	.155(.092) *	.082 (.183) NS
CNI	→	FOA	NA	-.024(.062) NS	NA	-.058(.058) NS
CNI	→	DSU	NA	-.258(.085) ***	NA	.299(.09)***
CNI	→	CC	NA	-.285(.071) ***	NA	-.034(.08) NS
CNI	→	IP	NA	.212(.115) *	NA	.017 (.094) NS
CNI	→	PATSAT	NA	-.015(.057) NS	NA	.079 (.158) NS

Notes:

(a) All hypotheses were supported with the inclusion of CNI was a control.

(b) Standardized coefficients are reported. ***p < .01, **p < .05, *p < .10, NS: Not significant.

(c) We evaluated the robustness to the inclusion of the interaction effect of CNI with each of the theorized predictors. We found all hypotheses to be supported and only nominal changes to the path coefficients and standard errors. All but one interaction was nonsignificant (CC × CNI → IP for low mortality group, p < .1).

(d) P values for main effects are theorized and use one-tailed tests, two-tailed tests used for controls.

(e) AGE = Team members' average age (in years); CC = Communicative Coordination; COA = Consensus on Appropriation; EOU = Team Perceived Ease of Use; EXP = Team Average Experience with CPOE; FOA = Faithfulness of Appropriation; HOSP PATSAT grand mean for patient care teams at a hospital; LOS = Patient Length of Stay; IP = Informating the Patient; CNI = Cross-Nesting Index; PATSAT = Patient Satisfaction with Care Team; RC5= Clinician Shared Knowledge; RC6 = Clinician Mutual Respect ; RC7 = Clinician Shared Goals; TPP = Team Physician Proportion; DSU = Team Deep Structure Use of CPOE; Size = Patient Care Team Size; USFL= Team Perceived Usefulness.