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Mitigating the curse of complexity: The role of focus and the implications for costs of care

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Abstract

There has been a resurgence of interest in the role of operational focus in the healthcare operations literature in the backdrop of increasing demand for efficient and effective care. However, the evidence on the benefits of focus in healthcare is mixed. Our study proposes that a key piece of this puzzle that is been largely missing is an explicit consideration of the complexity of patient care needs. Specifically, our study serves to answer the questions: How does the complexity of care requirements affect care delivery operations? How does focus across the hierarchical levels of care affect care delivery outcomes across complexity regimes? The empirical analysis in the study is based on a large generalizable dataset of 246,663 patient discharges across 26 categories at 154 hospitals. We develop a multi-factor measure of complexity of care requirements. The study results point to the deleterious impact of complexity on the costs of care. Next, our findings highlight the differential impact of focus across hierarchical levels (task-level focus, category-level focus, and selective focus in related areas) on the costs of care. Third, our study findings highlight the role of focus in mitigating the effects of complexity on costs in a healthcare setting. We discuss the implications of the study findings for theory and practice, and the directions for future research.

KEYWORDS

category focus, complexity of care, costs of care, related focus, task focus

Highlights

- Complexity of care, a key characteristic of the demand for healthcare, is a multi-dimensional construct with considerable implications for patient outcomes including the costs of care.
- Strategic focus in a hospital (at the task level, at the category level, or across select categories) can offer significant benefits to hospitals including reducing their costs of care.
- Focus on select categories and tasks can serve as a strategic lever for hospitals to combat complexity of care in its operations.

1 | INTRODUCTION

> "*No longer does every hospital have to be everything* …" [Dr. Sricharan Chalikonda, Chairman of Surgical Operations, Cleveland Clinic, in Schlossman, US News, Nov. 3, 2016.]

> "*These guys at the surgery centers are walking on a tightrope with no safety net*." [Christina Jewett, in USA TODAY, Mar. 2, 2018].

There has been a resurgence of interest in studying the role of operational focus in the healthcare operations literature (Kuntz et al., 2019, Huckman & Pisano, 2006, Kc & Terwiesch, 2011, McDermott & Stock, 2011). While there is a push to move toward a "focused" approach in healthcare, there are others who caution that such efforts may not be without risks (Ding et al., 2020). Studies in the extant literature have found mixed results in this regard. While some studies (e.g., Ding, 2014; Huckman & Zinner, 2008; Tsikriktsis, 2007) find support for the performance benefits of focus, others (e.g., Brush & Karnani, 1996; Ding et al., 2020; Kc, 2014; Ketokivi & Jokinen, 2006; Staats & Gino, 2012) have seen contrasting effects. For example, in a detailed account examining the impact of focus in healthcare, KC and Terwiesch (2011) looked at hospital-level discharge data for cardiac patients in California. While they found some evidence for the conventional wisdom that focus will lead to better outcomes, the beneficial effects of focus [in cardiology] at the operating unit and the hospital disappeared when they accounted for selective admissions (or hospitals "cherry-picking" patients). These studies have opened the debate on whether focus really matters in the broader healthcare setting. We build upon this earlier body of work to examine three nuances (and gaps in our understanding) related to the impact of focus in healthcare.

Focus and Complexity of Care: Peter Drucker's (2002, p. 5) statement "The hospital is altogether the most complex human organization ever devised" highlights the level of complexity confronting healthcare organizations. Hospitals are constantly challenged to provide effective and efficient care in the face of such complexity. Unlike factory operations with standardized products/processes and homogeneous inputs, hospitals are often overwhelmed in their attempts to address the varied facets of complexity—heterogeneous patients, variety of diagnoses, interdependencies in treatments, and comorbidities. The larger question, then, is *how should hospitals manage their operations to combat complexity?* There is limited research, however, in the healthcare operations literature that examines the mitigation of complexity in healthcare (Tucker et al., 2007). Recent work in healthcare operations (e.g., Ding & Peng, 2022; Kc & Terwiesch, 2011; Peng et al., 2020) highlights the significance of examining complexity in care delivery settings.[1] Similarly, while there is relatively more research on complexity in the medical literature (e.g., Churruca et al., 2019),[2] the emphasis there is not on the operational aspects of managing complexity or the implications for costs of care. The gap in both the operations and medical literature, thus, is the notion of operational levers to combat complexity in healthcare.

Complexity of care requirements is characteristic of the demand for care realized by a hospital, and is reflective of the variety and interdependency of patient care requirements. Complexity is indicative of the information processing needs of the hospital. On the other hand, focus is a key supply-side [provider] characteristic and an organizational choice to emphasize or restrict attention to a narrow set of tasks to facilitate information processing and operational planning. One way then to address the complexities in healthcare, we posit, is operational focus. While much of the extant work in healthcare on focus has examined the direct effect of focus on performance, we add to this research stream by postulating not just the direct effect of focus, but more importantly, focus as a way for hospitals to mitigate the effects of complexity of care needs that they face. This is one of the first studies (see Figure 1) to propose and test this proposition. In doing so, we directly measure complexity as a multifactor construct and examine how its effect on costs of care is mitigated by focus.

Focus, Hierarchical: The reality of healthcare organizations is that they exist as hierarchies in the care delivery process—yet very few studies acknowledge this hierarchy and address how this affects the relationships examined. Specifically, focus can be conceptualized at different hierarchical levels within the hospital, including task level focus—emphasis on a task; category level focus—emphasis on a category; or related focus—emphasis on selective categories [clinically] most relevant to a primary area of care. Some of the ambiguity in the benefits of focus in healthcare might be due to the differential impact of focus across hierarchical levels of care. With the exception of a handful of studies (e.g., Kc & Terwiesch, 2011; Sfekas, 2020), literature on the heterogeneous impact of focus across hierarchical levels, and across complexity regimes, is sparse. Our study provides a nuanced examination of the direct and moderating effects of focus across hierarchical levels on the costs of care. We address the complexity angle directly by compiling a measure for complexity and estimating its effect on healthcare outcomes in conjunction with focus across hierarchical levels.

Sample of Representative Papers	Examines Effects of Focus	Examines Effects of Related Focus	Examines Effects of Complexity	Examines Interaction Effects of Focus with Complexity	Across Hierarchical levels	Across Care Categories in Hospital	Patient Level Analysis	Endogeneity Controls	Costs of Care
KC & Terwiesch 2011	yes	no	no	no	yes	no	yes	yes	no
McDermott & Stock 2011	yes	no	no	no	no[2]	no	yes	no	yes
Clark and Huckman 2012	yes	yes	no	no	no	no	no	yes	no
Andritsos and Tang 2014	yes	no	no	no	no	no	yes	yes	no
Kuntz et al. 2019	yes	no	no	yes[1]	no	yes	yes	yes	no
Miedaner & Sulz 2020	yes	no	no	yes[1]	no[2]	no	yes	no	no
Ding et al. 2019	yes	no	no	no	no	yes	no	yes	no[3]
Sfekas 2020	yes	yes	no	yes[1]	no	no	yes	yes	no
Freeman et al. 2021	yes[4]	no	no	no	no	yes	no	yes	yes

1 Examine Hi vs. Low Complexity levels; **2** Account for hierarchical effects in the empirical model; **3** Assess cost efficiency as operating expenses*price index/adj patient days
4 Examine the scale and scope effects of specialization; **5** We account for these outcomes in our models

FIGURE 1 Gaps in the literature.

Focus and Costs of Care, Patient-level Outcomes: While there is a rich body of work in healthcare operations/IT where the unit of analysis is the organization (hospital), patient-level analyses is a relatively newer phenomenon. Given that complexity of patient care is inherently a patient-level phenomenon, from a measurement perspective, the most fine-grained level of assessment occurs at the patient level. Our study contributes to this emerging trend to examine patient-level data. While posing some computational challenges in analyzing large datasets, such granularity in the level of analysis provides advantages in controlling for various patient-level sources of heterogeneity in outcomes. Furthermore, from an outcome perspective, the dependent variable of interest in our study is the costs of care, a critical performance measure that has received relatively less attention in the literature. The rising healthcare spending (18.3% of the Gross Domestic Product) in the United States[3] highlights the significance of costs of healthcare delivery as a key variable of interest. This measure of patient care outcomes also complements prior work in healthcare operations that has examined clinical outcomes including length of stay, and mortality.

From a theoretical perspective, we primarily draw on the Organizational Information Processing Theory (OIPT) to develop our study hypotheses linking focus, complexity, and costs of care. According to OIPT, organizations may be viewed as information processing systems that match their information processing needs with information processing capabilities (Bensaou & Venkatraman, 1996; Tushman & Nadler, 1978). We first examine the implications of complexity in increasing the information processing needs in care delivery, and then examine the role of focus as an enabler of information processing capabilities

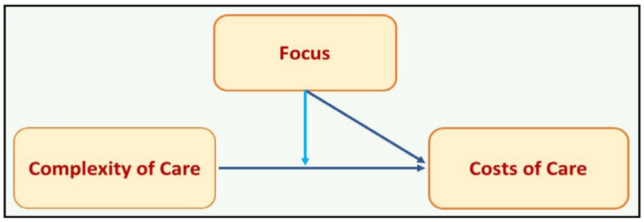

FIGURE 2 Conceptual framework—Complexity of care, focus, and outcomes in healthcare.

of the healthcare organization. The conceptual model illustrating these inter-relationships is provided in Figure 2.

The empirical analysis of the study hypotheses is based on a large generalizable dataset of 246,663 patient discharges at 154 hospitals across six states in the Northeast United States. Our empirical model estimates the effect of operational focus and complexity of care requirements on costs of care while accounting for a rich set of covariates including hospital, category, task, and patient-specific heterogeneity. Our study results suggest the following insights.

First, consistent with our expectations, our results indicate that higher levels of complexity are associated with higher costs of care. This finding suggests that the resource-intensity of care increases with the complexity of care demands, both within and across categories. As discussed in our study, the increase in resource needs may be attributed to the heightened information processing challenges, and the costs of coordinating care across multiple providers for complex patients with interdependent care requirements. Highlighting the impact of complexity of care requirements on costs of care across care categories based on a holistic measure of complexity is a unique contribution of this work.

The *second* set of results points to the important role of focus in mitigating the effects of complexity on the costs of care. Our findings here are nuanced, highlighting the heterogeneous direct and moderating effects of focus across the hierarchical levels. Specifically, our findings suggest that when care delivery operations at the task level are focused, they are associated with lower costs of care. However, we find that the moderating effects of focus are weaker under conditions of high patient care complexity. The average marginal effects of task focus are largely negative (i.e., beneficial for costs of care), but they turn positive (i.e., detrimental to costs of care) at the upper end of the spectrum of complexity. This finding sheds an interesting light on the differential effects of focus in moderating the impact of complexity on costs of care.

Third, reaffirming our contention that focus may have a differential impact across hierarchical levels of care, we find that focus at the category-level may not help lower costs. The average marginal effects remain positive (i.e., detrimental to costs of care). However, additional analyses in this regard reveal that while the main effect of category focus is positive, its interaction effect with task focus has a negative (beneficial) impact on the costs of care. In other words, focus at the category level may be detrimental to performance, unless the category is highly focused on a small subset of tasks.

Finally, an interesting finding from our analysis is that related focus is significantly beneficial in lowering costs of care. We find that related focus has significant and negative (direct and moderating) effects, reinforcing the beneficial impact of related focus on costs of care across complexity regimes.

These results highlight not only the differential impact of focus across hierarchical levels but also the value of focus in mitigating complexity in healthcare settings. Highlighting the direct and moderating effects of focus, across hierarchical levels and complexity regimes, is a unique contribution of this work that serves to complement and extend prior work in this area (e.g., Clark & Huckman, 2012; Ding et al., 2020; Kc & Terwiesch, 2011; Kuntz et al., 2019; Sfekas, 2020).

2 | CONCEPTUAL DEVELOPMENT

2.1 | Theory

The primary theoretical lens we use to understand the benefits of focus is organizational information processing theory (OIPT) wherein organizations process information to reduce uncertainty that arises from task and role interdependencies (Galbraith, 1973; Gattiker & Goodhue, 2004; Tushman & Nadler, 1978). Galbraith (1973) looked at the information processing problem as an organizational design problem and proposed that organizations can use four different design strategies to address this problem: (a) they can create slack resources; (b) they can create self-contained tasks to reduce the need for information processing; (c) they can invest in organizational information processing capability; and, (d) they can create lateral relations across the organization to increase the information processing capability. In this study, we rely on the creation of self-contained tasks and lateral relations as the primary mechanisms to address the information processing challenges in care delivery operations. Note that, one of the greatest challenges facing healthcare organizations today is meeting complex and uncertain patient demand in the face of scarce resources—so, understandably, the design option of creating slack resources is rarely an exercisable option. Similarly, the design approach of creating more information processing capability via investments in health information technology is not the focus of this study. Several studies in the recent literature draw from OIPT to examine the impact of health information technology on hospital performance. For example, Wani and Malhotra (2018) used OIPT as a theoretical lens in looking at the impact of meaningful use of electronic medical records technology on patient length of stay. Ding and Peng (2022), and Peng et al. (2020) also use OIPT to make arguments about the relationships between technology use in hospitals and performance.

Another theoretical perspective that serves to inform our understanding of the impact of complexity and focus in healthcare settings is the Theory of Swift-Even Flow (TSEF). While OIPT provides a broad high-level organizational design perspective, TSEF provides a more granular process-level perspective on flows (information flows in our case). Schmenner and Swink (1998) presented TSEF in an attempt to understand performance differences among various manufacturing operations. They contend that while traditional microeconomic theory is useful in understanding how labor and capital inputs translate into productivity, there are many aspects of factory floor operations where it has relatively little to say. There are five basic tenets/laws that govern the TSEF, including the law of variability, bottlenecks, scientific methods, quality, and factory focus. While early work on TSEF primarily used the factory floor as the platform, more recent work has extended it to the service context and suggested its applications to other sectors such as financial services and healthcare (e.g., Devaraj et al., 2013; Fredendall et al., 2009). For instance, Devaraj et al. (2013) examine the impact of information technology investments on swift and even flow of patients in hospitals, and the impact downstream in turn on hospital revenue. They observed a significant positive relationship between swift/even flow and net patient revenue of hospitals, and that these financial returns did not come at the cost of quality of care. Similarly, in a case study of a perioperative surgical services department, Fredendall et al. (2009) observed that swift and even flow constructs—process standardization, quality problems, and bottleneck starvation/blockage—affected flow speed and variance. In this vein, our study draws from the theoretical arguments of TSEF in examining the implications of complexity and focus for patient care outcomes.

2.2 | Complexity of care requirements and costs of care

Complexity of systems has been a construct of significant interest in prior work across disciplines in the natural and social sciences, medical, and operations literature (e.g., Campbell, 1988; Choi et al., 2001; Churruca et al., 2019; Ding & Peng, 2022; Haunschild & Sullivan, 2002; Kauffman & Levin, 1987; Peng et al., 2020; Simon, 1962). Central to the conceptualization of complexity, in this body of work, are the variety and inter-relatedness of the tasks within the system of interest (Jacobs & Swink, 2011; Ramasesh & Browning, 2014). While variety in this conceptualization points to the multitude of constituting tasks, inter-relatedness refers to the interactive relationships among tasks within the process. In healthcare, a multitude of diverse and interrelated diagnostic conditions, comorbidities, and chronic conditions is reflective of higher complexity of care requirements for individual patients. Beyond just increasing the count of care needs, a larger number of comorbidities and chronic illnesses introduce interdependencies in care needs that are quite heterogeneous even among patients with the same primary diagnosis (Clark, 2012; Kuntz et al., 2019). It must be noted that our conceptualization of complexity is based on the care requirements presented by the patient and does not consider the hospital-specific factors including availability of capacity, clinical expertise, or quality. Maintaining the distinction between the demand-side [patient care needs] and the supply-side [hospital constraints, decisions, and/or outcomes], allows for a criterion-free assessment of complexity of care requirements that is inherent to patients (cf. Jacobs & Swink, 2011). Complexity of care requirements is thus an inherent characteristic of the demand for care that is patient-specific, heterogeneous across patients and categories, and exogenous to hospital-specific factors.

Complexity of care requirements affects the treatment processes and increases care delivery costs for two key reasons: increased information processing, and increased coordination needs. *First*, according to OIPT (Galbraith, 1973), complexity of a task is directly associated with the amount of information that needs to be processed by decision-makers to accomplish the task—the greater the complexity higher the information processing needs. The execution of complex tasks requires processing more information about the various elements of the task and their interactions (Campbell, 1988; Gittell, 2002). In extending OIPT, Daft and Lengel (1986), state that two information attributes—uncertainty (lack of information) and equivocality (ambiguity)—can affect decision-making or outcomes. In dealing with more complex patients, there is both uncertainty and equivocality of information. Patients with complex care needs might present novel combinations of comorbidities and primary conditions on which information is not readily available. Thus, treating complex patients will likely require gathering additional information via costly diagnostic evaluations. Further, making sense of such information, once gathered, might exceed the processing capabilities of medical units due to the lack of existing knowledge, expertise, or routines. Indeed, Ramasesh and Browning (2014) propose that the likelihood of uncertainty increases with complexity, making existing operational routines less efficient. Essentially, a "large number of interrelationships in a complex process leads to the possibility of a seemingly small change in one area leveraging a much larger, emergent change in the whole process" (Browning & Heath, 2009, p. 39).

Second, coordinating care delivery for complex patients is challenging because the causal pathways from patient conditions to effective treatments are not well-defined or structured (Argote, 1982; Christensen et al., 2009). Standard healthcare routines often fail to accommodate the needs of complex patients, forcing healthcare professionals to adopt resource-intensive and error-prone, ad hoc procedures (Faraj & Xiao, 2006). Complex care requirements could accentuate the need for nonlinear process flows and necessitate variable courses of treatment across patients even within the same category owing to heterogeneous interdependency in their care needs. To handle complex patients, medical teams will need to exchange resources on a simultaneous and reciprocal basis, and such resources will likely be distributed among entities with differentiated specialties (Argote, 1982; Saavedra et al., 1993; Faraj & Xiao, 2006). As a result, the system will experience operational bottlenecks (Saavedra et al., 1993) and require higher overhead costs to coordinate operations and traverse the heterogeneous and nonlinear pathways (Christensen et al., 2009; Lovejoy & Sethuraman, 2000). While such fluid practices enable effective delivery of care (Gittell, 2002; Faraj & Xiao, 2006), they are less conducive to efficiency gains because they spread hospital operations across heterogeneous units with low volume and variable pathways

(Lovejoy & Sethuraman, 2000). Based on the preceding arguments, we offer the following hypothesis:

> **Hypothesis H1.** Ceteris paribus, greater complexity of care will be associated with higher costs of care.

2.3 | Focus: The direct and moderating effects

2.3.1 | Focus: An overview

Focus refers to narrowing down of tasks by productive entities to a limited, consistent set of activities based on a deliberate selection of customer segments, geographies, process technologies, products, and/or service lines (Ding, 2014; Ding et al., 2020; Huckman & Zinner, 2008; Hyer et al., 2009; Kc & Terwiesch, 2011; Kuntz et al., 2019). It enables the producer to achieve efficiency gains by aligning the structural and infrastructural resources at its disposal toward the narrowed set of activities. Acute care hospitals, the context of this research, must be able to offer a wide range of services to a diverse patient population. Focus in this environment may be achieved by an emphasis on specific tasks or categories, for example, transforming a department within the hospital into a specialty center, in line with the "focus as emphasis" approach (Hyer et al., 2009; McDermott & Stock, 2011; Nair et al., 2013). This is different from narrowing services to a limited set of diagnostic categories observed in specialty hospitals (e.g., Shouldice Hospital) in that an acute care hospital may continue to offer a wide breadth of service while allowing for a disproportionate emphasis in certain service areas. By allocating more organizational resources and restructuring operational elements relevant to the emphasized service areas, hospitals may be able to achieve focus in those areas within the broader service setting, akin to the plant-within-a-plant concept of a focused factory (Skinner, 1974).

Focus within the hospital can be conceptualized across hierarchical levels of care (see Figure 3) within a hospital (e.g., Kc & Terwiesch, 2011). At the task level, care delivery teams (physicians, nurses, and support staff) work on care activities related to the diagnostic related group (DRG). Focus at the task level is reflective of a relatively greater emphasis on that primary DRG within the department. For example, a disproportionately higher number of patients with Coronary bypass W cardiac Cath W MCC (DRG#231) as their primary DRG is indicative of depth of expertise in that task (i.e., task-specialists).

The category level represents the major diagnostic category (MDC) under which the DRGs in a hospital are uniquely listed. For example, DRG#231 mentioned above is listed under the category of "Diseases and Disorders of the Circulatory System," that is, Department of Cardiology, with a unique identification (MDC#5) in our sample. Focus at the category level is reflective of a relatively greater emphasis on that major diagnostic category in the hospital. For example, a disproportionately higher number of patients in the Cardiology (MDC#5) is suggestive of emphasis in that category (i.e., category-leader).

Interestingly, as Clark and Huckman (2012) suggest, care delivery in a focal category may additionally call for expertise in other "relevant" categories that often appear as secondary diagnoses for patients in the focal category. To that end, we define *Related Focus* as focus on selective categories that are clinically relevant to a focal category. It is reflective of an emphasis on categories [clinically] most relevant to care within a focal category. For example, a hospital that has a disproportionately higher number of patients within select categories (e.g., Endocrinology, Pulmonology, Digestive Systems, and Urology) is suggestive of Related Focus in Cardiology (Clark & Huckman, 2012).

2.3.2 | Focus: The direct effects

As noted earlier, we rely on creating self-contained tasks and lateral relations as the primary OIPT mechanisms to address the information processing challenge. In the healthcare setting, the creation of homogeneous pockets of care enables healthcare units to benefit from several coordination techniques including the co-location of the medical staff, pooling of critical resources, and development of collaboration routines and a productive team

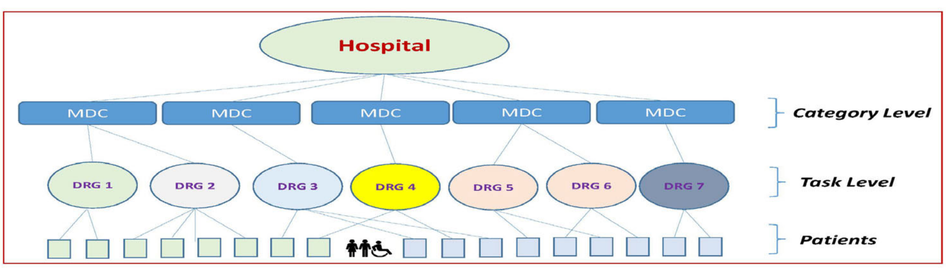

FIGURE 3 Hierarchical care structure.

culture (Hyer et al., 2009). Focused care units may also serve to facilitate lateral "communities of practices," with different groups of medical staff working closely together as a unit and effectively sharing tacit and explicit knowledge (Faraj & Xiao, 2006). Thus, theoretically, the two organizational design strategies under consideration are the creation of self-contained tasks and lateral tasks. Mapping the types of focus to these theoretical strategies, focus at the task and category levels, rely on the benefits related to the creation of self-contained tasks. On the other hand, our construct of related focus maps onto the theoretical strategy of creating lateral relations.

Focus could also facilitate learning (Ding, 2014; Kc & Terwiesch, 2011). From an organizational learning perspective (Levitt & March, 1988), firms that solve the same kinds of problems should get better at it, leading to steeper learning curves. In the healthcare context, repeated care delivery within select bands of care may improve performance, owing to the deeper task knowledge and faster learning (Ding, 2014; Hyer et al., 2009; Tucker et al., 2007). For instance, several healthcare studies have examined how cardiac surgery, radiology, total joint replacement, and intensive-care units learn to reduce operative procedure times through cumulative experience at various levels (Edmondson et al., 2001; Huckman & Pisano, 2006; Pisano et al., 2001; Tucker et al., 2007).

Invoking the tenet of focus from TSEF, operational focus serves as a mechanism for reducing variability in the process flow. By grouping like products and/or processes together, it also enables the identification and elimination of bottlenecks and non-value-added steps in the process flow. Furthermore, the emphasis on a limited set of activities enables the organization to accrue performance gains owing to the predictability of routines, better planning and resource allocations, and the expertise achieved in the process. This increased ability to design and configure the elements of the operating system around a focused set of goals is purported to provide significant operational benefits, beyond the economies of scale from repetitive production in high volumes (Huckman & Zinner, 2008; McDermott & Stock, 2011). Thus, healthcare units may achieve performance gains from repetitive tasks involving homogeneous groups in a focused setting.

Beyond the many benefits of focus as discussed above, there are benefits associated with breadth of expertise that is engendered by focus across a broader range of tasks. Specifically, category focus that is broadly focused on tasks within a category (vis-à-vis focus on a single task), and related focus that is broadly focused on clinically relevant categories of care (vis-à-vis focus on a single category) may be associated with key benefits in a healthcare setting. Category focus and related focus may be associated with learning from the scope of operations. Prior studies (e.g., Narayanan et al., 2009; Schilling et al., 2003) suggest that learning rates can be higher when there is some degree of variation among tasks. The underlying argument is that exposure to different tasks and problem domains allows for a deeper understanding of the nature of the problem (Schilling et al., 2003), positive spillovers (Clark & Huckman, 2012), and flexible and adaptive routines (Haunschild & Sullivan, 2002). In this vein, focus on a broader range of tasks within the category and across related areas may allow healthcare units to gain from economies of scope, discover efficient routines and reduce costs. By removing silos among tasks and bringing experts with distinct but related knowledge, departments, and hospitals can learn to streamline operations, eliminate redundancies, and improve coordination among these various tasks (Christensen et al., 2009). Hence, we posit:

> **Hypothesis H2.** Ceteris paribus, greater (a) task focus, (b) category focus, and (c) related focus will be associated with lower costs of care.

2.3.3 | Focus: The moderating effects

In this section, we examine the moderating influence of focus (task focus, category focus, and related focus) on the implications of complexity of care requirements for costs of care.

Task Focus—We argue that the beneficial impact of focus in lowering the costs of care for complex patients is a matter of the level at which focus is occurring. Specifically, focus can become detrimental to efficiency if it leads to organizational silos that impede the integration of knowledge and information from different specialties and give rise to what Halvorson termed as "care linkage deficiencies" (2007, p. 14). In this respect, there are at least two reasons to believe that focus at the task level may lead to higher costs for complex patients.

First, a higher proportion of admissions in a specific task is likely reflective of a fragmented system that lacks proper coordination and knowledge integration capabilities (Clark & Huckman, 2012; Enthoven, 2009). A fragmented system of care can be beneficial to routine patients whose care requirements are limited in scope (Kuntz et al., 2019). However, complex patients require wide-ranging coordination of expertise to handle information processing challenges and manage their interdependent needs. Without adequate and systematic coordination, complex patients will likely follow pathways that involve redundant and incongruent procedures. As Clark (2012) noted "a more focused scope of activities pushes organizations [to place] boundaries where coordination is required" (p. 88). Moreover, the silos that arise in a fragmented system could produce a situation in which physicians lack a shared language to communicate and share information (Enthoven, 2009), a scenario that exacerbates coordination costs.

Second, psychologists note that narrow specialization often leads to cognitive fixedness (Dane, 2010). Specialists might simply become too entrenched to welcome expertise from other domains. Indeed, the literature suggests this problem is prevalent in healthcare organizations. Halvorson (2007) argues that "the culture of healthcare can directly and strongly oppose shared learning at local levels" (p. 87). The absence of shared learning contributes to the costs of complex patients through lower utilization of medical knowledge that could help patients avoid unnecessary procedures or hospitalization (Enthoven, 2009). Hence, we posit:

> **Hypothesis H3a.** Focus at the task level moderates the relationship between patient complexity and costs of care such that an increase in complexity is associated with a relatively higher increase in costs at higher levels of task focus.

Category and Related Focus—In contrast, at broader levels of focus such as focus at the category (departmental) level and focus in related areas, the hospital will likely start to experience benefits that attenuate the negative impact of complexity on costs of care. This is because focus at broader levels enables the hospital to understand better the wide-ranging needs of complex patients and, as a result, achieve better learning and coordination. From an OIPT perspective, the organizational design mechanism to deal with complex information processing needs is creating lateral relationships across the organization, which enables information processing capabilities. The category and related focus strategies examined in this study enable such lateral exchanges between related areas of care, thereby supporting an efficient and coordinated care delivery process when serving patients with complex care needs. We highlight two key mechanisms underlying this moderation effect.

First, notwithstanding the detrimental effects of complexity on healthcare outcomes, it can produce important knowledge and engender learning when the organizational design is conducive to learning (Haunschild & Sullivan, 2002). Exposure to multiple informational cues and varying causal scenarios when serving complex patients may enable a deeper understanding of the tasks and apply more complex mental schemas avoiding the traps of simplification and superstitious attribution (Levitt & March, 1988; Schilling et al., 2003). However, as Haunschild and Sullivan (2002) note, learning from complexity is not uniform across different organizational forms. In this vein, Narayanan et al. (2009) note that individuals maximize learning from diverse tasks when they also develop depth of knowledge in some of these tasks. Focus at the category level and focus on related categories may enable the opportunity for care delivery teams to immerse themselves in knowledge-rich complexity and achieve better learning (Stan & Vermeulen, 2013). Organizational units learn from complexity when focused across tasks within the category or on related areas because they are more likely to internalize the challenges and intricacies of complexity given their depth of knowledge and the dedicated resources in their focus areas. Put differently, while complexity and task diversity are associated with scattered and shallow knowledge, category level focus and focus in related areas allows for learning from complexity, devoting necessary and appropriate resources to deliberately investigate, articulate, and institutionalize the knowledge generated from caring for complex patients.

Second, effective delivery of complex healthcare solutions requires dynamic and implicit forms of coordination that include assembling individuals with varied expertise, anticipating the needs of others, and developing ad hoc practices (Faraj & Xiao, 2006; Vashdi et al., 2013). The interdependencies and uncertainties of complex tasks could become multiplicative in nature and exacerbate the coordination challenges in the delivery of care (Faraj & Xiao, 2006). While coordination demands are often met with hierarchies and protocols (cf. Handley & Benton, 2013), the criticality and unpredictability of healthcare delivery diminish the potential of such formal forms of organizational design (Plsek & Greenhalgh, 2001). Focus at the category level or focus in related areas can meet these coordination challenges because they enable better sense-making of complex care requirements. Teams in focused care settings work closely and frequently with each other, and possess better transactive memory and working relationships that enhance coordination and knowledge sharing (Hyer et al., 2009). The proximate pooling of relevant medical staff and resources enables them not only to identify the gaps in the requisite knowledge for care delivery, but also to coordinate and share knowledge with outside experts in filling these gaps. Furthermore, focus at the category and related areas levels reflect an integrated delivery system (Christensen et al., 2009). These benefits should translate into an efficient design of care pathways for complex patients whose interdependent needs call for the timely assembly of multiple specialties. By understanding how different conditions presented by a patient interact together, healthcare providers can develop integrated practices that are centered on the patient as a whole instead of specific tasks (Enthoven, 2009; Halvorson, 2007). Also, integrated care facilitates proper interdependence management through cross-functional teams instead of channeling complex patients sequentially through individual specialists (Saavedra et al., 1993). Hence, we posit:

Hypothesis 3b. Category Focus moderates the relationship between patient complexity and costs of care such that an increase in complexity is associated with a relatively lower increase in costs at higher levels of category focus.

Hypothesis 3c. Related Focus moderates the relationship between patient complexity and costs of care such that an increase in complexity is associated with a relatively lower increase in costs at higher levels of related focus.

3 | RESEARCH DESIGN

3.1 | Data

Our study sample comprised patient discharge data from hospitals in six states across the Northeast US. Our sample included complete patient discharge data for 246,663 patients from 154 hospitals in 2015. These patients are spread across a total of 751 unique DRGs, across a total of 26 unique major diagnostic categories (or departments) in our sample. The data for this study are obtained from the National Inpatient Sample (NIS) Database compiled by the Agency of Healthcare Research and Quality (AHRQ) as part of the Healthcare Cost and Utilization Project (HCUP, 2015). The NIS database includes data on patient discharges from community hospitals, excluding rehabilitation and long-term care hospitals. It includes patient stay information that is found in the billing data that hospitals submit to statewide organizations in the US.

Hospital structural characteristics in the data include the urban/rural location, teaching status, ownership, and size of each hospital. The clinical variables provide patients' admission information, chronic conditions, comorbidities, the primary DRG, the MDC, costs of care, and their disposition at discharge. However, in keeping with patient privacy protection laws, the NIS database does *not* include patient identifiers to track patient status prior to admission or subsequent to discharge. Similarly, the NIS database masks all hospital identifiers to prevent identification of individual hospitals and linking hospital information in the database with outside information. This precludes our attempts to build a longitudinal panel database of hospitals in our study.

About 75% (75.9%) of the hospitals in our sample were urban with close to 40% of those being teaching hospitals, and a majority (90.3%) of the hospitals were private not-for-profit. A little over half (56%) of the patients were female, 80% of the patients in the sample were White, 7% were Black and 8% Hispanic, and the average (median) age of patients in our sample was 52 (58). As for the Payor listed on the patient records, 45% of them were Medicare, 21% were medicaid, and 31% private insurance. This data formed our effective sample for all analysis in our study.

3.2 | Variables

3.2.1 | Complexity of care requirements

The construct for *complexity of care* in the existing healthcare operations literature has been dealt with in several ways along a continuum—from being unaccounted for, being used as a control variable, to being explicitly studied. A representative body of literature that has accounted complexity of care is presented in Table 1.

Complexity of care requirements at the patient-level, as discussed earlier, arises from the variety and interdependency of care requirements. Our study builds upon the existing literature by estimating a more comprehensive measure for each patient, assessed as a composite score of indicators in our data that were representative of the complexity of patient care requirements. Specifically, these include (a) the total number of *unique diagnostic conditions* experienced by the patient; (b) the number of *chronic conditions* reported; and (c) the comorbidity index—summation count of all the *comorbid conditions* (i.e., "coexisting medical conditions that are not directly related to the principal diagnosis). Our measure of complexity of care requirements at the patient level overcomes three key limitations of current assessments of complexity in the extant literature (see Table 1):

First, assessments of complexity in the literature have largely been based on broad *dichotomous indicators* of complexity of care. For example, Kuntz et al. (2019) assess complexity based on whether or not the patient had multiple comorbidities, and whether the procedure was an elective or an emergency. While dichotomous indicators of complexity of care are empirically convenient measures in identifying the broad effects of complexity, they fail to observe the heterogeneity in complexity of patient care needs within and across major diagnostic categories and the subsequent implications for

TABLE 1 Representative literature: Measures for complexity of care.

LightCyan reference	Measure	Description
KC and Terwiesch (2011)	Charlson's Index, Cardiology-specific patient characteristics (e.g., myocardial infraction, congestive heart failure)	Charlson's comorbidity index is a good measure of patient complexity. However, other measures are specific to complexity in dealing with a specific population of cardiac patients
McDermott and Stock (2011)	Patient severity	Single-item measure of patient severity
Clark and Huckman (2012)	Secondary diagnosis for patients with a primary diagnosis of cardiac care	Complexity not measured directly but embedded in diversification of services. Specific to cardiac patients
Devaraj et al. (2013)	Casemix Index	Hospital-level measure and does not vary from patient to patient
Nair et al. (2013)	Proportion of heart attack cases with complications	Addresses complexity of cases for cardiac patients
Vashdi et al. (2013)	Single-item subjective assessment of complexity by head surgeon	Not a good fit for overall patient complexity
Ding (2014), Ding et al. (2020), Peng et al. (2020)	Casemix Index and Outpatient Mix	Both variables capture complexity of care aggregated at hospital level and do not vary from patient to patient
KC (2014)	Task complexity	Subjective measure of triage severity level determined by the triage nurse at the time of admission. Appropriate for Emergency Department (ED)
Kuntz et al. (2019)	Comorbidity Index	Single measure (index) that addresses patient-level variation in complexity of care

care delivery outcomes. Our study provides an assessment of complexity of care requirements at the individual patient level on a continuous scale to account for such heterogeneity.

Second, assessments of complexity in the literature are often anchored at the (aggregate) hospital level, ignoring the heterogeneous uncertainty and interdependency of care needs at the patient level. For example, *casemix index*, as measured by the Center for Medicare and Medicaid Services (CMS), is the average relative DRG weight of a hospital's discharge. While this measure enables a comparative assessment of hospitals accounting for the resource intensity of patient care in their settings, it does not directly address the multitude and interdependencies in patient care needs. Our assessments of complexity of patient care requirements includes the number of diagnostic conditions, comorbidities, and chronic conditions at the individual patient level directly tap into the interdependencies and account for these emergent uncertainties (Sfekas, 2020) during care delivery.

Third, assessments of complexity in the literature have largely been situated within narrow clinical settings or within the context of a single diagnostic category (e.g., Cardiology). For example, KC and Terwiesch (2011) and Nair et al. (2013) examine complexity of care within Cardiology as their clinical setting. On the contrary, our assessments of complexity of care requirements examine the interdependency and variety of care needs for patients across 25 major diagnostic categories, further improving its relevance and generalizability.

In the first step of estimating complexity of care requirements we consider data on five items related to the patient being treated: (1) the number of *chronic conditions*—the greater the number of chronic conditions the greater the level of complexity of care (Grembowski et al., 2014); (2) the patient's *comorbidity index*—Charlson's Comorbidity index is a well-established weighted index of the various comorbid conditions (i.e., "coexisting medical conditions that are not directly related to the principal diagnosis") based on the Internal Classification of Diseases (ICD) that affect the complexity of care (Morales-Espinoza et al., 2016; Valderas et al., 2009); (3) the number of unique *diagnostic conditions* experienced by the patient—similar to the chronic conditions, the number of total diagnostic conditions imposes challenges in providing for care (Grembowski et al., 2014); (4) major operating room (OR) procedure—this measure focuses on the primary factor or procedure that might drive complexity (cf. Dexter et al., 2018); and (5) number of procedures—in contrast to the prior item that focuses

TABLE 2 Assessing complexity of care.

Variables		
Number of chronic conditions	.909	
Comorbidity Index	.855	
Number of diagnostic conditions	.898	
Major OR procedure		.673
Number of procedures		.706
Eigen value	2.421	0.952

Note: Extraction method: Principal factors. Rotation method: Orthogonal quartimax, coefficients cutoff at 0.50.

on only the primary procedure the objective of this measure is more broad-based to include all procedures conducted on the patient (cf. Dexter et al., 2018).

The next step is to build an aggregated score of these five measures related to complexity of care. We used factor analysis, a well-established method of data reduction, in creating the composite score. This involved using the "Principal Factors" extraction method with Orthogonal Quartimax for the rotation. A single factor (with an eigenvalue >1.0) emerged from this analysis (see Table 2). This single factor primarily loaded on the three patient characteristics (number of chronic conditions, comorbidity index, and the number of diagnostic conditions) that were representative of complexity presented by the patient. Two other indicators that did not load on our factor were representative of the care characteristics received by the patient at the hospital for their complex care needs, including (d) the number of *procedures* received by the patient during their stay; and, (e) whether any *major operating procedure* was performed on the patient. Factor scores were then obtained for each patient as a (regression) composite of the three indicators. This formed the measure of complexity for each patient.[4]

3.2.2 | Task focus, category focus, and related focus

Following prior literature (e.g., Kc & Terwiesch, 2011; McDermott & Stock, 2011) in this area, focus is assessed as the relative emphasis or volume of operations in that area. We assess focus at the task and category levels in our study. Notationally, let P_{ijk}, P_{jk}, and P_k refer to the number of patients receiving care in (task) DRG$_i$ $(i = 1,2,3,\ldots751)$ in (category) MDC$_j$$(j = 1,2,3,\ldots,26)$ of hospital$_k$, in (category) MDC$_j$ of hospital$_k$, and in hospital$_k$, respectively.

Task focus assessments are intended to capture the emphasis on a given DRG relative to others within that category. Hence, our measure for task focus is the number of patients within a specific DRG divided by the total number of patients in the MDC. *Focus at the* $Task - Level_i$ at hospital$_k$ ($Task\_Focus_{ijk}$) is then assessed as the proportion of patients in (category) MDC$_j$ of hospital$_k$ receiving care in DRG$_i$. It is calculated as $\left[\frac{P_{ijk}}{P_{jk}}\right]$. Note, while task focus may also be assessed relative to the total hospital population, given our attention to the relative emphasis on various DRGs within a category, we used the patient volume in the category as the base.

Category focus is intended to capture the emphasis on a given category within the hospital. *Focus on* $Category_j$ *at* $hospital_k$ (Cat_Focus_{jk}) is then assessed as the proportion of patients in a hospital receiving care in MDC$_j$. It is calculated as $\left[\frac{P_{jk}}{P_k}\right]$.

Related Focus, that is, focus on related areas, reflects a department's expertise across care categories that are most relevant to care in that department. Following Clark and Huckman (2012), we identified the most relevant categories of care for each department as follows: first, for each department, we identified the frequency of all the secondary diagnoses for all patients within that department. Then we sorted these frequencies to identify the most relevant diagnostic categories (departments) with at least 5% of patients.[5] Note that our determination of the related categories of care is population-based, that is, for each category (MDC) of care, we identify the related categories based on the observed relatedness in the population of patients within that primary MDC. We then calculate the related focus of each hospital based on their focus in each of these related categories of care. Table A-1 in the Online Appendix S1 provides the most relevant care categories for departments in our study. The related focus of department$_j$ in related care categories (Rel_Focus_{jk}) is then calculated as $\sum_{id}\left[\frac{P_{idk}}{P_k}\right]$, where $d(\neq j)$ includes all relevant categories of care (Clark & Huckman, 2012).[6]

3.2.3 | Costs of care

The dependent variable of interest in this study, *ln(Costs of Care per Day)*, is obtained as the logarithmic transformation of the ratio of the *Costs of Care* for the inpatient stay and the *Length of Stay* (in days) during that episode of care for individual patients. The HCUP Costs of Care data estimates the cost of resource use for inpatient hospital stays and its variation across hospitals and conditions. The costs of care reflect the actual expenses incurred in the production of hospital services, such as wages, supplies, and utility costs. Data on costs of care for inpatient stay is obtained from the HCUP NIS Charges[7] database and the HCUP Cost-to-Charge Ratio (CCR) for Inpatient Files database. Length of Stay (in days) is a patient's number of days spent as a "hospital inpatient" from admission to discharge. While payment arrangements such as the Inpatient Prospective Payment Systems may serve to disentangle hospital revenue incentives from inpatient length of stay, it is conceivable that the variable costs of care delivery (viz., resource expenditures tied to inpatient stay) may increase with the patient length of stay. Hence, we normalize the costs of care by the length of inpatient stay to allow for a comparison of costs across patients within each diagnostic condition.

3.2.4 | Patient-level controls

Following Clark and Huckman (2012) and Kc and Terwiesch (2011), we note that comparisons of raw measures of outcomes of care may be biased and may unfairly penalize hospitals owing to heterogeneity in patient characteristics. To that end, in our study, we account for patient heterogeneity arising from patient-specific risks arising from *clinical*, *demographic*, and *environmental* factors.

Specifically, patient clinical characteristics accounted for in the study include individual intercepts for approximately 30 *coexisting conditions* (Clark & Huckman, 2012; Elixhauser et al., 1998) that patients may be associated with, and the *major diagnostic category* on the patient record. We also account for patient disposition at discharge. Specifically, *DISPUNIFORM* is a categorical variable that captures a routine discharge, transfer to short-term hospital, other transfer (includes skilled nursing facility, intermediate care facility, another type of facility), home health care, discharged against medical advice, mortality, or discharged. This variable in our model specification accounts for patient outcome quality/mortality and the inherent tradeoff relationships among these outcomes in the empirical specification for costs.

Next, we account for patient demographic characteristics such as *age, gender*, interactions between *age* and *gender*, *race*, *primary payer*, and *metropolitan location* to control for the heterogeneity in the nature of demand and supply of healthcare across patients.

Lastly, we account for environmental factors such as the type of patient admission, including whether the admission was *elective* or non-elective, an *emergency* admission, and if the patient was *transferred in* from another facility at admission and/or *transferred out* to another facility at discharge. Controlling for the patient-level demographic, clinical and environmental factors above enabled a comparative evaluation of the implications of focus and complexity across hospitals.

3.2.5 | Hospital fixed effects

To account for unobserved heterogeneity in individual hospital operations, we include *hospital fixed effects* in our model specification. Inclusion of the *hospital-level fixed effects* subsumes any observed and unobserved heterogeneity across hospitals. Thus, the hospital-specific variation that may directly or indirectly patient outcomes is captured via the fixed effect intercepts for individual hospitals.

3.2.6 | Category fixed effects

To account for unobserved heterogeneity in care delivery operations and outcomes across individual departments (for e.g., it is conceivable that departments such as Cardiology may have higher costs and mortality rates compared to Orthopedics), we include individual *category fixed effects* in our model specification. Inclusion of the *category fixed effects* accounts for the heterogeneity in care delivery practices and outcomes specific to the category, enabling a comparison of outcomes of care across patients across departments. Note that our category focus variable is the focus on a category by an individual hospital which is distinct from the category level mean (across hospitals) or the fixed effect. This variation allows for the estimation of the study model.

Further, it is also conceivable that some tasks within departments, for example, Coronary-Aortic-Bypass-Graft (CABG) procedure in Cardiology, are inherently more challenging than others and may have systematically poorer outcomes compared to other DRGs within the same department. To allow for such heterogeneity at the task level within each category, we also include *Task Random Effects*.

3.2.7 | Time fixed effects

To account for unobserved heterogeneity in care delivery across time, we include *time fixed effects* in our model specification. Our data includes time stamps (month of the year) at the individual patient discharge level, which enables us to overcome any systematic time trends in care needs and delivery operations.

3.2.8 | Scale effects

Lastly, following Miedaner and Sülz (2020), we account for differences in the *scale effects* of each department across hospitals. Specifically, we include standardized

(z-scores) category-level and task-level volumes in each hospital in the model to control for hospital-specific scale effects at the category and task levels.

3.3 | Modeling strategy

Our empirical model (see Figure 4 for a graphic of the model that shows the multilevel relationships) captures the effects of focus ($Task\_Focus_{ijk}, Cat\_Focus_{jk}, Rel\_Focus_{jk}$), complexity of care requirements ($Complexity_{pijk}$), their interactions on the costs of care at the individual patient level ($lnCostspd_{pijkt}$). In examining these relationships, heterogeneity across units within and between the hierarchical levels ($patient_p$ receiving care $task_i$ within $category_j$ of $hospital_k$) is accounted for by specifying a mixed effects model as follows:

$$
\begin{aligned}
lnCostspd_{pijkt} &= \beta_0 + \beta_1\ Complexity_{pijk} \\
&+ \beta_2\ Task\_Focus_{ijk} + \beta_5\ Task\_Focus^{*}Complexity_{pijk} \\
&+ \beta_3\ Cat\_Focus_{jk} + \beta_6\ Cat\_Focus^{*}Complexity_{pijk} \\
&+ \beta_4\ Rel\_Focus_{jk} + \beta_7\ Rel\_Focus^{*}Complexity_{pijk} \\
&+ \gamma\ W_{pijk} + \alpha_k + \nu_j + \theta_t + \phi_{ijk} + \epsilon_{pijkt} \qquad (1)
\end{aligned}
$$

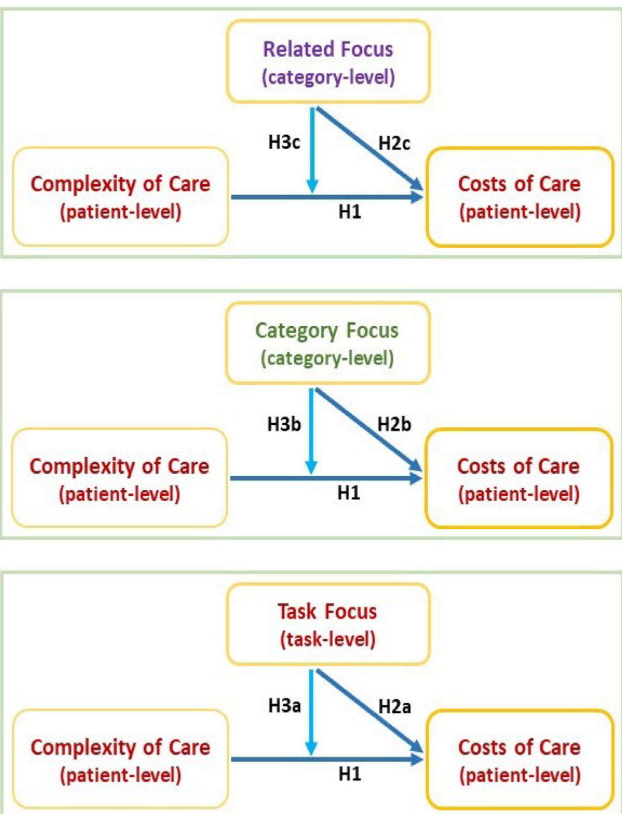

FIGURE 4 Multi-level relationships.

where W_{pijk} is a $1 \times K$ vector of (control variables) observed characteristics specific to the patient, task, category and the hospital. As discussed earlier, we control for unobserved factors arising from hospital, category, and time through inclusion of fixed-effects ($\alpha_k, \nu_j, \theta_t$, respectively). ϕ_{ijk} and ϵ_{pijkt} denote the task-level random effects and random error components with $\phi_{ijk} \sim N\left(0, \sigma_{\phi}^2\right)$ and $\epsilon_{pijk} \sim N\left(0, \sigma_{\epsilon}^2\right)$. The main parameters of interest are $\beta_1 - \beta_7$, representing the marginal effects of focus across the spectrum of complexity.

The inclusion of fixed effects allows us to control for hospital-specific, and category-specific unobserved heterogeneity that may confound our analysis. From a modeling standpoint, the *Hospital Fixed-Effects* and *Category Fixed-Effects* intercepts remove the unique cross-sectional variation from unobserved heterogeneity, identifying the slope coefficients for focus using within-variation in our analysis (cf. Rossi, 2014). For example, the fixed effects at the hospital-level and the category level may systematically account for the emphasis on selective patient groups based on insurance, demographics, or care characteristics.

To ensure that the correlations among the regressors do not affect the estimation in our analysis, we checked the Variance Inflation Factor (VIF) scores of the regressors in our model (Mansfield & Helms, 1982). The average of estimated VIFs in our model was less than 3.0 indicating no significant concerns of multicollinearity in our study.

4 | RESULTS AND DISCUSSION

Table 3 provides the descriptive statistics[8] of the key variables in the study sample. The variance partition coefficients based on the observed outcomes (i.e., proportion of observed variation explained by each hierarchical level in the unconditional model without the predictor variables) are also reported in Table 3.[9] We note that considerable variance is observed across the hierarchical levels, consistent with our expectations that patient outcomes depend not only on care delivery operations at the task level, but also on operational decisions at the aggregate levels (category and hospital levels, respectively).

An examination of the distribution of the focus across the hierarchical levels (see Figure 5) reveals interesting insights: first, we note that focus at the task level and the category level are skewed heavily on the low end

TABLE 3 Summary statistics.

	Count	Mean	SD	Min	Max
lnCostpd	246,588	7.444236	.7300294	−.3793737	12.10046
Pat. complexity	246,663	.0127249	.8964903	−1.289436	4.5867
Task. focus	246,663	.2327139	.2564624	.0006435	1
Category. focus	246,663	.0973584	.0917233	.0001538	.9731801
Related. focus	246,663	.3749654	.1308005	0	.9885057

Correlation matrix of key variables

	lnCostpd	Pat. complexity	Task. focus	Category. focus	Related. focus
lnCostpd	1.000				
Pat. complexity	0.206***	1.000			
Task. focus	−0.340***	−0.232***	1.000		
Category. focus	0.003	−0.129***	0.060***	1.000	
Related. focus	0.239***	0.385***	−0.187***	−0.428***	1.000

Variance partition

Hierarchical level	%
Hospital level ($\alpha_{..k}$)	0.11
Category level ($\nu_{.jk}$)	0.19
Task level ($\phi_{.ijk}$)	0.42
Patient (ϵ_{pijk})	0.28

Note: $^{*}p < 0.05$; $^{**}p < 0.05$; $^{***}p < 0.001$.

(left tail), suggesting that high task focus or category focus is infrequent among providers. Second, we see that related focus is not a dominant phenomenon suggesting that disease-focused hospitals with expertise in relevant areas are not ubiquitous.

4.1 | Main effects

Table 4 presents the results from the estimation of the empirical models in our study. Models 1–4 provide the results from ML estimation of the main effects only. We find significant effects of complexity, task focus, category focus, and related focus on costs of care across the estimated models.[10] The parsimonious main effects specification (Model 4 in Table 4) reveals the following insights.

4.1.1 | Complexity of care requirements and costs of care

The coefficient estimate for complexity of care requirements, $\beta_1 = 0.0332$, is both positive and significant ($p < 0.01$). This finding is consistent with theoretical arguments that highlight the information processing challenges and the non-linear process flow associated with complexity. Specifically, the increase in the costs of care with complexity of care requirements highlights the resource implications of process flow impediments (Devaraj et al., 2013; Kuntz et al., 2019; Schmenner & Swink, 1998). It is conceivable that under high levels of complexity, care providers may be required to deviate from standardized protocols and redefine care process maps to suit patient care requirements (Faraj & Xiao, 2006; Plsek & Greenhalgh, 2001; Tushman & Nadler, 1978). Additionally, heterogeneous interdependency of care requirements may also exacerbate the "frequency of exceptions," variability in processes and routines, and the cognitive burden of care providers (e.g., Campbell, 1988; Tushman & Nadler, 1978). These mechanisms may, in turn, trigger additional time and resource commitments with detrimental effects on the costs of care. Overall, the results suggest that complexity of care requirements is associated with higher costs of care, in support of Hypothesis H1.

4.1.2 | Focus and costs of care

The coefficient estimate for *task focus*, $\beta_2 = -0.0411$ (standardized $b = -0.017$), is negative and significant

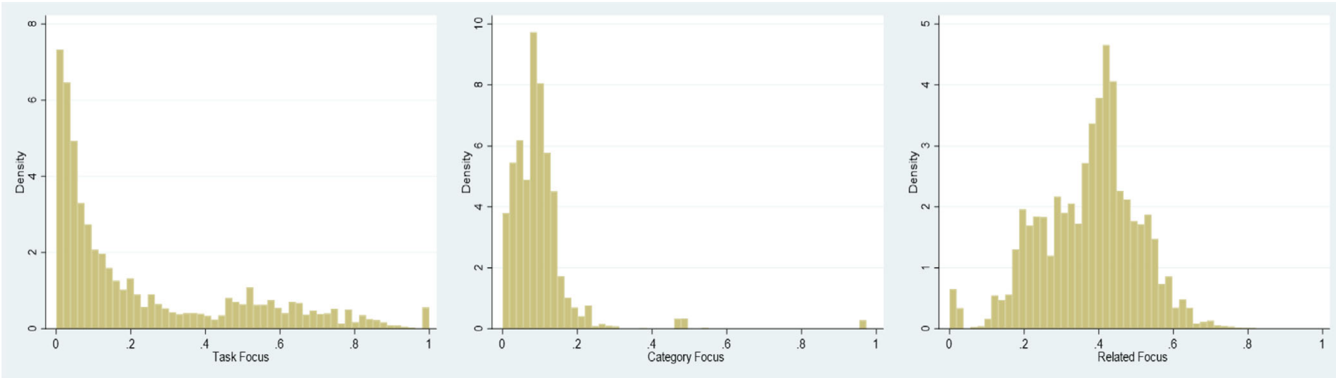

FIGURE 5 Focus—distribution.

TABLE 4 Effects of focus and complexity on costs of care.

	Base model	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
The main effects						
Complexity	0.0330***	0.0330***	0.0330***	0.0333***	0.0332***	0.0405***
	(.00262)	(0.00262)	(0.00262)	(0.00262)	(0.00262)	(0.00594)
Task focus		−0.0540***			−0.0411***	−0.0278***
		(0.0120)			(0.0121)	(0.0121)
Category focus			0.361***		0.243***	0.240***
			(0.0282)		(0.0294)	(0.0296)
Related focus				−0.345***	−0.300***	−0.302***
				(0.0203)	(0.0210)	(0.0211)
The interaction effects						
Task focus*complexity						0.0615***
						(0.00498)
Category focus*complexity						−0.0263
						(0.0160)
Related focus*complexity						−0.0398***
						(0.0113)
Fixed effects						
FE: Hospital	X	X	X	X	X	X
FE: Category	X	X	X	X	X	X
FE: Month	X	X	X	X	X	X
RE: Task	X	X	X	X	X	X
Other controls and patient-level covariates included but not shown here are:						
Hospital-Category Scale Effects, Hospital-DRG Scale Effects, Weekend Admission, Hospital Birth, Race						
*Transfer In, Transfer Out, Patient Age, Gender, Age*Gender, Comorbities, Payor, Disposition at Discharge*						
R-squared	0.410	0.410	0.411	0.413	0.414	0.416
Chi-squared	65,134.9	65,160.5	65,343.5	65,505.5	65,617.8	65,827.7
Degrees_of_freedom	251	252	252	252	254	257
Prob > Chi-squared	0	0	0	0	0	0

Note: $N = 234{,}171$. Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$.

($p < 0.01$). This suggests that when care delivery operations at the task level are focused, they are associated with lower costs of care. This indicates support for H2a. This is consistent with findings from past studies examining the impact of operational focus on healthcare performance metrics including length of stay and mortality rates (Clark & Huckman, 2012; Huckman & Zinner, 2008; Kc & Terwiesch, 2011). The drop in costs of care with task focus, as observed in our study, lend support to the key mechanisms that highlight the benefits of task focus including improved information coordination and processing capabilities (Hyer et al., 2009), learning from repetition (Ding, 2014), and improved process flows (Schmenner & Swink, 1998) in healthcare delivery.

The coefficient estimate for *category focus*, $\beta_3 = 0.243$ (standardized $b = 0.054$), is positive and significant ($p < 0.01$). Contrary to our expectations in H2b, we find that focus at the category level is associated with significant increase in the *costs of care*. In contrast to the findings earlier that specialization at the task level is beneficial, the increase in costs of care with focus at the category level is suggestive of dilution of organization efforts and resources across tasks within the category. Specifically, the finding that the benefits of specialization from the task level do not carry over to the category level suggests that focused departments may be drawn too thin across multiple tasks and procedures within that category (Huckman & Zinner, 2008).

The coefficient estimate for *related focus*, $\beta_4 = -0.300$ (standardized $b = -0.031$), is negative and significant ($p < 0.01$). This suggests that when care delivery operations at the category level are focused on related areas of care, they are associated with lower costs of care. This indicates support for H2c. As discussed earlier, the benefits from related focus may be attributed to breadth of expertise in all relevant areas of care for each department. Specifically, departments that co-specialize in areas that most frequently are associated as secondary diagnoses may be better positioned to diagnose, source and coordinate care delivery in a timely and efficient manner. This is consistent with findings from past studies such as Clark and Huckman (2012), and Sfekas (2020), that identify the healthcare performance implications (for mortality rate, and patient utility, respectively) of specialization in related areas by individual departments (Cardiology, and Obstetrics & Gynecology, respectively).

4.2 | Moderating effects of focus

Model 5 in Table 4 presents the results for the models representing the main effects and the interaction effects. The consistency of the estimates across the models is suggestive of the robustness of the results. We conducted a Chi-square test comparing the model chi-square before and after the introduction of the focus interaction terms. The chi-squared difference was significant ($\chi^2_3 = 214.86, p < 0.01$), indicating the significant explanatory power the interaction (focus*-complexity) variables. The interaction effects specification (Model 5 in Table 4) reveals the following insights.

We notice that the coefficient estimate for the interaction between *task focus and complexity*, $\beta_3 = 0.0615$, is positive and significant ($p < 0.01$). This result is consistent with our expectations in H3a. We find that at higher levels of task focus, greater complexity leads to higher costs of care. Our results earlier indicated that task focus may lower costs of care owing to multiple factors including depth of expertise, learning from repetition, predictability of tasks, better planning and control and lowered uncertainty. However, care delivery for patients high complexity calls for expertise across a range of procedures within and across categories. Task focus may offer too narrow an expertise to address such complexity. While task focus may enable care providers to achieve expertise depth and efficiency by limiting the scope of processes to well-defined manageable subset, they may need to coordinate care activities and share knowledge with providers within and across care categories when faced with highly complex task requirements. This mismatch between the narrow capabilities from task focus and the broad requirements from complex patients may be associated with additional resources expenditures and care delivery routines that contribute to an increase in costs of care.

Interestingly, however, we find that the coefficient estimate of the interaction between *category focus and complexity*, $\beta_5 = -0.0263$, is negative but not significant. As for related focus, we notice that the coefficient of the interaction between *related focus and complexity*, $\beta_7 = -0.0398$, is negative and significant ($p < 0.01$), indicating support for H3c. The negative and significant interaction effect suggests that related focus (focus on related areas) can help in combating the effects of the complexity of patient care requirements on costs of care. These results are indicative of coordination and learning benefits from an emphasis on related areas of care. As noted earlier, departments with higher levels of related focus may be able to coordinate and integrate expertise across relevant areas in a timely manner for patients with complex needs. High focus in related areas may also facilitate the "cross-pollination" of best practices and ideas in the effective delivery of care. Although complexity is associated with significant costs of care, exposure to patients with a complex cocktail of chronic, comorbid conditions may offer healthcare providers opportunities to learn from and transfer knowledge across the related areas, lowering the costs of care (Stan & Vermeulen, 2013). Unlike learning from specialization which arises from the depth of exposure gained in working with patients within a narrow band of conditions, learning from variety leverages the breadth of exposure that is gained from treating patients with complex care requirements. Focus in related areas may facilitate the assimilation of expertise (breadth) gained from treating complex patients (Narayanan et al., 2009). The diverse experience gained from working with more complex patients may support the development of a broader schema of knowledge relevant to the complex conditions, and enhance implicit learning (Dane, 2010; Schilling et al., 2003). Thus, hospitals with higher than-average levels of complexity may be better off developing expertise in relevant pockets of care instead of a piecemeal approach to specialization and care delivery.

4.3 | Key insights

The Curse of Complexity: Our study findings suggest that complexity of care requirements is associated with a significant increase in costs of care. The drop in the efficiency of care delivery with complexity is consistent with theoretical arguments in the extant literature identifying the information processing challenges, coordination difficulties, and nonlinear process flows attributed to complexity of care requirements (Faraj & Xiao, 2006; Schmenner & Swink, 1998).

Focus, The Savior: Operational focus, as our study findings suggest, may be the strategy that lowers costs and mitigates the effects of complexity. However, the beneficial effects of focus on costs of care are nuanced, with differential effects of focus across the spectrum of complexity and varying by the hierarchical level. To further understand the impact of focus on costs of care, we estimated the average marginal effects of focus at the various hierarchical levels (see Figure 6) based on our results of Model 5 of Table 4. The average marginal effects are reflective of the main effects and moderation effects of focus. The response surface [contour plot] is provided in Figure 6.

Our findings indicate that "*task-specialists*" (i.e., hospitals with high focus at the task level) tend to achieve significant drop in costs of care relative to others. However, we find evidence for differential effects of task focus with the marginal effects decreasing in complexity. This finding lends support to the theoretical arguments for specialization at the task level when complexity is low, attributed to improved information coordination and processing capabilities, learning from repetition, improved process flows, and economies of scale. However, task focus may not beneficial to the provider when faced with complex care needs. Overall, this finding suggesting the need for hospitals to followed a tailored approach to their focus strategy.

Related focus has a consistent beneficial effect (both main and interaction effects are negative, as are the average marginal effects) on costs of care. Specifically, we find that the hospitals that are disease-focused, with high focus on relevant areas of a disease category, achieve significantly lower costs of care than others. As discussed earlier, the efficiency gains from related focus, especially in the presence of complexity of care requirements, can be attributed to the access to expertise in relevant areas of care, improved coordination among the various specialists in the delivery of care, and providers' gains from sense-making and learning from addressing complexity.

On the contrary, we notice that the average marginal effects of category level focus remain consistently positive. In other words, category focus is associated with higher costs of care across the spectrum of complexity. As noted earlier, the lack of significant benefits from focus on a department may be attributed to within-category expertise that is neither as specialized as the task-specialists (i.e., lack of depth) nor as relatedly diverse as the disease-focused experts (i.e., lack of relevant breadth).

Taken together, the above insights reinforce the beneficial but nuanced impact of focus in healthcare settings. Hospitals that may attract more complex patients owing to multiple factors such as hospital and/or department reputation, teaching status, location, etc., may achieve lower costs of care by a strategic choice of focus, specializing in select procedures and developing expertise in the related categories areas most relevant to its patient population. Hospitals that offer care across the spectrum DRGs and categories of care, may not be best positioned to achieve the lowest costs of care.

4.4 | Additional analysis and robustness checks

We conducted several robustness checks to ensure that our study findings are not an artifact of the modeling and data considerations in our study. In this vein, our additional analyses examined alternative model specifications, alternative data, alternative variables and measures in our empirical models. Specifically,

1. Alternative model specification—we examine endogeneity in our empirical models, the potential synergistic effects of task and category focus on outcomes of care, heterogeneity in the effects of focus across care categories and patient admission type (emergency vs elective), and empirical robustness owing to cross-

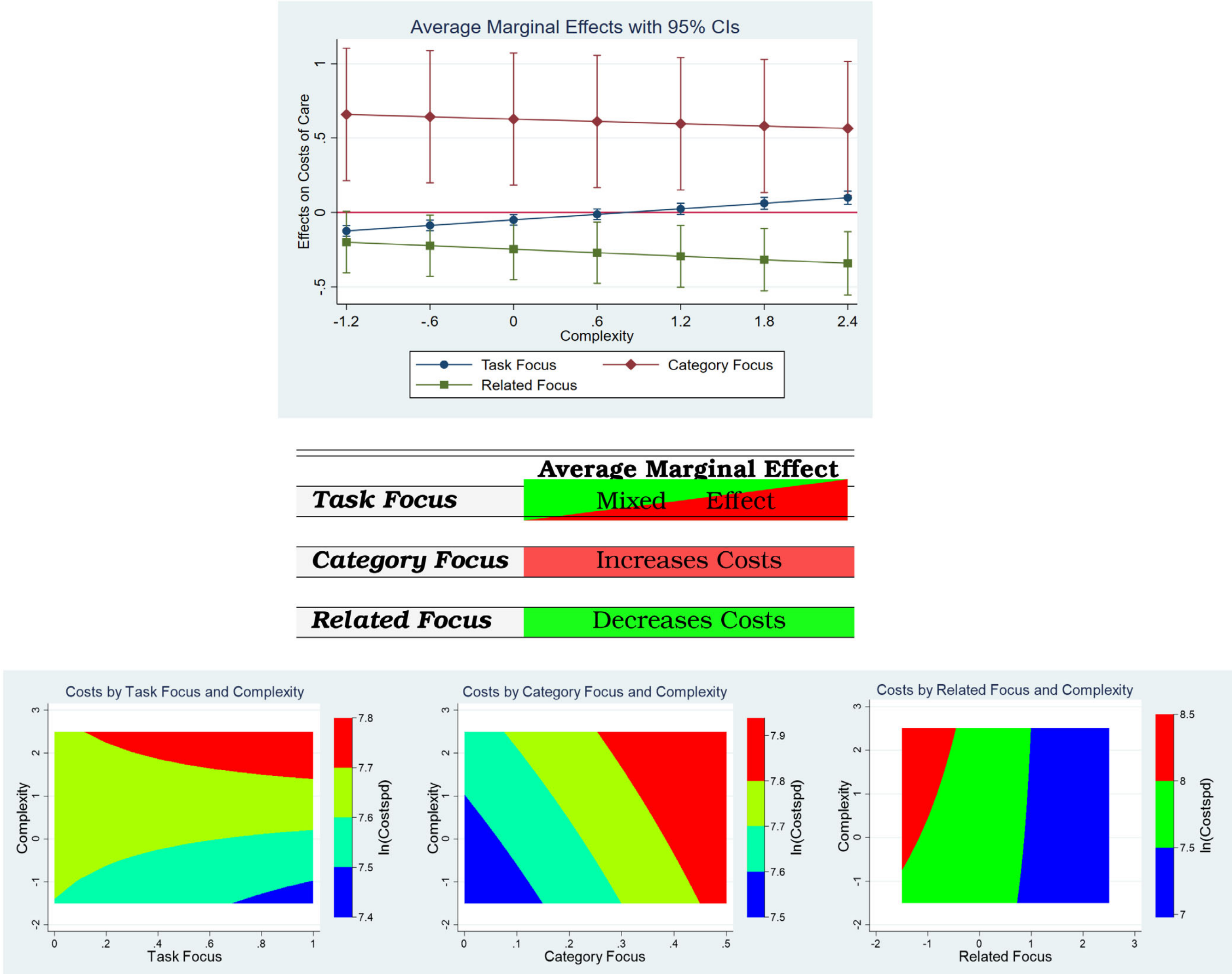

FIGURE 6 Focus and costs of care—marginal effects and contour plots.

sectional correlations across patient discharges owing to hospital-type, payor or discharge timing characteristics. We describe these additional analyses and the results in Online Appendix C.

2. Alternative data—we examine the robustness of our results to data from other hospital divisions across the U.S., other years of NIS data, and data from Statewide Inpatient Database. Online Appendix D provides a detailed discussion of these additional analyses and results using alternative data.
3. Alternative variable measurement—we examine the robustness of our study insights to alternative measures of complexity and related focus, and explore the consistency of our study insights for other outcomes of interest (e.g., patient length of stay and mortality) examined in prior studies. We provide a discussion of these additional analyses and the results in Online Appendix E.

Overall, the rich set of robustness checks and additional analyses serve to reinforce our study findings.

5 | CONCLUDING REMARKS

The efficacy of healthcare delivery conceivably depends not only on the nature of the *demand* for care (viz. complexity and heterogeneity of patient care requirements), but also on the *supply* of care (viz. how healthcare resources are structured and organized [focus]) in a hospital. In this study, we provide a window into the interactive effects of the demand- and supply-side care operations by examining the effects of organizational focus on the costs of care, directly incorporating the effect of the complexity of care. Below, we highlight the theoretical contributions of this study and implications for practice.

5.1 | Theoretical contributions

Measuring the Impact of Complexity—Our study provides an assessment of the complexity of care requirements across patients and its implications for costs of care. Our study serves to complement and extend recent research in this area (Ding et al., 2020; Kc & Terwiesch, 2011; Kuntz et al., 2019) by conceptualizing and holistically measuring complexity of care requirements across individual patients (vis-à-vis a hospital-wide [casemix] measure), across care categories (vis-à-vis for a single category), on a continuous scale (vis-à-vis a dichotomous measure) that is based on multiple items reflective of the variety and interdependency of patient care requirements. The theoretically grounded empirical analysis of the relationships between complexity of care requirements and costs of care is, to the best of our knowledge, among the first of its kind to be reported, and serves to address an important gap in the healthcare operations literature.

The Direct and Moderating Effects of Focus, across Hierarchical Levels—While extant literature has examined the direct effects of focus in healthcare settings, there remains considerable ambiguity in this regard. Furthermore, the moderating role of focus [mitigating the impact of complexity] has heretofore been understudied. Our research complements prior work in this area by providing a combined assessment of the (direct and interactive) effects of focus and complexity on costs of care, across multiple care categories (vis-à-vis for a single category such as Cardiology or OB-GYN), and based on a large and diverse sample of hospitals. Highlighting the differential impacts of focus on the costs of care across the spectrum of complexity is a unique contribution of the study. This research brings together two streams of literature—one that examines the benefits of specialization (e.g., Ding et al., 2020; Kc & Terwiesch, 2011), and the other that highlights the value of diversification (e.g., Clark & Huckman, 2012; Kuntz et al., 2019; Sfekas, 2020) in healthcare settings. Our findings provide a unifying view of the benefits of both the depth of expertise and breadth of expertise across complexity regimes, and provides a window into the arguments calling for disease-based routing within the hospital.

Furthermore, we explicitly model the role of focus across the hierarchical levels of care and employ a large dataset incorporating measures for cost of care outcomes. Our study highlights the implications of *task focus*, *category focus*, and *related focus* for costs of care, accounting for the complexity of care needs.

Overall, a patient-level examination of the impacts of complexity and focus on the costs of care, across hierarchical levels of a hospital and across care categories, based on a large and diverse [generalizable] sample of hospitals, is a unique contribution of this study.

5.2 | Implications for practice

First, our study points to the benefits of task focus, and focus in related areas. We show that depth of expertise from specialization at the task level is associated with lower costs of care, when complexity of care needs are low. For illustration, we considered a 1 SD increase in these variables. To identify the cost impact, we then exponentiated the effect sizes to obtain the percentage impact on the average costs, the cost impact in dollars, and the aggregate cost changes at the hospital-level (see Table 5). This computation reveals that a change of about 25% in categorical (task) focus is associated with an increase of on average $236,475 in total care costs. Similarly, a change of about 10% change in task (task) focus is associated with a decrease of $10,198 in total care costs. We note that the cost impact is significant, lending further import to the strategic decisions related to focus.

Second, our study points to the perils of complexity in healthcare operations. However, limiting the exposure to complexity is not an option for most acute care providers. It is thus imperative that hospitals identify operational levers to mitigate the effects of complexity. To that end, our study findings inform managerial decision-making by highlighting the moderating influence of focus on the performance impact of the complexity of care requirements. Specifically, our study results indicate that departments with more complex patients tend to perform better than others when they develop expertise in related areas of care. This calls for managers to create structural and infrastructural mechanisms—such as care coordination

TABLE 5 Illustrating the cost impacts of focus.

	Beta	SE	% Change in costs/day	$ Change in costs of care	$ Change in total costs
Std.Task_Focus	−0.013	0.005	−1.24	−152.21	−10,198.19
Std.Dept_Focus	0.058	0.021	5.92	725.38	236,474.06
Std.Rel_Focus	−0.032	0.014	−3.18	−389.58	−127,003.41

across specialists, teamwork, and technology tools that facilitate collaboration within and across departments.

Third, we shared the results of our analysis with physicians and hospital administrators from four hospitals across the US. This generated a range of discussions on the implications and application of our study. For instance, practitioners felt that there was significant value in exploring the effect of focus in related areas. They opined that if departments that traditionally focused on an area (e.g., neurology) expanded their staff expertise in other closely related areas (e.g., psychiatry in the case of neurology), not only would it be more seamless care for the patient but also increase revenues for the department. Therefore, a useful exercise for hospital departments might be to analyze which other areas might be closely related and how closely related might they be to justify hiring care providers in that area. Additionally, we observed general consensus on the use of a multidimensional measure of complexity at the patient level. Hospital administrators expressed interest in furthering our study and collaborating to understand other important consequences of such complexity (such as hospital readmissions or hospital staffing).

5.3 | Limitations and future research

While our study builds upon prior research in this area and employs a larger more generalizable data-set, several limitations need to be acknowledged.

First, the lack of hospital identifiers in the NIS data precludes merger of other datasets that may provide information on hospital-specific technology capability (e.g., Ding & Peng, 2022; Peng et al., 2020) or operational characteristics (e.g., process conformance). Currently, in our analysis, we include unobserved hospital heterogeneity as part of our hospital fixed effects. An analysis of the moderating influence of hospital-specific factors (technology, operational, and strategic) forms a valuable direction for future research.

In a related manner, hospital focus strategy may include multiple deliberate and interlinked operational decisions related to physician and staffing levels, patient volumes served, or facility and resource allocations across care categories. While a holistic assessment of hospital focus strategy may build on these varied aspects, our operationalization of focus in the paper is based on proportion of patient volume in an area, which is consistent with prior research in this area (e.g., Clark & Huckman, 2012; Kc & Terwiesch, 2011). We believe future research that operationalizes focus using other supply-side metrics (e.g., beds, staff level, or resource allocations) may serve to provide a holistic perspective on a hospital's focus strategy.

Second, our primary outcome measure of interest in this study is costs of care, accounting for the patient length of stay and disposition at discharge. However, it is possible that other measures (e.g., readmission rates, patient satisfaction, clinical quality) might yield different results and these different measures might constitute avenues for future research as well. Prior studies in healthcare operations (e.g., Kc & Terwiesch, 2011; Roth et al., 2019; Thirumalai et al., 2022) examine the tradeoff among multiple outcomes in healthcare settings. An examination of the differential effects of focus across the various objectives in healthcare, and its moderating influence on tradeoffs among outcomes of care may be a valuable direction for future research.

Third, there might be additional mechanisms (e.g., utilization levels of facility, individual "star" specialists) at play that may influence the relationship between complexity, focus, and healthcare outcomes. For example, hospitals may deliberately choose to serve a niche patient population (based on location, demographic and socio-economic factors, or other regulatory drivers) with targeted services. An examination of the drivers and contingencies with joint strategic decisions related to supply [focus] and demand [location and complexity] for care and its implications for care outcomes may be valuable directions for future research.

Another aspect that our study examined was the heterogeneity in the effects of complexity and focus across departments. While our analysis indicated variance in the impact (both direction and magnitude) of the focus and complexity, an examination of this variance, that is, why some departments realized greater benefits than others, was beyond the scope of this research. Future research may examine the sources of such heterogeneity in the clinical and operational implications of complexity and focus across departments.

CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest to declare.

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ENDNOTES

[1] For instance, Ding and Peng (2022) report on the moderating effect of complexity and focus on the relationship between electronic medical records (EMR) and process of care. Peng et al., 2020 studied the effect of complexity on experiential

quality (patients interacting with care providers) and the moderating role of information technology. KC and Terwiesch (2011) examine the effects of focus while accounting for the [low] complexity of patients.

[2] Churruca et al. (2019) provide a concise review and bibliometric analysis of complexity from a complexity theory perspective.

[3] Healthcare spending grew 2.7% in 2021 and reached 4.3 trillion at about 12,914 per person in the U.S. (http://CMS.gov).

[4] Additionally, we performed a confirmatory factor analysis (CFA) for the complexity factor using the three indicators that emerged in our exploratory factory analysis. The results indicate support for the convergence and unidimensionality of the construct, lending further confidence in our measures.

[5] As a robustness check, we created an alternate measure of related using *all* related categories (not just those with at least 5% of patients). The results using this alternate measure are consistent with our main findings (see discussion on robustness checks, in Section 4).

[6] We also additionally assessed related focus as the diversification of hospital expertise in related areas of care following an entropy measure. Using this approach, the related focus of department$_j$ in related care categories (Rel_Focus_{jk}) is calculated as $\sum_{id}\left[\frac{P_{idk}}{P_k} ln\left(\frac{P_k}{P_{idk}}\right)\right]$, where $d(\neq j)$ includes all relevant categories of care (Jacquemin & Berry, 1979; Palepu, 1985; Ramanujam & Varadarajan, 1989; Sorescu et al., 2003). Interestingly, the Clark and Huckman's (2012) summation score approach (we follow this approach in our study), and the Jacquemin and Berry (1979)'s entropy approach for assessing focus in related areas are highly consistent (correlation = 0.98) lending further confidence in our measures.

[7] HCUP includes TOTCHG, a variable reflective of the total charges on the patient discharge record.

[8] We use STATA 17 for all our analysis in the study.

[9] Tables B.1 and B.2 in Online Appendix B provide a summary of the key study variables, and the correlation matrix for all the study variables.

[10] The chi-squared difference comparing the models before and after the introduction of the focus variables was significant $(\chi^2_6 = 533.57, p < 0.01)$, indicating the significant explanatory power of the focus variables.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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