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Building a Better Operating Room: views from surgery and architecture

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The operating room is the single most important place in the hospital for surgeons. Despite enormous innovation in surgical practice, relatively fewer advances have been made to the actual operating room itself. New technology and devices have been introduced to crowd the space, but changes to the actual lay out and how to organize the room remains largely unchanged. Indeed, many of the design shortcoming described by surgeons four decades ago in *JAMA Surgery* -- *"faults in equipment, inaccessibility of necessary items, problems in communication, inefficient handling of materials, unconscionable delays … that are an expression of a hazardous environment"*[1] – could readily be identified by today's surgeons.

The problem of building a better operating room is not new and arises largely from knowledge gaps between architects and users of the operating room. Many surgeons and nurses who have been involved in operating room planning and are around to occupy that space afterwards are often disheartened by the gap between their suggestions and the end result. The architects, however, are faced with enormous constraints – budgets, regulatory codes, materials limitations – that they cannot or do not communicate well. Revisions made to accommodate these constraints can often make the initial plan unrecognizable leaving care providers wondering why they ever offered their input to begin with.

In this perspective we take both an architectural and surgical view to outline current limitations of operating room design and potential mechanisms to facilitate improvement.

Limitations of Current Operating Room Design

Current approaches to designing operating rooms are limited by inadequate user input, a narrow focus of traditional outcomes and a limited evidence base to inform design.

Inadequate user input.

Architects often hold multiple focus groups to solicit surgeon and clinical staff input when designing an operating room. These sessions usually get stretched over months, rarely

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include the same surgeons each time and have variable value to the architectural practitioner. While it is self-evident that user input should inform design of their built space and that focus groups are necessary, they are not nearly sufficient.

Narrow focus of operating room outcomes.

Our most common outcomes of interest in surgical environments include mortality and post-operative complications. For most procedures, these events are rare making it difficult to generate enough statistical power (i.e. sample size) to detect meaningful differences even when they exist[2]. Furthermore, the determinants of these primary clinical outcomes are widely thought to be multifactorial making it more challenging to identify the impact of the built environment.

Limited evidence base to inform design.

The field of "Evidence Based Design" (modeled after evidence based medicine) has grown exponentially in the last decade, with numerous studies linking the hospital built environment to clinical outcomes[3]. Despite the growing body of research, the field is still nascent and lacks many of the characteristics academic surgeons are now accustomed to in health services research. For example, the majority of evidence based design studies are observational, from single institutions, have limited sample size and lack methodology to risk and reliability adjust patient outcomes. Moreover, even less of these studies examine operating rooms or have clinical co-authors to give the design assessments clinical face-validity.

Improving Future Operating Room Design

With the increasing interest on hospital and surgeon performance, the time is ripe to explore how the operating room could be designed better to improve both. Adopting simulation, staged construction, user-centered outcomes and new research collaborations could help begin improving future operating room design.

Utilizing simulation.

While focus groups may be helpful to generate ideas for the operating room, surgeons are "hands-on" and need direct involvement with a built space to evaluate it. In the era of simulation, virtual and mock operating rooms could be created based on different built environment changes (e.g. room size, lighting, layout) with rapid and iterative improvements. Emerging techniques of video recording to evaluate surgeon technical performance[4] and operating room communication[5,6] provide important frameworks to connect built environment simulations to surgical outcomes and patient safety.

Staged construction.

Hospitals could be built in a staged fashion. After the first operating room is constructed, it could be put into live clinical practice followed by real-time feedback before the remaining operating suites are built. While a potential delay in construction, it would give real face validity to the design with users and ultimately add value to the overall new construction investment. Precedent for doing so has been established accommodate construction budgets

(i.e. not enough money to complete entire project initially) but could be adapted for the purpose of quality improvement and better design.

Examine user-centered outcomes.

Mortality and complications will and should remain the important outcomes of interest for surgeons and architects, but may be less influenced by the built environment than other measurable attributes of the operating room. Including user-centered outcomes –e.g. patient comfort on bed transfer, nurse ability to find important equipment, surgeon ergonomics during long procedures, anesthesia ability to communicate during patient hand offs— may identify more variability that designers can influence with changes to the operating room built space.

Collaborative research.

Research related to the operating room often is carried out with limited collaboration between architects and healthcare researchers. To help facilitate connecting these two disciplines the American Institute of Architects has developed a *Design & Health Research Consortium*[7] where by architects are partnering with health researchers to improve design. At present, clinicians (and specifically surgeons) are grossly underrepresented. Integrating the methodology developed by health services researches in surgery with the design variables better defined by architects would be essential to developing a shared evidence base to improve future operating room design.

Conclusion

The built environment where we work – hospital wards, operating rooms, outpatient clinics –are often thought to be static structures. Viewed differently, changes to the size, layout and organization of the physical spaces we occupy have potential to be a meaningful healthcare intervention that improves patients outcomes and organizational culture. As such, it deserves be evaluated and improved with the same scientific rigor subjected to all of our interventions in healthcare, guided by a strong, multidisciplinary evidence base.

References

1. Laufman H Surgical hazard control. Effect of architecture and engineering. Archives of surgery. 10 1973;107(4):552–559. [PubMed: 4125598]
2. Dimick JB, Welch HG, Birkmeyer JD. Surgical mortality as an indicator of hospital quality: the problem with small sample size. Jama. 8 18 2004;292(7):847–851. [PubMed: 15315999]
3. Ulrich RS, Zimring C, Zhu X, et al. A review of the research literature on evidence-based healthcare design. Herd. Spring 2008;1(3):61–125.
4. Birkmeyer JD, Finks JF, O'Reilly A, et al. Surgical skill and complication rates after bariatric surgery. The New England journal of medicine. 10 10 2013;369(15):1434–1442. [PubMed: 24106936]
5. Hu YY, Parker SH, Lipsitz SR, et al. Surgeons' Leadership Styles and Team Behavior in the Operating Room. Journal of the American College of Surgeons. 10 16 2015.
6. Yule S, Parker SH, Wilkinson J, et al. Coaching Non-technical Skills Improves Surgical Residents' Performance in a Simulated Operating Room. Journal of surgical education. Nov-Dec 2015;72(6):1124–1130. [PubMed: 26610355]

7. AIA. American Institute of Architects; Design and Health 2015; http://www.aia.org/practicing/designhealth/. Accessed 11 Decemeber, 2015.

Table 1.

Current Limitations and Future Design Solutions to Building a Better Operating Room

Current Design Limitation	Future Design Solution
Inadequate actionable user input	Utilize simulation and staged construction for “hands on” feedback
Narrow outcomes examined that fail to detect differences	Include user-centered outcomes that have more variablity
Limited evidence base to inform design	Collaberative research combining surgical and architecture expertise