The ambitious challenge of a patient-centered medical home, and even more so value-based payment models, require clinics that efficiently deliver broad ranging services on an as-needed basis. As family medicine evolves to meet increased demands, the impact of physical workspace is often overlooked. Unfortunately, traditional office design impedes the effectiveness of primary care teams in multiple ways.

Built in 1990, the University of North Carolina (UNC) Family Medicine Center was once a state-of-the-art facility. By 2011, faculty and staff realized they were making the most of an outdated facility. Decreased patient satisfaction, increased wait times, and poor staff/provider experience scores all indicated a need for improvement. Simultaneously, demand for services increased. That year, the clinic reached a record number of 52,000 patient visits in a building that was designed for maximum capacity of 35,000. Departmental leadership sought an innovative, patient-centered solution to expand the clinical capacity and enhance patients’ overall experience.

Methods
Clinic leadership partnered with the Office of Operational Efficiency (OE) to use lean methodology in renovation and redesign efforts. Lean methodology originates from Toyota manufacturing. It emphasizes value to the customer through continuous improvement and respect for all members of the team. Thus, all members of the clinical operation are trained and encouraged to continually identify areas of waste and eliminate steps that do not add value to the patient. Long before any construction work, lean coaches trained clinic leadership, faculty, staff, and members of the patient advisory council to ensure buy-in and a working understanding of lean principles at all organizational levels (Table 1).

Once the clinic had embraced lean thinking, clinic leadership assembled a multidisciplinary team of providers, staff, patients, architects, and quality improvement coaches to renovate and redesign our clinic. The team observed our current state and several key findings emerged. Patients spent too much time waiting at various steps in their visit (eg, in line to check in). Providers spent too much time outside of the exam room (eg, looking
for supplies). Patients had to walk through the building too much to access services (e.g., lab). Patients had little sense of privacy during the check-in and check-out processes.

The team then envisioned and mapped the care we aspired to provide. Using lean principles, we examined the gaps between our current and future state. We then identified metrics that would measure progress toward our ideal state. To evaluate changes in patient care capacity, we identified total number of patient visits, total patient cycle time, and the amount and proportion of space dedicated to actual patient care as our main outcomes of interest. To evaluate patient experience, we chose Press Ganey patient satisfaction surveys as our key indicator of success.

Through the lean redesign process, new patient flow was mapped out and endorsed by faculty, staff, and patients, and subsequently the team worked with architects to design a physical space to support their vision. The team completely redesigned the patient experience, eliminating waste and streamlining patient movement through the visit (Table 3). This included bold changes like eliminating the check-in desk in exchange for a process wherein every patient was briefly greeted at the front door and then taken to their exam room for check-in. To minimize loss of patient care capacity during renovation, we converted a former waiting area into examining rooms first, and then remodeled one module of four at a time.

The UNC Institutional Review Board approved this study as exempt from formal review (#19-1651).

Results
At the conclusion of this roughly $3 million project, the UNC Family Medicine Center accomplished several outcomes. First, the amount of space dedicated to clinical care increased by 31%, from 14 to 18.4 exam rooms per 10,000 square feet of space dedicated to clinical care. The processes we signed patient flow and planning and future state. We then identified the gaps between our current state and our vision. The team completely redesigned the patient experience, eliminating waste and streamlining patient movement through the visit (Table 3). This included bold changes like eliminating the check-in desk in exchange for a process wherein every patient was briefly greeted at the front door and then taken to their exam room for check-in. To minimize loss of patient care capacity during renovation, we converted a former waiting area into examining rooms first, and then remodeled one module of four at a time.

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Discussion
Our experience indicates lean methodology is an effective tool for redesigning patient flow and planning clinical space. The processes we implemented allowed us to envision and create new clinical space that was more efficient, private, and

Table 1: Lean Transformation Prerequisites

| Term or Strategy                  | Description                                                                                           |
|----------------------------------|-------------------------------------------------------------------------------------------------------|
| Engaged leadership               | Engaged leadership                                                                                   |
| Training and involvement at all staff levels | Training and involvement at all staff levels                                                         |
| Protected staff and provider time to participate in improvement events | Protected staff and provider time to participate in improvement events                               |
| Experienced lean coaches         | Experienced lean coaches                                                                              |
| Data management capacity         | Data management capacity                                                                             |
| Engaged patient advisory council | Engaged patient advisory council                                                                       |

Table 2: Lean Strategies and Terminology

| Term or Strategy | Description                                                                                           |
|------------------|-------------------------------------------------------------------------------------------------------|
| A3 thinking      | A structured problem-solving method organized in nine steps:                                          |
|                  | (1) reason for action, (2) current state, (3) target state, (4) gap analysis, (5) solution approach, |
|                  | (6) rapid experiments, (7) completion plan, (8) confirmed state, (9) insights                         |
|                  | A format and physical form for mapping progress through a lean transformation                         |
| Value stream analysis | A structured process of observing and diagraming the current state of workflow with the intent of |
|                    | identifying actions and activities that add value for the customer and eliminating those that do not |
| Gemba walk        | Direct observation of the actual place where work occurs                                               |
| Kaizen event      | A 4- to 5-day rapid improvement event involving a cross-sectional team of providers and staff focused on improving one aspect of workflow within the value stream|
| 2P event          | Preparation/process—an exercise of running operational simulations through a proposed space, ideally at actual scale under realistic conditions |
satisfying for our patients. We were also able to successfully integrate additional members of the health care team into our workflow.

As more clinics embrace the principles of a patient-centered medical home or transition to value-based models, lean processes could be used to redesign existing clinical space and design more comprehensive indirec care.

We benefitted from a highly moti-vated, talented leadership team with signifi-cant experience and buy-in regard-ing lean methodology. They were able to quickly pick up new lean principles and communicate earnestly about their value with colleagues. In addition, UNC HealthCare has a large team of expert lean coaches. Our project was supported by a health care system that highly values the contribution of primary care, and to them, the return on investment was clear. These factors may have contributed to a more successful than usual lean transformation of our workflow and space.

In conclusion, the application of lean principles led to a successful transformation of our clinic. Patient satisfaction and sense of privacy increased. Total cycle time decreased. Multiple clinical quality metrics increased. The number of patients seen also increased. Future endeavors of this kind should carefully consider the multiple lean processes we implemented to identify the most effective steps among the many we employed.

| Table 3: Lean Transformation Changes Implemented During Redesign |
|---------------------------------------------------------------|
| Eliminate waiting rooms                                      |
| Standardize exam rooms                                        |
| Simplify and clarify way-finding                               |
| Eliminate nursing station                                     |
| Colocate providers and medical assistants at work stations be-tween exam rooms |
| Convert underutilized office space to clinical space          |
| Centralize supply storage                                     |
| Colocate phone room and nurse triage teams                    |
| Centralize resident precepting space                          |

Figure 1: Family Medicine Center Layout

Table 3: Lean Transformation Changes Implemented During Redesign

Figure 1: Family Medicine Center Layout

Shaded portions represent nonclinical areas prior to renovation. Nonclinical areas included two waiting rooms, a large check-in space, and underutilized offices.
Figure 2: Median Patient Cycle Time (From Door-In to Door-Out), by Month

Source: direct observation of at least 30 patient encounters per month

Figure 3: Overall Patient Satisfaction according to Press Ganey Email Patient Surveys From January 2015 to June 2016

Shaded area represents the 95% confidence interval for all practices, with half the width approximating the degree of change that would be statistically significant.
Figure 4: Patient Satisfaction: Patient Privacy

Taken from Press Ganey question specifically addressing patient privacy.
Renovation from January 2015 to June 2016.
Y axis=percentile among large health care systems.

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