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ENHANCING THE QUADRUPLE AIM THROUGH DATA-DRIVEN DECISIONS IN THE BUILT ENVIRONMENT

A REPORT BY IMEG CORP. AND LINEAR A

Many healthcare organizations are beginning to understand that their buildings play a large role in the quest for provider satisfaction, healthier patients, and reducing the cost of care. These institutions also recognize that their buildings have an impact that goes beyond the walls of the healthcare facility to positively influence patient care at home, support healthier communities, and improve the global environment.

The built environment also can be an indispensable component of the Quadruple Aim, a framework for healthcare excellence that focuses on population health, cost, patient experience, and provider satisfaction. By aligning design decisions with this framework, the built environment can reflect, support, and help implement the Quadruple Aim's goals. For example, energy-efficient LED lighting can enhance the patient experience, support staff satisfaction through better light quality, and improve population health through reduced energy usage and associated pollution.

Numerous healthcare organizations have adopted the guiding principles of the Quadruple Aim and understand their buildings' impact on outcomes. Many of these organizations, however, have not aligned their buildings and infrastructure capital strategies with the Aim. The authors believe this is due to a combined lack of awareness, executive focus, and supporting data.

This executive guide provides a high-level examination of the intersection of the Quadruple Aim and the built environment. The information included is intended to help healthcare organizations understand the many ways that data-driven design decisions can guide a healthcare facility to ensure the built environment dovetails with the four guiding principles of the Quadruple Aim. While all healthcare organizations and facilities have unique characteristics and needs, the material provided here can be utilized to aid in the development of any institution's strategy for achieving the Quadruple Aim.

The Quadruple Aim

In 2008 Dr. Donald M. Berwick created what was originally known as the "Triple Aim," a framework for providing a higher standard of patient care. The Triple Aim was expanded into the Quadruple Aim following a 2013 report by the RAND Corporation highlighting the impact of physician burnout on the quality of healthcare delivery. Since then, the Quadruple Aim has become increasingly important as healthcare organizations find themselves at the crossroads of an ancient calling—medicine—and the modern business environment.

Responsible practice of medicine has sought positive patient outcomes for centuries, but modern healthcare needs to be guided by more than the Hippocratic Oath and AMA compliance. Today's patients are demanding an increase in the degree of choice and convenience in their healthcare marketplaces, resulting in interventions ranging from retail healthcare to telemedicine.

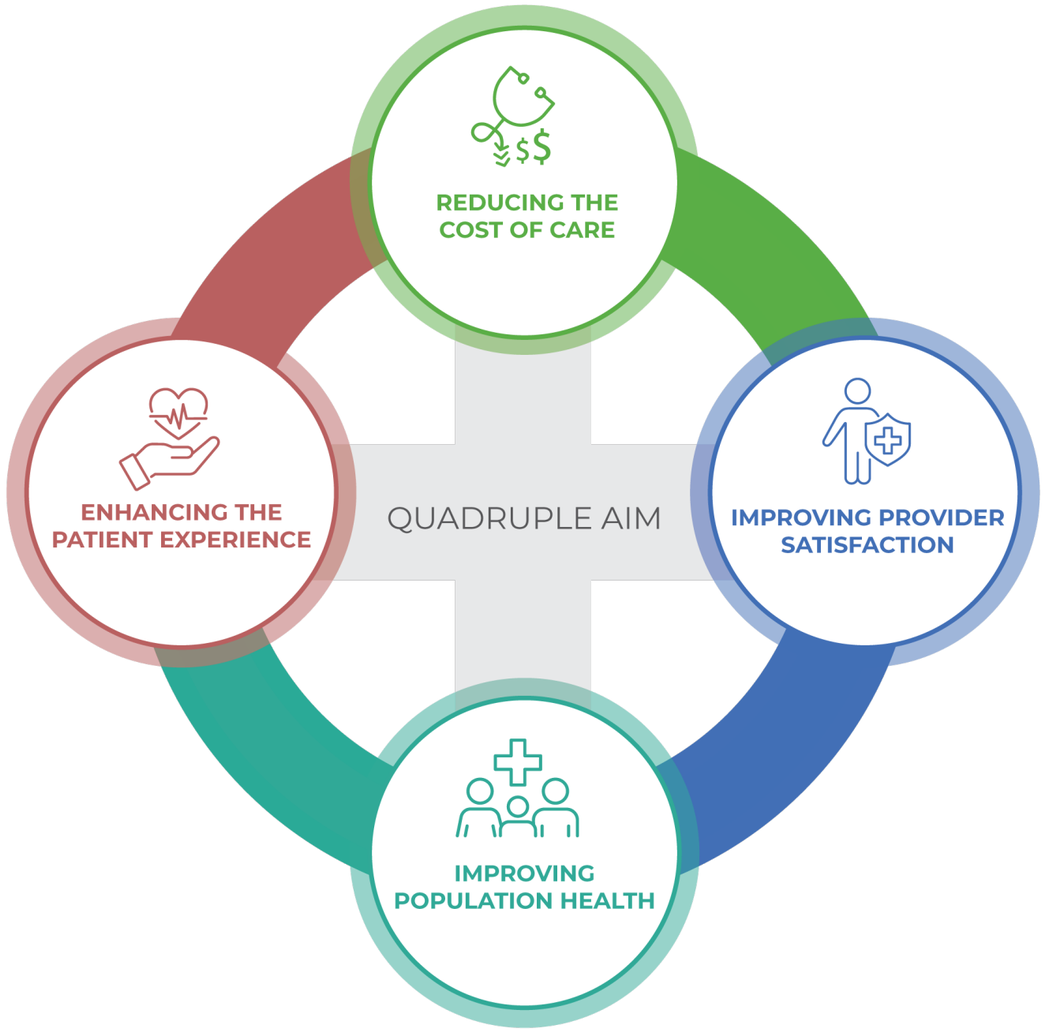
As a result, healthcare organizations have awakened to the fact that they can't just rely on a built-in patient base with no other options. They must stand out. The Quadruple Aim acknowledges this need for new standards of quality and stakeholder satisfaction in healthcare.

Each healthcare organization will interpret the Quadruple Aim in its own way, but in general it helps all organizations attract and retain patients and providers and ultimately serves as an example and a guiding light for their communities.

The Quadruple Aim's four goals—and the authors' interpretation of each one for purposes of this guide—seek to:

1. **Improve population health.** Whereas providers focus on treating the patient in front of them, the first goal of the Quadruple Aim seeks to expand this focus to the health of entire populations. The population in question might be the local neighborhood, the city, country, or the world.

2. **Reduce the cost of care.** According to the American Medical Association, the cost of healthcare in the U.S. has increased by over 4 percent each year since 2017, well above the rate of inflation over the same time frame. As healthcare costs continue to rise, families face an increased risk of bankruptcy in the event of a significant healthcare incident. The second goal of the Quadruple Aim calls on healthcare organizations to take ownership of this situation and produce better outcomes for their patients, not just medically but also financially. Various shared savings program models are examples of the increased focus on reducing costs and improving outcomes.



3. **Enhance the patient experience.** While population health is important, the patient experience is the core of the healthcare value proposition. As the third goal of the Quadruple Aim, the mandate to enhance the patient experience extends further than "doing no harm" and producing better medical outcomes. It involves treating the patient as a person, not a problem to be solved—a valued customer whose happiness and comfort matters at every stage of their interaction with the organization.

4. **Improve provider satisfaction.** The last goal of the Quadruple Aim addresses the growing problem of physician burnout and acknowledges healthcare providers deserve the same considerations as those given to the patients and populations they serve. When providers are unsatisfied with their jobs and environment, patient outcomes suffer. Healthcare organizations committed to the Quadruple Aim must therefore prioritize provider satisfaction just as highly as patient satisfaction.

The role of the built environment

The "built environment" refers to everything that is designed and constructed. It is a holistic term that encompasses architecture, engineering, and construction, as well as designed qualities of the environment such as acoustics, aesthetics, and indoor climate. Through intentional design, the leveraging of data, and building automation systems, this physical environment can maximize passive benefits of building orientation; anticipate and respond to the interaction between infrastructure components, technology, physical spaces, and occupants; and improve operational aspects such as staff travel distance and line of sight to patients. The built environment's influence also can be felt beyond a building's walls, impacting the community, its residents, and the air they breathe.

Such an intentionally designed built environment assists in delivering on the Quadruple Aim in a variety of ways—some of them obvious, others much more subtle.

Consider the temperature or light within a hospital building. In the summer, sunlight through the windows might warm the space, reduce the need for artificial lighting, and improve staff and patient satisfaction. Though natural light is not "built," per se, engineers and architects specify the number, location, and size of windows to leverage natural light so that it becomes a natural and seamless part of the built environment.

Suppose, too, that the hospital has a courtyard with a small garden. The plants and trees in the garden are not built, either, but these natural elements and the space they occupy become an extension of the building and the built environment, enhancing the healing and calming aesthetic of the hospital.

The built environment is also starting to incorporate Intelligent Building attributes that play an exponentially larger role in the patient and caregiver experience.

By leveraging the ever-expanding interconnectedness of technologies, the built environment can include Intelligent Building features such as robust digital front doors, improved wayfinding, smart patient rooms, and more.

By encouraging stakeholders, architects, designers, analysts, and builders to buy into a healthcare organization's vision early and keep the Quadruple Aim in mind at every stage of design and construction, the resulting built environment can effortlessly contribute to positive outcomes inside and outside its walls. Framing design decisions and their impact to the Quadruple Aim allows health systems to truly align their operational and capital strategies in an impactful and meaningful way.

The following sections provide specific examples of how the built environment can support, enhance, and help achieve the Quadruple Aim.

1. Improving population health

A built environment can contribute to the health of the nearby population by mitigating any negative impacts it may have on the environment. Healthcare facilities rarely directly produce emissions or toxic waste at scale compared to other large industries, but that does not mean their built environments don't negatively impact local and global populations. By understanding the relationship between the built environment and communities, those involved in a facility's design and construction can contribute to improving population health in the following ways:

Reducing the carbon footprint

Studies confirm the negative public health impact of carbon emissions. CTC Global estimates that a global reduction in greenhouse gas emissions could prevent as many as 3 million deaths between now and the year 2100. According to Healthcare Without Harm, the healthcare sector is responsible for 8.5 percent of the U.S. carbon footprint and 4.4 percent of the global footprint. (The New York Times, meanwhile, reports that the U.S. healthcare industry accounts for more than a quarter of health-sector carbon dioxide emissions globally.)

Several organizations and governments have announced their intentions to curb emissions from the healthcare sector. According to the World Health Organization (WHO), 50 countries, including the U.S., have committed to develop climate-resilient and low-carbon health systems after attending the 2021 UN Climate Change Conference in Glasgow (COP26). The U.S. Department of Health and Human Services is also establishing the Office of Climate Change and Health Equity and announced a commitment to reduce emissions at federal health facilities, including those operated by the Department of Defense and the Department of Veterans Affairs.

The construction of one healthcare facility might seem like a drop in the bucket compared to the global carbon conundrum, but every bit of carbon reduction helps. Healthcare organizations can set an example for global population wellness by reducing the carbon footprint of their built environment. Strategies include:

- **Building for energy efficiency.** This includes proper building orientation and siting to take advantage of passive heating, shading, and ventilation to reduce the size and energy use of HVAC equipment; maximizing the use of natural light to reduce the use of electric light; building envelope measures such as proper insulation to reduce heat transfer; energy-efficient lighting fixtures and occupancy sensors; and investing in energy-efficient mechanical equipment. These measures and more combine to save on energy use and costs—and reduce a building's operational carbon emissions.

- **Using low-embodied carbon materials and equipment.** In addition to reducing carbon emissions by utilizing high-performance, energy-efficient mechanical equipment, a healthcare facility can further reduce its effect on the environment by reducing its embodied carbon—the greenhouse gas emissions arising from the extraction, manufacturing, transportation, installation, maintenance, and disposal of building materials and equipment. Steel, wood, and concrete have varying levels of embodied carbon, as do refrigerants and mechanical equipment. Design firms, including IMEG, have joined architectural, structural, and mechanical initiatives (AIA 2030, SE 2050, and MEP 2040) and are committed to reducing embodied carbon in their projects and helping owners navigate toward the lowest embodied carbon possible in both new construction and renovation projects. Two recent structural case studies by IMEG, for example, showed a 40 percent to 50 percent reduction in embodied carbon by switching from steel to mass timber. While the path to decarbonization may seem daunting, owners can take low-risk, low-cost steps to start the process.

- **Purchasing carbon offsets.** Some amount of carbon emission is inevitable in the construction process, but many companies compensate by purchasing "carbon offsets"—investments in projects that take greenhouse compounds out of the environment instead of putting more in.

- **Utilizing renewable energy.** A new facility offers a prime opportunity to commit to solar panels, geothermal, wind, and other renewable energy sources. Renewable energy can be procured for use directly on the site, on other land owned by the healthcare group, or through renewable power purchase agreements with the utility.

- **Committing to recycling.** The built environment can be designed for easy disposal of recyclable materials, both during construction and operation.

Adding green space

Green space not only provides respite for patients and caregivers, thus improving the quality of care and outcomes, it also is a major contributor to improved public health. According to the World Health Organization, urban green space leads to better air quality, improvements in mental health, more opportunities for physical activity, and less overall stress. Healthcare organizations can incorporate green space into their built environment with such amenities as healing gardens, courtyards, arboretums, etc. These spaces have proven to be beneficial for patients and families by providing a space away from medical procedures and equipment. Such outside spaces also benefit employee health, wellbeing, and retention by providing respite from the constant noise, stress, and demands of the job. Viewing outdoor amenities through this lens allows healthcare organizations to frame green space not as a cost but as an investment into the improved health and wellbeing of patients and employees.

Reducing runoff

Runoff occurs when the land can't absorb the water that gets dumped onto it, usually by storms. This runoff then spills into stormwater removal systems and harms surrounding populations by carrying oils, pesticides, bacteria, dirt, and other toxic materials into the water supply. Any built environment designed with population health in mind needs to address reduction of runoff, particularly now that climate change has increased the frequency of historic floods and rains.

Runoff is particularly troublesome for commercial building structures—including healthcare facilities and campuses—which have large building footprints, parking lots, and roadways that cover large areas of the ground. Strategies to reduce such large amounts of runoff include:

- Using beams and curb cuts to redirect stormwater to absorbent areas and away from easily overwhelmed stormwater collection drains
- Installing permeable pavement for water to seep into rather than having nowhere to go but the drain
- Installing rain gardens. In addition to the other advantages of green spaces, the soil of a rain garden absorbs stormwater and reduces runoff.
- Installing bioswales, a type of soil-covered drainage trough
- Installing water filter units under storm grates and replacing the filters as needed

2. Reducing the cost of care

With government policy repeatedly failing to curb the cost of healthcare, the second goal of the Quadruple Aim has become a rallying cry for healthcare organizations to take responsibility for the prices they charge their patients for potentially lifesaving care—and earn priceless brand loyalty in the process. The built environment of a new facility can contribute significantly to this goal since facility costs represent a huge portion of the red ink on a healthcare company's ledger.

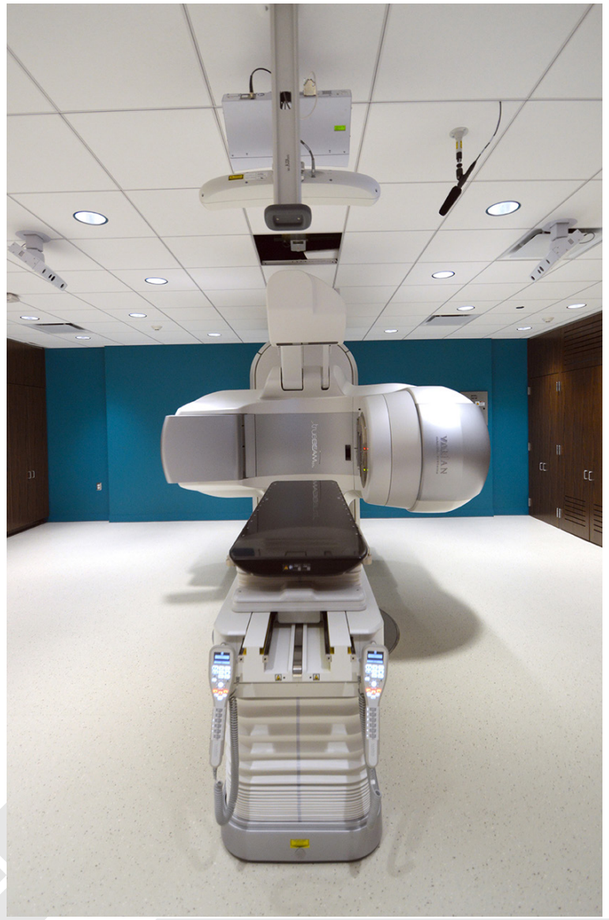
Cost is always associated with both the building and operation of a facility, and healthcare organizations must transparently pass that cost on to their customers to remain solvent. In the interest of reducing the cost of care, however, healthcare organizations can plan their built environment so both first- and life-cycle costs are as minimal as possible. Healthcare facilities should be considered investments that positively impact population and community health.

Controlling construction costs

Using the built environment to control the cost of care starts with managing the cost to build the environment in the first place. However, if cost decisions are based solely on simple cost of construction, an institution may miss opportunities that support and maximize the goals of the Quadruple Aim. To guard against this, healthcare organizations should:

- **Balance first cost vs. operating cost.** The first cost of a facility is the initial cost of construction and outfitting before the building is put into service. The operating cost is the ongoing cost of operating the building, including the cost of personnel. Designing the right size facility is the first step in reducing first costs. Simply put, building less saves more. Investment in features like energy efficiency and high-end fixtures can increase the first cost while reducing operating costs, but a high first cost can haunt a facility in terms of debt service. Finding a balance between first costs and operating costs is critical to producing the maximum cost savings to pass on to patients while still meeting the goals of the Quadruple Aim.

- **Prioritize the ROI of building features.** Some building features provide more return on investment than others. While high-ROI features may increase first and operational costs, they may also lead to additional revenue or increase the value of the property, making it easy to refinance. This can improve the organization's bottom line, enabling it to offer lower costs of care. Aspects of the built environment that produce high ROI include investments in sustainable construction (see "Improving Population Health"), safety, aesthetic enhancements, and operational efficiency and resiliency. As stated earlier, it is important that ROI and budget discussions not only consider first cost and operational savings but also the opportunity cost for a healthier community.



- **Manage medical equipment purchases strategically.** Medical equipment can account for up to 30 percent of a new facility's construction budget. By strategically planning, procuring, and installing the equipment just in time or on a tailored schedule, healthcare organizations can help ensure they receive the right medical equipment at the right price, delivered at the right time—reducing costs associated with storage and normalizing the average monthly cost of equipment expenditures.

Reducing operating costs

The built environment can be used as a tool to control operating costs in various ways. This creates cost savings that can then be passed on to the patient in the form of reduced cost of care. Here are some ways to use the built environment to reduce and control operating costs:

- **Include an efficient HVAC system.** Heating and cooling represent roughly 40 percent of the energy cost of most commercial buildings. Installing efficient HVAC systems can more than pay for themselves by delivering a reduction of 30 percent to 50 percent in the building's energy expense. Healthcare facilities—particularly hospitals, which have stringent air change rates and pressure requirements—are acutely sensitive **to improvements in efficiency.**

- **Leverage data.** For years the Internet of Things (IoT) has provided building owners with the ability to gather robust data on their facilities, systems, and operations. To improve operations and reduce cost it is imperative to harness that data and leverage IoT's ability to change the way infrastructure operates, communicates, and is controlled. This enables healthcare organizations to expand the role of technology design beyond IT, A/V, and security systems and into emerging systems such as Power over Ethernet (PoE) lighting, network-based electrical control systems, mesh network MEP controls/sensors, and network-controlled medical equipment. By taking advantage of this ever-growing interconnectedness of systems, a healthcare facility—which can easily have more than 100 different systems—can maximize its operations, minimize operational costs, and have the flexibility to adapt to future technology more easily and at lower cost.

- **Design the building with full-time employees in mind.** Designing the built environment from the beginning with the expectation of a large, full-time staff can save costs on expensive renovations in the future. Strategies for designing a built environment for full-time employees include making design allowances for movement, private employee spaces, employee devices, and employee amenities.

- **Avoid unnecessary features.** One of the easiest ways needlessly increase operating costs is to incorporate features that ultimately don't contribute to the satisfaction and efficiency of full-time employees. Some of the key culprits include overbuilt mechanical systems, overlapping equipment locations, and overbuilt interiors that run up material costs.

3. Enhancing the patient experience

The viability of a healthcare facility ultimately comes down to the patients and their families. If the patients and their loved ones are happy with their care, the healthcare organization thrives. Dissatisfied patients and negative HCAHP survey scores, however, can adversely impact the organization's bottom line.

Since providers, not buildings, render medical care, the impact of the built environment on the patient experience often gets overlooked. However, if providers are the "who" of medical care, the built environment is the "where"—and makes a huge difference. Here are some amenities and benefits the built environment can provide to positively influence the patient experience:

A welcoming, navigable environment

Even before patients enter a hospital or clinic—and even while they are at home—healthcare facilities with a cloud-based "front door" provide "entrance" and assistance in many ways. Think of it as a "storefront" for a business that doesn't lend itself to a storefront—i.e., the patient can't just walk in the hospital unannounced and expect care (unless it's emergency care). This digital front door, however, enables them to access many healthcare services remotely, make appointments, and complete preparations to make their physical visit to the facility more efficient for themselves and for staff. When the built environment includes a digital front door solution from the beginning, it is much more cost-effective and easier to integrate.

Once a patient does enter the hospital, the built environment can continue to help them navigate the facility and services by providing:

- **Wayfinding.** A science unto itself in the study and design of built environments, wayfinding is a strategy used by architects, designers, and builders to compose spaces such that employees and visitors don't get lost. This extends to making sure that patients can always find their way through intuitive design, signage, and digital navigational aids. With concepts like geofencing¬—the use of GPS or RFID technology to create a virtual geographic boundary—any visitor can interface with the facility before they even step foot on the premises and subsequently be guided throughout their visit/experience.

- **Signage.** Digital signage conveys public space messages and is located throughout building lobbies, departmental waiting areas, and elevator corridors. The displays are typically non-interactive but with advancements can be interactive and even contactless while being managed via enterprise-wide software with the ability to customize departmental-specific messaging. The signage can connect with the building's emergency communication system to aid in critical, event-based notifications such as evacuation or shelter-in-place instructions during emergency situations. The proliferation of digital signage enhances the overall experience while allowing for real-time messaging to support branding or marketing.

Smart patient rooms

Each healthcare facility must create and implement its own vision of a smart patient room. In general, however, a smart patient room eases a patient's mind and improves their experience by providing them with a higher level of autonomy and control. Common solutions include:

- **Enabling the patient to control their environment** from their bed. Using their own device or a hospital-provided tablet or voice-controlled device like Alexa enables them to control the lights, shades, and room temperature, helping them feel as though the space is "their" room. Such devices also can make a room safer by controlling the frequency of unaccompanied bed exits, thus preventing falls and injuries.

- **Installing multi-use cameras** that can be accessed bedside to enable telemedicine, provide eICU/acute care, function as a tele-sitter, and allow for remote patient/family interactions

- **Providing entertainment and education displays** that are integrated with the electronic medical record (EMR), dietary department for ordering food, or the TV to access a relaxation channel

Ease of care-team engagement

The patient-provider relationship makes all the difference in upgrading the patient experience. In a social media age, patients don't want professional distance—they want direct access. That does not mean providers and other clinicians

must submit to total access, but the built environment can be configured to make access easier while still maintaining boundaries. This includes interfacing with patients through the organization's digital front door, patient portals, and wearable technologies, and digital patient status awareness (e.g., displays) to inform the patient and caregiver where they are in their care plan. Direct patient-to-caregiver communication—when not possible face-to-face—can be enabled via integrated BYOD or nurse call, telehealth, and secure messaging to maintain an open, constant, and automated line of communication between patients, their families, and the care team.

Maximized use of daylight

Daylight helps alleviate depression, increase productivity, maintain circadian rhythm, and contributes to a variety of positive health outcomes. Designing a new healthcare facility provides the perfect opportunity to take advantage of these benefits and help optimize the built environment's positive impact on patient spaces by incorporating the appropriate amount of natural light through sun-facing windows. Daylight has also been shown to improve provider satisfaction and productivity and, to a small degree, positively impact population health due to reduced energy use and associated pollution.

Peace and quiet

The peace and quiet of a hospital or clinic can be dramatically impacted by the built environment. Successfully designing for serenity depends largely on:

- **Providing noise control and good acoustics.** Good acoustics can contribute greatly to a quiet patient environment. It starts by building an insulated envelope around the built environment to protect occupants from outside noise. Including sound-absorbent materials and paying attention to the shape of rooms and hallways contributes significantly to the dampening of sound inside the built environment and provides speech privacy between provider and patient.

- **Eliminating alarm fatigue.** Alarm fatigue results from the tendency of a clinic or hospital to have a high number of alarms and alerts on the nurse call system, EMRs, and, to a lesser degree, on building public address systems. This can result in clinicians becoming numb to the alarms and patients becoming agitated by their frequency. The built environment can be used to reduce alarm fatigue by decreasing the number of false or inconsequential alarms, using techniques like push messages to funnel alarms to the right people, using software to triage alarms, and arming building systems for other means of notification.

Pain management

Pain management is often the most immediate concern of patients. While the underlying condition may be unknown, the pain is obvious, and its relief is an imminent priority. The built environment can be tailored to be conducive to pain management, dramatically increasing the quality of the patient experience. This can be accomplished through:

- **AR and VR.** One of the most dramatic use cases for augmented reality (AR) and virtual reality (VR) technology is the ability to aid in pain management.

Patients exposed to soothing AR and VR have been shown in studies to require lower doses of painkillers. The built environment of a modern hospital or clinic can be outfitted with AR and VR technology to provide a different modality to reduce pain for patients.

- **Ease of communication about medication.** Patients who can communicate their pain levels effectively and efficiently to their providers through multiple avenues such as an interactive patient education display/portal or via their smartphone can benefit from more effective, tailored pain management with less medication and a lower risk of long-term dependency.

4. Improving provider satisfaction

Patients are the priority, and their healthcare depends on providers who are willing and able to provide excellent care. However, provider burnout is a real, complex issue, and the competition for attracting and retaining the best physicians, advanced practice providers, and medical assistants is getting fierce.

The built environment can greatly contribute to the satisfaction of providers, enabling organizations to retain their best staff and provide the highest level of care. This can be accomplished by a variety of strategies, including:

- **Lean designed facilities.** Providers don't want to spend their careers in complicated environments. Opting for a lean, simplified environmental design contributes to easy and more efficient use of space.

- **Proximity-focused layout.** Physical fatigue can play a big role in the dissatisfaction of healthcare providers, who spend most of each day on their feet. Designing the built environment so that related workspaces are nearby often requires careful planning and strategy, much like a chess game. Reducing the number of steps providers must take throughout their shift is well worth the effort as it enables more efficient care and minimizes fatigue.

- **Individualized temperature control.** Every provider is a unique person with different preferences for the temperature of their working environment. Designing the built environment for individualized temperature control—so each provider can select the temperature for their workspace—will help increase their satisfaction with their work environment.

- **Utilization of daylight.** As mentioned earlier, daylight is just as important for the physical and mental health of providers as it is for patients. Studies also have shown that provider productivity is increased with exposure to natural light, strengthening an already strong business case for utilizing natural light to its highest and best potential.

- **Site design.** The built environment is not just about the facility interior—the entire site contributes to the provider's experience. This includes attention to employee parking, accessibility to necessary mechanical systems, and private space where providers can work and take breaks in peace and quiet.

Getting started

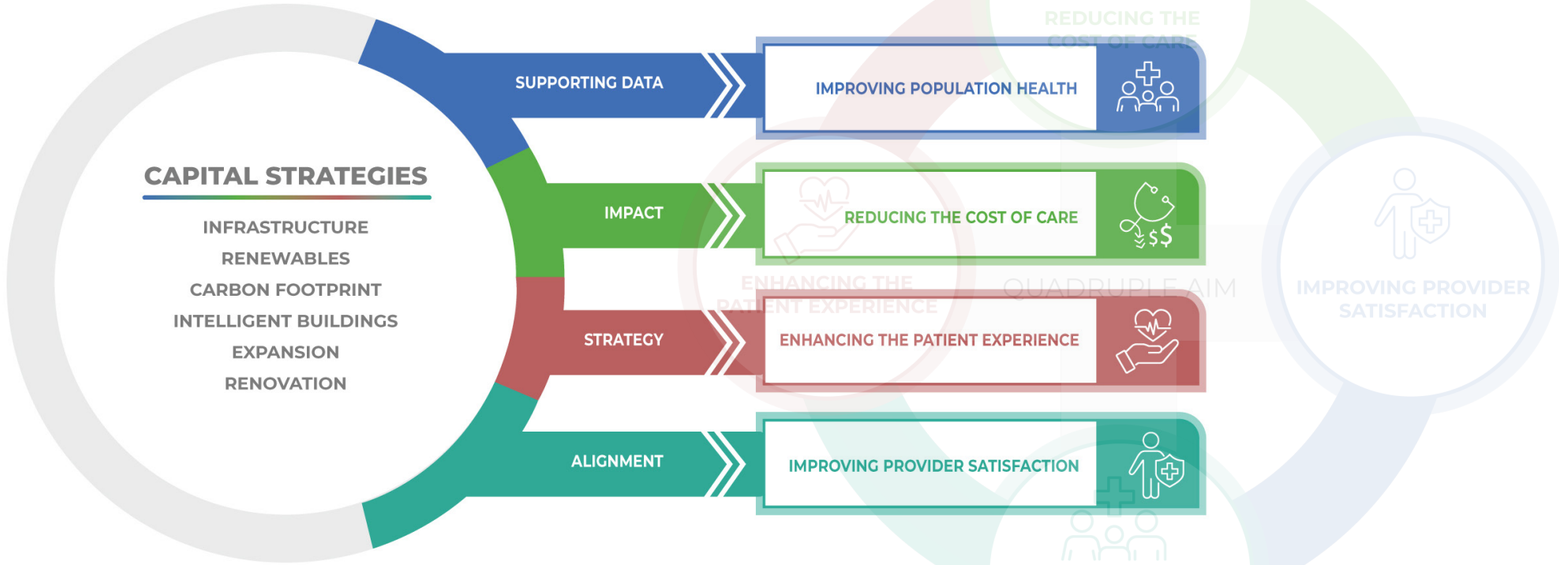
Using this guide as a starting point, healthcare organizations can conduct deeper dives into the Quadruple Aim and how they can best achieve it within the context of their individual organization's vision, goals, and brand. Just as importantly, healthcare executives can refer to the built environment strategies presented here as proven approaches to ensuring their building supports the goals of the Quadruple Aim.

When making final decisions on capital expenditures and infrastructure upgrades, the impacts on the Quadruple Aim needs to remain part of the discussion. This perspective can provide motivation and clarity on the importance of any project and lead to the best allocation of capital.

To help ensure a successful outcome, it is critical that a healthcare organization's planning team include representation from everyone who has a stake in the Quadruple Aim—hospital executives, caregivers, patients, and community leaders. Going one step further, a "champion" can be designated to keep the Quadruple Aim and built environment front and center during all discussions and decisions. Choosing a design and construction team with a deep understanding of the connection between the built environment and the Quadruple Aim is also critical—as is adding the team to the planning process as early as possible.

Upon completion of a project that is planned and designed in this manner, a healthcare organization can have the assurance that its goals, vision, and brand can be met, and that their clinical staff, care practices, and built environment can work in unison to provide positive outcomes both inside and outside the facility's walls.

QUADRUPLE AIM & BUILT ENVIRONMENT



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