FRANKLIN BECKER AND JANE CARTHEY[1]

Evidence-Based Healthcare Facility Design: Key Issues in a Collaborative Process

ABSTRACT

Over the past twenty years interest had grown in developing three related approaches to improving the quality of healthcare: "patient-centered care", "patient-centered design", and "evidence-based design". All three approaches to improving the quality of healthcare are grounded in and require crossing of the disciplinary boundaries of clinical practice, architecture and its allied disciplines, the social sciences, and business and administration. This paper examines the premises underlying the concept of evidence-based design. It argues that the basic premise underlying evidence-based design is sound, but that considerable ambiguity and misunderstanding exists about what it means to actually implement the concept of "evidence-based design" in practice. More attention needs to be paid to the diverse forms of "evidence" that are considered, and to the "filters" through which the wide variety of stakeholders view the research findings, including their use of these as an "evidence base" for healthcare facility design. The authors propose that a combination of both academic-based and practice-based research are needed, and that appropriate solutions for a specific project emerge from a collective problem-solving process involving key stakeholders considering diverse forms of evidence.

KEYWORDS

Evidence-based, Design, Patient-centered, Patient-focussed, Research

INTRODUCTION

Over the past twenty years considerable concern has been expressed and effort expended to improve the quality of health care (Institute of Medicine, 2001). The reasons for concern about the state of the American healthcare system are reflected in statistics like the following (Lavizzo-Mourey, 2004):

- 44,000,000 Americans without health insurance coverage
- ~98,000 patients die each year from medical errors
- 62 percent of Americans believe the health care system will get worse
- 20-50 percent of surgeries that are unnecessary
- 30 percent of health care costs are attributable to poor patient care
- 55 percent of patients in Harvard survey were dissatisfied with the quality of health care.

The Australian healthcare system has its own problems. A recent WHO report (Healy, Sharman, and Lokuge, 2006) cited endemic problems related to the sustainability of rising health expenses, tension between different levels of government involved with health care service delivery, long waiting lists for elective surgery, disparities between urban and rural service areas, and the continuing very poor health status of Indigenous Australians. Similar to Healy et al, those writing about the Australian health system e.g. (Leeder, 1999) tend to concentrate on system issues that impact on the delivery of care in an equitable manner that raises standards for all rather than for select groups such as privately insured patients. Specific concerns are often raised, in addition to the need for increased funding for the health system, regarding the type and location of health services to be delivered, whether in hospitals, community settings or the patient's home.

[1] Franklin Becker, Ph.D., is Professor and Chair of the Department of Design & Environmental Analysis in the College of Human Ecology at Cornell University, Ithaca, New York. Jane Carthey is the Director of the Center for Health Assets Australasia (CHAA) in the Faculty of the Built Environment at the University of New South Wales, Sydney, Australia.

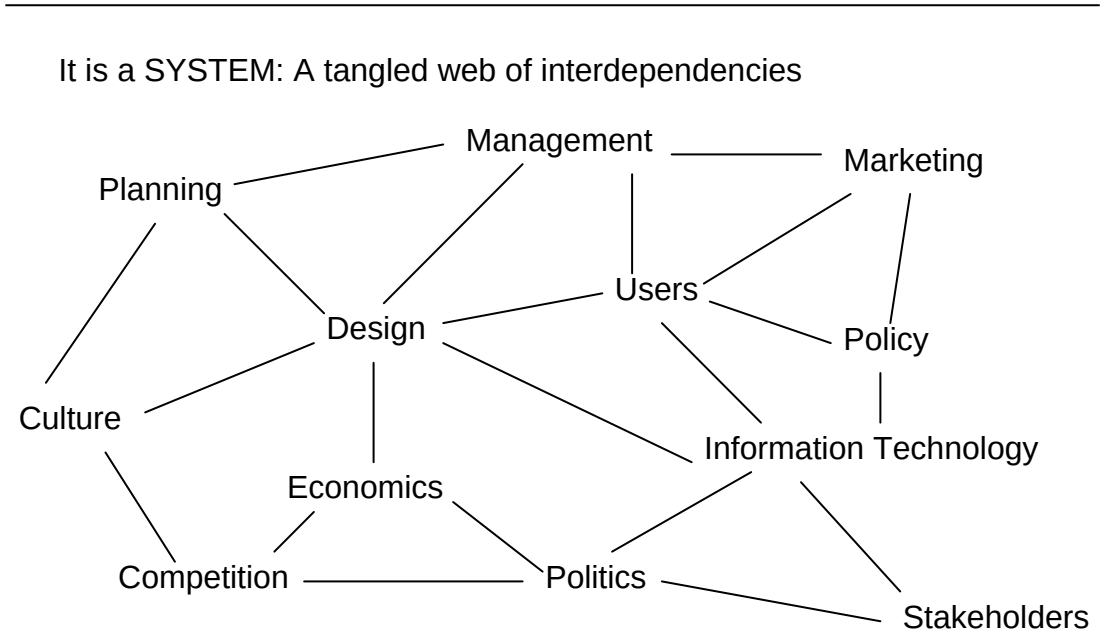
For example, the review of the Queensland (Australia) Health system in 2005, the Forster Review (Forster, 2005) considered all these aspects of care delivery in that State, but also talked about the substandard nature of some Queensland Health facilities and the problems associated with improving them. It was considered necessary to shift the emphasis of the system away from administration to the delivery of front line care and to focusing on the needs of the patient and on the clinicians delivering services. Pertinent to the focus of this article, the report also criticized the Queensland Health system for not having appropriately rigorous methods for assessing the condition and functionality of its health buildings (assets), and for not conducting post occupancy evaluations on completed projects. As a consequence, the opportunity to learn from existing projects and feed that learning forward into the planning and design of future facilities was lost. The report refers in many instances to similar situations existing in other Australian States. In effect, the report highlights the need for evidence-based planning and design as a means of supporting and improving the delivery and quality of health care.

Referring to the American context, but equally applicable to Australia, the Institute for Healthcare Improvement (IHI) argues that:

You might not think our health care system needs to be reminded to center its efforts on the patient. But as the system has grown more complex and fragmented, and as providers feel more pressure to see more patients in less time, care has become centered not on the needs of patients, but around the needs of the system itself. (Institute for Healthcare Improvement, 2007)

Because problems with healthcare are systemic, rather than being caused by any single factor (see Figure 1), there is no single solution to improving healthcare. The Forster Review in the Australian context also makes this point quite clearly. Yet for those interested in improving healthcare, understanding that healthcare's problems are embedded in complex systems is little solace. One still needs to break into the system somewhere in order to address health care quality issues. One point of intervention gaining increasing attention has been the physical design of healthcare facilities, and hospitals in particular (Carpman and Grant, 1993; Verderber and Fine, 2000; Ulrich and Zimring, 2004; Marberry, 2006).

Figure 1: The Organizational Ecology of Healthcare Environments



PATIENT-CENTERED CARE AND EVIDENCE-BASED DESIGN

In the United States, the reason for the interest in the relationship between the design of healthcare facilities and healthcare quality is not surprising. It has been estimated that between $20-30 billion is expended on healthcare construction and renovation in the Unites States annually (Marberry, 2006). The annual Australian health capital expenditure, albeit at $2.8 billion much smaller, is also a significant investment in that country's social infrastructure. Given that buildings last from 25-50 years, this is literally a once in a lifetime opportunity to influence the settings in which healthcare is delivered. Ulrich and Zimring's (2004) review of the research literature on health and design suggesting that design factors such as single vs. multiple bed rooms, separate medication dispensing rooms, and ventilation and air conditioning systems can affect nosocomial infection rates, medication errors, and patient satisfaction has added to the interest in what has come to be known as "evidence-based design." This is a subset of a larger interest in "patient-centered care" and "patient-centered design." This paper argues that the basic premise underlying evidence-based design is sound, but that considerable ambiguity and misunderstanding exists about what it means to actually implement the concept of "evidence-based design" in practice.

Patient-centered design is a subset of patient-centered care – in Australia the term "patient-focussed care" refers to a similar interest in focusing service delivery on the patient and the care setting. The premise behind these concepts is that the manner whereby the physical settings for the delivery of health care are planned, designed, and managed affect both the quality of the patient's (and family's and friends') experience, and the cost and quality of care, including patient safety (Zimring et. al., 2006.). Evidence-based design is viewed as the means of delivering design solutions that improve patient-centered care, including improved health outcomes. The Center for Healthcare Design writes:

The forecast of annual capital spending on healthcare facilities rising from $15 billion today to $25 billion in the year 2010 makes the topic of a "better building" important and timely. The need for new healthcare facilities offers a rare opportunity for management to learn about and use the emerging science of evidence-based design to build better hospitals with healing environments that improve patient care and staff loyalty, medical outcomes, safety, institutional productivity, and financial performance while decreasing medical errors and waste (Center for Health Design, 2004)

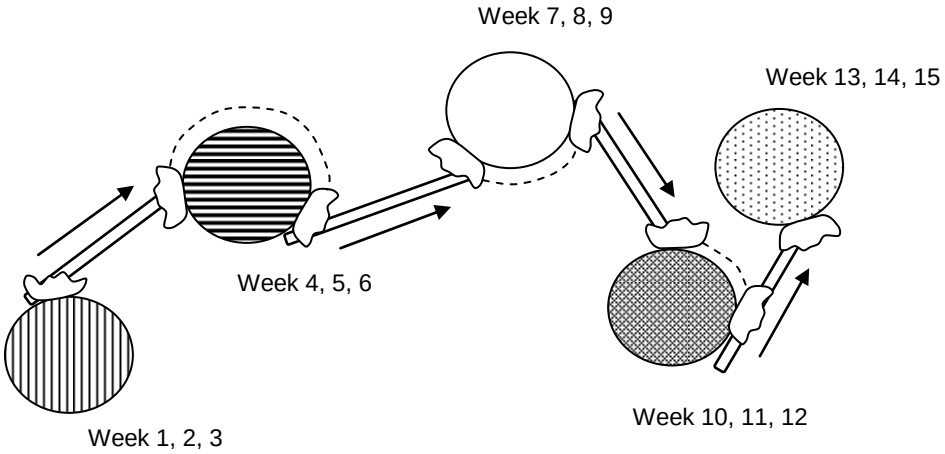
Although the United States and Australian systems differ, there is clearly a common preoccupation with continuously improving the delivery of healthcare to the populations of both countries, and using some form of "evidence-based design" to do so.

The Evidence-Based Design Premise

The fundamental premise of evidence-based design is that design of health care facilities that support patient-centered care should be, but are often not, guided by credible evidence generated through research. But what kind of "evidence," gathered, interpreted, and applied by whom? In fact, "evidence" comes in many forms that include formal academic research, in-house institutional research, professional experience, design guidelines (based on both formal research and experience), and informal "best practice" benchmarking. Further, the data and information generated by these different ways of knowing are filtered through the various lenses of diverse stakeholders involved in planning, designing, funding, managing, and using a healthcare facility. These stakeholders include patients and their families, architects, engineers and planners, hospital administrators, clinicians, financial institutions, and government agencies and regulatory bodies. The seemingly simple concept that "evidence-based design" will lead to better health outcomes is, in practice, much more complex.

Implicit in the evidence-based design premise is a kind of relay-race model of design (Becker and Steele, 1995). The researcher hands off the research findings to the architect, who works on the design and then hands the design over to the administrative-clinical staff. The clinical staff then use the finished built project to deliver quality care. (Figure 2)

Figure 2: Relay Race Model of Design (Becker, 1990)



This simple linear model works no better, and reflects reality no more accurately, in improving care in clinical settings than it does in promoting innovation in corporate and manufacturing firms or any other type of setting. One reason is that no research findings are ever incontrovertible. Different interpretations of the same findings are the hallmark, in fact, of scientific inquiry. So, too, is the call, at the end of each study, for further research! No less open to interpretation are the implications for practice of research findings, even when these may generate wide acceptance. As Figure 1 suggests, this stems from the fact that the design and planning of a healthcare facility occurs within a web of interdependent and often competing values and priorities. Single patient rooms may increase patient satisfaction and possibly reduce nosocomial infection rates. However, if they also are more costly because they require not just more space (capital investment) but also higher staffing levels, then the decision to implement can be problematic for organizations fiscally constrained, as are most hospitals. This chain of consequences is, of course, the beginning not the end of a debate, since if patients are less satisfied they may go elsewhere (if they have a choice); and the cost of dealing with nosocomial infection rates can be significant (Sadler et al., 2006). Like the disappearance of the magician's rabbit from the hat, what seemed obvious often is not.

The history of evidence based medical practice has been written about more extensively than evidence based design practice, yet illustrates issues that are similar for both fields of professional practice. For example, (Rubin et al., 2000) writing in the Australian context notes that

The rate of transfer of the knowledge gained from health and medical research into evidence-based practice is determined by many factors. Preconditions for the uptake of new evidence are the availability of good evidence, ready access to the evidence, a supportive organisational environment, and effective mechanisms for promoting knowledge uptake…The short to medium term future of evidence-based medicine in Australia is likely to be shaped by … increased demand for information to fill the gaps in research-based evidence on specific problems.

The development of evidence-based design will likewise require information generated from research into specific problems and paths for dissemination and uptake of this knowledge by practitioners. However, as in medical practice, evidence is not the only information relied upon for professional design practice to occur. It is one part of the repertoire of skills and information that practitioners use to determine how to perform their work and to generate design solutions.

To improve care, quality evidence-based design requires grounding in, and the crossing of the disciplinary boundaries, of clinical practice, architecture and its allied disciplines, the social sciences, and business and administration. For that collaboration to be successful, several things need to happen. The first is that more attention needs to be paid to what *evidence-based design* can and cannot do. The second is to recognize the need for *different forms of evidence-based design*, some based in academia and some based in practice. The third is to understand the need for *collective problem solving* of all of the key stakeholders involved in developing, implementing, operating, and using hospital facilities.

What Evidence-Based Design Can and Cannot Do

The most important point to realize about evidence-based design is that it will never be either broad or deep enough to address or answer every conceivable question about how physical design influences healthcare quality that arises in planning and designing a health facility. Christopher Alexander (1964) and others (Jones, 1992; Lawson, 1997) have written extensively concerning extant knowledge and other factors impacting on even fairly simple design decisions. Because of this, the one-to-one translation of even quite definitive evidence into design practice is rarely straightforward.

In real life, data doesn't make decisions; people do. Evidence-based design can help practitioners make more informed decisions, ones grounded in but not solely determined by research. The alternative is investing millions of dollars in facility design based to a much greater extent on personal experience, intuition, preference and values. These are not always wrong, of course, and they never disappear. Research is not a substitute for experience, preference, and values. Its value comes in helping shape and test these, and in assisting designers to synthesise all these factors into a design solution for a specific project.

Academic vs Practice-Based Evidence

Academic Research

Academic research is intended to provide practitioners, over time and across multiple studies, with credible insights and generalizations based on evidence that has been collected following accepted canons of scientific practice. Academic research typically is rigorous. It is also time-consuming. Findings are generated after a year or two or more of study, not a few weeks or months. One study's results generate new questions that lead to new studies in a never-ending quest for better understanding why certain outcomes, from infection rates and medical errors to the retention rate of nurses, occur. Nothing is ever "proved," once and for all. The hallmark of the scientific method is that a finding stands only until the next study suggests that other critical factors may be at work, influencing outcomes in different and unexpected ways.

For the practitioner, this constantly shifting knowledge landscape can be highly unsettling. How can you base a decision on evidence that may not hold up next month or a year from now? The answer is that it makes no more sense to blindly apply the findings from an academic research study than to ignore all research and to just go with "what feels right". Research provides insights that can guide decisions. It does not make them. The great value of academic research is that the findings are likely to be more robust than other forms of inquiry because they have used methodologies designed to reduce the likelihood that the results occurred by chance, or simply reflected personal values and preferences.

For healthcare facility design, the more pervasive problem is that academic studies typically focus, of necessity, on one or two key variables and/or outcomes. The research on single patient rooms, for example, is quite clear in terms of patients' preferences for single rooms and the higher levels of patient satisfaction experienced in these. Research demonstrating the effects of single rooms on nosocomial infection are far fewer and the results less clear. The effects of this design on staffing and capital costs are even less well understood. Because the results for one kind of outcome may be clear while they are not for others, the decision about how to translate the findings into practical design decisions is driven as much by values and priorities as by the evidence itself. Design, in practice, is about trade-offs. Evidence can certainly help inform these kinds of decisions, but they are rarely dictated entirely by the evidence.

The generizability of results is another important issue. Generalizing outcomes from one setting to another more typically depends on several studies that have examined the same process or factors but in different settings generating similar findings. Allen's (1976) research on the relationship between physical distance and face-to-face communication patterns in R&D units illustrates this perfectly. Over twenty-five years in dozens of studies done in different firms, industries, and countries Allen consistently found that after about 30 meters face-to-face communication declined dramatically. That relationship is now widely accepted, but it took years to build that level of confidence in the relationship between distance and communication frequency.

The range of conceptual frameworks, research questions, and research methodologies is enormous. The common thread is that academic researchers use research methodologies widely accepted as generating trustworthy findings within the research tradition in which they operate; and they typically submit their research to peer review where other disciplinary experts, not involved with the specific project, can assess the quality of the research. The peer review process is not, of course, infallible. Nothing is. However, the greatest limitation of academic research, for the practitioner, is not that what was found in a specific study is inaccurate. It is that it is not project specific. It does not provide data about *this hospital,* only other hospitals that may be a lot or a little like it. Nor does it necessarily address the specific design questions about which there is the least agreement among the people involved in a specific project. What's more important in attracting nurses, the layout of the nurses' station or better information technology? Will decentralized nursing stations reduce medical errors, and will that be because of more direct opportunities to observe patients; or will they increase medical errors because they reduce opportunities for informal on-the-job learning and mentoring between more and less experienced nurses? Will dedicated dictating rooms for doctors reduce errors because of less noise and fewer distractions? How will the organizational culture of *our hospital* affect how doctors use electronic medical records systems, or their willingness to try a new layout for the emergency department? Even where the question is relatively simple and apparently straightforward, such as "will providing more hand basins increase hand washing by clinical staff?" the answer may be both "yes" and "no", as in this case cultural considerations add qualifying factors to the conclusions drawn by the study. (Whitby et al., 2004, 2006)

Practitioners, of course, cannot ever wait for all the evidence to be in. Nor can they rely only on even the best evidence that was generated in a context that may be different from their own. Hence, the need for and value of practice-based research.

Practice-Based Research

Practice-based evidence takes many forms and has three key criteria. The first is that the research is done for, and often in, the institution that is embarking on a significant construction project. The findings are project specific. The second is that the time frame for collecting evidence is quite short, more often days or weeks rather than months or years. As such, the research will almost always be less rigorous than academic research. Its primary purpose is to generate insight and stimulate debate grounded in empirical evidence, rather than relying only on previous experience or preconceptions. Third, the form of the data and its method of collection vary enormously. It ranges from using academic research protocols but in a shorter time frame and with fewer data points than is true with academic research to personal visits to comparable facilities (informal best practice benchmarking) and professional experience with similar projects over time.

Recent research by the Centre for Health Assets Australasia shows that for architects "research" often takes the form of informal communication with people within their own firm who may have had previous knowledge and experience about hospital design (Carthey et al., 2006). This study found that the term "research" had many meanings for healthcare facility designers; their use of the term generally meant that they generated their own "evidence" by means that included "experience on previous projects", "consulting with colleague(s)", going on "study tours", looking at "architectural journals", and a range of other activities that gather information for their projects. In fact the findings of the study demonstrate the relatively lowly importance placed on more traditionally derived "research", especially academic research, which was placed 10th in the list of most commonly used information sources used. See Table 1.

Table 1: Information Resources Used by Healthcare Designers – 10 Most Used Categories

No.	Resource Category
1	Information gathered from previous projects
2	Own / firm's original research
3	Information from client
4	Other guidelines
5	Other consultants / colleagues
6	Magazines and journals
7	Health Facility (Design) Guidelines - Australia/NZ
8	CPD
9	POE (own POE and others)
10	Research summaries by others

(Carthey et al., 2006)

Informal benchmarking (e.g., visiting other similar facilities), talking with colleagues, one's own personal experience, etc. all provide relevant information and input to what the architects describe as their "own/firm's original research". However, it seems to us that the term "evidence" implies something more structured and formalized, without necessarily following all the canons of academic research. Running a small scale "quick and dirty" survey or conducting focused interviews with nurses on how they are responding to the design of an ICU may not generate publishable findings because of the small sample size, but the results can generate insights grounded in a more systematic assessment than, for example, concluding that everything is working well because no one has filed a complaint! Similarly, spending a week carefully observing and recording how often decentralized nursing pods are used, and for what purposes, followed by interviews with staff, can generate useful insight into whether the design is really increasing the ease and frequency of nurses observing patients. The results will not be definitive. But in combination with more academic research, as well as personal experience and what has been gleaned from talking with others and visiting different facilities, the understanding of how design is affecting desired outcomes can be significantly increased.

COLLECTIVE PROBLEM SOLVING

Application of Evidence to Design Practice

As is true of academic research, no definitive answers will emerge from practice-based research, whatever form it takes; and it will take many forms. Neither architects and planners nor hospital planners and managers are going to park personal and professional experience at the door, and rely only on formal research, even when it is available. There is no reason they should, in fact, since good decisions are most likely to emerge from a lively debate about all the forms of evidence available and its implications for practice. The challenge is to transform various forms of evidence into useful information, *specific to the particular context and institution*, through a collective-problem solving process. A key part of that process is discussing and comparing the site-specific data and professional experience with academic research findings, taking into consideration the particular economic, social, culture, and political factors that form the context within which a particular design is developed and implemented.

Evidence as Risk Management

Evidence can increase our confidence in the probability that certain outcomes will occur and that we have considered as many relevant factors as possible that may impact on these outcomes. Evidence-based design is a form of risk management. At the heart of risk management is the need to assess the likelihood, the probability, that some event will occur (Loosemore, 2006). The amount that one invests in anticipating coping with that event depends not only on the likelihood of it occurring, but on its likely consequences. The frequency of a serious earthquake hitting California or Japan may be low, but because the consequences if (when) it does occur are enormous, we put in place building regulations and construction codes, for example, that significantly increase costs *now* in anticipation that these will improve health and safety — and possibly save lives and reduce costs-- at some unknown point in the future.

Loosemore notes that risk management is neither a precise science nor a "particularly well-developed artform" (Loosemore, 2006, 31) He makes the point that

Effective risk management is most fundamentally a human process of systematic, rigorous and creative thinking underpinned by some simple tools and techniques…Organisations which recognise the limitations of numbers in risk decision-making and become more attuned to the political, social, emotional and ethical aspects of risk management are more likely to understand the full diversity of risks facing them.

Clearly similar aspects are important in determining the research findings that are used to guide design decisions and that constitute the filters for assessing potential solutions.

Design as a Series of Weighted Evidence-based Decisions by Stakeholders

We propose that the health facility design process passes through a series of filters applied by stakeholders and that the order in which these are applied and the coarseness or fineness of the filter applied determines the issues to which the design process responds and the final solution chosen for implementation in terms of a built facility.

Figure 3 illustrates one view of this process. The importance of issues determines the order in which the filters are applied and clearly determines which of the many possible solutions may reach later stages of the assessment process. The figure was derived from Jones (1992) who uses a similar diagram to explain the process for the design of a window. Clearly the design of a window is a much simpler problem than the design of a whole health facility and many fewer filters are required for the assessment of the evidence in that case than are required for assessing the evidence for all the facets of a health facility design. It is also important to note that the process is not usually simply linear and this is highlighted by Alexander (1964), Jones (1992), Duffy (1998), Lawson (1997) and others when discussing the process of design. However, for both the simplest or most complex problems, evidence has a place in the hierarchy of filters, both generating and assisting in the prioritization of their application.

The decision undertaken on many health projects to determine the number and proportion of single patient bed rooms provided in an inpatient ward illustrates this process. Single vs. multiple-bed rooms is an issue that generates debate from a range of perspectives and for which much evidence is quoted both for and against providing everything from a low percentage of single rooms through to 100% provision. The US perspective on this issue is that 100% single rooms should be provided, and Ulrich (2005) and others insist that the evidence exists to support this approach. Review of the evidence suggests that this is not a simple decision. It is, in fact, influenced by a range of considerations, as discussed above.

A recent study reviewed the literature and attempted to summarise the findings for optimal numbers of single rooms from an Australian perspective (Carthey et al., 2007). The researchers concluded there were several perspectives from which to view the evidence and that the perspective adopted influenced the outcome chosen. The first (and possibly most important) consideration was the nature of the Australian health system and its principal drivers; namely, the political implications of Australian public healthcare funding and thus the importance of the issue to those spending the funds on behalf of the Australian public. Consideration of the same issue starting from the perspective

associated with a US context, where public funding is much less of an issue, would clearly result in a very different filter being applied to this first factor.

Having reviewed the first filter, the next set of filters to be applied to the evidence for different paths of action were determined based on the themes developed in the literature reviewed. These filters were identified as including:

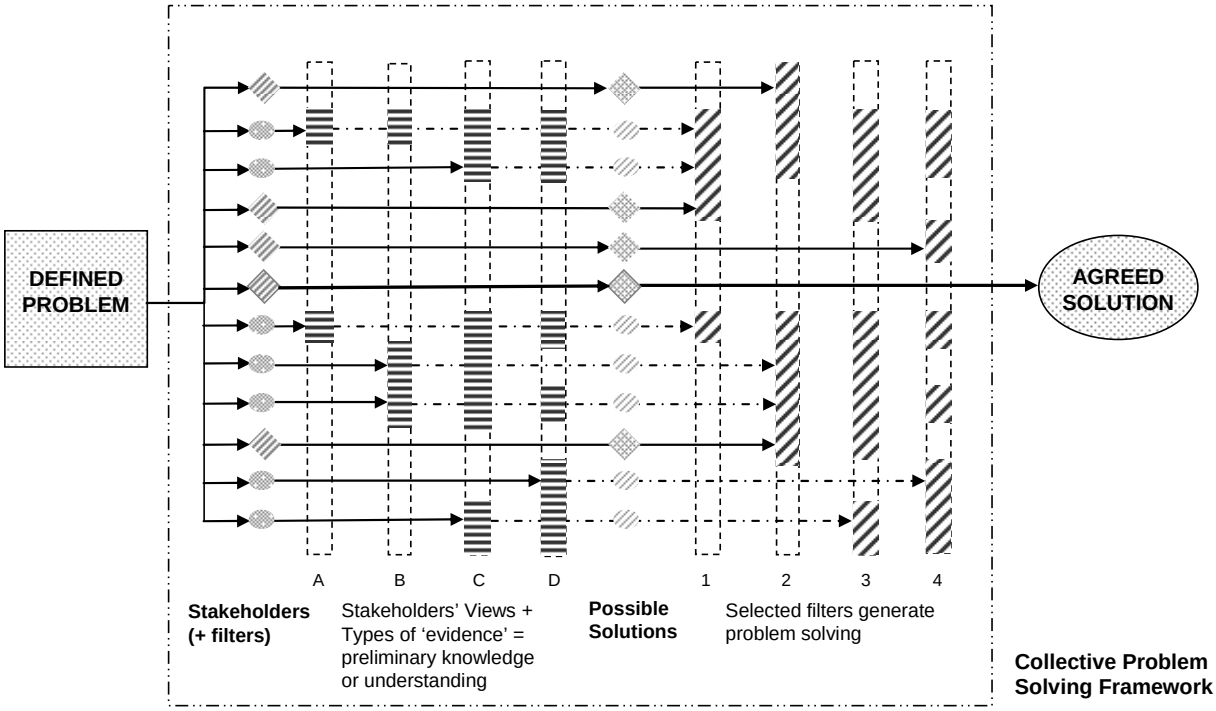
- Changing environments for the delivery of patient care
- Risk management of cross infection (HAI) and adverse events in hospitals
- The need for building in flexibility and the ability to manage different patient needs and changing models of care
- Changes to community expectations for better therapeutic environment for patients
- Differently apportioning capital and operational costs to gain a true life cycle cost for a facility to drive better investment related decisions.

Whether this list is comprehensive, appropriately ranked, or indeed defensible, is not the issue. Rather, it is that a wide ranging set of issues was considered important, and that these need to be weighted in making decisions regarding the number of single rooms to be provided. The evidence supporting each of these filters was assessed and appears not infrequently to be inconsistent and, in some instances, to conflict. In using the evidence, different stakeholders with differing levels of influence or power will rank these issues differently and ensure those of most importance are applied first and those of lesser importance are perhaps not applied at all.

This specific issue serves to illustrate the complexity of design decisions that arise in a collaborative problem solving process where many stakeholders are involved, from different professional backgrounds and with differing priorities. Thus collaborative problem solving is by its nature reliant on the interaction of evidence of various kinds within a filtering framework that applies various types and levels of evidence to the assessment of a range of potential solutions for a particular problem.

Practice based research is an approach that may assist in this individualization and can render academic findings more useful for a particular design problem. It is one of the types of evidence that interact with the views of stakeholders as “filters” that inform the development of possible solutions for a design project. A large number of stakeholders will view the evidence in different ways and a collaborative problem solving process will allow solutions to pass through the negotiated filters to arrive at an agreed solution for the problem.

Figure 3: Use of Evidence and Filters to Determine Facility Design Solutions



CONCLUSION

Because research findings are always uncertain; that is, open to debate, we need to consider the probability of events occurring, and design interventions that we believe increase the likelihood of achieving positive outcomes. Precise numbers and "hard" evidence are difficult if not impossible to find for this purpose. One way to address this uncertainty is to subject to collective interpretation all the evidence that is available by exploiting the value of different stakeholders' experience and perspectives. Through this collective sense-making the implications of both academic and practice-based evidence can be debated in a structured manner. Questions about why the site specific findings might be at odds with academic results can be discussed. Is there something about *our* culture, the demographics of *our* hospital, or the limits of *our* technology that could account for the discrepancies we are finding? Could our understanding of our own context, discovered through a structured and collective discourse, stimulate new insights about what we could do in *our* situation that might not have been possible in others we have visited, read or heard about? In combination, practice and academic-based research generate evidence which serves as the *starting point* for collective problem-solving, where the key challenge is making sense of and interpreting diverse evidence in ways that lead to interventions and design decisions that increase the likelihood of improving the quality of healthcare.

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