Aligning Evidence-Based Design & Evidence-Based Medicine
to Design a More Efficient and Higher Quality Patient-Centered Healthcare Delivery Model

A Panel Discussion presentation by Byron Edwards, AIA, ACHA, EDAC, LEED AP
Professor of Practice – Architecture + Health Graduate Studies
Clemson University, Clemson, SC
Evidence-based medicine (EBM) can be defined as the formal practice of making decisions regarding the best treatment of patients based on the systematic and detailed approach of current best research evidence. EBM is of paramount importance in the provision of the best health care policy.

Professor Archibald Cochrane was a pioneer in this area and can be considered the father of EBM in our era. His passionate call to require collection and analysis of systematic reviews led to the creation of The Cochrane Collaboration 5 years after his death.
Professor Archibald Cochrane (1909–1988) is considered to be the originator of the idea of evidence-based medicine in our era. With his landmark book ‘Effectiveness and Efficiency: Random Reflections on Health services’ he managed to inspire and positively influence the medical society with respect to the proper assessment of reliable evidence for the provision of the best medical care. His vision combined with his scientific achievements can be considered as the foundation of the Cochrane Collaboration; named after him in recognition of and gratitude for his pioneering work. We present the highlights of his adventurous and vibrant personal and academic life in an attempt to honor his contribution to shaping modern medical research.

“\textbf{The Father of Evidence-Based Medicine}”

\url{http://icvts.oxfordjournals.org/content/early/2013/10/17/icvts.ivt451.full}
Evidence-Based Design (EBD) is the process of basing decisions about the built environment on credible research to achieve the best possible outcomes. Included in this process are the following eight steps:

1. Define evidence-based goals and objectives.
2. Find sources for relevant evidence.
3. Critically interpret relevant evidence.
4. Create and innovate evidence-based design concepts.
5. Develop a hypothesis.
6. Collect baseline performance measures.
7. Monitor implementation of design and construction.
History of EBD

1972
Evidence-based design is structured in part along the lines of the evidence-based movement, which began with Professor Archie Cochrane’s book "Effectiveness and Efficiency: Random Reflections on Health Services".

1978
An event that has been critical for the development of evidence-based design (EBD) was the start of the patient-centered care movement which began in the U.S. with the establishment of the nonprofit organization, "Planetree".

1984
Dr. Roger Ulrich publishes a pioneering study linking views of nature to patient outcomes.

1993
The Center for Health and Health Care in the Built Environment (CHD) is founded in 1993 to initiate and fund research and to serve as a consortium for knowledge in many different fields that contribute to the creating healing environments that improve outcomes for patients and staff. CHD’s mission is to transform healthcare environments for a healthier, safer world through design research, education, and advocacy.

1999
Institute of Medicine produces a landmark report on U.S. healthcare quality and safety. To Err is Human: Building a Safer Health System, lays out a comprehensive strategy by which government, health care providers, industry, and consumers can reduce preventable medical errors.

2001
Institute of Medicine publishes The Quality Chasm: its second landmark report on U.S. healthcare quality. It offers a set of performance expectations for the 21st century health care system, a set of 10 new rules to guide patient-clinician relationships, a suggested organizing framework to better align incentives inherent in payment and accountability with improvement in quality, and key steps to promote evidence-based practice and strengthen clinical information systems.

2003
Joint Commission on Accreditation of Healthcare Organizations (JCAHO) approves revised standards for the prevention and control of health care-associated infections. The JCAHO 2005 Infection Control Standards address the areas of ambulatory care, behavioral healthcare, home care, hospital laboratory and long-term care organizations. The revised standards are designed to raise awareness that healthcare associated infections are a national concern that can be acquired within any care, treatment or service setting. Therefore, prevention represents one of the major safety initiatives that a health care organization can undertake.

2005
"The Business Case for Better Buildings" first appears in Frontiers of Health Services Management, Vol. 21, No. 1, Fall 2004, by Roger Ulrich and Craig Zimring. To illustrate the case, the researchers created Fabio Hospital, which was a composite of recently built or redesigned healthcare facilities that have implemented facets of evidence-based design in their facilities.

2005
The Robert Wood Johnson Foundation endows CHD to define a standardized evidence-based design process and create the EDAC program.

2007
CHD and Vendome Group launch the Health Environments Research & Design Journal, a peer-reviewed journal, further legitimizing the growing field of EBD.

2008
The launch of CHD’s Evidence-based Design Accreditation and Certification (EDAC) program is the first attempt to standardize the practice and process of EBD, and qualify an individual’s knowledge of that process.

2008
CHD publishes "Review of the Research Literature on Evidence-Based Healthcare Design" by Ulrich, et. al. The complete paper was originally published in the spring 2008 issue of HERD (Health Environments Research and Design Journal, Vol. 1, No. 3).

2012
1000 individuals EDAC Certified
In 1984, Roger S. Ulrich launched a thousand think pieces, papers, and research projects with the publication of his seminal work on evidence-based design (EBD), “View Through a Window May Influence Recovery from Surgery.” Thirty years later, he’s still the most widely cited researcher in the field. Ulrich left the U.S. four years ago and now lives in Sweden, where he continues his research endeavors and serves as guest professor of architecture for the Centre for Healthcare Architecture at Chalmers University of Technology. As the Center for Health Design bestows its Changemaker Award upon Ulrich at this year’s Healthcare Design Expo & Conference, Healthcare Design spoke with him about the evolution of EBD and what excites him about its future.

http://www.healthcaredesignmagazine.com/article/seeds-change-interview-roger-ulrich
**EBD/EBM Similarities:**

Making decisions based on the best available evidence
Complexity of decisions (how each human function/ modality effects the other- like architecture)
Focused on improved outcomes

**Differences:**

Architecture creates conditions - these conditions rarely change as drastically as the people and processes staged on them do. EBM can evolve, EBD once put in place has to be in place for many years to come. In EBM, the patient health condition is the direct outcome. In EBD, the patient health condition is the indirect outcome

**Alignment:**

A person, their lifestyle, and their environment all contribute to health and wellbeing. Keeping EBM and EBD goals aligned may help us move to a more nimble, personalized medicine world that is where our health system is moving today.
The growth of evidence-based design. The Center for Health Design's definition of evidence-based design is “the process of basing decisions about the built environment on credible research to achieve the best possible outcomes.” That evidence is much more abundant.

In 1998, a review found fewer than 100 solid studies. A 2004 analysis found more than 600 worthy studies. In 2008, a team found 1,200 methodologically sound studies.

Facility design guided by credible research has become the standard for architects and designers, as witnessed by conferences focused on evidence-based design and the appearance of new publications.

More than 1000 healthcare and design professionals have been accredited by The Center's Evidence-Based Design Accreditation and Certification (EDAC) program, which was launched in 2009.

Although the growth of evidence-based design has provided considerable guidance, other evidence comes from management, finance, computer science, human resources, ergonomics, supply chain distribution, and conservation – e.g. Same-handedness from Airplane Cockpits and Nuclear Reactor Controls.
• Research – Informed Design versus Evidence –Based Design?

**Note:** Is this simply the difference in Right Brained versus Left Brained perspectives?

“The Evidence is about a mile wide and an inch thick at the moment, and not very useful or compelling yet, but the intuitive design and planning responses to that limited research seem to have merit.”

“Although we (AAH/AAHF/CHD/etc) are working to improve this, EBD suffers from having a limited body of research to work with and is difficult to find and use by practitioners.”

“‘Aligning’ EBM and EBD may have some interesting results—I suspect that many EBM studies have connections to design of health facilities that we have not uncovered yet, but hopefully continued support of Research and the Knowledge Repository will succeed in making such connections.”
Knowledge Repository

The Knowledge Repository, a centerpiece for all healthcare design research, papers, articles and references, allowing users to search publications by types of publications, terms, design category, outcome category, environmental condition category or setting, and provides the number of references available for each defined category. Users can also conduct searches by entering a key word in the search box. The results appear with the most recent references at the top of the page.

Easy-to-use key point summaries for select references are available and allow users the ability to easily and quickly review important concepts found in each of these articles, such as findings and design implications. Additional key point summaries provided by Research Design Connections will continue to be added.

Designed as a living library, this repository provides a one-stop, complete source of healthcare EBD research, and as such will continue to grow and develop as healthcare design evolves. For researchers, it increases the visibility, usage and impact of their work. For users, it provides a complete source of healthcare design research. If you would like to participate in the development of this resource, contact us at admin@healthdesign.org.

https://www.healthdesign.org/search/articles
Fable Hospital 2.0: The Business Case for Building Better Health Care Facilities

BY BLAIR L. SADLER, LEONARD L. BERRY, ROBIN QUINTHEY, D. KIRK HAMILTON, FREDDICK A. HESSLER, CLAYTON PERRITT, AND DEREK PARKER

Despite deep and vocal disagreements over health care reform, virtually everyone believes that the current system is not economically sustainable. We are spending too much and getting too little in return. This article has explored health care leaders to examine every aspect of hospital operations. But how does health care building itself: the physical environment within which patient care occurs? Too often, cost-cutting decisions have overlooked the hospital structure. Changes in the physical facility provide real opportunities for improving patient and worker safety and quality while reducing operating costs.

The “Fable hospital,” an imaginary analog of the best design innovations that have been implemented and measured by leading organizations, was an early attempt to analyze the economic impact of designing and building an optimal hospital facility. The Fable analysis, published in 2006, showed that carefully selected design innovations, though they cost more initially, could return the incremental investment in one year by reducing operating costs and increasing revenue. Reaction to the Fable hypothesis was swift, compelling, and unusual. Health care leaders and architects to think differently about balancing cost and revenue building costs with ongoing operating costs. Evidence of success at this level would be a great asset described and asked for more evidence.

Today, the Fable hospital is no longer a fantasy. During the past three years, numerous hospitals have implemented many of its attributes and have realized their impact on patient, family, and staff. Several members of the Center for Health Design’s Fable Project, a group of organizations that apply evidence-based design to improve quality and financial performance. Two Fable hospitals are featured in many surrounding this article. These and other pioneering organizations and their architectural/design teams are achieving such interventions at lower single-patient rooms, which reduce the incidence of health care-associated infections: wider bathroom doors, which reduce patient falls; 110% filtration for inpatient rooms and other single-patient rooms, which reduce health care-associated infections: appropriate task lighting in medication dispensing areas, which reduces medication-related errors; hygienic ceiling lifts in patient rooms and bathrooms, which reduce patient and staff falls; improved air and water quality, which reduce anxiety and depression and speed recovery.

Since 2006, much has changed that affects decision-making about hospital care design and construction. It is true for a future look at the Fable hospital. Drawing on the latest design and health care knowledge, research, the 2010 health reform law's emphasis on value and quality improvement, and our collective experience, we present Fable hospital 2.0.

Good Health Care by Design

The Changing Health Care Landscape

For major health care trends relevant to our analysis: the growth of evidence-based design, the safety/quality revolution, pay for performance and increasing consumer transparency, sustainability and green design, and access to capital.

January/February 2011

© 2011 The Hastings Center. Permission is required for reproduction.
### Table 1: Costs of Evidence-Based Design Innovations

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Additional Construction Costs</th>
<th>Design Details and Cost Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larger Single-Patient Rooms</td>
<td>$13,000,000</td>
<td>Increase additional 200 single-patient rooms by 100 sq ft. 110 sq ft. x $100/bt = $13,000,000</td>
</tr>
<tr>
<td>Acute-Lung Failure Rooms</td>
<td>$200,000</td>
<td>Additional reversers and monitor rooms to provide ICU-type level, continuous care, for all 45 single-patient rooms. All rooms are converted to ICU capacity, 5 rooms at $15,000/room.</td>
</tr>
<tr>
<td>Larger Windows</td>
<td>$25,000</td>
<td>Increase 10% more window to room area size at 3 sq ft. 45 sq ft. x 0.600 = 27,000,000</td>
</tr>
<tr>
<td>Larger Patient Bathrooms with Bade-Shower Access</td>
<td>$2,500,000</td>
<td>An increase of 32 sq ft. in 6 rooms at 0.500 = 1,600,000.</td>
</tr>
<tr>
<td>Ceiling-Mounted Patient Lifts</td>
<td>$210,000</td>
<td>Patient lift equipment, track access to main rooms, including corridors, for all ICU and step-down rooms, as well as general nursing units. 3 rooms at $45,000/room.</td>
</tr>
<tr>
<td>Enhanced Interior Air Quality</td>
<td>$110,000</td>
<td>Improved ventilation, air filters, and increased or changed air source for all handling units serving patient care areas. 36 at $3,000/room.</td>
</tr>
<tr>
<td>Decontaminated Nursing Substations (Micros)</td>
<td>$82,815</td>
<td>Air locks with wire mesh of patients for 230 non-ICU rooms. Includes air locks, partitions, and access to every patient's room to reduce cross-contamination. 230 rooms at $355/room.</td>
</tr>
<tr>
<td>Hand-Hygienic Facilities</td>
<td>$38,872</td>
<td>Hand washing sinks in all 200 patient rooms. Automated sink and hand wash dispenser at each bedside in both 176 nursing substation. 200 sinks at $700 each. 400 alcohol hand wash dispenser at $355/room.</td>
</tr>
<tr>
<td>Medication Area Task Lighting</td>
<td>$100,000</td>
<td>Increased lighting controls and lighting levels for all medication dispensing and staff work areas.</td>
</tr>
<tr>
<td>Noise Reducing Measures</td>
<td>$93,500</td>
<td>Sound-absorbing materials, high-performance acoustical ceiling tiles, and carpet with acoustical properties in all patient care areas. Sound-absorbing wall materials with an outer layer of vinyl, and acoustical panels with improved noise reduction in all 200 patient rooms.</td>
</tr>
<tr>
<td>Energy Demand Reduction</td>
<td>$225,000</td>
<td>Reduce energy demand by 10% below baseline building performance, accomplished by enhanced building commissioning.</td>
</tr>
<tr>
<td>Water Demand Reduction</td>
<td>$250,000</td>
<td>Increase water usage by 30% with high-efficiency fixtures and by using rechargeable water for irrigation. 150 rooms at $400/room = 60,000.</td>
</tr>
<tr>
<td>e-ICU Comprehensive Respiratory ICU Monitoring Capability</td>
<td>$1,500,000</td>
<td>e-ICU infrastructure and equipment for each of the 15% patient rooms in ICU and step-down unit. 15 rooms at $100,000/room.</td>
</tr>
</tbody>
</table>

### Table 2: Costs of Experience-Based Innovations: Supported by Experience but Warranting Further Study

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Additional Construction Cost</th>
<th>Design Details and Cost Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family/Social Spaces</td>
<td>$1,000,000</td>
<td>Space at each nursing unit to accommodate family and visitor and access to each unit in the healing process. Includes family rooms, kitchen, dining, communication and business rooms, and sleeping rooms.</td>
</tr>
<tr>
<td>Imprompt U &quot;Way-Finding&quot;</td>
<td>$500,000</td>
<td>Enhanced navigation aids include overhead signs, different colored pathways and lighting, information kiosks, etc. Includes chat rooms, interactive directories, and other services.</td>
</tr>
<tr>
<td>Health Information Resource Center</td>
<td>$500,000</td>
<td>An area with internet accessible health information. 100 rooms at $300/room.</td>
</tr>
<tr>
<td>Staff Area</td>
<td>$200,000</td>
<td>Private space for family and staff (separate) located on each nursing unit. 100 rooms at $2,000/room.</td>
</tr>
<tr>
<td>Decontaminated Nursing Logistics</td>
<td>$650,000</td>
<td>Additional space for such nursing unit and label, linens, supplies, communication, and other equipment.</td>
</tr>
<tr>
<td>Environmentally Responsible Materials</td>
<td>$100,000</td>
<td>Local, regional, and recycled materials with little or no toxic content, &quot;green&quot; cleaning maintenance protocols.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Construction Cost Premium for Experience-Based Innovations</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL Construction Cost Premium for Experience-Based Innovations</td>
<td>$2,246,275</td>
</tr>
<tr>
<td>Percentage of Construction Cost</td>
<td>0.87%</td>
</tr>
</tbody>
</table>

Note: All costs are estimated based on Turner Construction's experience and may vary.
### Table 3. Improved Outcomes and Cost Savings

<table>
<thead>
<tr>
<th>Improved Outcomes</th>
<th>Savings of Antimicrobial Resistance</th>
<th>Calculations</th>
<th>Design Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient Falls Reduced</strong></td>
<td>$1,534,386</td>
<td>300 beds @ 80% occupancy = 240 beds @ 87.8% patient-days/bed; three falls/year/1,000 patient-days = $15,950 x 30 beds = $482,050 per year.</td>
<td></td>
</tr>
<tr>
<td><strong>Device-Related Revisions</strong></td>
<td>$717,500</td>
<td>25% of 15,000 patient days are on the ICU’s floor/unit. Assuming one transfer per patient day, 4.61 transfers x $338,000 (ICU cost) = $1,652,483 for transfers each year.</td>
<td></td>
</tr>
<tr>
<td><strong>Adverse Drug Events Reduced</strong></td>
<td>$811,040</td>
<td>0.5 adverse drug events/100 patient days/year x 700 event/year x assuming 50% are avoidable, $26,370,000 x 0.5 = $13,185,000 for preventable adverse drug events/year.</td>
<td></td>
</tr>
<tr>
<td><strong>Health Care-Associated Infections Reduced</strong></td>
<td>$50,400</td>
<td>Ten health care-associated infections (HAI) at 1,000 patient days x $40,000 = $40,000.</td>
<td></td>
</tr>
<tr>
<td><strong>Length of Stay Reduced</strong></td>
<td>$1,099,375</td>
<td>$9,000 patient days/5 days average length of stay = 18.2 patient days. One study showed a reduced length of stay of one day as a result of increased access to care.</td>
<td></td>
</tr>
<tr>
<td><strong>Nursing Time Saved</strong></td>
<td>$179,500</td>
<td>At 1.55 configuration per bed, 3,100 direct-care employees, 2,350 of whom are nurses, 14% of nurses turned from 15% to 10% with 16 nurse times/1,000 nursing time/year.</td>
<td></td>
</tr>
</tbody>
</table>

**Total Annual Savings**: $10,082,162

$25,269,275 total savings/costs $15,087,113. Annual savings: a return on investment within three years.

Blair L. Sadler, JD, is a senior fellow at the Institute for Healthcare Improvement.

Leonard L. Berry, PhD, is a distinguished professor of marketing, MB Zale Chair in retailing and marketing leadership, and professor of humanities in medicine at the Mays Business School at Texas A&M University.

Robin Geunther, FAIA, LEED AP, EDAC, is a principal at Perkins+Will.

D. Kirk Hamilton, FAIA, FACHA, EDAC, is an associate professor of architecture, Texas A&M University, and founding principal of WHR Architects.

Frederic Hessler is the managing director, healthcare group, at Citigroup.

Clayton Merritt, M. Arch, has a certificate in health systems and design from Texas A&M University and is vice president of Traton Engineering Associates and president of Caliche Creek Investments.

Derek Parker, FAIA, RIBA, FACHA, EDAC, is the director emeritus at Anshen+Allen Architects.

To read the Fable 2.0 article in full, please visit www.thehastingscenter.org
• **Pebble Project ®**

• The Pebble Project is a unique and dynamic collaborative, where forward thinking healthcare organizations, architects, designers and industry partners work together to identify built environment designs and solutions that measurably improve patient and worker safety, clinical outcomes, environmental performance and operating efficiency.

• **Become a part of the growing Pebble community and enhance the quality of your project, creating a more efficient and effective healing environment. The purpose of the work is to:**

  • create a ripple effect in the healthcare community
  • increase the body of knowledge that ripples through the healthcare community
  • motivate other organizations and inspire change

• **38 Hospitals currently on website**

  https://www.healthdesign.org/pebble/facilities

  [Dublin Methodist Hospital – Dublin, Ohio]
Palomar Medical Center (PMC) is the 28th Pebble Project, a joint research effort between the Center for Health Design (CHD) and selected health-care providers. Pebble Projects are CHD's main research initiative. Their goal is to improve health-care facilities using evidence-based design to maximize patient care, environmental performance, and operational efficiency.

So successful is PMC that CHD has acknowledged it as the first Fable Hospital (an ideal health-care facility) for incorporating a majority of evidence-based design findings into its program.
5 TRENDS IN HOSPITAL DESIGN

Healing Environments

Patient Safety

Family Involvement

Care Team Evolution

Integrated Services
Healing Environments

Rest = Recovery

- Daylight
- Views of Natural World
- Noise control
- Companionship
- Minimal interventions
- Environmental control
Patient & Staff Safety

No Complications

- Prevention of hospital acquired infection
- Patient fall prevention
- Transport injury prevention
- Medical error prevention
- Staff injury prevention
Family Involvement

Post Care Preparations

- Present in the care environment
- Involved in the care
- Educated by the care-givers
- Practiced in care-giving
- Prepared for home care-giving
Care Team Evolution

Continuity of Care

- Maximize time with patient & family
- Multi-disciplinary care planning
- Distributed services
- Connectivity - electronically
Integrated Services

Team-Based Future

- Multi-disciplinary collaboration
- Consolidation of patient care programs
- Long term flexibility
- Adapt to future clinical / technological / operational best practices
Acuity Adaptable Patient Unit

Potential Benefits:
The full realization of the Acuity Adaptable Unit should minimize or possibly eliminate the need to transfer patients to other units/rooms during their hospital stay.

This in turn would potentially:
• Provide better continuity of care and care teams
• Reduce medical errors
• Improve patient and staff satisfaction
• Improve operational efficiencies
Same-handedness Patient Rooms