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Mission of the Academy Journal

As the official journal of the AIA Academy of Architecture for Health (AAH), this publication explores subjects of interest to AAH members and others involved in the fields of healthcare architecture, planning, design, and construction. The goal is to promote awareness, educational exchange, and advancement of the overall project-delivery process and building products.

Letter from the Editor

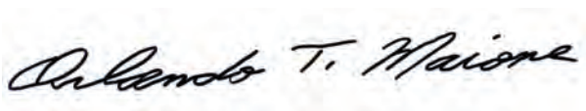
This is the 14th edition of the *Academy Journal*, published by the AIA Academy of Architecture for Health (AAH) knowledge community. As the official publication of the Academy, the *Journal* electronically publishes articles of particular interest to AIA members and the interested public involved in the fields of healthcare architecture, planning, design, research, and construction. Since 2005 we have also published a hard-copy version of the *Journal* that has expanded our distribution worldwide. The goal has always been to promote awareness and educational exchange between architects and healthcare providers and to broaden our base of understanding about our clients.

Articles are submitted to, and reviewed by, an experienced nationally diverse Editorial Review Committee (ERC). Over the years, the committee has reviewed more than 183 submitted articles, responded to countless writers' inquiries, and encouraged and assisted numerous writers in achieving publication. The *Journal* has provided valuable opportunities for new and seasoned authors from the architecture and healthcare professions. With this issue, four articles have been selected and printed supporting the enhancement of the built environment for healthcare. Throughout the 14-year history of the *Journal*, the authors have included architects, physicians, nurses, other healthcare providers, academics, research scientists, and students from the United States and many foreign countries.

Published articles have explored a broad range of medical topics, including trends and the future of healthcare architecture, cardiac care, future and evolving technology, patient rooms and patient safety, lighting design for healthcare, psychology, workplace design, cancer care environments, emergency care, women's and children's care, and various healthcare project delivery methods. Visit the *Academy Journal* archives at http://www.aia.org/practicing/groups/kc/AIAB080716 for earlier articles you may have missed. We would like to encourage more graduates who have received healthcare research scholarships and others involved with research within the architecture for healthcare fields to submit their research to the *Journal* for publication consideration. We will continue to develop a cross-referenced article index and a broader base of writers and readers. The deadline for the 2013 Call for Papers is May 31, 2013.

My special thanks to the AIA for its continued support and hard-working staff and to the many volunteers who have contributed to our growing and continued success. I would especially like to thank the other members of the 2012 ERC: James G. Easter Jr., FAAMA, Assoc. AIA (Tenn.); Ed Jakmauh, FAIA, ACHA, LEED AP (Pa.); Joyce Redden (Tenn.); John Sealander, AIA, ACHA (Calif.); Professor Kent Spreckelmeyer, PhD, FAIA (Kan.); and Janice Stanton, RN, MBA, EDAC, LEED Certified (Ill.)

As always, we appreciate your feedback, comments, and suggestions. Call Susan Parrish, manager, AIA Knowledge Communities, at 202-626-7332 or me at 631-246-5660.



Orlando T. Maione, AIA, ACHA, NCARB
Editor, Academy Journal
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A Sustainable Model: Creating Facilities with a Future

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Abstract

Daniel Burnham, creator of Chicago's 100-year-old master plan, once said, "Make no little plans. They have no magic to stir men's blood." As healthcare systems adapt to trends in economics, required care, and developments such as home healthcare, they will do well to heed Mr. Burnham's advice. There is a need for facilities that are efficient for patients and caregivers and that foster collaborative care. Healthcare facilities must also respond to the trend toward preventive care and the changes implicit in the treatment of chronic diseases rather than acute disorders. All of these developments mean that people will make more frequent visits to the doctor's office. More than just an exam room will be required to fulfill what people will expect as part of their "patient experience."

Healthcare facilities must also respond to the trend toward preventive care and the changes implicit in the treatment of chronic diseases rather than acute disorders.

Introduction

Daniel Burnham, creator of Chicago's 100-year-old master plan, once said, "Make no little plans. They have no magic to stir men's blood." As healthcare systems adapt to trends in economics, required care, and home healthcare, they will do well to heed Mr. Burnham's advice. There is a need for facilities that are efficient for patients and caregivers and that foster collaborative care. Healthcare facilities must also respond to the trend toward preventive care and the changes implicit in the treatment of chronic diseases rather than acute disorders. All of these developments mean that people will make more frequent visits to the doctor's office. More than just an exam room will be required to fulfill what people will expect as part of their "patient experience."

Green buildings that contribute to sustainable environments and that support, integrate with, and act as an anchor for their communities will also be important. While these are not wholly new concepts, the need for facilities that accomplish all of the above in one movement is more of a necessity than ever. To accomplish this, healthcare systems will need to adopt a master-plan mentality rather than a simple one-step plan. When Oakwood Healthcare (major healthcare system), Midwest Health Center (local provider), Redico (national real estate developer), and the city of Dearborn (local municipality) formed a partnership to develop a mixed-use complex on one of the city's strategic properties, they did just this—created a facility not of the future but with a future.

Figure 1: Dearborn Town Center at the corner of Michigan Avenue and Schaefer Road in Dearborn, Mich. (copyright submitting firm)

Changing Healthcare

Healthcare is an ever-changing industry. It has developed from home care to religious institutions to what we know now as hospitals, and today it is moving back toward homes in expanding communities through ambulatory care centers. It is important to develop facilities that can adapt over time and remain useful as the environment of care continues to develop. In the near future, both economics and changing care needs will push more and more care out of hospitals and into ambulatory facilities.

The economy and health reform are strongly linked. Health reform has been the subject of political discussions since President Truman's

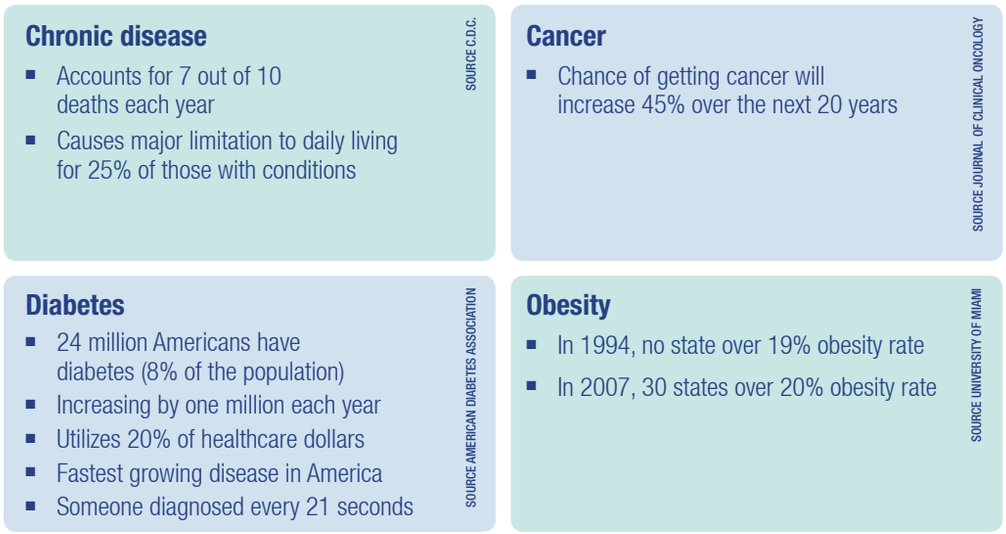

Figure 2: Chronic disease statistics (copyright submitting firm)

time, but recently it has been brought to the forefront because of drastic changes in the economy. Current reforms emphasize wellness and pay-for-performance models, largely in response to changes in our society, how people live, and the progress medicine has made in treating people and diseases. In the last decade advances in medicine have dramatically changed the focus of patient care. Great strides have been made in curing many diseases and acute medical conditions. Many of the diseases and acute conditions that people died from at an early age have disappeared with medications and treatments. While these advancements have done much to extend life, they have created a population afflicted with chronic disease.

According to the Centers for Disease Control and Prevention, chronic diseases such as heart disease, cancer, and diabetes are the leading causes of death and disability in the United States. Chronic diseases account for 7 out of 10 deaths of Americans each year. A quarter of people with chronic diseases also face major limitations in daily living. Chronic disease, which is most prevalent in urban areas, can be treated with a process of prevention, prescription, and personalized care. People with these conditions need to be coached and led into a lifestyle or program of healthy living and to receive care on an ongoing basis. Managing care for chronic conditions and preventing people from developing these conditions will require centers teamed with caregivers to provide education, diagnosis, treatment, and care.

Wellness Centers

This change in focus of care has led to a change in the delivery of care. Changes in delivery of care cause changes in the facilities that support care delivery. So what types of facilities are needed?

A major difference in providing care for chronic-vs-acute problems is the frequency with which patients are expected to take action to improve or maintain their health. If taking action is made an easy part of their lifestyle, then the chances for success will increase. Providing facilities that fit into patients' lifestyles will provide a greater chance for interaction and support of patients during their journey toward wellness. In the past people went to their provider when something was wrong, and they expected to return home with the problem solved and feeling better. This visit was all about the end result. The provision of ongoing care and support requires a different outlook. If we keep in mind that in life it is not the end that matters—the end is always the same—but the journey along the way, we can perhaps have a better understanding of how to facilitate healthcare for today's patients. Healthcare providers need to create pleasant, convenient wellness centers that enhance the patient experience and provide them with all the tools needed to improve their health. Without these, it will become increasingly difficult to keep patients engaged in improving their health.

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Providing such centers requires the facility to be part of the community, and not just a building located within the community it is intended to serve. Matthew DeGeeter, ASID, LEED® AP+C, an interior designer at Perkins + Will, stated, "The connection between healthcare provider and patient needs to be developed to improve the delivery model. If the healthcare system is rooted in the community, then the image is a portrayal of what the community aspires to be."[1] For healthcare facilities to influence the patients they serve, they "need to provide patient-centered care in a facility that honors the environment and community." Such facilities, he said, will "have the opportunity to become the community center for health and wellness." From an even broader perspective, when discussing where evidence-based healthcare design will head in the future, Debra Levin, president and CEO of the Center for Health Design, stated, "We will broaden our understanding to explore the role that the design of communities plays in health as well."[2] Given the effect communities have on health, providing facilities that are integrated with and enhance the communities they support is clearly the right direction.

Figure 3: Clockwise from left: Interior details of the community room with sculpture, meeting room, and elevator lobby (copyright submitting firm)

Development of a Facility with a Future

After considering the multiple changes in medicine and healthcare delivery, Oakwood Healthcare undertook a mission of addressing the needs of its patients by providing not only a new facility in which to practice medicine but a whole new outlook at the practice of medicine. Oakwood Healthcare has a long tradition of providing care to poor and working-class individuals in the greater Detroit and southeast Michigan region. The health system was founded in Dearborn, Mich., in the 1950s by Henry Ford to promote healthcare and wellness to employees of the Ford Motor Company as well as the greater Dearborn community.

After evaluating a number of programs for providing services in the best manner possible, Oakwood realized that demographic expansion would slow down and expansion to newer far-reaching suburbs would subside. Therefore, it made sense for Oakwood to reinvest in its core communities. The healthcare system turned to Dearborn for development of the next stage of healthcare: a newly defined ambulatory care center. Oakwood has been in the ambulatory care practice since the early 1980s when satellite campuses were developed to reach patients in newly emerging suburbs. In addition, Oakwood maintains ambulatory care centers near its major hospitals in order to reduce hospital density.

A number of factors were considered in the decision to develop this new medical center:

- Location: As mentioned earlier, the hospital system maintains a large number of satellite facilities in the outreach portion of its service district. The intent of the new program is to provide continuous, collaborative care to the core community residents. Oakwood recognized that in the coming years, these would be areas of growth. A downtown community with transportation alternatives was chosen as the appropriate location.

- Population: Chronic disease affects persons of lower means the most intensely, because they often do not receive proper medical attention and health education. Again, the downtown community location will provide access for such persons. As well, the system's initiative is aimed at providing residents with education.

- Basis of service: A program that responds to the needs of the community must address all of the conditions afflicting the population. With a baseline of medical programs ranging from primary care and internal medicine to optical, dental, and cardiology, such a center needs to address all of the educational, preventive, prescriptive, and treatment needs for the service lines.

- Collaboration: A network must be available for sharing the patient's information and establishing protocols for what may involve multiple conditions. Electronic medical records will be critical as patients are able to network with caregivers from their homes for discussion of conditions, education, and in some cases treatment.

- Community resource: Early in the development of the program for this new medical center, Oakwood made it clear that the facility would not be used exclusively for caring for the sick. The healthcare system would recruit residents to come to the facility when they are well, thereby creating a community resource. This criteria required that the new center be welcoming and available and have an open environment that would inspire residents to take advantage of the resource.

- Architecture: A special architecture would be required for this new medical model. The design must communicate strength and permanence, along with an image of caring and welcome.

Such an organization already existed in the community. Midwest Health Center supported primary care and some specialties through a managed care system. Midwest has been providing care to the core communities of Dearborn and parts of greater Detroit for 30 years and has become a recognized brand in this community.

The directors of the organization shared a vision of developing a more comprehensive care model, embracing the virtues of prevention, prescription, and personalized care. Midwest was in a search to collaborate with a major health organization, one that would aid in the development of a truly integrated model. After much negotiation, Midwest Health and Oakwood reached an agreement to develop

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Figure 4: Schaefer Road elevation

a new medical center that would service the regional population with a comprehensive and collaborative care model, incorporating the attributes of the Midwest Health managed care model with the vast resources of Oakwood Healthcare.

At the same time that Midwest and Oakwood were negotiating, a national developer, Redico, was pursuing plans for a significant mixed-use development on a site in the heart of downtown Dearborn, across from the historic city hall.

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Dearborn's community master plan called for a significant development to be located on this property. For many years it was the site of a Montgomery Ward's store and had become a major epicenter for the community. The city, aware of all parties' desires, became instrumental in development of the new medical center's base for a major mixed-use program. Oakwood Healthcare, Midwest Health Center, Redico, and the city (which provided the much-needed funding for the parking structure) formed a partnership to develop the Dearborn Town Center, a set of facilities for the benefit of the community.

Figure 5: Mixed-use development with City Hall in background

Figure 6: Site plan

Interest from this point focused on how to make the best use of the site for multiple benefits to the community. Issues included:

- Construction of a medical center that would provide the community with a collaborative resource.

- Consideration for the needs of an aging population, and potential for housing.

- The need for a catalyst to redevelop the city's downtown and to encourage retail for this site and ongoing community development.

- The need for a community resource center.

- The need for a "statement" facility that would inspire the future of the city. Such a complex should embrace the solid virtues of the city relative to its commercial base, history, and tradition, but with an eye to the future. Promotion of best land-use policies and sustainability also formed important criteria.

Planning for the new Dearborn Town Center included all of these important criteria. The result is a two-city-block mixed-use composition that responds to the needs of greater Dearborn. The site is anchored by the Oakwood Midwest Medical Center, a three-story, 152,000-square-foot building. The base of the building houses retail that services the center and the public. Medical office space is located on portions of the first floor and upper floors. Land has been established for construction of a multistory, 100-resident assisted living center and an additional mixed-use retail/medical/office building. Parking is provided in a five-story parking structure with 524 parking spaces.

Care Delivery Model

With the master plan for the Oakwood Midwest Medical Center concluded, the focus turned to programming and planning for service lines and best-in-class accommodations for the program. At this point, it is important to look at how healthcare reform and the need to provide care for chronic disorders require a different delivery model from the traditional ambulatory care model, in which individual elements are separated in silos. While the silos in hospitals have been broken down significantly, many ambulatory sites have not made such a change. The change from care for acute disease to care for chronic disease means that an increasingly large number of people will make frequent visits to medical facilities for treatment of multiple conditions. A new medical center needs to be responsive to this change. People may spend a large portion of their day at such a facility in order to receive primary and specialty care, diagnosis, and treatment. These medical facilities need to foster collaboration, be welcoming and responsive, and offer efficiency to the provider in order to maintain profitability.

Effectiveness needs to be derived from the efficiency of the operation. Planning needs to address the basis of a clinic module, the most effective way to treat patients, providing them with the information they need and removing many of the difficulties and encumbrances placed on patients from the equation. If planned correctly, ambulatory sites offer the ability for patients to access care and amenities much more easily and comfortably with less confusion than in a traditional hospital setting.

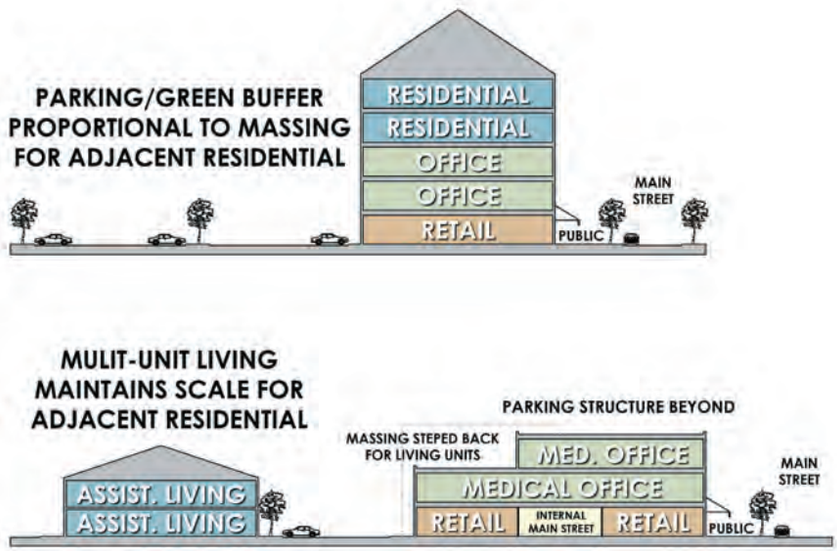

Figure 7: Conceptual Main Street sections

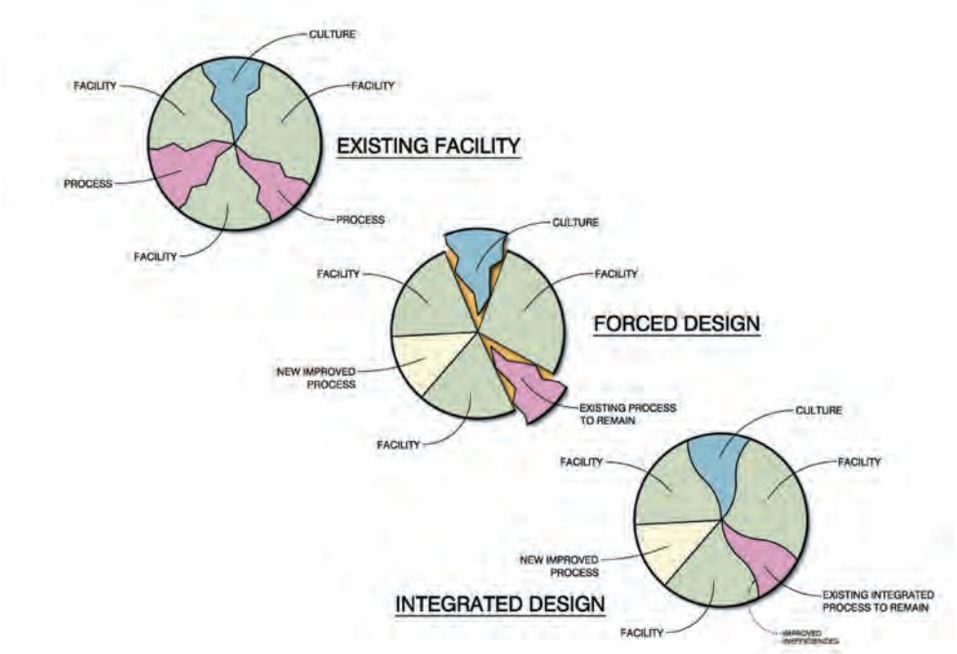

Figure 8: Integrated design

The change from care for acute disease to care for chronic disease means that an increasingly large number of people will make frequent visits to medical facilities for treatment of multiple conditions.

Ease of use, access, and understanding are key to patients developing a comfort level with a facility and their provider, and ultimately continuing on a journey toward better health. Blending the existing providers, Oakwood healthcare standards, and a collaborative model required the use of an integrated design approach in which existing processes and clinical culture were refined and incorporated into the new facility to enhance already successful services.

The clinical module needs to be a model of efficiency, anticipating large patient volumes. Registration for the new medical center was designed to be a combination of telephone and data, combined with a registration center at the entrance with a simple check-in/check-out process. Within the clinic's areas for taking patients, vital statistics were incorporated, nursing and physician areas were standardized, and an on-stage/off-stage concept was introduced. Private and semiprivate waiting areas have been provided. Staff and services are managed through the off-stage circulation, which allows trash and other dirty materials to be removed without interacting extensively with the public or patient circulation areas and also helps manage infection control concerns. Of equal importance, the off-stage connections provide a means for dialogue and collaboration between provider staff and physicians.

The clinical modules are standardized to the greatest extent possible. With the continuing evolution of medicine, changes in treatment, patient procedures, and service lines will continue. Clinics need to be interchangeable to accommodate the ebb and flow for these facilities. Arrangement of the multiple service lines and their adjacencies was considered crucial to the success of the medical center. Arrival at the facility needed to be simple and the entrance points visible. Two major entrance points were developed, one for those arriving by car and a second for those using public transportation. The entrances, which are at opposite ends of the center, are linked with a mall gallery that provides a welcoming, wide route through the facility. Consideration for persons arriving by car meant that the access points to the building and adjacent parking structure not only needed to be contiguous, but welcoming to one another.

Figure 9: Parking structure entrance

Figure 10: Deck features—sky bridge and sustainability

Because the facility is located in an urban environment, security for patients and staff, especially at night, was important. The parking facility is well-lit and security cameras and call boxes are located throughout the facility.

Certain healthcare services, including urgent care, imaging, orthopedics, labs, and physical therapy, are located on the first floor. This location aids patients with limited mobility or who require immediate contact at the urgent care center and provides a convenience for those who need a quick visit to a lab. A sky bridge provides quick and convenient access from covered parking to the center's Women's Health and Surgical Centers.

Other considerations for the new Oakwood Midwest Medical Center included:

- Promotion of staff efficiency by minimizing travel distances between frequently used spaces.
- Efficient use of space by locating support spaces so they can be shared by adjacent functional areas, and making prudent use of multipurpose spaces.
- Inclusion of all needed spaces; elimination of redundant areas.
- Grouping of functional areas with similar system requirements.
- The vital importance of staff and physician retention versus replacement is environmentally dependent. The spaces and operation must respond to the needs of staff including the work environment and respite accommodations.

Stewards of the Community

The Oakwood Midwest Medical Center is clearly intended to be a model facility for healthcare. On a large scale the entire mixed-use complex is intended to be a model for stewardship of the community. Sustainability virtues were high on the priority list of criteria for design and development of the complex.

> If planned correctly, ambulatory sites offer the ability for patients to access care and amenities much more easily and comfortably with less confusion than in a traditional hospital setting.

Many accommodations were made in the design and engineering, construction, and building systems to earn the facility's LEED® Silver certification. The solar-powered parking structure has earned a Green Building Award from the Construction Association of Michigan.

As healthcare providers strive to make plans that can "stir men's blood," it can only be hoped that more development can be incorporated in the fabric of the communities they strive to serve. As we look around the country the outlook is good. In Chicago, Mount Sinai Hospital has a proposed outpatient pavilion planned adjacent to mixed-income housing to provide an anchor for a community redevelopment plan. As projects like this one and Dearborn Town Center continue to develop, we will provide the infrastructure to support a healthier population, healthier communities, and sustainable facilities with bright futures.

Notes

[1] DeGeeter, Matthew. "Changing Perception: Hospital Brand as a Design Strategy." *Healthcare Design Magazine.* December 2009: 10-15.

[2] Levin, Debra. "The Center for Health Design—Improving Healthcare through Building Design." *Healthcare Design Magazine.* February 2010: 8.

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Design for the Latest Technology in Cancer Treatment: A Carbon Therapy Center

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Abstract

Carbon therapy is the latest technology for cancer treatment; it is a form of radiation therapy not found in the present U.S. healthcare system but already being used in parts of Europe and Japan. The aim of this study was to understand the complex functioning of a carbon therapy center and derive design guidelines that determine the architectural response to it. The study was carried out by visiting prototype carbon therapy centers around the world and operational proton therapy centers in the United States. In addition, interviews with nuclear physicists, technicians, radiologists, and architects provided insights into the physics behind the technology, shortcomings of the prototypes, and the future of this modality of treatment. The study was focused on staff and patient needs, radiation shielding, wayfinding, stress reduction, and other physiological factors. Observations and comparisons were drawn to inform these selected parameters and reveal potential areas for new research.

The findings of the study were assimilated in a student project to design a carbon therapy center, sited at the University of Texas M D Anderson Cancer Center, illustrating the application of evidence-based principles to generate a design successfully integrating this novel technology while creating a humane environment for cancer patients.

Introduction

Cancer is one of the biggest healthcare crises in the world today. It is the cause of one out of every four deaths in the United States (Jemal and Siegel et al. 2008). Hence this disease requires the utmost attention, and it is extremely vital that we be better prepared to fight it. Some of the common forms of cancer treatment currently being used are chemotherapy, surgery, targeted therapy, immunotherapy, photodynamic therapy, antiangiogenesis therapy, hyperthermia, and radiation therapy. Over the years, new methods of treating cancer have revolutionized the world of healthcare and in turn influenced the architectural response to it. Gamma rays replaced by x-rays, and then radiation therapy became the most widely used form of cancer treatment, with two out of every three patients being treated with it (Mandrillon 1993).

Research with proton and ion beams has been conducted for almost 50 years, and thousands of patients have been treated with proton therapy. It is considered one of the biggest advancements in the history of cancer treatment. Its efficiency and effectiveness have made it a popular method of treatment. The number of proton therapy centers in the United States has grown from two to ten in the last decade, with a large number of proposals for future centers.

Over the years, new methods of treating cancer have revolutionized the world of healthcare and in turn influenced the architectural response to it.

What Is Carbon Therapy?

Although proton therapy has taken the lead today, there is another variation of radiation therapy making its way into the world of cancer treatment: carbon therapy (Mandrillon 1993). Currently being used mainly in parts of Europe and Japan, this therapy is on the verge of revolutionizing cancer treatment.

As the name suggests, carbon therapy is a technology in which heavy ions of carbon are accelerated with calculated velocity to target deep-seated tumors. It is usually used to treat tumors in the lungs, cervix, head, neck, liver, prostate, or soft tissues, all of which are difficult to operate on and cannot be eradicated effectively by conventional treatments. Inoperable tumors for which no other treatment is available or tumors located close to sensitive organs, such as the spinal cord or optic nerve, can be treated effectively with carbon therapy because of the dosage distribution and depth of penetration possible (Brower 2009). The use of carbon ions in radiotherapy came into practice in 1994 in Japan. Since then, each step forward

The walls of the treatment room are generally made of concrete or a combination of steel plates and concrete, since these materials have the maximum capacity to absorb and prevent leakage of radiation.

has worked to maximize the capability of these ions to cure without harming healthy tissues in the body.

Treatments like standard chemotherapy do not differentiate between cancer cells and normal cells, and hence destroy both equally, a major reason why chemotherapy has such adverse side effects (retrieved from http://news.bbc.co.uk/2/hi/health/4734507.stm). Proton ions offer some respite in preventing excessive damage to healthy tissues, but carbon ions have an even greater advantage in this regard (Miyamoto et al.2003). They offer the benefit of using higher dosages of radiation while considerably reducing the harmful effect on healthy tissues (Schulz-Ertner and Tsujii 2007; Mizoe, Tsujii et al. 2004). The peak at which ions possess maximum energy right before coming to rest is called Bragg peak. Being larger in size, carbon ions achieve a sharper Bragg peak and destroy tumors more efficiently compared to protons (retrieved from http://www.gsi.de; Schulz-Ertner, Nikoghosyan et al. 2004). This property also makes them a useful supplement to surgery. Exposure to carbon ions before or after surgery does not harm healthy tissues and can help reduce the size of the tumor. Carbon therapy is also used in addition to proton therapy and x-rays (Brower 2009).

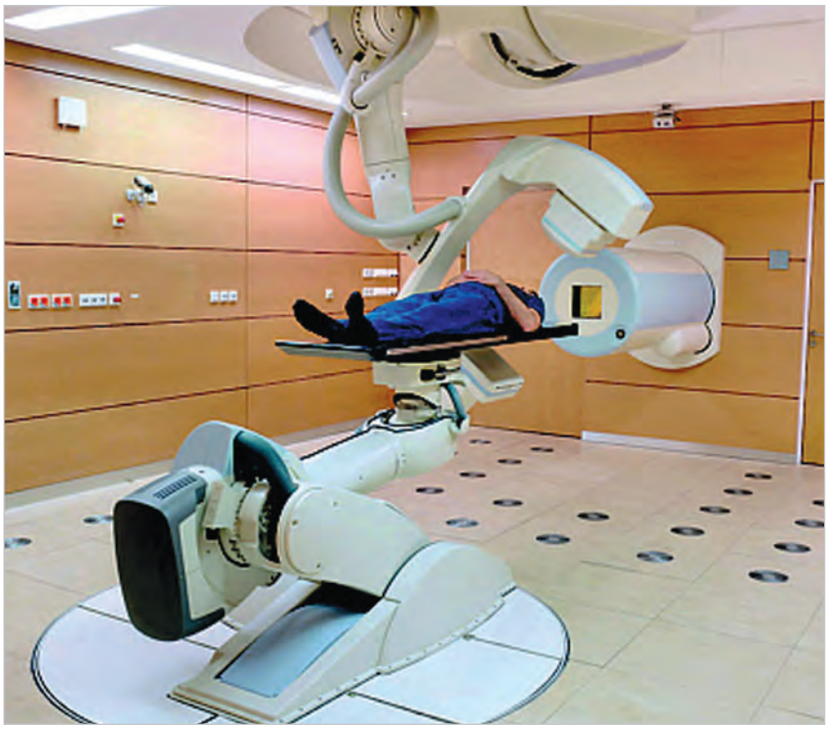


Figure 1: Siemens design of the patient table with the robotic arm for accurate positioning before treatment (retrieved from http://www.siemens.com on May 22, 2011)

The Process

Once approved for carbon therapy, patients undergo a simulation process. A customized immobilization mold is created for every patient. The mold helps to obtain accurate x-ray images showing the exact position and size of the tumor. Imaging allows the tumor to be detected and analyzed.

Based on the results, physicists plan the course and duration of the treatment. When the patient returns for carbon-ion therapy, images are taken using x-ray or ultrasound technologies, which are compared to the pretreatment images to ensure precise alignment of the patient with respect to the beam. The treatment begins only after accurate positioning of the patient is complete.

Main Components of a Carbon Therapy Center

Waiting area

Given the treatment and course of the disease, cancer patients experience high levels of stress. The novelty of the treatment and its high cost can be intimidating factors as well. The main waiting area is the first point of contact for patients. Hence, it is essential to determine design interventions that create a calm and relaxing environment, thereby enhancing the overall patient experience.

Changing area
Based on existing carbon therapy centers there are two different approaches to designing changing areas. Both have varying impacts on the circulation pattern and patient experience.

In the first approach, patients are directed into changing rooms from the main waiting area. After changing, they proceed to a common waiting room before immobilization. The second approach is to provide individual changing areas outside each treatment room. Patients wait in their respective changing rooms until directed to proceed for immobilization. In this case proximity to the control area raises issues of HIPAA violation and lack of patient privacy. Though this design is more convenient in terms of space planning, it has been observed that patients feel more relaxed in the company of other fellow patients, although this observation has yet to be validated.

Immobilization room
Positioning of the patient is an important determinant of the workflow. There are primarily two locations in which immobilization can be carried out: inside the treatment area or in an immobilization room outside of the treatment area.

- Inside the treatment room: Patients place themselves on the table when they are brought into the treatment room. The therapy is carried out on a patient table similar to a tabletop. This table is connected to a robotic arm that helps adjust the patient's position (figure 1).

- Outside the treatment room: The provision of an immobilization room outside the treatment area facilitates the positioning of the patient before treatment begins. This room is equipped with a tabletop connected to a shuttle, which helps align and transport patients for treatment or imaging. The therapy area includes a robotic table base that docks to this tabletop and makes positioning accurate yet comfortable for the patient. The general time frame for patient positioning is around 30 minutes. When performed outside, the use of treatment areas is maximized. Patient scheduling can be optimized by reducing the immobilization time for each patient and allowing greater usage of the therapy rooms.

In both cases, technicians verify the position via robotic x-ray imaging or cone beam computed tomography. Verified data is transferred to the control area located close to the treatment room or right outside it.

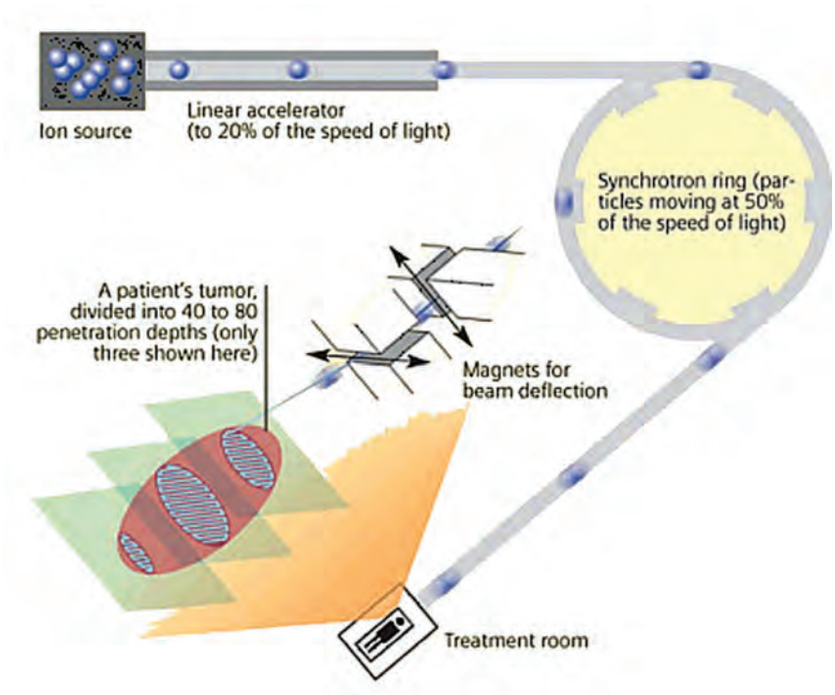
Treatment room
During the treatment process, neutron particles are generated in parallel with the carbon ions. Thus, radiation shielding is a major issue in these areas. To ensure that these particles are guarded within the confines of the treatment area, the entrance to the room is designed as a maze so that the neutron particles are unable to travel long distances. They collide with the walls of the maze and are unable to reach outside the room. The walls of the treatment room are generally made of concrete or a combination of steel plates and concrete, since these materials have the maximum capacity to absorb and prevent leakage of radiation. The walls, ceiling, and floor generally have a minimum thickness of approximately 3 ft. The exact thickness is calculated by physicists and depends on a number of factors. The typical size of a treatment room is about 40 ft x 60 ft but can vary depending on the type of beam being used for treatment. Beams can be vertical, horizontal, or angular. A combination of vertical and horizontal beams can also be used for more precise treatment. Vertical beams require treatment rooms with additional height in order to accommodate the beam coming from the upward direction. Treatment rooms with angular beams can either have a fixed angle (30 or 45 degree) or a gantry (360 degrees) to generate the accurate angle, depending on the location of the tumor.

Gantry room
The gantry occupies the maximum volume of space. A typical gantry used for bending carbon ions is about 13 m in diameter, 25 m in length, and over 20 m in height; it requires an area of approximately 340 sq m. The design of this space is extremely complicated because a gantry is usually housed in a room rising up to three levels. The lowest level is

The waiting areas on both levels were designed to relieve the extreme stress that patients undergoing this therapy may experience.

The equipment area in a carbon therapy center is divided into three components: ion source, injector (linear accelerator), and synchrotron/cyclotron room (figure 2).

Figure 2: The complete sequence of production of carbon ions to utilization for treatment (retrieved from http://www.siemens.com, October 30, 2010)



usually an accessible space for inspecting the equipment. The middle level is the treatment area, and the top level is a balcony for viewing the equipment. These levels are connected internally through a means of vertical circulation and feature an entrance from each level.

Control room

There are three levels of control in a carbon therapy center. They each function in collaboration to ensure safe, efficient treatment.

1. Inside/immediately outside the treatment room: A small control area is provided inside the treatment room or immediately outside it with work space for one or two technicians. The main function of this room is to verify the position of the patient. Each treatment room has its own control area.

2. Common control area: A larger common control area, typically across the treatment rooms, monitors the activity taking place during beam emission. It is usually not an enclosed room in order to enable free flow of information and easy access to treatment rooms.

3. Dosimetry control room: This is the main control area, which monitors the entire process beginning with the production of ions from the source, the process of acceleration in the injector and synchrotron, and the delivery of the beam into the treatment room. This room is the largest in area as compared to the other control rooms. The preferred location of this room is close to the common control area; it is not located near public or patient accessible spaces.

Equipment room

The equipment area in a carbon therapy center is divided into three components: ion source, injector (linear accelerator), and synchrotron/cyclotron room (figure 2).

The linear accelerator is located between the ion source and the synchrotron. Its function is to provide the initial acceleration to the particles before reaching the synchrotron. The length of the linear accelerator room is typically between 5 m and 10 m. Even though linacs would be more cost-effective since they do not use bending magnets, radiation therapy with protons and carbon ions requires high power linacs that have to be extremely long to be able to provide the required velocity to particles. Hence, circular accelerators such as synchrotrons or cyclotrons prove to be more beneficial. Initially the synchrotrons used to accelerate carbon ions were 20–30 m in diameter and about 65 m in circumference. Advanced experimentation has led to a new design solution enabling the ion source and the injector to be included within the circumference of the synchrotron ring. This largely decreases the overall length and size of the equipment area, which is a huge concern in such centers. The diameter of the synchrotron in the new compact design is about 10 m. The specification of material and wall thickness is the same as the other shielded areas.

The Design: An Evidence-Based Approach

The observations and conclusions drawn through this study were summarized in the design of a carbon therapy center sited on the campus of the M D Anderson Cancer Center in Houston (figure 3). The main idea was to use evidence-based principles and best practices to generate an architectural solution for this technology, also aimed at reducing patient and staff stress and facilitating wayfinding.

The carbon therapy center was designed on three levels. The carbon ion treatment area was placed on the first floor, below grade, in order to use the earth around it as a natural shield for radiation (figure 4). Thick concrete walls and huge equipment spaces can prove to be detrimental to easy wayfinding. As a response, transparent and linear circulation routes were created to help patients orient themselves at any given location within the facility (figure 5).

Imaging, examination, and other support areas were located on the second floor, which was also the entry level (figure 6). Since these areas needed to be adequately shielded, they were located toward the center of the building, making it possible to provide windows on the periphery and bring natural light into the facility. The waiting areas on both levels were designed to relieve the extreme stress that patients undergoing this therapy may experience. Courtyards on both sides of the corridors leading to the procedure areas provide a positive distraction for patients, and a series of green areas throughout the building continues the patient experience from beginning to end (figure 7).

The third floor occupied a smaller footprint and housed administrative and office areas (figure 8). The idea was to use the therapeutic effects of nature not only for patients but also for staff (Hartig and Marcus 2006). For the same reason, this floor was designed with a balcony overlooking a green roof. Most of the staff work and respite areas were provided with window views and access to natural light. The privacy of the users was maintained

Figure 3: Perspective views

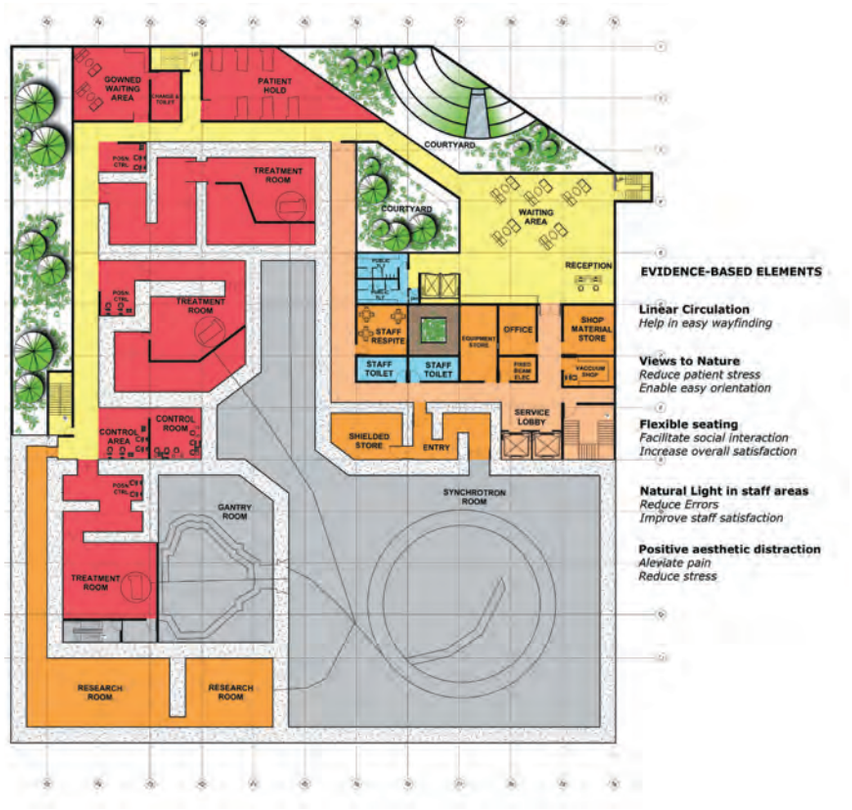


Figure 4: First-floor plan: Procedure and equipment areas were designed below ground level to use the earth around the building as a natural shield for radiation. The layout of the equipment room was based on the latest concept of locating the ion source and the linear accelerator within the circumference of the synchrotron ring, thereby decreasing the amount of space required. A horizontal beam treatment room, an angular room, and one with a gantry were designed to illustrate different room types.

Using evidence-based design to determine architectural solutions for this facility type could be a real breakthrough.

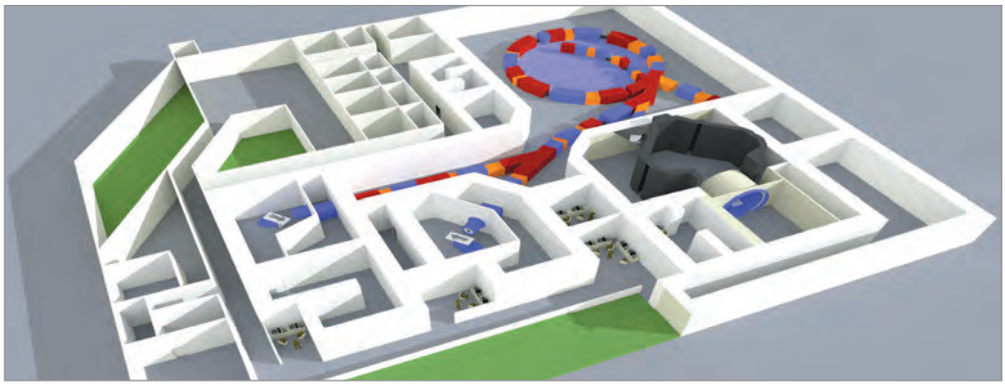


Figure 5: Layout of the carbon therapy procedure area

Figure 6: Second-floor plan: The entrance was designed at the same level as the imaging and support areas. A series of courtyards throughout the building balances the intimidating and sterile components with soft, sensitive elements. Evidence-based principles were adopted to create a design that reduces patient and staff stress and facilitates wayfinding.

Figure 7: View of the courtyards from the waiting area

by a peripheral wall running along the entire circumference of the building, also lending an aesthetic character to it.

The biggest challenge of this project was balancing the sterile and intimidating aspects of the building with soft, sensitive elements (figure 9). The effort was to develop an understanding for the technology and translate it into architecture that responds positively to its users.

Challenges of Carbon Ion Therapy

High cost and lack of sufficient research are the probable reasons for the absence of carbon therapy from the American healthcare system. Although U.S. researchers are interested in the technology and treatment, several of them feel that scarcity of data and clinical trials obscure the prediction of the effect of this technology in the long run. Another major issue is the expensive and difficult expansion/conversion of a proton into a carbon facility.

Increase return on investment of carbon therapy facilities
Because this technology is relatively new and unexplored, it is extremely expensive, and the construction cost of such facilities is high. There is a need to find innovative ways to balance the initial investment with the ongoing operational costs. Using evidence-based design to determine architectural solutions for this facility type could be a real breakthrough. Increasing the number of facilities could also help reduce the capital investment by providing competition in the market.

Size of the equipment
Downsizing the facility to reduce costs is essential. With nano-technology being the order of the day, the size of the equipment needs to be reduced. Smaller equipment will enable hospitals and other existing facilities to include this treatment in their facilities, thereby generating higher revenues.

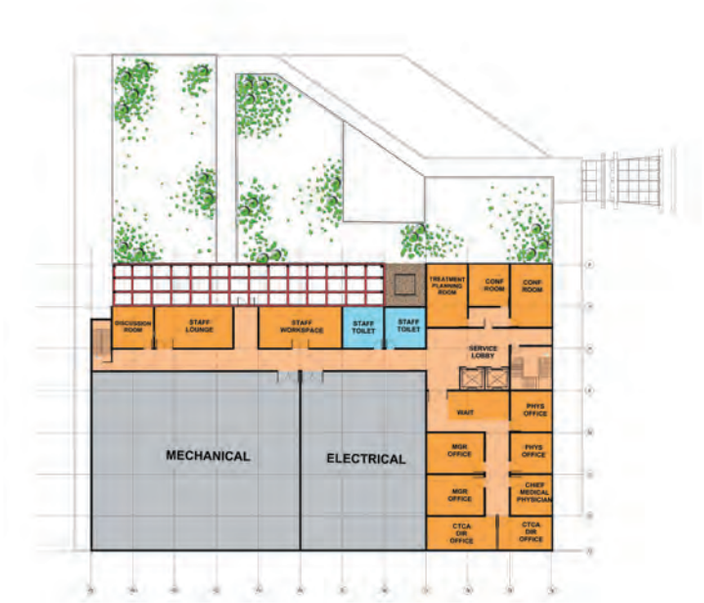


Figure 8: Third-floor plan: Administrative areas were designed with access to natural light and views of nature. An outdoor terrace overlooking the green roof was created near the staff lounge to provide respite in a stress-reducing environment. The mechanical and equipment areas were located in the southwest part of the building as a response to the local climate.

To evaluate the effectiveness of the technology in comparison to proton therapy
It is critical to conduct more research and clinical trials in order to determine the effectiveness of carbon therapy compared to proton therapy and other forms of cancer treatment. Tumors are often treated first with protons and then followed up with carbon ions to increase the chances of successful eradication of the tumor. Hence, it is important to find out which diseases and cancer types respond to carbon therapy. Such data will help the technology be accepted worldwide and encourage further research in this field.

In spite of the present reticence, many believe that the increase in the number of carbon therapy centers in Europe and Japan will produce sufficient evidence to prove the validity of this technology to the rest of the world including the United States (Brower 2009).

Figure 9: Sections illustrating the relationship between hard and soft elements

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Design and the Bottom Line: Practical Patient-Centered Approaches to the Physical Environment

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Abstract

In the multipriority world of hospital administration, it is a rare and precious occurrence when "the right thing to do" coincides with business opportunity. However, an established and still-growing body of data, both hard and anecdotal, indicates that a patient-centered approach to the planning and design of hospitals, medical clinics, outpatient facilities, retirement villages, and continuing care facilities is the rare case where "too-good-to-be-true" is simply a fact. Industry experts now agree that the physical environment where care is received, in conjunction with other patient-centered care principles, provides enormous opportunity for improving the quality of patients' healthcare experience, and actually accelerates the healing process. It is not simply that patients fare better in an environment that provides for their social, cultural, and intellectual needs—it is that hospitals that create environments conducive to fulfillment of these needs can expect to see significant improvements in patient satisfaction, patient outcomes, and employee engagement. These improvements ultimately save money.

This article examines misconceptions about the long- and short-term costs associated with the evolution of a hospital toward a patient-centered design, as well as the tendency to dismiss changes to the physical care-delivery environment as irrelevant to the organization's bottom line. In fact, more satisfied patients, better outcomes, less costly care, and increased employee dedication can be achieved by incremental changes over time, as an integral part of a hospital's capital improvement, renovation, or expansion budget.

Introduction

In the multipriority world of hospital administration, it is a rare and precious occurrence when "the right thing to do" coincides with business opportunity. However, an established and still-growing body of data, both hard and anecdotal, indicate that a patient-centered approach to the planning and design of hospitals, medical clinics, outpatient facilities, retirement villages, and continuing care facilities is the rare case where "too-good-to-be-true" is simply a fact. The business case for investing in the design of patient-centered care environments comprises four categories:

1. Outcomes that are produced in the hospital: the success rate of individual procedures, including decreased follow-up care and a reduction in the average length of stays. (The latter is a source of substantial savings.)

2. Attracting users: creating an inviting and navigable setting for patients and their families, as well as for staff. This includes varied areas for privacy, interaction, family time, contemplation, and contact with the outdoors.

3. Human resources impact on the bottom line: the number of productive hours per patient day at all staff levels, impact on staff retention, and effect on recruitment.

4. Repeat business: reputation in the community; continued patient and family patronization, especially in choice-driven areas such as obstetrics and pediatrics; and the ability to attract new patients and garner additional donations.

The Healing Value of Design

Angelica Thieriot, founder of Planetree, the nonprofit organization for patient-centered care, provides a compelling firsthand account of an all-too-typical patient experience in a facility where design was a low priority. Hospitalized in the mid-1970s, she was impressed by the technological and clinical prowess of the facility but was also struck by how little it addressed or even acknowledged the harder-to-

> Once leadership has realized the merits of patient-centered care, however, imparting therapeutic or "healing value" goes beyond changing a few paint colors or light bulbs.

Technology, equipment, or processes that worked five years ago must be continually assessed as the science of healthcare advances; design and planning must undergo the same evolution and merit the same budgetary allocations.

quantify "human" aspects of her stay. Thieriot was placed in a monotonous environment with little privacy and less information provided to her about her condition, which was life-threatening. Glaring fluorescent lighting exacerbated her discomfort. The hospital's policies restricted her family's time at her bedside, and the only homelike splash of color or visual interest was provided by an orchid her mother brought her. She would later say that her experience of her illness was not as bad as her experience of the hospital itself. This impression was reinforced over the next year, when Thieriot's father and brother were both hospitalized, and she had the same frustrating experience from the family perspective. Kept from effectively providing emotional support to her kin during this very stressful time, Thieriot decided that there must be a better way, one that was more respectful of patients' and loved ones' personhood. In 1978 she founded Planetree as a nonprofit organization devoted to "personalizing, humanizing, and demystifying the healthcare experience for patients and their families." To this end, the organization assessed every aspect of a healthcare facility from the perspective of the patient, eventually arriving at its present 10 tenets:

1. We are human beings, caring for other human beings.
2. We are all caregivers.
3. Caregiving is best achieved through kindness and compassion.
4. Safe, accessible, high-quality care is fundamental to patient-centered care.
5. A holistic approach best meets people's physical, intellectual, and spiritual needs.
6. Families, friends, and loved ones are vital to the healing process.
7. Access to understandable health information can empower individuals to participate in their care.
8. The opportunity for individuals to make personal choices related to their care is essential.
9. Physical environments can enhance healing, health, and well-being.
10. Illness can be a transformational experience for patients, families, and caregivers.

It is possible and, in many project instances, desirable to make incremental changes to the physical environs of a hospital. Once leadership has realized the merits of patient-centered care, however, imparting therapeutic or "healing value" goes beyond changing a few paint colors or light bulbs. It requires a thorough understanding of the needs and expectations of patients and staff, the purpose and practices of the healthcare facility, and the psychological and social effects of design and planning. Because cultural identity, type of illness, length of stay, and physical/psychological constraints may vary substantially from one patient to the next, a successful patient-centered design must strive to foster a full spectrum of positive and uplifting psychological responses, including:

- Privacy and undisturbed rest/contemplation.
- An inclusive environment that welcomes families and allows them to be involved in care.
- Mobility and exploration of communal areas.
- Separation between staff and patient areas, allowing staff to "go offstage."
- Ownership/control of immediate surroundings.
- Socialization and interaction with others.
- "Bringing the outside in": integrating patients with nature via views, artwork, landscape, and water features.
- Opportunities for patients to be outdoors when feasible.

While a hospital may be a single building of millions of square feet, a collection of smaller buildings, or a multicampus conglomerate, the selective renewal or replacement of facilities that must occur anyway can be accomplished with a patient-oriented approach without undue cost.

Outcomes, Costs, and Benefits of the Patient-Centered Approach

At many hospitals and clinics, budgeting prioritizes technological improvement. It is not difficult to discern the reason: the purchase of a new device, accompanying software, and staff training is worthwhile on its own merits, but also has the benefit of carrying a finite cost. In contrast, because design and planning is only one part of patient-centered care and cannot succeed without some cultural or organizational change, executives contemplating the next quarter's or year's expenditures may be tempted to ignore the potential savings in favor of business as usual.

The majority of success stories, however, have not involved constructing a whole new hospital or even a whole new ward. Given budgetary constraints and a compelling vision of their future, the facilities highlighted below worked with knowledgeable consultants to make the incremental changes that collectively resulted in exemplary patient-centered care. Technology, equipment, or processes that worked five years ago must be continually assessed as the science of healthcare advances; design and planning must undergo the same evolution and merit the same budgetary allocations. The ongoing journey entails scanning the horizon for the "next right thing" and a commitment to making small improvements when larger ones are not feasible for a particular fiscal period.

A 2007 doctoral dissertation contrasted the results of two orthopedic postsurgical units in two hospitals located within 15 miles of each other in a large urban county, both of which provided elective knee or hip replacement surgery. One was part of Sharp Coronado, a San Diego facility that had implemented patient-centered design and planning principles;

Figure 1: Before: Kaiser Permanente West Los Angeles lobby

Figure 2: After: Simple changes bring positive results to the Kaiser Permanente West Los Angeles lobby

the other had not (although both hospitals were managed by the same not-for-profit system). The study's findings, obtained through examination of benchmark data provided by the facilities and by double-blind survey, indicated the following:

- A lower mean length of stay at the patient-centered care unit for the years 2002–2006.
- Lower costs per case than at the patient-centered care unit for the same period (partially attributed to shorter lengths of stay).
- A significant increase in productive nursing hours per patient per day at the patient-centered care unit, primarily obtained by more effective allocation of higher-cost staff's hours.
- Higher overall patient satisfaction scores in seven of the nine dimensions measured.

Griffin Hospital in Derby, Connecticut, saw a 24 percent increase in inpatient volumes after leadership embraced a patient-centered philosophy and implemented specific patient-centered care approaches.

Other studies indicate significant upticks in category 2 of the business case for patient-centered care: attracting and retaining users. A 2002 study contrasting patient satisfaction scores at 12 hospitals one year before implementing a patient-centered approach and two years after yields some striking examples. Griffin Hospital in Derby, Connecticut, saw a 24 percent increase in inpatient volumes after leadership embraced a patient-centered philosophy and implemented specific patient-centered care approaches. This increase correlates neatly with the hospital's steadily improving patient satisfaction scores, which outranked the 2002 state average (14.4 percent) by nearly 10 percent. Similarly, Wisconsin's 13-hospital Aurora Health Care system observed significantly higher scores for both patient outcomes and satisfaction at its pilot patient-centered facilities, leading it to implement them at an additional six of its hospitals.

Also related to both category 2 and category 4 (repeat business) is the fact that for many patients, the decision about which healthcare facility to patronize is determined by expedience, often defined as proximity to the home. People visit hospitals for specific reasons, and a simple test can result in follow-up procedures that make ease of access (even if not to the preferred environment) a selling point. For this reason, many hospitals have felt secure in their consumer base, expecting that locals will patronize and return to their establishment. But given the choice, people will go elsewhere—and will endorse or denounce a healthcare establishment based on their experience in the same way they would a restaurant or a hotel. Patient choice and its impact are clearly illustrated by the repeat business of one group of patients for whom choice is not only possible but actively researched: first-time mothers, who are considering where to give birth. Their positive experience of a hospital for this generally happy visit correlates compellingly with the likelihood that they will use the facility for other services (and not just pediatric or gynecological). It also indicates that they are more likely to recommend that facility to other expectant mothers.

Human Resource–Related Benefits of Patient-Centered Care

Leaders who are unconverted to patient-centered care may also suspect that increased staffing will be needed to fulfill patient-centered care objectives. In fact, the approach emphasizes maximizing available staff resources and creating efficiencies that require no such increase. One study of four patient-centered hospitals over five years demonstrated that there was no change in RN staffing ratios or HPDs. Moreover, category 3 (the human resources impact on the bottom line) cannot be overlooked in any assessment of the costs and benefits of patient-centered care, although it is often underreported. Darryl McCormick, senior vice president for talent and culture at Connecticut's Griffin Hospital (cited previously for its increase in market share after implementing patient-centered care), guided an organization-side migration to patient-centered care principles in 2004 as part of a response to low patient satisfaction scores in the 1990s. In a significant correlation, in 2003, employee engagement scores at Griffin were in the 33rd percentile. In 2009, after Griffin had made

significant strides in implementing patient-centered care, employee engagement had vaulted to the 96th percentile.

For the ongoing success of any hospital, creating an environment where people want to work is essential. Evidence suggests that a patient-centered approach not only increases productive nursing hours per patient day by more appropriately delegating nonmedical tasks but also provides personal, professional, and cultural support that attracts staff and encourages them to give their all. A patient-centered approach to care shows significant promise in increasing the engagement levels of staff that are moderately committed (approximately 71% of any given organization) although perhaps not the highest performers.

To be clear, there are costs associated with patient-centered care: the initial training of staff and ongoing education are examples. However, these initial costs are dwarfed by the long-term costs of poor Hospital Consumer Assessment of Healthcare Provider and Systems (HCAHPS) scores, increased malpractice costs, HIPAA fines for violations, and turnover rates. The cost of replacing an employee is estimated to be no less than that employee's annual salary, and often up to three times that much. This is due in part to the hard costs of recruitment (advertising, head-hunting, etc.). It is telling that Griffin Hospital, Mid-Columbia Medical Center, and Loma Linda University Medical Center have, or have had, waiting lists for applicants for job openings (an ideal situation for a growing, thriving hospital).

The patient-centered approach considers staff engagement and patient experience to be inherently interrelated, and the impact of the workplace's physical environment is undeniable. In addition, provision of nutritional choices for both patients and staff is key. While hospitals should not consider it an obligation to run a restaurant, neither should they ignore food's complex effects as a comfort-giving and social-interaction medium. From a design and planning perspective, these choices should be supported by ones related to privacy: the decision to eat alone, with other staff, or with patients.

Designing and Planning for Multiple Privacy Levels

The planning and design of interaction points, especially as electronic medical records become the norm, is one example of how patient-centered principles can maximize efficiency. Rather than constructing a new nurse station, rethinking how workflow can be done at the bedside might best benefit an organization. Careful operational analyses can lead to vastly more efficient use of space, reducing the need for renovation or expansion—and perhaps saving millions of dollars. A savvy facility strategic plan will consider human interaction at every major touch-point (nurses' stations, family consultation areas, patient rooms, conference areas) and also the spectrum of privacy versus communality. The best evidence-based healthcare designs provide spaces for patients, staff, and families that range from interactive to private. Examples include:

- A lobby or cafeteria (public)
- A chapel or reference library (semipublic)
- A family lounge (semiprivate)
- A patient room or consultation area (private)

Unlike business transactions, healthcare transactions are inherently personal, and thinking about how privacy is to be respected is among the most fundamental design decisions. When this is done well, the distinct demarcation between the types of spaces is palpable—even just the noise level. (Weakest spaces typically include ER triage, where the need to deliver services quickly is in direct competition with the acquisition of critical data in a nonprivate setting.) From admission through checkout, a patient-centered facility must reduce or eliminate barriers between patients and caregivers. It must allow for compassion and empathy while also providing designated private areas for conversations

For the ongoing success of any hospital, creating an environment where people want to work is essential.

to educate them about their condition and their choices. Perhaps most important, permeability of the caregiving space for family members—historically viewed as operationally inconvenient—has been shown to be beneficial. It often empowers the patient and family to take on some of the basic services that pull nursing staff away from clinical responsibilities.

New Incentives for Patient-Centered Design and Operations

Careful operational analyses can lead to vastly more efficient use of space, reducing the need for renovation or expansion—and perhaps saving millions of dollars.

With the passage of the 2010 federal healthcare reform package and growing consumer awareness about patient choice, many hospitals face an operational shift. The HCAHPS survey (the results of which are available on Web sites such as Hospital Compare) is a valuable tool for patients who want to shop around for their next healthcare experience. Through Quality Check, hospitals that demonstrate superior patient-centered quality, safety, and reporting metrics gain credence with The Joint Commission, whose accreditation is viewed as a condition for Medicaid reimbursement in many states.

At some hospitals, on-demand access to electronic medical records is daunting to physicians or administrators. However, it is a patient right; the contents of these records are not the property of the hospital or the insurance company. A common misrepresentation is that shared medical records violate HIPAA, but while certain procedures (such as the way a release is signed) do need to be carefully enacted, the exchange of medical information between the patient and care providers is valuable—after all, people have subjective insight into their bodies that even the most qualified health professional can only approximate. In any case, with the exponential growth of information available via the Internet (including longstanding access to personal financial records and transactions), it is nearly unthinkable that medical records will not be online within the next 25 years. Those hospitals that establish a culture of transparency now will be ahead of the curve—and poised to benefit from improved HCAHPS scores.

The VA Example

In recent years, the Department of Veterans Affairs (VA), the largest healthcare system in the United States, has begun a top-down implementation of patient-centered care to better serve veterans and their families. This change will likely eventually affect many of

Figure 3: Loma Linda Rehabilitation Center

the 153 VA hospitals, 773 outpatient centers, and 260 vet centers. VA patients now span several generations and both genders. Many are elderly or have mobility issues. As a subset of all patients, veterans represent a unique case study. Facilities must accommodate not only the physical, cultural, and social needs of the patient but also those of the family member/members who may accompany him/her to the facility or support-givers during medical tests and procedures.

In addition to the more general design principles of color, noninstitutional lighting, and privacy-conducive acoustics that apply to patient-centered care, VA facilities share the need for an expression of culture and place that will resonate with patients' experience as veterans. This consideration should be integrated into the design standards and reflected throughout the facility. For example, waiting and consultation rooms must accommodate the vet's family and consist of groupings of furniture conducive to conversation (rather than rows of seats), and exam rooms must be appropriately sized. Family-oriented single-occupancy rooms and family restrooms are often a requisite. In certain areas, such as those specializing in PTSD, special emphasis may be placed on noise reduction.

Catching the Wave: Patient-Centered Design as the Future of Healthcare

Like many aspects of patient-centered care, design of the physical and built environment plays an integral role in achieving financial and marketing advantages for a hospital. While thorough review of new technologies, medications, and procedures is indispensable in determining how and when they should be implemented, evidence-based design aspects are often given short shrift. This is often due to apprehension that large capital expenditures on a new ward or a new building are necessary in order to realize the benefits of patient-centered design and planning. These fears can be alleviated once healthcare leadership understands one of the most elemental virtues of patient-centered design and planning: it is a gradual, if pervasive process that considers the hospital's overall priorities and evolution. Most facilities simply do not have the wherewithal to build new rather than to repurpose. This does not mean that they cannot make appropriate strategic-plan budget allocations that will enable important incremental changes.

At its most basic, a design approach that facilitates patient-centered care is about instituting physical surroundings that enable a culture of kindness, empathy, and human

Unlike business transactions, healthcare transactions are inherently personal, and thinking about how privacy is to be respected is among the most fundamental design decisions.

Figure 4: Catching the Wave: Patient-Centered Design as the Future of Healthcare

It is nearly unthinkable that medical records will not be online within the next 25 years.

Figure 5: Before: Renown Regional Medical Center, postpartum wing

Figure 6: After: Renown Regional Medical Center, postpartum wing

interaction. However, there is no one-size-fits-all approach. Every hospital must determine what it is trying to accomplish, and then assess how those goals can be optimally realized within the realities of budget and existing facilities. Many low- or no-cost opportunities exist in artwork, improved views to the outdoors, soothing colors, plants, rearrangement of furnishings, music, staff training, and improved access for family members. In determining priorities, administrators should consider the healing environment for patients and the working environment for staff.

When a hospital is considering implementing a patient-centered approach, obtaining feedback from patients, families, staff, and the wider community is essential. Surveys or focus groups (often best conducted by a qualified outside agency) can provide a valuable foundation for all changes that are to be considered by the hospital over time. For example, patient satisfaction surveys consistently reveal that access to family and friends, access to information, and personalized care are three important ways to improve the experience of a facility. Proper design, even if it is incremental, can facilitate all three, although operational changes contribute at least equally.

Hospital decision-makers should assess the value of patient-centered design in light of the fact that upgrades, expansions, renovations, and new construction are all necessary components of "staying open." If a new technology or methodology necessitates any of the above, why not do it in a patient-centered way? Small steps toward the larger desired effect can go a long way on their own. The success of facilities that have implemented patient-centered principles, often in the face of challenging fiscal circumstances, is telling when viewed alongside the trends of healthcare reform and growing involvement of patients in their own care. Costs associated with changes to processes and to the physical environment are balanced by improved HCAHPS scores, decreased malpractice costs and HIPAA fines, increased retention of valuable staff, and increased staff discretionary effort. Moreover, once the commitment is made, change can be as sweeping or as incremental as is feasible. Some hospitals tackle the transformation in a concentrated way; some do it over years to defray costs. Some communicate their accomplishment loudly and repeatedly; some prefer more modest communications (especially if—as with the VA—there is concern over the perception of how taxpayer money is being used). However, there can be a plan for every budget that will empower patients and family members as part of the healing process, enrich the surrounding community, and save money in the long term.

Perhaps at some point in the future, Angela Thierot's vision of healthcare will simply be the way things are done. In the meantime, administrators unconvinced that the "right thing to do" happens to make excellent business sense might benefit from a visit to a hospital that has made patient-centered principles the core of its strategy—even if that hospital is a competitor. These visitors will likely not see brand new facilities or smell cookies baking, but they will sense a subtle difference: the continuum of patient-centered care factors, including effective design and planning, have made things better for patients, family, and staff.

Like many aspects of patient-centered care, design of the physical and built environment plays an integral role in achieving financial and marketing advantages for a hospital.

How Lean Design for Healthcare Can Improve Your Hospital's Bottom Line

Alan Sullivan, AIA, ACHA; Michael S. Smith Sr. (Col. USAF Ret.); Mary Ann Derr, RN, MBA; and W. Patrick Davey, MD, MBA

Abstract

A panel discussion was held in March 2011 at the American Society of Healthcare Engineers Professional Development Conference in Tampa, with panel moderator Alan Sullivan, AIA, ACHA, and three panelists chosen for their diverse backgrounds and their involvement with similar approaches to cutting costs in healthcare environments. Sullivan is director of the healthcare studio at KZF Design in Cincinnati and works with functional concepts during early planning stages to plan efficient departmental adjacencies and sharing of common services in a "just in time" methodology. Mike Smith Sr. (Col. USAF Ret.) led the U.S. Air Force's continuous process improvement program (AFSO21), which focused on increasing Air Force operational effectiveness and business efficiency. This work included facilities, base infrastructure, acquisition, aircraft maintenance, healthcare, and training/operations as well as base realignment for increased efficiencies. Mary Ann Derr, RN, MBA, works with clinical lean process to reduce workplace waste and inefficiencies as well as identify patient safety and infection control issues. W. Patrick Davey, MD, MBA, worked as a managing partner for an eight-physician dermatology surgery practice in the design of a new lean process surgery center/clinic, the largest freestanding dermatology surgery center in the country. This paper is a summation and further analysis of the discussion among these four professionals and demonstrates how lean design for healthcare can improve hospitals' operational efficiency and cost effectiveness.

Healthcare Reform and Lean Process

Healthcare costs are being scrutinized from every angle. With costs escalating out of control, hospital systems and operations are reviewing internal processes and options to streamline efficiency, productivity, and workflow, contributing to quality patient outcomes and cost savings. This challenge brings multiple perspectives to improve facility responses to cost control by evaluating, reviewing, and containing the existing processes to achieve this goal.

There has been a good deal of discussion about healthcare reform. As they did nearly two decades ago, hospitals are aggressively purchasing physician groups and attempting to reel in their practices. We have been through the Balanced Budget Act of 1992 and the rise of managed care. It is time to embrace a new era of cost reduction while increasing quality of patient care, which is indeed a monumental challenge. These are noble objectives. Medicare and Medicaid reimbursements have been minimized, and hospitals are suffering financial deficits.

Discussions focus on the cost savings realized by lean planning and functional reorganization of a facility to bring those dollars to a hospital's bottom line. This initiative is targeted either by department or by an overall program to examine the entire hospital. Focus on key areas that have operational inefficiencies stand to gain the most. The lean process enhances efficiency by eliminating waste such as instrument processing and distribution of supplies. However, it must be noted that the best way to implement a program for lean design is to undertake a comprehensive program with complete buy-in by the "C–Suite."

The lean process enhances efficiency by eliminating waste such as instrument processing and distribution of supplies.

Transitioning Air Force and Toyota Processes to Healthcare

Since his retirement, Mike Smith has used his experience with the Air Force and now as president of Total Systems Development (TSD) in lean design of hospitals and manufacturing facilities by applying the Air Force process with Toyota and auto industry techniques to the hospital environment. The Air Force AFSO21

program was able to incorporate lean process into Air Force hospitals and clinics and has applied the lessons learned to develop more efficient patient care delivery while improving operational costs.

The application of lean in a hospital design setting requires drilling down into the operational processes early in the planning stages to determine how work is actually accomplished in each area. Once these processes are mapped, inefficiencies can be identified and "planned out" of new or existing departments. This early process can be applied to hospital master planning, and results may include determining appropriate departmental adjacencies, improving patient and staff flow by decreasing distances traveled, and designing flexible shared space. A business plan can then be prepared with a more accurate foundation since operations can represent as much as 70 percent of project cost. In the old planning process, the foundation was to simply guess and wait for results. Applying lean design and its principles to the planning process will produce better results.

This improvement is based on five guiding principles of lean:

- Value
- Value stream
- Flow
- Pull
- Perfection

Value is determined in the eyes of the customer. The value stream is the set of activities for each product/process that produces value. Flow is the progressive achievement of value without interruptions such as queues, stoppages, or backflows of products, information, or services. Flow is created by removing waste from processes. The "pull" is a system in which a supplier produces nothing until a customer signals the need. The principle is to always compete against perfection, not just your current competition. Perfection comes from the perspective of the customer.

The classic Toyota system and the Air Force identify eight kinds of waste to benchmark and evaluate processes:

- Transportation
- Inadequately used intellect
- Motion
- Excess inventory
- Nonstandard work
- Waiting
- Overproduction
- Defects

The benefits of continuous process improvement (CPI) are to reduce lead time, improve the speed of the process, lower costs, improve quality and safety, develop an agile response to change, and engage people to solve the root causes of problems.

The Air Force's massive enterprise transformation, called AFSO21, involved more than 700,000 people across 83 installations worldwide. The process included more than 5,000 aircraft and more than 50 percent of the total U.S. government energy consumption. The annual budget is $127 billion, and its personnel and leadership team are in constant motion.

The Air Force has strategic imperatives that require seeking operational improvements and business efficiencies. These imperatives include congressional budget pressure, a highly dynamic global war on terrorism, increasing fleet age (the average aircraft is now more than 26 years old), rising costs of personnel and healthcare, and a 31 percent increase in fuel cost in the past several years.

The outcome of applying lean was a streamlined process in which the number of steps was reduced from 20 to nine by standardizing work and eliminating duplicate data entry.

Lean is a tool to aid in achieving the goal of cost savings and making a direct contribution to the bottom-line budget of a hospital.

AFS021 represents a fundamental transformation in how airmen work. Early objectives of the program included increasing the productivity of people, the USAF's most valued asset. Another objective was to see a significant increase in availability rates of key USAF assets as well as to improve response time and agility. Other key objectives were to sustain safe and reliable operations while improving energy efficiency. The final results were to establish a resilient CPI foundation.

The Air Force's eight-step problem-solving methodology can easily be translated into a hospital environment.

1. Clarify and validate the problem
2. Breakdown the problem and identify performance gaps
3. Set improvement targets
4. Determine root causes
5. Develop countermeasures
6. Implement countermeasures
7. Confirm results and process
8. Standardize successful processes

Case Studies from the Air Force

The examination of the healthcare component developed several case studies from the Air Force initiative. The east coast port realignment saved $42 million annually because of more efficient routing of aircraft traffic. This kind of global mapping can be used to track and reduce nursing staff travel and improve time management for an overworked nursing staff.

The Air Force studied the vehicle registration process at one of its European bases. The average wait time was reduced by 76 percent while simultaneously decreasing the need for multiple patient visits. This can be directly applied to the hospital registration processes.

In one USAF hospital, new electronic medical record requirements and non-value-added activities resulted in appointments scheduled for 20 minutes actually taking up to 40 minutes to complete. Staff was staying late and patients were unhappy. The outcome of applying lean was a streamlined process in which the number of steps was reduced from 20 to nine by standardizing work and eliminating duplicate data entry. The room setup was tailored and standardized, reducing setup time. A nurse was engaged in the process of managing the appointment scheduling system to ensure that the patients scheduled were the ones with the most pressing medical issues. Satisfaction levels increased from 85 percent to 95 percent, and a 20-minute appointment now takes 19 to 20 minutes to complete. The staff now leaves on time and patients are satisfied.

Decreasing pharmacy wait time at Goodfellow and Tyndall Air Force Bases became the subject of an improvement activity. These clinics reduced prescription wait times and dispensing errors by redesigning the prescription process. Part of this redesign included adding automated dispensing machines to fill more common prescriptions. As a result, the average prescription process went from 35 minutes to 15 minutes on over 90 percent of all prescriptions. In addition, the capacity and speed in the pharmacy refill process increased by 600 percent. Automation was a key component in eliminating errors as well as filling prescriptions with increased efficiency.

Getting airmen back on the job was the goal for a surgery project that virtually eliminated the backlog of patients waiting for orthopedic surgery, increasing OR usage from 73 percent to more than 90 percent. There was a 16 percent overall increase in productivity representing more than $2 million in surgical output per year. This result was achieved without increasing resources or the number of personnel. In a similar case study the Keesler AFB ambulatory surgery unit decreased patient admission time 56 percent, from 172 minutes to 75 minutes, and reduced staff 71 percent, from 14 to four.

Using Lean in the Clinical Process

Mary Ann Derr uses lean processes to streamline workflow, eliminate waste, enhance throughput, organize the clinical work space, and provide quality training, all of which inspires staff, improves morale, and contributes to quality patient outcomes. Lean is a tool to aid in achieving the goal of cost savings and making a direct contribution to the bottom-line budget of a hospital.

Ergonomics and safety are areas of great concern for hospitals. Back strains are one of the most often reported injuries for clinicians. The use of lean processes made it possible to identify these potential areas and eradicate them, saving thousands of dollars and protecting staff. Other concerns include needle sticks, cross-contamination, joint deterioration, and stress-related diseases. These issues are very costly for hospital operations, because they have a negative impact on employee satisfaction and challenge recruitment and retention efforts.

Again, cost savings are realized by importing lean processes. Lean processes in healthcare help reduce accidents, prevent cross-contamination of nosocomial infections, and reduce ergonomic stress by identifying and removing barriers to the safest and most efficient delivery of patient care. The lean approach affects all of these by optimizing processes and work space organization. Lean also decreases the cost associated with risk.

A culture that has fully adopted the leanest process by eliminating waste will accomplish the goal with the fewest resources. These are the hospital facilities that will stand in the face of economic, political, and regulatory constraints. Fully adopting lean processes allows hospitals to compete for excellence in this tough and strained healthcare market.

The categories of waste found in healthcare environments vary depending upon the specialty unit and the acceptance of improved situation awareness. Lean allows us to consider these major categories of waste and opens the perspective of adopting improved lean processes. Areas of major waste include confusion, motion, waiting, processing, inventory, rework, overproduction, transport, and unused employee creativity. Productivity is increased by reducing wasted motion and time and allows nurses to accomplish more in less time, thus contributing more time and attention to patients.

When errors in medication administration became an issue, the nursing process developed the Five Rights. The adoption of this critical yet simple process resulted in an overall improvement in medication administration without error. This is an example of identifying a need and developing an improved process, such as lean. The Five Rights of medication administration are the following:

1. Do we have the right patient?
2. Do we have the right medication?
3. Do we have the right dosage?
4. Are we administering the medication by the right route?
5. Are we administering the medication at the right time?

Just as in any other routine process, identifying the Five Rights leads to fewer errors, better quality patient care, and better outcomes. Essentially, this leads to potential savings in lives and dollars. Lean process contributes to getting it right!

The average hospital contains more than 40 separate departments. The most efficient hospitals use lean process to reevaluate departmental boundaries, adjacencies, opportunities for shared services, and elements that contribute to evidence-based design through data collection. This is an excellent platform for cost savings from every angle.

Fully adopting lean processes allows hospitals to compete for excellence in this tough and strained healthcare market.

Leadership in Lean

Most scholars of healthcare reform believe there will be three elements in the future for healthcare: performance measurement, "value" based on quality and cost, and teamwork. The development of performance metrics has already begun in the government's Product Quality Research Institute (PQRI) program, which many subspecialty organizations have begun to help develop.

Healthcare services will no longer be provided by one physician in isolation but rather by an integrated team of providers.

The "value" equation is yet to be defined because quality is so difficult to measure. The cost of providing a healthcare service will be in the formula. Healthcare services will no longer be provided by one physician in isolation but rather by an integrated team of providers. This future approach to healthcare provision will have facility design implications, and the lean process will have to adopt these future trends. The third fact is that improvement in performance requires teamwork across disciplines, and superior coordination is required to achieve performance goals while sharing information.

Leadership is the ability to tell people where they should go and why. Management is the ability to get people there. To implement a lean process, management must set up the process and ensure its implementation and successes.

At Virginia Mason Medical Center, physicians and staff come second to the patients. For example, in the cancer center, physicians and staff come to the patient, who stays in a room with natural light and artwork. The physicians who bought into this process engineered a financial turnaround, and Virginia Mason developed national prominence. The Toyota production system that eliminates waste and improves the return on investment was used by Virginia Mason as a tool in its financial turnaround.

At the Cleveland Clinic, CEO Delos M. Cosgrove, MD, MBA, has stated that "patients first" means a serious commitment to measuring outcomes and has demonstrated that commitment to the world on the clinic's Web site. He has established "institutes" defined by patient conditions; for example, the Heart and Vascular Institute is staffed with cardiologists, cardiac surgeons, and vascular surgeons.

W. Patrick Davey, MD, MBA, was managing partner for a new 45,000-square-foot dermatology clinic/ambulatory surgery center. Dr. Davey used lean principles to develop what was the largest freestanding dermatology center in the United States. "We began by considering how the patients would most efficiently move through the building. Once that was established we had to consider how to station the staff and equipment needed to optimally serve the patient's needs." The lean process was incorporated into this design-build surgery center to bring two offices together into one building with a common culture and an emphasis on patients as "clients." The lean process starts with the client goals and focus. This project was to be designed and built on established time and budget constraints agreed to by all the physicians as stakeholders.

Design features incorporated into the lean process included treatment "pods" for each physician. Each pod had three exam rooms and a treatment room that could be shared with another pod to maximize efficiency. By designing for the future with electronic medical records, the paper medical records were moved to the basement level until the electronic medical record system could be developed and implemented. Moving medical records off the clinic floor allowed maximum efficiency in building stacking between clinic and surgery floors. Every exam room had daylighting, and offices for physicians were located on interior walls. A split-level building made efficient use of the site and acted both as wayfinding and a barrier between the clinic and surgery patients for privacy.

Dr. Davey's EMBA team at the University of Michigan's Ross School of Business evaluated the space utilization for an operations course by using a time study and the surgery center's financial documents. The team analyzed areas for improvement in the surgical process that would have a positive impact on patient satisfaction.

According to Davey, "We identified ways to increase the efficient use of key resources so that patient flow could be improved giving us the ability to treat more patients daily." From this analysis, the team developed a value stream model to identify the affect of process changes on each process step, patient wait times, and resource utilization. Davey continued:

> We found that the patient wait time was decreased and patient satisfaction increased by eliminating patient batching. By staggering the patient arrivals the patient care was completed in a shorter period of time. An additional patient could be added to the surgical schedule. In order to further increase the patient load the surgery center would have had to increase laboratory personnel which did not make financial sense. By using this design and evaluating the surgical process with lean techniques there was increased customer satisfaction, more efficient and effective patient care, and as a result increased profitability.

Lean and the Future of Healthcare

A brief look at the development of our healthcare system over the centuries will help provide an understanding of where healthcare and lean design for healthcare facilities are headed in the future. Medicine has gone through five identifiable phases: physicians began with bedside observation; wrote descriptive accounts of what was seen, heard, and felt; moved patients into a hospital setting; worked to improve public hygiene; developed laboratory testing; and now are moving to today's healthcare system.

The lean process is a useful tool for today's hospital, but we are seeing the emergence of the Medical Home, which allows primary care physicians to coordinate the patient's care, and Accountable Care Organizations, which tie healthcare reimbursement to providing quality patient care based on performance metrics. How does lean fit into this new model?

With lean process, the quality of care improves the patient experience as the processes and organizational competency improve. Nurse satisfaction and retention are improved with workplace and workflow improvements. Lower costs and higher margins will allow the organization to do more with fewer resources.

The lean process can be used at the macro level to streamline an entire system of various components and eliminate waste. At the micro level, lean can be used to improve the efficiencies of the individual workplace. Lean can also be used to eliminate errors in processes and improve quality—both important issues in today's cost-driven environment.

However, the best benefit of lean design is to begin at the top with management "buy in" and create goals for improvement. From there, the design and planning team can incorporate the value stream at the earliest level of planning when the space program is being generated. By discussing operations hand-in-hand with design, your organization can achieve the best and most cost-effective solution, while continuing to improve at the micro level of operations.

Design features incorporated into the lean process included treatment "pods" for each physician.

Resources

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