

Danish Regions conference on new hospital construction

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Evidence-based design in hospital construction

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Evidence-based design (EBD)

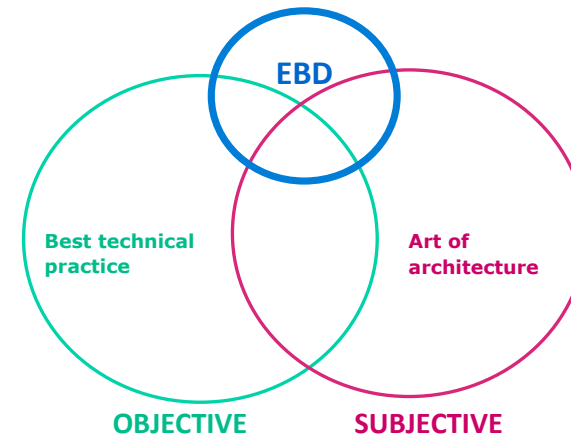
Evidence-based design (EBD) is a **process** for the explicit use of current best evidence from research and practice in making decisions, together with an informed client, about the design of each individual project.

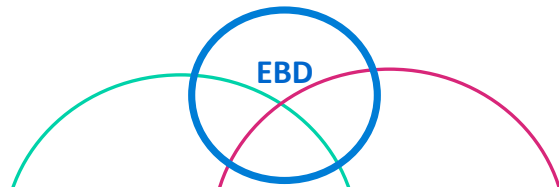
Hamilton & Watkins (2009). *Evidence-Based Design for Multiple Building Types*. New York: Wiley

Evidence-based design (EBD) research

More than 2,500 strong studies link the hospital physical environment to outcomes in following major areas:

- **Patient safety** (infection, falls, errors)
- **Other patient outcomes** (such as pain, length of stay)
- **Staff outcomes** (work satisfaction, retention, effectiveness)
- **Costs of healthcare**





Amount of EBD knowledge is fairly small. But it carries weight with decision-makers and medical professionals because most of the knowledge relates to priority issues such as safety, and can be linked to cost savings.

OBJECTIVE

SUBJECTIVE

EBD research example:

Effects of **noise** on outcomes and costs

Hospital noise levels are far higher than recommended values

- Noise sources are too numerous and too loud
- Surfaces are sound reflecting

There is growing evidence that noise worsens patient and staff outcomes

Noise worsens outcomes

- Reduces oxygen saturation in infants
- Elevates blood pressure, respiration
- Worsens patient sleep
- Erodes emotional well-being
- Increases staff work pressure, strain, fatigue, burnout
- Worsens speech comprehension

Design to reduce **noise** can improve several outcomes and reduce costs

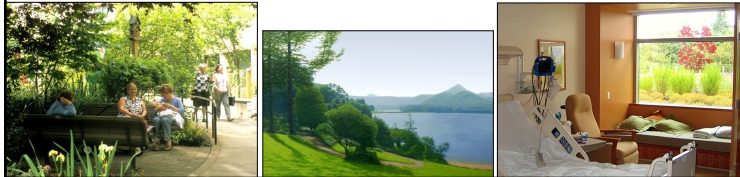


Installing high-performance sound-absorbing ceiling tile **reduced physiological stress** in myocardial infarction patients, **improved sleep**, and **reduced re-hospitalizations** (Hagerman et al., 2005).

Research summary:

Effects of NATURE in health facilities

- Nature reduces stress
- Reduces pain
- Lessens anger/aggression
- Increases satisfaction



Effects of nature window view on recovery outcomes following surgery (Ulrich, 1984)

- Less pain
- Fewer minor complications
- Shorter stays

Analgesic Strength	Number of Pain Drug Doses (days 2-5 after surgery)	
	NATURE patients	WALL patients
Strong	0.96	2.48
Moderate	1.74	3.65
Weak	5.39	2.57

Providing access to daylight improves patient and staff outcomes

Exposure to natural light/sunlight:

- Lowers depression (improves emotional well-being)
- Reduces pain
- Increases staff satisfaction. May help foster alertness.

Speaking of windows:

The importance of protecting patient privacy is increasing.

- Health authorities in different countries have increased design requirements to ensure privacy.
- Requirements have expanded to prevent visual intrusions by persons looking into patients' windows from nearby spaces.

Spacing between buildings affects patient **privacy, daylight, and nature** exposure



- Spacing between buildings: 15 meters
- Can persons look into a patient's window from another building?
- How much daylight will actually reach patient spaces on lower floors?

Building spacing and patient **privacy**

- If spacing between buildings becomes narrow, patient **privacy** is violated if strangers can look in their windows from nearby buildings.
- Patients who feel their privacy can be invaded by persons looking into their windows **close their blinds**, losing daylight and view.
(Sherman, Varni, Ulrich & Malcarne, 2005)
- (My opinion): architecture that violates patient privacy cannot be considered green or sustainable.



Suggestion to help ensure patient privacy in new buildings

- Clients require the design team to provide a computer rendering or visualization that accurately shows the view into a patient room from a nearby window or outside space.

The single most important EBD recommendation for improving patient safety and other outcomes:

Provide single-bed rooms

Single-bed vs. multi-bed patient rooms (Ulrich, 2004, 2014)

	Single	Multi-bed
Healthcare associated infections	✓	
Medical errors	✓	
Falls	✓	mixed ✓
Staff observation of patients	✓	mixed
Staff/patient communication	✓	
Confidentiality of information	✓	
Presence of family	✓	
Patient privacy and dignity	✓	
Avoid mixed-sex accommodation	✓	
End-of-life with dignity	✓	
Low noise	✓	
Sleep quality	✓	

Single-bed vs. multi-bed patient rooms (Ulrich, 2004, 2014)

	Single	Multi-bed
Pain	✓	
Patient stress	✓	
Daylight exposure	✓	
Patient satisfaction	✓	
Patient choice of hospital	✓	
Staff satisfaction	✓	
Staff work effectiveness	✓	
Reducing room transfers	✓	
Adapt to handle high acuity	✓	
Managing bed availability	✓	
Initial construction costs		✓
Operations and whole life costs	✓	

Single rooms improve staff-patient communication, support family presence and privacy



St. Gemma Hospice, UK
Design: Jane Darbyshire & David Kendall

(Kaldenburg, 1999; Chaudhury et al., 2003)



A three-bed room in a nordic children's hospital. There is tight space for parent of one child to stay overnight. No space for parents of other two patients to stay overnight. Privacy curtain blocks daylight and view for foreground patient. Acoustic privacy is non-existent. Staff communication with patients and family is seriously hampered.

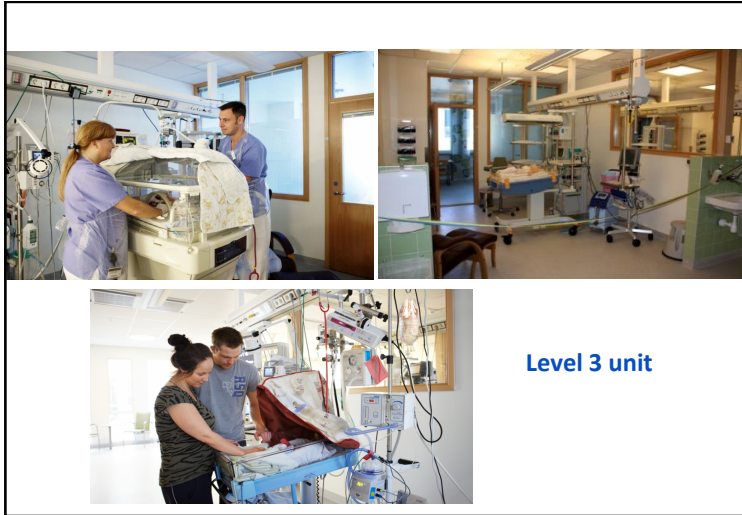
Single rooms make possible new care processes/operations that can improve clinical outcomes and reduce costs.


- **Implication:** a healthcare project should begin by rethinking care processes.

Example: Karolinska neonatal intensive care

Prior to renovating NICU to provide family-centered single rooms, the care model at Karolinska (Huddinge) emphasized family-centered care with early skin-to-skin contact and bonding.

- But infants were in multi-incubator rooms with very little space for family (built in 1970s).
- Mothers (C-sections) were assigned patient room in another unit. Afterward family stayed in hotel.




Karolinska Institutet

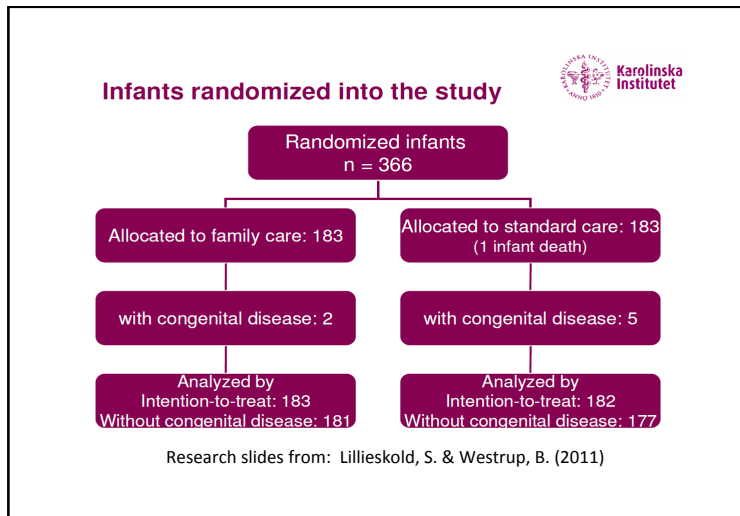
The Stockholm Neonatal Family Centered Care Study:


effects on length of stay and infant morbidity

A Örténstrand, B Westrup, E Berggren Broström, I Sarman, S Åkerström, T Brune, L Lindberg, U Waldenström

Karolinska Institute, Stockholm Sweden

Pediatrics Jan. 2010;125: e278–e285




Karolinska Institutet

Length of stay in *intensive care* (level II and level III)

Adjusted for: gestational age at birth^A, non-Swedish-speaking background^{A,B}, setting^{A,B}

	Family care n = 183	Standard care n = 182	difference days
All infants ^A , mean	13.3	18.0	-4.7 d (p= .02)
<i>By gestational age ^B</i>			
24 – 29 w, mean	32.4	43.1	-10.6 d (p= .04)
30 – 34 w, mean	6.0	8.5	-2.5 d (p= .02)
35 – 36 w, mean	1.5	2.5	-1.0 d (p= .24)

Research slides from: Lillieskold, S. & Westrup, B. (2011)

Infant morbidity

Adjusted for: gestational age at birth, non-Swedish-speaking background, setting

	Family care n = 183	Standard care n = 182	OR (95% CI) ^A
Verified Sepsis, %	7.1	9.8	0.68 (0.3-1.6)
Verified NEC, %	2.7	3.3	0.83 (0.2-2.8)
Diagnosed. PDA, %	15.3	16.9	0.90 (0.4-1.9)
IVH grade II-III, %	3.3	3.8	0.95 (0.3-3.2)
ROP stage II-V, %	2.7	6.6	0.34 (0.1-1.1)
BPD moderate-severe, %	1.6	6.0	0.18 (0.04-0.8)

Infections (all categories) reduced 75%-80%

Do cost savings from better outcomes in single NICU rooms outweigh the higher construction and annual operating costs?

(source: Shepley et al., 2014, *Journal of Perinatology*)

- Savings estimates based on outcome improvements at Karolinska Hospital (Ortenstrand et al., 2010) and a U.S. children's hospital (Stevens et al., 2012).
- Even conservative analysis shows that the added cost of single rooms is repaid within one year, with substantial savings each year thereafter.

Growing and serious challenge for hospitals in all countries:

Multi-drug resistant infections

The **post-antibiotic era** is here

There are strong reasons for expecting risk from resistant infections will increase in Denmark and other "safe" countries

- Hospital inpatients are getting sicker, more vulnerable and immune-compromised.
- New resistant infections appear in other countries. Danish citizens travel abroad a lot and bring back serious infections.

But many hospitals are older, designed before resistant infections became problem. These have few single rooms with private toilets.

Study: Converting a critical care unit to single rooms reduces infection

(Teltsch et al. 2011, *Archives of Internal Medicine*)

- **Study site:** 25-bed critical care unit before and after renovation to 100% single rooms
- **Main findings:**
 - ♦ *C. difficile* decreased 43%
 - ♦ MRSA decreased 47%
 - ♦ Overall average length of stay decreased 10% (all patients in intensive care)

Do cost savings from reduction of infections justify the higher costs of single-bed rooms in intensive care units for adults?

(source: Sadatsafavi et al., 2016, *Journal of Critical Care*)

- Study compared return on investment of converting ICUs from multi-bed to single rooms in varied scenarios (varying construction costs, infection risks, length of patient stay, etc.)
- Conclusion: in all scenarios single rooms yielded substantial cost savings, repaying added costs of construction.

More patients have infection risk factors and require single rooms when admitted to hospital

- Suppressed immune function
- History of infection
- Respiratory infection symptoms, possible influenza
- Previously hospitalized
- Diarrhea
- Recent foreign travel
- Admitted from long-term care facility

Hypothetical scenario

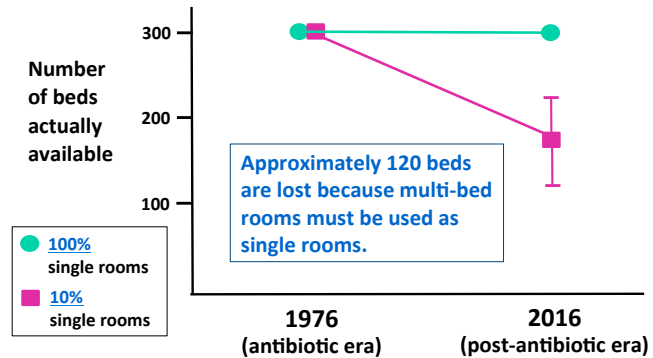
Estimating number of hospital beds actually available in two American 300-bed hospitals

- **Hospital A**
 - ♦ 300 beds: 100% 1-bed rooms
- **Hospital B (built in 1965-75)**
 - ♦ 300 beds: 10% 1-bed rooms (30 beds)
 - 30% 2-bed rooms (90 beds)
 - 60% 4-bed rooms (180 beds)

Assumptions

- Bed occupancy rate in 1976: 83% - 87%
- Bed occupancy rate in 2016: 95% - 100%
- Infected patients assigned **single** room
- Patients with *infection risk factors* should have **single** rooms
- Patients during end-of-life care assigned **single** room for dignity and privacy
- Patients assigned multi-bed rooms are matched by gender

Estimating number of beds available in two hypothetical U.S. 300-bed hospitals



EBD for reducing **infections** in the post-antibiotic era

- 100% **single** rooms with **private toilets** (important!)
- Alcohol **hand-rub dispensers** located near bedside, toilet, other accessible locations.
- Handwashing **sinks** placed in prominent locations near staff movement paths.

Clostridium difficile

- Causes many patient deaths internationally.
- Produces **spores** that survive for months on surfaces and equipment.
- **Handwashing** needed, not alcohol hand rub.
- Essential to put patients in **single rooms**.

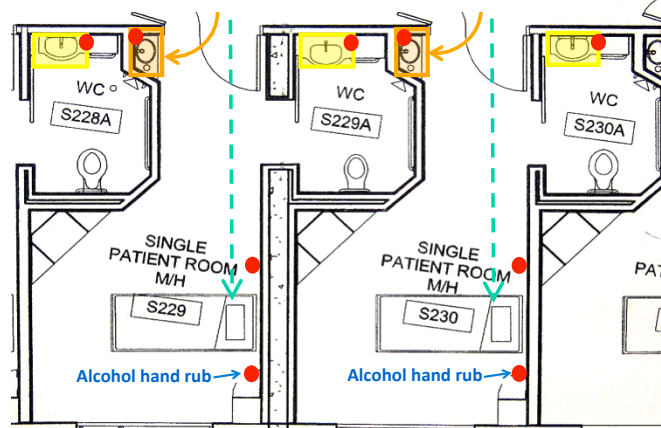
Clostridium difficile and hand washing sinks

- Because of *C. difficile* outbreaks, healthcare design guidelines increasingly stipulate there be **two sinks in each single patient room**.
- One sink for staff, a second sink for the patient, to help prevent cross-contamination from *C. difficile* spores.

Clostridium difficile

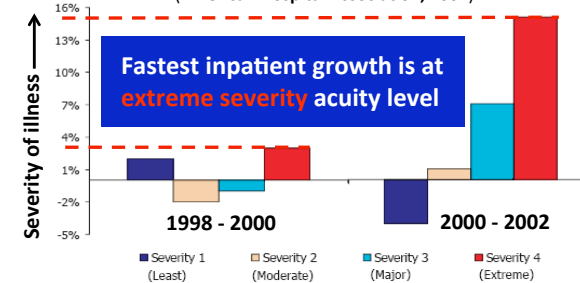
- “Hand hygiene should not be carried out at a patient sink as this will re-contaminate the health care worker’s hands.” (Canadian Ministry of Health and Long-Term Care, 2004, 2006).
- “Two handwashing stations shall be provided in each patient room: 1) a hand-washing sink shall be located in the toilet room; and 2) a hand-washing sink in the patient room.” (American Hospital Association, Facility Guidelines Institute & American Institute of Architects. *Guidelines for Design and Construction of Health Care Facilities*. 2006, 2010, 2014).

Two handwashing sinks in each single patient room Royal Jubilee Hospital, Victoria, Canada



Design of the future must support caring for *sicker* patients

Change in share of cases by severity of illness
(American Hospital Association, 2004)





- Single room with direct observation of patient from localized nurse station.
- Larger rooms to support higher acuity and family presence.
- Somewhat better air quality.



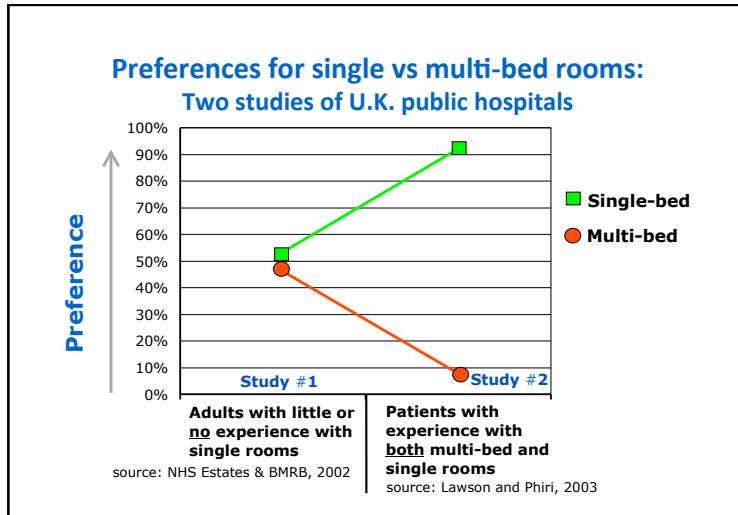
In multibed rooms, visual access to patients can be blocked by privacy curtains

- A European study found that **>80%** of falls in multi-bed rooms were neither witnessed nor reported at the time they occurred (Schwendimann, 2006).



Do many patients like having roommates?

- Not many. Evidence shows that 85%-90% of the time roommates are source of **stress** not positive social support.
 - ♦ *Stress examples:* roommate who is unfriendly or seriously ill.
 - ♦ Roommates generate much noise and reduce privacy.
 - ♦ Roommate incompatibility causes many **room transfers**.



Much research supports this general conclusion:

- Improving building design is centrally important to improving healthcare quality.