Mitigating Hazards Through Continuing Design: The Birth and Evolution of a Pediatric Intensive Care Unit

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Often, researchers study organizations in which design is largely in place and the design process is shrouded in the distant past. However, the design process can have dramatic implications for how organizations function. This paper reports a specific attempt to design one organizational subunit, a pediatric intensive care unit (PICU), to function under difficult circumstances. The founders aimed to create a highly reliable and safe unit, but implementing their vision required continuous effort. The unit needed constant buffering from external pressures and a dissimilar parent organization, and these forces shaped the unit's ultimate design. Through the presentation of this case, we discuss the impact of design on the organization, its members, and the larger hospital organization to which the unit belonged. The study reveals that the PICU's design was an ongoing effort and its most stable component was a vision of distributed knowledge and decentralized intensive care. We conclude by discussing implications of the case for organizational design theory and practice.

Key words: high-reliability organizations; design; pediatric intensive care; healthcare; safety; organizational design

Introduction

A recent report published by the Institute of Medicine (IOM) found that medical errors kill as many as 100,000 people each year in American hospitals (2000). The report argues that many medical errors stem from structural problems in healthcare organizations and the U.S. healthcare system, suggesting that increasing patient safety is (at least in part) an organizational design problem. To the surprise of interested healthcare managers and professionals, the literatures on organizational safety and design offered little guidance on how to design a safe hospital and on designing organizations for hazardous environments more generally.

While several studies examine organizations in which safety-enhancing characteristics and structures already exist (e.g., Bigley and Roberts 2001, LaPorte 1988, Roberts 1990), details of the design processes that allowed these organizations to become reliable are shrouded in the past. Given this gap in the literature, a renewed examination of organizational design processes seems overdue. To address the gap, this paper focuses on a specific attempt to design a new organizational unit and examines how the design evolved over time. We present a case study detailing the design of a new pediatric intensive care unit (PICU), the evolution of the unit's structure and processes over time, and the impact of the unit's design on its performance. Based on the case, we discuss the process of design and highlight practical concerns in the quest to manage organizations as their designs evolve.

WHTCH Pediatric Intensive Care Unit: Research Setting and Methodology

Pediatric intensive care is a complex and unpredictable domain. The potential for treatment-induced complications abounds. Children often react differently than adults. Even minor procedures such as injections or intravenous line insertions can cause patients to become agitated and move in unpredictable ways.

To meet the challenges associated with treating children in critical condition, William Howard Taft Children's Hospital (WHTCH)[1] established a new PICU in 1988. WHTCH is the tertiary children's hospital for a

geographic area more than three times the size of Vermont. The population is 2.5 million, with 500,000 under the age of 15. In 1988 WHTCH brought in a pediatric intensivist as the director of the new PICU. A second intensivist joined the unit a year later, and these two physicians headed the unit until 2000, when they both left the hospital. During their tenure, the PICU grew from an initial size of 8 beds to 25 beds with an average daily census of 21 children, including an average of 9 on ventilators. By 1999, the PICU had more than 1,300 admissions per year, making it one of the largest PICUs in the United States in terms of both number of beds and admission rate.

Our activities in the focal PICU did not begin as an organized research effort, but rather as a collaboration between scholars and practitioners to exchange knowledge. One of the authors met the two intensivists a few years after the PICU was founded. This author observed activities in the PICU repeatedly over a number of years, often discussing practices with the intensivists and providing them with relevant academic literature. The dialogue continued following the intensivists' departures from the focal unit. As part of this dialogue, the other authors were introduced to the intensivists as well as to several current and former employees of the PICU and the broader hospital organization that interacted with the PICU. Because of the informal nature of our contact with the unit over the years, we did not collect detailed observational data. Therefore, the description of the PICU's design and development that follows is derived from the authors' intimate familiarity with the unit and from recent conversations with former and current PICU personnel. Our description of the PICU setting also draws, with permission, on an unpublished paper authored by the two lead intensivists (the paper is not cited to preserve confidentiality). In addition, literature on the design and operation of medical organizations in general and PICUs in particular was reviewed to develop an understanding of the typical structure and functioning of such units, and characteristic studies are cited where appropriate.

In presenting and analyzing the case study, we follow a grounded theory approach (Glaser and Strauss 1967). Grounded theory treats research findings as emergent. Hypotheses are not tested; rather, an empirical setting is examined for patterns or unique properties. These elements are compared to existing theory so that theory can be expanded or refined. This approach is particularly appropriate in the present study, as we seek to refine theoretical knowledge regarding organizational design.

The Evolution of Organizational Design in the PICU

The Setting
Many medical organizations follow a model of treatment that delineates the attending physician as the primary decision maker, more or less solely responsible for the care of his patients and the management of their medical outcomes (see Harvey et al. 2000). Therefore, if one physician establishes a care plan but is unavailable when another physician sees the patient, the second physician may change the care plan without any interaction with the first. Because traditional physician roles in this model are highly individualistic, the teamwork aspect of care is often missing. In this model, physicians may be unaware that each one works differently, and there is no incentive for doctors to forge agreed-upon plans. The physician answers to the patient, not to another physician, and medical doctors rarely accept advice from peers on how to practice medicine. At the extreme, aggressive, inflexible postures dominate conflict resolution, with settlements often reached by imposed authority (Harvey et al. 2000).

Furthermore, while a physician's relationship to other doctors is one of independence and individual responsibility, her relationship to nurses and other healthcare personnel is usually one of hierarchy and authority. This model dictates unidirectional planning and communication, with the physician as director in a vertical hierarchy (Harvey et al. 2000). The physician remains the "final common pathway" for decision making regarding the patient's care (Herbertson and Walley 1998). In the PICU director's experience, many physicians underscored their authority through belligerence and criticism, leading nurses and other support staff to live in fear of physicians. He had seen that the culture of fear encouraged nurses to think independently as little as possible and focus instead on avoiding physician notice. In this environment, nurses, therapists, and residents quickly learned that the path of least resistance was to follow physician instructions to the letter. The PICU director observed how interactions among physicians and staff unnecessarily complicated patient care.

The Birth of a PICU
With these experiences in mind, the first pediatric intensivist came to WHTCH as PICU director in 1988. At this time, the PICU did not exist as a distinct unit within the broader 627-bed medical center. Prior to this, critically ill children were either treated in the adult ICU or transferred to other hospitals with pediatric facilities. With the intensivist's arrival, the adult ICU donated eight beds and the PICU began to function independently.

From the beginning, the new PICU director saw founding a new unit as an opportunity to diverge from the traditional design of critical care units as he had seen it. He was a Navy combat veteran from the Vietnam War. As a pilot, he had witnessed firsthand how a rigid hierarchy with authority enforced through verbal abuse caused accidents in hazardous situations. When he left the Navy and entered medical school, he found a very similar design in place.

During his training, the first intensivist noticed a sharp distinction between the bedside caregiver, typically a resident nurse who spends long hours monitoring individual patients or small groups of patients, and the physician, whose responsibilities include attending to a larger number of patients, with less time spent monitoring each individual patient. Because of their experience with individual patients over long periods of time, bedside caregivers such as nurses are often the first organizational members to detect slight changes in patient conditions that signal latent health problems. Therefore, while the information necessary to provide care for a child may come from advanced knowledge of disease processes or from discussions with other experts, it may also come from intimate knowledge gained by bedside nurses. The intensivist noted that physicians with whom he was familiar relied on information from laboratory values, radiographic findings, and physician colleagues as resources to make effective decisions, but often overlooked information from bedside staff.

The intensivist wanted to design a unit that avoided the mistakes of the U.S. Navy and departed from the worst aspects of organizational design in traditional medical units as he saw them. To this end, he believed that the unit's design should involve nurses and other support staff more equally in patient care decisions. When the PICU began admitting patients, the intensivist began asking nurses for their opinions on patient treatment options and inviting them to perform some tasks traditionally reserved for doctors. This approach was not well received at first. Accustomed to traditional roles, some nurses became resentful, suggesting that the intensivist was asking them to work too hard or to do his job as well as their own. Other nurses saw the intensivist's behavior as a sign of incompetence or lack of confidence and became concerned about his abilities as a physician. This initial reaction surprised the new PICU director and convinced him that instituting his desired participative organizational design in the unit would require a long-term commitment and evolving effort. He came to see that many of the nurses did not feel adequately trained to take on the added responsibilities he was offering them.

During the PICU's first months, nondedicated nurses and respiratory care practitioners worked some of their shifts in the PICU and others elsewhere in the hospital. Based on the resistance encountered to delegating some decision-making responsibilities to nurses, the intensivist decided that his design interventions could work only with dedicated support personnel. This was true for two reasons. First, because people resisted roles other than those to which they had become accustomed through training and experience, only dedicated staff members could accumulate enough experience with a new design to begin to trust it. Second, even if nurses could be convinced to participate in patient treatment decisions, they needed additional training to do so successfully. This type of training would be possible only with a relatively small number of dedicated nurses.

Early in his tenure, the PICU director approached hospital administration to request a dedicated nursing staff. Administrators granted the request. Later, the director also asked for dedicated respiratory care practitioners. While initially resistant, administrators also eventually granted this request.

As the intensivist continued encouraging nurses to assist in making patient care decisions, many of the dedicated nurses (and later the dedicated respiratory care practitioners) began warming to his approach. At this point, participative decision making in the unit was quite informal and largely involved queries for staff members' observations about patients and requests for their opinions about appropriate treatment options. Several nurses and respiratory care practitioners working in the unit at the time report that the intensivist's approach made them feel valued, but that they did not feel qualified to offer suggestions on patient treatment options at that time. In response to this concern, the intensivist started teaching staff members about medical decision making. He introduced lessons through conversations with care staff and increasingly invited staff members to attend his physician's rounds.

Growth

The PICU director's inclination to involve the support staff in patient care decisions was reinforced by necessity. He made an early policy decision to not turn away any children referred to the PICU. This policy contrasted sharply with prior practices in the original adult ICU, which resulted in the admission of only 40% of referred children (the ICU turned away children that they could not treat with available equipment and also deemed some children to be in insufficiently critical condition for admission). The new PICU policy quickly raised the admission rate to more than 90% (and eventually as high as 99%) of referred children.

WHTCH's PICU admitted more than 500 children during its first year, while the PICU director was its only physician. This is a heavy workload for a pediatric intensivist. For reference, an average PICU has one physician for every 4–5 beds and roughly 200–300 admissions per year. The focal PICU, at 8 beds and more than 500 admissions, had roughly double this ratio in its first year. Thus, in addition to involving staff members to improve patient care, the intensivist realized that he simply needed their help.

Eleven months after the PICU's establishment, a second intensivist came to the unit as assistant director of critical care. The PICU director recruited him specifically because of his background in fire department emergency medical services. The second intensivist independently concluded that organizational structures in fire departments could handle emergencies more

effectively than those in the medical centers with which he had experience.

Despite the addition of a second intensivist, the patient/physician ratio at the PICU remained high. The PICU admitted roughly 900 children in its second year, nearly 1,200 in its third, and 1,400 in its fourth. The unit's growth quickly outstripped its allotted 8-bed space in the adult ICU. During its second year, the PICU moved into a new building with 25 beds. A study published shortly thereafter found that 40% of PICUs in the United States have 4–6 beds, while those with more than 18 beds comprise less than 6% of the national total (Pollack et al. 1993). The latter averaged $1{,}277 \pm 63$ patient admissions per year. According to these numbers, WHTCH's PICU was one of the largest PICUs in the country by its third year. Part of this growth resulted from a pediatric critical care transport system established by the second PICU intensivist in 1989, allowing the unit to transport and accept highly critical children from other less-equipped hospitals. WHTCH's pediatric critical care transport system quickly grew into one of largest of such systems in the country (McCloskey and Johnston 1990).

At the end of 1994, an intermediate ICU was established as a separate unit at WHTCH. The intermediate ICU served three purposes related to the functions of the PICU: It admitted children who required a high level of nursing attention but not the same level of critical care as patients in the PICU, it took recovering PICU patients who no longer required intensive care, and it housed the WHTCH cardiothoracic ICU, where children with heart conditions were treated. The establishment of the intermediate ICU served to increase the severity of conditions treated in the PICU because the less critical patients were referred directly to the intermediate ICU.

Staff Training as Continuing Design

Because of his background, the second intensivist became an enthusiastic supporter of the PICU director's push to delegate care decisions and functions to nurses, respiratory care practitioners, and residents. The first intensivist's efforts had secured the unit a dedicated nursing staff, many of whom learned to enjoy taking an active role in treatment decisions. Yet nurses and other staff members still complained that they lacked the expertise to make important medical decisions. The PICU's emerging design required a high level of distributed knowledge and expertise as well as distributed authority. As both intensivists wanted to further increase the level of bedside caregiver participation in the PICU, they made attaining this level of staff medical knowledge one of the major drivers behind their design efforts.

While the first intensivist previously conducted informal lessons, training became increasingly formalized after the second intensivist's arrival. The intensivists began teaching staff members how to identify medical problems that brought children to the PICU. They taught caregivers how to identify and treat complications that could arise because of disease or inappropriate medical care. The intensivists also gave staff members formalized decision-making aids to help them know when they could treat a patient themselves and when they should ask for help. They taught staff members to break down a patient's symptoms into categories, assess the severity of each category, and begin treating the most acute symptoms while calling for additional help if needed.

To further facilitate decentralized decision making, the intensivists emphasized that they would respond immediately to staff questions. They gave out their personal phone numbers and encouraged staff to feel comfortable calling them if they were not present and the attending physician could not assist.

Both intensivists continued to teach informally when opportunities arose, but they also initiated formal inservice training sessions for all staff members on duty. As part of the training, the intensivists encouraged staff members to read medical journals and textbooks to further educate themselves. Several former nurses and respiratory care practitioners report that they became so interested in what they were learning in these training sessions that they decided to return to school for advanced degrees.

Furthermore, all staff members regardless of position and disciplinary background were encouraged to attend the physicians' rounds on the PICU floor, and these rounds included an educational component to ensure that staff possessed the abilities necessary to function across roles. The intensivists took up the practice of wheeling a blackboard around the PICU during rounds so that they could write notes and draw diagrams to facilitate staff training.

While residents and fellows commonly take part in physicians' rounds at hospitals, the level of participation instituted at the focal PICU was extraordinary. Morning rounds routinely included all residents, the fellow (if on service), lead respiratory therapist, charge nurse, pharmacist, social worker, and the patient's bedside nurse and respiratory therapist. As PICU staff members became accustomed to participating in physicians' rounds, they undertook larger roles. Nurses began presenting patients and discussing treatment options with the physicians.

One intensivist notes that it took several years before staff members were trained well enough to implement his vision of an optimally decentralized PICU design. Prior to this time, staff members did not possess the knowledge to participate in medical decisions and treatments to the extent that he desired. Thus, the establishment of the PICU's decentralized design was a process rather than an event.

Supporting Staff Decisions

As staff members received more training, they began to feel comfortable accepting more responsibility and the two intensivists increasingly delegated authority to them. However, specialists from other hospital departments were unaccustomed to such a degree of knowledge distribution and occasionally resisted decisions made by staff when treating PICU patients. The PICU directors developed a policy to always support their staff members' decisions in these situations. While staff members' decisions were not always right, the two PICU intensivists believed that their decentralized design improved response times and decision quality on average because staff with direct information about critical situations made important care decisions. Distributed decision-making authority reduced the need for information to flow up through the chain of command and back to the bedside caregiver.

The PICU directors also assigned bedside caregivers the role of ensuring common and consistent patient treatment plans. As situations developed and additional people and resources responded to critical events at the PICU, arriving members were trained to inquire about and use information from bedside caregivers to assess the situation and develop a common treatment strategy. This was one of the PICU's central design elements, and also perhaps the source of its greatest difference from other units in the hospital.

When the second intensivist arrived in the PICU, he brought the notion of postevent debriefings from his experience in emergency services, and frequent debriefings were quickly institutionalized in the unit. He routinely conducted debriefings open to all involved staff following major events. While most large healthcare organizations utilize some form of postcrisis debriefing, the intensivists believed that these meetings tended to be rare and typically restricted to physicians, residents, and hospital administrators. Debriefings at the PICU became unusual in their frequency and inclusiveness. The purpose of these debriefings was twofold: First, to encourage staff to learn from an experience while it was still fresh, and second, to act as a form of therapy for staff members. These sessions allowed staff members to talk through their emotions and prepare themselves to return to work.

Resistance and Buffering

The decentralization and elevated educational focus designed into the unit encountered opposition from some staff members. As a result of their educational focus, some of the physicians' rounds lasted longer than normal. This was, and still is, one of busiest PICUs in the country, and some staff members considered the rounds a waste of time. Some resistance to the goal of increasing staff autonomy also arose. While most of the staff embraced or at least cooperated with the intensivists'

push to delegate decision making, the approach required a significant commitment by staff members to learn how to perform new duties.

However, internal resistance to the decentralized design in the focal PICU was not nearly as strong as resistance from other departments in the hospital. Colleagues from other departments increasingly discussed the PICU's design and processes with the intensivists, at times to advise the intensivists of resistance from administration, and at other times to argue that staff members made poor care decisions. Hospital administrators and some physicians from other departments also saw the practice of staff members attending in-service trainings and physicians' rounds as a waste of time and resources.

To preserve their desired organizational design in light of these concerns, the PICU directors developed formalized protocols to constrain bedside caregiver discretion within certain boundaries. For instance, they created new rules that required bedside caregivers to first open the airways of new patients before beginning to design a treatment plan. This rule ensured that patients were stable before staff members began to think about appropriate treatments and gave staff members time consult with physicians as needed. In addition, the new protocols required PICU staff to ask for assistance under specified conditions. When a patient exhibited one or more of a certain set of symptoms, they were required to get a second opinion from another staff member before proceeding with treatment; when a patient exhibited one of more of a second set of symptoms, they were required to ask a PICU physician for assistance; and when a patient had one or more of a third set of symptoms, they were required to call a specialist from another department in the hospital for a consultation.

By following these metarules for decision making, bedside caregivers maintained their ability to make decisions regarding routine patient care without consulting physicians while avoiding further conflicts with outside specialists. The metarules placated administrators and physicians outside the PICU by giving them indirect but formalized control over caregiver activities, because physicians could modify rules governing the breadth and scope of allowable discretion. While the PICU's initial design called for broad staff decision-making authority, the two intensivists realized that the new formalization created a superior organizational design. Not only did the institution of formal metarules placate hospital administration, but it also helped some staff members feel more confident in their patient care decisions.

Despite this change, some physicians in the hospital remained uncomfortable. To minimize resistance from these physicians, the two intensivists moved to buffer the PICU from the remainder of the hospital as much as possible. Early efforts in this direction led to the assignment of dedicated nurses and respiratory care practitioners to

the unit. Later efforts were aimed at increasing the unit's autonomy. Before the PICU's establishment, physicians from other hospital departments (pediatricians, surgeons, cardiologists, and others) came from their home departments and managed critically ill children in the original adult ICU as needed. This practice continued to an extent after the PICU's founding because critically ill children often required the care of medical specialists. The two intensivists came to see the porosity of the PICU's boundaries as a potential hazard to patient safety.

As their vision of an effective organizational design evolved, the two intensivists decided to minimize the unit's porosity by assuming primary responsibility over all ventilator patients. They became the main points of contact for specialists from outside the PICU to discuss patient matters and solicit advice regarding patient care within the unit. This simplified work for staff members but complicated the intensivists' responsibilities because they now handled conflict with outside physicians. Discussions about appropriate care would occasionally arise between them and external specialists, diverting some of their time and attention away from responding to their own staff. The intensivists viewed the change positively, believing that staff members could operate more effectively when buffered from external conflict.

In addition to serving as gatekeepers between the PICU and the hospital, the two founding intensivists took steps to reduce PICU's dependence on outside expertise. They each received additional training so that they could personally perform many of the functions that previously had required the services of a specialist. For example, at the beginning of the PICU's history, external ear, nose, and throat (ENT) specialists performed difficult intubations in the unit. When some ENTs voiced disagreement with practices in the PICU, the two lead intensivists began performing difficult intubations themselves and training their fellows to do them as well. They also requested that an anesthesiology fellow be assigned to the unit to reduce their dependence on outside anesthesiologists.

The intensivists argued that the changes improved patient care in the PICU because children's conditions often deteriorated while they were waiting for specialists to arrive. However, these moves also further buffered the PICU and its unique design from the rest of the hospital. The second intensivist took additional steps to make PICU admission through the pediatric critical care transport system independent of the outside hospital by training transport paramedics and PICU staff to perform functions originally assigned to hospital triage staff. In addition, the intensivists gradually discontinued offering care outside of the PICU. While the high workload within the PICU itself often precluded the intensivists from responding to pediatric emergencies in other departments, the intensivists also felt that they could not maintain a consistent quality of care when working with resources and staff outside of the PICU.

Reliability and Outcomes

Compared to the other PICUs examined in the Pollack et al. (1993) study, the focal PICU had normal mortality rates for a PICU of its size during its first two years. After this period, however, its mortality rate began to decline, even while the unit was growing rapidly. By 1993—the year the Pollack et al. study was published—the focal PICU's mortality rate was 4.6%, compared to the average rate of $7.8 \pm 0.8\%$ for PICUs with more than 18 beds. Except for a brief increase in 1994, associated with the establishment of the intermediate ICU (which increased the average severity of the conditions of PICU patients), the mortality rate at WHTCH's PICU remained low. In 1999, the last full year that the original intensivists remained at the unit, its mortality rate was 3.5%.

Mortality rate is a poor indicator of healthcare performance both because numbers are difficult to obtain and because it is notoriously difficult to control for the severity of a unit's case load. We mention it here simply as an indicator that the PICU's design appears to have helped it perform well. Aside from mortality, several other indicators of patient medical outcomes also appeared to improve as the PICU's distinctive decentralized design was put in place. For instance, the unit's staff introduced several innovations that improved patient care. These innovations would not have been possible without the additional medical training and patient-care discretion given to staff members in the PICU. In one case, respiratory care practitioners changed the blend of helium and oxygen when administering gas to patients with severe asthma. The innovation gave children on ventilators increased energy, allowing them to play for longer periods. In another case, resident nurses began placing the children on their stomachs during a period when the unit experienced a higher incidence of acute lung disease. They discovered that children had better lung function in this position, with oxygen entering the blood more easily. In a third case, some respiratory care practitioners began setting ventilators to higher breath rates, sometimes reaching levels higher than those generally considered safe. Further study of the practice found that higher ventilator rates made some patients more comfortable and alert and did not cause adverse health outcomes.

The design instituted by the two managing intensivists also led to higher satisfaction and lower turnover among staff members in the unit. The PICU's founding director saw one of his primary responsibilities to be creating a supportive environment. As a consequence of this effort, the PICU had an extremely low turnover rate for nurses and therapists, much lower than is common in intensive care generally. Several former residents reported the

PICU residency to be the most difficult but most enjoyable of their residencies.

Culture Clash

In 1993 the PICU brought in an additional pediatric intensivist fellow to assist the original two intensivists. As the unit grew, others were hired and the number of doctors (including fellows) in the unit soon stabilized at five. Until 1997, the only physicians assigned to the PICU were the original two intensivists, their fellows, and intensivists who had received their fellowship training in the unit. As a result, the unit's physicians strongly agreed that its decentralized design, although unorthodox, was effective.

Beginning in 1997, intensivists trained elsewhere were hired into the unit. The PICU's continuing expansion and the departure of intensivists trained in the unit for leadership positions elsewhere created vacancies. The PICU's high utilization demanded that vacancies and new positions be filled quickly, and the founding intensivists eventually turned to externally trained intensivists to expedite staffing needs.

A few of the externally trained intensivists did not see the value of the PICU's approach and believed instead that the unit's design might constitute malpractice because physicians in the unit did not always control patient treatments. The new intensivists introduced notions of strict physician authority and one-way, downward communication. Although the protocols allowing staff to exercise discretion remained in place, staff members learned that the new doctors interpreted them differently than the original two intensivists did. In fact, during this period, staff members began to refer to cultural differences between "PICU north" and "PICU south" because the founding intensivists' offices were located on the south side of the unit. Concerns of malpractice liability from physicians inside the PICU resonated with negative feelings about the unit held by some physicians elsewhere in the hospital. Physicians from other departments saw the growing rift within the PICU and became more outspoken about their disagreement, often refusing to let the two founding intensivists treat their patients even within the PICU. Some hospital administrators, never completely comfortable with the level of autonomy at the PICU, used these concerns to argue against providing dedicated resources or supporting the unit's continued expansion. In this environment, both of the original intensivists chose to leave WHTCH and accept positions elsewhere in 2000.

According to staff members who remained at the PICU, the design features of the unit changed following the departures of the two original intensivists. Physicians began to assert their authority over patient care decisions and ignore suggestions from bedside staff members. Staff turnover in the unit increased and staff members who remained learned to follow physician instructions and largely keep their opinions to themselves. Although the PICU retained some procedures allowing staff discretion and might still have been considered "participative," its staff no longer enjoyed broad decision-making autonomy. Furthermore, procedures put in place to support staff autonomy were gradually discontinued. The new physicians did not encourage staff members to participate in rounds and no longer used rounds as a training opportunity. Similarly, the practice of holding postevent debriefings was all but discontinued and, when debriefings were held, staff members were not encouraged to participate.

Although current staff members believe that the new PICU intensivists are skilled doctors and that the PICU remains a relatively safe unit, they suggest that its health outcomes are not as good as they once were. The annual mortality rate at the unit has increased since its low in 1999. Finally, as noted previously, staff turnover has increased during the same period. WHTCH's PICU remains a good unit but has lost its distinct design and may be less reliable than in its previous form.

Discussion

The design of WHTCH's PICU evolved over time in response to environmental and technological demands, resulting in an extremely decentralized decision-making structure for an industry where strictly enforced hierarchical relationships are more often the norm. The PICU also became unusually self-sufficient in an area in which organizational boundaries are typically porous or unidentifiable.

The PICU's experience provides several implications for organizational design theory and practice. The case draws a connection between organizational design and leadership. The coincidence of the founders' departures and design changes at the PICU suggests the alternative explanation that good leadership rather than organizational design led to the PICU's performance. It may have been that the charisma and personal leadership qualities of the two head intensivists motivated staff members to achieve high performance independent of any design interventions that were introduced. According to the PICU members with whom we spoke (including the two intensivists), this was not the case. Neither intensivist claims extraordinary leadership qualities, and other staff members do not attribute such to them. In fact, while most of the PICU staff accepted and came to agree with the intensivists' approach, others did not—some harboring personal dislike for the intensivists themselves. Furthermore, current staff members are quick to point out that the intensivists who headed the PICU after 2000 are neither poor leaders nor poor physicians. Rather, several of them emphasized that the reason for the PICU's success stems from the fact that its design differed from those of other ICUs.

Despite these assertions that the PICU case is a design story and not a leadership story, the case seems to suggest a closer connection between the two explanations than previously acknowledged. Organizational design is often seen in terms of impersonal structural characteristics: span of control, levels of hierarchy, formalization of rules, and so on. The PICU case instead suggests that organizational design exists at least as much in designers' visions as in organizations' formal structures. For example, the PICU director's vision for the unit was continuity of high-quality care through a highly knowledgeable, motivated, and involved support staff. While this vision did not change during the PICU's growth and evolution, many of its structural characteristics did change as the unit met new challenges. For example, when the first intensivist arrived at the unit, he did not fully appreciate the amount and formality of staff education necessary to fulfill his goals for the unit. Similarly, the two intensivists originally sought to minimize formal boundaries on staff decision-making authority, but later decided that encasing staff authority in formalized metarules actually created a more effective design in line with their original vision.

The PICU's design was an ongoing effort, and its most stable components centered on a vision of distributed knowledge and decentralized intensive care. To the extent that this vision existed largely in the minds of the two PICU directors, the unit's design cannot easily be separated from its leaders. The PICU's experience resonates with Boland and Collopy's (2004) notion of managing as ongoing design. Many (perhaps most) of the design features that eventually came to characterize the PICU were not planned from the foundation of the unit. Rather, they were instituted in response to new challenges or unanticipated consequences of the unit's evolution. For example, neither of the two intensivists anticipated the lengths to which they would eventually go to isolate and buffer their unit from the broader hospital. Their buffering efforts were necessitated by unexpected hostility to the PICU's design from other hospital units. The case highlights the cyclic nature of organizational design. Organizational leaders put a design in place, observe its effects on the organization, adjust the design, again observe the effects, and so on.

In another vein, the PICU experience shows that a design's origin may be as important as its content. While much work examines the adoption of legitimized forms and increasing conformity among organizational designs in a field (DiMaggio and Powell 1983), few perspectives address the motivation to search for alternative designs when commonly accepted forms exist. The PICU story highlights the idea that organizational leaders with diverse prior experiences can introduce this form of divergent change (see Kraatz and Moore 2002). Many of the unit's design features were based on organizational designs employed by fire department emergency medical service organizations. However

appropriate these designs may have been to pediatric intensive care, they were unfamiliar to nurses, therapists, and physicians. Unfamiliarity led many members of WHTCH and the PICU itself to distrust the new design. Much of the ongoing design effort undertaken by the two PICU intensivists was devoted to combating this distrust.

Similarly, the PICU case also illustrates some of the unique challenges of designing an organizational subunit to operate much differently than does its parent organization. Any organizational design that differs from an accepted, institutionalized model in its industry is necessarily fragile. However, the PICU's design was even more tenuous because it was at odds with accepted designs in its parent organization. While the PICU directors succeeded in implementing such a design, the unit's design required constant and effortful maintenance. The PICU's director quickly discovered that his unique design was difficult for many physicians and staff members to accept. He responded by taking steps to buffer his unit from its parent organization and associated designs. He obtained dedicated nurses and respiratory care practitioners, unified the unit's contact with other departments through himself and his associate, and limited the need for outside specialists to enter the unit.

The PICU case suggests that buffering subunits with unique designs from their environments is important to their operation, but also raises specific challenges. Much prior work focuses on organizations naturally buffered from outside pressures and lacking exposure to market or competitive forces (LaPorte 1988, LaPorte and Consolini 1991, Roberts 1990, Rochlin et al. 1987). Indeed, many such organizations may be conceived of as "total institutions" (Goffman 1984), as they achieve strong cultures by largely removing their members from outside society. The present examination reveals that such isolation takes considerable effort in multiunit organizations. While such a subunit may need to distance itself as much as possible from its parent organization, the case illustrates that resistance may develop from members of other organizational subunits and organizational leaders who perceive such buffering as a threat to their power. Without continuous buffering efforts, the unit may easily be overrun by the culture of its parent organization or its industry at large.

The case also suggests that several characteristics of the PICU's design evolved in direct response to challenges posed by the unit's technology and environment. There are many examples of organizations facing similar hazards that have attempted but were unable to reach goals for safety and operational reliability (e.g., McCurdy 1993, Roberts et al. 2005, Vaughan 1996). There are several differences between the PICU and designs at these other organizations. Specifically, the PICU was highly decentralized, as its founders delegated authority through the organization. Organizations desiring consistent performance under hazardous

conditions indeed must be designed to give front-line employees tremendous levels of decision-making authority and flexibility (LaPorte 1988, Roberts and Bea 2001, Rochlin et al. 1987). The relationship between complex organizational environments and decentralized decision-making authority has long been acknowledged by contingency literature on organizational design (e.g., Burns and Stalker 1961). While many organizations distribute knowledge and delegate decision-making authority during periods of abnormal operations or crises, they normally display high levels of centralization and formalization during more routine periods (Roberts et al. 1994). However, the decentralization of decision making at WHTCH's PICU was broad based and not confined to emergency situations, suggesting that decentralized decision making need not be coupled with periods of strict hierarchy.

The PICU experience also reinforces the assertion that decentralization requires distributed knowledge (Roberts 1990, Weick and Roberts 1993). The founding intensivists devoted a great deal of time and attention to training staff members about how to make treatment decisions. Their experience shows that front-line employees cannot be expected to effectively shoulder decision-making responsibilities without sufficient knowledge and training. Some prior studies suggest that the high levels of training required to create such knowledge distribution may be too costly for organizations in most environments (Roberts et al. 1994). However, the focal PICU functioned quite efficiently with such a structure in spite of the training requirements. Indeed, the unit's low doctor/patient ratio was one of the conditions that necessitated decentralization.

The PICU experience also lends support to a growing recognition that even generally successful organizations make mistakes and must learn from them to maintain their consistency (Weick et al. 1999). Behavioral perspectives argue that organizations and the people in them often learn through performance shortfalls, interpreting successes as a sign that change is not needed and learning only in response to failure (Haunschild and Sullivan 2002, March and Simon 1968). Crises inevitably arise in any complex healthcare setting. Postcrisis debriefings provided opportunities and time for the staff and founders to learn from failures, and because PICU leaders did not search for "responsible" parties to blame for poor outcomes, unit members were able to learn from their experiences without fear of retaliation.

A recurring question for the founders, however, was whether an organization can be designed to operate reliably in some more benign way than waiting for lessons learned in blood, as failures are costly and often difficult to learn from (March et al. 1991). In fact, the leaders of the PICU did not wait for a serious accident before delegating authority, developing structures to distribute knowledge, and creating other conditions that

they believed would lead to enhanced learning and performance. Rather, in designing the unit, they drew on the failures and successes of other organizations with which they had been associated. As a result, their design interventions sought to avoid strict hierarchy, absolute physician control over patient treatment, and strict individual accountability (or blame) for adverse patient outcomes.

Conclusion

This paper develops important and neglected aspects of the literature on organizational design and advances implications for the design of any organization facing environmental and technological challenges. Much research in organization theory has shifted away from organizational design and its provision of practical knowledge regarding the design and operation of organizations. Our examination of WHTCH's PICU leads us to conclude that extreme flexibility, distributed knowledge, emergent organization in the face of crisis and decentralized decision-making authority can all be designed into organizational units.

We find that organizational design in the PICU was an ongoing process, not an event that occurred at the unit's initiation. The PICU directors continually readjusted their design to meet internal and external challenges. In this sense, the PICU's design resided perhaps more in its leaders' vision than in its structures and processes. The vision of how the PICU should operate remained constant, while its structures were often changed in response to unexpected consequences of the design itself. We also find that it is difficult for organizational subunits to institute unique designs. Because it contrasted with the designs of other subunits in its parent organization, the PICU's design was fragile. Only the vigilant efforts of PICU leaders to buffer it from the rest of the organization allowed it to maintain its distinctiveness. And in the end even these efforts were not enough.

Endnote
[1] A fictitious hospital name was used to preserve the confidentiality of the facility and its employees.

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