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Team Scaffolds: How Mesolevel Structures Enable Role-Based Coordination in Temporary Groups

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This paper shows how mesolevel structures support effective coordination in temporary groups. Prior research on coordination in temporary groups describes how roles encode individual responsibilities so that coordination between relative strangers is possible. We extend this research by introducing key tenets from team effectiveness research to theorize when role-based coordination might be more or less effective. We develop these ideas in a multimethod study of a hospital emergency department (ED) redesign. Before the redesign, people coordinated in ad hoc groupings, which provided flexibility because any nurse could work with any doctor, but these groupings were limited in effectiveness because people were not accountable to each other for progress, did not have shared understanding of their work, and faced interpersonal risks when reaching out to other roles. The redesign introduced new mesolevel structures that bounded a set of roles (rather than a set of specific individuals, as in a team) and gave them collective responsibility for a whole task. We conceptualized the mesolevel structures as team scaffolds and found that they embodied the logic of both role and team structures. The team scaffolds enabled small-group interactions to take the form of an actual team process with team-level prioritizing, updating, and helping, based on newfound accountability, overlapping representations of work, and belonging—despite the lack of stable team composition. Quantitative data revealed changes to the coordination patterns in the ED (captured through a two-mode network) after the team scaffolds were implemented and showed a 40% improvement in patient throughput time.

Keywords: team scaffolds; team effectiveness; role-based coordination; fluid personnel
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Introduction

Many of today's firms operate in a fast-paced 24/7 service economy characterized by irregular work schedules and multiple shifts (Barnett and Hall 2007, Presser 2003). Although staggered round-the-clock staffing provides flexibility, it also involves considerable flux in personnel, meaning that the composition of professionals may vary greatly from one shift to the next, and even from one day to the next. Operating with fluid personnel is possible because people are typically organized around roles, or activity-based positions that can be assumed by anyone with the necessary training.

At the same time, organizational work is increasingly interdependent and team based (Devine et al. 1999). Team-based work (that is, work assigned to a team rather than an individual, or work that requires multiple specialties to work together) provides real benefits such as access to more and more diverse knowledge, gains in accountability and efficiency, satisfaction, learning, and synergistic processes (Batt 2004, Cummings 2004, Dahlin et al. 2005, Edmondson 1999, Larson 2010).

These two trends at first seem to be in tension in important ways. In role-based work, the roles are so well defined that anyone who has been trained on the responsibilities and activities of the role can easily occupy the role and do her work (Bechky 2006, Bigley and Roberts 2001, Klein et al. 2006). Role-based work does not depend on the unique identity of the person occupying the role (i.e., the role is "deindividualized"; see Klein et al. 2006, p. 616). Role-based work also involves clear role boundaries and accountabilities.

In contrast, team-based work involves ongoing member interaction and discretion in working out unclear areas of accountability and interdependence. Work teams thus depend on knowing individual members' unique skills and experiences to accomplish complex interdependent tasks. For this reason, team membership stability has been considered a powerful source of team effectiveness (Wageman et al. 2005). A team's ability to draw on the expertise and knowledge of its members promotes performance (Reagans et al. 2005) and is the basis of a transactive memory system (Lewis et al. 2005, Liang et al. 1995). In general, teams in which members know each other's strengths, weaknesses, expertise, and abilities perform better than those that lack this knowledge, allowing them to become "highly skilled in coordinating their activities, anticipating one another's next moves and initiating appropriate responses to them even as those moves are occurring" (Hackman 2002, p. 27).

Role-based work (often integral to shift work, or any work that requires flexible staffing) and team-based work are both attributes of many modern organizations, but their implications have rarely been examined together. One might conclude that these two trends exist in separate sectors of the economy (e.g., healthcare versus consulting or manufacturing). Thus far, academic research mirrors this interpretation because the two trends have been examined in separate research streams. Specifically, one body of research has described how roles and role structures enable coordination among temporary groups (Bechky 2006, Bigley and Roberts 2001, Klein et al. 2006). A separate body of research has focused on understanding why some work teams coordinate more effectively than others. This research has shown that teams with certain properties (e.g., membership stability) engage in more effective group-level coordination than those lacking those properties (Hackman 1987, 2002; Wageman 1995; Wageman et al. 2005). Despite the potential disconnect between role-based and team-based work (and despite the current separateness of the research literatures), organizations are in fact introducing team-based work into operations with fluid personnel. We argue that these research streams could profitably be integrated to explain conditions that can support effective teamwork among fluid personnel and role-based operations.

This paper integrates team effectiveness research with research on role-based coordination to theorize conditions under which temporary role-based groups coordinate more or less effectively. We developed and tested these ideas in a multimethod field study of a work redesign in a hospital emergency department (ED). Prior to the redesign, individuals coordinated in a role structure based on three roles: nurses, residents (junior physicians), and attendings (senior physicians). Interactions occurred in ad hoc and unstructured groupings. Then, the ED implemented new mesolevel structures that bounded small sets of roles (three nurses, two residents, and one attending) and gave them shared responsibility for a group of patients. These bounded role sets embodied both the logic of role theory because they encompassed deindividualized roles and the logic of team effectiveness because people were bounded and collectively responsible. We labeled these mesolevel structures *team scaffolds* because they supported extremely fluid groups in group-level prioritizing, updating, and helping behaviors.

Our qualitative data revealed key components of team scaffolds (boundary, role set, and shared responsibility) and illuminated how these structures support group-level coordination (because of accountability, overlapping representations of work, and belonging). Our quantitative data revealed simple but significant changes to the coordination patterns (captured through a two-mode network) in the ED after the team scaffolds were implemented and a 40% improvement in patient throughput time. In summary, this study shows the nature and value of team scaffolds for enabling temporary or fluid groups to construct effective team-level coordination.

Role-Based Coordination and Team Effectiveness

Coordination in organizations is enabled by organizational structures, which are "descriptions of and templates for ongoing patterns of action" (Barley and Kunda 2001, p. 76). Role structures and team structures both provide templates for coordination of work, albeit through different means. We review and integrate the research on role-based coordination and team effectiveness to introduce team scaffolds.

Role-Based Coordination in Temporary Groups

Role theory helps explain how relative strangers can coordinate complex tasks. Roles delineate expertise and responsibility so that anyone in a particular role will know her individual responsibilities and interdependencies with those in other roles, even in the absence of interpersonal familiarity (Bechky 2006, Griffin et al. 2007). Roles thus allow coordination to be deindividualized: people do not rely on knowing others' unique skills, weaknesses, or preferences to figure out how to work together; instead, they rely on knowing one another's position in the role structure (Briscoe 2007, Klein et al. 2006). Indeed, many studies show, and many operating environments rely on, the efficacy of roles in facilitating nonprogrammed coordination in dynamic settings such as firefighting, trauma departments, and film crews (Bechky 2006, Bigley and Roberts 2001, Klein et al. 2006). These studies also show that even when roles encode responsibility, some unscripted interaction is required to execute shared work (often referred to as "constrained improvisation"; see Bigley and Roberts 2001, p. 1282). People must flexibly react to changing environments or changing task demands within the scope of their highly specified roles.

Prior research thus describes how role structures deindividualize coordination, but it has not yet explored performance implications of how deindividualized roles are organized. We seek to advance understanding of role-based coordination by examining effects of how role structures are organized.

Team Effectiveness

Effective coordination has long been a focus of team effectiveness research (Hackman 1987, 2002). We consider key tenets from team effectiveness research to explore conditions for effective coordination among temporary role-based groups. Hackman (2002) and Wageman et al. (2005) identified boundedness, stability of membership, and interdependence as essential elements of stable work teams.[1] *Bounded* means that it is explicitly clear who is on the team and who is not on the team. *Stable* means the same group of individuals compose the team over time. *Interdependent* means that the people on the team have to work together "for some common purpose ... for which members bear collective responsibility" (Wageman et al. 2005, p. 377), rather than having "their own individual jobs to do, with little need for them to work together" (p. 382). Taken together, these dimensions of a traditional team structure—boundedness, stability, and interdependence—allow the group to see itself and be seen as an intact social entity and also allow group members to coordinate effectively, because they get to know each other well and are able to anticipate each other's moves and adjust to each other's strengths and weaknesses.

Collective responsibility, in particular, shapes the behavior of stable work teams and differentiates "real" work teams from other groups (e.g., "co-acting groups"; see Hackman 2002, p. 42). Collective responsibility gives people the ability and motivation to think and act in collective terms. Wageman (1995) assigned groups of technicians to work under conditions of collective responsibility or individual responsibility. The results of this experiment, reinforced by subsequent research, showed that groups function as teams when they collectively experience the consequences of their work. Under those conditions, they engage in constructive team processes such as active communication, knowledge sharing, and problem solving (Hoegl and Gemuenden 2001, Wageman and Fisher 2014, Wageman et al. 2005). They also exhibit "the collective motivation engendered by group outcomes" (Wageman 1995, p. 175).

Team effectiveness research thus suggests that effective coordination is most likely under enabling conditions established by team structures such as boundedness and stability. Role structures may be organized in ways that do not establish these kinds of enabling conditions, with implications for coordination effectiveness. For example, if people in the role structure are not collectively responsible for their work, they may focus on individual role responsibilities at the expense of the overall work. Also, role occupants may not easily find and communicate with interdependent partners in large or unbounded groups. Additionally, there is an intrinsic risk that role groups will function as divisive in-groups or stifling hierarchies (Alderfer and Smith 1982, Bartunek 2007, Hogg and Terry 2000). Role structures, then, do not *necessarily* support effective coordination.

Integrating Research on Team Effectiveness and Role-Based Coordination

We argue that key tenets of team effectiveness (boundedness, stability, and interdependence) can be applied to understanding effective coordination in temporary role-based groups. Clearly, team stability cannot be leveraged in situations requiring fluid personnel, but we propose that both boundedness and collective responsibility are relevant for temporary role-based groups.

First, effective coordination in temporary role-based groups may depend on whether and how the group is bounded. A team boundary by definition makes it clear whom to work with, on what, and possibly where (Hackman 2002, Wageman et al. 2005). In the absence of such an organizing structure, role occupants must work out these details themselves, which can result in not knowing either the specific individuals to whom their updates should be addressed or the importance of their question relative to their collaborators' other work. In team research, boundaries are defined by membership composition—that is, by specific individuals. This feature can be adapted for fluid personnel in the form of a deindividualized boundary that defines a set of roles instead of a group of specific individuals.

We argue that a deindividualized boundary might help role occupants coordinate for several reasons. First, people know whom they are working with and how to find each other. Also, in a bounded group, individual effort is more easily identified (Harkins and Szymanski 1989, Wagner 1995), which supports more proactive communication and coordination because the group can monitor and influence each other's efforts (Kidwell and Bennett 1993, Williams and Karau 1991). This logic should even apply to a temporary group because research has shown that even minimal, arbitrary distinctions can give rise to a shared in-group (Tajfel 1970). Being a member of a clearly bounded role set might become temporarily as or more salient to a role occupant than his other social identities. In the absence of such a designated group affiliation, he may be self-conscious about his role or status in relation to colleagues in other role groups (Bartunek 2011). In this way, a temporarily shared in-group may help role occupants feel empowered to communicate, ask questions, and hold each other accountable.

Second, effective coordination in temporary role-based groups may depend on whether and how a group is made collectively responsible for shared work. Roles within a role structure are by definition task interdependent (Bechky 2006, Klein et al. 2006), but they may not have collective responsibility for interdependent work. As noted above, collective responsibility for a whole task implies a high level of interdependence and a need for coordination (Wageman 1995). When people know they are jointly responsible, they may be more likely to monitor each other's progress and to provide frequent updates. Collective responsibility also supports common understanding of shared work, which may foster psychological safety for questions, clarifications, or updates (Okhuysen and Bechky 2009).

Team Scaffolds

As discussed, role structures can take many forms. We propose that in some situations, deindividualized roles can be organized within mesolevel structures that bound a set of roles and give them collective responsibility. We conceptualize such mesolevel structures as team scaffolds. A team scaffold is not a team in the traditional sense (i.e., a stable group of specific interdependent individuals; see Cohen and Bailey 1997), but rather a stable structure that helps fluid personnel act like a team.

The term "scaffolding" was first used in the education research literature to refer to the processes teachers use to help students succeed in solving problems that would otherwise be too difficult (Wood et al. 1976). This widely used term[2] now refers to processes, structures, and tools that educators use to help people "solve a problem, carry out a task, or achieve a goal which would be beyond their unassisted efforts" (Wood et al. 1976, p. 90; see also Quintana et al. 2004). The mesolevel structures we call "team scaffolds" have important features in common with educational scaffolding. Both represent goal-driven designs—that is, purposefully planned designs implemented with the goal of enabling specific behaviors that might otherwise not occur. Neither use of the term "scaffold" refers to an emergent process or structure, but rather to structures designed to enable success at an otherwise difficult task (i.e., learning or teamwork). Furthermore, the purpose of both types of scaffold is to enable behavior, not to build a structure. A team scaffold is not a team (the participants are constantly changing), but rather a structure that makes it easier for people to act like a team. Similarly, scaffolding does not make the student learn, but rather makes it easier for the student to learn.

In this research we used qualitative data (Study 1) to conceptualize team scaffolds and the coordination behaviors enabled by them and to identify the mechanisms that linked the structures and the behavior. We used quantitative data (Study 2) to assess whether and how the team scaffolds improved objective performance compared to coordination carried out in the more flexible unstructured groupings.

Study 1: Qualitative Data and Analysis

Research Context

We conducted this research in a hospital emergency department. Many EDs in the United States had recently adopted or planned large-scale process redesigns to address overcrowding, ineffective teamwork, and other challenges (Adams and Biros 2001, Derlet et al. 2001). Ineffective teamwork is a serious problem in many healthcare settings, including EDs, and has been attributed to several factors (Institute of Medicine 2001). EDs operate 24/7, with multiple, staggered shifts, so that the group of people staffing the ED constantly changes, making coordination and teamwork complicated. Also, status differences between medical role groups inhibit teamwork because both high- and low-status role occupants avoid open conversation for fear of embarrassment or disrupting the hierarchy (Edmondson 1996, Nembhard and Edmondson 2006). These interpersonal challenges affect patient outcomes: in a review of 54 malpractice incidents in an emergency department, 8 out of 12 deaths and 5 out of 8 permanent impairments were judged to be preventable if appropriate teamwork had occurred (Risser et al. 1999). Errors are often the result of missing information from poor communication rather than misjudgment (Siegal 2010).

One common redesign involved dividing an ED into smaller sections, sometimes called pods. Pod design varied by ED, but typically each pod had the personnel and equipment needed to treat any type of ED patient. The pod design was intended to control department scale by dividing staff and patients into subgroupings. Some EDs also used the pods to support team-based work. This was the case at "City Hospital."

Research Site

The City Hospital ED had particularly poor performance before its redesign. Members of the ED leadership team told us that their baseline performance was so poor that they were considered an outlier by a national consortium that benchmarks ED performance at major academic medical centers.

Ad Hoc Role-Based Coordination. Before the redesign, the City Hospital ED was divided into two large rooms, and each room had separate doctors' and nurses' workstations. When patients arrived at the ED waiting room, they would be triaged, and their chart would be placed on a counter. Any available nurse could take the chart to begin the patient-care work and then return the chart to the counter. Any available resident could then take the chart and begin her work, returning the chart to the counter when done, signaling that the patient case was ready for an attending. Finally, any attending could take the chart to join the case. This design was intended to match the first available nurse, resident, and attending to each new patient. Yet caring for shared patients involved reciprocal coordination among nurse, resident, and attending, and back-and-forth discussion was not enabled by this design. Residents were responsible for ordering tests and making decisions about diagnosis, treatment, and disposition (i.e., admitting or discharging the patient). The nurses carried out these orders and sometimes communicated updates to the resident (e.g., results from the lab tests ordered). Attendings approved or changed residents' orders and decisions. Communication about shared patients occurred in brief episodes that took place anywhere in the ED.

City Hospital Pod System. City Hospital ED implemented a redesign dividing the large ED into four pods. The pods at the City ED bounded a small group of roles (physicians and nurses) into a set and assigned the role set a queue of patients. The design of the pod structures at City Hospital is consistent with our conceptualization of team scaffolds, as detailed in the data analysis section.

A pod was a physical location with dedicated computers, supplies, and patient beds. Each pod was staffed by one attending, one in-charge resident and possibly another resident or intern, and typically three nurses, one of whom was designated the "pod lead." Providers were assigned to a pod for each shift more or less at random. The pods were thus stable structures that persisted over time, but the individuals staffing each pod changed constantly. In fact, within as little as five hours, all of the individuals staffing a pod could change (but not simultaneously) as a result of shift changes staggered across roles. Patients were assigned to a pod upon arriving at the ED. Patient assignment was "round-robin"—consecutive patients were assigned to Pod 1, then 2, then 3, then 4, and then again to 1, and so on. The shift options for nurses and physicians did not change with the pod implementation; the staffing patterns remained extremely flexible and fluid.

No other major changes occurred in the ED at the time of the pod redesign, but the implementation of the pod system involved significant change. The redesign team first conducted a thorough review of existing work processes, then standardized those processes for the pods. One member of the redesign team explained,

> We tried to standardize care and decrease variation between pods as much as possible. We standardized the person, time, and location for the initial nursing assessment and all discharge paperwork. We standardized the processes around lab draws and radiology testing. We also used our IT [information technology] system to hardwire processes. For instance, we created color-coded alerts for when a patient had stayed beyond a certain threshold. We also built in alerts for orders that were waiting to be reviewed or orders that needed to be completed.

The redesign team also carefully managed the transition to the pod system. One team member explained,

> Before going live with the pod system, we created a pilot environment and trained all staff in this space, including physicians. Everyone cycled through the training pod for at least one shift. This training period allowed us to adapt and test different processes. We saw immediate results: in the first three days of the pod-pilot we were able to treat almost half the ED patients with only 15 beds, with a three-hour length of stay. The contrast provided by the pod-pilot operating side-by-side with the old process provided the evidence we needed to drive immediate change.

Research Design

We used a single-site hybrid methods research design. First, an in-depth study of a single organization is consistent with current practices in theory building (Eisenhardt 1989, Eisenhardt and Graebner 2007). Using a single organization works well for focusing on a phenomenon-driven research question (Eisenhardt and Graebner 2007). Our study builds on theories that explain coordination among fluid personnel, but our focus was on understanding how new mesolevel structures affected coordination in temporary role-based groups (Golden-Biddle and Locke 2006). We propose that an in-depth look at team scaffolds at City Hospital can provide what Siggelkow (2007, p. 20) calls a "very powerful example" from a single organization. A second, related reason for using a single site was to control variation. The design of team scaffold-like structures may vary across EDs and other research settings. The use of a single case allowed us to develop deep understanding of how these new mesolevel structures influence coordination among fluid role-based groups. Future research should seek to explain possible variation across sites. A single case was also more conducive to collecting longitudinal data.

Our hybrid methods included both qualitative interview data and longitudinal quantitative data. The quantitative data allowed us to assess the performance impact of the pods compared with the prior sequential role-based work flow. The City Hospital ED implemented a department-wide, time-limited discrete intervention to change between these two work designs. The redesign was accomplished with low cost, only minor additions of physical space, and minimal staff changes or changes in patient population. This allowed for a relatively pure comparison of the organizational structures before and after the redesign because little else changed in the department at the time of the intervention.

Qualitative Data

Our first site visit was two months before the redesign and included a tour and explanation of the original work design and the developing pod system by the ED nursing director, as well as formal interviews with four hospital executives (the chief executive officer, chief marketing officer, chief financial officer, and chief nursing officer). Extensive qualitative data collection occurred six months after the redesign. The first author observed the pods in action for five three- or four-hour sessions, held informal conversations with ED leadership and staff during meals and between meetings over the course of a week, and conducted formal interviews with the ED leadership team (medical director, nursing director, assistant nursing director, operations specialist, redesign manager) and four frontline providers (two physicians and two nurses). Following an iterative process of reviewing relevant literature and analyzing the formal interviews and archival materials collected during the first visit, we conducted a second site visit one year after the redesign. The first author again visited the ED and observed the pod staffing process, the patient triage process, and several ED leadership meetings about patient flow. The first author and a research assistant each observed the pods for five three- or four-hour sessions. The first author and a research assistant also formally interviewed six attendings, six residents, and eight nurses. We judged that we had reached theoretical saturation because the answers to our interview questions were largely consistent across interviewees, and we were not gaining additional insight from additional interviews, even though the specific details, examples, and personalities varied (Strauss and Corbin 1990, p. 136). The ED represents a particularly institutionalized setting characterized by rigid work routines and strongly socialized professional role identities and responsibilities (Bartunek 2011, Pratt et al. 2006, Reutter et al. 1997). These characteristics are intended to reduce variability, so that any physician or nurse can step into any situation in the ED and carry out his or her role responsibilities. Eliciting similar substantive descriptions of coordination within such a regimented system was therefore not surprising. People also described working in the pods similarly at the 6- and 12-month interviews.

Our interview questions probed how people coordinated in the pods. Because there had been a recent redesign, people often explained their work activities in the pods using a comparison to the previous system (e.g., “Before I did not know who I was working with, but now my nurses are right there with me.”) These data should be interpreted as revealing the way that people understood the current system, not as a source of data about the previous system, because such retrospective sensemaking could be biased. One of our interview questions asked interviewees for an explicit comparison of the pods with the previous structures because we wanted to give the interviewees opportunity to raise issues not necessarily related to coordination in the pods, but we do not use the interview data to characterize the system and coordination behaviors in place before the pods. Instead, we use the interview data to understand the system that was in place at the time of the interviews (i.e., pods).

Qualitative Data Analysis

Our qualitative data analysis was informed by the background material, site visits, and observation mentioned above, but our formal qualitative analysis was focused on coding the recorded and transcribed formal interviews. After our initial visit and analysis of the pods, we adopted a high-level theoretical framework consistent with literature that suggests that organizational structures influence work activities (Barley and Kunda 2001, Hackman 2002, Hackman and Oldham 1980). We conducted line-by-line analysis of every quote to identify common ideas (Miles and Huberman 1994, Strauss and Corbin 1990). We used a research assistant to check our coding scheme on a selection of interviews (Yin 2003).

One part of our qualitative analysis focused on understanding how the descriptions of the structures related to existing literature. Through an iterative process, we realized that the new structures embodied the logic of role theory and team effectiveness research, and so we chose labels that reflected these literatures. For example, interviewees described the pods as having an explicitly designated group (which relates to the definition of a team boundary; see, e.g., Hackman 2002) and having “plug-and-play” roles (which typifies the research on role-based coordination; see, e.g., Klein et al. 2006). We then adopted a conceptual label (*bounded role set*) that related our data to the existing literature.

Findings from Study 1: Qualitative Analysis

We conceptualized the mesolevel structures as team scaffolds. As noted, the team scaffold consisted of a boundary, a role set, and collective responsibility for a whole task. Table 1 lists the dimensions of team scaffolds and presents representative data that supported this conceptualization.

Boundary

In this setting, the boundary included an actual physical barrier: a counter circumscribed the space within which nurses and doctors worked together. In contrast to the boundaries in stable teams (Hackman 2002), it was a deindividualized boundary defined by space and a set of roles, not by people; it did not help people know each other’s names or identities (we sometimes saw people introduce themselves after working in a pod together for an hour). But the boundary made it possible to quickly identify interdependent partners, even without knowing each other. One attending described how fluid the groups populating the pods were, saying, “It is a totally different team most of the time,” and a nurse explained how the boundary enabled people on these extremely fluid teams to identify each other: “It is not hard to keep track of who you are working with any more—you just look over and see who is in the pod with you.” People did not “look over” and necessarily recognize the individuals with whom they were working—rather, they looked over and accepted that the colocated person was on their team. Boundaries are often associated with enduring identity in communities and groups (Lamont and Molnar 2002). Thus the use of a deindividualized boundary—i.e., one that did not delineate specific individuals and therefore could not establish enduring identity—is intriguing, particularly because the deindividualized boundaries still ended up establishing a temporary in-group, discussed more below.

Table 1 Three Attributes of Team Scaffolds

Attribute	Definition	Representative data
Boundedness	It is explicitly clear who is part of the team at any time	"[Within a shift] I have a designated group of nurses [and] a faculty that's assigned to me." (Resident)
Role set	Group of interdependent deindividualized roles with the complement of skills needed to produce the joint deliverable	"If you have clearly defined roles and plug somebody else in who know what they're doing, it's going to continue to function fine." (Resident) "Who I work with is pretty random. That's kind of a good thing about coming to work. I don't know who I'm working with. I don't know where I'm working…whether it be Pod 1, or Pod 2, it's very 'carousel-ed' around." (Nurse)
Collective responsibility	Those on the team are responsible together as a group for their product or outcome	"Patients are assigned to [your] pod, and you own them, no ifs, ands, or buts." (Attending)

Role Set

Enclosed within this explicit boundary was a role set: a small group of roles with the complement of skills needed to accomplish shared work. A resident explained, "If you have clearly defined roles and plug somebody else in who knows what they're doing, it's going to continue to function fine." The difference is that the role *set* was small and bounded, in contrast to the large and unbounded role structures in place before the pod system, in which any combination of nurse, resident, and attending could work together. One resident described the difference he felt in working in a role set: "Working with a set group of nurses during your shift means you know whose attention you need to draw to something. You also know people's names a little better, to be honest, as silly as it sounds.… You learn their names, and you're getting them involved."

Collective Responsibility

Finally, the team scaffolds included collective responsibility for a whole task. As patients entered the ED, they joined the queue for a specific pod (rather than for the entire department), so that each pod had responsibility for a set of patients. The patient queue for each pod grew or shrunk depending on (among other things) how effectively the people populating the pod at a given time worked together. The pod's collective responsibility for a set of patients shaped how interdependence was experienced and enacted: providers became focused together on "moving patients out" (to discharge or hospital admission) and were interdependent in getting this done, rather than in simply executing separate role-based tasks.

Group-Level Coordination Behaviors

The team scaffolds supported group-level coordination processes to carry out patient care. Group-level coordination was made up of four major behaviors: prioritizing mutual effort, updating respective progress, holding each other accountable, and helping each other. These behaviors are reminiscent of tightly coupled coordination behaviors described in previous research, such as plug-and-play teaming (Faraj and Xiao 2006) or active communication to develop and update shared mental models (Bigley and Roberts 2001). The important feature of the behaviors that we describe is that they were newly focused on advancing group-level work.

Prioritizing Mutual Effort. Communicating information about priorities allowed small tasks with the potential for significant patient movement to occur before longer tasks that would not affect patients as quickly. One nurse described,

> If the docs need something urgent they'll say, "Hey, this is just the one last thing we need," and then I'm going to try to make that blood pressure happen before I go do something else that's going to take 10 or 15 minutes. I know that BP [blood pressure] can take two minutes, and then we can get somebody out of there.

Adjusting plans to accommodate each other's priorities was critical to group coordination in this setting, and it sometimes took extensive discussion to determine whose opinion about the highest priority should be followed. An attending explained,

> It takes a lot of communication to find the least sick patient and then to get consensus among the providers—nurses, [residents], and attendings—that that patient who may still feel ill and may have stuff going on is just less sick than the new person who came in and they've got to get out of that bed; you've got to get them discharged.

Interviewees reported that this kind of negotiation of priorities happened rarely before pods were implemented, because without the shared focus of the pod's patient queue, there was no way to think about, let alone discuss, competing priorities. A doctor might share six different patients with six different nurses, so there was no sense of group-level priorities.

Updating Respective Progress. People working together in a pod were likely to verbally ask for things, check up on requests, and confirm that something had been done. Some of the physicians referred to this as a feedback loop, which was part of the formal protocol for patients who "coded" (i.e., whose hearts stopped beating). In the pods, the feedback loops were adapted to an informal coordination dynamic as well. One of the residents explained,

> So much of what we do changes minute to minute. [The pods] allow us to interface with each other in the whole closed-loop communication. That really matters in what we do because priorities change constantly. If you can actually communicate that [priority change] to someone directly as opposed to putting an order in the computer, it makes a huge difference.... You give the order, someone repeats the order, and then you confirm that that's the right order.

Most interviewees described such feedback loops. A nurse said, "I would say [interactions like this happen] about 80% to 90% of the time for the people I work with. They're like, 'Hey, just to let you know, I've got this done,' and I'm like, 'Thanks.'" An attending offered a similar perspective: "On a good shift, there is a positive feedback loop verbally. There is a lot of verbal communication. People are telling each other what's going on." Frequent communication to update respective progress was felt to be largely absent before pods were implemented.

Holding Each Other Accountable. Having bounded partners and collective responsibility supported people in actively holding each other accountable. A nurse said,

> You definitely know who your team is. You know that you've got Doctor So-and-So and that he should be fairly close to your area, and you know how to get in touch with him if he's not...[it helps] knowing who you're accountable to that day and who's accountable to you.

Both nurses and doctors said that when progress was not made or when they were not updated on progress, they would verbally remind each other or ask that an account be given of why something had not been done. A resident said that when he would see "the human factor part of the job" as his nurses started to slow down toward the end of their respective shifts, he would "make that extra verbal, 'Hey, I really do need this done. Let's get these patients discharged.'" Holding each other accountable was not always effective, or amicable. An attending gave an example:

> A patient was having pain and needed a bunch of [tests sent to the laboratory]. I kept asking and asking and the nurse was like, "I'll get there; I'll get there," but it was two hours later, and nothing had happened. The patient was angry and I was kind of angry. The interactions are not that great when everybody starts getting angry at each other. Sometimes you get the eye-rolling like, "We're very busy"; I understand that everybody is busy, but on the other hand, we need to be proactive. I try to communicate that to the person.

Holding each other accountable was a group coordination process described by many interviewees. They felt that people did not actively or frequently hold each other accountable in the absence of the pods.

Helping Each Other. Another aspect of coordination in the pods was helping each other. Help was given by taking on someone else's responsibility, anticipating another clinician's need, or adjusting behavior to accommodate a recognized weakness. Residents described doing some of the nurses' duties if the nurses "were slammed." Another nurse suggested that they traded responsibilities to help each other out:

> I'll be like, "Hey, I'm having a really hard time sticking this lady. Would you go do this one? I'll go start your liter." Kind of just trading responsibility to help one another out. That way, it's not one person getting the brunt of work if someone else is struggling.

Table 2 reports additional data to illustrate group-level coordination in the pods.

Mechanisms Linking Team Scaffolds and Group-Level Coordination

Our data revealed that the team scaffolds supported group-level coordination by establishing accountability, belonging, and overlapping representations of work. Specific to our context, they also established competition and proximity. Table 3 reports representative data on these mechanisms.

Accountability. The pods established accountability because of the boundary and collective responsibility. People said that before the pods were implemented, they did not know who they were working with on their various patient cases, they did not know each other's names or faces, or they did not know how to find each other. The pod boundary made it explicitly clear who was on the team together and thereby established accountability. An attending explained,

> The pods make everybody responsible for a chunk of the ER [emergency room]. Your nurses are assigned. Everybody knows that you have to work and that makes everything more efficient. You cannot hide from the pod.

Accountability was also established because people in the pods had collective responsibility for a queue of patients. As a resident said, "You know all those patients are yours. Nobody else is going to come in and save you. There is nobody else that's going to come see your patients. Anybody who comes to your pod is yours." People were thus accountable to their designated team members and collectively responsible for a whole task (a shared queue of patients). A sense of accountability for their shared work made people feel entitled to ask each other for updates and established expectations that they would update their respective progress.

Overlapping Representations of Work. Having collective responsibility for a queue of patients meant that the nurses and doctors had overlapping representations of their work (Bigley and Roberts 2001, Weick and Roberts 1993). They were all focused on moving the same set

Table 2 Representative Data Illustrating Group-Level Coordination

Coordination behaviors	Representative data illustrating behaviors
Holding each other accountable	"You have one particular patient that's been in the waiting room, and it's out of sight, out of mind, but we say, 'This patient really needs to be seen. Can you see this patient? Why hasn't this patient been picked up? Why are you skipping over this patient?' It's part of the responsibility of the pod lead to gently remind the physicians." (Nurse)
	"Sometimes I have to say, after an hour and a half, 'Hello? Have you drawn blood on XYZ patient and, if so, what happened?' And they'll be like, 'Oops. She was a hard stick, and I couldn't get a line.' Then it's, 'Why wasn't I notified?' That's usually not a problem because they'll usually tell me first. I make it a point to say, 'Hey, let me know if there are problems, because I like to keep things moving.' " (Resident)
Updating respective progress	"There are all kinds of stuff communicated [in the pods] that weren't communicated before: 'Hey, I just added on some lines for the patient in 12 that I forgot to order initially. We need to get vitals on that guy. This new one just came in that I'm a little worried about.' We communicate constantly in the pod." (Resident)
	"But, little things like somebody needs a liter of fluid and some Zofran, gosh, anybody can do that. And it's all about, 'Hey, I'm going to grab that for Mr. Jones on Bed 8, and I'm heading over there now,' so they know you're doing this and they need to just take another order and go do it." (Nurse)
Prioritizing mutual effort	"If the docs need something urgent they'll say, 'Hey, this is just the one last thing we need,' and then I'm going to try to make that blood pressure happen before I go do something else that's going to take 10 or 15 minutes. I know that BP can take two minutes, and then we can get somebody out of there." (Nurse)
	"When things are going well, the orders pop up. We say to each other: 'There's three of them. You take that one, I'll take this one, and he's going to take that one.' It isn't a lot of, 'Well, that's not my patient. That's on your bed. You need to take care of that.' " (Nurse)
Helping each other	"Last night the nurse told me, 'I ordered an X-ray [on a routine patient].'...By the time I finished with my other patient, I could pull up the X-ray and tell that obviously there were no fractures....That helped me expedite her care." (Attending)
	"Most of the time when your patients are in a stable state and there's nothing at the moment that you can do for them, you try to find a patient who you can do something for, whether it be give medications or, if they're ready to be discharged, getting their paperwork together and kind of getting them out, because that can help." (Nurse)

of patients through care episodes. Overlapping representations enabled the people working temporarily in the pods to prioritize their efforts at the group level, rather than each person prioritizing within her own work flow. As illustrated above, a nurse or doctor would do a short subtask for a team member before starting a longer task, so that the group's queue of patients could be processed more quickly. Without overlapping representations, it would have been much more difficult to even think about mutual priorities, let alone negotiate them. One nurse explained,

> Beforehand, there may have been 15 orders, but nobody really—I don't want to say "cared"—"cared" is not the right word. But, if it took you 30 minutes to get a lab, it was fine. If it took you two and a half hours to do the same thing, that was fine, too. There was nobody monitoring things. There was this giant stack of orders, and you got to them when you got to them.

A nurse contrasted that dynamic before the pods were implemented with the ability to see together how work was progressing. She said, "With a smaller group being responsible for the whole package, you sort of know what's going wrong that day, and it's not just, 'Well, nothing is getting done anywhere,' throwing your hands up, and just ignoring it." Overlapping representations allowed for quick updates (e.g., "I've got this one, you got that one?") because referring to tasks and subtasks held in common was easy.

Belonging. Despite the extreme fluidity of the groups working together in the pods, there was an affective meaning attached to being on a team together—even temporarily—particularly for the nurses who had traditionally held lower status in the medical hierarchy. One nurse explained that, before the pods, "You had to walk across the ED and be all timid, 'Uh, excuse me?' " She continued, "Now [the doctors] are in the trenches with us." Another nurse agreed, "Now there is much more of a sense of ownership of each other. I'll say, 'My pod isn't running well. Where is my doctor?' And he'll be accountable to me." A resident said, "There's more a sense of camaraderie, a sense that 'these are my nurses.' " The sense of camaraderie and ownership arose from being assigned to a small group together for only a few hours and illustrates the social power of belonging together on, essentially, a pickup team.

Context-Specific Mechanisms: *Competition and Proximity.* In any work context, a team scaffold could plausibly establish accountability, overlapping representations, and belonging. Our data also revealed two mechanisms—competition and proximity—that arose

Table 3 Representative Data Illustrating Mechanisms Linking Team Scaffolds and Group Coordination

Mechanisms	Representative data illustrating behaviors
Accountability	"The best part of it is that you know who is there [working in the pods with you] and you know that all the patients are yours. Nobody else is going to come in and save you. There is nobody else that's going to come see a patient. Anybody who comes to your pod is yours." (Resident)
	"The pods make everybody responsible for a chunk of the ER, whereas, before it was you pick up the next chart and could go back and forth and kind of cherry pick. Right now, you have your beds, and you have your patients that are assigned to you. Your nurses are assigned. Everybody knows that you have to work and that makes everything more efficient. You cannot hide from the pod." (Attending)
Overlapping representations of work	"The sorting into teams helps too... it is helpful to have your little area to be able to sort of zoom in on." (Nurse)
	"You look at your small portion of the ER, and so you can say, 'Hey, all of your people are waiting a really long time for this. What's going on? What do you need from us?' The thing is that with a smaller group being responsible for the whole package, you sort of know what's going wrong that day, and it's not just, 'Well, nothing is getting done anywhere,' throwing your hands up, and just ignoring it." (Nurse)
Belonging	"Beforehand, I remember being like, 'Oh, let me see if I can go find Doctor So-and-So and ask him about this.' Now, you definitely know who your team is. You know that you've got Doctor So-and-So and that he should be fairly close to your area, and you know to get in touch with him if he's not... knowing who you're accountable to that day and who's accountable to you... it does keep things on track." (Nurse)
Proximity	"The pods put us all in closer physical proximity. That has created an increased comfort factor for approaching physicians. There's cramped quarters with more talking, more opportunity to overhear, more interjecting." (Nurse)
	"You're all sitting in the same area. Before you might be sitting at one end of the work station and the nurse would be 60–70 feet away. It facilitates a lot more communication when you're all sitting at the same station." (Resident)
Competition	"The way the Pods Wars play out is that someone will say 'Pod 4 is killing us!' and then the pace and intensity of communication will increase." (Resident)
	"Before there was much more of a comrade-in-arms attitude among the nurses, with the sense that everyone was getting hammered together so everyone [nurses] came to help. Now your pod may help you, but the other pods won't. If it isn't their pod's patient, they have less willingness to help." (Nurse)

from the pod design interacting with certain context-specific conditions that likely generalize to some but not all organizational settings.

First, the pods supported competition because there were multiple pods and real-time performance data. The competition was jokingly referred to among the ED personnel as the "Pod Wars." The performance metric used to determine who was winning the Pod Wars at any time was the number of patients in each pod's queue, visible through the computer system. The round-robin triage process contributed to this dynamic; each pod was supposed to be "dealt" the same number of patients, so if Pod 1 still had 25 patients when Pod 4 was down to 9, then it was said that Pod 4 was winning. Several people attributed the performance improvements to the urgency and quick work pace that came from the competitive dynamic between pods. One of the nurses explained that the competitive dynamic would play out when someone would say, for example, "Pod 1 is killing us!" and then everyone would increase work pace and communication.

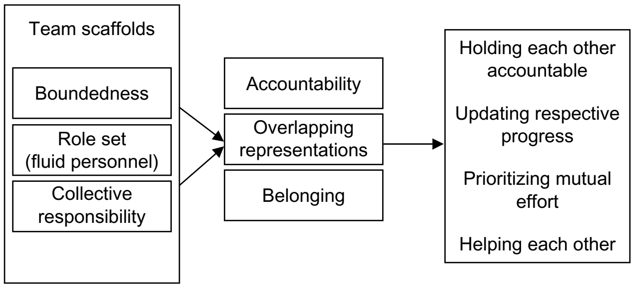
Many acknowledged another aspect to this competition that they viewed as problematic. The competitive dynamic sometimes prevented pods from helping each other across pods. A nurse explained,

> You hate to be in that pod that's losing.... If one pod is kind of getting killed there isn't a lot of cross-pod help. I feel like, before the pods, somebody was going to help whether they were in your area or not. I feel like, sometimes, now it's an "every pod for themselves" mentality, like, "Ooh, that sucks that you guys have three sick [patients]. I'm going to go take care of my [patient with] ankle pain."

The competitive dynamic between pods changed the temporarily salient in-group from the role group to the pod: a nurse in Pod 1 worked more cooperatively with the physicians in Pod 1 than nurses in other pods. Note that this dynamic played out between groups of people with constantly changing membership. There was no enduring affiliation for any individual with any given pod to explain the in-group competitive behavior. One attending explained, "It's pretty natural... if you were playing a pickup game of any sport, if you picked teams, it might be a different team every day, but people want to come together, bond together, and win." Competition as a mechanism linking team scaffolds and group coordination is specific to contexts with multiple teams and real-time performance metrics. Still, it highlights the salience of even temporary team membership. People accepted their place on the pickup teams and played competitively.

Second, the pods also ensured that the small bounded groups were colocated, which allowed people to

Figure 1 Conceptual Model



Notes. The conceptual model illustrates proposed relationships: team scaffolds establish accountability, overlapping representations, and belonging, which enable group-level coordination behaviors. Role sets accommodate fluid personnel.

communicate frequently and spontaneously. (We argue that roles can be bounded with shared work, even when not colocated.) Shared space has long been recognized to support communication (Allen 1977, Kellogg 2009). Our data complement that research and emphasize the importance of shared space for overcoming both social barriers and physical distance between role groups (Kellogg 2009). In summary, we found that the team scaffolds supported group-level coordination among fluid groups by establishing accountability, overlapping representations, and belonging—and, specific to our context, competition and proximity. Figure 1 depicts these relationships.

Study 2: Quantitative Data and Analysis

To better understand conditions under which role-based coordination is more or less effective, Study 2 presents a performance impact analysis of the pod implementation. Recall that nurses and doctors work interdependently to treat queues of patients. During our study period, the work flow changed from sequential pooled queuing (i.e., available nurses and physicians would separately draw their next patient from a "pool" of patients) to a team work flow (i.e., groups of nurses and physicians were assigned their own dedicated queue of patients; Van De Ven et al. 1976). Both the sequential and the team work flows were carried out by fluid personnel, made possible by the clearly defined roles. The sequential work flow lacked both predesignation of who worked with whom on each patient and collective responsibility for completing the whole episode of patient care. The rationale for the kind of pooled queuing originally used in the ED is avoiding idle time because the next available worker can immediately take on a task from the pooled queue (Benjaafar 1995, Houck 1987, Mandelbaum and Reiman 1998). Similarly, pooled queuing can prevent bottlenecks because handoffs are not delayed by waiting for a specifically designated partner to be ready.

Other recent operations research suggests that as a result of human factors, sequential pooled queuing does not work well when costs accrue from switching from one person to the next. For example, in work contexts where workers specialize, have discretion over which tasks to take when, or face interpersonal risks that inhibit interrole communication, sequential pooled queuing may not be effective (Hopp et al. 2007, Jouini et al. 2008, Nembhard and Edmondson 2006). Also, when tasks are complex and require significant information processing, sequential pooled queuing may be less effective; these tasks are effectively handled in a team work flow (Van De Ven et al. 1976).

We assessed human factor costs of switching flexibly between partners (in sequential pooled queuing) by examining the network formed by shared tasks. The network becomes more complex as people have more coordinating partners. If no human factors influence task flow through the network, then increasing network complexity (e.g., each nurse working with multiple doctors on multiple patients) would not negatively impact performance. In contrast—and as vividly illustrated in our qualitative data—if there are both cognitive demands from tracking multiple partners and interpersonal dynamics such as low accountability and inhibited communication across roles, then increasing network complexity would be related to decreased performance. In Study 2, we constructed a network based on nurses' and doctors' shared patients to show the performance effects of having multiple partners and few repeated tasks with those partners and to test whether the pods (and related team work flow) mitigated that complexity.

Quantitative Data

We used two-mode network data and methods to map and analyze the complex patterns of coordination in the City Hospital ED. In two-mode networks, actors are linked when they share an event (Borgatti and Everett 1997, Wasserman and Faust 1994). In this case, the actors are the nurses, residents, and attendings staffing the ED, and the shared events are the patient cases that various providers worked on together. Linking providers through shared patients provides a network of who coordinated with whom, and, importantly, it accommodates the complexities of our study—namely, that people worked together through multiple staggered shifts and that people worked together within two different work designs. Using network data and methods, we assessed structural changes in the pattern of who worked with whom to assess performance effects of the redesign. Linking providers through shared patients is methodologically similar to, but conceptually different from, constructing a network as commonly understood in the sociological literature, which focuses on relationship structures that last longer than a few hours. To differentiate from such networks, we refer to our constructed network as a *coordination pattern*. For another example of creating a network based on shared tasks, see Briscoe and Tsai (2011).

To construct the coordination pattern, we used operational data from the ED's electronic medical records (EMRs). Deidentified summary records (including time-stamped events) of every patient seen in the ED during the 18-month study period (6 months before the redesign and 12 months after the redesign) were merged with deidentified records of the providers affiliated with each patient case.

It was critical to identify the appropriate way to "slice" the data to create and test meaningful coordination patterns. We could use the time stamps to create networks based on who worked together over the course of a month, a day, or a shift. The most logical "slicing" for coordination patterns within shift work might be at the shift level because all of the people who could potentially work together would be contained in that time slice. The shifts at the ED are staggered, however, such that a clean shift break never occurs. We therefore decided to use a 24-hour period to create the slices of time within which to measure the coordination patterns. Using the list of possible shifts provided by the ED leadership, we determined that creating 24-hour slices of time starting at 7 A.M. would break up the fewest number of shifts, although there are still a few shifts that get split between two slices. We created the 24-hour slices by including any patient case with a triage time stamp after 7:00:00 A.M. on a given day and up to and including 7:00:00 A.M. the next day. Then, using the patient cases and providers identified within each 24-hour period, we developed a two-mode network for the 24-hour period that linked providers to their patient cases. Two 24-hour periods, one from before the redesign and one from after the redesign, matched on number of patients and providers, are shown in Figure 2. Coordination network patterns were illustrated using UCINET software (Borgatti et al. 2002).

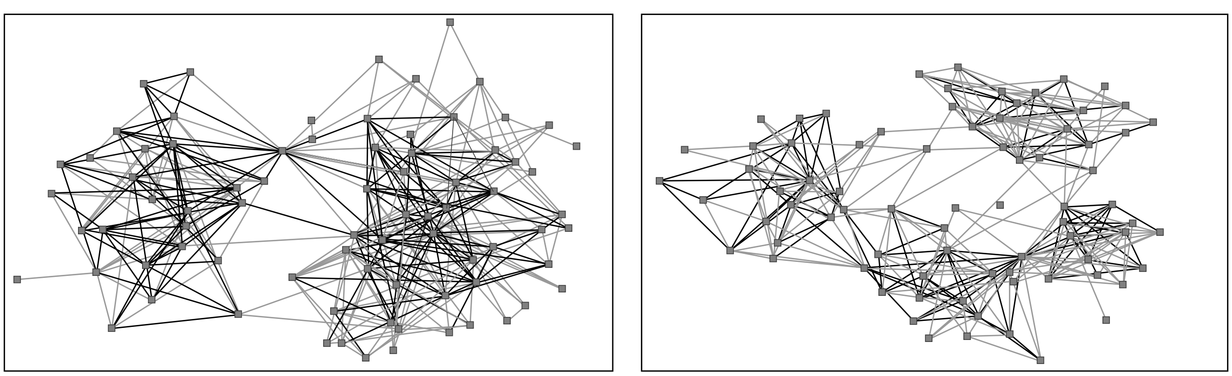
We used these 24-hour networks to calculate statistics about the provider-day—for example, how many partners the index provider had in a 24-hour period and the average length of stay across every patient the provider treated in that same 24-hour period. Using the provider-day as the unit of analysis allowed us to control for time invariant properties of the providers and also allowed us to control for changes in staffing patterns (e.g., how many providers staffed the ED before and after the redesign).

Six hundred twenty different providers worked at least one day during the 503-day study period. These providers worked, on average, 160 out of the 503 days. (The histogram of the number of days each provider worked showed a trimodal distribution, with one large cluster working fewer than 100 days, the largest cluster working around 200 days, and a small cluster working around 300 days.) There were an average of 75 providers for 251 patients (1:3.5) per 24-hour period before the pods were implemented and 81 providers for 321 patients (1:4) per 24-hour period after the pods were implemented. There were 139 days before and 394 days after the redesign. The total number of provider-days was 42,595.

Quantitative Measures

Patient Time in ED (Hours). A critical measure of ED performance is the time elapsed between when a patient arrived at and was discharged from the ED. Time in the ED is strongly correlated with patient outcomes (Casalino et al. 2012). We calculated the average time patients were in the ED for each provider for each 24-hour period based on the arrival and discharge time stamps in the EMRs.

Figure 2 Examples of Coordination Patterns Before and After the Redesign



One 24-hour period before the redesign.	**One 24-hour period after the redesign.**
291 patients, 81 staff (43 nurses, 12 attendings, 26 residents)	294 patients, 76 staff (38 nurses, 15 attendings, 23 residents)
Average ego size: 16.7	Average ego size: 13.1
Average throughput time: 7.9 hours	Average throughput time: 4.2 hours

Notes. Gray squares represent providers. Lines represent at least one shared patient case. The weight of each line (four possible weights) indicates the number of shared patients.

Pod Implementation. The pod implementation was designated by a dichotomous variable indicating time before or after the pod redesign.

Number of Partners. We calculated the number of partners with whom the index provider worked during a shift (i.e., ego network size) using the row count of nonzero entries in the projected affiliation matrix.

Repeat Collaborations. We calculated the number of patients that the index provider shared with each partner by averaging the values of the nonzero entries in the projected affiliation matrix by row.

Control Variables. We controlled for the level and shift changes related to different phases of the redesign: the pre-pod trend, up-staffing level and trend, training level and trend, and post-pod trend. We also controlled for the day of the week because acuity and volume vary by day (Arkun et al. 2010). We used the Hausman test to determine whether to include random or fixed effects; a significant value ($p < 0.001$) indicated that fixed effects were appropriate, and we included provider fixed effects in the model.

Quantitative Data Analysis

Using the provider-day as the unit of analysis, we conducted a segmented regression analysis to test the performance impact of the pod implementation. Segmented regression analysis of time-series data estimates how much an intervention changed an outcome by controlling for baseline, transition, and postintervention level changes and trends (Smith et al. 2006, Wagner et al. 2002). It is a form of interrupted time-series analysis, which is the strongest experimental design for evaluating longitudinal effects of time-delimited intervention (Cook and Campbell 1979). Autocorrelation, which violates the assumption of independent observations, is likely in consecutive time periods in an ED. The Durbin–Watson measure (0.93) indicated autocorrelation in our data, so we used Newey–West regression models to adjust standard errors. We analyzed whether number of partners and repeat collaborations mediated the relationship between pod implementation and time in ED with a Sobel and bootstrapping test (Baron and Kenny 1986, Edwards and Lambert 2007, Shrout and Bolger 2002, Sobel 1982) using Stata 13 commands *sgmediation* and *bootstrap sgmediation* (StataCorp 2013).

We also analyzed the effect of the redesign on quality of care. ED care quality is challenging to assess because "no single disease is assessed or treated. Instead, patients present with heterogeneous etiologies and pathophysiology, and treatment recommendations vary according to diagnosis" (Graff et al. 2002, p. 1097). In acknowledgement of the difficulty of assessing ED care quality, we took several steps to examine quality impact. First, we note that our main outcome variable (patient time in ED) is a strong predictor of clinical patient outcomes (Casalino et al. 2012, Singer et al. 2011). Second, we compared patient mortality before and after the pods were implemented using the EMR data. Third, we used Medicare.gov Hospital Compare website data sets (https://data.medicare.gov/data/hospital-compare), which report quality-of-care data for all Medicare-certified hospitals, to compare the rate at which standard processes of care (e.g., aspirin administered at arrival) were met for patients with acute myocardial infarction (i.e., heart attack), a condition typically treated in the ED.

Results from Study 2: Quantitative Analysis

Table 4 reports correlations and pre and post means for study variables. As expected, the pods were associated with significant changes in the coordination pattern: people worked with fewer partners during each shift and shared more patients with each partner. The coordination pattern thus captured the design of the pods, specifically bounded groups working together on a queue of patients. Note that people still worked with an average of 12 other

Table 4 Study Variables—Means and Correlations

		Pre-pod mean (SD)	Post-pod mean (SD)	1	2	3	4	5	6	7	8	9	10	11
1	*Patient time in ED*	**8.3** (1.6)	**5.3** (0.9)	1										
2	*Number of partners*	**17.1** (2.2)	**12.8** (1.9)	0.30	1									
3	*Repeat collaborations*	**2.7** (0.3)	**3.1** (0.3)	−0.32	−0.10	1								
4	*Diagnoses per case*	**1.5** (0.1)	**1.8** (0.1)	−0.22	−0.33	0.08	1							
5	*Pods*			−0.33	−0.69	0.10	0.62	1						
6	*Trend pre-pod*			0.23	0.55	−0.07	−0.41	−0.83	1					
7	*Trend post-pod*			−0.21	−0.41	0.09	0.66	0.66	−0.55	1				
8	*Up-staff start*			0.07	0.16	−0.02	−0.08	−0.33	0.54	−0.22	1			
9	*Up-staff trend*			0.06	0.14	−0.01	−0.08	−0.29	0.48	−0.19	0.87	1		
10	*Training start*			−0.01	0.15	−0.01	−0.07	−0.23	0.44	−0.15	−0.03	−0.02	1	
11	*Traning trend*			−0.01	0.11	−0.01	−0.05	−0.21	0.39	−0.14	−0.02	−0.02	0.88	1

Notes. Means are based on 24-hour periods for interpretability. Correlations are based on provider-day. Bold indicates significant differences in means ($p < 0.05$).

providers during a shift because of the fluidity of pod membership.

The pod system was significantly associated with improved patient throughput time. A decrease in average time in the ED occurred when the pod system training began and continued over the next year. This change was significant: even after controlling for various intervention phases, baseline trends, and other operational characteristics, the average time in ED was three hours shorter than before—a nearly 40% reduction in time from the previous average time of eight hours (Table 5, Model 1). Figure 1 in the online appendix (available as supplemental material at http://dx.doi.org/10.1287/orsc.2014.0947) provides more detail on the three-hour improvement in average patient time in the ED. When patient flow was managed through sequential pooled queuing, long time intervals elapsed between each step of the care process. In contrast, when patient flow was managed by teams, each step began sooner and sometimes in parallel (i.e., nurses and residents saw patients at the same time).

Next, we tested whether the network changes mediated the relationship between the pod system and improved average time in ED. Variables reporting the number of partners and average number of shared patients were entered in Table 5, Model 2. All coefficients are significant in the expected direction (i.e., having more partners and fewer shared patients is associated with longer average times in the ED). When both the indicator for the pod intervention and partners and shared patients were entered into Model 3, the coefficients on pods, partners, and shared patients were significant but attenuated. This result shows that having fewer partners partially mediated the relationship between pod implementation and the average time in the ED: 38% of the impact of the pods on the average time in the ED was related to the reduction in partners.

Table 5 Regression of Pod Implementation on Patient Time in ED (Hours)

Variable	DV = *Time in ED* Model 1	Model 2	Model 3
Pod implementation	−3.7243*** (0.1038)		−2.5433*** (0.1130)
Number of partners		0.2589*** (0.0087)	0.1527*** (0.0098)
Repeat collaborations		−0.8649*** (0.0137)	−0.8524*** (0.0136)
Diagnoses per case	0.2596 (0.1615)	−1.5197*** (0.1454)	−0.1449 (0.1569)
Pre-pod trend	−0.0052*** (0.0012)	0.0152*** (0.0009)	−0.0030* (0.0012)
Up-staff start	−0.4619* (0.2082)	−0.7930*** (0.1992)	−0.3805† (0.1989)
Up-staff trend	−0.0298† (0.0153)	−0.0402** (0.0147)	−0.0219 (0.0146)
Training start	−1.9774*** (0.2964)	−3.1915*** (0.2797)	−2.0136*** (0.2829)
Training trend	−0.0438 (0.0405)	0.0001 (0.0389)	−0.0301 (0.0387)
Post-pod trend	0.0003 (0.0002)	−0.0004† (0.0002)	0.0003 (0.0002)

Notes. $N = 42{,}595$ provider-days. Models control for provider fixed effects and day of the week. DV, dependent variable.
†$p < 0.10$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Table 6 Quality Metrics Before and After the Pod System Was Implemented (Percentage of Patients)

Quality metric	Before redesign	After redesign
Mortality in the ED	0.11	0.09
Mortality within 30 days of discharge following heart attack[a]	15.8	15.5
PCI within 90 minutes of arrival[a]	56	67
ACE inhibitor at arrival[a]	100	95
Aspirin at arrival[a]	98	97
Beta blocker at discharge[a]	99	98
Smoking cessation advice/counseling[a]	99	100

Note. ACE, angiotensin-converting-enzyme; PCI, percutaneous coronary intervention.
[a]These data are publicly reported quality data based on samples of patients; see https://data.medicare.gov/data/hospital-compare.

The pod implementation was not related to significant differences in quality of care, beyond improvement in average time in the ED (see Table 6). Patient death—a rare event in the ED—was not more prevalent after the redesign ($p = 0.422$). The Hospital Compare quality data reported that mortality within 30 days of being treated for a heart attack did not significantly change. Hospital Compare data are based on samples of patients and are reported at the hospital level, so they should be interpreted conservatively.

Discussion

In this study, we integrate team effectiveness research with research on role-based coordination to introduce and explain the effects of team scaffolds—mesolevel organizational structures that consist of a bounded role set with collective responsibility for a whole task—on coordination in temporary groups. Our conceptualization of team scaffolds extends research on role-based coordination by showing that role structures do not necessarily provide sufficient structure for effective coordination. When people do not know each other well, ad hoc unstructured collaborations in large groups can be overwhelming and ineffective. Role occupants can focus on their own role responsibilities at the expense of the overall task. Also, role groups can function as divisive in-groups that inhibit coordination between role occupants. We found that team scaffolds can mitigate these challenges by creating small groups of roles with shared work.

Team scaffolds enabled extremely fluid groups of people to engage in effective group-level coordination processes, such as mutually prioritizing their efforts, updating each other about their progress, holding each other accountable, and helping each other. By providing additional mesolevel structure, team scaffolds helped fluid personnel to function much like traditional teams, despite a lack of familiarity and practice. Our research thus elucidates mechanisms that enable independent individuals to cohere into a temporary interdependent performing unit; this new process theory (as depicted earlier in Figure 1) helps explain factors enabling coordination in fluid teams. Using operational data to assess the impact of the pods on the coordination patterns and performance in the ED, we found a 40% improvement in patient throughput time. This performance difference was explained in part by the mesolevel constraints on the coordination patterns that resulted in fewer partners and more shared patients with each partner.

Potential Trade-offs in Team Scaffolds

There are trade-offs to using bounded groups rather than individuals as the unit of work and the mechanism of coordination. For instance, when patient volume is low in an ED, it may be easier to flexibly reduce individual shifts than to shut down entire pods. Furthermore, it is less costly for an individual to sit idle than for a whole pod to sit idle. This trade-off was not particularly salient for City Hospital, because they had more patients seeking ED care than they could treat (before the pods were implemented, an average of 10% of patients left without being seen because of delays), and the staff were rarely idle because of low patient volumes. Pods may not be efficient for EDs or other contexts at risk for low work volume.

Another trade-off presented by the use of a team scaffold is that the boundary constrains interactions across groups. In the ED we studied, the attending physicians felt this most acutely, because they no longer interacted with each other. Instead, they had to hear from the residents and nurses in their pod about how the other attendings handled different situations. Counterbalancing this loss, team scaffolds may improve interprofessional relationships. For instance, in the ED, the pods created temporary shared in-groups that bound nurses and doctors together—so much so that they felt competitive with other pods. Their temporary identification with a pod rather than with their professions is noteworthy given the professional divide between physicians and nurses (Bartunek 2011) and given the hyperfluidity of the pod membership. To those working in this particular ED, it seemed natural, though; as the one attending expressed, “If you were playing a pickup game of any sport, if you picked teams, it might be a different team every day, but people want to come together, bond together, and win.”

Contributions to the Literature

Overall, this study extends the research literatures on role-based coordination and team effectiveness. Our findings are compatible with research on role-based coordination, which focuses on how role structures enable coordination among extremely fluid groups (Bechky 2006, Bigley and Roberts 2001, Faraj and Xiao 2006, Klein et al. 2006). Our findings complement this general model and add to it by leveraging a work redesign to explore the effectiveness of different ways of organizing roles structures. Our research suggests that temporary role-based groups may coordinate more effectively when interdependent people are clearly bounded into meaningful groupings and explicitly share responsibility for a whole task—designs reminiscent of those advocated by team effectiveness theory.

Our findings also relate to an emerging theme within team effectiveness research that recognizes that the team mode of coordination can take myriad forms (Van De Ven et al. 1976, Wageman et al. 2012). Prior research has emphasized that one of the main benefits of teams is that team members get to know each other’s strengths, weaknesses, expertise, and abilities (Hackman 2002). The present study and other contemporary studies are beginning to identify the benefits of team types where that kind of familiarity is not possible. For example, recent research examined fluid work teams (Hackman and Katz 2010, Huckman et al. 2009), multiple-team memberships (O’Leary et al. 2011), and extreme action teams (Klein et al. 2006, Vashdi et al. 2013). Our study suggests that even as team membership becomes more fluid, other dimensions of team design such as boundedness and collective responsibility still may prove useful for promoting effective team functioning (because they establish accountability, for example). We expect that various mesolevel structures could enable temporary arrangements of workers to effectively coordinate their actions, and we hope future research extends our findings including other settings such as professional firms and global or virtual work.

The pod system we studied is similar to other work systems in which team structures are used to facilitate coordination among interdependent and functionally diverse workers. Integrated product development (IPD) often organizes manufacturing and design into cross-functional teams (CFTs) (e.g., Adler 1995, Gerwin and Barrowman 2002). Similarly, repair cells often organize repair and maintenance into CFTs (e.g., Mayer et al. 2008). Similar to the pods, these CFTs enable mutual adjustment focused on an overall deliverable (Adler 1995, Van De Ven et al. 1976). Yet CFTs—even with more stability of membership than the pods—have not uniformly and significantly improved performance in these other work settings. A meta-analysis of IPD research similarly showed that cross-functional teams were only moderately correlated with improved development time and were not correlated with improved goal achievement (Gerwin and Barrowman 2002).

Why then did our research show such strong performance results from team scaffolds compared to mixed results found in the CFTs literature? We propose two compatible explanations. First, when CFTs are used in an organization, their design and implementation can vary greatly, and this variation is likely to affect their performance impact. Similarly, with only one site, our research has an important limitation, and strong conclusions about the performance effects of team scaffolds cannot be drawn from a single study. As we noted, the City Hospital ED had especially poor baseline performance relative to other EDs. Additional research into variance in the design, implementation, and functioning of such scaffolds is needed. Second, the nature of the work accomplished by IPD teams and other CFTs, compared with the work done in our site, suggests that the two structures differ in important ways. The division of labor between nurses and physicians is well specified (and in some cases set by policy or law). Although nurses do provide information to physicians, physicians are responsible for the cognitive tasks of making decisions about diagnoses and disposition (Thomas et al. 2003). Thus, the need for knowledge integration to accomplish the work in the pods is lower than in IPD teams or other CFTs. The main ED performance challenge is the need for fast-paced coordination that is responsive to varying patient acuity and patient flow (Argote 1982), which the pods addressed by facilitating group-level coordination.

Conclusion

Our research suggests that even when team membership stability is not feasible, other dimensions of traditional team structures, such as boundedness and collective responsibility, can be adapted to facilitate group coordination. The organizations of the future will continue to encompass fluid, fast-paced, interdependent work. Understanding the conditions and practices that facilitate effective coordination and teamwork despite these challenges remains a crucial area for theoretical and practical advances.

Supplemental Material

Supplemental material to this paper is available at http://dx.doi.org/10.1287/orsc.2014.0947.

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Endnotes

[1]In the research literature, two main categories of team structures have been studied. One category of team structures is the *intrateam* structures such as *within team hierarchy* or *specialization* (see Bunderson and Boumgarden 2010). A second category of team structures is structures that set up a group of people to function as a team. Our use of the term "team structure" relates to this second category.

[2]Okhuysen and Bechky (2009) use the term "scaffolding" in a broader sense to refer to objects in organizations (e.g., maps of interdependencies) that help people coordinate.

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