Project Summary

This project is a collaboration between The Center for Health Design and Georgia Institute of Technology and is funded by a grant from the Robert Wood Johnson Foundation. Together, they have created a series of resources to help healthcare decision makers become familiar with evidence-based design (EBD) and begin to implement it into their building projects.

Five studies are identified in this research series, and each demonstrates the wide-reaching and positive effects of evidence-based design. In addition, and perhaps more importantly, the series offers practical solutions, action steps and frameworks for implementation.

The white papers are a free resource available for download online. Visit http://healthdesign.org/hcleader/whitepapers.html.

Two on-demand webcasts and a podcast, each of which are based on select white papers are also accessible online. Visit http://healthdesign.org/hcleader/webcasts.html.

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Hospitals Leaders Positioned to Successfully Use Evidence-Based Design to Improve Outcomes for Patients and Staff, and the Bottom Line

New series from The Center for Health Design and Georgia Institute of Technology offers design and hospital leaders roadmap to implementation.

September 30, 2008 - A new research series from The Center for Health Design and Georgia Institute of Technology provides hospital, healthcare and design decision-makers with a comprehensive examination of evidence-based design and the positive, practical impact it has on patient outcomes, staff retention, quality and safety, work place culture, and a health system's bottom line.

The current “building boom” within the healthcare industry has been spurred by obvious needs to renovate old facilities and driven by demands of the aging population. For hospital and design leaders, this marks an exciting, unprecedented opportunity to build better hospitals and renovate existing ones to create healing environments that can produce measurable improvements. These key decision makers can now use the emerging science of evidence-based design to build better hospitals. Evidence-based healthcare designs are used to create environments that are therapeutic, supportive of family involvement, efficient for staff performance, and restorative for workers under stress.

The five studies in this new research series demonstrate the wide-reaching and positive effects of evidence-based design. In addition, and perhaps more importantly, the series offers practical solutions, action steps and frameworks for implementation. “Now hospital, healthcare and design leaders can find, in one place, the research, background and framework they need to implement evidence-based design in their facilities,” says Debra Levin, president and CEO of The Center for Health Design, the California-based non-profit research and advocacy organization that produced the research series, which was funded by the Robert Wood Johnson Foundation.

The series includes:

- **A Review of the Research Literature on Evidence-Based Healthcare Design.** Ulrich, Roger, Craig Zimring, et al. This updated and expanded version of a 2004 report features new and more extensive research of empirical studies linking hospital physical environments with healthcare outcomes. The study reviews the literature on three types of outcomes: patient safety issues, other patient outcomes, and staff outcomes.

- **The Business Case for Building Better Hospitals through Evidence-Based Design.** Sadler, Blair L., Jennifer DuBose, and Craig Zimring. This paper addresses the perceived economic barriers
to implementing evidence-based design and offers a powerful business case that implores intelligent evidence-based design decisions. Also included are specific design recommendations, a toolkit for action – 10 steps to implement evidence-based design, and a suggested return on investment framework to calculate specific evidence-based innovations.

- **Implementing Healthcare Excellence: The Vital Role of the CEO in Evidence-Based Design.** Zimring, Craig M., Godfried L. Augenbroe, Eileen B. Malone, and Blair L. Sadler. Based on a series of CEO interviews, this paper illustrates how successful CEOs have navigated the multi-year process of project development and use of evidence-based design to achieve cultural and care-process design transformation, to improve healthcare quality and safety. The paper identifies 10 CEO-based strategies for implementation.

- **Organizational Transformation: A Model for Joint Optimization of Culture Change and Evidence-Based Design.** Hamilton, Kirk D., Robin Diane Orr, and W. Ellen Raboin. The authors explain the interdependent relationship between facility design and organizational culture by identifying four possible triggers of transformative initiatives: changes in care delivery models; increases in patient capacity; improvements in patient safety; and implementation of hiring and retention strategies. Through stories and examples, the authors invite stewards of healthcare organizations to consider the possibilities afforded by joint optimization of facility design and the process of culture change.

- **Maximizing the Impact of Nursing Care Quality: A Closer Look at the Hospital Work Environment and the Nurse’s Impact on Patient-Care Quality.** Hendrich, Ann and Marilyn Chow. This article reviews the evidence relating to nursing work processes and their inseparability from physical space, infrastructure, and patient safety, and highlights potential solutions to promote transformational change to the nursing work environment.

Central to all reports is the key role hospital CEOs play in successfully implementing evidence-based design. “The CEO is the pivotal leader who makes the greatest difference in project success,” says report author Craig Zimring, Professor of Architecture at Georgia Institute of Technology. And that success is not limited to increased patient and staff safety and quality. Zimring continues, “rather than simply being regarded as cost centers, in evidence-based design, buildings are seen as strategic tools where calculated investments can yield important benefits.”

###

**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. Its 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.
The **Georgia Institute of Technology** is one of the nation's premier research universities. Ranked seventh among U.S. News & World Report’s top public universities, Georgia Tech’s more than 19,000 students are enrolled in its Colleges of Architecture, Computing, Engineering, Liberal Arts, Management and Sciences. Tech is among the nation's top producers of women and African-American engineers. The Institute offers research opportunities to both undergraduate and graduate students and is home to more than 100 interdisciplinary units plus the Georgia Tech Research Institute.

The **Robert Wood Johnson Foundation** focuses on the pressing health and healthcare issues facing our country. As the nation's largest philanthropy devoted exclusively to improving the health and healthcare of all Americans, the Foundation works with a diverse group of organizations and individuals to identify solutions and achieve comprehensive, meaningful and timely change. For more than 30 years, the Foundation has brought experience, commitment, and a rigorous, balanced approach to the problems that affect the health and healthcare of those it serves. By helping Americans lead healthier lives and get the care they need, the Foundation expects to make a difference in our lifetime.
About The White Papers

The Business Case for Building Better Hospitals Through Evidence-Based Design
Blair L. Sadler, JD, Jennifer R. DuBose, MS, Eileen B. Malone, RN, MSN, Craig M. Zimring, PhD

This paper is adapted from a full-length article, “The Business Case for Building Better Hospitals Through Evidence-Based Design” by Blair L. Sadler, Jennifer DuBose, and Craig Zimring, originally published in the spring 2008 issue of HERD (Health Environments Research and Design Journal), Vol. 1, No. 3. For more information about HERD, visit the Web site at www.herdjournal.com.

Building a new hospital or undertaking a major renovation is likely to be the biggest financial decision that a CEO or hospital board of trustees will ever make. There is a growing body of evidence that now links the physical environment with safety and quality outcomes for patients and staff. As part of their management and fiduciary responsibilities, hospital leaders and boards must base decisions about built-environment investments that include cost-effective evidence-based design (EBD) interventions in their strategic plan and investment portfolio or risk suffering the economic consequences in an increasingly competitive and transparent environment.

This paper provides an EBD toolkit for leaders to use when considering a major building project, as well as a proposed return-on-investment framework to evaluate the business case for each EBD feature included. These features, when combined with a transformation of the organization’s culture and processes, maximize the capital investment by quantifiably improving patient safety and quality, enhancing workforce recruitment and retention, and producing a significant multiyear return on investment.

Culture Change and Facility Design: A Model for Joint Optimization
D. Kirk Hamilton, FAIA, FACHA, Robin Diane Orr, MPH, W. Ellen Raboin, MBA, MSOD, MAHOS

This paper is adapted from a full-length article, “Organizational Transformation: A Model for Joint Optimization of Culture Change and Evidence-Based Design” by D. Kirk Hamilton, Robin Diane Orr, and W. Ellen Raboin, originally published in the spring 2008 issue of HERD (Health Environments Research and Design Journal), Vol. 1, No. 3. For more information about HERD, visit the Web site at www.herdjournal.com.

Successful stewardship of a healthcare organization is without a doubt challenging in a world full of change and where human environments forever need attention. In this context, stewards of the transformation process must be open to the innovations available when facility and culture-change agents engage in continuous conversation. They must also consider the possibilities afforded by joint optimization of facility design and the process of culture change.
This paper presents inspirational examples of the exponential value of proactively engaging multiple disciplines in creating safe and effective environments for care. More importantly, the stories address the benefits of productive dialogue between agents of culture change and those involved with facility design. And, ultimately, illustrate how evidence-based design now validates what many of us have intuitively known—that organizations will only thrive if they create a culture of engagement and dialogue.

**Implementing Healthcare Excellence: The Vital Role of the CEO in Evidence-Based Design**
Craig M. Zimring, PhD, Godfried L. Augenbroe, MSCE, Eileen B. Malone, RN, MSN, Blair L. Sadler, JD

This paper is adapted from a full-length article, “Implementing Healthcare Excellence: The Vital Role of the CEO in Evidence-Based Design” by Craig M. Zimring, Godfried L. Augenbroe, Eileen B. Malone, and Blair L. Sadler, originally published in the spring 2008 issue of HERD (Health Environments Research and Design Journal), Vol. 1, No. 3. For more information about HERD, visit the Web site at www.herd-journal.com.

There is growing evidence that chief executive officers (CEOs) can use research-validated evidence-based design (EBD) features as a tool to transform healthcare safety and quality. This paper explores how successful CEOs were able to navigate the multiyear process of project development. The utilization of EBD to create a building that supports cultural transformation and care redesign can reduce patient and staff harm and stress and still improve the bottom line. The CEOs of successful projects were the pivotal leaders who inspired their organizations to measure and confront unacceptable patient and staff outcomes, established strategies to meet improvement goals, and required disciplined reengineering of clinical and business processes—resulting in the achievement of the organizations’ desired end state.

This paper also identifies 10 strategies that reflect the systems thinking and leadership approaches shared by CEOs who bridged the gap between aspiration and reality. They used daily decision-making and team-shaping opportunities over the lifecycle of the building to create a genuinely healing environment.

**Maximizing the Impact of Nursing Care Quality: A Closer Look at the Hospital Work Environment and the Nurse’s Impact on Patient-Care Quality**
Ann Hendrich, MSN, RN, FAAN, Marilyn Chow, RN, DNS, FAAN

Nurses are the cornerstone of hospital care delivery and the hospital’s most costly and valuable resource; their efficiency and effectiveness are central to any effort to maximize patient safety or minimize costs. Studies suggest that elements of the current hospital work environment, including inefficient work processes and physical designs, gaps in technology infrastructure, and unsupportive
organizational cultures, contribute to inefficiencies and stress for hospital nurses, limiting the time they can spend in direct patient care. These same elements contribute to nurse burnout, which, in turn, hinders the recruitment and retention of nurses. Furthermore, reduced nurse-patient ratios have been linked to increased mortality, highlighting the fact that nurse staffing and efficiency are linchpins of patient safety. Innovations in hospital design and work processes have the potential to enhance the recruitment and retention of staff, increase the efficiency of care delivery, and improve the quality of clinical care and patient safety while avoiding reimbursement penalties.

This article reviews the evidence relating to nursing work processes and their inseparability from physical space, infrastructure, and patient safety and highlights potential solutions to promote transformational change to the nursing work environment.

A Review of the Research Literature on Evidence-Based Healthcare Design
Roger S. Ulrich, Craig Zimring, Xuemei Zhu, Jennifer DuBose, Hyun-Bo Seo, Young-Seon Choi, Xiaobo Quan, Anjali Joseph

This paper was originally published in the spring 2008 issue of HERD (Health Environments Research and Design Journal), Vol. 1, No. 3. For more information about HERD, visit the Web Site at www.herd-journal.com.

This review found a growing body of rigorous studies to guide healthcare design, especially with respect to reducing the frequency of hospital-acquired infections. Results are organized according to three general types of outcomes: patient safety, other patient outcomes, and staff outcomes. The findings further support the importance of improving outcomes for a range of design characteristics or interventions, including single-bed rooms rather than multibed rooms, effective ventilation systems, a good acoustic environment, nature distractions and daylight, appropriate lighting, better ergonomic design, acuity-adaptable rooms, and improved floor layouts and work settings. Directions for future research are also identified.
# About The Authors

<table>
<thead>
<tr>
<th>Author</th>
<th>Biography</th>
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</table>
| **Godfried L. Augenbroe, MSCE** | Godfried Augenbroe has a 25-year track record of research and teaching in computational building behavior, performance assessment, and management of building processes and project teams. He currently advises graduate students in the Doctoral Program in the College of Architecture at Georgia Tech. He has chaired several international conferences, is associate editor of two scientific journals, has delivered six keynotes at international conferences and has published several books and over one hundred refereed papers.  
*Implementing Healthcare Excellence: The Vital Role of the CEO in Evidence-Based Design* |
| **Young-Seon Choi, M.Arch** | Young-Seon Choi holds a master’s degree in Architecture and is a doctoral student in the College of Architecture at the Georgia Institute of Technology. Young-Seon Choi has been involved in research of healthcare environments for more than three years and has been involved in several healthcare research projects, including: design recommendations and evaluation studies of neurological intensive care units at Emory Hospital and the Medical College of Georgia; a nurse-stress work study at the Children’s Hospital of Atlanta at Egleston; a family presence study at the Tampa General Hospital granted by the American Institute of Architecture Health Foundation; and an extensive literature review paper, funded by a grant from the Robert Wood Johnson Foundation, in the relationship between hospital design and health outcomes.  
*A Review of the Research Literature on Evidence-Based Healthcare Design* |
| **Marilyn Chow, RN, DNS, FAAN** | Dr. Marilyn Chow is the Vice President, Patient Care Services, Program Office at Kaiser Permanente. She is responsible for providing national strategic clinical leadership for Program-wide nursing and related patient care services across the care continuum, including the strategic design and innovation of nursing and related patient care delivery systems, processes and models common across the organization. Dr. Chow is also the Program Director for the RWJ Executive Nurse Fellows Program. She serves on a number of national boards, including The Joint Commission At-Large Nursing Representative to the Board of Commissioners, and the Joint Commission Resources (JCR) Board.  
*Maximizing the Impact of Nursing Care Quality: A Closer Look at the Hospital Work Environment and the Nurse’s Impact on Patient-Care Quality* |
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*The Business Case for Building Better Hospitals through Evidence-Based Design  
A Review of the Research Literature on Evidence-Based Healthcare Design* |
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Kirk Hamilton is a Fellow of the Center for Health Systems & Design and Associate Professor of Architecture at Texas A&M University in College Station, TX, where his research area is the relationship of evidence-based design of health facilities and measurable organizational performance. He is also a Founding Principal of Emeritus, WHR Architects, Houston and Dallas, TX. WHR is an internationally recognized firm that specializes in healthcare architecture.

*Culture Change and Facility Design: A Model for Joint Optimization*

#### Ann Hendrich, MSN, RN, FAAN
Ann Hendrich is Vice President of Clinical Excellence Operations for Ascension Health in St. Louis, MO. In this role, she guides the implementation of clinical excellence initiatives in partnership with administrative and clinical leadership. She was of 15 national nurse executives selected for a three-year Robert Wood Johnson Executive Nurse Fellowship in 1998 and is also the former Senior Vice President, Senior Nurse Executive of Nursing Administration and Patient Care Services on the Methodist campus of Clarian Health in Indianapolis, IN.

*Maximizing the Impact of Nursing Care Quality: A Closer Look at the Hospital Work Environment and the Nurse’s Impact on Patient-Care Quality*

#### Anjali Joseph, Ph.D
Anjali Joseph is the Director of Research at The Center for Health Design, leading research activities at The Center. Her work focuses on understanding how the environment influences the health and well being of occupants. Dr. Joseph's areas of expertise include activity friendly environments, qualitative and quantitative research methods, and research applications in design. She obtained her Ph.D in Architecture from the Georgia Institute of Technology in Atlanta, Georgia, and her Master's degree in Architecture from Kansas State University.

*A Review of the Research Literature on Evidence-Based Healthcare Design*

#### Eileen B. Malone, RN, MSN
Eileen B. Malone is the Senior Partner for Mercury Healthcare Consulting, LLC located in Alexandria, Virginia. Ms. Malone retired from the United States Army at the rank of colonel having served as a hospital commander (CEO), the Chief Information Officer (CIO) for the Army Medical Department and in many other clinical, administrative and facility project leadership positions. Ms. Malone currently supports the Military Health System by consulting with planners, designers and organizational leaders in their efforts to use evidence based design features over the facility life cycle for a $6B portfolio to improve patient and staff outcomes, improve the bottom line and contribute to EBD research findings.

*Implementing Healthcare Excellence: The Vital Role of the CEO in Evidence-Based Design*

*The Business Case for Building Better Hospitals through Evidence-Based Design*

#### Robin Diane Orr, MPH
Robin Orr is President of a Santa Barbara, CA based consulting firm providing services to healthcare systems, providers, architects, designers and manufacturers. Ms. Orr has been a hospital administrator and continuing champion of consumer and patient rights. She was profiled in Hospitals and Health Networks magazine as one of the “top innovators and entrepreneurs” in the healthcare industry and by the Healthcare Forum Journal as “a maverick and revolutionary”. She was featured...
on the cover of Working Woman magazine for outstanding management and the first recipient of The Center for Health Design’s Change Maker Award given “for her leadership and dedication to creating life-enhancing environments in healthcare facilities across the United States”.

Culture Change and Facility Design: A Model for Joint Optimization

Hyun-Bo Seo, M.Arch

Hyun-Bo Seo is a Ph.D student in Architecture at the Georgia Institute of Technology where he also gained his professional Master of Architecture degree. His research explores the impact of hospital settings on people’s experience, performance, and hospital outcomes as well as the design implications of these relationships. He was involved in the design of Emory University’s 2D neurological ICU and is currently conducting a study there to measure how the design affected nurses’ time use and task performance. He also conducted unit evaluation studies of the 3W neurological ICU at the Medical College of Georgia to learn how the unit design supported patient-centered care and staff work environment.

A Review of the Research Literature on Evidence-Based Healthcare Design

Xiaobo Quan, Ph.D

Xiaobo Quan is a Research Associate for The Center for Health Design. His research examines the impact of the built environment on human behaviors and healthcare outcomes, evaluates the effects of evidence-based design innovations, and disseminates research findings through presentations and publications. Dr. Quan is also an experienced professional architect and is the recipient of design and multiple academic awards. He earned a Ph.D in architecture and a Certificate in Health Systems & Design from Texas A&M University. He holds a Masters in Architecture from Southeast University in Nanjing, China.

A Review of the Research Literature on Evidence-Based Healthcare Design

W. Ellen Raboin, MBA, MSOD, MAHOS

W. Ellen Raboin is a consultant and doctoral student in Human and Organization Systems. Ms. Raboin has 25 years of experience in process engineering, software implementation, and organizational change. Her current research explores cultural and contextual resources that enable change and collaborative practice in hospital units. Her work engages front line care providers in socially constructing a safe place to give and receive care.

Culture Change and Facility Design: A Model for Joint Optimization

Blair Sadler, JD

Blair L. Sadler is a Senior Fellow at the Institute for Healthcare Improvement, and a member of the faculty at the UCSD Schools of Medicine and Management. He served as President and CEO of Rady Children’s Hospital in San Diego from July 1980 until July 2006. Under his leadership, Rady Children’s was the first pediatric hospital in the United States to win the Ernest A. Codman Award for its work in developing clinical pathways. He gave the Commencement Address at the 2005 UCSD Medical School graduation on the healthcare quality revolution and the implications for hospitals and academic medical education. He speaks widely to healthcare Boards of Trustees about their new role in patient safety and quality.

The Business Case for Building Better Hospitals through Evidence-Based Design

Implementing Healthcare Excellence: The Vital Role of the CEO in Evidence-Based Design
Roger Ulrich, Ph.D
Roger Ulrich is Professor of Architecture at Texas A&M University and a Faculty Fellow of the Center for Health Systems and Design. A behavioral scientist, he conducts research on the effects of healthcare facilities on safety and other medical outcomes. Among other achievements, his research is the first to document scientifically the health-related benefits for patients of viewing nature. Dr. Ulrich is published widely in both scientific and design journals, and is the most frequently cited researcher internationally in evidence-based healthcare design. His work has influenced the architecture, interior design, and site planning of scores of major hospitals in different countries.

A Review of the Research Literature on Evidence-Based Healthcare Design

Craig Zimring, Ph.D
Craig Zimring is an Environmental Psychologist and Professor of Architecture at the Georgia Institute of Technology in Atlanta, GA. His work focuses on understanding the relationships between the physical environment and human satisfaction, health, performance, and behavior. He has served on the board of several organizations, including the Robert Wood Johnson Foundation’s Building Bridges program, National Research Council’s Board on Infrastructure and the Constructed Environment, the Environmental Design Research Association, and others. He has won 10 awards for his outstanding research.

The Business Case for Building Better Hospitals through Evidence-Based Design
Implementing Healthcare Excellence: The Vital Role of the CEO in Evidence-Based Design
A Review of the Research Literature on Evidence-Based Healthcare Design

Xuemei Zhu, Ph.D
Xuemei Zhu is an Assistant Professor in the College of Architecture at Texas A&M University and a Faculty Fellow of the Center for Health Systems and Design. Dr. Zhu conducts environment-behavior research in two areas: the impact of hospital physical environment on healthcare quality, and the influence of community environment on physically active lifestyles and health disparity. She is published in scholarly journals such as the American Journal of Preventive Medicine and Health Environments Research and Design Journal, as well as a book titled Transportation Research Trends. Dr. Zhu expects to continue and expand her research to improve human health and well being through evidence-based design, in various courtiers such as the United States, Canada, and China.

A Review of the Research Literature on Evidence-Based Healthcare Design
A Sample Business Spreadsheet: Reduce Hospital Acquired Infections

In order to evaluate the business case for incorporating evidence-based design features into a new construction or renovation project, a hospital should have a framework or process for determining which features will have the greatest impact on their operations.

In the example provided here, a return-on-investment (ROI) framework is offered that describes the business case issues that need to be considered when evaluating specific evidence-based design innovations that have the goal of reducing hospital-acquired infections (HAI).

This framework requires specific performance information to identify the scope of the problem and target improvement goals. This framework should work equally well for other types of evidence-based design innovations. This ROI framework contains four steps and requires filling in each table with your hospital’s data.

Use this framework and fill in the blanks with your own hospitals’ most recent base year data.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Number of Cases</th>
<th>Number Who Died</th>
<th>Mortality Rate</th>
<th>Average Length of Stay</th>
<th>Average Hospital Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No HAI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Calculate your hospital acquired infection rate: number of patients who developed a hospital acquired infection divided by the total number of admissions (cases) for the same period of time.
- Identify the average increased hospital charges for those with an infection.
- Calculate the number of patients with hospital acquired infections for which there will be no reimbursement such as, vascular catheter associated, catheter associated UTI, ventilator acquired pneumonia, and staff septicemia.
## Identification of Potential Cost Savings Associated with Reducing Hospital Acquired Infections

### Intervention Costs

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Initial cost</th>
<th>Life cycle cost</th>
<th>Calculations/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide 100% single patient rooms</td>
<td></td>
<td>Increased SF with associated housekeeping, energy, replacement furnishings costs</td>
<td>Single -patient rooms are now the standard for new hospital construction. However, these rooms are estimated to be ________SF larger resulting in an average increase of ________ SF for an average inpatient unit, which will increase associated life cycle operational costs.</td>
</tr>
<tr>
<td>Separate sink for staff in patient room</td>
<td></td>
<td>Increased operational plumbing maintenance costs</td>
<td>Separate staff sinks are now standard for new hospital construction. There will be marginal but increased life cycle operational costs.</td>
</tr>
<tr>
<td>Alcohol-based gel devices</td>
<td></td>
<td>Replacement and maintenance costs and gel refill costs</td>
<td>Initial cost = total number of devices per room X number of rooms</td>
</tr>
<tr>
<td>Clinical &amp; administrative interventions</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total Intervention Costs**

### Revenue Improvement through Cost Avoidance

<table>
<thead>
<tr>
<th>Outcome Target</th>
<th>Calculations</th>
<th>Cost Avoidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease HAIs by ________% or ________ case</td>
<td>Identify the total number of cases to be eliminated and multiply times the average increased cost for patients with an infection</td>
<td>Expressed in dollars</td>
</tr>
</tbody>
</table>

**Total Cost Avoidance**

- Identify the difference in hospital charges for patients with and without infection.
- Identify the patients for whom no reimbursement will be received for specified hospital acquired infections.
- Identify the hospital acquired infection reduction goal and identify the cost avoidance.

### Return on Investment Equation

<table>
<thead>
<tr>
<th>Variables</th>
<th>Initial, First Year</th>
<th>Two Year Life Cycle Point</th>
<th>Five Year Life Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cost Avoidance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Intervention Costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Savings</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Compare the total initial cost avoidance identified in #3 with the total initial cost of the planned interventions in #2 to identify the ultimate financial savings over interim points along the hospital’s life cycle. Your financial officer can help to calculate the projected, two year and five year life cycle costs adjusted for inflation.

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Priority Design Recommendations

The following design recommendations have been developed based on the strength of the evidence available and their impact on safety, quality, or cost (Table 1). These recommendations can be implemented in any facility at any time without significant modification to the facility and at relatively low cost.

<table>
<thead>
<tr>
<th>Design Intervention</th>
<th>Quality and Business Care Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Install handwashing dispensers at each bedside and in all high patient-volume areas.</td>
<td>Reduces infections</td>
</tr>
<tr>
<td>2 Where structurally feasible, install high-efficiency particulate air filters in areas housing immunosuppressed patients.</td>
<td>Reduces airborne-caused infections</td>
</tr>
<tr>
<td>3 Where feasible, install ceiling-mounted lifts.</td>
<td>Reduces staff back injuries</td>
</tr>
<tr>
<td>4 Conduct a noise audit and implement a noise-reduction plan.</td>
<td>Reduces patient and staff stress, reduces patient sleep deprivation, increases patient satisfaction</td>
</tr>
<tr>
<td>5 Install high-performance sound-absorbing ceiling tiles.</td>
<td>Reduces patient and staff stress, reduces patient sleep deprivation, increases patient satisfaction</td>
</tr>
<tr>
<td>6 Use music as a positive distraction during procedures.</td>
<td>Reduces patient stress, reduces patient pain and medication use</td>
</tr>
<tr>
<td>7 Use artwork and virtual-reality images to provide positive distractions.</td>
<td>Reduces patient and staff stress, reduces patient pain and medication use</td>
</tr>
<tr>
<td>8 Improve wayfinding through enhanced signage.</td>
<td>Reduces staff time spent giving directions, reduces patient and family stress</td>
</tr>
</tbody>
</table>
Priority Design Recommendations

Other strategies require greater financial investment and significant physical modifications and are best incorporated as part of a major renovation or a new construction project (Table 2). Healthcare leaders should seriously consider including these cost-effective design strategies as part of their quality-improvement efforts.

<table>
<thead>
<tr>
<th>Table 2: DESIGN INTERVENTIONS AS PART OF CONSTRUCTION OR MAJOR RENOVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design Intervention</strong></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
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<tr>
<td>3</td>
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<td>13</td>
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