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Who Should See the Patient? On Discretionary Patient-Provider Assignments in Hospitals

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Traditional principles in operations management and organizational theory suggest that standardizing assignments of tasks to individuals can have substantial benefits and boost performance. However, in various organizations including hospitals, individuals are not forced to follow recommended assignments, and thus, deviations from routine task assignments are often observed. This is due to the conventional wisdom that professionals should be given the opportunity to use their discretionary judgement and deviate from routine assignments when they perceive it to be advantageous. It is unclear, however, whether and when this conventional wisdom is true. We use evidence on the assignments of generalist and specialists to patients in a children's hospital, and generate insights into whether and when hospital administrators should allow providers to use their discretion to deviate from routine assignments. To perform our analyses, we identify 73 top medical diagnoses and use detailed patient-level electronic medical record (EMR) data of more than 4,700 hospitalizations. In parallel, we conduct a carefully-designed survey of physicians and utilize it to identify the routine provider type that should have been assigned to each patient. Using these two sources of data, we examine the consequence of discretionary deviations from routine provider assignments on three sets of performance measures: operational efficiency (measured by length of stay), quality of care (measured by 30-day readmission rates and rate of adverse events), and cost (measured by total charges). Taken together, our findings suggest that allowing providers to use their discretion in order to deviate from routine assignments is beneficial for task types (patients' diagnosis in our setting) that are either (a) well-defined (improving operational efficiency and costs), or (b) require high contact (improving costs and adverse events, though at the expense of lower operational efficiency). For other task types (e.g., highly complex or resource-intensive tasks), we find that routines should be enforced: deviations are either detrimental or yield no tangible benefits. Our findings also establish a no free lunch theorem: while for some task types deviations are beneficial regarding some performance measures, they simultaneously degrade performance in terms of other dimensions. Finally, by comparing deviations during weekdays and weekends, early shifts and late shifts, and high congestion and low congestion periods, our results shed light on some environmental conditions under which discretionary deviations are invoked more in practice.

Key words: Hospital Operations; Task Assignment; Routines; Patient-Provider Assignment; Division of Labor
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1. Introduction

Motivation. Routines, or repetitive and recognizable patterns of interdependent actions, are an importance source of efficiency and reliability in organizational performance (Feldman and Pentland 2003, Nelson and Winter 1982, Cyert and March 1963). Recognizing this, organizations have created numerous coordination mechanisms to formalize processes and move toward more routine practices, such as the integrating role of a central manager (see, e.g., Lawrence and Lorsch 1967a), which can aid in reducing unnecessary variability and improving performance. Through such coordination mechanisms, the role of routine versus deviating practices can have important bearing on performance outcomes. For example, as professionals gain more experience, they tend to deviate from routine practices in batching and sequencing tasks for completion, which ultimately diminishes productivity (Ibanez et al. 2017). In another example, the loss of practice routines due to the transfer of a central manager to a competing organization diminishes performance (Briscoe and Rogan 2015, Aime et al. 2010).

In contexts like professional organizations, routines frequently emerge through task assignments, specifically in the division of expert knowledge and invoking roles relevant to a given context. While deviations from routine task assignment can have advantages and drawbacks (see, e.g., Becker 2004, Timmermans and Angell 2001), the ability of professionals to balance both forms of decision-making is essential to professionalization and performance (Spee et al. 2016, Feldman and Rafaeli 2002). To reduce role ambiguity and establish measures for accountability, professionals attempt to induce consistency through routines guiding who should be in charge of a particular task (Stinchcombe 2001, Kahn et al. 1964, Borgatta and Bales 1953). Yet at times, professional expertise often involves invoking appropriate discretion to deviate from routine task assignment so that performance does not suffer (Fong Boh et al. 2007).

Realizing this tension, some theories suggest an “optimal” level of upholding routines and standards of practice in the professional context (Engel 1969). In contrast, others argue that such inflexibility can be disastrous, since professionals must regularly deal with complex and nuanced issues in serving their clients (Champy 2009). Similarly, while decision theories discuss that decision-makers must possess the ability to know when to invoke discretion to deviate in their practice (see, e.g., D’Adderio 2014, Cyert and March 1963, and the references therein), operations management theories suggest avoiding discretionary deviations, indicating that establishing routines and standardizing how tasks are routed to different servers have important advantages (for studies on optimal routing in service systems with hetregenous servers see, e.g., Armony and Ward 2010, and the references therein). Due to these conflicting arguments, it is rather unclear whether and when enforcing routines (i.e., disallowing use of discretionary judgments in deviating from standard practices) is beneficial.

Research Questions. In this study, we focus on routines around task assignment, specifically the division of labor among generalist and specialist professionals. Our goal is to examine the consequences of permitting professional discretion in deviating from routine assignments, focusing on the following research questions: *What is the impact of professionals using routine versus deviating task assignments on performance outcomes? When is using discretion to deviate from routine assignments beneficial?*

Challenges and Importance. In addressing these questions, we note that in highly complex professional environments, how roles are identified and invoked is not always clear, particularly when expertise overlaps as in the case of generalists and specialists (Krikorian 2014). Our focus on task assignment of generalist and specialist professionals stems from various challenges and changes in the modern professional climate that make the delineation of such roles more complicated than ever. One critical characteristic of these changes is the ever-increasing specialization and sub-specialization of professions, which can impose novel challenges around decisions related to task assignment and which role to invoke. To manage environmental complexity and maintain competitive advantage, many professional service organizations such as accounting and law firms have taken a multidisciplinary orientation; they have decided to increase the number of specialists who offer customized solutions as well as the number of generalists who integrate work and reduce silos (Brock 2006, Brock and Powell 2005, Greenwood et al. 2002a). Paradoxically, organizations taking this approach in managing complexity have experienced other challenges. Organizations comprised of many specialists and generalists with overlapping expertise experience difficulties in effectively carrying out the division of labor, because it is frequently the case that the best person responsible for completing a task is not always clear (Ben-Menahem et al. 2016, Cronin and Weingart 2007). Moreover, given the complexities and nuances of professional work, task characteristics can have important bearing in the use of routines and subsequent performance outcomes. However, these relationships remain yet unclear.

Data and Research Setting. To answer our research questions, we collected a data set of nearly six years of electronic medical record (EMR) information from our partner hospital, which is a children's hospital in the west cost of the United States. Our data set contained information on 4,729 hospitalized patients with common pediatric diagnoses for which physicians desired clearer guidelines around generalist and specialist assignment. Separately, we also conducted physician surveys and collected data by asking generalist and specialist physicians who should have been in charge of such patients. We developed a variable for routine assignment that represented the generally accepted, or most common opinion, about generalist-specialist assignment as captured in the survey results for each diagnosis. We compared actual generalist and specialist assignments as documented in the medical records to routine assignment as indicated by the survey responses, and analyzed resulting performance outcomes along three important dimensions: *operational efficiency* (measured by length of stay), *quality* (measured by readmission rate as well as adverse event error rate), and *cost* (measured by total charges). We also assessed outcomes based on the interaction between routine physician assignment diagnosis (i.e., task) characteristics, focusing on the following types of tasks: *well-defined*, *high complexity*, *high contact*, and *resource-intensive*.

Main Findings. Our analysis of the data suggest that, for certain types of tasks, discretionary deviations from routine assignments are beneficial. Specifically, we find that for well-defined tasks such deviations can reduce costs and improve operational efficiency. For resource-intensive tasks, however, such deviations are associated with higher costs. Further, when tasks involve high contact, discretionary deviations from routine assignments are associated with worse operational efficiency, lower costs, and higher quality of care through a lower rate of adverse events. Put together, our findings indicate that allowing physicians to use their discretion in order to deviate from routine provider assignments when needed is beneficial for some (but not all) tasks. In particular, we find that invoking discretion to deviate from routine assignments is beneficial when (a) the patient's needs are well-defined (improving operational efficiency and cost), or (b) serving the patient requires high contact (improving costs and adverse events, though at the expense of lower operational efficiency). For other task types, we find that hospital administrators should enforce routine assignments: discretionary deviations are either detrimental or come with no tangible benefits.

Main Contributions. Inefficiencies with the division of labor and task assignment have been long-standing and costly challenges for managers. As organizations become more complex and new roles are introduced (causing existing roles to shift), effective task assignment only becomes more critical. We shed light on how routine versus deviating task assignment can influence outcomes, especially in relation to task type. Thus, our research provides evidence on how organizations can utilize a *task-type view* to standardize assignment decisions through use of routines. In particular, our study provides a novel perspective for professional role coordination and allocation of tasks by illuminating task types for which deviations from routine assignments can be beneficial. In doing so our study offers new insights that have both managerial and theoretical implications, which we discuss next.

Managerial Implications. We provide evidence establishing that enforcing routines can have advantages and disadvantages. Importantly, understanding the underlying tradeoffs and knowing when to enforce such routines affords managers the opportunity to improve operational efficiency, cost, and quality of their services. Additionally, as our interviews at our field site reveal, understanding the current assignment guidelines and when to deviate from them can be exceedingly helpful in practice:

> *"If there are pre-determined guidelines in terms of how physician assignments are done, this would be a benefit to how clinical care would work efficiently [...] The 'guidelines' are a difficult task to accomplish, as it would be a hard to achieve a sort of universal consensus. Perhaps the best method is to have guidelines be guidelines, but to have open communication if there are questions or concerns regarding physician assignment."* [Endocrinologist]

and

> *"It would be helpful to first understand what the current process for assignment is and what the goals for assignment are. Is the goal to maximize patient satisfaction? Patient care? Teaching for residents? Facilitate consistency in care for complex patients? My current dissatisfaction arises from not knowing what the goals and expectations are and thus not being able to adapt. These also do not seem to be consistent among all the hospitalist faculty that I rotate with."* [Gastroenterologist]

Finally, our results help hospital administrators as well as physicians to gain a better understanding of the environmental conditions under which discretionary deviations occur more. In particular, our findings indicate that discretionary deviations are invoked more during weekends than weekdays and during morning shifts (8am-1pm) than other shifts. However, we observe that deviations are invoked similarly during high congestion (busy) and low congestion (less busy) periods.

Theoretical Implications. Our results have a few essential theoretical implications. First, to the best of our knowledge, our work is the first to shed light on the dependency between task type and whether discretionary deviation from routine assignment can be beneficial. Second, by taking into account various performance metrics (operational efficiency, quality, and cost), we establish a *no free lunch theorem* in that although for some task types (e.g., those requiring high contact) deviations are beneficial in certain aspects of performance (e.g., quality and cost), they are simultaneously detrimental in other aspects (e.g., operational efficiency). Thus, while enforcing routine assignment is the dominant strategy for some tasks types, permitting discretionary deviations is typically not dominantly the better option, regardless of the task type. Third, our results indicate that there is an intriguing interplay between professional status and discretionary deviations from routine assignments, which in turn presents opportunities for future research. Specifically, we find that specialists deviate more than generalists from standardized assignments. A reason for this could lie in the way professional status manifests in the workplace. Professional power is characteristic of roles with greater specialization, and hence, resides largely among specialist professionals (Waring and Currie 2009, Freidson 1970). Specialists' ability to use their relative status over generalist professionals can reflect in instances when specialists deflect work to generalists, thereby deviating from standardized assignment. In such situations, specialists' reasons for deviating from rules may not necessarily correspond to what they believe is most suited for performing the task, but instead a way to assert their position and jurisdiction in the workplace relative to generalist colleagues (e.g., by opting for more work that is considered interesting or of greater prestige). A consequence of the potential assertion of specialist power, and therefore deviation from standard practice, may be greater costs in the services provided, as our analysis shows.

Organization. The rest of the paper is organized as follows. In Section 2, we describe the theoretical background of our work and state our hypotheses. In Section, 3, we discuss our research setting, data sets, and analyses. In Section 4, we present our results. Finally, we discuss the limitations of our work in Section 5, and briefly conclude in Section 6.

2. Theoretical Background

2.1. Task Assignment between Generalists and Specialists

To deal with environmental complexity and remain competitive, contemporary professional organizations have increasingly become multidisciplinary settings in which many different types of specialists and generalists provide services (Brock 2006, Greenwood et al. 2002b). A multidisciplinary approach, especially the inclusion of a variety of specialists and generalists, enables organizations to respond to an increasing repertoire of knowledge and new technologies in their industry (Spitz-Oener 2006). It also allows organization to keep pace with growing demands from their clients (Greenwood et al. 2002b). However, the strategy of incorporating many types of professionals also requires organizations to develop critical capabilities such as dividing tasks across roles for optimal performance (Lawrence and Lorsch 1967b) and coordinating across professional boundaries (Huq et al. 2017).

The known skillsets generalists and specialists provide in an organization can facilitate task assignment, or the mapping of tasks to different types of professionals (Puranam et al. 2014). For example, generalists provide a more holistic perspective with their breadth of knowledge while specialists provide more tailored services with their intricate and detailed knowledge (Cohen 2013, Currie and White 2012, Grant 1996). Consequently, whereas specialists' narrower expertise enables them to deliver more customized services to increase effectiveness in meeting particular client demands, generalists' broader expertise can facilitate the efficient completion of routine client demands (Chase and Tansik 1983). Additionally, it is known that generalists have the know-how to employ a greater variety of resources to complete a task as well as deal with large quantities of information that span a variety of disciplines (Treem 2012), while specialists have the capability to troubleshoot nuanced or ambiguous issues in their knowledge domain (Boone et al. 2000).

Although the operations management literature has studied optimal task assignment in settings where professionals differ in their knowledge levels and other abilities (see, e.g., Saghafian et al. 2018, for task assignment in knowledge-based service systems), the above-mentioned differences as well as the significant overlap between generalist and specialist expertise bring new challenges to understanding suitable ways of task assignment. For example, generalists' and specialists' overlapping jurisdictions can make the process of task assignment considerably complex, since professional contexts increasingly embody collaborative environments in which gray areas around roles can become more salient as jurisdictions have greater opportunity to collide (Thornton et al. 2005).

Understanding suitable ways of task assignment is further complicated by negotiations that take place in practice. For example, professionals persistently negotiate their roles and daily work, invoking discretion over task assignment to establish jurisdictions, resolve disputes, and effectively fulfill client needs (Hirschkorn 2006, Abbott 1995). This workplace negotiation in using discretion over task assignment—a fact that is largely overlooked in traditional operations management theories—takes multiple forms in the professional workplace. It can occur at a macro-level, as members within a professional group continue to establish their jurisdictions through norms of practice, training and education certifications, and association presence (Larson 1979). Conversely, at a micro-level, professionals within a domain will also impose personal preferences in their discretionary decisions that may respond to the politics in an organization, ultimately making decisions around task assignment deviate from routine practice (Kleinbaum et al. 2013). Task assignment can also be negotiated between professionals and upper-level management, who attempt to enact rules around professional practice, as in the case of organizational controls on individual projects performed by R&D professionals (Cardinal 2001). Further, discretion over task assignment frequently occurs as a negotiation between professional groups. For instance, engineers, technicians, and assemblers in a manufacturing firm may use artifacts to establish and alter relative roles (Bechky 2003). Across each of these examples, disputes concerning task assignment arise among professionals to establish jurisdictions that are consistent with the advancement and protection of their professional status (Zetka 2003, Allen 2000, Gieryn 1983), but also align with ethical standards that resonate at the institutional level of a given profession (Wright et al. 2017).

In our study's setting, task assignment is negotiated between generalists and specialists who are at the organization-client interface and equipped with expertise to (a) make autonomous decisions in managing the complexity inherent in their daily work (Thomas and Hewitt 2011), and (b) proactively deviate from routine practices to enhance service and accommodate circumstances in the work environment (Reay et al. 2006). Due to the complications caused by such negotiations, and the subsequent need to streamline professional work, organizations have attempted to routinize decisions around task assignment. Yet, professionals may still maintain their capacity for discretionary decision-making in their work. Since professionals engage in routine and deviating practices to manage task assignment (Krikorian et al. 2018), we aim to study whether and when deviation from routine assignments is beneficial.

In closing this section, we note that while little is known about when discretionary deviations from routine task assignments can yield performance improvements, discretionary deviations have been studied from other aspects, including task sequencing (see, e.g., Ibanez et al. 2017), task processing time (see, e.g., Hopp et al. 2007, Schultz et al. 1998, 1999), and following system generated recommendations (see, e.g., van Donselaar et al. 2010). Similarly, previous studies have discussed the effect of differentiating between task types on improving performance, including separating complex patients (see, e.g., Saghafian et al. 2014) and customer types that should be routed to a specialist (see, e.g., Shumsky and Pinker 2003). Our research unifies these separately studied, yet critical aspects of professional performance.

2.2. Routine Task Assignment and Task Types

Routines can be dictated by task characteristics. For example, tasks that are high risk or present significant uncertainty can benefit from routine and more standardized practices to support coordination, especially by enhancing the shared understanding about a task (Van de Ven et al. 1976). However, reliance on routines can have unintended consequences in potentially diminishing communication and coordination needed for a particular task (Orasanu 2001, Entin and Serfaty 1989, Orasanu 1993). The effect of routine practices on performance is driven by the type of task and who is enacting the practice (Hong et al. 2019, Kuntz et al. 2016). Seminal literature on task design includes four prominent features, which are the focus of our research: *well-defined*, *high complexity*, *high contact*, and *resource-intensive* tasks. In what follows, we describe each of these task types in our setting and provide related hypotheses.

Well-Defined Tasks. Tasks can be organized in terms of how well-defined they are, specifically in terms of two related components: epistemological clarity and invariability in procedures. First, epistemology refers to the means for knowing the nature of something—what an entity is and how it came into existence. It explains how "cognitive subjects come to know the truth about a given phenomenon in reality" (Bodenreider et al. 2004). Since epistemology explains how knowledge can be incorporated into practice, it can be a term used to describe the scope of knowledge pertaining to an entity. In the work environment, a task with high epistemological clarity means that both the type of problem and its source can be understood and measured. Relatedly, the second feature of well-defined tasks is that procedures in handling the task are largely invariable. This means that knowledge is applied to tasks through procedures that have been tried and tested, yielding greater certainty in the content and the context of application. Therefore, since well-defined tasks are those which have high epistemological clarity and low variability in procedures, we hypothesize that they are more conducive to routine task assignment:

HYPOTHESIS 1. *For well-defined tasks, routine rather than deviating assignment improves performance outcomes.*

High Complexity Tasks. Classical organizational design theories identify two key features of the scope of complex work: variety and interdependence (Langfred and Moye 2004). Task variety refers to the number of exceptions, or different types of situations and problems, encountered while performing a task (Perrow 1967). Tasks with high variety have many exceptions, so cannot be easily standardized or routinized. One result of an increasing number of exceptions may be the need to invoke different types of expert knowledge and skills to creatively handle a novel situation. Since settings with high task variety require more flexibility, bureaucratic and rule-based structures are not as effective. The other feature of complex work is interdependence, which refers to tasks that rely on what others do. For such tasks, therefore, designating a professional from the mix can be a challenging endeavor (Thompson 1967). We hypothesize that these features of highly complex tasks would make them less conducive to routine assignment. That is, when tasks are highly complex, professionals are more likely to deviate from assignment to enhance performance, as discretion in assignment will likely be more appropriate adaptations to the nuances of complex tasks. This leads us the following hypothesis:

HYPOTHESIS 2. *For high complexity tasks, routine rather than deviating assignment worsens performance outcomes.*

High Contact Tasks. The extent of "client contact," or the degree to which a client is in direct contact with a particular service facility relative to the total time needed to service the customer, is known to be an important factor that affects organizational performance (see, e.g., Chase and Tansik 1983). Organizations with high levels of client contact are found to be less productive, since the presence of customers can disrupt routines and the flow of work, as well as put exaggerated demands on professionals that would not otherwise occur (Danet 1981). As a result, we hypothesize that assignment decisions are largely programmable for work involving low client contact, because these settings are typically well-structured and less turbulent compared to high client contact settings (Chase and Tansik 1983):

HYPOTHESIS 3. *For high contact tasks, routine rather than deviating assignment worsens performance outcomes.*

Resource-Intensive Tasks. Resources refer to the inputs required to effectively complete a task, which for the purposes of this study, may include both human and physical capital. One of the most important functions of a manager centers on allocating resources among different groups in an organization (Kraut et al. 1989), because managerial decisions about task partitioning involve efficient utilization of specialized resources (von Hippel 1990). For optimal performance, tasks that are highly-resource dependent require a systematic identification, selection, and assignment of resources (Crowston 1991, 1997). We hypothesize that this makes such tasks more amenable to routine task assignment, because for a given task a particular professional may have the best expertise in carrying out this assessment of resources:

HYPOTHESIS 4. *For resource-intensive tasks, routine rather than deviating assignment improves performance outcomes.*

3. Research Setting, Data, and Analysis

3.1. Research Setting

We use data that we have collected from an urban academic children's hospital on the west coast of the United States, and focuses on routine versus deviating generalist and specialist physician assignments to patients. We focus on generalists and specialists mainly because their task assignments are often not clear-cut, and hence, there is a considerable level of discretion on how tasks are assigned in practice. This gives us enough data points in which discretionary deviations have occurred. This, in turn, allows us to study when such deviations are suitable.

In practice, assigning tasks to generalists and specialists requires the ability to manage the tension between breadth of generalist expertise and the depth of specialist expertise based on the situation. Managing this tension involves making the decision to invoke generalist and specialist expertise with awareness of the financial and human resource implications (e.g., specialists are fewer in number and cost more to utilize than generalists). In our setting, the generalist physicians could be general pediatricians practicing in a private office with admitting privileges to the hospital, or hospitalist physicians who work solely in the inpatient environment. The specialist physicians included in our analysis belong to one of seven different specialties: cardiology, endocrinology, gastroenterology, hematology/oncology, neurology, pulmonology, and rheumatology.

The integrator in our partner hospital is the *"Doctor of the Day" (DOD)*, who is a hospitalist physician with the authority to make an initial decision to put a generalist or specialist in charge. This task assignment can either match routine assignment or deviate from it. Deviation can be a product of the DOD invoking their discretion to make a more appropriate assignment given particular circumstances, or a result of the assigned physician challenging the decision. We examined the DOD's routine versus deviating decisions on who should be in charge for a variety of patient conditions. For the purposes of our study, generalist and specialist task assignment is a process that involves two primary decision points. Figure 1 illustrates these decision points. First, for a patient hospitalized with diagnosis X, either a generalist or specialist physician can be assigned as the patient's primary attending (or the ultimate decision-maker in providing care). A DOD makes the initial assignment decision, which can align with or deviate from routine practice. It should be noted that even if the DOD initially chooses a routine assignment, the assigned physician can either accept the patient into their service or push back on assignment for many reasons (e.g., inexperience with the patient's condition or heavy workload). This can start a negotiation process of task assignment between generalists and specialists, and potentially cause a deviation from routine assignment.

Thus, decisions around physician assignment can vary on a case-by-case basis, and physician discretion is applied with regard to many factors including professional expertise, workload, personal comfort and experience level, the complexity of the patient condition, and a gamut of other factors. Figure 1 captures this variation in the second decision point concerning routine assignment: generalist or specialist assignment either aligns with common opinion of who should be in charge (routine assignment), or varies based on the discretion of the assigning physician or negotiations ensuing between the DOD and assigned physician (deviating assignment). As Figure 1 also shows,

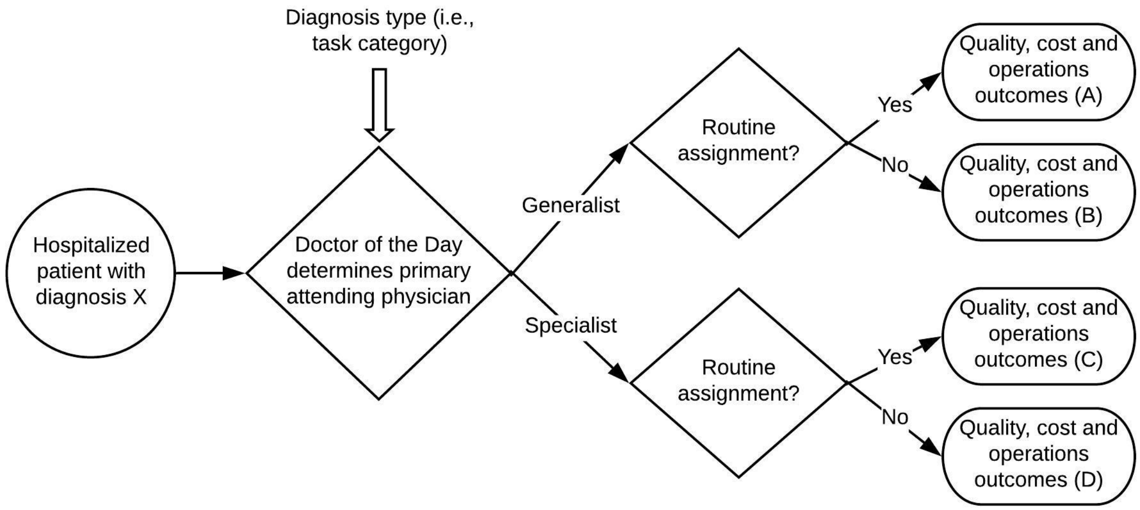


Figure 1 **Physician Assignment Process at Study Hospital**

we set out to understand the impact of professionals' decisions in coordinating work, namely the effect of routine versus deviating assignment (scenarios A through D), on three sets of outcomes: quality, cost, and operational efficiency.

3.2. Data

Using a mixed methods approach, we collected data from two primary sources: survey of physicians and electronic medical records (EMRs).

Survey of Physicians. To identify routine physician assignment, we administered an online survey using Qualtrics software to the department of pediatrics at the children's hospital, which included hospitalists and specialists belonging to the seven specialties. To design the survey, we iteratively solicited feedback from the division head of hospital medicine and the research director at the hospital. Once a pilot version of the survey was developed, we made modifications based on the feedback we received after performing cognitive tests on three hospitalists. The survey listed the "top diagnoses" for each specialty (a total of 176 diagnoses across seven specialty areas) and asked respective specialists, as well as a randomized group of hospitalists, who should be in charge: a generalist or a specialist. If the responding physician thought they would not be able to specify a generalist or specialist, the option "unsure—my selection depends greatly on other factors" was provided; that option was selected approximately 5% of the time and was dropped from our analysis. Top diagnoses lists for each specialty were first generated based on a query to the health information management department at the hospital, requesting the highest volume conditions for which patients were hospitalized. We also included variables for task category, or diagnosis type, which correspond to the task dimensions described earlier: well-known, high complexity, high contact, and resource-intensive. In order to operationalize the nature of tasks as it relates to diagnosis categories, we asked eight focus groups of two to three hospitalists each to classify the top diagnoses from the survey into four corresponding categories. These categories were inductively derived during an observational period at the hospital (e.g., patient rounds, physician meetings), consultation with the medical and management literature, and with input from several physicians at the hospital in order to ensure relevance to the professionals in our context.

Electronic Medical Records. We also collected electronic medical record (EMR) data for patients hospitalized between January 1, 2009 and August 31, 2015 for any of 73 top diagnoses ($n = 4,729$ hospitalizations). The top diagnoses list aligning with the EMR data was shorter for multiple reasons, including issues with mapping distinct ICD-9 codes to the condition specified, as well as the fact that a modal response (i.e., routinized assignment) did not exist for several conditions. The EMR data included detail on patient demographics, the nature of the diagnoses, patient outcome measures, and the physician of record (i.e., the physician ultimately taking responsibility for the patient's care). Identification of documented adverse events was a more complicated process. Using the assistance of an EMR coder at the hospital, we examined the five primary ICD-9 codes associated with each patient hospitalization for evidence of any adverse events, and categorized them accordingly.

3.3. Analysis

We analyzed outcomes based on four performance metrics: length of stay, total charges, 30-day readmissions, and adverse events. For length of stay and total charges, we used a generalized linear model (GLM) with gamma distribution to account for non-negativity and skewedness of distributions of these continuous outcome variables. For readmission and adverse events, we used a GLM with binomial distribution, since these outcome measures are integers. For all GLM models, we assumed proportional effects for each outcome variable, and hence, applied a logarithmic link function. We addressed the clustering of patients by physician using robust standard errors, and performed cluster correction based on the physician assigned. Our main effects of interest were routine (versus deviating) assignment and type of task (well-defined, high complexity, high contact, and resource-intensive). Our control variables included various patient, physician, and diagnosis characteristics as well as year fixed effects. Below, we discuss all of these in detail.

Dependent Variables. Our outcomes variables focused on three dimensions of performance: *operational efficiency*, *cost*, and *quality*. Operational efficiency was measured by *length of stay*, which is the total number of days from when a patient is admitted into the hospital until s/he is discharged. To measure cost, we used *total charges*, which is the amount billed to insurance for costs incurred during the patient's hospitalization. Of note, total charges are an estimation of costs, since this amount is billed but may not be the amount ultimately reimbursed and/or incurred. Finally, we measure quality by making use of two metrics: (1) *30-day readmission rate*, which captures if the patient was hospitalized again within thirty days of their last discharge, and (2) *adverse event rate*, which represents whether a non-surgical harmful event resulting from care at the hospital was documented in the medical records. Adverse events were inputted initially by the physician in charge of the patient, and then were revised as needed after medical record coders at the hospital conduct a review of the patient's hospitalization records post-discharge; these include adverse drug events, infections, and device events.

Independent Variables. Our independent variables include the following:

1. *Routine assignment* is a binary variable that equals one if the physician assigned (a generalist or specialist, as recorded in the medical records) matches who should be assigned based on the modal results from the physician assignment survey. In other words, routine physician assignment reflects the survey responses, where the majority of physicians indicated that either a generalist or specialist should be assigned to a patient with a given condition. If the actual assignment recorded in the medical records deviated from that, we noted that assignment as invoking individual professionals' discretion, and therefore, discretionary assignment (variable takes value of zero). For the 73 diagnoses in the survey, physicians expressed that specialists should be assigned to 44 (60%) diagnoses and generalists to 29 (40%) diagnoses (based on the modal responses in the survey).

2. *Well-defined diagnosis* was categorized according to the following definition: "well-defined expected course, complications, treatment and monitoring needs that are in a certain [physician's] domain of knowledge, skills and comfort-level." Such a diagnosis is less ambiguous, and is usually associated with what is known as the "standard of care" in the medical field, which is comprised of treatment guidelines that specifies appropriate patient care based on scientific evidence or collaboration among relevant medical professionals. The standard of care outlines patient treatment for a particular condition, such that medical errors and possible malpractice issues could be avoided. Thus, these diagnoses demonstrate high fundamentality, because they have a clearly outlined course of treatment and often coincide with legal protections of physician practice.

3. *High complexity diagnosis* was defined as follows: “patient has a diverse set of conditions and multisystem disease; may be technology dependent; has frequent inpatient admissions; and requires multiple medications, multiple specialists, and optimal care coordination across inpatient/outpatient settings” (Simon et al. 2010, Feudtner et al. 2014). Such a diagnosis involves multiple organ systems as well as the ability to address uncertainties in the patient’s diagnosis and course of treatment that result from higher levels of complexity in the underlying condition.

4. *High contact diagnosis* was defined as follows: “patient has a condition that requires frequent intervention and has a propensity for acute deterioration, and who is likely to require a physician who can be rapidly available.” Such diagnoses require greater patient contact for multiple reasons. This type of patient is in an unstable state in which unexpected deterioration can rapidly take place, and therefore instinctive decision-making under conditions of uncertainty places greater demands on the physician in charge. Also, a patient with this type of diagnosis requires much time from their assigned physician, who may frequently intervene during the course of treatment.

5. *Resource-intensive diagnosis* was classified based on the following definition: “diagnosis/workup often requires use of multiple ancillary services and support (e.g., physical/occupational/speech therapy, social work, discharge planning, etc.), possible frequent admissions, and longer length of stay.” The use of multiple types of resources, as well as the higher costs incurred from potentially longer patient stays and frequent readmissions, makes these types of diagnoses more resource-intensive.

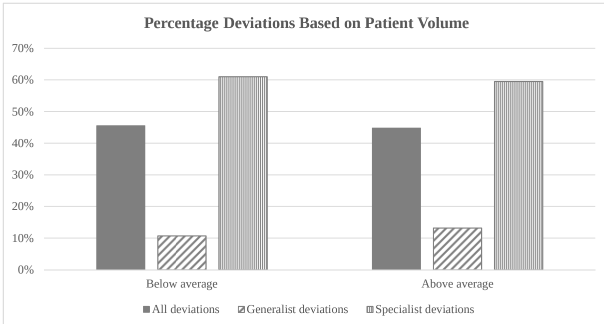
Interactions. Since it is likely that the effect of routine assignment on performance depends on the type of task category, we included interactions between each of the four task categories and routine assignment.

Controls. We controlled for several patient characteristics, including variables related to demographic and diagnosis characteristics. With regard to patient demographic characteristics, we included (1) age, defined as the patient’s age at the time of discharge from the hospital; (2) sex, defined as the patient’s gender based on the EMR; and (3) insurance type, defined as a binary variable indicating whether the patient possesses private or public insurance. To control for the nature of the patient’s condition, we incorporated a chronic condition indicator (CCI), which is a case mix adjustment categorical variable taking a value 0 through 4 that dichotomizes ICD-9 codes into chronic or non-chronic conditions and aggregates chronic conditions into 1 of 18 mutually exclusive clinical groups to assess both the severity and complexity (i.e., number of comorbidities, or different diagnoses afflicting the patient) associated with the patient hospitalization (Khan et al. 2015, Berry et al. 2013). Additionally, we controlled for timing of the patient's hospitalization, namely if it occurred during flu season, by using a binary variable indicating if the hospitalization occurred between October and April. During these months, hospitals typically experience higher patient volumes and patients who are sicker because their underlying conditions can be complicated by flu viruses or other seasonal illnesses. Patients hospitalized during this time are affected by more limited hospital resources and exposure to more sick patients. We also controlled for patient volume by directly including the number of hospitalized patients with one of the medical diagnosis in our data set as one of our controls. In addition, we used year fixed effects, which includes controls for the year of the patient's hospitalization. This was done for multiple reasons, including the fact that an increasing number of hospitalists were hired at the hospital since 2009. Finally, to control for the type of professional, we included a variable termed *generalist assigned*, which takes a value of one when a generalist is assigned and zero if a specialist is assigned.

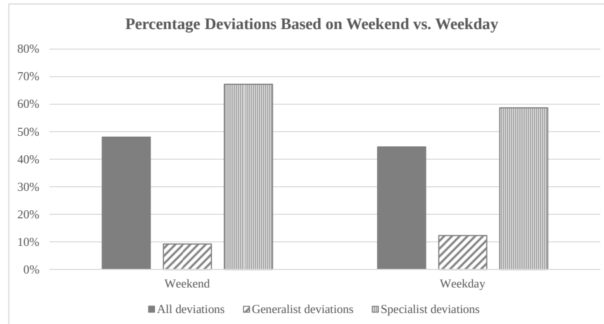
4. Results

We provide descriptive statistics and correlations in Table 1. The table displays weakly positive correlations between each of the task categories, except for the high complexity and resource-intensive tasks, which demonstrate a strongly positive correlation (r = 0.749). The stronger relationship between high complexity and resource-intensive tasks is expected, since highly complex tasks potentially involve a greater breadth of issues, the integration of a diverse set of activities, and more uncertainty. Thus, handling highly complex tasks typically require making use of many resources. To account for potential collinearity in our models, we residualized the resource-intensive task variable from high complexity tasks.

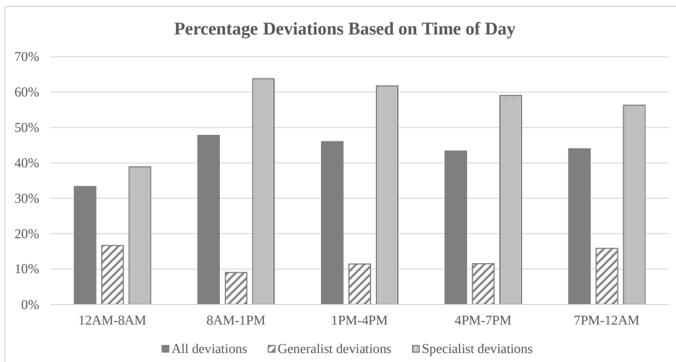
We started our analyses by generating insights into the following question: do deviations from routine assignments occur more during (1) high volume periods (versus low volume periods), (2) weekdays (versus weekends), and (3) earlier shifts (versus later shifts)? The results are presented in Figure 2. Part (a) of this figure indicates that percentage deviations do not differ much between high volume and low volume periods. Specifically, percentage of deviations both when a generalist is assigned (labeled as "generalist deviations") and when a specialist is assigned (labeled as "specialist deviations") are fairly similar between periods with below average and above average patient volume. However, part (b) of Figure 2 reveals that deviations occur more during weekends than during weekdays, and that this is primarily due to the fact that deviations when a specialist is assigned (while a generalist should have been assigned) is much higher during weekends than during



(a) Volume Effect



(b) Day of the Week Effect



(c) Time of the Day Effect

Figure 2 Percentage Deviations Based on Patient Volume, Day of the Week, and Time of the Day

weekdays. Finally, part (c) of Figure 2 shows that the highest and lowest percentage of deviations occur during morning shifts (8am-1pm) and after mid-night shifts (12am-8am), respectively.

Next, we examined the effect of task type on routine assignment, as shown in Table 2. The analysis also included professional type (generalist or specialist) to further examine patterns in routine assignment that relate specifically to professional role that may be due to knowledge differences between the two, as other research suggests (see, e.g., Atkinson et al. 2018, Shafritz et al. 2015, Crowston 1997, Galbraith and Galbraith 1977). Since the dependent variable is binary, we used a GLM model with binomial family and logit link, with standard errors clustered at the physician level. Average marginal effects (AME) are also shown in Table 2. The model includes controls for patient characteristics (i.e., various demographic and diagnostic variables discussed earlier) as well as year fixed effects.

From Table 2, we observe the following. First, a generalist assignment had a positive and statistically significant estimated coefficient. The AME indicates that each additional hospitalization assigned to a generalist increases the likelihood of routine assignment by 48.2%; when compared to the sample average for routine assignment of 54.8%, this increase is actually an 87.8%. By looking

Table 1 Descriptive Statistics and Correlations

	Variable	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Routine assignment	0.548	0.498	1															
2	Generalist assigned	0.312	0.463	0.4548*	1														
3	Length of stay (days)	5.900	14.774	0.0273	-0.0458*	1													
4	Total charges ($)	$54,800	$200,798	0.0313*	-0.0576*	0.9317*	1												
5	Readmission rate, 30-day	0.065	0.246	-0.0148	0.0193	0.0334*	0.0310*	1											
6	Adverse event rate	0.070	0.256	-0.0754*	-0.0624*	0.0491*	0.0538*	-0.0287*	1										
7	Well-defined task	0.681	0.466	-0.0143	-0.1541*	-0.0451*	-0.0308*	-0.1060*	0.0410*	1									
8	High complexity task	0.484	0.500	0.1788*	-0.2337*	0.0346*	0.0466*	-0.0879*	-0.1343*	0.2510*	1								
9	High contact task	0.357	0.479	0.1300*	-0.2063*	0.0064	0.0390*	-0.0791*	-0.0375*	0.1168*	0.3286*	1							
10	Resource-intensive task	0.382	0.486	0.1792*	-0.2630*	0.0262	0.0449*	-0.0900*	-0.1177*	0.1630*	0.7488*	0.5144*	1						
11	Patient volume	2.123	1.570	0.0157	0.0272	0.0105	0.0215	0.0111	0.0089	-0.0162	0.0157	-0.0335*	0.0122	1					
12	Patient age (years)	7.786	6.483	-0.1154*	-0.1747*	-0.0314*	-0.0138	0.0966*	0.0415*	0.1117*	0.0051	0.0227	0.0207	0.015	1				
13	Male patient	0.474	0.499	-0.0242	0.0214	-0.0032	-0.0028	-0.1052*	-0.0016	0.0116	0.0181	0.0215	0.0082	-0.0351*	-0.0615*	1			
14	Private insurance	0.303	0.460	-0.0382*	-0.0674*	-0.0336*	-0.0267	0.0528*	0.0162	0.001	-0.0360*	0.0036	-0.0366*	0.0135	0.0061	0.0035	1		
15	CCI	1.537	1.030	0.0208	0.0252	0.0696*	0.0434*	0.0331*	-0.0199	-0.1277*	0.1142*	-0.0031	0.1370*	0.0267	0.0154	0.0028	-0.0263	1	
16	Flu season	0.590	0.492	0.0018	-0.0035	0.014	0.0089	-0.0025	0.0095	0.005	-0.003	-0.0072	-0.0166	0.0369*	-0.0136	-0.021	-0.0107	-0.0108	1

Notes: CCI = Chronic condition indicator. n = 4,729. * p < 0.05

at task categories, we also observe from Table 2 that well-defined tasks had a statistically insignificant coefficient. However, tasks that were high in complexity, contact, and resource intensity each had statistically significant results. High complexity tasks had a positive coefficient ($p < 0.001$), and AME results indicating a 16.0% increase in the likelihood of routine assignment, or 29.2% when

Table 2 Factors Influencing Routine Assignment

Dependent Variable: Routine Assignment	Coefficients	AME
Generalist (vs. Specialist) assigned	3.530*** (0.269)	0.4820
Well-defined task	-0.046 (0.101)	-0.0061
High complex task	1.237*** (0.117)	0.1602
High contact task	-0.469*** (0.136)	-0.0621
Resource-intensive task	0.387** (0.153)	0.0.0881

Notes: Generalized linear model results reported (binomial family, logit link). Standard errors are in parentheses. Model is adjusted by patient characteristics and patient volume, and clustered by physician assigned. Includes year fixed effects. ** p < 0.01, *** p < 0.001. AME = Average marginal effect.

compared to the sample average of 54.8%. For high contact tasks, the results indicate a negative coefficient ($p < 0.001$), with an AME showing that high contact tasks decrease the probability of routine assignment by 6.2%, or 11.3% when compared to the sample average of 54.8%. Resource-intensive tasks had a positive coefficient ($p < 0.001$), that represented an increase in the probability of routine assignment by 8.8%, or 16% against the sample average of 54.8%.

In Table 3, we report the performance implications of routine assignment and task characteristics as a precursor to testing our hypotheses. Results for operational efficiency (length of stay) and cost (total charges) are reported in M1 and M2 using GLM models with a gamma family and logistic link, while quality outcomes (readmission and adverse event rates) are reported in M3 and M4 using GLM models with binomial family and logit link. All models include adjustments for patient characteristics and year fixed effects, with standard errors clustered by physician. As M1 and M2 show, routine assignment has a statistically significant effect on costs ($p < 0.001$), specifically in increasing the length of stay and total charges. M3 and M4 indicate no statistically significant relationship routine assignment and quality outcomes. With regard to task categories, M1 and M2 show that well-defined tasks do not have a statistically significant effect on cost outcomes, though have a statistically significant negative effect on readmission rates ($p < 0.001$) and statistically significant positive effect on adverse event rates ($p < 0.001$), as displayed in M3 and M4. Thus, well-defined tasks have a mixed effect on quality outcomes, demonstrating lower readmission rates yet higher adverse event rates.

For high complexity tasks, M1 and M2 in Table 3 indicate no statistically significant effects on cost outcomes. However, M3 and M4 show that high complexity tasks, compared to those with low complexity, have readmission rates that were significantly lower ($p < 0.01$), and adverse event

Table 3 Performance Implications of Routine Assignment and Task Categories

Dependent Variable:	Operational Efficiency	Cost	Quality	
Variables	Length of stay (days) M1	Total charges ($) M2	Readmission rate, 30-day M3	Adverse event rate M4
Routine assignment	0.173***	0.218***	0.259	0.200
	(0.035)	(0.036)	(0.183)	(0.202)
Generalist (vs. Specialist assigned)	-0.280***	-0.565***	-0.183	-1.173***
	(0.085)	(0.097)	(0.214)	(0.284)
Well-defined task	-0.003	-0.011	-0.758***	0.573***
	(0.031)	(0.032)	(0.136)	(0.157)
High complexity task	-0.007	0.016	-0.451**	-1.427***
	(0.034)	(0.035)	(0.172)	(0.189)
High contact task	0.125**	0.238***	-0.356	0.023
	(0.042)	(0.043)	(0.190)	(0.191)
Resource-intensive task	0.102*	0.135**	-0.551*	-0.697*
	(0.048)	(0.049)	(0.236)	(0.274)
Constant	1.448***	10.228***	-2.741***	-2.388***
	(0.082)	(0.088)	(0.348)	(0.336)
No. of Observations	4,729	4,729	4,729	4,729

Notes: Generalized linear model results reported (M1-M2: gamma family, logistic link; M3-M4: binomial family, logit link). Standard errors are in parentheses. Model is adjusted by patient characteristics and patient volume, and clustered by physician assigned. Includes year fixed effects. * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 4 Summary of Performance Implications of Routine Assignment and Task Categories

Dependent Variable:	Operational Efficiency	Cost	Quality	
	Length of stay (days)	Total charges ($)	Readmission rate, 30-day	Adverse event rate
Well-defined task	0	0	-	+
High complexity task	0	0	-	-
High contact task	+	+	0	0
Resource-intensive task	+	+	-	-

Notes: + = positive effect; - = negative effect; 0 = no effect.

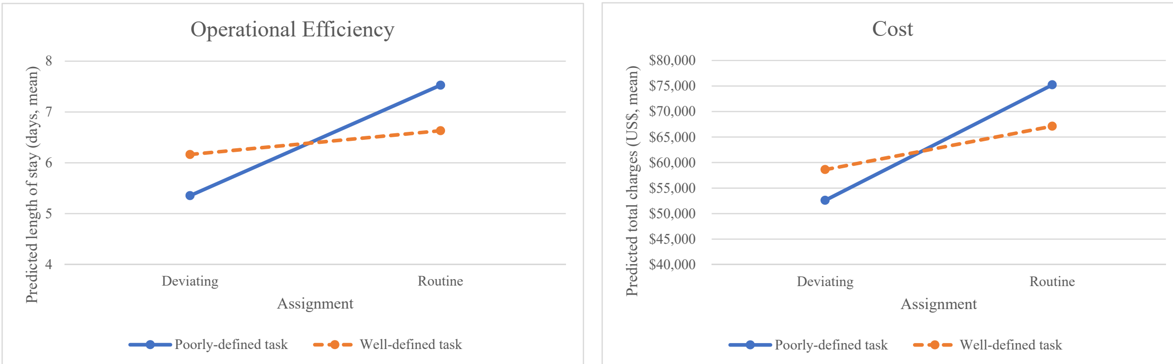
rates that were also significantly lower ($p < 0.001$). Considering M1 and M2, we also see that tasks requiring high (versus low) contact and those that were resource-intensive (versus those with low resource requirements) had significantly longer length of stay and higher total charges. M3 and M4 show no statistically significant effects on either of the quality outcomes for high contact tasks, yet statistically significant declines in readmission and adverse event rates for resource intensive tasks ($p < 0.05$). Finally, Table 4 provides a summary of the results provided in Table 3 and highlights our main findings.

To further examine the results from Tables 3 and 4, specifically the combined effect of task characteristics and routine assignment on performance, we tested interaction effects. The results are shown in Table 5. Our first hypothesis (Hypothesis 1) is that routine assignment, versus deviating

Table 5 Performance Implication with Interaction Terms

Dependent Variable:	Operational Efficiency				Cost				Quality							
Variables	Length of stay (days) M5	Length of stay (days) M6	Length of stay (days) M7	Length of stay (days) M8	Total charges ($) M9	Total charges ($) M10	Total charges ($) M11	Total charges ($) M12	Readmission rate, 30-day M13	Readmission rate, 30-day M14	Readmission rate, 30-day M15	Readmission rate, 30-day M16	Adverse event rate M17	Adverse event rate M18	Adverse event rate M19	Adverse event rate M20
Routine assignment	0.341***	0.206***	0.301***	0.188***	0.358***	0.195***	0.347***	0.230***	0.463	0.074	0.199	0.258	0.615*	0.452	-0.111	0.208
	(0.052)	(0.053)	(0.046)	(0.035)	(0.054)	(0.054)	(0.047)	(0.035)	(0.240)	(0.250)	(0.219)	(0.182)	(0.297)	(0.258)	(0.256)	(0.200)
Generalist (vs. Specialist assigned)	-0.275**	-0.298***	-0.348***	-0.345***	-0.561***	-0.552***	-0.635***	-0.628***	-0.199	-0.071	-0.147	-0.194	-1.170***	-1.350***	-0.988***	-1.237***
	(0.084)	(0.088)	(0.087)	(0.084)	(0.097)	(0.100)	(0.099)	(0.096)	(0.215)	(0.236)	(0.226)	(0.215)	(0.282)	(0.306)	(0.297)	(0.284)
Task categories																
Well-defined	0.141**	-0.001	0.023	0.025	0.108*	-0.012	0.016	0.021	-0.569**	-0.769***	-0.768***	-0.751***	0.883***	0.590***	0.523***	0.600***
	(0.045)	(0.031)	(0.032)	(0.031)	(0.046)	(0.032)	(0.033)	(0.032)	(0.197)	(0.136)	(0.138)	(0.137)	(0.230)	(0.157)	(0.159)	(0.157)
High complexity	-0.000	0.019	-0.038	-0.035	0.019	-0.002	-0.015	-0.010	-0.438*	-0.618**	-0.438*	-0.453**	-1.417***	-1.188***	-1.395***	-1.429***
	(0.034)	(0.047)	(0.035)	(0.034)	(0.035)	(0.048)	(0.036)	(0.035)	(0.172)	(0.234)	(0.174)	(0.172)	(0.188)	(0.237)	(0.190)	(0.187)
High contact	0.142***	0.126**	0.323***	0.095*	0.252***	0.238***	0.441***	0.203***	-0.336	-0.347	-0.455	-0.362	0.068	0.006	-0.390	0.003
	(0.042)	(0.042)	(0.063)	(0.042)	(0.043)	(0.043)	(0.065)	(0.043)	(0.191)	(0.190)	(0.279)	(0.190)	(0.193)	(0.191)	(0.282)	(0.191)
Resource-intensive	0.108*	0.098*	0.093*	0.592***	0.140**	0.137**	0.125*	0.673***	-0.530*	-0.531*	-0.545*	-0.441	-0.675*	-0.698*	-0.691*	-0.147
	(0.048)	(0.048)	(0.048)	(0.071)	(0.049)	(0.049)	(0.049)	(0.073)	(0.236)	(0.237)	(0.236)	(0.377)	(0.271)	(0.272)	(0.275)	(0.428)
Interactions																
Well-defined x Routine assignment	-0.268***				-0.222***				-0.360				-0.605			
	(0.062)				(0.064)				(0.270)				(0.315)			
High complexity x Routine assignment		-0.056				0.039				0.345				-0.538		
		(0.068)				(0.069)				(0.319)				(0.343)		
High contact x Routine assignment			-0.311***				-0.318***				0.171				0.747*	
			(0.073)				(0.076)				(0.348)				(0.363)	
Resource-intensive x Routine assignment				-0.784***				-0.865***				-0.165				-0.893
				(0.087)				(0.090)				(0.441)				(0.518)
Constant	1.322***	1.440***	1.406***	1.464***	10.125***	10.234***	10.187***	10.242***	-2.892***	-2.706***	-2.727***	-2.738***	-2.662***	-2.421***	-2.280***	-2.385***
	(0.086)	(0.083)	(0.083)	(0.082)	(0.093)	(0.089)	(0.089)	(0.087)	(0.368)	(0.349)	(0.349)	(0.347)	(0.369)	(0.336)	(0.338)	(0.336)
N	4729	4729	4729	4729	4729	4729	4729	4729	4729	4729	4729	4729	4729	4729	4729	4729

Notes: Generalized linear model results reported (M1-M8: gamma family, logistic link; M9-M16: binomial family, logit link). Standard errors are in parentheses. Model is adjusted by patient characteristics and patient volume, and clustered by physician assigned. Includes year fixed effects. * p < 0.05, ** p < 0.01, *** p < 0.001



(a) Operations Outcome (Length of Stay) (b) Cost Outcome (Total Charges)

Figure 3 Predicted Performance Outcomes Resulting from Interaction of Routine Assignment and Well-Defined Tasks

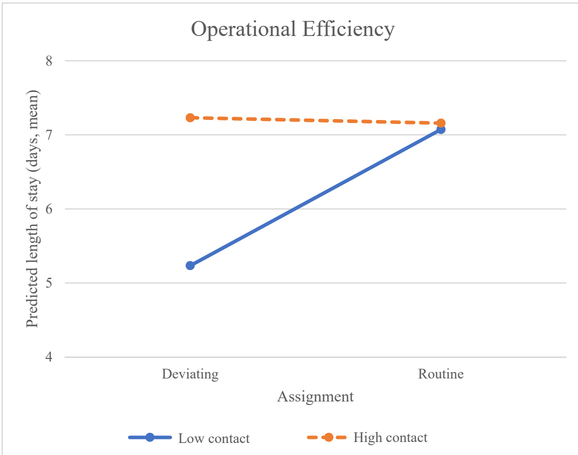
assignment, will yield higher performance for tasks that are well-defined. The results in Table 5 (see M5 and M9) show that *well-defined* $\times$ *routine assignment* interaction has a negative coefficient for both cost outcomes ($p < 0.001$ for both length of stay and total charges). However, the interaction is statistically insignificant for both quality outcomes, as shown in M13 and M17. Figures 3(a) and 3(b) graphically capture the marginal effects of routine assignment and well-defined tasks, indicating that Hypothesis 1 is not supported by the significant interactions pertaining to length of stay and total charges outcomes. Specifically, comparing routine and deviating assignments, we observe that routine assignments are associate with an increase of 0.466 days and $8,474 in length of stay and total charges, respectively. However, the graphs also demonstrate that (1) well-defined tasks have lower length of stay and total charges compared to poorly-defined tasks when assignment is routine; and (2) although routine assignment, compared to deviating assignment, tends to increase both length of stay and total charges, the effect is greater for poorly-defined tasks. These findings indicate that routine assignment is more detrimental for poorly defined tasks (increase in length of stay by 2.18 days and in total charges by $22,700), supporting the notion that deviations in assignment benefits operational efficiency and cost outcomes more for poorly-defined tasks than for well-defined tasks.

Hypothesis 2 postulates that routine assignment, compared to deviating assignment, will result in worse performance for tasks with high complexity. In M6 and M10 (Table 5), we see no statistically significant effect related to the interaction *high complexity* $\times$ *routine assignment* on either operational efficiency or cost. Similarly, M14 and M18 indicate no statistically significant effect on either of the two dimensions of quality as it relates to high complexity and routine assignment.

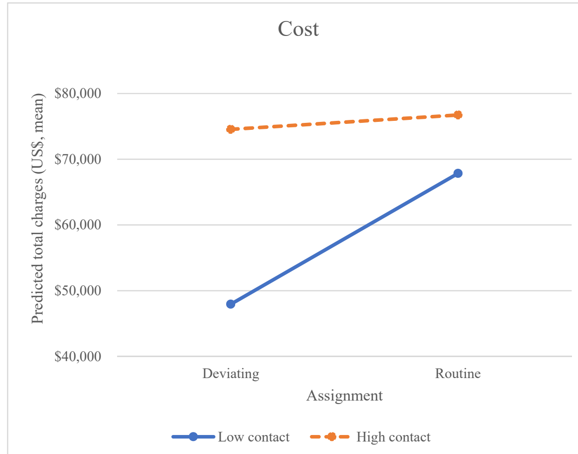
Hypothesis 3 states that routine assignment results in worse performance when tasks involve high contact. M7 and M11 in Table 5 show that both length of stay and total charges have a statistically significant negative coefficient ($p < 0.001$) for the *high contact* × *routine assignment* interaction. However, in terms of quality outcomes, M19 shows a statistically significant positive effect ($p < 0.05$) on adverse events pertaining this interaction, indicating that routinely assigned high contact tasks have an increased incidence of adverse events. However, our results show statistically insignificant effects in the other quality outcome, readmission rate, as shown in M15. To further evaluate these effects, Figures 4(a) and 4(b) demonstrate the predicted cost outcomes associated with *high contact* × *routine assignment*. These graphs show partial support for our hypothesis, in that compared to deviations in assignment, routine assignment reduces length of stay by 0.07 days but increases total charges by $2,152. However, the figures also demonstrate a steeper slope for low contact tasks, indicating that deviation is likely more beneficial for low compared to high contact tasks. In addition, from Figure 4(c), we observe that routine assignment for high contact tasks increases the adverse event rate by 4.18%, compared to situations when assignment deviates. Thus, our findings are somewhat mixed for outcomes related to high contact tasks with routine assignment: while operational efficiency improves, cost and quality (in terms of adverse events) degrade.

Finally, Hypothesis 4 suggests that routine assignment improves performance for tasks that are resource-intensive. In Table 5, M8 and M12 show statistically significant negative effects in support of this hypothesis. We see no statistically significant results, however, for the quality measures in M16 and M20. In examining this interaction (*resource-intensive* × *routine assignment*), Figures 5(a) and 5(b) provide graphs illustrating the moderating effect, which show that in comparison to deviations in assignment, routine assignment involves lower length of stay by approximately 2.25 days and lower total charges by $22,463 when tasks have high resource intensity.

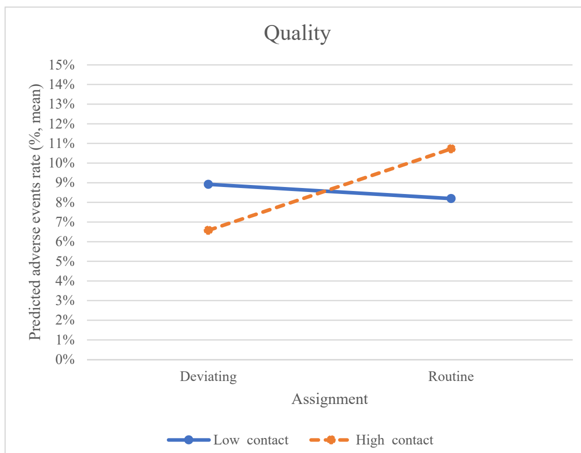
Summary of Hypothesis Tests. The summary of our results regarding our hypothesis tests is provided in Table 6. A quick look at this table shows that we can reject our first hypothesis, Hypothesis 1, with respect to operational efficiency and total cost outcomes. We can also reject Hypothesis 3 with respect to operational efficiency. On the other hand, our results indicate that Hypothesis 3 is true with respect to total cost and adverse event outcomes, and Hypothesis 4 is true with respect to operational efficiency and total cost outcomes. Taken together, these results suggest that allowing physicians to use their discretion in order to deviate from routine assignments is beneficial in (a) well-defined tasks (improving operational efficiency and costs), and (b) high contact tasks (improving costs and adverse events, though at the expense of lower operational



(a) Operations Outcome (Length of Stay)



(b) Cost Outcome (Total Charges)



(c) Quality Outcome (Adverse Events)

Figure 4 **Predicted Performance Outcomes Resulting from Interaction of Routine Assignment and High Contact Tasks**

Table 6 **Summary of Hypothesis Tests**

Hypothesis #	**Operational Efficiency**	**Cost**	**Quality**	
	Length of stay (days)	**Total charges ($)**	**Readmission rate, 30-day**	**Adverse event rate**
1	F	F	–	–
2	–	–	–	–
3	F	T	–	T
4	T	T	–	–

Notes: T = true; F = false; – = insignificant results.

efficiency). For other tasks, routines should be enforced, as deviations either negatively impact performance or yield no tangible benefits.

(a) Operations Outcome (Length of Stay) (b) Cost Outcome (Total Charges)

Figure 5 Predicted Performance Outcomes Resulting from Interaction of Routine Assignment and Resource-Intensive Tasks

5. Limitations

Our study has some limitations. First, we performed this analysis at a single institution in the healthcare sector. Future work can conduct a similar analysis in other hospitals, as well as across other sectors that rely on professional expertise that may overlap. Another limitation of this study is that the implementation of routine assignment guidelines did not formally occur in our analysis. Specifically, we built our understanding of routine assignment on prior work explaining how routines are typically a product of consensus opinion (Brivot 2011). Thus, the way the majority of physicians in our sample viewed assignments was retrospectively chosen as the main factor determining the routine practice. In the ideal study, which future research in this area could attempt, routinized practices would be formally made known to professionals, and analysis of performance could occur using prospective data collected from the implementation of routines onward. Finally, we controlled for the nature of the work being performed by generalist and specialist physicians, namely the nature of the patients' diagnoses in our data set. However, we may be missing aspects of the task that could impact performance outcomes. For example, our readmission rate was not adjusted to account for whether a diagnosis would have involved a scheduled hospitalization in the future due to the nature of the condition and follow-up treatment required.

6. Conclusion

We study the impact of professionals using routine versus deviating task assignments on various performance outcomes, and shed light on whether enforcing routine assignments can boost performance. Our work is motivated by the contrast between (a) operations management and organizational theories that promote standardization and reduction of use of discretionary judgements, and (b) decision theories and the conventional wisdom that suggest professionals should be given the opportunity to use their discretionary judgement and deviate from routine assignments when needed. Our results allow a *task-type* view of this contrast by generating insights into specific task types for which permitting discretionary deviations can improve performance.

To perform our analysis, we use data on the assignments of generalist and specialists to patients in a children's hospital, and consider three sets of metrics: operational efficiency (measured by length of stay), quality of care (measured by 30-day readmission rates as well as rate of adverse events), and cost (measured by total charges). Specifically, we make use of detailed patient-level EMR data of more than 4,700 hospitalized patients who had one of the 73 top medical diagnoses. Our EMR data includes various patient demographic inofmration, the nature of the diagnoses, patient outcome measures, and the physician ultimately taking responsibility for the patient's care. In parallel, we conduct detailed physician surveys and utilize it to identify the type of provider that should have been in charge of each patient based on the medical diagnosis of the patient.

Comparing these two sources of data, we find that invoking discretion to deviate from routine assignments can improve performance when (a) patient needs are well-defined (improving operational efficiency and cost), or (b) serving the patient requires high contact (improving costs and adverse events, though at the expense of lower operational efficiency). For other task types, we find that hospital administrators should enforce routine assignments. These insights provide a better understanding of the underlying tradeoffs in standardizing assignment decisions through routines, and can help managers balance permitting and not permitting use of discretionary judgements in their practice.

Our results also establish a *no free lunch theorem*: while for some task types deviations are beneficial from some aspects, they are simultaneously detrimental from other aspects. Hence, in contrast with the finding that enforcing routine assignments is the dominant strategy for some tasks types (e.g., highly complex or resource-intensive tasks), permitting discretionary deviations is typically not dominantly the better option (regardless of the task type). In addition, our results indicate that there is an intriguing interplay between professional status and discretionary deviations from routine assignments in practice. This potential assertion of power in deviating from standard practice changes division of labor and can have negative consequences on some outcomes.

Finally, our results show that there might be environmental conditions under which discretionary deviations are invoked more frequently. In particular, we find that such deviations are invoked more during weekends than weekdays, and during morning shifts (8am-1pm) than other shifts. However, we observe that deviations are invoked similarly during high congestion (busy) and low congestion (less busy) periods, suggesting that congestion might not be an influential environmental factor. Future research can further investigate these issues and provide more insights into changes in environmental conditions that can cause an increase in deviations from routine assignments. Future research can also go beyond the healthcare sector, and investigate other professional settings in which a task-type view can inform the advantages and disadvantages of disallowing use of discretionary judgements in deviating from routine assignments.

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