DESIGNING TEAM ROOMS
FOR COLLABORATION
IN THE OUTPATIENT CLINICS

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A SHIFT TO TEAM-BASED COORDINATED CARE

US health systems are moving away from episodic care delivered in silos to coordinated, team-based care with a goal to improve the experience for individual patients and improve population health overall. Ambulatory care clinics are increasingly adopting the Patient Centered Medical Home (PCMH) model of care that is an integrated, team-based model for treating and managing patients, with the goal of delivering:

- Comprehensive primary care that helps patients stay well and avoid or manage chronic diseases;
- Care that develops long-term relationships with patients rather than focusing just on transactional medicine made up of individual clinical encounters;
- Population health management instead of reactive individual care;
- Care by a multidisciplinary team that includes physicians, care-coordinators, nurses, medical assistants, pharmacists, behavioral health specialists, dieticians and others; and
- Coordinated care by "high performing" teams where every team member practices "at the top of their license," feels able to speak up and contribute their expertise and communicates and coordinates effectively through electronic medical records and face-to-face communication.

This kind of integrated, proactive, team-based care has the opportunity to reduce cost, improve outcomes and improve patient experience. By catching problems earlier, patients can be treated at home or in the clinic rather than the hospital and will need to go to the emergency department or ICU less often. Because providers coordinate, there are fewer unneeded tests and procedures, better communication with specialists and better follow up care. Patients with multiple co-morbidities are expected to benefit greatly from this approach. Some five percent of patients constitute 50% of US healthcare cost, and these patients often have multiple chronic diseases and frequently end up in the emergency department or ICU (Cohen & Yu, 2012). Despite these reported benefits, the move to team-based care is difficult for many healthcare organizations who are used to providing care where each provider operates more independently. In this report we focus on the role of the built environment, and particularly the team room, in creating and sustaining teamwork.

PCMH emerged from a philosophy of primary care that is patient-focused over a continuum of care. The well-coordinated PCMH team is accessible to patients and focuses on quality long-term outcomes and safety. The move towards a more comprehensive establishment of the concept for PCMH gained momentum in 2007 when four major primary care associations developed and endorsed the "Joint Principles of the Patient Centered Medical Home" (AAFP, AAP, ACP, & AOA, 2007). The medical home concept includes the following features:

Patient centered: Ensures that the physical, spiritual, and educational needs of patients and their families are respected and provided for, and that medical decisions result from a partnership between providers, patients and their families.
Comprehensive: Ensures a team approach to the whole patient. Care is a long-term relationship that encompasses the mental health and physical needs of the patient, from prevention, to acute, to chronic care, to long-term wellness.
Coordinated: The care is organized across the health system, which includes hospitals, to specialists, to home care, to community programs.
Accessible Services: This includes an assortment of options: 24/7 care, same day appointments, after hours visits, tele homecare.

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Committed to Quality and Safety: Beyond standards, a commitment on the part of clinicians and staff that patients and families have the information they need to ensure informed decisions.

The National Committee for Quality Assurance (NCQA) issued the original set of standards for their recognition program in 2008 and released updated versions in 2011 and most recently in 2014. The standards incorporate the base principles and provide constructive means by which primary care practices can affect the operational and structural changes required to be a recognized Patient Centered Medical Home. The changes run the gamut from daily huddles to coordinate care, implementing electronic health records (an essential component for the successful coordination of care across the board), to tracking of patient health over time for population metrics.

Thousands of large organizations and primary care practices have adopted the PCMH model, representing about 10 percent of the primary care clinicians nationwide, ranging from the 9.6 million patient Military Health System and Mayo Clinic to the Cherokee Indian Hospital and local Federally Qualified Health Clinics (NCQA, 2014). Many other organizations are moving towards integrated team-based care even without seeking PCMH accreditation.

Despite its popularity, the movement toward team-based care has not been easy. The healthcare field has well-established roles and hierarchies and changes slowly. It has proven particularly difficult to move from a physician-centered practice to one where a physician leads a *team* in which everyone communicates with each other and performs at his or her highest level of expertise. Yet, shifting from the traditional healthcare model to a team-based approach is a critical component of the PCMH. High performing teams are necessary to successfully deliver high-quality, patient-centered care. For this reason one of the more significant structural changes that PCHM clinics are making is eliminating private offices for doctors and care team members in favor of shared workspaces for the whole care team (referred to as collocation). The collocation of care team members into integrated team rooms sets a foundation for open lines of communication and collaboration, which are essential to the PCHM. This report provides insight into the ways that the physical environment, in particular the design of the team room, can support effective team collaboration.

THE ROLE OF THE SHARED INTEGRATED TEAM ROOM IN CREATING AND SUSTAINING HIGH PERFORMING TEAMS

The layout and design of workplaces have long been used to provide support for heads-down work, in addition to communication and teamwork. Private offices are generally perceived to allow quiet work, private meetings and, often, confer higher status; shared spaces are intended to encourage teamwork and communication and facilitate supervision by management. In healthcare, physicians and other providers have traditionally been provided private offices. However, a number of healthcare organizations see private offices for providers as reinforcing patterns of hierarchy, disconnected roles and limiting collaboration. In response, many organizations are creating shared team rooms to encourage team-based care. Clinics such as the Alaskan Native Southcentral Foundation, the Group Health Puyallup Clinic, and others, have eliminated private offices for care team members, including physicians. While patients are seen in exam or consult rooms, all other collaborative and individual work goes on in a shared, integrated team room. The goals of these integrated team rooms are to help break down traditional barriers and improve clinical workflow, as well as increase communication and

collaboration by facilitating spontaneous, and contemporaneous conversations, and reducing the need for planned meetings or hunting for another staff member.

These leading healthcare organizations have reported anecdotally that using open collaborative team rooms significantly improves communication and team functioning. For example, Healthcare administrators at Southcentral Foundation reported that since implementing a collaborative team-based approach in a thoughtfully designed team space, staff and customer satisfaction improved, and are now both in the top 90% ("A Village Leads a Nation," n.d.).

However, while it may seem obvious for people to collaborate more when moved into a shared space, a long history of workplace research shows that this does not always occur. Instead, several studies that have surveyed office workers moving from cellular offices to open-plan offices have shown that workers may communicate *less in the new open offices,* because they do not want to bother others or do not want to be overheard. They also reported increased stress and decreased productivity (Brennan, Chugh, & Kline, 2002; Davis, Leach, & Clegg, 2011; Oldham & Fried, 1987; Pejtersen, Feveile, Christensen, & Burr, 2011).

Despite these negative findings, thought leaders such as Google have demonstrated that organizations can thrive, not in spite of, but because of open-office plans. Magazines such as Forbes and Bloomberg BusinessWeek frequently feature stories about Google's success in creating fun, collaborative, productive work environments, and Google has repeatedly been ranked as the number one "Best Company to Work For" by Fortune Magazine. The company has also received global recognition, from Canada to Japan. Google asserts that its people make the company what it is, and it therefore promotes a community, team-based culture.

WHAT WE DID

While there is much to learn from office design, it is not clear how to apply these often conflicting findings to the newly emerging clinical team space. This section describes the approach that we used to sort through the existing findings, conduct new research and develop guidance relevant to particular needs of healthcare clinics. The research involved multiple investigative approaches including:

- A review of the literature;
- Case studies, interviews, & field observations;
- Behavior mapping and provider shadowing; and,
- A simulation exercise.

Literature Review

Our overall goal was to understand how the workspace layout could impact collaboration, particularly the more spontaneous, unplanned communication which the evolving new clinic models need in order to operate efficiently and effectively. Workspace layout has been widely reported to impact communication. Collocation and interpersonal distance were key factors affecting worker effectiveness. The size of team and the workspace, their proximity to others, as well as the orientation of the individuals impacted communication.

We also learned that openness in and of itself didn't guarantee communication – in fact, openness sometimes worked against it. The nature of the work and the type of tasks, as well as the artifacts, played a role in communication as well. However, carefully considered and crafted designs did have the capability to have a positive influence on communication and collaboration, which will be explained in the section, *DESIGN FACTORS IMPACTING COLLABORATION*.

Case Studies

The clinics included in our case studies were selected through a multipronged approach aimed at identifying a cross section of PCMH clinics. Full case study evaluations were completed for the following five clinics:

- Cherokee Indian Hospital Outpatient Clinic
- Emory Patient Centered Primary Care Clinic
- Mercy Care Downtown
- White's Pediatric
- Group Health Pullayup Clinic

We were fortunate to have a diverse cross-section of clinics all pursuing a more collaborative process model. While none of them proved uniquely exceptional above the others, several offered excellent insights and learnings. All of the case studies featured teams with fewer than 20 people, which is a threshold for effective collaboration identified from the literature review (Hartkopf & Consortium, 1993), and several were structured with smaller subgroups – typically a provider and several additional care team members. Correspondent with that configuration, most of the clinics contained a smaller group of clinicians working in closer proximity to each other, sometimes referred to as "pods". Though the clinical work flow varied, the clinics were generally migrating away from separate work areas for physicians and nurses/medical assistants. To varying degrees staff configurations were aimed at increasing collocation and collaboration, while decreasing distance and hierarchy.

The configuration within these team spaces or pods also revealed differences in collaboration and communication. Observations conducted in two team rooms at the Cherokee Indian Hospital's outpatient clinic revealed that orientation and posture in the team room, as well as distance and visibility, significantly impacted team collaboration and communication. A detailed spatial analysis of the Cherokee clinics and the Emory clinics added analytical support to those observations.

In general, configurations with team members facing each other were observed to have more communication episodes than areas where team members were side-by-side or back-to-back, and those in a perching posture were observed to communicate more frequently than those in a seated posture. It was also found that right angle or oblique orientation of workers facilitates casual or spontaneous communication more so than side-by-side orientation in other settings and further research in clinical settings is needed to confirm this. In the dynamic, fast paced clinic environment, spontaneous, contemporary communication was seen as a key to effective and efficient PCMH clinical workflow.

Observation

More in-depth research at one of the case study clinics, Mercy Care Clinic Downtown, was conducted by observing their team members in action. In order to understand the role of care team members and care team communication with regards to their clinical space, two types of observation methods,

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behavioral mapping and provider shadowing, were conducted using, the Detailed Observation Task and Time or DOTT™ tool developed by BBH Design.

Observations were limited to the public or care staff work area in order not to disturb care process and patients. No observations were made inside patient-related rooms such as exam rooms or the laboratory, nor did we make observations inside of individual offices or the medication supply room.

The behavioral mapping observations were conducted over four days during the first and second weeks of December 2014 by five trained researchers. By following a standardized path every 20 minutes, the researchers stopped at designated observation points and recorded the locations and other variables for all the people they could see. As a result, a total of 94 unique behavioral mapping routes were conducted and 1238 data points were collected. Shadowing observations were conducted on three days during the same period by three trained researchers. Each researcher followed one provider and recorded their locations (limited to the pre-determined area), postures, engaged activities, devices used, and their communication counterparts when they were talking. A total of four different providers were followed which resulted in 947 data points. Detailed supporting materials and results are available in the appendix C.

Simulation

To round out the research findings it was essential to give clinicians and care team members the opportunity to directly provide feedback about team room design. Their feedback was sought via a structured simulation exercise that allowed clinical staff to experience different team room designs. While the primary goal for the simulation was to evaluate the research findings about the elements of team hub design that support the key objectives., the team also wanted to understand the value of a simulation for evaluating team collaboration in proposed team spaces.

The research team worked with Dr. Michael Toedt, the Executive Director of Clinical Services for the Cherokee Indian Hospital, to develop the procedures for the simulation exercise. Dr. Toedt's insight was particularly useful because he was instrumental in establishing the Cherokee Indian Hospital PCMH, including their integrated team room and therefore understood the challenges involved in changing organizational culture and work process. Two care teams from Mercy Care Clinic to come to an offsite setting at the SimTigrate Design Lab and worked through several patient scenarios or flows, in two different settings, followed by a discussion of the spaces and decisions about the desired layout.

The simulation was very useful in more accurately and richly evaluating designs. By starting with identifying the key objectives and the needs of the staff, and then translating those both to the mockups and the simulation exercise, we were able to effectively and efficiently gain staff feedback, support, and even increased interest in the new processes. A process simulation can provide a much more accurate experience as well as a deeper engagement, and as our surveys suggested, can positively influence the end result. Detailed supporting materials and results of the simulation are available in the appendix D.

This combination of data sources helped us to understand broadly how the design of workspaces impacts communication and collaboration. Interactions with PCMH clinics provided invaluable insight into the interplay between design, culture and care process far beyond what was available in the published literature. The report is organized to share enough detail about the background research to ground the recommendations, but the main outcome of this effort is the Quick Start Guide (Appendix A),

offering guidance and recommendations for designing effective care team rooms as a concise document.

The next section of the project summarizes the key objectives for integrated team rooms that were revealed through the research process and is followed by an explanation of how these objectives can be translated into clinic-specific needs as functional scenarios. These scenarios provide a context for a meaningful examination of the physical environment elements that influence communication and collaboration. The report concludes with guidance of how to use this research in a design project through an illustrated example from our collaboration with Mercy Care clinic. Detailed supporting materials are available in the appendices.

KEY OBJECTIVES OF INTEGRATED CARE TEAM ROOMS

Shared, integrated team rooms are aimed at helping the functional and cultural transition to team work. They are intended to allow care teams to work together, share information and coordinate care. At the same time, they need to allow staff to do their heads-down individual work accurately, at high efficiency and without undue interruption. Based on our literature review and observations, integrated care team rooms have four major objectives:

- **Supporting care coordination and situational awareness**: A high-performing team needs to understand and anticipate each other's needs and movements. In addition to impacting specific communication, an open, shared team room can allow staff to quickly assess what is going on with their own team and with others, see who is swamped or under-used and how to help the choreography of the team. This is facilitated by architectural layouts of rooms and hallways where people can see and encounter each other over the course of the day.
- **Supporting staff individual roles:** Each team member has specific behaviors, needs and functions that must be supported, such as talking on the phone, reviewing paper records, accessing a computer, locating medical equipment, training students or retrieving educational materials. These tasks require use of information on paper and available electronically and sometimes require concentration and the ability to focus.
- **Facilitating team communication**: Shared integrated team rooms are intended to foster communications within teams and between teams. They aim to foster communication across roles—such as between physicians and nurses, nurses and pharmacists—and between peers on other teams. Some communication is structured into the workflow for a patient care and is less impacted by design. Seeing and encountering other staff particularly facilitates communications that are unplanned and do not have formal organizational triggers. Also, seeing people all day face-to-face helps break down hierarchical role-based patterns of communication and reminds staff to check in with other staff.
- **Highlighting the role of the team**: Team-based care represents a significant shift for most organizations and providing a shared team room represents substantial evidence that an organization is changing the way care is delivered. A shared office is a powerful symbol that care is primarily delivered by teams rather than individual providers. This is particularly true if shared rooms are the prime place where work is done. This symbolism is reinforced every day as team members see each other in daily contact and get to know each other's stories.

The next section details the impact that specific design elements have on communication and collaboration in integrated care team rooms. Following this exploration of the design factors, we explore a set of functional scenarios that can used to evaluate how well a design meets the needs of collaborative team. Then we tailor them to a clinic project by developing stories that give life to the scenarios allowing us to create a crosswalk between the scenarios and design factors that support them.

DESIGN FACTORS IMPACTING COLLABORATION

A number of different aspects of the physical environment have been identified as influential on the behavior of individuals and teams that can be used to support better team dynamics and to ease the flow of clinic operations. These findings were derived from a review of academic and industry literature, observations during field research in several clinical settings, case studies, and feedback during a facilitated simulation exercise with clinical staff. In this section, spatial characteristics that affect collaboration/communication are reviewed at three different levels: overall clinic layout, team room design, and workstation or furniture features. The specific aspects of the environment that pertain to each of these levels are listed below in Table 1.

Table 1. Environmental aspects of collaboration at three levels

CLINIC LEVEL	TEAM ROOM LEVEL	WORKSTATION LEVEL

• Visibility
   - Throughout the clinic
   - To patient rooms
• Proximity and accessibility to team members
• Defined boundaries
• Talking rooms
	• Collocation and interpersonal distance
	• Limited distraction
	• Arrangement
	• Visibility to each other
		• Artifacts
		• Vertical surfaces
		• Workspace height

CLINIC LEVEL DESIGN ISSUES

The heart of this research effort is the design of the integrated care team room but it is also important to understand the key issues in how the team room relates to the rest of the clinic, and in turn how the overall clinic layout effects communication and collaboration of the patient care team. The layout of the clinic and relationships between the workspaces and exam rooms exert a significant influence on interaction among staff and with patients. Major factors identified include the location of the team room with respect to the corridors, patient traffic, the facilitation of impromptu conversations and whether or not the team is fully co-located or there remain some separate offices.
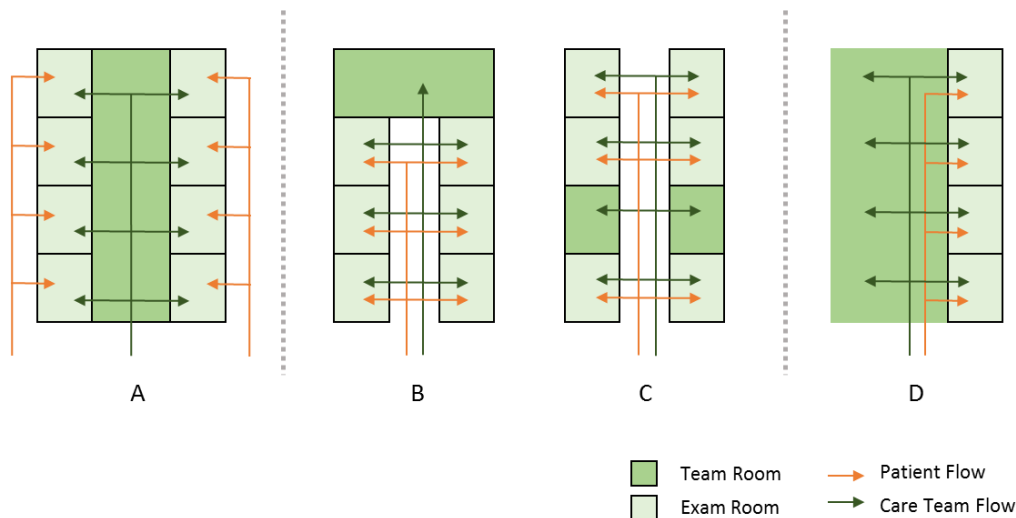
Figure 1. Spatial typologies of clinic layout that range from maximally segregated to fully integrated as illustrated below going from left (A) to right (D).

We observed several spatial typologies of clinic layout that range from maximally segregated to fully integrated as illustrated below going from left to right in Figure 1. The circulation of patients and care team members is segregated in schematic A, where the exam rooms have double entrances insulating the team room from public view. Schematic D shows the other end of the spectrum, where patients and care team members use the same paths and traverse through the team room to reach the exam rooms.

Visibility

Having good visibility to the overall clinic can support care team members' abilities to understand and anticipate the needs and movements of colleagues, as well as patients. Good visibility allows care team members to be aware of patient status and makes it easy for them to reach out to other team members. It is important to provide sufficient visibility to the clinic pathways from the team room, where our observations found care team members spent the majority of their time. Visibility to co-workers not only facilitates spontaneous and intentional communication, but also contributes to greater awareness of peers and increases opportunities for knowledge sharing and tacit learning (Cai & Zimring, 2012).

Visibility of spaces can be quantitatively calculated using Space Syntax methodologies ("Space Syntax Network," n.d.). These spatial analyses can reveal more about a space than may be apparent when viewing a floor plan. Using the open source Depthmap software created by University College London, we conducted a visibility analysis of the case study clinics and found a high degree of variability in visual affordance (how much of the space can be seen from a certain point) of the whole clinic due to layout. The visibility analysis results for three integrated care team rooms are illustrated below (Figure 2). The location and size of high visibility zones (indicated in red) in the three clinics are different. In the Emory clinic, the red zone covers the medical assistant station, which is where most of the team communication occurs. In Cherokee Indian Hospital's green clinic, the team room has the most visibility in the clinic, but the highest visibility is limited to the middle desk and does not cover all seats of the team room. Lastly, none of red zones in Mercy Care's previous clinic floor plan are located at or near either the provider or medical assistant offices, in fact these spaces are shaded blue indicating that they have some of the lowest levels of visibility.

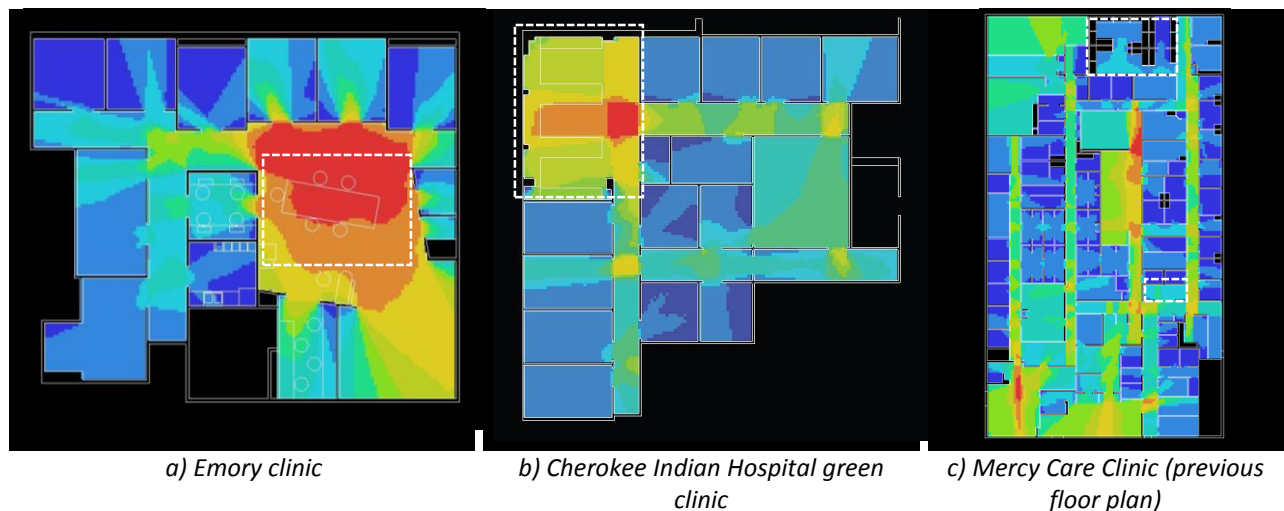| *a) Emory clinic* | *b) Cherokee Indian Hospital green clinic* | *c) Mercy Care Clinic (previous floor plan)* |

Figure 2. Visibility analysis of three clinics where, the red zones indicate locations on the floor plan that have the highest degree of visibility to all other areas and blue zones indicate locations with the least visibility to other spaces. The team rooms are indicated with the dotted white lines revealing that the highest visibility areas at Emory and Cherokee occur in the team room.

Proximity and Accessibility to Team Members

Physical proximity among co-workers has been found to be influential for collaboration and communication (Allen, 2007; Hartkopf & Consortium, 1993; Heerwagen, Kampschroer, Powell, & Loftness, 2004; Oldham, Kulik, & Stepina, 1991). In a study of a single department that was located on two different floors of the same building, Allen (2007) found two separated clusters of communication networks divided by level. The study concluded that the probability of communication declined with distance, indicating the importance of close proximity among coworkers to enhance the communication and collaboration.

Our observations confirmed that distance and accessibility between workspaces is critical for teamwork, especially when different roles that are working as a team are not located together. For example, Mercy and Emory both had shared offices, however they were spaces designated to specific roles (i.e. for providers or medical assistants). Despite the similar arrangements, the reported effectiveness and satisfaction were markedly different in these clinics. At the Emory Clinic, team members had high visibility with direct accessibility to each other. However, care team members in Mercy found the location of shared spaces for providers and nurses, which were far apart and had no visibility to each other, was problematic and resulted in less face-to-face communication. The lack of connectivity between their two shared offices was a major driver in Mercy's decision to renovate the clinic to create team hubs for all team members to share.

This difference in visibility between the two clinics is illustrated using a step depth analysis method from Space Syntax ("Space Syntax Network," n.d.) to compare the layouts from these two clinics to see the impact that their configurations have on visibility. Visibility step analysis illustrates how many steps (or effort) are needed to see other areas from specified locations. Using the work location of the medical assistants as the starting point, Figure 3 shows that while there is immediate visibility between the medical assistants and all the other care providers at Emory, in the pre-renovation Mercy Care clinic much more effort is needed for medical assistants to see providers.

a) Emory clinic   *b) Mercy Care Clinic*
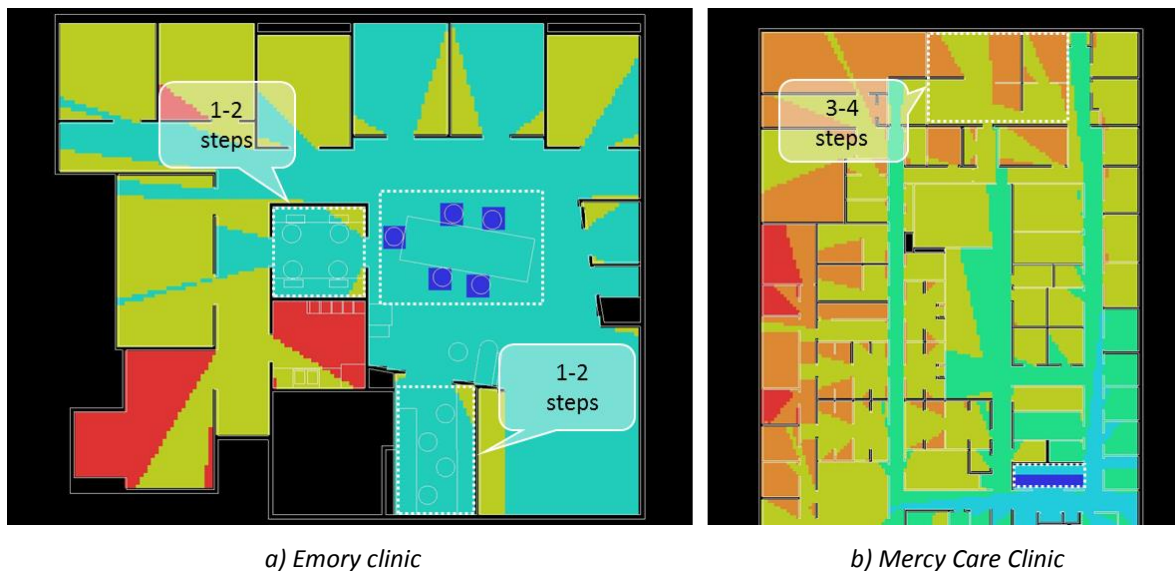
Figure 3. Step Depth analysis from MA station to the provider office revels that the medical assistants (indicated in blue) have more accessibility to the providers at the Emory Clinic (left, 1-2 turns) with less number of turns (or 'steps') compared with Mercy Clinic's previous layout (right, 3-4 turns). Turquoise indicates spaces that require no effort to have visibility and warmer colors indicate increased effort required.

Visibility to Patient Rooms

Along with global visibility and accessibility to team members, another important aspect of the clinic layout is providing visibility to patient-related areas from team areas. Care team members need to be aware of patient status and their stage in the care process to appropriately provide care and support their needs. This can be supported by the relationship between team rooms and patient-related spaces such as exam rooms, triage rooms, labs and sub waiting areas. Care team members also use occupancy of these areas to intuit fellow team members' locations and activity.

As an example, while conducting observations and interviews at Cherokee's two clinics, nurses stated that visibility of exam room doors is important to them because it allows them to recognize the status of patients. In particular, it permits them to know if a patient opens the door and exits an exam room, or if the provider is in the room. Emory clinic has high visibility to patient room doors from the medical assistant station. Figure 3a above represents the number of turns needed to see and access throughout the clinic from seats of medical assistant station (marked as blue-square). The light green area indicates the space that can be directly seen and accessed by medical assistants without additional efforts. As shown in the figure, this area covers five exam room doors out of the six exam rooms in the clinic. For the one exam room door that MAs cannot directly see, they pointed out that they use the color-coded flags placed on the wall to indicate patient status for that room.

Defined Boundaries

One significant difference of healthcare workspace compared to other workspaces is the regular presence of clients (i.e. patients) in addition to the staff (i.e. care team members). Patients are care-receivers, yet increasingly regarded as core members of their team, and still they are outsiders when it comes to the other care teams and patients in the clinic at the same time. Therefore, while it is

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important to incorporate patients into the care process, it is also important to protect their private information from other teams, especially other patients. In an observational study of the impact of nurse station design Gum, et al. (2012) found that open nurse stations lack privacy for conversations. In the nurse stations they studied that were more enclosed they observed more spontaneous conversations and less interruptions, which demonstrates the importance of defined boundaries to team communications.

The integrated team space should be defined with explicit territoriality differentiating it from the patient care areas. Design elements should passively signal areas of limited access to patients, to avoid confusion and potential privacy breeching behavior such as patients wandering into workspaces and viewing protected health records. This can be achieved by setting clear visual and/or physical boundaries with walls, partitions, ceilings, windows, or other physical cues such as changes in flooring materials.

However, considerations for privacy and confidentiality must be balanced with the needs for visibility, proximity and accessibility. Care team members also need situational awareness of patient status and other staff members, which is facilitated by having good visibility to patient-related area. Therefore, spatial considerations at several scales must be balanced, including the location of team room in regards to the patient flow, distance from corridor and treatment rooms to the team area, the configuration of work area, and height of partitions and work surfaces in order to balance team member's visibility to patients and support ease of movement, while maintaining appropriate levels of privacy and curtailed accessibility by patients.

This finding was highlighted during the simulation exercise with the Mercy Care clinicians. While the care team members initially preferred layout B (Figure 4) reservations about that layout regarding privacy emerged once the facilitated exercise began. Even though some aspects of layout B were very attractive to them, they felt that the opening between the two workstations read as an access point that might appear to be inviting patients to enter. Furthermore, beyond the issue of protecting privacy, the providers were concerned that this layout left them exposed to the patient and did not provide them with any egress options if a patient were to block the opening. Despite a similar degree of visibility to the exam room doors, participants felt the location of countertops between the patient flow area and the workstations provided a clear boundary in layout A.

Layout A   Layout B
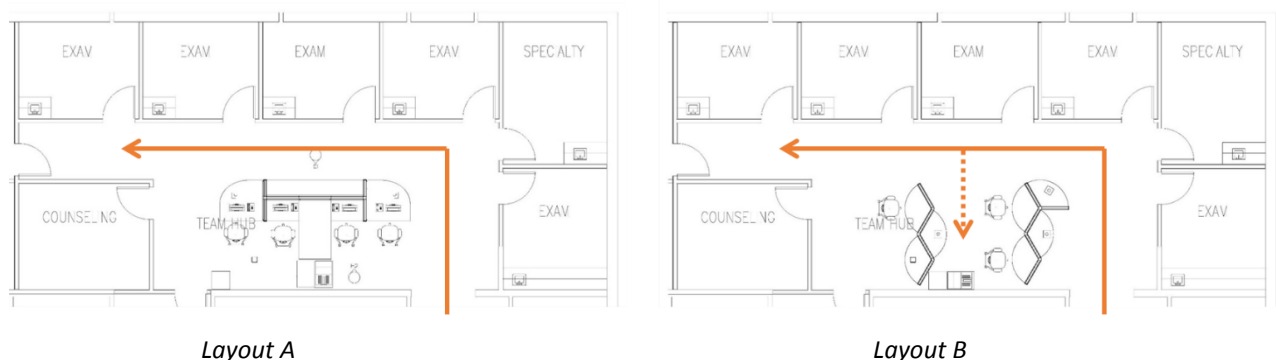
Figure 4. Minor configuration differences between the two layout options for Mercy Care result in a different sense of territoriality and privacy for the care team while maintaining similar levels of visibility to the exam room doors.

A common concern of care teams without private offices is the perceived lack of sufficient spatial resources for private conversations between care team members or between care team members and patients. This concern can be addressed by placing several multi-purpose consultation rooms throughout the clinic. These multi-purpose consultation rooms, or 'talking rooms' in the parlance of the Southcentral Foundation, can be adjacent to the team area and patient related area. As an example, Emory clinic has two multi-purpose rooms adjacent to one another that are available for private communications, specialist consults or can be used by group visits by opening up the high-noise rated accordion wall to combine the two rooms into one larger space.

Although spatial resources, such as additional consultation rooms, may not have a formally programed function and therefore could be construed as excess and unnecessary square footage, they play a critical role for facilitating desired short, intentional communications of care teams.

TEAM ROOM LEVEL DESIGN ISSUES

Eliminating private offices and creating a shared workspace for the care team goes a long way toward building a culture of collaboration, yet there are many more decisions about the design of that shared space with can facilitate the team further along the collaborative journey, or inhibit their progress. As previously mentioned there is a significant of body of literature examining the impact of design of shared spaces at this scale in white collar offices, social settings and experimental environments upon which we can draw some conclusions for PCMH team spaces. The integrated team room needs to support the collaborative work of the team as well as the focused work that the individual team members must do throughout the day. Small design elements such as the orientation of workstations, distance between co-workers, visibility and privacy accommodations all influence how well the space supports the team performance.

Collocation and Interpersonal Distance

Co-presence in shared workstations has been found to result in greater situational awareness. Studies of nurse station design have found that when nurses are collocated they communicate with each other more (Gurascio-Howard & Malloch, 2007; Hua, Becker, Wurmser, Bliss-Holtz, & Hedges, 2012). A comparison of inpatient nurse station design reported that nurses in centralized nurse stations are more likely to be aware of their fellow nurses' workload and offer assistance to one another (Gurascio-Howard & Malloch, 2007).

The number of people in a workgroup, and the distance between the individuals is important, in addition to the layout of workspaces. One study found that work groups with more than 20 people were less likely to form a strong community, and even groups with more than 7 people struggled to relate to a collective goal (Hartkopf & Consortium, 1993). Allen (2007) attributed the tendency for smaller units to form more cohesive groups to increased familiarity and communication. This emphasizes the importance of team room design, especially with large open spaces, to support smaller more effective teamwork.

The impact of collocation on communication patterns was reinforced by the observations conducted at Mercy Care Clinic. Although providers and Certified Medical Assistants (CMAs) make up the primary care team at Mercy Care and thus require frequent and accurate coordination between them, the observed frequency of face-to-face communication between these roles was actually lower than face-to-face

communication between people in the same roles (Figure 5). For example, providers talked to other providers for 41% their communication while only 21% of their communication episodes were with CMAs. Similarly, 40% of the communication by CMAs was talking to other CMAs and only 13% was with providers. This pattern of communication appears to have been driven by the clinic layout, which created distance between team members. Providers had their shared office in the backside of the clinic, while CMAs stayed together around the front NURSE/CMA station resulting in close proximity to the same roles and encouraging more communications with each other.
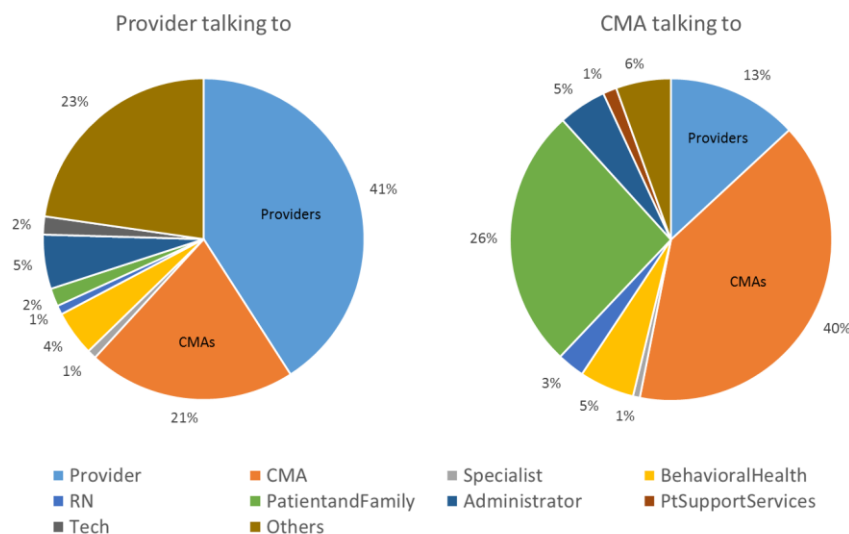

Figure 5. Communication counterparts per role: providers and CMAs talk more to the same roles than other roles

Additional support for this theory is illustrated by mapping the location in which providers and CMAs were observed to be talking, regardless of who they were talking to. The images in Figure 6 show that the main location of the providers while talking is inside the Provider office and the main location of the talking CMAs is around the NURSE/CMA station.

Limited Distraction

Close interpersonal distance does not always enhance employees' work productivity (Oldham & Fried, 1987; Oldham et al., 1991). While PCMH clinics emphasize the value of communication and collaboration amongst team members, there are still significant and critical tasks that are completed by individuals. Tasks such as documenting in electronic medical records, reviewing and prescribing medications, and making phone calls to specialists happen throughout the course of the day and require focused attention to be done accurately.

According to Oldham, et al. (1991), employees were more productive and satisfied when they worked in areas that were distant from the nearest co-worker. It is possible that the process and nature of the work being completed may require different proximities. Additionally, it is possible that when employees are arranged too close to each other they may be disturbed by the presence of that close coworker.

a) *Providers* b) *CMAs*

Figure 6. Location while talking (Left: providers, right: CMAs): the main location of the providers while talking is inside the Provider office and the main location of the CMAs while talking is around the NURSE/CMA station

This need is often described as the need for privacy, but that term (being alone and unobserved) does not quite capture the need as observed in care teams; what clinicians describe wanting is the opportunity to block out diversions and disruptions so that they can narrow their focus. It isn't that they want to be unseen/unheard but rather that they do not want see or hear things that distract them. These tasks arise many times during the day and can happen while a patient waits in the exam room, so they need to be done quickly and preferably in a nearby location. This perceived need is also a major point of contention and push back from physicians when they are 'de-officed' and told to work in the shared team room. There are times occasionally, but less frequently, when individuals do want privacy, such as for a sensitive conversation, but this need can often be accommodated with a consult room or other similar hoteling-space in close proximity to the team room.

Some physicians may not want to verbalize that they do not think of themselves as part of a team because of the negative connotation such an admission would impart. They may push back against the concept of team-based approach to healthcare because they view their primary role as independent and cognitive. Other physicians may embrace the team based approach because they understand their primary role to be an integral part of the team—a leader who is truly present and available to both provide team direction and to receive and utilize a high level of support. An important concept integral to successful pairing of workspace and employees is that the employee should have a clear understanding of their role in the organization. Space should be designed to support the employee's primary role. If the employee's role is primarily collaborative, then a thoughtfully designed and arranged collaborative team space will likely facilitate teamwork. A space that is designed to support heads-down focused individual work will surely support an employee in performance of that primary role, but will

not facilitate or enable transition to a team-based approach. Thus it is important not to over emphasis 'heads-down' spaces to the detriment of team cohesion.

Some guidance about the appropriate distances comes from the work of Edward Hall. Hall (1966) first described four major interpersonal distance zones based on the social relation between two people. According to these four zones, personal distance for two people in an intimate conversation is 18-30 inches and for a personal conversation is 2.5 – 4 feet. These findings are supported in additional work, suggesting that the optimal distance between workers is between 2' and 4' (Batchelor & Goethals, 1972).

Arrangement

Layouts that allow workers to face each other and interact at a comfortable distance often encourage interaction. In the late 1950s Humphrey Osmand and Robert Sommer identified kinds of furniture arrangement that encouraged or discouraged communication, that they labeled sociopetal and sociofugal (Cherulnik, 1993; Sommer & Ross, 1958). Interaction-encouraging sociopetal arrangements have chairs in small clusters where people can interact at short distances—3' to 8', and are at right angles for conversation and side-by-side for collaboration. Interaction-discouraging sociofugal layouts had chairs in rows or side-by-side. This work has been replicated in numerous field and lab studies and has been applied to workplaces (Cassidy, 2013; Folkestad & Banning, 2009).

The ideal positioning of seats varies depending the type of interactions (Greenberg, 1976). For example, Sommer (1965) conducted a study to see how people would arrange themselves for different group tasks: conversing (to chat for a few minutes before class), cooperating (to study together for the same exam), co-acting (to study for different exams), and competing (first to solve a series of puzzles). The preferred seat positions for two participating people were different according to group tasks. People cooperating together strongly preferred to sit side-by-side, while people conversing chose a corner-to-corner or opposite arrangement. Although this study did not confirm that seat positions influence the frequency or quality of collaboration, it was found that people arranged themselves differently according to nature of the task and therefore the team room needs to be responsive to the nature of integrated team collaborations.
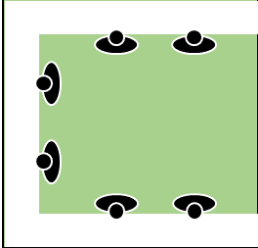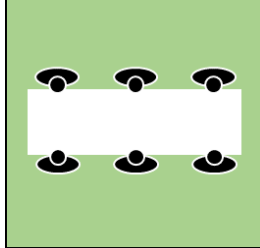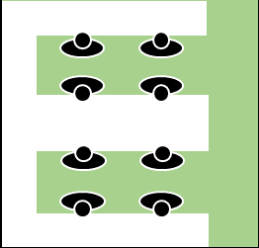
We observed a range of configurations in the case study clinics and share the three below in Table 2 as instructive of that variation. The communications of the sociofugal, exterior facing orientation of Cherokee's blue team room were limited, while the communications in their green team room were observed to be much richer – both among and between the teams, as well as between clinicians of different status – much as research suggests. It is interesting to note that the majority of the cases observed used sociofugal seating arrangements despite the fact that research suggest this is configure is least supportive of communication. The prominence of this arrangement may be a result of the desire to provide privacy or for its perceived economy of space utilization, but given the implicit objective of the team room for supporting enhanced communication this should be rethought.

Previously cited research recommended side-by-side orientation for collaboration, and right or oblique angles for casual communication. Further research is needed to examine the effect on communication by orientation. For example, to what extent does offsetting individuals rather than having them directly face each other alter communication patterns? At this point the best clear guidance is to avoid having team members with their backs to one another.

Visual contact is critical in stimulating communications (Allen, 2007; Wineman, 1984). Allen (2007) explained that people need to be reminded of the existence of potential communication partners. Visibility between communication partners often prompts individuals to seek assistance. Considerable research has shown that people who are visible to others take on a more important role in their social network; people who are seen are more likely to be consulted and talked to (Rashid, Kampschroer, Wineman, & Zimring, 2006). This visibility among team members is determined by several spatial elements, including the workstation arrangement as mentioned above, and the configuration and height of visual barriers such as partitions, as well as work surface height.

Table 2. Team Room layout types

Type			
Characteristics	Sociofugal Exterior facing Seated	Sociopetal Centrally facing Seated	Sociopetal Group facing Perching height
Examples	• Cherokee) Blue Team Room • White) Provider and nurse office, station and call centers • Mercy) Provider office, Nurse/CMA station, and CMA/BH Specialist office • Emory) Nurse and Provider offices	• Emory) MA station • Group Health) Work Station	• Cherokee) Green Team Room

WORKSTATION OR FURNITURE LEVEL DESIGN ISSUES

Although specialized spaces are often included in floor plans for intentional collaborative activities, such as meeting rooms, individual workstations are also critical elements in workplaces for collaboration. One report found that as much as 70 percent of collaboration happens at the individual workstation (HermanMiller, 2012). Also, there is a clear preference for individual workstations for collaborative work and casual interaction compared with corridors or shared open spaces, indicating the importance of the design of workstation layouts for collaborative and interactive behaviors (Hua, Loftness, Kraut, & Powell, 2010). Through our observations we found the most significant design elements at this scale where the presence/location of devices, vertical surfaces for sharing information and the height of the work surfaces.

The appropriate use of artifacts can support collaboration and communication. Collaboration and communication in healthcare settings often requires the use of paper or screen-based documents at hand. Bardram & Bossen (2005) identified the key artifacts used in healthcare settings with a case study of a hospital unit: the team room's whiteboard, the ward office's whiteboard, the examination sheets, post-it notes, and personal notes. Luff, Heath, and Greatbatch (1992) found that the use of paper persists along with the use of screen-based documents in various settings. They identified that although screen-based systems are designed to support collaboration, they localize the user's activities to the screen, generating certain constraints for collaboration. Even now, decades later, paper remains an important part of clinic operations and yet workstation designs do not always make accommodations for paper. The desks at one clinic that we visited were only deep enough to fit the computer monitors and keyboards, so as a work around the clinic staff pulled out filing drawings to create a work surface to support their papers (Figure 7). In another clinic providers told us that they routinely used the printer station as a temporary writing surface to jot down notes between patient exams.

Figure 7. Paper remains an important part of clinic operations and yet workstation designs do not always make accommodations for paper

Vertical surfaces

The use of shared information displays (Heerwagen et al., 2004; Olson, Covi, Rocco, Miller, & Allie, 1998) such as vertical display spaces for temporary and more long term information can support collaboration (HermanMiller, 2012). Olson, et al (1998) found that large, complex, and persistent shared artifacts (e.g. flip charts, whiteboards, tack boards, and walls) supported collaboration, and large and persistent cognitive artifacts (e.g. to-do lists with items assigned to individuals) also facilitated coordination.

One example of active use of vertical surface is presented with the figure below (Figure 8). At this clinic, as several providers and the team members are collocated and the schedule of the providers varies, a whiteboard was used to note the providers on duty that day and their assigned exams rooms so that all team members would be aware of the use of resources. This vertical surface, a whiteboard, was located in the middle of the team room, and visible from all seats inside the team room and was updated each day.

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Figure 8. An active vertical surface used to display immediate and more persistent information

Workspace height

The impact of workspace height is another area for exploration of the impact on collaboration and communication. Herman Miller internal research on clinicians found that most nursing tasks in team areas are short (2 minutes or less) resulting in clinicians moving from their work surface to other areas of the clinic frequently. Perching height workstations are more conducive to short bursts of work because they permit easy access without the effort required for constantly changing from sitting to standing. Standing height work surfaces also more readily facilitate collaboration and shared viewing of paper or digital records with colleagues.

The observations at Cherokee provided an interesting comparison of the impact of different work surface heights. All of the work surfaces in the blue team room were at the traditional desk height and all team members sat down while at their workstations. The students who were shadowing providers working out of this team room stood up next to their mentor who remained seated throughout the interaction. This is contrasted with the green team room where all the work surfaces were at standing height. Even though high rolling chairs were available for sitting, the providers in the green room predominately chose to stand while charting between patient exams. Consequently the interaction between providers and the students appeared more congenial and lasted longer possible due to the more equitable configuration.

MAPPING OBJECTIVES TO SPATIAL ELEMENTS

How can a design team make sense of the numerous spatial elements that need to be considered when designing a team room, given the variability of the impact those elements have on behavior and the range of activities performed by a PCMH team? To make these findings more concrete the design factors can be mapped to the key objectives. This map demonstrates the relevance of the highlighted spatial elements and provides a matrix to help designers and project teams begin to prioritize the most important features and balance the competing needs for a given clinic based on the critical functional scenarios for that care team. The section following this matrix provides an example of how this process was used to help a federally qualified health care design their renovated team hub.

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Table 3. Design factors and functional scenarios/key objectives

KEY OBJECTIVES		SITUATIONAL AWARENESS				SUPPORT INDIVIDUAL ROLES			COMMUNIC ATION			SYMBOLISM			
FUNCTIONAL SCENARIOS (FS) & DESIGN FACTORS		FS # 1	FS # 2	FS # 3	FS # 4	FS # 5	FS # 6	FS # 7	FS # 8	FS # 9	FS # 10	FS # 11	FS # 12	FS # 13	FS # 14
CLINIC LEVEL	Visibility throughout the clinic		x		x										
	Visibility to patient rooms				x									x	
	Proximity and accessibility to team members			x			x		x						
	Defined boundaries							x							x
	Talking rooms									x					
TEAM ROOM LEVEL	Collocation and interpersonal distance						x			x					
	Limited distraction					x									
	Arrangement								x			x	x	x	x
	Visibility to each other	x	x												
WORK-STATION LEVEL	Artifacts					x			x						
	Vertical surfaces										x				
	Workspace height					x									

EVALUTING KEY OBJECTIVES USING FUNCTIONAL SCENARIOS

While the above stated design factors mapped to the key objectives help to frame the important issues for the design of the team room, they do not provide explicit direction for action. To translate this research into practical guidelines and recommendations that help owners and design teams build better healthcare environments the research team developed a methodology for operationalizing the objectives and spatial elements into more specific functional requirements. By articulating the essential functional requirements for the team room through dynamic scenarios we make the spatial requirements more obvious and easier to evaluate.

The team developed 14 unique functional scenarios based on field observations and expert input. These scenarios were based on activities that go beyond routine workflow, and attempt to reveal dynamic situations that are more difficult or complicated to accomplish and where there is evidence that the physical environment plays a role. These include deviations from the typical workflow leading to activities where there is a quick shift in flow, and often an immediate need for accessing a different resource. As such, the set of scenarios does not capture all the activities that an integrated care team performs in the team space; the intention is that these functional scenarios represent a range of the more disruptive activities that an integrated care team will encounter on a regular basis. The scenarios are intended to highlight conflicting needs that arise over the course of the clinic day and illustrate the tradeoffs and compromises that may be necessary in the design of the team space. The scenarios are performance based situations, as opposed to prescriptive space based criteria, and were constructed to be general enough that they are applicable to a wide variety of PCMH clinics, and can guide the evaluation of different spatial designs. The functional scenarios are organized by the key objectives they are intended to support, and are designed to test the presence of the spatial elements that support each objective.

Situational Awareness

- Care team members need to be able to reach out to each other throughout the day
- Care team members need to be able spontaneously seek advice and education with a range of peers throughout the day
- Care team members are able to get/give workload assistance from/to others when busy
- Care team members need to be aware of patient needs, process, and point in journey

Support Individual Roles

- Care team members need to be able to focus on detailed work that requires concentration
- Care team members need to work at the top of their license
- Care team members need to be able to manage their accessibility by patients

Communication

- Intentional: Care team members need to be able to get advice from other care team members
- Spontaneous: Care team members want to confirm or exchange information quickly with other care team members
- Care team members need to have shared understanding of current information

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- Care team members need to feel that they are part of a team that provides patient centered medical home care
- All care team members need to feel empowered to provide care up to the limits of their professional abilities
- Patients need to feel confident that they are being treated by a care team whose members have a shared understanding of their health needs
- Patients need to feel confident that their private medical information is protected and secure from other patients and other clinical staff not on their care team

MAKING IT REAL: ILLUSTRATIVE STORIES AND CHALLENGING QUESTIONS

The research team had an extraordinary opportunity to partner with Mercy Care, a local federally qualified health clinic that was in the midst of a renovation project to create a team hub where there was none previously. The initial engagement included behavior mapping and observation of the clinic workday to understand their culture and care process in the existing space. Herman Miller developed several design alternatives that we were able to mock up in the SimTigrate Design Lab. Details about the simulation are provided in Appendix D.

To help the Mercy's care team choose a design we took the functional scenarios and went one step further by creating test cases that would enable greater specificity of requirements and tools for evaluating the effectiveness of the design solutions. Working with the clinic leadership and Dr. Michael Toedt, Executive Director of Clinical Services for Cherokee Indian Hospital and a PCMH expert, we developed stories, or test cases, to make the functional scenarios real. Below is a table with the specific scenarios and test cases developed for Mercy Care; each functional scenario has at least one example which consists of a case that sets up a scene, this is paired with a measure of success that we used to evaluate the performance of the team in a space. Finally, we have identified the elements of space that have the most significant influence on team performance for that functional scenario. The table is organized by the four objectives: situational awareness; support individual roles; communication; and symbolism.

The work of a high-functioning team is dynamic, and benefits from short, spontaneous interactions. While process maps are strong tools to help uncover the explicit needs of the team, creating a dynamic simulation is needed to capture the tacit activities and behaviors critical to a high functioning clinical workflow. Mercy agreed to bring a couple of teams to the SimTigrate Design Lab to participate in a simulation exercise to run through the some of the test cases. For each case that we enacted we observed or asked the care team to respond to the measures of success to see how well each of the mocked-up layouts performed for that function. This process helped the clinicians understand the importance of the design and to see what other people do in the clinic. The simulation provided a framework for the team to collaborative evaluate the alternatives and make informed contributions to the final design development.

FUNCTIONAL SCENARIO # 1		**Care team members need to be able to reach out to each other throughout the day**
Example	CASE	Provider learns in the middle of an exam that patient needs to see the behavioral health specialist; provider needs to find behavioral specialist to brief them on the patient
	MEASURE OF SUCCESS	° Can provider find behavioral health specialist quickly? ° If not, does the provider know when/where they will be available?
SPATIAL ELEMENT		Visibility to each other

FUNCTIONAL SCENARIO #2		**Care team members need to be able spontaneously seek advice and education with a range of peers throughout the day**
Example 1	CASE	Provider wants opinion from fellow doctor on complex patient before discharging the patient
	MEASURE OF SUCCESS	° Is provider able to find other provider in team room for quick consult?
Example 2	CASE	New MA never dealt with behavioral health questionnaire
	MEASURE OF SUCCESS	° Is MA able to observe/witness and learn how fellow MAs do it?
SPATIAL ELEMENT		Visibility throughout the clinic, Visibility to each other

FUNCTIONAL SCENARIO #3		**Care team members are able to get/give workload assistance from/to others when busy**
Example	CASE	MA is going to get patient and learns that provider wants them to redo EKG on earlier patient and another MA is idle
	MEASURE OF SUCCESS	° Can MA easily and quickly ask for help? ° Can fellow MA sense problem to offer help?
SPATIAL ELEMENT		Proximity and accessibility to team members

FUNCTIONAL SCENARIO #4		**Care team members need to be aware of patient needs, process, and point in journey**
Example	CASE	Patient has been waiting in room for provider for 30 minutes and exits room to leave without being seen
	MEASURE OF SUCCESS	° Does the MA have enough info to know that the provider hasn't been in to see the patient yet? ° Does the MA know when the provider will be ready to see the patient?
SPATIAL ELEMENT		Visibility throughout the clinic, Visibility to patient rooms

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FUNCTIONAL SCENARIO #5		Care team members need to be able to focus on detailed work that requires concentration
Example	CASE	Provider needs to review medication list and prescribe new medication for a complex patient while the patient is waiting in exam room
	MEASURE OF SUCCESS	° Can the provider quickly access the EMR, consult with external pharmacy and calculate appropriate dosage without error? ° Is the provider free from visual and auditory distraction for tasks requiring concentration?
SPATIAL ELEMENT		Limited Distraction, Artifacts, Workspace height

FUNCTIONAL SCENARIO #6		Care team members need to work at the top of their license
Example 1	CASE	Provider realizes in the middle of the exam that they need an updated glucose reading
	MEASURE OF SUCCESS	° Can the provider communicate this to the MA quickly? ° Can the MA get the supplies needed and get to the room quickly?
Example 2	CASE	MA decides that patient needs to be seen by behavioral health and wants to make the connection without having to ask provider permission
	MEASURE OF SUCCESS	° Does MA feel confident about their decision? ° Does MA feel that provider will back up their decision? ° Does MA feel that other team members will be there to support her if she gets in over her head?
SPATIAL ELEMENT		Proximity and accessibility to team members, Collocation and interpersonal distance

FUNCTIONAL SCENARIO #7		Care team members need to be able to manage their accessibility by patients
Example	CASE	Provider is working in an open team room while patients are waiting nearby
	MEASURE OF SUCCESS	° Can patients clearly recognize the boundary of the team space that indicates that they are not allowed to come inside that area?
SPATIAL ELEMENT		Defined boundaries

FUNCTIONAL SCENARIO #8		**Intentional: Care team members need to be able to get advice from other care team members**
Example	CASE	Provider is seeing a patient with a rare condition and is not familiar with the treatment protocol
	MEASURE OF SUCCESS	° Can provider consult with fellow provider who has more experience?
SPATIAL ELEMENT		Proximity and accessibility to team members, Arrangement, Artifacts

FUNCTIONAL SCENARIO #9		**Spontaneous: Care team members want to confirm or exchange information quickly with other care team members**
Example	CASE	Provider thinks that a certain medication is no longer covered by Medicaid but wants to be sure
	MEASURE OF SUCCESS	° Is there someone who can quickly verify their belief? ° Can they talk right away at appropriate space nearby them?
SPATIAL ELEMENT		Talking room, Collocation and interpersonal distance

FUNCTIONAL SCENARIO #10		**Care team members need to have shared understanding of current information**
Example	CASE	Two providers are working at the same time and a provider is wondering what exam rooms are available.
	MEASURE OF SUCCESS	° Can provider see the vertical surface that contains related information such as assignment of the exam rooms to providers?
SPATIAL ELEMENT		Vertical surfaces

FUNCTIONAL SCENARIO #11		Care team members need to feel that they are part of a team that provides patient centered medical home care
Example	CASE	Patient presenting in outpatient setting for hospital discharge follow-up visit is accompanied by appropriate care summary documents and medication reconciliation has been performed.
	MEASURE OF SUCCESS	° Staff satisfaction (Physicians feel they have immediate access to support; Care team members feel physician is immediately available to provide direction); Minimize delay and/or rework
SPATIAL ELEMENT		Arrangement

FUNCTIONAL SCENARIO #12		All care team members need to feel empowered to provide care up to the limits of their professional abilities
Example	CASE	Medical assistant identifies a positive depression screen and knows they are empowered (and have appropriate supporting education and protocol) to contact the behavioral health consultant without having to first ask the physician
	MEASURE OF SUCCESS	° Staff satisfaction; Elimination of bottlenecks in workflow
SPATIAL ELEMENT		Arrangement

FUNCTIONAL SCENARIO #13		Patients need to feel confident that they are being treated by a care team whose members have a shared understanding of their health needs
Example	CASE	Patient with a needle phobia is sent to the lab for a blood draw
	MEASURE OF SUCCESS	° Does the phlebotomist know what test the patient is there for? ° Does the phlebotomist take extra care with the patient, or do they not know to about their needle phobia?
SPATIAL ELEMENT		Arrangement, Visibility to patient rooms

FUNCTIONAL SCENARIO #14		Patients need to feel confident that their private medical information is protected and secure from other patients and other clinical staff not on their care team
Example	CASE	Patient is waiting in the sub-waiting area in the clinic for the lab work
	MEASURE OF SUCCESS	° Can care team members maintain appropriate distance from patients to protect private patient medical information?
SPATIAL ELEMENT		Defined boundaries, Arrangement

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CONTRIBUTIONS TO THE FIELD

The simulation exercise proved to be extremely informative. It was initially envisioned as a research method for testing design strategies with the hope that it would yield metrics for evaluating layouts and possibly generic strategies applicable to all projects. However, it was most useful as a facilitation tool enabling the care team to become aware of their tacit activities and needs, and make a more richly informed decision about the desired layout and configuration. The exercise also furthered our understanding of key design elements for this specific project, though it did not translate into specific metrics that could be applied to all clinic projects.

The staff self-awareness and discovery during the simulation produced thoughtful discussions among the care team members as the scenarios were played out. There were moments of learning when the rest of the team finally understood the particular work that another role was routinely performing. The simulation made the tasks and actions of each team member visible and vivid to everyone, increasing the team's understanding of the workings of the team, as well as highlighting redundant or inefficient processes. It was clear from this experience that a carefully constructed simulation exercise has the potential to be a powerful force for change, creating understanding and empathy, as well as a shared vision for how team should collaborate effectively together.

Mock up and simulation process has great value. The Mercy team was surveyed about the two layout options before and after the simulated scenarios, and had different opinions and comments after the simulation. They were clearly influenced by the exercise and – we believe made a more informed decision with more confidence.

An additional value of the exercise was the opportunity for the team to examine their care process and realize opportunities for improvement. They were educated and understood the clinical process much more holistically, as well as in the context of physical space. The cumbersome aspects of information acquisition for new patient, the long journey for a patient referral, these were just a few of the challenges to routine activities that were revealed.

This research effort revealed insights about the key design elements in shared team rooms that support successful communication and collaboration for an integrated care team. No body of evidence-based research specific to clinic team rooms was found in the literature search. This project makes a significant contribution to the field by assembling the evidence from other physical settings and identifying the studies with relevance to PCMH team spaces based on an understanding of the goals of PCMH clinics. The construct of dynamic functional scenarios for simulation makes the findings actionable by design teams in the absence of specific design recommendations. An abbreviated guide for how design teams can use this process is provided in the appendix.

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Appendix

Appendix A: Quick Start Guide for Designing Effective Care Team Rooms

Appendix B: Case Study

Appendix C: Observation

Appendix D: Simulation

DEFINE THE TARGET

Step 1. **Establish a vision for how the PCMH team will operate**:
Clinic leadership needs to spearhead this first step of setting a vision for how care will be delivered by the team in the new space. At this stage the focus should be on the organization and care process, with particular attention given to how the patients will flow through the process, and how the team will collaborate and practice at the top of their license. The operational vision should drive a functional vision for the overall clinic space, in addition to functional goals for the care team's workspace. At a minimum we suggest the following four objectives for the PCMH team rooms:

- **Support care coordination and situational awareness**: a high-performing team needs to understand and anticipate each other's needs and movements
- **Support staff individual roles:** focused individual work needs to be support even in a shared room
- **Facilitate team communication:** seeing and encountering other staff facilitates communications
- **Highlight the role of the team**: the team room can be a powerful symbol that care is primarily delivered by teams rather than individual providers

Step 2. **Gather information on process**:
Assemble an interdisciplinary team with at least one representative from each role and have them create a process and/or patient flow and describe the role of each team member. This should be an interactive process to make sure there are no missing activities or duplication of tasks. Some key questions regarding roles include:

- Who is on the team and what role does each team member play?
- What are the other supporting players who might not work out of the team room all the time but will interact with the team often?
- What tasks/activities do they do, and where do these tasks happen?
- Who do they need to communicate with?

Step 3. **Define functional scenarios for the project:**
A functional scenario is a brief statement that reflects what someone needs or want to be able to do in the setting. Building on the processes and roles defined in the previous step select scenarios that reflect a typical patient visit or process. The list below is good starting point of scenarios that develop the four major objectives. The design team should refine these to fit the specific project - some may not be relevant and there may be others needed to represent additional clinic objectives.

Situational Awareness

- Care team members need to be able to reach out to each other throughout the day
- Care team members need to be able spontaneously seek advice and education with a range of peers throughout the day

- Care team members are able to get/give workload assistance from/to others when busy
- Care team members need to be aware of patient needs, process, and point in journey

Support Individual Roles

- Care team members need to be able to focus on detailed work that requires concentration
- Care team members need to work at the top of their license
- Care team members need to be able to manage their accessibility by patients

Communication

- Intentional: Care team members need to be able to get advice from other care team members
- Spontaneous: Care team members want to confirm or exchange information quickly with other care team members
- Care team members need to have shared understanding of current information

Symbolism

- Care team members need to feel that they are part of a team that provides patient centered medical home care
- All care team members need to feel empowered to provide care up to the limits of their professional abilities
- Patients need to feel confident that they are being treated by a care team whose members have a shared understanding of their health needs
- Patients need to feel confident that their private medical information is protected and secure from other patients and other clinical staff not on their care team

DESIGN AND TEST ALTERNATIVES

Step 4. **Develop design alternatives**:
Create multiple design alternatives at the schematic and team room layout level based on the input from the previous steps. In Table A1 critical spatial elements at the clinic, team room and workstation or furniture level are associated with the four key objectives for integrated team rooms. All of the listed spatial elements should be accommodated with the design and priorities of the client should be used to guide trade-offs or conflicts.

Table A1. Design factors and key objectives

	Situational Awareness	Support Individual Roles	Communication	Symbolism
CLINIC LAYOUT				
Visibility				
• Throughout the clinic	x			
• To patient rooms	x			x

Proximity and accessibility to team members	x	x	x	
Defined boundaries		x		x
Talking rooms			x	
TEAM ROOM LAYOUT				
Collocation and interpersonal distance		x	x	
Limited distraction		x		
Arrangement			x	x
Visibility to each other	x			
WORKSTATION LAYOUT				
Artifacts		x	x	
Vertical surfaces			x	
Workspace height		x		

Step 5. **Conduct Simulation Exercise**:
While visual mockups are helpful, they often fail to reveal tacit needs or particular process needs. A simulation allows the design team to gain a deeper, operational understanding of how the proposed space will facilitate or hinder clinical workflow and collaboration. The best approach is to build a mock up to a scale that allows the clinic team to experience the size, height and configuration of the team room. At a minimum the design should be rendered as a floor plan of the whole clinic as a supporting tool during discussions. Ideally it is best to have both a mockup and a drawing of the floorplan.

For the content of the simulation exercise, take the functional scenarios developed in Step 3 and work with the clinical representatives to craft realistic patient scenarios for each functional scenario. These should be the primary responsibility of the clinicians but the design team needs to be an active participant making sure that the cases truly push the limits of the design and guide the development of measures that capture the effectiveness of the team.

Use the patient care scenarios and make sure to address the metrics of success. Since the simulation is designed to gain a deeper understanding, challenges and strong opinions may often surface. Ideally an external and neutral facilitator - who is knowledgeable and a strong communicator – can be more effective than an internal one who might be perceived to have a point of view to press. A skilled facilitator can be flexible, sense when the group wants to have a longer conversation and let it go or move on to other scenarios if one isn't yielding anything fruitful.

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IMPLEMENT

Step 6. **Finalize Design**:
Go back to the drawing board with the feedback from the simulation exercise and develop the next iteration of the design. If there was little consensus from the clinicians, or the changes needed are significant it is wise to consider conducting a second simulation exercise. Even if a full simulation is not needed, at a minimum the new plans should be presented to a group of the clinicians to make sure it captures their wishes. Once a design is settled on the team should make a record of the assumptions and goals for the final design; this can serve as a reference document to the clinic staff on how to get the most benefit from the space and for conducting a post occupancy evaluation later on down the road.

Step 7. **Continual improvement**:
The design team should go back to the clinic 6 to 12 months after completion to assess how the team space is working and if the design accomplished goals. The designers should talk to the client to get their feedback and better yet, spend a couple of hours watching how they use the space to see it first-hand. Study what you have done, tweak things that did not work in the next project, drop design strategies that failed. And share your findings with the field -this is the best way for the field to learn and build an evidence base.

Case study clinics were selected through a multipronged approach aimed at identifying a cross section of PCMH clinics. Some clinics were identified through a search of review articles and the NCQA (The National Committee for Quality Assurance) PCMH recognition directory and others were identified through our network of contacts. A total of five clinics were selected as case studies from among those clinics, based on willingness to participate in the project by providing related materials and their time for interviews, as well as the usefulness of their clinic designs to inform the project. Full case study evaluation was completed for the following clinics:

- Cherokee Indian Hospital Outpatient Clinic
- Emory Patient Centered Primary Care Clinic
- Mercy Care Downtown
- White's Pediatric
- Group Health Pullayup Clinic

These clinics provide a good sampling of the different ways in which the PCMH model has been implemented in terms of the organizational structures, staffing, culture and physical settings. Although they are all PCMH practicing clinics, the way of operating clinics, including patient assignment and staffing, and the use of their space was distinct. Each approach has something to teach about the best way to design team spaces to support effective team based care. In the following section we discuss the process used for conducting the case studies, and provide a description of each clinic.

We have used consistent language across the case studies, rather than relying on the unique terminology of the individual clinics, to make it easier for the reader to follow the argument. A care team is the group of caregivers that work together to manage the care of a defined group of patients (patient panel). A pod is the physical space that supports an individual care team; it usually includes a shared workspace and dedicated exam rooms. Team rooms are shared workspaces that can support one or more care teams; when multiple care teams share a team room they can be organized into distinct pods formally or informally. The clinic is typically defined as the full business entity at a given physical location and often includes more than one care team.

CASE STUDY PROCEDURE

We followed a standard methodology for conducting each of the case studies in order to understand general information, clinical operation, care process, and spatial use of the clinic. After establishing a point of contact with the clinic and explaining the purpose of the study we held phone interviews, requested materials including architectural drawings and pictures of their clinic, and in some cases visited the clinic and conducted additional analyses such as process mapping and Space Syntax analyses. Table B1 provides an overview of the data collected for each of the clinics.

Table B1. Case study steps of the clinics

Case Study Clinics	Interviews	Requesting Materials		Site visit	Additional analyses
		Floorplans	Pictures		
Cherokee Indian Hospital Outpatient Clinic	✓	✓	✓	✓	✓
Emory Patient Centered Primary Care Clinic	✓	✓	✓	✓	✓
Mercy Care Downtown	✓	✓	✓	✓	✓
White's Pediatric	✓	✓	✓		✓
Group Health Pullayup Clinic	✓	✓	✓	✓	

Interviews

In each case we conducted phone interviews with representatives from the clinic, including nurse managers, providers, and administrators. The semi-structured interviews lasted one hour on average and were based on a set of questions developed in collaboration by the research team. The conversation was structured around four categories to understand the PCMH operation of the clinic: background questions, process questions, space questions, and communication questions. The list of questions can be found in Box B1.

Box B1. List of questions for phone interviews

Background Questions
1. Background: Tell me a little about your clinic such as the service lines, number of patients, hours of operation.
    a. Which service lines do you have full time, on site?
    b. Do you have any clinical specialists that work on your team full or part time?
2. Background: What makes your clinic a Patient Centered Medical Home (or similar) clinic?
    a. How do you define it?
    b. When did your clinic adopt the PCMH approach?
    c. Did you make any changes to your clinic environment as a result?
    d. Are you NCQA certified? What level of certification are you (from 1-3)?
3. Please tell us a little more about how the care team is organized, such as the number of doctors, nurses, case managers etc.
    a. How many Doctors ____NP's _____ PA's_____ Nurses_____ and Medical Assistants_____work at this clinic?
    b. What is the typical composition of a care team?
    c. How many care teams do you have?
    d. How many patients are assigned to the care teams?

Process Questions
1. Please describe the steps in typical patient visit, from when they contact the clinic to make an appointment through checking out.
    a. Do you employ patient self-rooming?
    b. Do you employ (patient) self-vitals or social or medical history?
    c. If the patient sees more than one clinician/specialist, does the patient move to different spaces, or do the clinicians rotate into a single exam room?

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	d. Do you conduct educational sessions or other group meetings with patients in addition to individual examinations or consultations?
	e. Do you conduct shared medical appointments or group appointments?

Space Questions

1. Tell me about all the different rooms/space types that are part of the clinic:
2. How many examination/consultation rooms are assigned to each provider (doctor or nurse practitioner)?
3. Tell me about the workspace for your care teams.
    a. Do you have a team room where the clinical staff works together? Is it an open space with minimal or no partitions between work spaces or is it closed?
    b. Inside the team room do team members have dedicated work spaces or do they simply select the first available open space?
    c. Do the physicians have dedicated private offices? Or dedicated, assigned private workstations? (no dividing walls to the ceiling) Or just touchdown spaces?
    d. Are team rooms shared between workgroup or "pods" of clinicians, or just for a single workgroup?
    e. Approximately how many providers (doctor or NP) are in each team (work) room? How many nurses & medical assistants?
4. How is the team workspace laid out?
    a. Do some of the workstations face each other, or are they arrayed against the perimeter, so they face the wall?
    b. Are any of the workspaces standing or perching height, as opposed to seated height? Can you tell me where those are? Do they having stools that support perching height as well as regular seated height task chairs?

Communication Questions

1. Tell me about care team meetings.
    a. How often do they occur?
    b. Who attends/participates in the care team meetings?
    c. Where does the team meeting happen?
    d. Are there any other regular meetings for the clinical staff?
2. Tell me about how your chart and use electronic medical records
    a. Which EHR are you using?
    b. Since approximately when? (i.e May 2011)
3. How do you communication with other care team members during the day? Electronically or verbally face-to-face?
4. Do you utilize tele-presence to consult with other, off-site clinicians?

Layout Documentation

To understand the adjacencies, visibility, and to chart probable interactions we asked for a scaled floor plan (CAD drawing or a scaled PDF) of the outpatient clinic, including team room, any provider/staff offices, exam rooms and waiting spaces. Several of the clinics also provided pictures of the different workstations that helped us to understand the furniture layout and equipment location.

Site visit

After collecting background information for the clinics, we made site visits to four of the five clinics. Site visits gave us a greater understanding of the spaces by giving us the opportunity to observe the patient flow, care process, teamwork of the care team members, individual work of the members, and current space use of the clinics.

We also conducted further analyses such as process mapping and Space Syntax analyses. In order to compare the PCMH process described by the case study clinics and general outpatient clinics, we constructed process maps for some of the clinics. In addition to that, we conducted Space Syntax analyses utilizing Depthmap to confirm the visibility among team rooms or between team room and exam rooms. Previous studies have used Space Syntax for evaluating visibility in healthcare settings and found important relationships between the layout and clinical communications and awareness (Haq & Yang, 2012; Lu & Zimring, 2011; Trzpuc & Martin, 2010).

CASE STUDY RESULTS

Clinical operation

In order to provide a sense of the operational size and organization of the clinic, the number of providers and care staff are listed in the table below (Table B2). Many PCMH clinics include a care coordinator and key specialists on their team for managing care and to be able to treat complex cases. Other PCMH clinics choose to transfer a significant portion of the operational responsibilities from physicians to senior nursing staff without a dedicated care coordinator role. Another strategy for maintaining continuity of care that these clinics employed is having determined patient panel for assigned to individual providers versus having multiple providers serving the same patient population.

Table B2. Clinical operation characteristics of the clinics

Clinical operation (Staffing and Patient Assignment)	Cherokee	Emory	Mercy Care	White's Pediatric	Group Health
Number of Providers	13	3	3	3	14
Number of Care Staffs (inc. specialists)	16	9	6	12	24
Have Care Coordinator	✓	✓	X	✓	X
Have Specialists	✓	✓	✓	X	✓
Determined patient panel for providers	✓	✓	X	X	✓

Team composition and communication

The way of organizing care teams was different across the clinics. Below in Table B3 we have created a graphic for each clinic to illustrate the different organizational structures. In some of the clinics all of the clinical staff work together as a team with the nurses and medical assistants (MA) supporting whatever provider is in the clinic and needs help. In other cases, such as Cherokee, they have designated care teams made up of a provider, nurse who serves as a care coordinator, medical assistant and case management support (CMS) person who assists the nurse with care coordination. At Cherokee only the specialists (behavioral health and nutrition) support more than one team. The organization of the care team can have implications for the most effective clinic layout and may be one of the drivers for the differences seen in spatial configurations. In clinics where nurses and medical assistants support multiple providers it may work best to have the different staff functions situated in group offices by role,

such as at Mercy or Emory, whereas when the team composition is stable, such as in Cherokee, it makes more sense to have a physical workspace that collocates the interdisciplinary team.

Table B3. Care Team Compositions and collocation
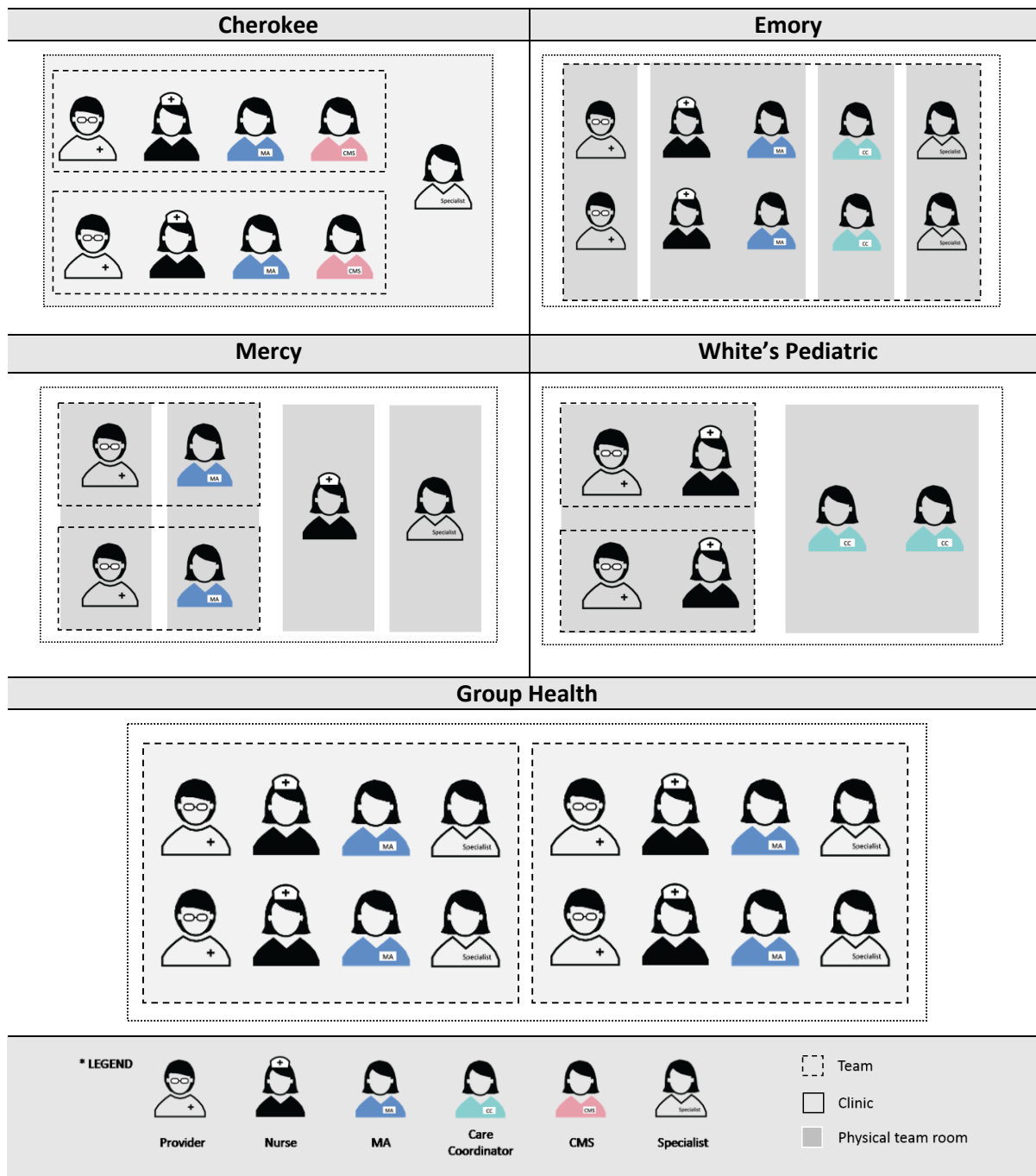
Spatial Layout and Circulation

The layout of the clinic and relationships between the workspaces and exam rooms exert a significant influence on interaction among staff and with patients. We observed a range of spatial solutions that go from maximally segregated to fully integrated as illustrated below going from left to right in Figure B1. The circulation of patients and care team members is segregated in the Group Health example as well as in the Blue team room at Cherokee. This configuration depends on exam rooms with double entrances and has the benefit of insulating the team room from public view. This arrangement is efficient and provides good privacy for the care team to speak freely about cases without fear of breaching patient confidentiality, but does not make the team apparent or easily accessible to the patient outside of the exam room. The team room at the Emory Patient Center Primary Care clinic, on the end of the spectrum, is completely accessible to the patients – in fact the patients enter the clinic in the team room and navigate through the room to get to the exam rooms. This has the advantage of making the patients highly aware that a team is responsible for their care, not just an individual doctor. Additionally it gives patients and care staff multiple opportunities to interact beyond the exam room. All this accessibility does come at the cost of dampening verbal communication between clinical staff about patients to protect confidentiality.

All the clinics selected for our case study had shared workspace for the care team members. Clinics were adopting two different strategies for shared workspaces: collocating different roles in the same space who are working as teams, or collocating similar roles for each shared space. Cherokee, White's Pediatric, and Group Health were utilizing the former approach; all the team members were collocated and were able to work together in a short distance with good visibility. Mercy and Emory had adopted the latter way for collocating team members with distinct shared spaces for similar roles, such as providers' office and MAs station.
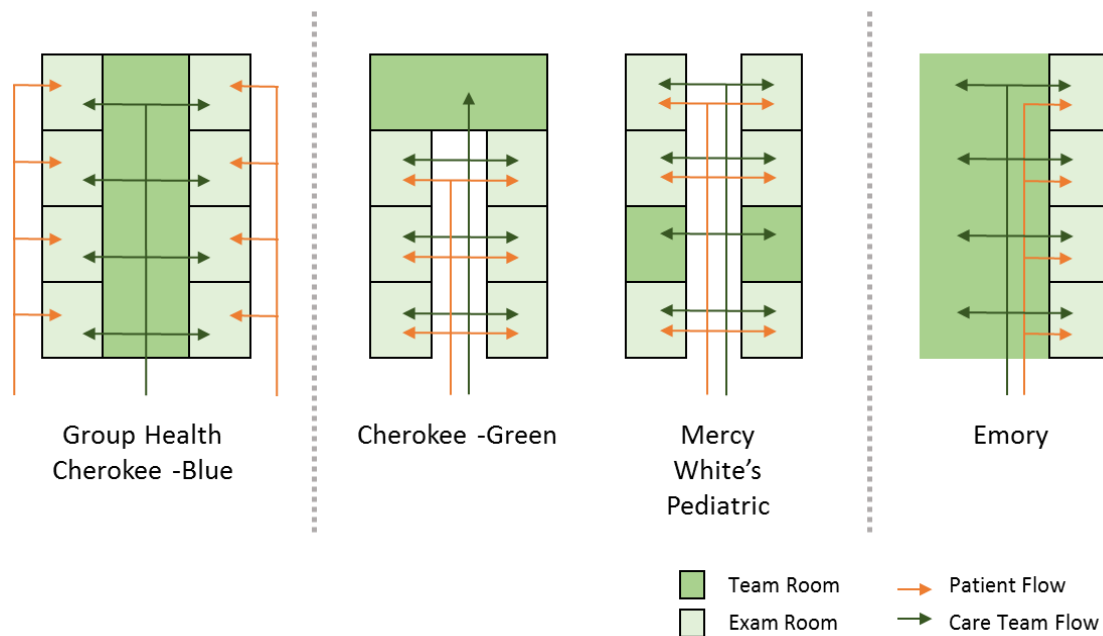
Figure B1. Typology of layouts and circulation

WHITE'S PEDIATRICS DALTON CLINIC

White's Pediatric practice in Dalton, Ga which has been recognized as a Level 3 PCMH clinic is notable for their early adoption of electronic medical records. The providers have a shared office on the floor above the clinic, but spend most of their time during the day on the clinic floor and use the nurse stations as a group office and place to communicate with the nurses. Staff in this clinic rely heavily on the electronic medical record to notify doctors and nurses when a patient is waiting for them, and therefore find visibility to each other less important than in other clinics. Unlike some of the other clinics, they have decided to place the care coordinators in another part of the building where they can make phone calls and manage population health without the constant disruption from patient visits.

CLINIC GENERAL INFORMATION

Location: Dalton, GA

Type of Facility: Stand alone

Size: 18,000 SF

Service lines: Primary Pediatric

Opened in: 1981 and this clinic built in 2003

PCMH started in: 2011

PCMH NCQA level: Level 3

Operation hours: Monday – Friday, 8am to 5pm

PATIENTS AND STAFFING

Number of providers: 3

Number of staffs: 12

Number of clinical specialists: 0

Number of patient visits per year: 19,000

Determined patient panel for providers: No

CARE TEAM AND COLLABORATION

Care team members: Provider, nurse

Have care coordinator: Yes, for all providers

Have care specialists: No

Team gathering: Do morning huddle for each team
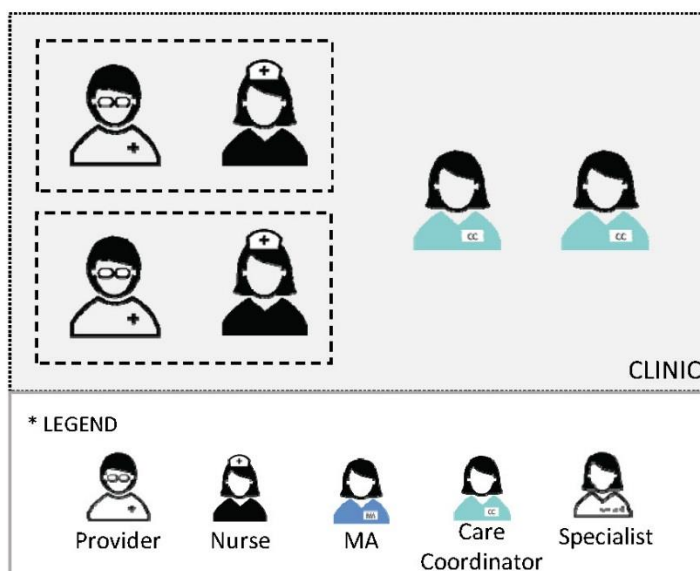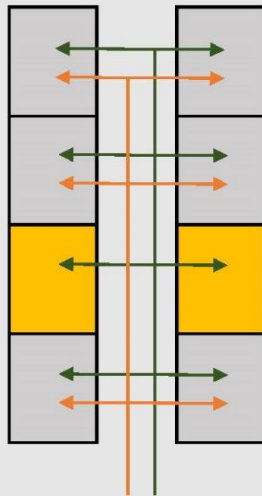
CLINIC

* LEGEND

Provider   Nurse   MA   Care Coordinator   Specialist

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PHYSICAL SPACE TYPOLOGY

- ■ Team Room
- ■ Exam Room
- → Patient Flow
- → Care Team Flow

PHYSICAL SPACE USAGE AND AREA

SECOND FLOOR

FIRST FLOOR
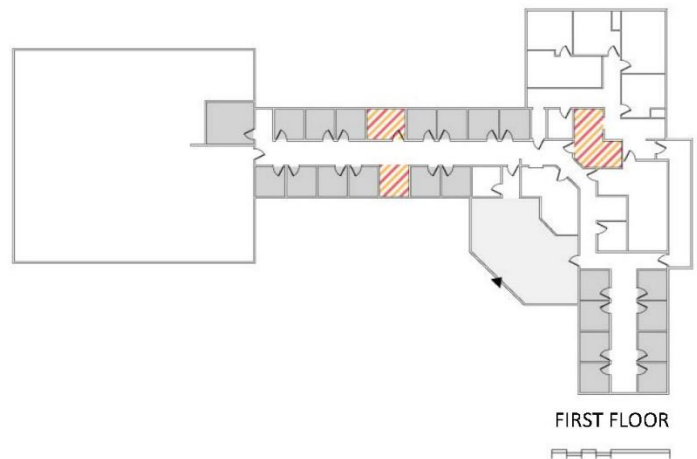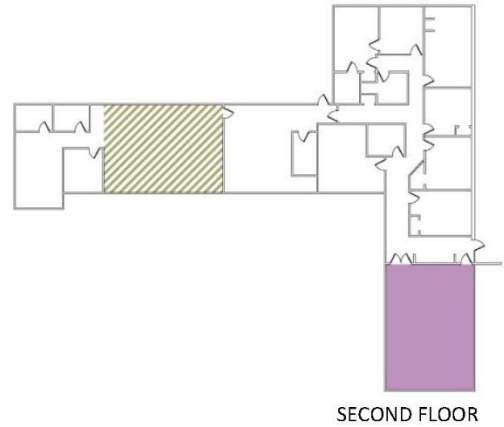
	List of room/space types	Usage	Number of spaces	Average area (SF)
▶	Main entrance	√		
	Check-in / waiting	√		
	Triage / exam room	√	22	76 SF
	Consultation room			
	Group visit room	√	1	886 SF
	Providers workspace	√	3	112 SF
	Nurse/MAs workspace	√		
	Care coordinators workspace	√	1	833 SF
	Specialists workspace			

WORKSPACE

Provider and nurse office

Provider and nurse station
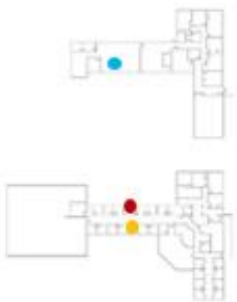
Call center
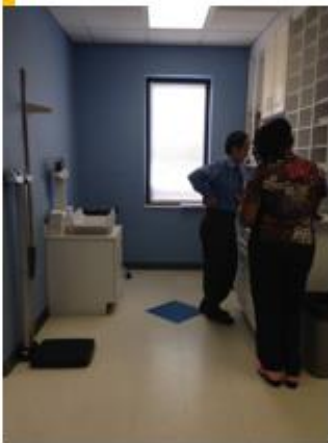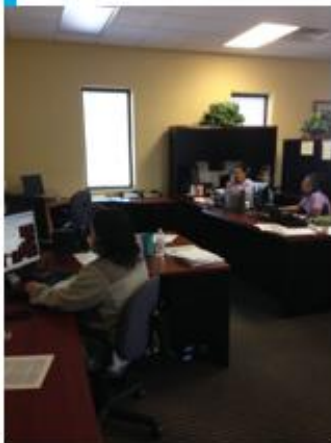
	Provider and nurse office	Provider and nurse station	Call center
Main users	Providers, nurses	Providers, nurses	Care coordinators
Area	92 SF	75 SF	833 SF
Seat assignment	Not determined	Not determined	Not determined
Orientation	Facing wall	Facing wall	Facing wall or partitions
Have a door	Yes	No	Yes
Have windows	No	Yes	Yes
Average # of occupying people	4-5	1-2	7

Furniture layout			

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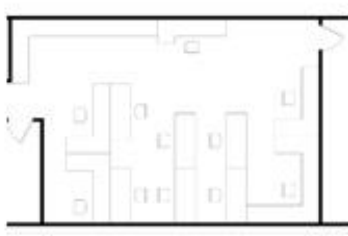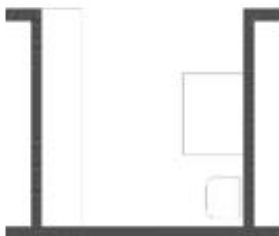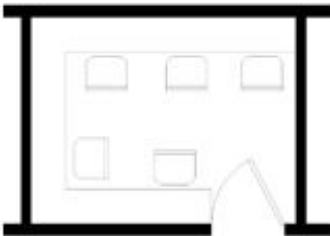
MERCY CARE DOWNTOWN

Mercy Care clinic in Atlanta is a federally qualified health center. They serve a mostly uninsured population with over 60 % of their patients being homeless and yet have achieved Level 2 NCQA recognition. Mercy Care has achieved this accomplishment despite having a less than optimal physical environment. At the present their providers and nurses are located at opposite ends of the clinic; the providers share an office at the far end of the clinic that is behind a closed door and situated deeply into the space. The nurses have desks in the adjacent space but spend most of their time during the day in a narrow shared work area at the front of the clinic. Clinic management recognizes the drawbacks to this layout and submitted a proposal to HRSA to renovate their clinic to create two shared team workspaces.
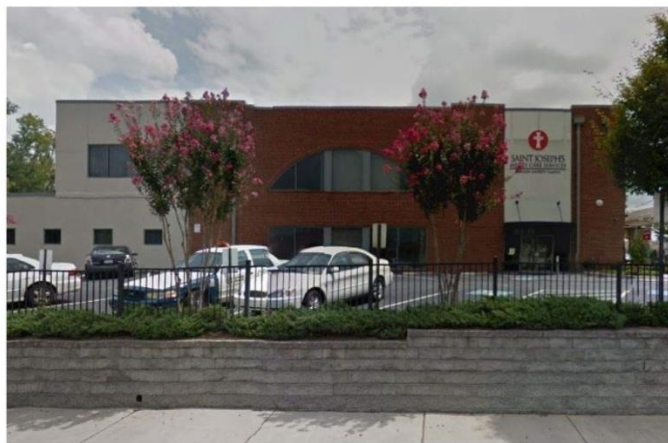
CLINIC GENERAL INFORMATION

Location: Atlanta, GA

Type of Facility: Stand alone

Size: 28,000 SF

Service lines: Primary, Behavioral Health, Dental, etc.

Opened in: 1985

PCMH started in: 2013

PCMH NCQA level: Level 3

Operation hours: Monday - Thursday: 7 am - 5 pm

Friday: 7 am - 1 pm (medical) and 7 am - 5 pm (dental)

PATIENTS AND STAFFING

Number of providers: 4-5 (Primary Care MD & NP, HIV Primary Care MD & NP; alternating Pediatrician)

Number of staffs: 4 (1 RN, 3 CMAs)

Number of clinical specialists: 2 (Behavioral health professional, Psychiatrist)

Number of patient visits per year: 5,900

Determined patient panel for providers: No

Patient population characteristic: 95% patients are uninsured; 67% are homeless

CARE TEAM AND COLLABORATION

Care team members: Provider and CMA

Have care coordinator: No

Have care specialists: Yes

Team gathering: Do morning huddle with everybody and do team huddle after the morning huddle
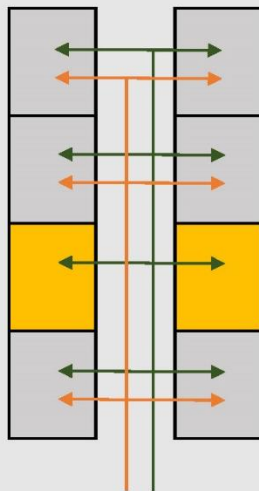
CLINIC

* LEGEND

Provider Nurse MA Care Coordinator Specialist

PHYSICAL SPACE TYPOLOGY

- ■ Team Room
- ■ Exam Room
- → Patient Flow
- → Care Team Flow

PHYSICAL SPACE USAGE AND AREA
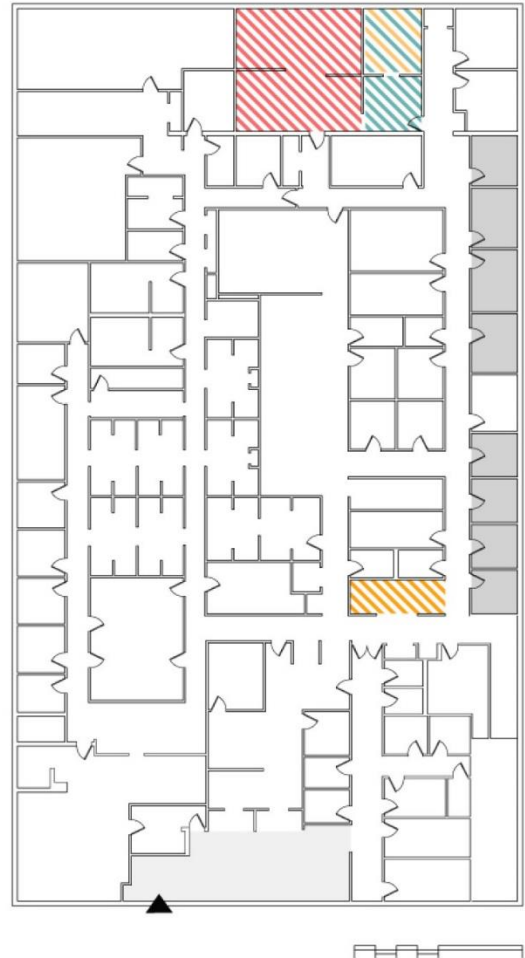
	List of room/space types	Usage	Number of spaces	Average area (SF)
▶	Main entrance	√	-	
	Check-in / waiting	√	-	
	Triage / exam room	√	8	90 SF
	Consultation room			
	Group visit room			
▨	Providers workspace	√	1	384 SF
▨	Nurse/MAs workspace	√	2	133 SF
▨	Care coordinators workspace			
▨	Specialists workspace	√	1	288 SF

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WORKSPACE

Provider office	Nurse/CMA station	CMA/BH Specialist office
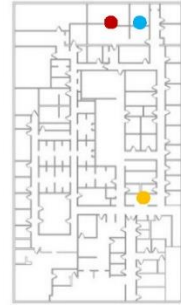
	Provider office	Nurse/CMA station	CMA/BH Specialist office
Main users	Providers	Nurse, CMAs	CMAs, BH Specialists
Area	384 SF	115 SF	288 SF
Seat assignment	Determined	Determined	Determined
Orientation	Facing wall	Facing wall/window	Facing wall
Have a door	Yes	No	Yes
Have windows	No	Yes (not to outside)	No
Average # of occupying people	5	4	5-6
Furniture layout			

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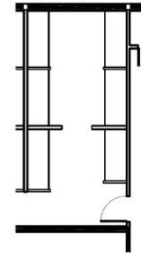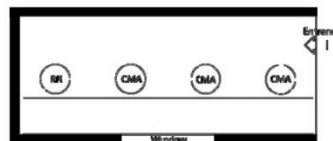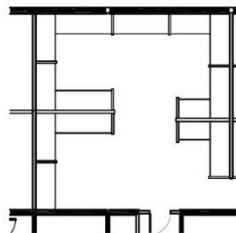
EMORY PATIENT-CENTERED PRIMARY CARE CLINIC

EMORY

Emory Healthcare has a great Patient Centered Primary Care clinic that is available exclusively to their employees and their families. The layout of their clinic is different from the other clinics we have studied. The four doctors that work in the practice have a group office that they share and the nurses also share a smaller office. Both these group offices are located adjacent to the open central area where the medical assistants work. This is the space in the center where the bulk of the collaboration happens.

CLINIC = TEAM

* LEGEND

Provider   Nurse   MA   Care Coordinator   Specialist
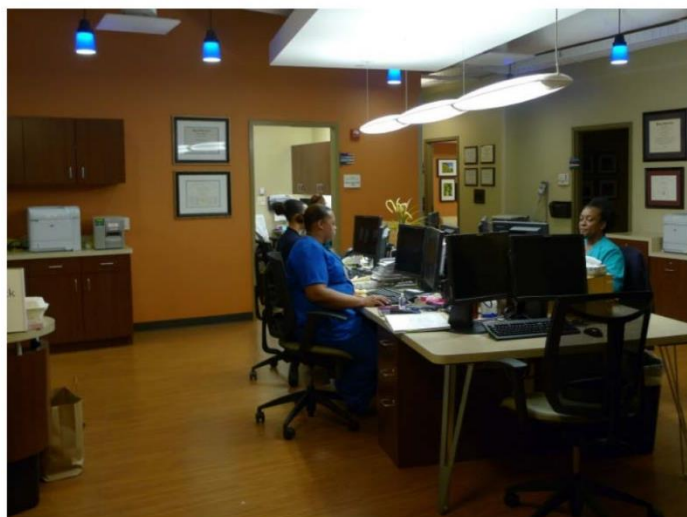
CLINIC GENERAL INFORMATION

Location: Atlanta, GA

Type of Facility: Shared building, 2nd floor

Size: 2,700 SF

Service lines: Primary care

Opened in: 2011

PCMH started in: 2012

PCMH NCQA level: Level 3

Operation hours: Monday – Friday, 8 am – 5 pm

PATIENTS AND STAFFING

Number of providers: 3 (MDs)

Number of staffs: 7 (2 RNs, 2 LPNs, 3 MAs)

Number of clinical specialists: 2 (Behavioral health specialist, Nutritionist)

Number of patient visits per year: *Awaiting response*

Determined patient panel for providers: Yes

Patient population characteristic: Emory employees and their adult family members

CARE TEAM AND COLLABORATION

Care team members: All together

Have care coordinator: Yes, for all providers

Have care specialists: Yes

Team gathering: Do team huddle in the morning
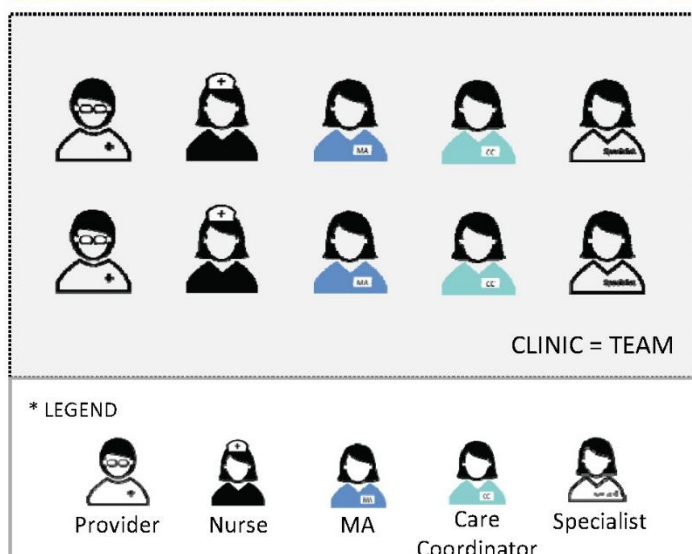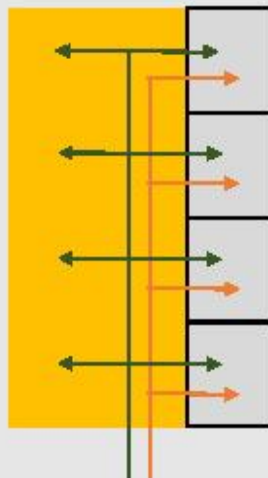
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PHYSICAL SPACE TYPOLOGY

- ☐ Team Room
- ☐ Exam Room
- → Patient Flow
- → Care Team Flow

PHYSICAL SPACE USAGE AND AREA
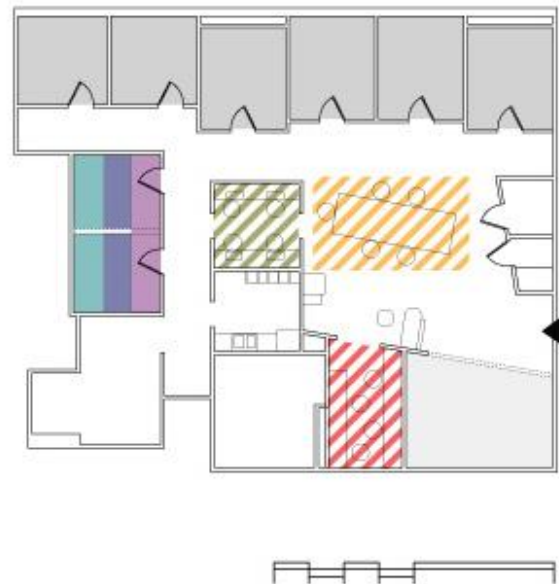
	List of room/space types	Usage	Number of spaces	Average area (SF)
▶	Main entrance	√	-	
☐	Check-in / waiting	√	-	
☐	Triage / exam room	√	6	111 SF
☐	Consultation room	√	2 (flexible use)	92 SF
☐	Group visit room	√	1 (flexible use)	184 SF
▨	Providers workspace	√	1	146 SF
▨	Nurse/MAs workspace	√	1	742 SF
▨	Care coordinators workspace	√	1	99 SF
▨	Specialists workspace	√	2 (flexible use)	92 SF

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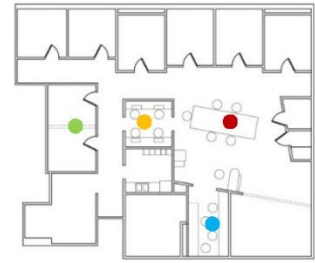
WORKSPACE

	MA station	Nurse office	Provider office	Specialist office / Group visit room
Main users	MAs	Care coordinator, Nurse manager, LPNs	Providers	Specialists
Area	742 SF	99 SF	146 SF	92 SF
Seat assignment	Determined	Determined	Determined	Determined
Orientation	Facing each other	Facing wall	Facing wall	Facing wall
Have a door	No	No	Yes	Yes
Have windows	No	No	No	No
Average # of occupying people	3-4	4	3	1
Furniture layout				
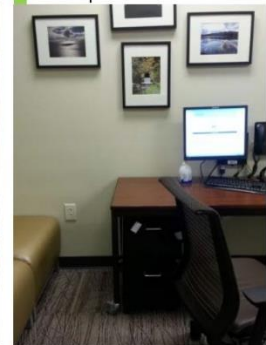
Georgia Tech | SimTigrate Design Lab
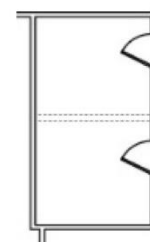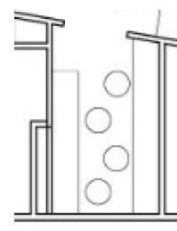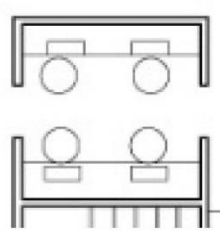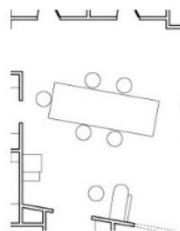
GROUP HEALTH PUYALLUP CLINIC

The Pullayup Clinic for Group Health in Seattle, Washington has a very intentionally designed team room, offstage from patient circulation. They used an intensive lean process and a plan to maximize efficiency and adaptability. The workstations are open and low, and offer no hierarchical differentiation between clinician types. There was strong emphasis on optimizing visibility and interaction. There is natural light, including by skylight, throughout, and the overall space has a number of amenities for patients and staff – a coffee bar and onsite pharmacy, and touch down and break areas among others. Additionally, as their clinical processes have evolved, so have their adaptive spaces.

CLINIC GENERAL INFORMATION

Location: Puyallup, WA

Type of Facility: Stand alone

Size: 54,500 SF

Service lines: Primary Care

Opened in: 2012

PCMH started in: 2012

PCMH NCQA level: Level 3

Operation hours: Monday – Friday, 7 am – 7 pm

PATIENTS AND STAFFING

Number of providers: 14 (11 MDs, 3 PA/NPs)

Number of staffs: 20 (2 RNs, 4 LPNs, 14 MAs)

Number of clinical specialists: 4 (2 Pharmacists,

Behavioral health specialist, Social worker)

Number of patient visits per year: 20,000

Determined patient panel for providers: Yes

CARE TEAM AND COLLABORATION

Care team members: All the members in the pod

Have care coordinator: No

Have care specialists: Yes

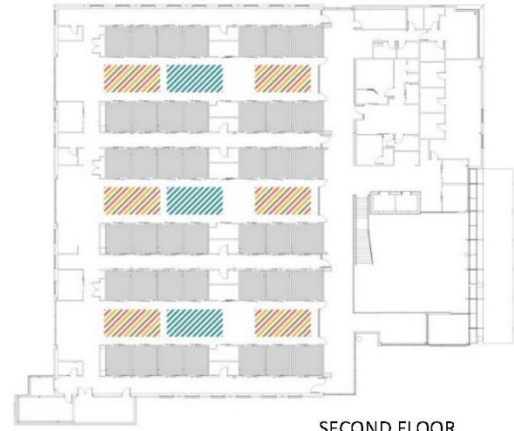Team gathering: Do pod (team) huddle in the morning / no across pods huddle
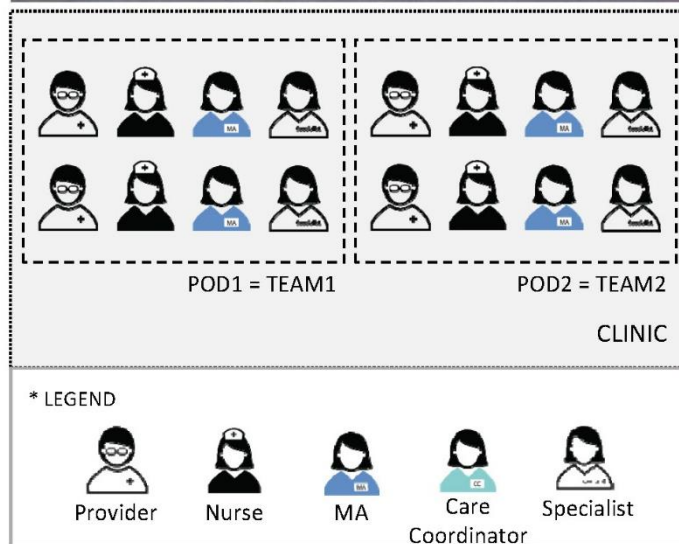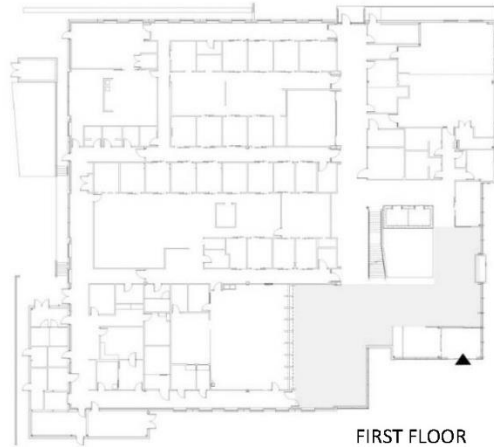
PHYSICAL SPACE TYPOLOGY
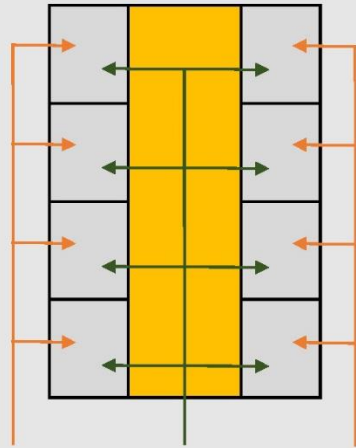
- ☐ Team Room
- ☐ Exam Room
- → Patient Flow
- → Care Team Flow

PHYSICAL SPACE USAGE AND AREA

SECOND FLOOR

FIRST FLOOR

	List of room/space types	Usage	Number of spaces	Average area (SF)
▶	Main entrance	√	-	
	Check-in / waiting	√	-	
	Triage / exam room	√	14	125 SF
	Consultation room			
	Group visit room			
	Providers workspace	√		
	Nurse/MAs workspace	√	2	460 SF
	Care coordinators workspace	√		
	Specialists workspace	√	1	460 SF

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SECOND FLOOR

WORKSPACE

Work Station

T-zone

	Work Station	T-zone
Main users	All care team members	All care team members
Area	1560 SF	460 SF
Seat assignment	Not determined → self-determined seats	-
Orientation	Facing other members	-
Have a door	Yes	No
Have windows	No	Yes
Average # of occupying people	18-19	-
Furniture layout		Varies depending on the pods
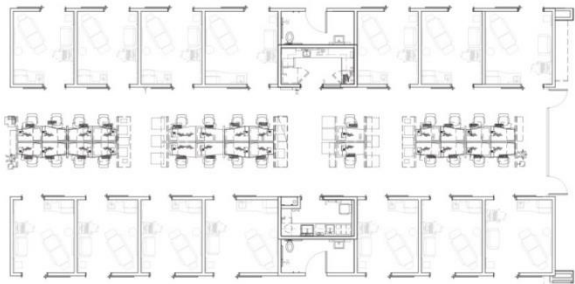
CHEROKEE INDIAN HOSPITAL OUTPATIENT CLINIC

The Cherokee Indian Hospital (CIH) in Western North Carolina runs an outpatient clinic that has been recognized as a Level 3 PCMH by NCQA. In their current hospital facility (which will be replaced in 2015) they have two distinct team rooms that support the outpatient clinic and provide a workspace for the full care team. The design of the new clinic space is presently underway and will draw on their experiences with the different team space layouts.

CLINIC GENERAL INFORMATION

Location: Cherokee, NC

Type of Facility: Part of stand-alone hospital

Size: 5,800 SF (just outpatient clinics)

Service lines: Primary care

Opened in: 1981

PCMH started in: 2012

PCMH NCQA level: Level 3

Operation hours: Monday – Friday, 8 am – 6 pm (7pm for late clinics)

PATIENTS AND STAFFING

Number of providers: 8 (4 MDs, 2 PAs, 2 FNPs)

Number of staffs: 18 (6 RNs, 6 LPN/CMAs, 6 CNAs)

Number of clinical specialists: 6 (2 Behavioral health specialists, 2 Nutritionists, 2 PharmDs)

Number of patient visits per year: 17,000

Determined patient panel for providers: Yes

Patient population characteristic: Members of the Eastern Band of Cherokee Indians
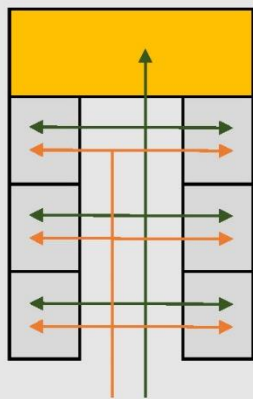
CARE TEAM AND COLLABORATION

Care team members: Provider, RN, MA, and CMS (specialists are shared among pods)

Have care coordinator: Yes, for each provider

Have care specialists: Yes, for each team room

Team gathering: Do team huddle for entire teams and each team
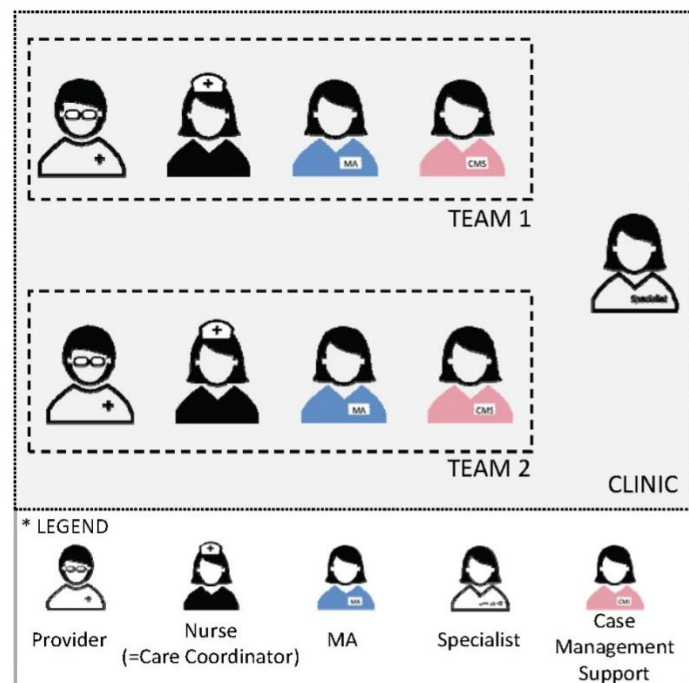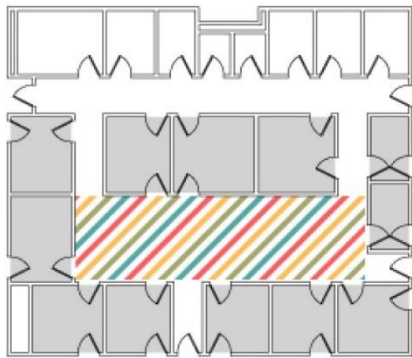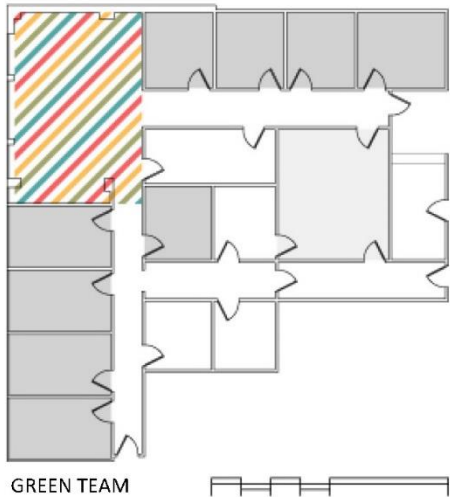
PHYSICAL SPACE TYPOLOGY
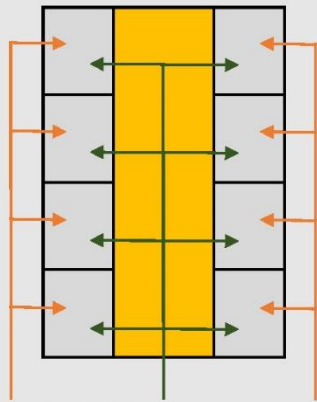
BLUE TEAM

GREEN TEAM

🟧	Team Room
⬜	Exam Room
→	Patient Flow
→	Care Team Flow

PHYSICAL SPACE USAGE AND AREA

BLUE TEAM

GREEN TEAM

	List of room/space types	Usage	Number of spaces	Average area (SF)
▶	Main entrance	√	-	
	Check-in / waiting	√	-	
	Triage / exam room	√	21	100 SF
	Consultation room			
	Group visit room	√	(in another building)	
	Providers workspace	√		
	Nurse/MAs workspace	√	2	430 SF
	Care coordinators workspace	√		
	Specialists workspace	√		

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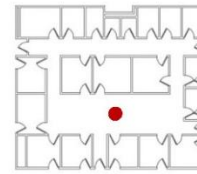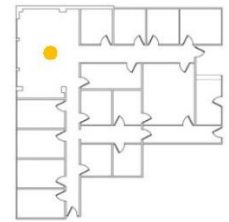
BLUE TEAM   GREEN TEAM
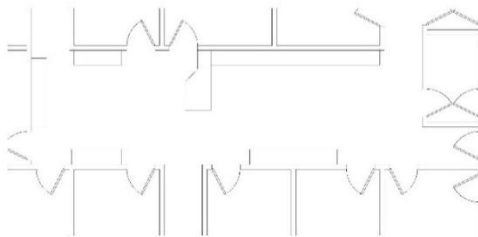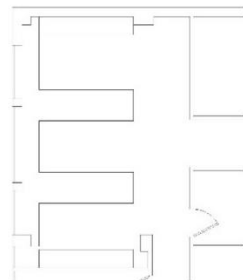
WORKSPACE

Blue Team Room

Green Team Room

	Blue Team Room	Green Team Room
Main users	All care team members	All care team members
Area	500 SF	360 SF
Seat assignment	Determined	Determined
Orientation	Facing wall	Facing wall & facing each other
Have a door	Yes	No
Have windows	No	Yes
Average # of occupying people	14	14
Furniture layout		

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APPENDIX C: OBSERVATION

We had the opportunity to conduct more in-depth research at one of the case study clinics to better understand the importance of space on the team dynamics. Mercy Care Clinic Downtown allowed us to observe their team members in action. In order to understand the role of care team members and care team communication with regards to their clinical space, two types of observation methods, behavioral mapping and provider shadowing, were conducted using, the Detailed Observation Task and Time or DOTT™ tool developed by BBH Design.

The DOTT tool is a web-based digital observation tool allowing observers to record data directly onto an image of the floorplan using on mobile tablets (e.g. IPad). In addition to the location each data point can include other variables. The interface of this tool and the variables collected during the observation were adjusted for the Mercy Care setting and the specific research study objectives. The research team decided to collect the following information for each observation: location on the floorplan; role; posture; activity; devices employed; and the role of any communication counterparts. A total of 10 roles were used to categorize the people present at Mercy Care: Provider, CMA, RN, Administrator, Behavioral Health, Specialist, Patient and Family, Patient Support Services, Tech, and Others.

To ensure consistency of the data collected the route for the behavioral mapping observation and the data collection points were determined and standardized in advance based on pilot tests at the facility, which also confirmed the inter rater reliability. The following figure illustrates the layout of the clinic, the observed area, and the standardized route for the behavioral mapping. Observations were limited to the public or care staff work area in order not to disturb care process and patients. No observations were made inside patient-related rooms such as exam rooms or the laboratory, nor did we make observations inside of individual offices or the medication supply room.

The behavioral mapping observations were conducted over four days during the first and second weeks of December 2014 by five trained researchers. By following the standardized path every 20 minutes, the researchers stopped at designated observation points and recorded the locations and other variables for all the people they could see. As a result, a total of 94 unique behavioral mapping routes were conducted and 1238 data points were collected.

Shadowing observations were conducted on three days during the same period by three trained researchers. One researcher followed one provider and recorded their locations (limited to the pre-determined area), postures, engaged activities, devices used, and their communication counterparts when they were talking. A total of four different providers were followed which resulted in 947 data points.

Some findings of the observation will be stated: the location of the care staffs, location of providers for certain activities, and location and counterparts of the communications. As Mercy Care considers provider and CMAs as a primary team and specialists, behavioral health specialist and RN as members of the teams, the results will be explained in regards to such roles with the focus on provider and CMAs.
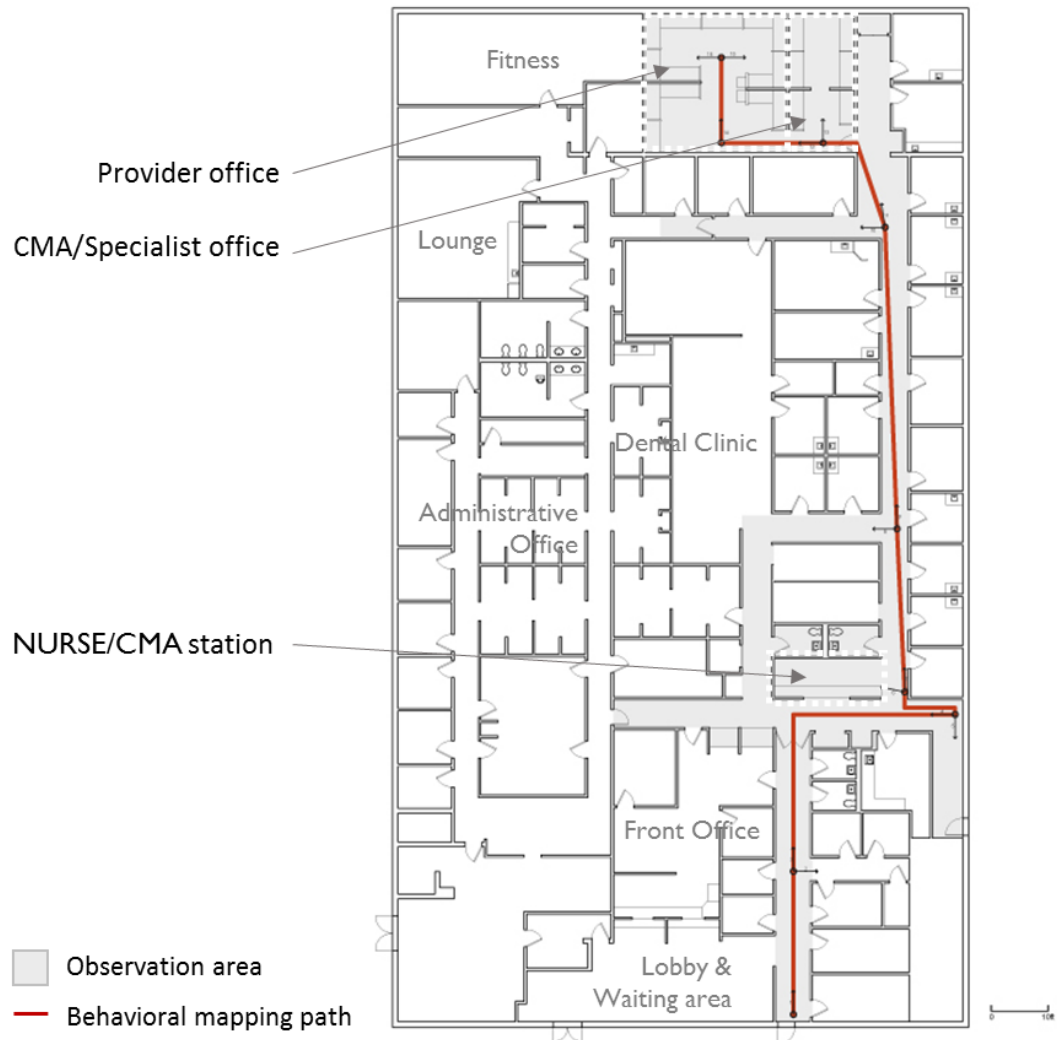
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Figure C1. Observation area for both methods and standardized path for the behavioral mapping

Location per role

The behavior mapping data revealed that the location of staff varied significantly by role. Among 239 records of providers, 75% the data were recorded in the provider office while only 4% of the observations were in the NURSE/CMA station. This indicates that providers are likely to stay in the Provider office and not likely to go to the NURSE/CMA station. Main areas were CMAs were observed are: NURSE/CMA station (37%) and Corridors (33%). Only 7% of the observations were in the Provider office. Also, CMAs were infrequently using the CMA/SP office (13% of observations), which is far away from the NURSE/CMA station. Specialists and Behavioral Health providers had similar patterns to Providers, with more that 80% of their observations occurring in the back office of the clinic.
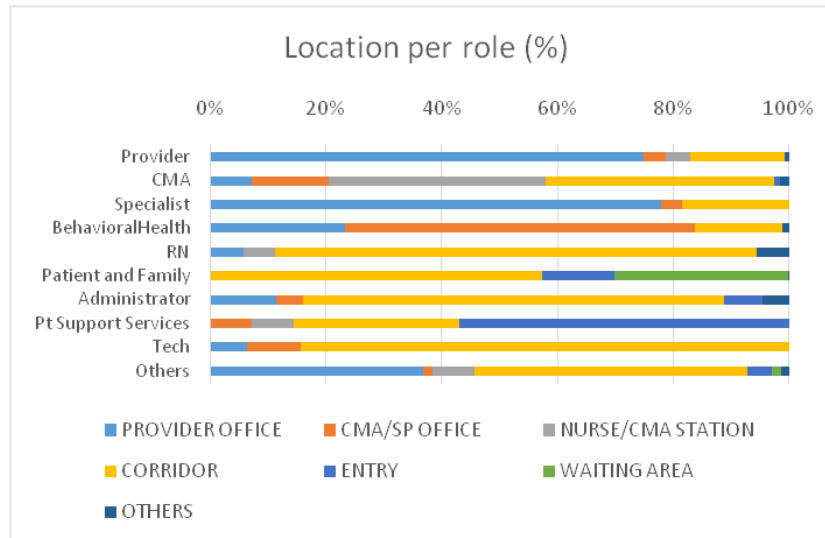
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Figure C2. Distribution of observations across locations per role shows that Providers, Specialists and Behavior Health Providers all spend the majority of their time in the back office.

Another way to look at the data to understand the use of space by providers is by looking at the frequency of activities by location of different activities as observed from provider shadowing. Figure C3 shows the location where providers were when they were observed engaged in the activities of talking, reading, documenting, hunting and other. As shown in the graph, the provider office was overwhelmingly the location for all activities. For "talking", 86% of the time occurred in provider office and only 7% in the NURSE/CMA station. For "reading" and "documenting", they occurred in provider office as providers had their own desk in the office and this is where their desktop computers were located. However, some "documenting" also happened in NURSE/CMA station (6%) and Exam room (4%) on computers there.
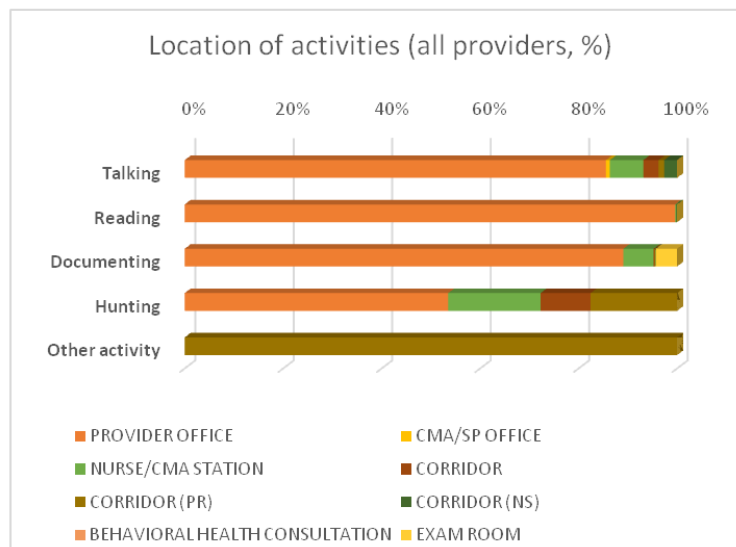

Figure C3. The primary activities that Providers do, outside of patient contact, happen in their office

Communication

The analysis of the communication counterparts from the behavior mapping data showed interesting results. Although providers and CMAs were primary care team members requiring frequent and accurate coordination between them, the frequency of face-to-face communication was less than the frequency of communication with other people in the same role. For example, 41% of the observed talking for providers was with other providers while only 21% of their verbal communication was with CMAs. Similarly, CMAs talked to CMAs for 40% of their observed verbal communication and to Providers for 13%. This seems to be related to the proximity between team members. Providers have their shared office in the back of the clinic, while CMAs stayed together around the front NURSE/CMA station which provides close proximity to the same roles, encouraging more communications to each other. This also can be seen with the following figures: the main location of the providers while talking is inside the Provider office and the main location of the talking CMAs is around the NURSE/CMA station.

The location of these communication episodes can be mapped onto the floor plan, see Figure C5. As shown in these figures, the major locations for communications are near provider office, and near NURSE/CMA station, with most of the communications for each role occurring near their respective offices. Overwhelming, providers hold most of their communications near the Provider office (82%) while only 9% of their communication occurred near NURSE/CMA station. It was a similar, but less extreme pattern for CMAs, who had 54% of their communications near the NURSE/CMA station, and only 16% near Provider office. Interestingly, not many communications occurred in the corridor between the provider office and NURSE/CMA station despite the fact they cross paths with each other here.
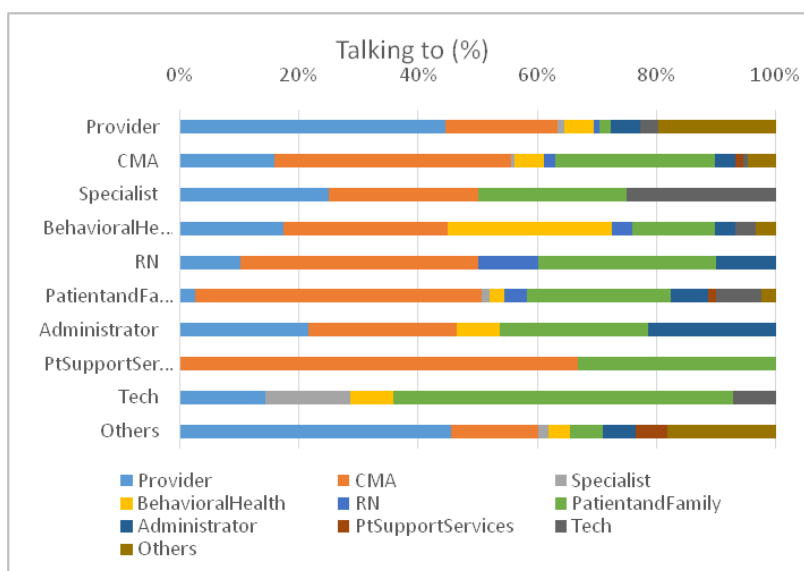

Figure C4. Communication counterparts per role

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Figure C5. Location while talking (Left: providers, right: CMAs)

Observation as a Research Tool

Formal structured field observations are extremely useful for revealing patterns that may or may not be obvious to the people engaged in those behaviors. While few of the findings from this particular exercise were surprising, the ability to quantify behaviors and interactions gives the research and care teams an opportunity to see the strength of the patterns, degree of variability and highlights potential problems. External observers are able to see problematic patterns that the occupants have long acclimated to.

The Mercy Care Clinic layout presented a challenge for observing the interactions of the full care team. Ideally we would have liked to conduct all the behavior mapping observations inside the team room; this is the approach that was used at Cherokee Indian Hospital and it allowed us to see all the members of the care team simultaneously. Because the providers and CMAs were located in distant offices this approach was not possible at Mercy Care. As a consequence we settle on taking observations along a standardized path and set intervals and augmented this data is targeted shadowing on providers. This approach yielded enough data to demonstration a pattern, but it would have benefited from a greater number of data collection days. A variety of factors including the construction schedule, holidays and limited funding resulted in abbreviated observation period.

The DOTT tool was an improvement in data collection over paper data sheets. The tool was flexible and able to be adapted to the variables that we wanted to capture. But, once the tool was set up it was harder to capture notes or corrections to observations compared with paper records. The most helpful aspect of this tool is the ability to display data onto the floor plan in addition to providing tabular data that can be analyzed to compute statistics.

APPENDIX D: SIMULATION

As a culmination of the research it was important to give clinicians and care team members the opportunity to directly provide feedback about team room design. A simulation exercise was designed that would allow clinical staff to experience different team room designs through a facilitated activity structured to mimic typical patient flows and encounters. The primary goal for the simulation was to evaluate the research findings about the elements of team hub design that support the key objectives. Additionally, the team wanted to understand whether or not a simulation exercise was a useful method for evaluating team collaboration in proposed team spaces.

The research team worked with Dr. Michael Toedt, the Executive Director of Clinical Services for the Cherokee Indian Hospital, to develop the procedures for the simulation exercise. Dr. Toedt's insight was particularly useful because he was instrumental in establishing the Cherokee Indian Hospital PCMH, including their integrated team room and therefore understood the challenges involved in changing organizational culture and work process. The plan for the simulation called for 2 care teams to come to an offsite setting and work through several patient scenarios or flows, in two different settings, followed by a discussion of the spaces and decisions about the desired layout.

First, eight candidate designs were proposed for the clinic team room from which two comparable furniture layouts were selected for physical mock-up and evaluation. The design of the models for the simulation was based on the initial information on the clinical team's needs as well as design principles from previous research from Herman Miller Healthcare. The research suggested addressing the design as a balance of the competing needs of the outpatient clinical workers. These included privacy and visibility, collaboration and concentration, and digital and face-to-face information sharing among others.

As these competing needs have to be addressed in the same, often small space, attention to finer details such as the height of work surfaces and vertical demising panels, the orientation of collocated workspaces, and the appropriate barriers and porousness of different portions of the work area are key to a successfully designed space. The design of these two versions was based on reflecting meaningful differences and choices from among the opportunities and constraints within the space. The two selected arrangements, illustrated in Figure D1, were distinct with regards to how they accomplished the four key objectives of situational awareness, supporting individual work, communication, and symbolism.

The two spaces reflected different orientations of the staff to each other as well as to the exam rooms and corridor, differences in work flow, and, as well, subtle though important differences in height of vertical elements. The intent was to both offer the staff a guided choice in the design of the space, and, through the guided simulation, create awareness of the competing and often tacit needs of the staff.

Layout A had a single large, collaborative workstation that faced the exam room doors, while Layout B was divided into two workstation clusters with 90-degree directionality from the exam rooms. These two layouts were physically installed at the SimTigrate Design Lab using wrapped Herman Miller workstation frames and foam core for the surfaces. The outer boundaries of each layout and the

location of the exam room doors were represented with a combination of physical partitions and tapelines on the floor (Figures D2 through D5).

In parallel to the development of design alternatives, Dr. Michael Toedt, and Kim Care, Mercy Care's Director of Quality and Risk Management constructed a total of five patient scenarios or test cases incorporating several challenging issues that would require both individual and communication work by PCMH teams. While the general scenarios were reviewed and approved by the staff, Dr. Toedt retained control over the details of each encounter, introducing small but important variables during the simulation exercise that would challenge the care process. The scenarios were designed to simulate the patient care embedded in the different settings allowing participants to be deeply engaged.

On January 30th, 2015 eight care team members from Mercy Care's Clinic spent the afternoon at the SimTigrate Design Lab at Georgia Tech to engage in the simulation exercise. The team members from Mercy Care included a medical assistant, an RN Case Manager, two providers, a behavior health specialist, a dentist, the Medical Director and the Director of Quality and Risk Management.

After orienting the group to the plan and purpose of the afternoon, the team members were given an overview of the two layouts and the opportunity to walk around them. After the overview and the walk around they completed a survey with their perceptions of the two layouts and indicated which one they wanted for their new team hub (See below for the results.)
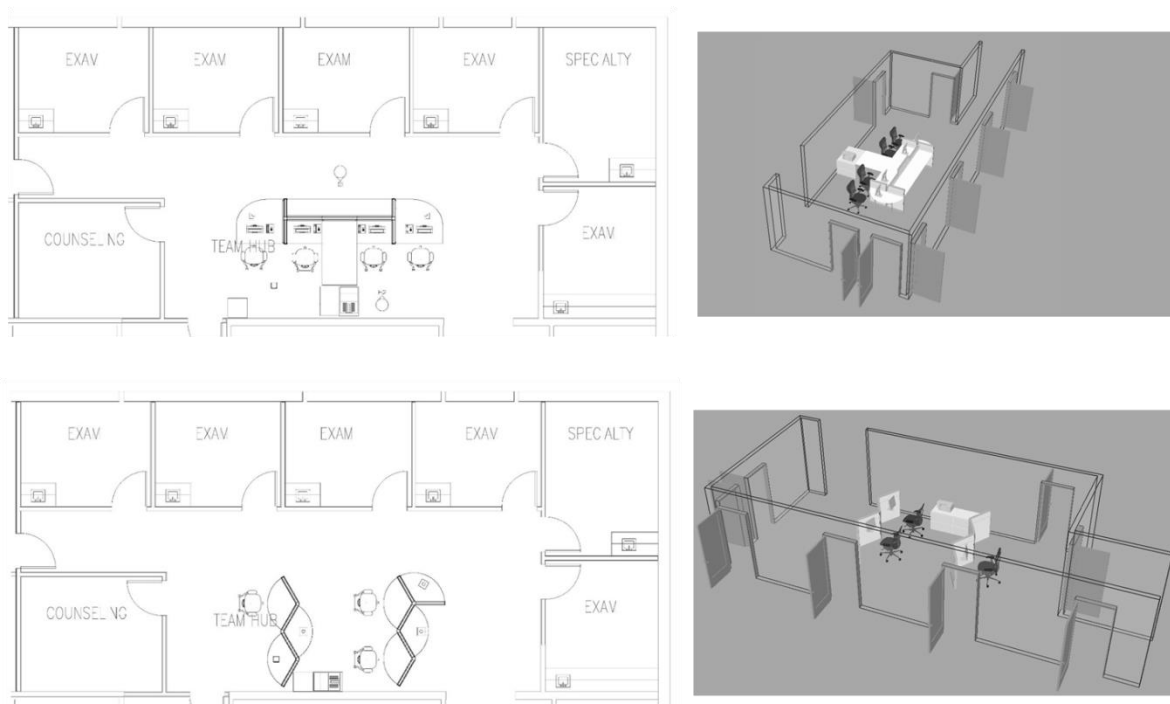

Figure D1. Mock-up Layout A (top) and Layout B (bottom)
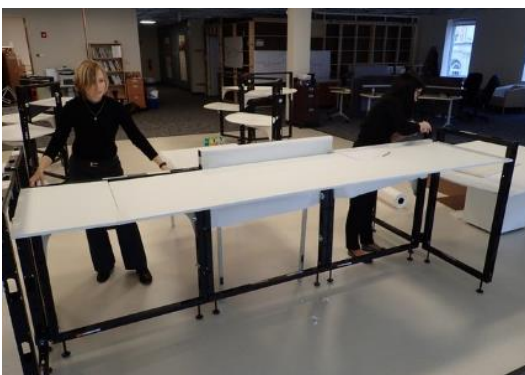
Figure D2. Installing the frames

Figure D3. Installing the foamcore surfaces of workstations

Figure D4. Marking the boundaries with partitions and tape

Figure D5. The two layouts ready for the simulation

Next, to prepare the participants for the simulation exercise and to create a shared understanding of the existing process, a typical patient journey was used to interview participants about the care process and where specific steps occurred within the current clinic layout. Then the team moved to the mock-up layouts and the scenarios were used, letting participants witness the care process flow in actual physical settings. The essential patient information for each scenario was entered into the EMR in advance, however Dr. Toedt introduced unknown, though quite realistic variables during the conducting of each scenario. For one patient might reveal they haven't taken their medications for several weeks, for another they may reveal they had just lost their insurance. While observing the scenarios it became evident that the patient/process variables Dr. Toedt introduced caused the staff members to become more aware of tacit needs which arose, and reflect on how the mockup space did or didn't accommodate those needs. The variations frequently shone a clearer light on the dynamic, fast paced activity that the clinical process reflects, and how situational awareness and short, often spontaneous, communications are important to the efficient and effective patient flow. At the conclusion of one exercise a participant commented that they hadn't realized how much time they spent searching for other staff members.

The patient test cases developed for the simulation were as follows.

Scenario 1: Patient A is a 59-year-old with well-controlled type 2 diabetes mellitus and psoriasis which was previously well-controlled, but now resistant to conventional treatment. She has an established relationship with a rheumatologist to whom she had been previously referred by the primary provider, her insurance has lapsed for over a year and she has not been able to return for follow up. The Patient walks in requesting a new appointment with primary provider to discuss her options since she is experiencing a flare up.

Scenario 2: Patient is a 64 year-old male with hypertension, hyperlipidemia, history of congestive heart failure, and type 2 diabetes mellitus with previous

history of coronary artery disease s/p previous bypass grafting who calls the nurse complaining of decreased energy and increased weight gain. He has an established relationship with a referring cardiologist with whom he missed his last appointment and has run out of medications.

Scenario 3: Patient is a 29-year-old unmarried single mother of two with no complaints who has not contacted the office. She is 3 years past due for a routine health exam. Her last exam was performed post-partum after delivery of her second child. She was contacted by the care team to schedule an appointment for a wellness exam, and readily accepted an appointment, but did not show for the exam.

Scenario 4: 19-year-old man with recently diagnosed HIV, who has his first Ryan White Early Intervention clinic appointment after completing the intake process just two weeks prior to the appointment. All of his initial lab test results have not yet been entered into the EHR.

Scenario 5: A new, out-of-care 50-year-old woman, who is a new resident in a shelter program presents for routine medical clearance, but also complains of stomach pain and scores high positive on the behavioral health screen.

The survey regarding the two mockup spaces for the staff consisted of a total of nine items that asked about their perceptions and experience inside the mock-ups and how the design would support their care team's collaboration. The items included the experience or perception of their situational awareness, individual work and privacy, communication, and feeling of working as a team with regard to the physical layout. Participants were first asked to select preferred layout between A and B and indicate their level of agreement with the following statements using a 7-point Likert scale:

- This space would allow me to be aware of what fellow patient care team members are doing throughout the day
- This space would allow me to be aware of what members of other patient care teams are doing throughout the day
- This space would allow me to be aware of where patients are in their care process and their emergent needs
- This space would allow me to focus on detailed work that requires concentration
- This space would allow me to feel that I have adequate level of privacy from patients
- This space would allow me to easily communicate with my colleagues when I want or need to
- This space would allow me to feel part of a TEAM that provides patient centered medical home care

Also, two open-ended questions were included to ask "what do you like most about this layout? What do you like least about this layout?"

The survey was conducted before and after the simulation to ask their perceptions of the two different layouts and to see if their perceptions changed as a result of the simulation.

Although the number of participants in the survey was not sufficient to test statistical significance (the number of responses was four before the simulation and five after the simulation), the tendencies between two layouts and between before and after the simulations are illustrated below.

First, the result of overall preference frequency between Layout A and B before and after the simulations is interesting. Before the simulation exercise was conducted the respondents were evenly split in their preference between the two layouts, but at the end of the exercise more of the participants selected Layout A (4 votes) than selected layout B (only 1 vote). This change in preferences suggests that the simulation exercise influenced the opinion of at least some of the participants.

Then, what aspects of the Layout A and B made them preferable? One way to answer this is by highlighting the percentage of frequency scoring 6 and 7 (out of a 7-point scale) for the items from the preferred answers (Figure D6). The results were different for Layout A and B, indicating they were preferred due to distinct aspects of the layouts. Left graph with orange color columns illustrates the results of the layout A, showing that item 3 "This space would allow me to be aware of where patients are in their care process and their emergent needs" and item 6 "This space would allow me to easily communicate with my colleagues when I want or need to" are the most frequent highly scored items for participants who preferred layout A compared to B. Amongst those who preferred layout B, item 4 "This space would allow me to focus on detailed work that requires concentration" and item 5 "This space would allow me to feel that I have adequate level of privacy from patients" were scored high most frequently.

The impact of the simulation exercise is indicated by a comparison of the ratings for each layout at the beginning and end of the simulation exercise. When the care team first arrived they had a preference for Layout B and this preference switched after the conclusion of the simulation exercise, see Figure D7.
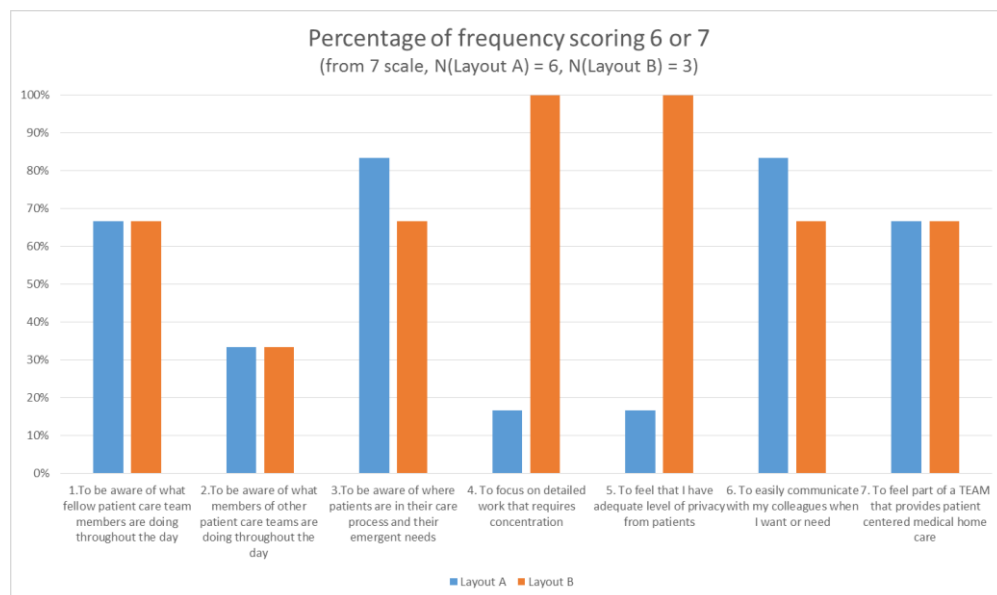

Figure D6. Percentage of frequency scoring 6 and 7 for layout A (left) and B (right)

The biggest shift in perception was how participants rated the two layouts on items 4 and 5 that deal with concentration for detail work and privacy from patients respectively. Initially Layout B was rated much higher than Layout A on these two items, but after the simulation there was little difference between how the two layouts were rated on these items. This shift in perception indicates that at first glance the caregivers thought Layout B was superior to Layout A on support for work that requires concentration and privacy from patients, but they rethought this view as a result of a more thoughtful evaluation of the two layouts.

Keys to a Successful Simulation:

· **Make the mockup physicality as rich as resources permit**. Most people have difficulty in even visualizing spaces, let alone how they will move or behave in that future space. Though keep it approximate and flexible – which enhances the ability to do "what if's" and quick variations

· **Start big, think small**. Design details are important – staff orientation while communicating, work surface height and adjustability, vertical space planning. By starting with principles and a clear vision and then following through in the detail of these of small but concentrated spaces

· **Offer choices – carefully crafted**. By thinking through the key objectives, the processes and the constraints, and by considering the needs as competing rather than conflicting, you can construct a meaningful exercise that both engages the staff and reaches consensus on key issues without excessive or unnecessary distraction - or worse, too much choice.

· Start with typical **patient flow scenarios** – and then enhance them - to get at the staff's tacit needs as well as foster the staff's deeper awareness of their dynamic work processes and the cultural shift to the new, more collaborative work flow.
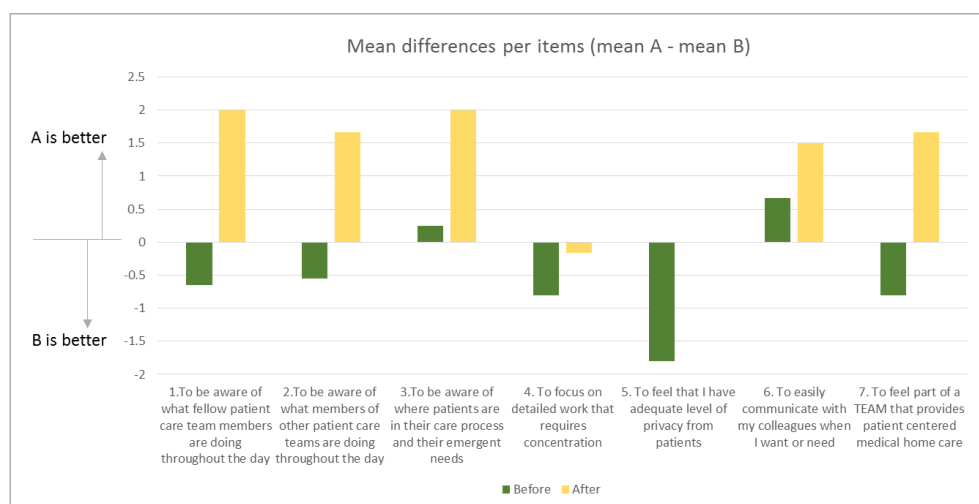

Figure D7. Mean difference per items (Mean A – Mean B)

Figure D8a. Patient care interviewing with current layout

Figure D8b. Patient care interviewing with current layout

Figure D9. Simulation at layout A

Figure D10. Simulation at layout B

Figure D11. Simulation at layout A

Figure D12. Simulation at layout B

The simulation was very useful in more accurately and richly evaluating designs. By starting with identifying the key objectives and the needs of the staff, and then translating those both to the mockups and the simulation exercise, we were able to effectively and efficiently gain staff feedback, support, and even increased interest in the new processes.

A shift to team based care is a major culture as well as process change for outpatient clinics. Well-designed environments can't alleviate all the challenges inherent in the change, though they can foster and facilitate a positive shift, starting with how the spaces are planned and how the staff is included in the planning. A simulation provides much richer information and feedback about how the processes and staff will perform in and experience the new team space than sharing a drawing or mockup alone. A process simulation can provide a much more accurate experience as well as a deeper engagement, and as our surveys suggested, can positively influence the end result.