



# EVIDENCE

# for Innovation

**TRANSFORMING CHILDREN'S HEALTH THROUGH  
THE PHYSICAL ENVIRONMENT**

**EXECUTIVE SUMMARY**



**NACHRI**  
National Association of  
Children's Hospitals  
and Related Institutions

  
**THE CENTER FOR  
HEALTH DESIGN**

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Rendering of a children's hospital lobby  
from a design competition.  
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A publication of the  
National Association of Children's Hospitals  
and Related Institutions  
in collaboration with  
The Center for Health Design



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# Executive Summary



Mother and son bond on the road to recovery.  
Photo by Leonard Myszynski, Solar Eye Photography  
Children's Hospital of Orange County, Orange, CA

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**Evidence-based design is defined as the deliberate attempt to base building decisions on the best available evidence with the goal of achieving the best possible outcomes for patients, families and staff while improving utilization of resources.**

**W**e are currently in the midst of an unprecedented health care building boom with \$100 billion in inflation-adjusted dollars spent on new hospital construction in the past five years (K. Henriksen, S. Isaacson, B. Sadler, & C. Zimring, 2007). Children's hospitals are part of this trend to upgrade, expand or replace existing facilities. The key drivers for this include: age of existing facilities (built in the 1950s-1960s) that no longer support efficient and safe care delivery; advances in treating childhood diseases; rapidly emerging technologies that fundamentally change care delivery processes; and the growing importance of patient and family centered care. Most importantly, the heightened focus on improving patient and workforce safety and quality has increased the need to create optimal physical environments.

In its landmark 2001 report, *Crossing the Quality Chasm*, the Institute of Medicine identified several problems with the health care system in the United States: that it was unsafe, ineffective, inefficient, untimely, lacking patient centeredness and not equitable (Institute of Medicine, 2000, 2001). Since then, a patient safety and quality revolution has swept the country. Consumers, employers and payers are demanding that hospitals dramatically reduce system-based errors that harm, even kill thousands of patients annually (Sadler, 2006). Further, negative outcomes such as patient falls, nosocomial infections, medical errors and staff turnover significantly impact costs of providing care. Universal health care access and escalating costs have emerged as a top issue in national and local political campaigns.

A growing body of research shows that the physical design of health care settings unintentionally contributes to negative outcomes. On the other hand, thoughtful evidence-based facility design can help bring the patient, staff and families into the center of the health care experience, increase patient safety and enhance the overall quality of care provided. For example, as part of a comprehensive

environment can help to eliminate avoidable harmful conditions such as hospital-acquired infections that cost hospitals millions of dollars. (Agency for Healthcare Research and Quality, 2007; Clancy, 2008; K. Henriksen, S. Isaacson, B. L. Sadler & C. M. Zimring, 2007).

It has become imperative to rethink facility design as a critical element in bringing about change in the way health care is provided and experienced in children's health care settings. Evidence-based design links the design of the physical environment with an organization's patient safety and quality improvement agenda. *Evidence-based design is defined as the deliberate attempt to base building decisions on the best available evidence with the goal of achieving the best possible outcomes for patients, families and staff while improving utilization of resources.* When the significant, multiyear, reduced operating costs of harm avoided are considered, there is a powerful business case for evidence-based design. Emerging trends in reimbursement and publicly reported patient satisfaction scores will further strengthen the business case.

*Evidence for Innovation* brings together key elements that can help leaders of children's hospitals to take action to create safer, less stressful and more patient centered healing environments. It consists of:

- *Key evidence-based design recommendations* that hospital leaders can incorporate in new, renovated or existing facilities (full report)
- *A tool kit* that outlines the key steps to take in implementing evidence-based hospital design
- *A comprehensive literature review* of evidence of the impact of the physical environment on patient, family and staff outcomes in children's hospitals
- *A business case analysis* that enables pediatric leaders to understand the cost benefits of investing in evidence-based environmental design strategies, including a suggested framework for return on investment.

## SUMMARY OF PUBLISHED LITERATURE

The literature review clearly demonstrates that the physical environment of pediatric settings impacts clinical, developmental, psychosocial and safety outcomes among patients and families. The physical environment represents a key component in providing family centered care in pediatric settings.

A scientific literature review identified the empirical evidence linking the design of the physical environment with patient, staff and family outcomes in pediatric health care settings. The literature review primarily focused on empirical studies published in scientific peer-reviewed journals. Of the 450 studies found on initial search using keywords, 320 articles met the criteria for inclusion in this study. Of these, 223 are cited in the literature review. Seventy-eight articles were analyzed in detail, and that analysis forms the core of the full report, *Evidence for Innovation*.

The review covers a range of pediatric services along the continuum of care and involving different patient populations. Of these, the greatest amount of research looking at impacts on patients, families and staff has been conducted in neonatal intensive care units (NICU). The key findings from the literature review are summarized here. For a more detailed review of the research findings and references, see the full report.

### Improved clinical and physiological outcomes in the NICU

The fragile state of the patients in the NICU makes them especially vulnerable to the harmful effects of environmental factors such as loud noise, high light levels and infectious pathogens. Exposure to excessive noise in the NICU impacts short-term and long-term auditory development. Removing sources of loud noises, instituting quiet hours, educating staff and parents, putting in sound absorbing ceiling

tiles and flooring and providing single patient rooms (as opposed to open wards) are all effective in reducing noise levels. Additional interventions demonstrating physiological benefits for infant development and convalescence include: placing earmuffs on the infants, covering the incubator, installing a sound absorbing panel in the incubator and putting sound absorbing foam next to the infant.

Cycled lighting (reduced light levels at night) and providing focused lighting over incubators helps to improve sleep and developmental outcomes among infants. Light is also beneficial in treating neonatal jaundice.

Many new NICU designs are moving from open wards to single family rooms with the primary purpose of providing an environment that can be customized to the developmental/health needs of the infant. Some studies suggest that families and staff are also more satisfied in these environments while others indicate that open bays may have some advantages related to ease of staff monitoring. Additional research is needed in this area.

### **Improved clinical outcomes**

Loud noise levels are common in general pediatric settings as well, and strategies such as providing single patient rooms and closing room doors have shown to be effective in reducing noise levels. There is, however, a lack of studies examining the impacts of noise on young children, adolescents or families on pediatric units.

Studies conducted in inpatient and outpatient settings show that positive distractions such as noise reduction and choice of music using a headset can be helpful in reducing anxiety, distress and perceived pain associated with difficult procedures. Music and music therapy is also an effective intervention in reducing stress, anxiety, perceived pain and the need for conscious sedation among hospitalized and

ambulatory patients. One study that examined the impact of music therapy on the need for sedation among children receiving ECGs (electrocardiograms) or CT (computed tomography) scans found 100 percent success rate in eliminating the need for sedation for pediatric patients receiving ECGs, 80.7 percent success rate for pediatric CT scan completion without sedation and a 94.1 percent success rate for all other procedures (Walworth, 2005). Savings per patient was \$74.20, and total savings for 92 patients was \$6,830 (Walworth, 2005).

Spending time in gardens is also effective in improving mood, reducing distress and increasing feelings of wellness among young children. Other studies show that healing among children is promoted through interior design elements such as color, furniture and carpet while use of ambient music can help patients cope with pain and aggression.

### **Improved psychosocial outcomes**

Providing spaces for families on nursing units and in patient rooms enables parents, siblings and friends to spend time with patients and provide the social interaction and support needed during this difficult time. Well designed positive distraction tools such as Starlight Starbright programs help school-age children connect with a community of peers and provide much needed social contact and intellectual stimulation. Studies show the therapeutic benefits of providing play spaces in health care settings to support play behavior and interaction among patients with different types of physical abilities and ages.

Adolescents have different social needs from younger children. Adolescent patients require a balance between privacy and intimacy and social interaction with people. Programmed amenities (game rooms, music areas) that provide distraction and remove the feeling of being in a hospital are likely to be preferred by adolescent patients.

### Increased patient safety

Patient safety outcomes such as nosocomial infections and falls are directly impacted by environmental factors. Poor air quality, inadequate supports for hand washing and materials (e.g., toys) harboring infectious pathogens have all been linked with nosocomial infections in children. Research shows that single patient rooms are more effective than open bays in reducing the spread of nosocomial infection among pediatric patients, especially among immunocompromised patients.

Environmental factors potentially contribute to falls in children although no studies have examined this in any detail. Other environmental hazards such as bedrails, wires and equipment that could lead to choking, tripping or burns among children should also be avoided. The physical environment can also compromise patient safety. For example, loud noises and inadequate meeting spaces are barriers to communication and team work. Chaotic environments, poor ergonomics and low lighting levels may compound the burden of stress in staff and result in errors. These studies have been primarily conducted in adult settings, but are applicable to pediatric settings.

### Increased staff effectiveness in providing care

Satisfied and effective personnel are integral components to providing quality care in pediatric hospitals, although few studies have focused specifically on staff outcomes in children's health care environments. However, findings from studies conducted with staff in adult settings likely apply to pediatric settings. Excessive noise is a stressor for staff and leads to fatigue and burnout. In contrast, exposure to gardens is a source of satisfaction, improved mood and reduced stress. Some studies have examined the impact of unit design and interior design changes on staff satisfaction. They suggest that staff prefers and has less stress in single family rooms in the NICU. However, in some cases, staff members in NICUs have expressed concerns

with single patient room designs believing that they make monitoring and effectively caring for patients more difficult. Unit renovations and physical design improvements are associated with greater staff satisfaction. Some studies conducted in adult settings suggest that unit layouts result in increased efficiency when designed to reduce walking, to increase staff access to patients, and to place equipment and supplies closer to staff. However, there is need for further research in pediatric settings.

In summary, research studies in various pediatric environments show how physical design can contribute to safety and quality. Many other studies on adult settings are also applicable to pediatrics. A strong body of information is now available to guide design decision makers in creating safe and therapeutic pediatric health care environments. Further research in pediatric settings is needed and is worthy of support to assure that our children are receiving optimal care. Based on the literature review, we recommend six key areas where further research is needed.

#### Key areas where future research is needed on designing for children and adolescents

- Role of design in reducing noise levels and associated negative outcomes
- Effect of natural light in reducing depression and improving outcomes
- Impact of unit design (i.e., decentralization) and patient room design on staff time at the bedside and staff efficiency
- Impact of unit design and acuity adaptable room design on patient transfers and errors
- Impact of positive distractions such as artwork and music on stress reduction and anxiety
- Cost effectiveness of various design innovations

## RECOMMENDED EVIDENCE-BASED DESIGN INNOVATIONS

While the body of research on the impact of the physical environment on patient, staff and family outcomes in pediatric settings continues to grow, the stronger focus has been on NICU settings as compared to environments for pediatric and adolescent patients. Although children and adolescents often have different physical and psychosocial needs from adult patients, in many areas, research from adult settings is applicable to pediatrics. For example, a strong body of research from adult settings shows that optimal exposure to sunlight is beneficial in reducing depression and perceptions of pain among adult patients. Although similar research has not been conducted among children and adolescents, it stands to reason that sunlight should also benefit these populations.

Some new trends in the design of health care settings – pediatric and adult – are not yet fully substantiated by research, but are extremely promising. As leaders of pediatric health care organizations embark on construction, renovation or physical improvement projects, they should consider the following evidence-based design strategies organized in three categories:

- Evidence-based design strategies from pediatric settings (NICU, children and adolescents)
- Evidence-based design strategies from adult settings applicable in pediatric settings
- Promising high impact strategies not yet fully substantiated by research

The evidence-based design strategies are organized as a matrix in Table 1 on page 6. Strategies for each of the three categories are indicated in terms of:

- *Relevance to a specific population* – the population directly impacted by the evidence-based design strategy. While indirect impacts on other groups

are likely, *Evidence for Innovation* focuses on the direct impacts as indicated by the research literature.

- *Relative construction costs* – the costs of incorporating this strategy relative to other strategies. A wide range of costs reflects the scale of changes and whether the strategy is to be incorporated in a new facility or in a renovation. The range describes: low = less than \$100,000; moderate = \$100,000 to \$1 million; and high = more than \$1million.
- *When to incorporate* – the types of situations (new construction, renovation or existing facility) when the evidence-based design strategy can be cost effectively incorporated into the physical environment.

## EVIDENCE-BASED DESIGN STRATEGIES BASED ON RESEARCH IN PEDIATRIC SETTINGS

The following strategies have proven effective in pediatric-specific settings. The timing and relative cost of the intervention are included.

### Construct single family rooms in the NICU

- New construction/renovation
- High cost

Studies show that single family rooms are beneficial in the NICU because they allow a greater degree of flexibility to care providers and families in customizing the environment (noise levels, lighting and temperature) needed for the care of a specific patient (Harris, Shepley, White, Kolberg & Harrell, 2006). These single family enclosed rooms include a patient care area (with incubator), a staff area (sinks, storage) and a separate family area (usually with sleeping space, workspace). Patient and family privacy is supported by having curtains/doors at the entrance to the room and curtains between the patient area and family area. Families and staff are also more satisfied in these environments as

**TABLE 1**

Evidence Based Design Strategies	Relevance to population						Construction cost			When to incorporate		
	General/all	NICU	PICU/pediatric	Adolescent	Staff	Families	Low	Moderate	High	New construction	Renovation	Existing
<b>Strategies from pediatric settings</b>												
Single family room NICU		■							■	■		
Circadian lighting in the NICU		■					■			■		
Incubator noise reduction in the NICU		■					■			■		
Sound absorbing ceiling tiles	■						■			■		
Space for families in all patient rooms and on all units	■							■	■	■		
Patient and family control over privacy and environmental conditions		■				■				■		
Calming music distractions before/during procedures		■					■			■		
Positive distractions to reduce anxiety				■			■			■		
Access to nature through gardens	■							■		■		
Age appropriate play areas			■	■				■		■		■
Overall ambience and attractiveness	■							■		■		
<b>Applicable strategies from adult settings</b>							■	■	■	■	■	■
Effective way finding systems								■		■		■
Single patient rooms for all patients									■	■		
Hand washing dispensers and sinks in every room					■		■			■		■
Access to natural light	■							■		■		
Ceiling lifts					■			■		■		■
Noise audits	■						■			■		■
Visual access and accessibility to patient	■							■		■		
Positive distractions	■						■			■		
HEPA filtration for immune-compromised patients		■	■					■		■		■
<b>Promising high impact strategies not fully substantiated by research</b>							■	■	■	■	■	■
Acuity adaptable patient rooms	■						■			■		
Increased standardization through same-handed patient rooms					■			■		■		
Increased standardization through consistent room and unit layout					■			■		■		

compared to open bay NICUs. Single family rooms are best incorporated into the facility during unit renovations or new construction because of the extensive modifications required.

### **Incorporate circadian lighting in the NICU**

- Any time
- Low cost

Research shows that when light levels are changed over the course of the day to mimic night and day cycles, infants show improved developmental outcomes such as improved sleep and weight gain. This low cost strategy can be incorporated any time. Single family rooms offer greater flexibility in terms of controlling light levels in the NICU to accommodate differing lighting needs of patients, staff and families.

### **Incorporate incubator noise reduction in the NICU**

- Any time
- Low cost

Altering noise levels within an infant's incubator can be an efficient low cost way to alter the noise environment and may not require facility renovations. Placing earmuffs on the infants, covering the incubator, installing a sound absorbing panel in the incubator and putting sound absorbing foam next to the infant all have demonstrated physiological benefits for infant development and convalescence.

### **Install sound-absorbing ceiling tiles**

- Any time
- Low cost

This relatively low cost strategy has proven effective in improving the acoustical environment by reducing noise levels and reverberation times. While only a few studies have been conducted in pediatric settings, the cost effectiveness of this strategy in reducing noise levels makes it a good solution in many health care settings. Further, this strategy can be incorporated in any situation. An acoustical consultant can provide input on placement and selection of tiles to achieve maximum effectiveness.

### **Provide space for families**

- New construction/renovation
- Moderate/high cost

To help children cope with their hospital experiences, family members can provide distractions, emotional and verbal expression, independent activities, familiarity and knowledge. Providing ample family space in each patient room to encourage parents and siblings to remain with the child can result in ongoing support. Single family rooms with space for families are the most supportive of family presence. It is easier to incorporate such family spaces when units are being constructed or renovated. However, even in existing facilities, spaces can sometimes be created for family use.

### **Provide patient and family control over privacy**

- Any time
- Moderate cost

Multiple studies demonstrate patients' needs for privacy as well as the ability to control their environments. While single patient rooms provide the greatest opportunity for individualization and privacy, small scale interventions such as individual storage space and furniture partitions between beds can help to promote privacy in multi-occupancy conditions. Adolescents particularly indicate a strong preference for privacy and the ability to control with whom they interact and when.

### **Provide calming music distractions**

- Any time
- Low cost

Music therapy and ambient music are effective and efficient non-pharmacological strategies in reducing anxiety, perception of pain and medication use among pediatric patients undergoing painful procedures. They can be introduced at any time.

**Provide positive distractions to reduce anxiety**

- Any time
- Low cost

Virtual reality games and programs have been used during painful procedures to decrease pain perception. Such interventions have been shown to be effective in reducing pain and anxiety and symptom distress. Other programs such as the computerized network Starbright World were created to link seriously ill children into an interactive online virtual community that enables them to play games, talk about their illness or learn about their condition with other chronically ill children. Since the inception of Starbright World, several research studies have shown improved outcomes: reduction in pain and distress, reduction in the fear and isolation of a prolonged illness, greater willingness to return for treatment, increased sense of peer support, increased knowledge and sense of responsibility for managing disease, distraction from the challenges that accompany their illnesses and increased ability to cope with their diseases.

**Provide access to nature through gardens**

- New construction/renovation
- Moderate cost

Exposure to nature in different forms (viewing nature, gardens, being in nature) have all shown a calming and restorative effect on pediatric patients as well as staff and families. Exposure to gardens has potentially beneficial effects on emotional states, feelings of anxiety, sadness, anger, worry and pain. Gardens are easier to incorporate in new construction although they could be incorporated into existing facilities if space permits. This is a moderate cost intervention.

**Provide age appropriate play areas**

- Any time
- Low to moderate cost

Play, used as a therapeutic tool, reduces tension, anxiety, anger, frustration and conflict among

pediatric patients and provides a means for children to “play out” frightening, stressful or frustrating experiences. Age appropriate play areas are recommended on all children’s units. Needs and preferences of children of different age groups as well as therapy goals should be considered when designing these spaces.

**Enhance overall ambience and attractiveness**

- Any time
- Low to moderate cost

Several studies show that patients, staff and families are more satisfied with the overall care in pleasant, clean and attractive settings. Even small design modification and unit renovations have been associated with increased satisfaction among staff. The cost of making a setting more attractive will vary depending on the scale of the modifications. Adding plants, paint or artwork to an existing unit would be low cost while interior design modification for the entire facility would be moderate to high cost.

**EVIDENCE-BASED DESIGN STRATEGIES APPLICABLE FROM RESEARCH IN ADULT SETTINGS****Incorporate effective way finding systems**

- Any time
- Moderate cost

Poor way finding systems cause stress and disorientation for patients, families and visitors. Further, hospitals incur significant costs associated with having staff provide directions to ameliorate way finding problems. A good way finding system includes four main components working at different levels:

- administrative and procedural levels — mail-out maps, pre-visit hospital information
- external building cues — signage and location of parking, local you-are-here maps
- signage at key decision points — directories, nomenclature
- global structure — simple and accessible building layout.

While overall building layout changes are feasible only in new construction projects, other components are low cost modifications, which can be incorporated in existing settings.

### **Provide single patient rooms for all patients**

- New construction/renovation
- High cost

Research reveals that adult patients recover faster in private rooms, and infection rates are lower due to lack of exposure to airborne pathogens originating from a roommate. Medication errors are reduced due to less confusion about which patient, and privacy issues are reduced when confidential patient information is not shared in close proximity to others. Additional documented benefits of all private patient rooms include: far less noise, better communication from staff to patients and from patients to staff, superior accommodations for family, and consistently higher satisfaction with overall quality of care. There is also strong indication that single patient rooms result in better outcomes among NICU and PICU patients. Studies among adolescents indicate a preference for single rooms. Based on this converging body of evidence, we recommend single patient rooms for all patients in pediatric settings. This intervention is best considered in new construction.

### **Provide hand washing dispensers and sinks**

- Any time
- Low cost

Several studies show that alcohol-based hand rubs in addition to sinks with soap and water in patient rooms increase the quality and frequency of hand washing. Further, alcohol-based hand-rub dispensers at the bedside are associated with increased hand washing compliance. This low cost intervention should be incorporated into any existing facility.

### **Optimize access to natural light**

- New construction
- Moderate cost

Studies of hospitalized adults show that exposure to light helps to reduce depression, intake of pain medication and length of stay. Exposure to light might have similar benefits for children and adolescents. New construction provides the best opportunity to bring natural light indoors. This is more difficult to achieve in existing facilities.

### **Install ceiling lifts**

- Any time
- Moderate cost

Ceiling lifts have been very effective in reducing back injuries among staff in adult settings. With growing obesity among children, it is likely that ceiling lifts will effectively reduce lifting injuries to staff in pediatric settings as well.

### **Develop a noise reduction plan**

- Any time
- Low cost

Noise audits can help a health care facility assess noise levels as well as sources of noise in and around the facility. An effective noise audit will provide valuable information that can lead to a comprehensive noise reduction plan including low cost solutions to specific noise problems (remove ice maker from the unit, train staff to reduce conversation levels, eliminate overhead pages, install ceiling tiles).

### **Promote visual access and accessibility**

- New construction
- High cost

Bringing staff and supplies closer to patients is likely to reduce staff time spent walking and increase time spent in direct patient care activities. Studies on the impact of the unit layout on the amount of time spent walking show that time saved walking translates to more time spent on patient care

activities and interaction with family members. New designs are incorporating decentralized nurses stations and alcoves outside patient rooms so staff is distributed around the unit (as opposed to being in a single central location) closer to the patients. Consider work flows in relation to location of key spaces (patient room, nurse work space, location of equipment and supplies) with the goal of minimizing walking distances and number of trips; consider locating frequently used supplies in patient rooms to minimize walking trips for staff.

#### **Provide positive distractions**

- Any time
- Low cost

Viewing artwork depicting images of nature has been linked to stress reduction for diverse groups of people. Studies conducted among adult patients show that viewing nature images (water, trees, large outdoor space) results in reduced anxiety and pain. A preliminary study conducted with children in a pediatric emergency department suggests that interactive art cart programs helped substantially in reducing their stress and anxiety. This low cost intervention can be incorporated into any type of pediatric facility.

#### **Install HEPA filtration**

- New construction/renovation
- Moderate cost

Several studies show that high-efficiency particulate air (HEPA) filters, in particular, are highly effective in filtering out harmful pathogens and are very helpful in reducing nosocomial infections, particularly among immunocompromised patients. Some special precautions to prevent infection during periods of construction and renovation include using portable HEPA filters and installing barriers between patient care and construction areas.

### **PROMISING HIGH IMPACT STRATEGIES NOT FULLY SUBSTANTIATED BY RESEARCH**

#### **Make single patient rooms acuity adaptable**

- New construction/renovation
- Low cost

Acuity adaptable rooms do not cost significantly more than regular single patient rooms. Additional costs include providing monitoring and oxygen so that care can be provided in the same room for patients with differing levels of acuity and thus eliminate the need for transfers. The path breaking study conducted by Hendrich and colleagues on the impact of acuity adaptable rooms on patient transfers in adult ICU settings provides strong justification for adopting acuity adaptable room and care models as a way to reduce patient transfers in the hospital (Hendrich, Fay & Sorrells, 2004; Hendrich & Lee, 2005). Significant improvement in many key areas was reported as a result of the acuity adaptable model: patient transfers decreased by 90 percent; medication errors decreased by 70 percent; and number of falls was drastically reduced. However, this study has not been replicated in other settings – adult or pediatric. There is reason to believe this concept would be equally effective in reducing unnecessary transfers in pediatric settings, but research is needed to understand more about how this approach should be adapted to pediatrics.

#### **Increase standardization using same-handed rooms**

- New construction
- Moderate cost

Many new designs in adult hospitals are incorporating same-handed patient rooms with all rooms identical in configuration and orientation. That is, the patient is always on the same side in all patient rooms and gases and equipment are always located in the same position in every room. The premise for this design innovation is based on human factors research from other industries showing that increased standardization results in fewer mistakes

because it reduces the cognitive burden on the decision maker. However, this innovation has a higher initial capital cost, and its effectiveness remains to be proven.

**Increase standardization using consistent layout**

- New construction
- Moderate cost

Hospitals are aiming toward greater standardization in all aspects of their designs and operations. This means standard location, design and use for specific building components throughout the organization. For example, nurses might be able to locate certain types of supplies at specific locations consistently throughout the facility. The goal is to minimize variability, which requires staff to spend precious time and effort reorienting to new physical situations to address problems

at hand. The impact of a higher degree of standardization on staff efficiency and medical errors remains to be substantiated by research.

**PRIORITY DESIGN RECOMMENDATIONS**

The following design recommendations have been developed based on their impact and the strength of the evidence available (Table 2). Some recommendations can be incorporated into any pediatric facility at low cost without significant modification (left column). All facilities could implement them at any time. Other strategies require higher investment and significant physical modifications and are best incorporated as part of a major renovation or new construction (right column). Leaders of pediatric facilities should seriously consider these key design strategies as integral to quality improvement projects.

**TABLE 2**

Priority Design Recommendations	
<p><b>Any time</b></p> <ul style="list-style-type: none"> <li>• Install hand washing dispensers at each bedside and in all high patient volume areas</li> <li>• Install incubator noise reduction measures in the NICU</li> <li>• Install circadian (cycled) lighting in the NICU</li> <li>• Install high performance sound absorbing ceiling tiles</li> <li>• Conduct a noise audit and develop a noise reduction plan</li> <li>• Use music as a positive distraction during procedures</li> <li>• Use virtual reality images and artwork to provide positive distractions</li> <li>• Incorporate age appropriate play areas</li> <li>• Improve way finding through enhanced signage</li> <li>• Where structurally feasible, install HEPA filters in areas housing immunocompromised patients</li> </ul>	<p><b>During renovation or new construction</b></p> <ul style="list-style-type: none"> <li>• Build single family patient rooms</li> <li>• Provide adequate space for families to stay overnight in patient rooms</li> <li>• Build accessible indoor or outdoor gardens</li> <li>• Design age appropriate and attractive play areas and amenities</li> <li>• Increase visual access and accessibility to patients</li> <li>• Optimize natural light in staff and patient areas</li> <li>• Install HEPA filters in all areas housing immunocompromised patients</li> <li>• Install effective way finding systems</li> <li>• Install ceiling lifts to reduce workforce injuries</li> <li>• Explore the feasibility of acuity adaptable rooms to reduce transfers*</li> </ul>

\*Limited evidence but potentially high impact

## THE BUSINESS CASE SUMMARY

### Revenue and Cost Impacts

When considering reduced operating costs and revenue enhancements, a powerful business case supports making intelligent evidence-based design decisions described in *Evidence for Innovation*. To fully appreciate this, it is important to consider the implications of several major forces beginning to change reimbursement formulas and require public reporting of quality/safety outcomes as well as comparable patient satisfaction scores.

#### Pay for performance

In the past few years, a fundamentally new concept has begun to emerge in the reimbursement to hospitals and physicians. It is called value-based purchasing or pay for performance, and it promises to have an important influence on the business case for quality improvement, including the physical environment where people work and care is received. While much of the emphasis so far has been on Medicare patients (driven by Centers for Medicare & Medicaid Services [CMS]), it seems safe to assume that Medicaid, the number one volume payer of children's hospitals, and commercial payers will follow in this direction. Indeed, some have already begun.

#### National Quality Forum "never events"

The National Quality Forum (NQF) has identified 27 "never events" that are largely preventable and should simply never occur in hospitals (National Quality Forum, 2006-07). CMS has identified specific harms, including infections and falls that should not be reimbursed. While the details are just emerging, it seems reasonable to assume that, within three to five years, virtually no payers will reimburse hospitals and physicians for serious harm caused by the care provider. Consumers will have easier access

to clear, comparable outcomes data and will begin to make choices about where to take their children for care based on this information. Increasingly, consumers will be channeled to payer-preferred networks based on quality measures. Poorly performing hospitals could risk losing significant market share.

#### Hospitals will no longer charge for errors

In this new era of transparency and public reporting, hospitals in some states have voluntarily decided not to charge payers and patients for errors caused by the care provider. In addition, the connection between hospital errors and the incidence of litigation has been effectively described (Gosfield & Reinertsen, 2005).

Several state hospital associations have adopted a "no charge" policy for hospital-caused errors and this may soon become standard practice. We are entering a new era in which patients and payers will no longer tolerate being charged for poor outcomes.

#### Patient satisfaction and transparency

Another emerging trend is the mandated reporting of patient experiences in hospitals. With support from CMS and the Agency for Healthcare Research and Quality, a survey, Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) was developed to:

- *produce comparable data* from the patient's perspective on topics important to consumers
- *create incentives* through public reporting for hospitals to improve care
- *increase public accountability* through increased transparency of quality of care.

The survey is composed of 27 items, 18 of which encompass critical aspects of the hospital experience including cleanliness and quietness of the hospital environment as well as overall rating of the hospital.

While there are no data yet to report the impact of this new trend, it seems reasonable to predict that those hospitals with more comfortable, safe and patient centered physical environments will be rated higher by patients in the HCAHPS survey. This could have significant influence on patient choice of hospitals with a resulting effect on a hospital's market share and its financial bottom line. While HCAHPS is focused today on Medicare beneficiaries, it also seems reasonable to assume that Medicaid and commercial payers will again follow and that this type of public reporting requirement will apply to children's hospitals.

These four trends combine to send a clear signal that children's hospitals could experience significant negative revenue consequences secondary to providing less than optimal environments that contribute to unacceptable clinical outcomes, lower patient satisfaction scores and reduced market share.

#### **BALANCING ONE-TIME CAPITAL COSTS AND ONGOING OPERATING SAVINGS**

Central to the business case is the need to balance one time construction costs against ongoing operating savings and revenue enhancements. The first attempt to analyze this balance was published in 2004 by a multidisciplinary team, which analyzed published research on the actual experience of health care organizations using evidence-based design in portions of construction projects. The team designed the hypothetical Fable Hospital. When the team analyzed the operating cost savings resulting from reducing infections, eliminating unnecessary patient transfers, minimizing patient falls, lowering drug costs, lessening employee turnover rates, as well as improving market share and philanthropy, it con-

cluded that, with effective management and monitoring, the financial operating benefits would continue for several years, making the additional innovations a sound long-term investment. In short, there was a compelling business case for building better, safer hospitals. While Fable Hospital was largely based on adult patients and research involving adults, a significant majority of components also apply to pediatric patients and their hospital environments.

#### **Going green**

In addition to evidence-based design features that attend to patient and staff safety, a number of emerging sustainable or "green" building features and strategies can improve the health care environment with little or no capital cost and should be considered for inclusion in new projects.

#### **From "light green" to "dark green"**

The movement of theoretical savings (light green dollars) to actual savings as reflected in hospital financial statements (dark green dollars) is a key success factor to accomplish the business case objectives. Documenting actual cost savings in financial forecasts can be invaluable in convincing boards of trustees that evidence-based design investments are cost effective.

A suggested framework for hospitals to calculate the return on investment of a specific evidence-based innovation is included in the full report, *Evidence for Innovation*. Each organization will need to incorporate the latest relevant evidence and use best judgment about cost and revenue impacts of the innovation being considered.

## HOW TO USE EVIDENCE-BASED DESIGN A Toolkit for Action

When planning to build a new hospital or to renovate an existing facility, children's hospital leaders should address a key question: How will the proposed project incorporate all relevant and proven evidence-based design innovations in order to optimize patient safety, quality and satisfaction as well as workforce safety, satisfaction, productivity and energy efficiency?

Traditionally, hospital leaders have asked five questions when considering a major building project:

1. Urgency – Is the expansion/replacement actually needed now to fulfill the hospital's mission? What is the cost strategically of not proceeding?
2. Appropriateness – Is the proposed plan the most reasonable and prudent in relation to other alternatives?
3. Cost – Is the cost per square foot appropriate in relation to other projects in the region?
4. Financial impact – Has the financial impact of additional volume, depreciation expense and revenue assumptions been reasonably analyzed and projected?
5. Sources of funds – Is the anticipated combination of additional operating income, reserves, borrowing and philanthropy reasonable and adequate to support the project?

*Today, hospital leaders should also address a sixth question:*

6. Evidence-based design – Will the proposed project incorporate all the relevant and proven evidence-based design innovations in order to optimize patient safety, quality and satisfaction as well as workforce safety, satisfaction, productivity and energy efficiency?

## From questions to action: Ten steps to implement evidence-based design (including the business case)

To address question six effectively, a hospital should undertake at least the following 10 steps:

1. Create a multidisciplinary leadership team and develop a compelling vision to achieve measurable safety/quality improvements involving patients, families and staff, as well as volume and the bottom line.
2. Select an architect with proven understanding and experience in evidence-based design. Ask for specific examples of planned or completed projects where the firm was instrumental in assuring that evidence-based design innovations were included and implemented.
3. Identify evidence-based design interventions. Management, medical staff and board leadership must collaborate with the architects to determine which cost effective, evidence-based design interventions will support their vision for the new project.
4. Evaluate current practice and develop a baseline. For example, determine the current rates of infections, transfers, employee turn over, patient falls institutionally and at the patient unit level. Identify the baseline operating costs associated with these outcomes.
5. Set measurable post-occupancy improvement targets. For example, identify a reduction in hospital-acquired infections from X to Y; an increase in patient satisfaction rates from A to B; a decrease in workforce lift injuries from C to D; and reduction in patient transfers from E to F. These measurable improvement targets must be agreed to by all key stakeholders and widely communicated. Key staff members must be included in this process and become active advocates. To be successful, it is essential to build an organizational culture of support for these changes.

6. Incorporate design improvements into capital and operating budgets. Management and medical leadership must incorporate the financial impact of these improvements into the hospital's annual capital and operating budgets to be reviewed and approved by the board of trustees.
7. Widely communicate improvement targets. Performance improvement targets should be included in all appropriate internal and external communications, including the methods used to collect data. This can provide public awareness and recognition that can differentiate the organization in the market place and increase market share.
8. Track and report progress. Upon completion of the new facility or renovation, the metrics of impact (including financial impact) at the overall institutional level and the unit level should be regularly reported to all key stakeholders, including the board.
9. Continually, incorporate new evidence-based design strategies. Regularly, review internal experience and new developments in evidence-based design research. Where appropriate, incorporate new evidence-based design interventions into the organization's facility maintenance activities, process and culture. While tracking results should continue for at least three years post-occupancy, new environmental design and process improvements should be systematically incorporated.
10. Publish your results. The organization should share lessons learned and publish its results (including financial results) with the rest of the health care and design communities. This will contribute to needed knowledge about the financial and clinical impact of evidence-based design.

(REFERENCE: This analysis is drawn from the article by Sadler, DuBose & Zimring, "The Business Case for Building Better Hospitals Through Evidence Based Design," *Health Environments Research and Design Journal*, April 2008.)

## CONCLUSION

Hospital leaders and boards of trustees face a new reality: they can no longer tolerate preventable hospital-acquired conditions such as infections and falls; injuries to staff; unnecessary intra-hospital patient transfers that can increase errors; or subjecting patients and families to noisy, confusing environments that increase anxiety and stress. They must effectively deploy all reasonable quality improvement techniques available. To be optimally effective, techniques will almost always rely on tactics that, when implemented, will produce best results.

Leaders must understand the clear connection between constructing well designed healing environments and improved health care safety and quality for patients, families and staff, as well as the compelling business case for doing so. The physical environment in which people work and patients receive their care is one of the essential elements to address a number of preventable hospital acquired conditions.

Emerging pay for performance methodologies that reward hospitals for quality and refuse to pay hospitals for harm they cause further strengthen the business case. At the same time that the costs of unnecessary harm are increasing, public and employer expectations are growing. The emerging practice of not charging for errors and the public reporting of comparable patient satisfaction scores add more weight to the revenue side of the business case. While much of the reimbursement and transparent public reporting requirements have been driven by Medicare, children's hospital leaders should take them into account as Medicaid and commercial payers adopt the same or similar practices.

As part of their management and fiduciary responsibilities, hospital leaders and boards must include cost effective evidence-based design interventions in all programs or risk economic consequences in an increasingly competitive and transparent environment. Implemented successfully, responsible use of evidence-based design will improve patient safety and quality, enhance workforce recruitment and retention and produce a significant multi-year return on investment. The effectiveness of any evidence-based design interventions will not occur in isolation from other process improvements that must be implemented concurrently. Similar to the experience of Institute for Healthcare Improvement in the 100,000 Lives and 5 Million Lives campaigns, effective change packages are a bundle of improvements that must be implemented together. The key point is that environmental design innovations included here are essential ingredients in optimally improving safety and quality.

As hospital leaders undertake building projects, it is imperative that they track ongoing operating savings as an integral part of their analyses. Hospital boards and management must hold each other accountable to new levels of environmental excellence and efficiency. Building a new hospital or undertaking a major renovation is likely to be the biggest financial decision that a board will ever make. It also provides a unique opportunity to transform the culture and processes of the overall organizational enterprise to maximize the investment. Hospital leaders have an opportunity and an obligation to assure that irrespective of whether patients are in their care for an hour, a day, a week or a year, they are provided an optimal healing environment.

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### **About the National Association of Children's Hospitals and Related Institutions (NACHRI)**

NACHRI is a nonprofit membership organization of children's hospitals with more than 218 members in the United States, Canada, Australia, China, Italy and the United Kingdom. NACHRI promotes the health and well-being of children and their families through support of children's hospitals and health systems that are committed to excellence in providing health care to children. It does so through education, research, health promotion and advocacy.

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### **About The Center for Health Design**

The Center for Health Design is a leading non-profit research and advocacy organization of forward-thinking healthcare and design professionals who are leading the quest to improve the quality of healthcare through building architecture and design. Our mission is to transform healthcare settings - including hospitals, clinics, physician offices, and nursing homes - into healing environments that contribute to health and improve outcomes through the creative use of evidence-based design. For more information, visit [www.healthdesign.org](http://www.healthdesign.org).

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