

# Learning in Temporary Teams: The Varying Effects of Partner Exposure by Team Member Role

Song-Hee Kim,<sup>a</sup> Hummy Song,<sup>b</sup> Melissa A. Valentine<sup>c</sup>

<sup>a</sup>SNU Business School, Seoul National University, Seoul 08826, South Korea; <sup>b</sup>The Wharton School, University of Pennsylvania, Philadelphia, Pennsylvania 19104; <sup>c</sup>Department of Management Science and Engineering, Stanford University, Stanford, California 94305

Contact: [songheekim@snu.ac.kr](mailto:songheekim@snu.ac.kr),  <https://orcid.org/0000-0002-3106-5726> (S-HK); [hummy@wharton.upenn.edu](mailto:hummy@wharton.upenn.edu),  <https://orcid.org/0000-0003-1335-9314> (HS); [mav@stanford.edu](mailto:mav@stanford.edu),  <https://orcid.org/0000-0001-7517-4054> (MAV)

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**Abstract.** In many workplaces, temporary teams convene to coordinate complex work, despite team members having not worked together before. Most related research has found consistent performance benefits when members of temporary teams work together multiple times (*team familiarity*). Recent work in this area broke new conceptual ground by instead exploring the learning and performance benefits that team members gain by being exposed to many new partners (*partner exposure*). In contrast to that new work that examined partner exposure between team members who are peers, in this paper, we extend this research by developing and testing theory about the performance effects of partner exposure for team members whose roles are differentiated by authority and skill. We use visit-level data from a hospital emergency department and leverage the ad hoc assignment of attendings, nurses, and residents to teams and the round-robin assignment of patients to these teams as our identification strategy. We find a negative performance effect of both nurses' and resident trainees' partner exposure to more attendings and of attendings' and nurses' exposure to more residents. In contrast, both attendings and residents experience a positive impact on performance from working with more nurses. The respective effects of residents working with more attendings and with more nurses is attenuated on patient cases with more structured workflows. Our results suggest that interactions with team members in decision-executing roles, as opposed to decision-initiating roles, is an important but often unrecognized part of disciplinary training and team learning.

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## 1. Introduction

In recent years, many industries have come to rely on temporary teams to accomplish complex, high-value work (Edmondson and Nembhard 2009, Huckman et al. 2009, Mortensen and Haas 2018, Kerrissey et al. 2020). This trend has been attributed to several factors, including new Internet communication technologies that facilitate the assembly of temporary teams, as well as new macro-employment models where people pursue career paths that span projects, organizations, and industries (Cappelli 1999, Klein et al. 2006, Benkler 2017). These temporary teams are often composed of members who may have not worked together before and who are assembled on demand for short-term engagements that require them to coordinate tightly coupled and complex work. Examples of temporary teams used in different industry settings include innovation project teams (Dugan and Gabriel 2013), crowdsourced “flash teams” and “flash

organizations” (Retelny et al. 2014, Valentine et al. 2017), “tour of duty” start-up teams (Hoffman et al. 2013), “fluid” project teams (Staats and Upton 2011), and ad hoc virtual teams (Crisp and Jarvenpaa 2013). Temporary teams are also now common in professional service industries including healthcare, consulting, and law (Weinberg et al. 2011, Gardner and Valentine 2015). These many examples of temporary teams can be differentiated by the “pool” of potential team members from which the temporary team is assembled and the duration and structure of the focal teams' work together (Bechky 2006, Salehi et al. 2017, Twyman and Contractor 2019). These industry trends prompt the need for research about the effectiveness of temporary teams that operate with extremely fluctuating membership (Hackman and Katz 2010).

A substantial research literature explores the ways in which various team characteristics contribute to effective teamwork and improved team performance.

This research examines topics spanning from collective intelligence (Woolley et al. 2010, 2015; Riedl and Woolley 2017), conflict (Jehn 1995, de Wit et al. 2012), network structure (Cummings and Cross 2003, Reagans et al. 2004, Balkundi and Harrison 2006, Sackett and Cummings 2018), and psychological safety (Edmondson 1999, Siemsen et al. 2009), among others. One of the most consistent and replicated results in this literature is that the amount of team members' prior shared experiences—sometimes called team familiarity—is associated with the team's performance (Katz and Allen 1982, Reagans et al. 2005, Espinosa et al. 2007, Staats 2012, Ramachandran et al. 2022). This result is particularly relevant for temporary teams, whose members are likely to have varying levels of familiarity or shared experience (Huckman et al. 2009, Huckman and Staats 2011, Cattani et al. 2013).

Recently, some studies broke new conceptual ground in this research area. These studies examined the implications of staffing teams to optimize team familiarity on other potentially useful properties of teams, such as the availability of team members (Salehi et al. 2017) or the opportunity for team members to learn from exposure to many new partners across repeat participation in temporary teams (Akşin et al. 2021).

In this paper, we develop new understanding about how team members learn from each other in temporary teams by examining the effects of partner exposure for teams with differentiated roles and authority structures (Wageman and Fisher 2014). In such teams, the team leader often has full decision-making authority, whereas team members only have authority to execute the team leaders' decisions (Edmondson et al. 2001a, Hackman 2002, Wageman and Fisher 2014). Team members' experience being in a decision-initiating versus decision-executing role will shape the ongoing interactions that produce learning from many partners, but this area has not yet been explored in extant research on partner exposure in temporary teams. In addition, team members in many temporary teams are also differentiated by skill. Cross-discipline partners have highly specialized tasks and skills and strong role differentiation (Bechky 2006, Klein et al. 2006); this role differentiation matters for team learning because team members are not learning to do the same work as their teammates. Rather than being exposed to a member of their own profession carrying out the decisions and tasks that they themselves will do, they are learning to react to and adjust to other professions' decisions and tasks. In addition, trainees are very early in their careers and thus need to learn basic skills and role expectations, which further shapes the kinds of learning interactions in which trainees and their partners will engage.

We analyze the effects of partner exposure for differentiated roles on temporary teams by leveraging the archival data in the electronic health records

(EHRs) of a hospital emergency department (ED). In many hospital EDs, temporary teams of attendings, nurses, and residents are formed ad hoc every shift, with no particular staffing policy. We leverage this team assignment and the round-robin patient assignment to these teams to cleanly identify the effects of partner exposure and team familiarity for differentiated roles. We focus on time to disposition as the main measure of team performance in the ED. We use these data and this empirical setting to answer the following research questions. What are the effects of team familiarity and partner exposure on performance? Do the effects of partner exposure vary by role? In addition, are these effects moderated by structured workflows?

We obtain the following results. We find a negative performance effect of both nurses' and resident trainees' partner exposure to more attendings and of attendings' and nurses' exposure to more residents. In contrast, both attendings and residents experience a positive impact on performance from working with more nurses. The respective effects of residents working with more attendings and with more nurses is attenuated on patient cases with more structured workflows. Our results suggest that interactions with team members in decision-executing roles, as opposed to decision-initiating roles, is an important but often unrecognized part of disciplinary training and team learning.

## 2. Related Literature and Hypothesis Development

Many contemporary work settings are structured around temporary teams that come together for one or a few tasks before disbanding. Typically, team members are drawn from some larger workforce, such as an incident command staff (Bigley and Roberts 2001), a larger industry such as film or construction (Goodman and Goodman 1976, Bechky 2006), or a clinical department or staff (Faraj and Xiao 2006, Klein et al. 2006, Akşin et al. 2021). Many researchers have explored the conditions under which temporary teams are able to effectively accomplish their complex, often mission-critical work. This research shows that temporary teams as a work structure offer particular challenges and benefits, especially related to how the teams are staffed or composed (Edmondson and Nembhard 2009, Twyman and Contractor 2019). People working in this kind of workforce tend to experience low team familiarity and high exposure to new teaming partners. Within this stream of research, many empirical studies have demonstrated the performance effects of *team familiarity* (Espinosa et al. 2007, Huckman et al. 2009, Huckman and Staats 2011, Avgerinos and Gokpinar 2017, Avgerinos et al. 2020, Niewoehner et al. 2022). Yet, to date, few empirical studies have cleanly identified the performance effects

of *partner exposure*—even though several relevant theoretical frameworks have recognized the possible learning benefits from exposure to more teaming partners (Edmondson and Nembhard 2009, O’Leary et al. 2011, Myers 2018). Partner exposure is defined as the number of distinct partners that a focal team member has worked with during a given time period. In this section, we review the well-established literature on team familiarity and then draw together several research streams to develop ideas related to partner exposure in temporary teams where the roles are differentiated by both skill and authority.

## 2.1. Team Familiarity and Performance

Team familiarity is defined as the amount of shared experience that team members have accumulated in working together on a focal task or project (Espinosa et al. 2007, Huckman et al. 2009). This structural property of teams emerges from prior team staffing patterns and is particularly relevant to temporary teams, which are teams that are typically short lived and characterized by highly fluid membership. A well-documented empirical result from the prior literature is that team familiarity has a significant impact on team performance—that is, how well a team performs new work depends on how much work experience members have accumulated together in the past. For example, in the context of software development teams, Huckman et al. (2009) finds that an increase in team familiarity leads to a reduction in defects and an improvement in schedule adherence. Espinosa et al. (2007) also use the context of software teams to illustrate that when it is challenging to coordinate the team (e.g., because of size or geographic dispersion), team familiarity is even more helpful in improving performance. In the context of the film industry, Cattani et al. (2013) illustrates that team familiarity can mitigate the negative effects of having too many stars on the same team. The few negative effects of team familiarity demonstrated to date include hampering creative performance (Ramachandran et al. 2022), increasing surgical duration but at higher levels of shared experience whereas lower levels were helpful (Luciano et al. 2018), and over many years reducing search outside of the team (Katz and Allen 1982). Some of this prior literature has examined team familiarity in the context of relatively stable teams. In contrast, we focus on temporary teams, in which team members frequently and quickly come together for a discrete task and then disband and reassemble with a different set of team members for the next task. This is relevant to how most healthcare settings operate. Specifically in this setting, prior work has shown team familiarity to be associated with shorter surgical operative time (Reagans et al. 2005, Xu et al. 2013, Avgerinos and Gokpinar 2017), shorter lengths of stay

(Patterson et al. 2015, Valentine and Edmondson 2015), and lower healthcare costs (Agha et al. 2021). Avgerinos et al. (2020) differentiate between horizontal familiarity (among peers) and hierarchical familiarity (across status differences) and find that there are greater gains from team familiarity in the absence of hierarchical relationships.

Consistent with this extensive prior literature, we expect team familiarity to positively impact team performance in our context of ED physician-nurse teams. Physicians and nurses who have had more experience working together in the past are likely to have more shared experiences that enable them to quickly synchronize their understanding of and responses to changing situations (Mathieu et al. 2000, Luciano et al. 2018, Yuan et al. 2018), resonant mental models of their respective skills and weaknesses (Lewis 2004, Zhang et al. 2007, Ren and Argote 2011), common language for talking about problems and solutions (Thompson and Fine 1999), and trust and psychological safety to facilitate knowledge sharing (Edmondson 1999, Siemsen et al. 2009). These relational qualities enable team members to coordinate faster, without sacrificing quality care. Consistent with this prior research, we hypothesize the following.

**Hypothesis 1.** *Team familiarity is positively associated with team performance.*

## 2.2. Partner Exposure and Performance

Relative to the prior research on the effects of team familiarity on performance, the empirical literature on the effects of *partner exposure* on performance is much less developed. Nevertheless, partner exposure is also an important structural property of temporary teams that arises from staffing patterns, and one that managers may need to trade off against team familiarity. Take, for example, an extreme case, in which a manager chooses to always keep one team together. In this scenario, these team members will have a high level of team familiarity but a low level of partner exposure, because they will not have worked with other partners, who could have been a source of learning. Familiarity and partner exposure are related but not strongly correlated. For example, a physician-nurse dyad may be new to working with each other, so have zero familiarity with each other, but the nurse may have also worked with many other physicians and the physician may have high familiarity scores with one or two other nurses. These simple examples illustrate that to fully understand the performance implications of how temporary teams are staffed, the effects of partner exposure should be considered alongside team familiarity.

To our knowledge, Akşin et al. (2021) is the only study to date that empirically measures the performance effects of partner exposure together with team familiarity in temporary teams. The authors study

ambulance transport teams, each of which is comprised of two paramedics, to examine how partner exposure and team familiarity affect team performance. The two paramedics were relative peers—neither was in formal training nor required supervision. Their study finds that both partner exposure and team familiarity positively impact the efficient performance of the transport teams, and that the benefits of partner exposure outweigh that of the benefits of team familiarity in this context. As such, they recommend that managers in this setting should prioritize maximizing partner exposure when staffing the transport teams. This study importantly broke new conceptual ground in the research conversation on temporary teams by considering the performance effects of partner exposure. Yet, its scope was limited to developing and testing new theory about teams comprised of team members who are peers. In contrast, temporary teams in many settings are comprised of team members who occupy specialized roles that are differentiated by authority and skill (Sundstrom et al. 1990, Klein et al. 2006, Hollenbeck et al. 2012, Avgerinos et al. 2020). One key role is the formal leader who has full authority to make or initiate decisions (Wageman and Fisher 2014). The team leader has the autonomy to exercise their professional judgement as they see fit, whereas other team members, including trainees and other team members, “have authority only for *executing* the tasks” (Hackman 2002). More needs to be understood about whether trainees and other team members learn from exposure to many team leaders who initiate decisions, and whether team leaders learn from being exposed to many teammates who execute decisions as well.

Our aim in this paper is to develop and test hypotheses for how those in decision initiating roles versus decision executing roles on temporary teams benefit from partner exposure. To connect to and extend Akşin et al. (2021), we begin by reviewing conceptual arguments for the known result about peer team members, and then develop and test new hypotheses.

**2.2.1. Partner Exposure Involving Peers.** Peer team members belong to the same ‘community of practice’. Community of practice is a conceptual label used in the research literature to refer an occupational or professional group where members learn by interacting together (Lave and Wenger 1991, Wenger 1999). A key idea advanced by this literature is that workplace learning tends to be situated and social, meaning that people learn as they interact with each other as they carry out their actual work in the relevant situations. A classic example comes from Orr (1996), who studied how technicians learned on the job. His study showed that learning by reading manuals or documentation was rarely relevant or helpful. Instead, technicians learned from each other as they interacted on the job, developing

informal, situated, and relevant understandings of each problem they encountered. To do this, the technicians embarked on what Orr (1996) referred to as a storytelling process of problems each had experienced before that might have relevance to interpreting the current problem; learning involved the technicians interacting around “narration,” “collaboration,” and “social construction.” Later studies built on these ideas and similarly demonstrated that learning is social, interactive, contextual, often involves narration or storytelling to interpret and explain ideas, and unfolds within communities of practice (Brown and Duguid 1991, 2001; Wenger 2000; Duguid 2005; Beane 2019).

When considered in light of this research literature, the results from Akşin et al. (2021) make sense. The ambulance transport teams were peer partners in the same community of practice. They shared a common problem space, a shared set of tasks, and had access to a shared set of stories and practices that could be used to interpret and understand the unexpected and ambiguous scenes they encountered. Each new partner had a different set of experiences from which the other could learn. The more exposure that any paramedic gained to new partners, the more varied practices they observed being applied in practice. In addition, they had a mature understanding of their field and could then generalize varied practices and choose among or synthesize the best practices at their next scene. This effect of partner exposure was a significant boost to performance, above and beyond simply accumulating additional experience on the job. Among peers within communities of practice, we expect that new partner exposure is likely to be commonly advantageous. (Zaheer and Soda 2009, p. 3) argue that a “heterogeneity of new ideas, processes, and routines” from past experiences can be a valuable source of individual and team learning.

**2.2.2. Partner Exposure Vis-à-Vis Team Leaders.** In contrast to the setting in Akşin et al. (2021), many temporary teams are not comprised of peers, but rather include a team leader, trainees within the team leader’s community of practice, and cross-discipline partners. This kind of team role structure does not involve learning from peers. The team leader has full autonomy to exercise their professional judgement as they see fit, whereas other team members (including trainees and other team members) “have authority only for *executing* the tasks” (Hackman 2002, p. 52). Those in decision-executing roles and trainees get exposure to many different team leaders who are issuing the formal orders, and this authority structure may shape how much they are learning from exposure to many team leaders. The team leaders and cross-discipline partners are exposed to many different trainees who are early in their training, who, unlike the paramedic teams described in Akşin et al.

(2021), may be still learning some of the basic content and skills of their profession. In addition, the team leaders and trainees are interacting with many cross-discipline partners, where the interactions involve them issuing formal orders that the decision-executing partners then carry out. We now draw on prior literature to develop new arguments about how each dyad in this role structure might be influenced by higher levels of partner exposure. Our research methods allow us to cleanly identify these causal effects, and future research can more fully substantiate the specific mechanisms as offered in prior literature.

First, we consider whether trainees and cross-discipline partners learn from exposure to many different team leaders. This argument involves considering how people learn from authorities and across disciplinary boundaries. In many temporary teams, the team leader holds the authority for decision-making about the teams' plans and courses of action, whereas the other members execute on those decisions and plans. Temporary teams with this authority structure tend to have well-defined hierarchies. In cardiac surgery teams, for example, physician decision making is generally "hierarchical, demanding, and direct" (Edmondson et al. 2001a, p. 704). The team leader in this authority structure can view the team as support systems for them as individuals (Wageman and Fisher 2014). Edmondson et al. (2001b, p. 128) quote a cardiac surgeon saying, "Once I get the team set up, I never look up [from the operating field] ... it is they who have to make sure that everything is flowing." In another example, trainees in the ED were described to us by several informants as "servants" of the attendings. This kind of tight unilateral control of the decisions that set other people's work in motion is common in the medical profession (Nembhard and Edmondson 2006).

There are several reasons why team members may struggle to learn from exposure to many team leaders in the context of this authority structure. Extensive research has shown that the full decision-making autonomy of the team leaders results in significant practice variation (Davis et al. 2000, Grytten and Sørensen 2003, Corallo et al. 2014, Valtchinov et al. 2019). Different team leaders will make different decisions, even when facing similar situations, and will have different preferences and styles for whether and how they narrate their decisions to trainees and other team members (Manojlovich 2005, Nembhard and Edmondson 2006, Robinson et al. 2010). These differences in practice and communication style may complicate trainee and cross-discipline partners' ability to generalize lessons from the variation they encounter across team leaders. Research has shown that people's learning is complicated by situations where variation between cases is not a reliable pattern that carries

meaning (Williams et al. 2010). In this case, cross-discipline partners and trainees may struggle to anticipate the next team leader's practice preferences and decisions, leading to slower processing, rather than quicker processing that comes from being able to anticipate what will happen next because of reliable repeat patterns.

Moreover, the hierarchy between the decision-initiating and decision-executing roles might inhibit the kind of ongoing dialogue that includes room for asking questions or narrating full decisions. One study quoted a nurse describing an interaction with a physician that involved "little information exchange," which would have supported her ability to learn from the case and possibly improve performance on later cases (Weller et al. 2008, p. 385). Many studies show that within a group, the mere presence of hierarchy—which can be beneficial for efficient coordination—inhibits low-status actors' ability to engage in the critical cognitive states and behaviors needed for experimenting and learning new ideas (Brooks 1994, Keltner et al. 2003, Foldy et al. 2009). In addition to the socially inhibiting effects of hierarchy on learning, the authority differentiation also limits trainees and other team members' sense of ownership of the decision process (Alexander et al. 2005, Lemieux-Charles and McGuire 2006, Greer et al. 2018, Greer and Chu 2020). Ownership is a useful cognitive state for learning (Druskat and Pescosolido 2002). However, as "order-takers," trainees and other team members are not necessarily engaging their minds on understanding the reasons for different decisions, but instead figuring out how to carry out the orders they are given. Finally, when facing practice variation but limited space and safety to engage in dialogue about it, team members may develop personal attributions about each team leader's varying practice styles rather than necessarily learning generalized best ways to handle future cases (Roussin 2008, Walumbwa and Schaubroeck 2009, Kim et al. 2021).

Furthermore, decision-executing roles are occupied by members of different disciplines, such as nurses working with many different attendings. Their different disciplinary training and socialization further complicates learning from many partners, especially within this authority structure. Cross-discipline partners will need to pay attention to different information to carry out their specialized work—they will be invested in different practices and identities around what they do to address different problems, and they will have a different language and culture for describing their different interpretations (Dougherty 1992). Different disciplines tend to understand the intricacies and details of their own practices but gloss over the complexities underlying other groups' practices (Alderfer 1980, Dougherty 1992, Bresman and Zellmer-Bruhn 2013). Specific to medical teams, doctors and nurses have been shown to have

different perceptions of many practices including “documentation practices, how reports on patients were provided and received during patient handoffs, daily schedules, unit routines, and methods of communicating with one another” (Benike and Clark 2013). These “silos” within disciplines develop early in professional training and are often reinforced by professional cultures (Bartunek 2011).

In sum, the authority structure in many temporary teams is likely to support practice variation and may inhibit the kind of interactions that support learning across varied cases. Trainee team members and cross-discipline partners in decision-executing roles may struggle to anticipate the preferences and decisions of a subsequent team leader on their next focal case based on their interactions with many prior team leaders. Summarizing the literature laid out previously, we state the following hypotheses.

**Hypothesis 2a.** *Cross-discipline partners’ exposure to more team leaders is negatively associated with team performance.*

**Hypothesis 2b.** *Trainees’ exposure to more team leaders is negatively associated with team performance.*

**2.2.3. Partner Exposure Vis-à-Vis Decision-Executing Partners.** Next, we can also consider whether trainees and team leaders benefit from partner exposure as they interact with more people working in cross-discipline decision-executing roles, such as attendings and residents learning from working with more nurses. Because of the medical hierarchy (Baggs and Schmitt 1997, Muller-Juge et al. 2013), trainees have more formal medical decision-initiating authority than the nurses, who have their own essential specialized professional training related to executing the medical decisions. However, trainees, being so early in their learning process, are still relying heavily on ongoing narration, interpretation, and clarification to make sense of new situations and problems. This kind of learning will likely involve ongoing, informal iterative questions and answers and might be basic compared with what an advanced member of their own profession might consider to be relevant to their professional realm. In this case, we argue that the nature of the nurse-resident role relationship, which puts them together “at the scene” more often, is more likely to offer these kinds of interactions. Many studies have begun to document the informal learning that nurses provide to residents, including helping them understand their new role as a physician, helping them understanding the professional hierarchy, and developing new skills; this learning was gained on-the-fly through interactions rather than through formal teaching (Burford et al. 2013). A time-and-motion study showed that attendings move about the ED less

than residents and nurses; residents and nurses were more likely to be going to the patient bedside and interacting there (Hollingsworth et al. 1998). The residents will clearly learn some things during the formalized professional interactions with attendings, such as formal rounding. But resident trainees may also learn through ongoing iterative interactions with nurses at the bedside or in the hallways as they are moving around to carry out the plan of care. Workflow studies in medical teams have characterized the highly interactive nature of the resident-nurse relationship, for example, with nurses making suggestions, reflecting and verifying the residents’ thinking, and sometimes even taking the lead in cases where the resident seemed to be struggling to do so (Baggs and Schmitt 1997, Lingard et al. 2004, Piquette et al. 2009, Muller-Juge et al. 2013). Related studies have shown that nurses sometimes saw it as their role to help, direct, or manage medical trainees even when outside of the attendings’ awareness (Weller et al. 2008, Adler-Milstein et al. 2011). Nurses can also help residents learn and practice with hands-on skills such as “peripheral IV, NG tubes, Foley catheters, ECG lead placements” that may take ongoing clarification, narration, and practice and that an attending may not directly supervise (Abourbih et al. 2015, p. 81). Thus, for trainees who are early in their professional development, exposure to more cross-discipline partners may provide them with many new partners who can narrate, interpret, and interact at the scene of the work. We summarize the above arguments by stating the following hypothesis.

**Hypothesis 3a.** *Trainees’ exposure to more cross-discipline, decision-executing partners is positively associated with team performance.*

Like the role relationship between trainees and cross-discipline partners characterized previously, the role relationship between the team leader and these partners who expertly execute decisions is similarly characterized by authority differences and different specialized tasks (Wageman and Fisher 2014). However, this second role relationship also differs significantly: the team leaders have finished their professional training and are now autonomous decision makers. They are considered experts in their profession rather than requiring such ongoing training and help with basic skills and role expectations (Flowerdew et al. 2012). Nevertheless, team leaders may still benefit from increasing partner exposure to many more decision-executing partners. Their interactions are structured by the expectation that the team leader will issue orders that fit into somewhat standardized workflows, templates, and information systems; the structured and standardized nature of these interactions allow the team leader to learn from repetition with varied

partners (Bunderson and Boumgarden 2010, Bresman and Zellmer-Bruhn 2013, Akşin et al. 2021). Teams characterized by this kind of team authority structure tend to have highly structured communication (Edmondson et al. 2001a, p. 704). In the ED setting, for example, each attending issues orders that the various nurses they are working with carry out (Fernandez et al. 2008). They gain experience giving their own typical orders to a range of partners in the decision-executing roles. Increasing experience on structured interactions with varied partners might allow the attendings to refine their orders and the way that they communicate them to the nurses. Because they are doing repeat orders and building repetition (Argote et al. 1995), they may learn to anticipate questions or assumptions and adjust their order-giving to be more efficient and clear no matter who they are talking to (Faraj and Xiao 2006). They must adjust how they communicate their orders to different nurses; they do not have to adjust their own work to understand and accommodate varying judgements and decisions coming to them from a variety of nurses (Grytten and Sørensen 2003). We summarize the above arguments by stating the following hypothesis.

**Hypothesis 3b.** *Team leaders' exposure to more decision-executing partners is positively associated with team performance.*

**2.2.4. Partner Exposure Vis-à-Vis Trainees.** Finally, we can consider whether cross-discipline team members in decision-executing roles and team leaders develop more efficient performance from exposure to more trainees as they work. As described previously, the interaction between decision-executing roles and trainees is not highly structured. Instead, the interactions are open ended, involving iterative communication of informal and tacit understandings. Cross-discipline partners will have to adjust their training interactions to each trainee's level of understanding and skill, learning style, and personality. They may get better at training residents, but this improvement might develop with their own increasing experience as well, rather than from each additional partner providing additional repetitions or experience on a structured interaction, or from being exposed to an experienced partner who has new ideas for improvement. Regarding the team leaders, their interactions with the trainees are likely to be more structured than the nurses' interactions, but still open ended. The team leaders might similarly have to adjust to working with new trainees, which does not aid efficient performance on subsequent cases. The team leaders are also delivering both formal and informal content about medical practice, and, although they might get better at explaining through their own

increasing experience, the open-ended nature of these interactions and variability in learning needs to the residents is not likely to support efficient performance. Moreover, in organizational settings that invest heavily in trainees, team leaders and nurses who work with many trainees may be purposefully focused on training tasks across their variety of partners (Rowley et al. 2000, Timmermans and Angell 2001, Brooks and Bosk 2012), trading off team efficiency for the learning benefits of the trainees. In summary, we hypothesize the following.

**Hypothesis 4a.** *Cross-discipline partners' exposure to more trainees is negatively associated with team performance.*

**Hypothesis 4b.** *Team leaders' exposure to more trainees is negatively associated with team performance.*

**2.2.5. Moderating Effect of Task Structure.** Many studies in the research literature on team familiarity also explore whether and how different task structures moderate the well-established relationship between team familiarity and performance. As one example, Espinosa et al. (2007) find that familiarity was less helpful for teams confronting complex tasks. In conversation with this research, Akşin et al. (2021) also examine the moderating effect of task structure on the performance benefits of partner exposure. They argue that the effects of partner exposure may similarly be contingent on the "characteristics of the underlying task process and the type of knowledge required to execute it" (p. 857). They find empirical support for this argument in the context of the ambulance transport teams. Greater partner exposure directly improves performance at the patient pick-up scene, where tasks are less structured but only benefits performance past a certain threshold at patient-hospital hand-offs, which involve more structured tasks. To continue to build on these ideas, we also analyze how task structures moderate the performance benefits of partner for these different team roles. We similarly expect that cases with more structured workflows also help structure interactions and scaffold learning for trainees and cross-discipline decision-executing roles as they encounter varying practices among team authorities. Some of the knowledge needed to complete complex tasks is tacit and ambiguous, which means it is best shared through ongoing, iterative interactions. Other aspects of knowledge are more easily codified, for example checklists or protocols encoded into workflows that shape the coordination between different disciplines on a team (Pronovost and Vohr 2010). Recent empirical research shows that standardized checklists and protocols in the electronic medical record helps reduce practice variation and improve the quality of care (Wolff et al. 2004, Weiser et al. 2010). The workflows would be helping to structure and focus the needed interactions and conversations, so they are less

variable and less subject to attending idiosyncratic practice styles. If trainees and nurses are not learning from exposure to attendings' varied practice styles in ways that they can generalize to more efficient coordination on future cases, then the structured workflows might alternatively help lessen the negative effects of exposure to varying practice. We summarize these competing arguments with the following hypothesis.

**Hypothesis 5.** *The relationship between partner exposure and team performance is attenuated on cases with more structured workflows.*

### 3. Empirical Setting: Temporary Teams in Hospital EDs

Many EDs have been facing an increase in patient volumes and higher levels of patient complexity without a corresponding increase in staffing levels (U.S. Government Accountability Office 2009, Pitts et al. 2012). This has resulted in longer wait times and higher rates of patients leaving without being seen (U.S. Government Accountability Office 2009), both of which are linked to worse patient outcomes in the form of higher rates of admission to the hospital and higher mortality rates, among others (Bernstein et al. 2009, Singer et al. 2011). To ensure access to emergency care with reasonable wait times, ED administrators have been looking for ways to improve patient throughput using existing resources without sacrificing the quality of care.

Recent reviews of the literature in healthcare management have highlighted that “operational characteristics play an important role in influencing patient outcomes and warrant just as much attention as patient-level clinical characteristics” (Kc et al. 2020, p. 75). A multitude of different operational levers have been studied in recent years, such as appointment scheduling (Gupta and Denton 2008, Liu et al. 2010, White et al. 2011, Zacharias and Pinedo 2014), bed utilization in hospitals (Kc and Terwiesch 2009, Allon et al. 2013, Kim et al. 2015, Kuntz et al. 2015, Berry Jaeker and Tucker 2017, Roth et al. 2019), and the time of treatment (Anderson et al. 2014, Batt et al. 2019, Deo and Jain 2019, Kc 2019, Song et al. 2022). In the setting of the ED specifically, others have documented the impact of multitasking (Kc 2014), operational flexibility (Laker et al. 2014, Ward et al. 2015), patient streaming and queueing (Saghafian et al. 2012, 2014; Song et al. 2015), peer influence (Song et al. 2018, Yuan et al. 2018), and staff quality and training (Morey et al. 2002, Kuntz and Sülz 2013). Yet, there exists an important and pervasive aspect of ED operations that has received little attention: how to staff physician-nurse teams and the performance implications thereof. In this paper, we examine how the staffing of ED teams can be improved to increase patient throughput.

To conduct our analyses, we use data from a hospital ED, which we anonymize as Metro ED. Metro ED

is part of a high-volume, academic hospital in a large metropolitan area of the United States. As is typical of most EDs, temporary teams comprised of physicians and nurses deliver care to patients at Metro ED.

#### 3.1. Temporary Teams at Metro ED

Metro ED organizes temporary teams of clinical providers by assigning physicians and nurses to work together as a team for the duration of their shifts. Start times of shifts are staggered across providers to ensure that at least one provider stays on the team who knows about the patient. In some cases when the patient's stay spans across a nursing shift change, the patient is handed off from the outgoing nurse to the incoming nurse, with the latter becoming the second nurse on the patient's record. Patients are rarely handed off across attending physicians' shift changes, as new patients are not assigned to physicians who are expected to end their shift in the next few hours. When this does happen, the outgoing attending physician develops a care plan for the patient, which includes specific instructions regarding patient disposition (e.g., if the laboratory test comes back positive, admit the patient; otherwise, discharge the patient). Resident physicians can also be assigned to care for patients alongside attending physicians and nurses, but this is a function of the residency program's schedule and is exogenous to the patient's condition. Hence, all teams have at least one attending physician and one nurse; some teams also have a resident physician as part of the team.<sup>1</sup> We define a team as the set of providers who are delivering care to a focal patient.

#### 3.2. Staffing and Patient Assignment at Metro ED

A feature of the staffing process at Metro ED that is important for our analysis is that the attending physician manager and the nurse manager each staff the ED separately (with attendings and nurses, respectively), with no attempt to preferentially pair specific attendings with specific nurses. This staffing process seeks to accommodate individual preferences for the type and number of shifts (e.g., if a nurse wants to work three 12-hour shifts or five 8-hour shifts in a particular week), but the process of staffing each attending-nurse team is by random assignment. In other words, there is no attempt to pair specific attendings with specific nurses in creating the teams. The assignment of resident physicians onto these teams is also exogenously determined and is random. This random assignment of attendings, nurses, and residents onto patient care teams is critical for our analysis, because it ensures that variation in team familiarity and partner exposure is exogenous, rather than based on team member preferences or capabilities.

In addition, patients are exogenously assigned to the physician-nurse teams. This is the result of a

department policy of using round-robin assignment for fairness reasons. In Figure A.1 of the online supplement, we use the data to illustrate that the average emergency severity index (ESI) level is tightly concentrated around three for all attendings, nurses, and residents, which suggests that Metro ED was adhering to the round-robin assignment policy in assigning patients to patient care teams. Several papers have explored the performance implications of round-robin patient assignment (Song et al. 2015, Chan 2016, Valentine 2018). In this paper, we leverage this round-robin assignment to cleanly identify variation in performance that is exogenous and not based on differential task assignment.

## 4. Data

We collected data for every adult patient who received care at Metro ED from January 2008 to December 2011. For each ED visit, the data include the patient-level information including age, gender, a five-level ESI (level 1 is the most urgent and level 5 is the least urgent) (Gilboy et al. 2011), discharge disposition, physician identifier, nurse identifier(s), resident identifier, and whether the patient returned to the ED within 48 hours after discharge. The data also include several time stamps related to patient flow through the ED: arrival (time of patient arriving at the ED), nurse start (nurse first signing up for the patient), physician start (physician first signing up for the patient), disposition order, and departure (patient leaving the ED).

### 4.1. Sample Selection

Table B.1 of the online supplement describes our sample selection process. To use a consistent lookback window across all observations when constructing our variables of interest (team familiarity and partner exposure), we exclude from the analysis sample those visits that occurred in the first 12 months of our three-year data collection period.<sup>2</sup> We also exclude visits by pediatric patients and those with a missing value for age, gender, attending physician identifier, or nurse identifier. We further limit our analysis sample to patients seen by attending physicians and nurses who treated at least 50 cases in the three-year data collection period. Using discharge disposition information, we also exclude patients who died in the ED, were transferred to another hospital, or left without being seen by a care provider. We exclude patients whose ESI level is 1 (most urgent); these patients comprise less than 1% of our sample. Finally, we exclude patients whose time to disposition (difference between disposition order time stamp and patient arrival time stamp; see Section 4.2 for details) is shorter than the 1st percentile value (28 minutes) or longer than the 99th

percentile value (652 minutes) to remove outliers in the time to disposition.

The resulting final sample consists of 111,491 ED visits, with 71 unique attending physicians and 100 unique nurses who worked in 4,572 unique physician-nurse teams in our two-year study period; of these, 76,377 involved a resident physician as well. During the two-year study period, each attending physician worked with 64 nurses (standard deviation (SD) = 26) and 65 residents (SD = 37) on 1,570 cases (SD = 1,413), on average. Each nurse worked with 46 attendings (SD = 15) and 71 residents (SD = 33) on 1,115 cases (SD = 916), on average. Each resident physician worked with 24 attendings (SD = 19) and 37 nurses (SD = 20) on 396 cases (SD = 540), on average.

### 4.2. Variables

**4.2.1. Measure of Team Performance.** Our main measure of team performance is time to disposition in the ED. This is a measure that has been used frequently as a proxy for provider productivity in ED settings (Pourmand et al. 2013, Saghaian et al. 2014, Song et al. 2015, Batt et al. 2019). Discussions with several ED managers and clinicians also point to this as a first-order productivity measure of interest. In contrast to the total time in the ED, which is defined as the time from patient arrival to departure from the ED, time to disposition focuses specifically on the time from a patient's arrival to the ED to the time a disposition order was signed (which indicates that a patient is ready to be discharged or admitted), thus excluding any time spent boarding in the ED or in an inpatient unit.<sup>3</sup>

The first panel of Table 1 shows summary statistics for this measure. Patients' time to disposition was 197.59 minutes, or 3.3 hours, on average.

### 4.2.2. Measures of Team Familiarity and Partner Exposure.

The key variables of interest are team familiarity and partner exposure, respectively. For each observation, we follow prior work and define *team familiarity* by counting the number of prior cases that each pair in the team worked on together within a defined lookback window and then averaging the pairs at the team level (Luciano et al. 2018). We define *partner exposure* as the number of partners of another role with whom a given provider has worked prior to the focal observation. For example, an *attending's partner exposure to nurses* is captured as the number of distinct nurses a given attending has worked with within the given lookback window, whereas a *nurse's partner exposure to attendings* is captured as the number of distinct attendings a given nurse has worked with within the given lookback window. To construct each of these measures of interest, we use a rolling lookback window of 12 months, following prior work (Weaver et al. 2014, Luciano et al. 2018).<sup>4</sup>

**Table 1.** Summary Statistics of Performance Measures and Variables of Interest

Variable	Mean	Standard deviation	Minimum	Median	Maximum
<i>Time to disposition (min)</i>	197.59	120.09	28	170	652
<i>Average team familiarity</i>	22.45	18.83	0	18.33	200
<i>NUR's partner exposure to ATTs</i>	43.93	8.83	0	46	59
<i>RES's partner exposure to ATTs<sup>a</sup></i>	37.36	11.44	0	41	54
<i>RES's partner exposure to NURs<sup>a</sup></i>	58.47	17.73	0	65	83
<i>ATT's partner exposure to NURs</i>	71.34	14.39	0	75	90
<i>NUR's partner exposure to RESs</i>	61.42	17.11	0	67	89
<i>ATT's partner exposure to RESs</i>	63.80	16.44	0	68	89
<i>Age (yr)</i>	49.77	19.20	18	48	108
<i>ATT current workload (cases)</i>	8.67	4.48	1	8	34
<i>NUR current workload (cases)</i>	3.28	1.80	1	3	15
<i>RES current workload (cases)<sup>a</sup></i>	3.82	1.99	1	4	17
<i>ATT experience (cases)</i>	2,884.16	1,579.80	0	2,829	7,368
<i>NUR experience (cases)</i>	1,614.02	967.92	0	1,526	4,542
<i>RES experience (cases)<sup>a</sup></i>	939.31	625.06	0	915	2,565
<i>ED census (cases)</i>	25.71	9.40	1	25	64
<i>Time since ATT shift start (hr)</i>	3.97	2.81	0	3.83	23.78
<b>Categorical variables</b>	<b>N</b>	<b>Percentage</b>			
<i>Female</i>	64,602	57.94			
<i>RES present</i>	76,377	68.51			
<i>Second NUR present</i>	40,476	36.30			
<i>ESI level</i>					
2	15,538	13.94			
3	66,702	59.83			
4	25,800	23.14			
5	3,451	3.10			
<i>Arrival day-of-week</i>					
Sunday	13,956	12.52			
Monday	17,539	15.73			
Tuesday	16,950	15.20			
Wednesday	16,289	14.61			
Thursday	16,043	14.39			
Friday	16,151	14.49			
Saturday	14,563	13.06			

Notes.  $N = 111,491$ . ATT, attending; NUR, nurse; RES, resident. Team familiarity is measured as the average number of prior cases that each pair of care providers worked on together over the last 12 months. Partner exposure is measured as the number of prior partners the focal care provider has worked with over the past 12 months. Variables not shown for brevity include (ATT current workload)<sup>2</sup>, (NUR current workload)<sup>2</sup>, (RES current workload)<sup>2</sup>, arrival hour-of-day, arrival year-month, attending fixed effects, nurse fixed effects, and resident fixed effects.

<sup>a</sup> $N = 76,377$  because this measure only pertains to cases that involve a resident.

In calculating team familiarity and partner exposure measures, we count a case toward each of the measures only if the case was completed at least 12 hours before the focal patient's arrival. We impose this restriction to exclude experiences that were accumulated within the same shift, because physicians and nurses are assigned to work together as a team for the duration of a shift. For example, a case would count toward the measure of team familiarity accumulated over the last 12 months only if the two providers worked on the case together within the last 12 months *and* if they had completed the case at least 12 hours prior to the time the focal patient arrived in the ED.

In Table 1, we provide summary statistics of each of the team familiarity and partner exposure measures. Table 2 presents correlation values between the team performance measures and each of the variables of interest. We find there is a negative correlation between

team familiarity and time to disposition, whereas there are a mix of positive and negative correlations between the partner exposure measures and time to disposition. In addition, the correlation between team familiarity and each of the partner exposure measures is positive but low.

**4.2.3. Control Variables.** Our data allow us to control for several patient-, provider-, and ED-level covariates that can potentially affect our performance measures. To adjust for heterogeneity across patient types, we control for patient age, gender, and ESI level. We also control for seasonality by including dummies for patient arrival hour, day-of-week, and month. Because prior studies have shown that workload can affect worker performance (Kc and Terwiesch 2009, Tan and Netessine 2014), we control for the number of cases that each of the assigned providers are concurrently

**Table 2.** Correlation Values Among Variables Included in Empirical Specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
(1) Time to disposition (min)	1.00																				
(2) Average team familiarity	−0.06	1.00																			
(3) NUR's partner exposure to ATT's	0.02	0.35	1.00																		
(4) RES's partner exposure to ATT's <sup>a</sup>	−0.01	0.35	0.05	1.00																	
(5) RES's partner exposure to NUR's <sup>a</sup>	−0.03	0.36	0.01	0.94	1.00																
(6) ATT's partner exposure to NUR's	−0.04	0.25	−0.07	−0.01	0.03	1.00															
(7) NUR's partner exposure to RESs	0.02	0.32	0.89	0.04	0.01	−0.03	1.00														
(8) ATT's partner exposure to RESs	−0.04	0.25	−0.04	−0.04	−0.03	0.92	0.00	1.00													
(9) Age (yr)	0.11	−0.05	−0.01	−0.02	−0.02	0.01	0.00	0.02	1.00												
(10) Female	0.02	−0.02	−0.01	−0.02	−0.02	0.01	−0.01	0.02	0.00	1.00											
(11) ESI level	−0.17	0.06	0.01	−0.02	−0.01	−0.02	0.00	−0.03	−0.18	0.01	1.00										
(12) RES present	0.06	−0.20	0.05	0.00	0.00	−0.01	0.06	−0.01	0.04	0.00	−0.10	1.00									
(13) Second NUR present	0.24	−0.08	−0.12	−0.04	−0.06	−0.02	−0.13	0.01	0.10	0.00	−0.10	0.02	1.00								
(14) ATT current workload (cases)	0.05	0.04	0.04	0.02	0.01	−0.04	0.02	−0.06	−0.06	−0.04	0.02	0.01	0.02	1.00							
(15) NUR current workload (cases)	−0.02	0.09	0.09	0.05	0.04	−0.04	0.07	−0.06	−0.09	−0.01	0.07	−0.03	0.00	0.27	1.00						
(16) RES current workload (cases) <sup>a</sup>	0.06	0.13	0.04	0.18	0.17	−0.06	0.03	−0.08	−0.04	−0.01	−0.02	0.03	0.43	0.31	1.00						
(17) ATT experience (cases)	−0.03	0.39	0.08	0.00	−0.05	0.53	0.08	0.66	−0.01	0.00	0.00	−0.01	0.07	0.04	−0.02	0.00	1.00				
(18) NUR experience (cases)	0.01	0.34	0.67	0.02	−0.03	−0.06	0.65	−0.01	−0.02	−0.01	0.01	0.02	−0.07	0.05	0.06	0.04	0.22	1.00			
(19) RES experience (cases) <sup>a</sup>	−0.02	0.35	0.09	0.72	0.71	−0.04	0.05	−0.05	−0.03	−0.03	0.00	0.00	−0.02	0.03	0.05	0.15	0.07	0.11	1.00		
(20) ED census (cases)	0.12	−0.02	0.01	−0.09	−0.11	−0.02	0.03	−0.01	0.02	0.05	−0.08	−0.07	0.08	0.37	0.30	0.31	0.01	0.04	−0.05	1.00	
(21) Time since ATT shift start (hr)	0.00	−0.02	0.03	0.02	0.01	0.00	0.03	0.00	−0.04	−0.02	−0.02	0.08	0.01	0.51	0.04	0.15	0.00	0.01	0.01	0.15	1.00

Notes.  $N = 111,491$ . ATT, attending; NUR, nurse; RES, resident. Team familiarity is measured as the average number of prior cases that each pair of care providers worked on together over the last 12 months. Partner exposure is measured as the number of prior partners the focal care provider has worked with over the last 12 months. Variables not shown for brevity include (ATT current workload)<sup>2</sup>, (NUR current workload)<sup>2</sup>, (RES current workload)<sup>2</sup>, arrival hour-of-day, arrival year-month, attending fixed effects, nurse fixed effects, and resident fixed effects. All correlation coefficients whose absolute magnitude is greater than or equal to 0.01 are statistically significant at the  $p < 0.05$  level.

<sup>a</sup> $N = 76,377$  because this measure only pertains to cases that involve a resident.

working on (i.e., attending current workload, nurse current workload, and resident current workload) and their squared terms. We also control for the number of cases currently in the ED (i.e., ED census) as a proxy for ED congestion. To account for potential changes in service rates over the course of a shift (Batt et al. 2019, Deo and Jain 2019), we control for the time since the start of the attending physician's shift. We also control for attending, nurse, and resident fixed effects and the presence of a second nurse on the case. Finally, we control for the number of prior cases that each of the providers (attending, nurse, and resident, respectively) have worked on since the beginning of the study period as a proxy for experience. For brevity, we refer to these measures as attending experience, nurse experience, and resident experience, respectively. Table 1 provides summary statistics of each of the control variables, and Table 2 shows their correlations.

## 5. Effects of Team Familiarity and Partner Exposure

### 5.1. Estimation Model

For our analyses, we leverage the exogenous variation in team and task assignment that comes from the random assignment of providers to teams and the round-robin assignment of patients to these teams. To test our hypotheses, we estimate the effects of team familiarity and partner exposure on time to disposition in a single model. Specifically, we estimate the following log-linear model at the encounter level for each lookback window  $l$ , where  $l = 12$  in our main model:

$$\begin{aligned} \log(\text{TimetoDispo}_i) = & \gamma_0 + \gamma_{1,l} \text{AvgTF}_{\text{Att}_i, \text{Nur}_i, \text{Res}_i, l} \\ & + \gamma_{2,l} \text{PE}_{\text{Nur}_i, \text{Att}_i, l} + \gamma_{3,l} \text{PE}_{\text{Res}_i, \text{Att}_i, l} \\ & + \gamma_{4,l} \text{PE}_{\text{Res}_i, \text{Nur}_i, l} + \gamma_{5,l} \text{PE}_{\text{Att}_i, \text{Nur}_i, l} \\ & + \gamma_{6,l} \text{PE}_{\text{Nur}_i, \text{Res}_i, l} + \gamma_{7,l} \text{PE}_{\text{Att}_i, \text{Res}_i, l} \\ & + \delta \mathbf{X}_i + \alpha_{\text{Att}_i} + \nu_{\text{Nur}_i} + \rho_{\text{Res}_i} + \varepsilon_i. \end{aligned} \quad (1)$$

Here,  $\log(\text{TimetoDispo}_i)$  represents the logged number of minutes from patient arrival to disposition for patient encounter  $i$ . We log transform the dependent variable to account for the right-skewed distribution of the time to disposition variable. The term  $\text{AvgTF}_{\text{Att}_i, \text{Nur}_i, \text{Res}_i, l}$  denotes the average number of prior cases that the attending and nurse of encounter  $i$ , the attending and the resident of encounter  $i$ , and the nurse and the resident of encounter  $i$  worked on together during the lookback window  $l$  preceding encounter  $i$ , that is, the team's average level of team familiarity (TF). For cases that did not involve a resident,  $\text{AvgTF}_{\text{Att}_i, \text{Nur}_i, \text{Res}_i, l}$  is equal to the team familiarity between the attending and the nurse. The variable  $\text{PE}_{j_i, k, l}$  measures the partner exposure (PE) by capturing the number of distinct providers of type  $k$  that provider

$j_i$  worked with during the lookback window  $l$  preceding encounter  $i$ . For example,  $\text{PE}_{\text{Nur}_i, \text{Att}_i, l}$  denotes the number of distinct attendings that  $\text{Nur}_i$  worked with during the lookback window  $l$  preceding encounter  $i$ , that is, the nurse's partner exposure to attendings. For cases that did not involve a resident, we set the related partner exposure measures to zero. Note that  $\mathbf{X}_i$  is a vector of control variables described in Section 4.2.3; and  $\alpha_{\text{Att}_i}$  are attending fixed effects where  $\text{Att}_i$  is the attending physician for patient encounter  $i$ . Similarly,  $\nu_{\text{Nur}_i}$  are nurse fixed effects where  $\text{Nur}_i$  is the nurse for patient encounter  $i$ , and  $\rho_{\text{Res}_i}$  are resident fixed effects where  $\text{Res}_i$  is the resident physician for patient encounter  $i$ . Collectively,  $\alpha_{\text{Att}_i}$ ,  $\nu_{\text{Nur}_i}$ , and  $\rho_{\text{Res}_i}$  allow us to control for time-invariant aspects of attendings, nurses, and residents, respectively. Thus, our model assesses within-attending, within-nurse, and within-resident variance in measuring performance. The variable  $\varepsilon_i$  captures standard errors clustered by provider teams. The main coefficients of interest are  $\gamma_{1,l}$  through  $\gamma_{7,l}$ , which capture the effects of team familiarity and partner exposure on time to disposition.<sup>5</sup>

### 5.2. Main Results

Table 3 presents the results of estimating Equation (1) using a 12-month lookback window (see Table B.2 of the online supplement for full results tables including coefficients for control variables).

**5.2.1. Team Familiarity.** We begin by examining the results on team familiarity. We find that higher levels of average team familiarity are strongly associated with improved performance—more specifically a shorter time to disposition. This is evidenced by the fact that the coefficient on average team familiarity ( $\gamma_{1,l}$  in Equation (1)) in column (1) of Table 3 is negative and statistically significant. Specifically, we find that a one-unit increase in average team familiarity accumulated over the last 12 months is associated with a 0.11% decrease in time to disposition ( $p < 0.001$ ). In other words, patients under the care of a provider team that has worked on an additional standard deviation of cases together over the last 12 months (i.e., 18.83 cases) experience a 2.1% decrease in the time to disposition on the focal case. As such, we find strong evidence in support of Hypothesis 1 that team familiarity is positively associated with faster speed.

**5.2.2. Partner Exposure.** Next, we turn to the results on partner exposure, beginning with the effects of being exposed to more team leaders. In our setting, the team leader is the attending physician on the care team. We find that nurses' partner exposure to more attendings has a negative impact on performance. Specifically, patients under the care of a nurse who has previously worked with 1 more attending in the last 12 months experience a 0.17% increase in time to

**Table 3.** Effects of Team Familiarity and Partner Exposure on Logged Time to Disposition

	(1)	(2)
<i>Average team familiarity</i>	−0.0011*** (0.0002)	−0.0006* (0.0002)
<i>NUR's partner exposure to ATT</i>	0.0017* (0.0007)	0.0020* (0.0008)
<i>RES's partner exposure to ATT</i>	0.0017+ (0.0009)	0.0070*** (0.0010)
<i>RES's partner exposure to NUR</i>	−0.0029*** (0.0005)	−0.0051*** (0.0007)
<i>ATT's partner exposure to NUR</i>	−0.0014** (0.0005)	−0.0013* (0.0006)
<i>NUR's partner exposure to RES</i>	0.0010* (0.0004)	0.0011* (0.0005)
<i>ATT's partner exposure to RES</i>	0.0010+ (0.0005)	0.0007 (0.0006)
<i>Laboratory or radiology test</i>		0.6705*** (0.0284)
<i>Average team familiarity × Laboratory or radiology test</i>		−0.0003 (0.0003)
<i>NUR's partner exposure to ATT × Laboratory or radiology test</i>		−0.0015+ (0.0008)
<i>RES's partner exposure to ATT × Laboratory or radiology test</i>		−0.0074*** (0.0010)
<i>RES's partner exposure to NUR × Laboratory or radiology test</i>		0.0028*** (0.0007)
<i>ATT's partner exposure to NUR × Laboratory or radiology test</i>		0.0001 (0.0006)
<i>NUR's partner exposure to RES × Laboratory or radiology test</i>		−0.0001 (0.0004)
<i>ATT's partner exposure to RES × Laboratory or radiology test</i>		0.0003 (0.0005)
Observations	111,491	111,491
R <sup>2</sup>	0.1863	0.3280

Notes. ATT, attending; NUR, nurse; RES, resident. Team familiarity and partner exposure are measured using 12-month lookback windows. Columns (1) and (2) are log-linear regression models estimated at the encounter level. Controls not shown include age, gender, ESI level, second nurse presence, time since attending shift start, arrival hour-of-day, arrival day of week, arrival year-month, attending current workload and its squared term, nurse current workload and its squared term, resident current workload and its squared term, attending experience, nurse experience, resident experience, attending fixed effects, nurse fixed effects, and resident fixed effects. Standard errors (in parentheses) are clustered by attending-nurse-resident teams.

+ $p < 0.10$ ; \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

disposition ( $p < 0.05$ ; Table 3, column (1)). This offers support for Hypothesis 2a, which stated that cross-discipline partners' exposure to more team leaders is negatively associated with team performance. Our findings are similar when it comes to residents' partner exposure to more attendings, albeit with weaker statistical significance. We find that patients under the care of a resident who has previously worked with one more attending in the last 12 months experiences a marginally significant 0.17% increase in time to disposition ( $p < 0.1$ ; Table 3, column (1)). Thus, we find weak support for Hypothesis 2b, which stated that trainees' exposure to more team leaders is negatively associated with team performance.

Our findings are quite different when we examine the effects of being exposed to more decision-executing partners (i.e., nurses) as opposed to decision-initiating team leaders (i.e., attendings). Here, we find that both

residents' and attendings' exposure to more nurses has a positive impact on performance. Specifically, patients under the care of a resident who has previously worked with one more nurse in the last 12 months experience a 0.29% decrease in time to disposition ( $p < 0.001$ ; Table 3, column (1)), and those under the care of an attending who has done the same experience a 0.14% decrease in time to disposition ( $p < 0.01$ ; Table 3, column (1)). Hence, we find strong support for Hypotheses 3a and 3b; trainees' exposure and team leaders' exposure to more cross-disciplinary decision-executing partners is positively associated with team performance.

Finally, we examine the effects of being exposed to more trainees (i.e., residents). We find that nurses' exposure to more residents has a negative impact on performance, where patients under the care of a nurse who has previously worked with one more resident in

the last 12 months experience a 0.10% increase in time to disposition ( $p < 0.05$ ; Table 3, column (1)). In other words, Hypothesis 4a is supported. When it comes to attendings' exposure to more residents, we obtain a similar result but with weaker statistical significance. Specifically, patients under the care of an attending who has previously worked with one more resident in the last 12 months experiences a 0.10% increase in time to disposition ( $p < 0.1$ ; Table 3, column (1)). Hence, Hypothesis 4b is weakly supported.

### 5.3. Moderation Effects

Are the aforementioned effects of partner exposure on performance moderated by the presence of structured workflows? To proxy for cases with more structured workflows, we construct a new indicator variable that identifies whether a case involved at least one laboratory test or radiology test; in our sample, 64% of cases involved at least one laboratory test or radiology test. This is a suitable proxy measure in the ED setting because cases that involve these diagnostic tests tend to follow a predefined structure and set of processes based on the test results. For our analyses, we interact the indicator variable for the presence of a laboratory or radiology test with each of the measures of partner exposure. For completeness, we also interact it with the average team familiarity.

We report the results of our estimation of these moderation effects in column (2) of Table 3.<sup>6</sup> We find that the negative effect of residents' partner exposure to attendings is attenuated for cases that involved a laboratory test or a radiology test. This can be seen from the negative and significant coefficient on the term interacting residents' partner exposure to attendings with the indicator for laboratory or radiology tests ( $p < 0.001$ ). We also find that the positive effect of residents' partner exposure to nurses is attenuated for these cases, which can be seen from the positive and significant coefficient on the term interacting residents' partner exposure to nurses with the indicator for laboratory or radiology tests ( $p < 0.001$ ). Thus, when it comes to trainees' exposure to more team leaders and more decision-executing partners, we find support for Hypothesis 5: the relationship between partner exposure and team performance is attenuated on cases with more structured workflows.

With respect to team leaders' exposure and decision-executing partners' exposure to other team members, we do not find support for Hypothesis 5 with one exception. We find a marginally significant attenuation effect when it comes to nurses' partner exposure to attendings ( $p < 0.10$ ). In other words, the negative effect of nurses' partner exposure to attendings seems to be somewhat attenuated for cases that have a more structured workflow.

## 6. Additional Analyses and Robustness Checks

We conduct several additional analyses to assess the robustness of our findings and the sensitivity of our main results.

### 6.1. Alternate Lookback Windows

Our main analyses use a rolling 12-month lookback window. Here, we consider alternate rolling lookback windows, specifically examining rolling lookback windows shorter than 12 months. Doing so allows us to assess whether the recency of the team members' experiences matter—an aspect of teaming that is often overlooked in previous work. On the one hand, team familiarity or partner exposure that accumulated a year ago may have little or no effect on performance, whereas one that occurred a month ago might have a stronger impact on performance. This differential relationship over time may be because the team members' shared mental models, shared language, and synchronized responses may be disrupted by different factors over longer periods of time (Anderson and Lewis 2014, Froehle and White 2014), including experiences with other teams (Kane et al. 2005), changes to the tasks or context (Leonard-Barton 1992), or simply the passing of time whereby experiences become less salient and retrievable (Ramdas et al. 2018). As team members encounter these various disruptions, the effects on performance may become diluted. If this were the case, managers should use a short lookback window to measure team familiarity and partner exposure. If they were to instead use a long lookback window, they would overcredit the experiences that were accumulated longer ago and thus overestimate the stock of team familiarity and partner exposure from which team members experience an impact. Conversely, it may be the case that the aforementioned disruptions do not alter the effects on performance from an experience that occurred a long time ago. In this case, managers may be better off employing a reasonably long lookback window to measure team familiarity and partner exposure, as the experiences accumulated longer ago may still meaningfully contribute to the stock of overall team familiarity and partner exposure that affect team members.

To examine these temporal and recency issues, we consider rolling lookback windows ranging from 1 to 11 months. We determined the range of alternate lookback windows based on the 20 interviews that we conducted with physician and nurse managers at 8 EDs. Our interviews suggested that the shortest lookback window ought to be at least a few weeks to ensure sufficient variation in the team-related measures of interest because many physicians and nurses may work either a few days per week or a few weeks per

month. We do not consider lookback windows longer than 12 months because many ED scheduling systems retain scheduling information for only one year.

Table B.2 in the online supplement shows the results of using these alternate lookback windows. We find the effects of average team familiarity to be highly robust across all 12 lookback windows, although its magnitude gradually decreases as the lookback window becomes longer. The effects of residents' exposure to more attendings and their exposure to more nurses is also robust and stable across all 12 lookback windows. We find that the effects of attendings' and nurses' exposure to other members of the team remain qualitatively similar to the main results using 12-month lookback windows, although the statistical significance tends to wane with some of the shorter lookback windows. This suggests that there is not a measurable forgetting effect, but the limited variation and statistical power inherent to shorter lookback windows makes it beneficial for managers to use longer lookback windows when calculating measures of team familiarity and partner exposure.

## 6.2. Alternate Sample Definitions

We consider alternate ways of defining the analysis sample. First, we consider a subsample of cases where patient care teams included only an attending physician and a nurse and did not involve a resident. As discussed in Section 3.1, although all patient care teams must include an attending physician and a nurse, about 69% of the cases also include a resident physician, as a function of the residency program's schedule. To see whether there are meaningful differences in the results when we consider all cases versus excluding those that did not include a resident physician, we estimate our model on the subsample that did not include a resident physician. We report these results in column (1) of Table 4. We find the team familiarity results are highly robust to the main results. We find no significant effects when it comes to attendings' partner exposure to nurses. However, we find strong negative effects of nurses' partner exposure to attendings, which lends further support for Hypothesis 2a. For completeness, we also consider a subsample of cases where patient care teams included members of all three roles, that is, one attending, one nurse, and one resident. These results, reported in column (2) of Table 4, are qualitatively similar to the main results reported in column (1) of Table 3. We note that we no longer find a statistically significant effect of residents' partner exposure to attendings and attendings' partner exposure to residents, which were previously the two effects with the weakest statistical significance. This may be because of the smaller sample size that results from the alternate sample definition.

Next, we consider an alternate sample where we relax some of our exclusion criteria. Specifically, we include in our sample visits whose time to disposition is shorter than the 1st percentile value or longer than the 99st percentile value (column (3) of Table 4). We also include visits of patients whose ESI level is one (column (4) of Table 4). We find our main results to be generally robust to these expanded samples. Last, we consider imposing additional exclusion criteria as opposed to relaxing them, whereby we exclude cases that included a second nurse to whom the case was handed off (column (5) of Table 4). Our main results are generally robust to these additional sample exclusions, with the exception of the effects of being exposed to more residents, which are no longer statistically significant, potentially because of the smaller sample size.

## 6.3. Alternate Measures of Performance

We examine whether our results are sensitive to different ways of measuring performance in the context of the ED and consider some additional measures of interest. To do this, we consider four alternate measures: logged time in the ED, logged time from first provider to disposition, logged time from disposition to departure, and ED revisit within 48 hours. For each of logged measures, we estimate a log-linear model at the encounter level using a rolling 12-month lookback window that retains the same form on the right-hand side as Equation (1). For the binary measure that captures whether patient encounter  $i$  resulted in a revisit to the ED within 48 hours after discharge, we estimate a logit model at the encounter level, also using a rolling 12-month lookback window with the same form on the right-hand side as Equation (1).

In column (1) of Table 5, we can see the effects of team familiarity and partner variety on logged time in the ED. This measure is different from logged time to disposition in that it includes discharge processing times and boarding times. These portions of time are typically beyond the control of the ED providers, but nevertheless have a significant impact on ED operations. We find our main results to be robust to the use of this alternate measure in terms of magnitude, directionality, and statistical significance.

In column (2) of Table 5, we repeat the estimation for logged time from first provider to disposition. This captures the time elapsed between when the first provider (either an attending, a nurse, or a resident) started interacting with the patient's EHR and the time when the disposition order was signed. With this model as well, we find our main results to be highly robust in terms of magnitude, sign, and statistical significance, with the exception of attendings' partner exposure to residents, which is no longer statistically significant.

**Table 4.** Effects of Team Familiarity and Partner Exposure on Logged Time to Disposition: Alternate Sample Definitions

	(1) Cases without residents	(2) Cases with residents	(3) Including outliers	(4) Including ESI 1	(5) Excluding cases with second nurse
<i>Average team familiarity</i>	−0.0007** (0.0002)	−0.0019*** (0.0003)	−0.0014*** (0.0002)	−0.0011*** (0.0002)	−0.0013*** (0.0002)
<i>NUR's partner exposure to ATT</i>	0.0035*** (0.0008)	0.0016+ (0.0008)	0.0016* (0.0008)	0.0017* (0.0007)	0.0024* (0.0009)
<i>RES's partner exposure to ATT</i>		0.0014 (0.0009)	0.0016+ (0.0009)	0.0016+ (0.0009)	0.0022* (0.0011)
<i>RES's partner exposure to NUR</i>		−0.0024*** (0.0006)	−0.0030*** (0.0006)	−0.0028*** (0.0005)	−0.0037*** (0.0007)
<i>ATT's partner exposure to NUR</i>	−0.0008 (0.0005)	−0.0013* (0.0006)	−0.0013* (0.0005)	−0.0013* (0.0005)	−0.0011+ (0.0006)
<i>NUR's partner exposure to RES</i>		0.0010* (0.0005)	0.0013** (0.0004)	0.0010* (0.0004)	−0.0003 (0.0005)
<i>ATT's partner exposure to RES</i>		0.0009 (0.0006)	0.0009 (0.0006)	0.0009+ (0.0005)	0.0008 (0.0007)
Observations	35,114	76,377	113,718	111,986	71,015
R <sup>2</sup>	0.2060	0.1835	0.1996	0.1858	0.1704

Notes. ATT, attending; NUR, nurse; RES, resident. Team familiarity and partner exposure are measured using 12-month lookback windows. Columns (1)–(5) are log-linear regression models estimated at the encounter level. Controls not shown include age, gender, ESI level, second nurse presence, time since attending shift start, arrival hour-of-day, arrival day of week, arrival year-month, attending current workload and its squared term, nurse current workload and its squared term, resident current workload and its squared term, attending experience, nurse experience, resident experience, attending fixed effects, nurse fixed effects, and resident fixed effects. Standard errors (in parentheses) are clustered by attending-nurse-resident teams.

+ $p < 0.10$ ; \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

In column (3) of Table 5, we estimate the effects on just a small portion of the total time that patients spend in the ED—specifically, the time from disposition to departure among patients who were discharged to home from the ED. Although this duration, which captures the discharge process, is not necessarily representative of the entire time the patient spent receiving care, it could be indicative of the extent to which the physician and nurse are coordinating effectively with each other. Our findings show that teams with higher levels of familiarity can complete this discharge process faster ( $p < 0.01$ ). This may be because such teams are better at communicating with each other. However, and as we would expect, partner exposure does not seem to meaningfully impact the speed of this discharge process.

Finally, in column (4) of Table 5, we estimate the effects on patients' likelihood of returning to the ED within 48 hours for patients who were discharged to home from the ED. This proxies for quality and is an important dimension of service in the ED, especially as it is possible that the reduction in time to disposition is associated with lower quality of care because of a speed-quality tradeoff (Anand et al. 2011, Song and Veeraraghavan 2018, Bartel et al. 2020). Unlike our findings for measures related to speed and efficiency, here we find little evidence of changes in the likelihood of revisit within 48 hours associated with an increase in team familiarity or partner variety. We find that nurses' exposure to more attendings negatively impacts (i.e., increases) the revisit rate ( $p < 0.05$ ),

which is aligned with our main results when we used logged time to disposition as the dependent variable. We also find that nurses' exposure to more residents positively impacts (i.e., reduces) the revisit rate ( $p < 0.05$ ), but the magnitude of this effect is small and does not rise to the level of economic significance. Specifically, patients under the care of a nurse who has previously worked with one more resident experience a 0.0089 decrease in the log odds of the patient returning to the ED within 48 hours.

#### 6.4. Alternate Measures of Team Familiarity

Although our main model captures team familiarity at the team level by averaging each pair's team familiarity (in line with the prior literature; Luciano et al. 2018), an alternate way to model team familiarity is to directly assess the impact of each pair's team familiarity on performance. In column (5) of Table 5, we should the results of estimating such a model, where we substitute the average team familiarity with each pair's team familiarity, and otherwise retaining the same form as Equation (1). We find that the effect of average team familiarity on performance seems to be driven mostly by the level of familiarity between the attending and the nurse.

### 7. Discussion and Conclusions

In this paper, we developed hypotheses exploring how team composition influences team performance, focusing on team familiarity and partner exposure in

**Table 5.** Effects of Team Familiarity and Partner Exposure: Alternate Measures

Dependent variable	(1) Logged time in ED	(2) Logged time from first provider to disposition	(3) Logged time from disposition to departure <sup>a</sup>	(4) ED revisit in 48 hours <sup>a</sup>	(5) Logged time to disposition
<i>Average team familiarity</i>	−0.0013*** (0.0002)	−0.0011*** (0.0002)	−0.0007** (0.0002)	0.0009 (0.0013)	
<i>Team familiarity between ATT and NUR</i>					−0.0010*** (0.0001)
<i>Team familiarity between ATT and RES</i>					0.0001 (0.0002)
<i>Team familiarity between NUR and RES</i>					−0.0002 (0.0002)
<i>NUR's partner exposure to ATT</i>	0.0017* (0.0007)	0.0018* (0.0008)	0.0015 (0.0011)	0.0137* (0.0068)	0.0016* (0.0007)
<i>RES's partner exposure to ATT</i>	0.0017+ (0.0009)	0.0015+ (0.0009)	−0.0005 (0.0014)	0.0019 (0.0083)	0.0017* (0.0009)
<i>RES's partner exposure to NUR</i>	−0.0024*** (0.0006)	−0.0027*** (0.0006)	−0.0002 (0.0009)	−0.0000 (0.0053)	−0.0031*** (0.0006)
<i>ATT's partner exposure to NUR</i>	−0.0011* (0.0005)	−0.0014* (0.0005)	−0.0009 (0.0008)	0.0010 (0.0048)	−0.0014** (0.0005)
<i>NUR's partner exposure to RES</i>	0.0013** (0.0004)	0.0010* (0.0004)	0.0001 (0.0006)	−0.0089* (0.0039)	0.0012** (0.0004)
<i>ATT's partner exposure to RES</i>	0.0009+ (0.0006)	0.0010 (0.0006)	0.0011 (0.0009)	0.0049 (0.0051)	0.0011+ (0.0005)
Observations	111,489	111,481	85,348	84,718	111,491
R <sup>2</sup>	0.3167	0.1844	0.0992		0.1866
Pseudo-R <sup>2</sup>				0.0186	
Mean of dependent variable	299.13 min	188.41 min	40.80 min	4.03%	197.59 min

Notes. ATT, attending; NUR, nurse; RES, resident. Team familiarity and partner exposure are measured using 12-month lookback windows. Columns (1)–(3) and column (5) are log-linear regression models estimated at the encounter level. Column (4) is a logit regression model estimated at the encounter level. Controls not shown include age, gender, ESI level, second nurse presence, time since attending shift start, arrival hour-of-day, arrival day of week, arrival year-month, attending current workload and its squared term, nurse current workload and its squared term, resident current workload and its squared term, attending experience, nurse experience, resident experience, attending fixed effects, nurse fixed effects, and resident fixed effects. Standard errors (in parentheses) are clustered by attending-nurse-resident teams.

<sup>a</sup>Sample is limited to patients who were discharged (i.e., have a departure time) as opposed to being admitted to the hospital.

+ $p < 0.10$ ; \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

temporary teams. We tested the hypotheses by leveraging the ad hoc team assignment and round-robin patient assignment at a hospital ED to cleanly identify the performance effects of these team composition variables. Most of the research in this area has focused on and found performance benefits of team familiarity in temporary teams. A recent study found performance benefits of partner exposure in teams comprised of peers. Our results contribute new empirical evidence demonstrating differential performance effects of partner exposure in temporary teams. We find a negative performance effect of both nurses' and resident trainees' partner exposure to more attendings, and of attendings' and nurses' exposure to more residents. In contrast, both attendings and residents experience a positive impact on performance from working with more nurses. The respective effects of residents working with more attendings and with more nurses is attenuated on patient cases with more structured workflows. These results make several contributions to the literature on the performance of temporary teams and lay out opportunities for future research.

These results contribute new insight into the composition of temporary teams and how it shapes the learning and performance of members over time. For medical professionals at our field site and many EDs, the ad hoc composition of the temporary teams meant that they were exposed to many new team members over the course of weeks, months, and years of working in the Metro ED. As the study of Akşın et al. (2021) suggested, this kind of team composition exposed them to many new partners and many different ways of working. However, the Metro ED teams, like most temporary teams, were comprised of roles that are differentiated by authority and skill, and these role structures influenced whether different team members performed better after being exposed to many partners in different roles. First, although prior research shows that attendings have considerable practice variation (Davis et al. 2000, Grytten and Sørensen 2003, Corallo et al. 2014) and therefore could potentially helpfully expose nurses and residents to many ways of carrying out the same case, we found instead negative performance impacts of partner exposure to more

attendings for both residents and nurses. This pattern of results suggests that the team authority structure contributes to the lack of learning and performance benefits from partner exposure to attendings. Neither nurses nor residents seem to be gaining generalized performance benefits as they work with additional attending partners. With this study, we cannot perfectly rule out the possibility that each new attending is taking the time to explain and narrate to both residents and nurses and that this additional discussion explains the negative efficiencies of attending exposure. This alternative explanation does not align with prior characterizations of teams with this authority structure, where the attendings bear responsibility for a set of life-and-death decisions and need to be authoritative and direct. It also does not align with any of our observations and interviews. The attendings were more likely to engage residents in the formalized treatment plans during rounds or at the computers but not necessarily through ongoing iterative narration and explanation.

In contrast, we found positive performance impacts for both attendings' and residents' partner exposure to more nurses. Regarding the attending and nurse role relationship, prior literature suggests that repeat experience on such a structured interaction offers attendings the opportunity to improve their efficiency and clarity in delivering orders to many partners, and our results supported this argument. Separately, the relevant literature suggests that despite the well-defined disciplinary silos that medical and nursing students are trained and socialized in, these two roles end up interdependent and interactive because they are the team members actively carrying out the plan of care. They are walking to and from the patient bedside carrying out the orders and are more likely to engage in the routine aspects of care delivery; because the residents are so early in their professional learning, these seemingly routine interactions wherein details are narrated and interpreted might be particularly useful for the residents. Different nurses might have different ways of explaining, narrating, or interpreting different patient cases and orders. Our results bore out this set of arguments: exposure to more nurses does significantly impact residents' performance on later cases in a positive way.

Taken together, these results demonstrate that the effects of partner exposure on team performance are setting specific and role specific. For some team members, partner exposure tends to hinder rather than bolster team performance. In addition, although it may not be emphasized in staffing procedures or formal training policies, trainees may benefit from exposure to more cross-discipline partners. Our results suggest that interactions with team members in decision-executing roles, as opposed to decision-initiating roles, is an important but often unrecognized part of

disciplinary training and team learning. Additionally, the moderating effect of more structured workflows also supports this interpretation of the results. This is because the cases that involve laboratory or radiology tests tend to have clearer if-then protocols based on the test results, which lessens the need for residents to rely on other providers for guidance on next steps.

As with many field-based studies, a limitation of this work is that our investigation was limited to a single organization. Future work should explore the extent to which these findings hold in other EDs. It is possible that this ED has a particularly demanding medical culture compared with other EDs. We expect that the larger organizational and professional cultures that shape expectations about how attendings interact with nurses and residents might be a salient contextual moderator of these results (Shortell et al. 1991, Alexander et al. 2005). At the same time, medical care and hospitals are a particularly institutionalized setting, so the underlying dynamics may not vary considerably between EDs. Within the ED context, it could be fruitful for future work to examine alternate measures of performance as well, such as knowledge transfer or professional development.

Our results suggest that the team authority structure shapes the value of partner exposure, and these dynamics may generalize to other hierarchical and institutionalized settings. It is useful to recognize that those properties of the medical setting, and particularly the ED setting, are often attributed to the demands of the work: fast-paced, dynamic, sometimes life-and-death decisions with varied workflow and changing staff (Klein et al. 2006). We hope that future research can extend this analysis to other inpatient hospital settings that similarly staff teams with fluid members across staggered shifts. Many of the contextual characteristics hold broadly in medical inpatient settings, although we expect the dynamics of learning from interprofessional team members might look different in, for example, primary care settings with more stable team staffing. Additionally, less hierarchical and less institutionalized settings might change results; thus, in developing future theory on partner exposure, future work should also explore these dynamics in a variety of other service settings, such as in new product development teams (Edmondson and Nembhard 2009). We were also constrained by some limitations in data availability, such as more detailed information about patient conditions, data on specialists who may also be involved in the patient's care, and the overall tenure of the provider. In addition, like many studies that use archival data to estimate impacts, we do not directly measure the conceptual mechanisms we develop in the argument. That said, these limitations should not bias our estimations, given the round-robin assignment of patients

to teams. This feature of the organizational setting provides a clean identification strategy to isolate performance effects.

In many industries, a growing number of organizations—within and beyond healthcare settings—are using temporary teams that are comprised of cross-discipline team members. These teams are essential to the execution of the complex service operations that these firms carry out daily. Our results provide managers with evidence on the staffing levers they might use to compose temporary teams. Team composition can be a relatively straightforward managerial tool for improving team performance (Ruef 2002, Beckman et al. 2007, Bell 2007, Mathieu et al. 2014, Twyman and Contractor 2019). Furthermore, given the many automated scheduling systems available for use, some of which are home-grown and relatively easy to program, our recommendation that organizations empirically assess the performance impacts of staffing decisions is a feasible one to implement.

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## Endnotes

<sup>1</sup> In Section 6.2, we consider alternate sample definitions in which we consider only the visits that did not include a resident physician, only the visits that included a resident physician, and only the visits that did not include a second nurse as part of the care delivery team.

<sup>2</sup> The lookback window is the time horizon (e.g., 12 months) over which team familiarity and partner exposure is measured.

<sup>3</sup> In Section 6.3, we consider time in the ED, time from first provider to disposition, and time from disposition to departure as alternate measures of performance.

<sup>4</sup> In Section 6.1, we consider alternate lookback windows ranging from 1 to 11 months to assess the sensitivity of the main results.

<sup>5</sup> We check for multicollinearity by calculating variance inflation factors (VIF). The mean VIF in our empirical model is 2.97, which falls below the conventional threshold of 10 (Hair et al. 1998). This suggests that multicollinearity is not a concern in our model (Wooldridge 2012).

<sup>6</sup> In Table B.3 of the online supplement, we report the same set of results with a different method of presentation to facilitate interpretation of the effects for cases with versus without laboratory or radiology tests, as opposed to the difference in effect for cases with such tests compared with cases without such tests.

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